HILTI

NORTH AMERICAN PRODUCT TECHNICAL GUIDE

Volume 2 :
Anchor Fastening Technical Guide, Edition 22

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All our continuing education courses for both on-demand and live webinars is available through our online specifier community, Ask Hilti.

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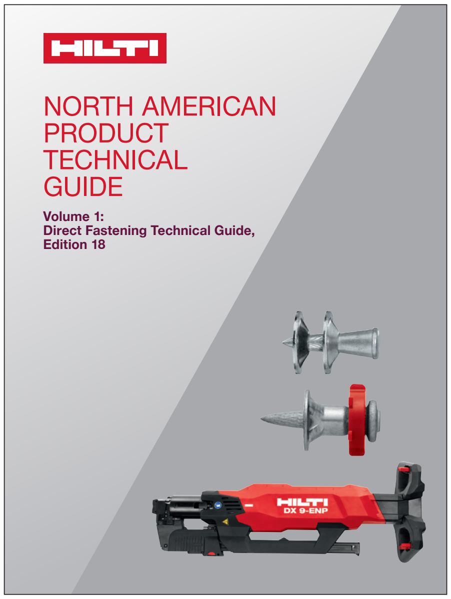
CONTENTS

Hilti North American Product Technical Guide Volume 1, Installation Technical Manual and Cast-In Anchor Channel Fastening Technical Guide.
Contact your Hilti Field Engineer about them today.



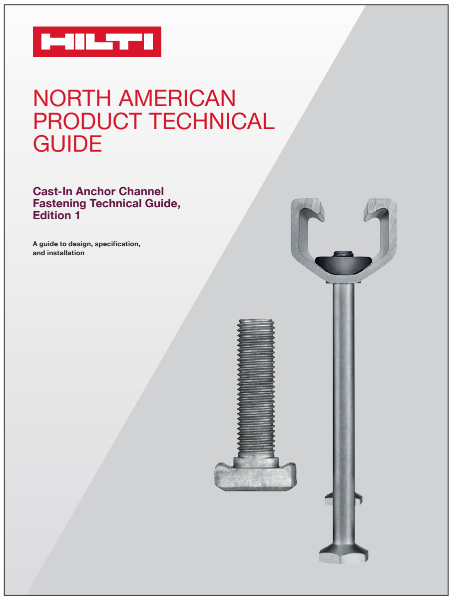
NORTH AMERICAN
PRODUCT
TECHNICAL
GUIDE

Volume 1:
Direct Fastening Technical Guide,
Edition 18

HILTI NORTH AMERICA
INSTALLATION
TECHNICAL MANUAL

Technical Data MI System

Version 1.2.1
August 25, 2017



NORTH AMERICAN
PRODUCT TECHNICAL
GUIDE

Cast-In Anchor Channel
Fastening Technical Guide,
Edition 1

A guide to design, specification,
and installation

CONTENTS

4.0 REFERENCE

Anchor selection guide

		Base material*, 1, 2								Installation*						
				LW						t_{gel} t_{cure}						
	Section number	Uncracked concrete	Cracked concrete[3]	Lightweight concrete	Hollow-core concrete	Grout-filled concrete block	Hollow concrete block	Hollow clay brick	Unreinforced Multi-wythe brick	Approx. gel/cure time at 68°F (20°C)	Compatibility with SafeSet™ Technology	Diamond-cored holes[4]	Water-saturated concrete	Water-filled holes	Submerged (underwater)	Overhead
HIT-HY 200 A/R V3 adhesive 	3.2.2	■	■	■		■				A: 7/45 min R: 15/90 min	■ w/HDB only	■	■	■		■
HIT-HY 200 A/R V3 adhesive with HIT-Z(-R) 	3.2.2	■	■	■		■				A: 7/45 min R: 15/90 min	■	■	■	■		■
HIT-RE 500 V3 Epoxy 	3.2.3	■	■	■						40min/ 6.5 hrs	■ w/ HDB or TE-YRT	■	■	■	■	■
HIT-HY 100 Adhesive 	online	■	■	■		■				8 min/ 60 min	■ w/HDB only		■			■
HIT-RE 100 Epoxy 	online	■	■	■						30 min/ 12 hrs			■	■	■	■
HIT-HY 270 	3.2.4				■	■	■	■	■	5 min/ 1.5 hrs	■ w/HDB only					☐
HIT-ICE Adhesive 	3.2.5	■	■	■		■				5 min/ 1 hrs	■ w/HDB only		■			■
HVU2 Capsule 	3.2.6	■	■	■						5 min	■ w/HDB only	■	■			■[5]
HIT-HY 10 PLUS 	online	■		☐		■	■	■		5 min/ 45 min			☐			■
HIT-1 	online	■		■		■	■	■		5 min/ 40 min						■
HIT-RE 10 Transportation Epoxy 	online	■		☐						2 hr/ 36 hr			■	☐		■

■ Suitable. Technical data is available for this application. Refer to related sections within this technical guide.

☐ May be suitable. Anchor system may function properly for this application. However, no substantiating data is available.

* Indicates suitability for the stated condition alone. If multiple conditions apply simultaneously, see product specific details within this technical guide or contact Hilti Technical Services.

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1 Base material may vary widely. Site specific anchor testing may be required.
2 Unless otherwise stated, testing is performed in normal weight concrete. Lightweight concrete may be available. See product specific details within this technical guide or consult the relevant building codes (ACI 318, IBC, etc.).
3 Refer to Section 2.1.2 for definition of cracked concrete.
4 Diamond coring is applicable where noted, however, it can be restricted to certain base materials, installation conditions and applications, certain Hilti tools, or have associated load reduction. See product specific details within this technical guide.
5 Except 1-1/4-in. diameter rod.

Anchor selection guide

	Approvals					Features*					Element Type			Corrosion resistance²			Size³	
	ICC-ES/IAPMO UES	ACI 355.4	COLA / LABC Supplement	FLORIDA BUILDING CODE	NSF 61	Seismic	In-place (through) fastening	High cycle fatigue¹	Shock / impact load¹	High temperature resistance	Threaded rod	Internally threaded insert	Rebar	Electro / mechanically zinc plated	Hot dip galvanized	Stainless steel	Minimum size (diameter)	Maximum size (diameter)
HIT-HY 200 V3 Adhesive (Type A or R) 	AC308 AC58	■	■	■ w/ HVHZ	■	■	■	☐		☐	■	■	■	■	■	304/ 316	3/8"	1-1/4"
HIT-HY 200 V3 Adhesive (Type A or R) HIT-Z(-R) 	AC308 AC58	■	■	■ w/ HVHZ	■	■	■	☐		☐	■			■		316	3/8"	3/4"
HIT-RE 500 V3 Epoxy 	AC308	■	■	■ w/ HVHZ	■	■	■	☐	☐	☐	■	■	■	■	■	304/ 316	3/8"	1-1/4"
HIT-HY 100 Adhesive 	AC308 AC 58	■	■	■ w/ HVHZ	■	■	■			☐	■	■	■	■	■	304/ 316	3/8"	1-1/4"
HIT-RE 100 Epoxy 	AC308	■	■	■ w/ HVHZ	■	■	■	☐	☐	☐	■		■	■	■	304/ 316	3/8"	1-1/4"
HIT-HY 270 	AC58 AC60		■	■		■	☐				■	■	■	■		304/ 316	1/4"	3/4"
HIT-ICE Adhesive 		■					■			☐	■	■	■	■	■	304/ 316	3/8"	1-1/4"
HVU2 Capsule 	AC308	■	■	■ w/ HVHZ	■	■	■			☐	■	■		■	■	304/ 316	3/8"	1-1/4"
HIT-HY 10 PLUS 						☐	■				■		■	■			3/8"	3/4"
HIT-1 							■				■	■		■		304/ 316	1/4"	5/8"
HIT-RE 10 Transportation Epoxy 						☐	■				■		■	■	■	304/ 316	3/8"	1-1/4"

■ Suitable. Technical data is available for this application. Refer to related sections within this technical guide.

☐ May be suitable. Anchor system may function properly for this application. However, no substantiating data is available.

* Indicates suitability for the stated condition alone. If multiple conditions apply simultaneously, see product specific details within this technical guide or contact Hilti Technical Services.

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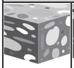
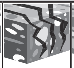
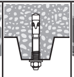
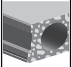
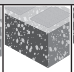
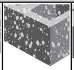
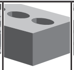
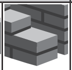
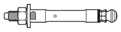
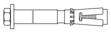
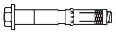
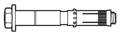
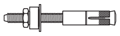
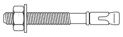
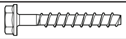
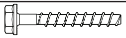
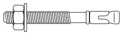
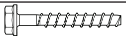
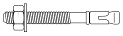
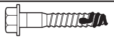
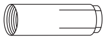
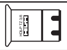
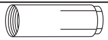
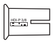
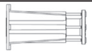
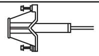
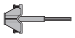
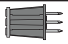
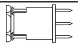
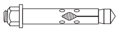
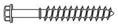
1 High cycle fatigue and shock/impact loading reference data is only available based on European testing and guidelines.

2 Refer to Section 2.3 for a more detailed discussion on corrosion and corrosion resistance.

3 Listed diameters are those with published load data. Larger diameter elements may be used with some adhesive anchor systems. Contact Hilti for more information.

Anchor selection guide

			Base material[1,2]									Features			
		Section number	 Uncracked concrete	 Cracked concrete[3]	 Lightweight concrete	 Concrete over metal deck	 Hollow-core concrete	 Grout-filled concrete block	 Hollow concrete block	 Hollow clay brick	 Unreinforced Multi-wythe brick	Seismic	In-place (through) fastening	High cycle -fatigue[4]	Shock / impact load[4]
HDA Undercut Anchor		3.3.1	■	■	■							■	■	☐	☐
HSL4 Heavy Duty Carbon Steel Anchor		3.3.2	■	■	■							■	■	☐	☐
HSL-3-R Heavy-duty Expansion Anchor		3.3.3	■	■	■							■*	■	☐	☐
HSL-GR Heavy-duty Expansion Anchor		3.3.4	■		☐							☐	■	☐	☐
HSL4-I Internally Threaded Exp. Anchor		online	■		☐							☐	■	☐	☐
KWIK BOLT TZ2 Expansion Anchor		3.3.5	■	■	■	■		■				■	■		
KWIK HUS-EZ Screw Anchor		3.3.6	■	■	■	■	■	■				■	■		
KH-EZ SS316 Screw Anchor		3.3.7	■	■	■			■				■	■		
KWIK HUS-EZ I Screw Anchor w/coupler		3.3.8	■	■	■	■	■					■	■		
KWIK Bolt 1 Expansion Anchor		3.3.9	■	■	■	■		■				■	■		
KWIK HUS Screw Anchor		3.3.10	■		■	■		■					■		
KWIK Bolt 3 Expansion Anchor		3.3.11	■		■	■							■		
HCA Coil Anchor		online	■										■		
HDI+/HDI-L+/HDI/HDI-L Drop-In Anchor		3.3.12	■		■	■		☐							
HDI-P TZ Drop-in Anchor		3.3.13	■	■	■		☐					■			
HDV Drop-In Anchor		online	■		■	■		☐							
HDI-P Drop-In Anchor		3.3.14	■		☐		■	☐							
KCM-WF/PD Cast-in Anchor		3.3.15	■	■	■							■			
KCM-MD Cast-in Anchor		3.3.16	■	■	■	■						■			
KCC-WF Cast-in-Anchor		3.3.17	■	■	■	■						■			
KCC-MD Cast-in-Anchor		3.3.17	■	■	■	■						■			
KCS-WF		online	■	■	■	■						■			
HLC Sleeve Anchor		3.3.18	■		☐	☐	☐	■	■	☐	■		■		
KWIK CON II+ Screw Anchor KWIK CON+ Screw Anchor		3.3.19	■		☐	☐	☐	■	■	■	☐		■		
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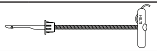
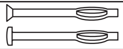
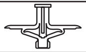
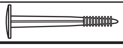
HTB-2		online							■				☐		
HSH Split Bolt		online	■										■		
HLD KWIK-Tog		online	☐		☐		☐	☐	■	☐	☐				
IDP Insulation Anchor		online	■		■		■	☐	■	☐	■		■		

■ Suitable. Technical data is available for this application. Refer to related sections within this technical guide.

☐ May be suitable. Anchor system may function properly for this application. However, no substantiating data is available.

* No diamond cored holes

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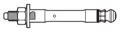
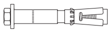
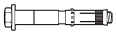
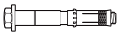
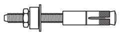
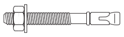
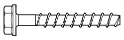
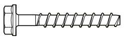
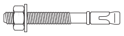
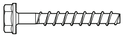
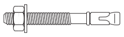
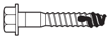
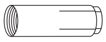
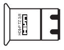
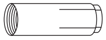
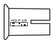
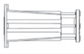
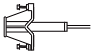
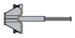
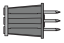
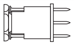
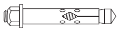
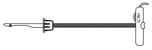
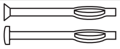
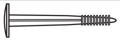
1 Base material may vary widely. Site specific anchor testing may be required.

2 Unless otherwise stated, testing is performed in normal weight concrete. Lightweight concrete may be available. See product specific details within this technical guide or consult the relevant building codes (ACI 318, IBC, etc.).

3 Refer to Section 2.1.2 for definition of cracked concrete.

4 High cycle fatigue and shock/impact loading reference data is only available based on European testing and guidelines.

Anchor selection guide

	Approvals						Head type				Corrosion resistance[1]				Size[2]	
	ICC-ES/IAPMO UES	ACI 355.2	FM	UL	COLA/LABC Supplement	Florida Building Code High Velocity Hurricane Zone	Stud (Externally threaded)	Internally threaded	Hex bolt	Countersunk/pan head	Electro / mechanically zinc plated	Hot dip galvanized	Sheradized carbo steel	Stainless steel	Minimum size (diameter)	Maximum size (diameter)
HDA Undercut Anchor 	AC193	■			■		■				■		■	316	M10	M20
HSL4 Heavy duty Expansion Anchor 	AC193	■			■		■	■	■	■	■				M8	M24
HSL-3 Heavy duty Expansion Anchor 	AC193	■			■		■	■	■		■				M8	M24
HSL-GR Heavy duty Expansion Anchor 							■							316	M10	M20
HSL-I Internally Threaded Exp. Anchor 							■	■			■				M12	M12
KWIK Bolt TZ2 Expansion Anchor 	AC01 AC193	■	■	■	■	■	■				■			304/ 316	1/4"	3/4"
KWIK HUS-EZ Screw Anchor 	AC193 AC106	■			■	■			■	■	■				1/4"	3/4"
KH-EZ SS316 Screw Anchor 	AC193 AC106	■			■	■			■	■				316	1/4"	1/2"
KWIK HUS-EZ I Screw Anchor w/coupler 	AC193	■	■		■	■		■			■				1/4"	3/8"
KWIK Bolt 1 Expansion Anchor 	AC01 AC193	■	■	■	■	■	■				■			304/ 316	3/8"	3/4"
KWIK HUS Screw Anchor 		■							■		■				1/4"	3/4"
KWIK Bolt 3 Expansion Anchor 	AC193	■	■	■	■	■	■			■		■		304/ 316	1/4"	1"
HCA Coil Anchor 									■		■				1/4"	3/4"
HDI+/HDI-L+/HDI/HDI-L Drop-In Anchor 			■	■				■			■			303	1/4"	3/4"
HDI-P TZ Drop-in Anchor 	AC193	■	■	■	■	■		■			■				3/8"	3/8"
HDV Drop-In Anchor 			■	■				■			■			303	1/4"	1/2"
HDI-P Drop-In Anchor 			■					■			■				1/4"	1/2"
KCM-WF/PD Cast-in Anchor 	AC446		■	■	■	■		■			■				1/4"	3/4"
KCM-MD Cast-in Anchor 	AC446		■	■	■	■		■			■				1/4"	3/4"
KCC-WF Cast-in-Anchor 	AC446		■	■	■			■			■				3/8"	1/2"
KCC-MD Cast-in-Anchor 	AC446		■	■	■	■		■			■				3/8"	1/2"
KCS-WF 	AC446		■	■	■			■			■				1/4"	3/4"
HLC Sleeve Anchor 				■					■	■	■			304	1/4"	3/4"
KWIK CON+ Screw Anchor 											■			410	3/16"	1/4"
Metal HIT Anchor 											■			304	3/16"	1/4"
HPS-1 Impact Anchor 											■			304	3/16"	5/16"
HTB-2 											■				3/16"	1/2"
HSH Split Bolt 										■	■				1/4"	1/4"
HLD KWIK-Tog 															#8	#10
IDP Insulation Anchor 																

■ Suitable. Technical data is available for this application. Refer to related sections within this technical guide.
☐ May be suitable. Anchor system may function properly for this application. However, no substantiating data is available.
* No diamond cored holes

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1 Refer to Section 2.3 for a more detailed discussion on corrosion and corrosion resistance.
2 Listed diameters are those with published load data.

ANCHOR FASTENING TECHNICAL GUIDE

1.0 INTRODUCTION

1.1 ABOUT PUBLISHED LOAD VALUES

The Anchor Fastening Technical Guide is intended to supplement the Hilti Product and Services catalog with technical information for the designer or specifier. Technical data presented herein was current as of the date of publication (see back cover). Load values are based on testing and analytical calculations by Hilti or by contracted testing laboratories using testing procedures and construction materials representative of current practice in North America. Variations in base materials such as concrete and local site conditions require on-site testing to determine actual performance at any specific site. Data may also be based on national standards or professional research and analysis.

Note that design values published in reports issued by approval agencies (e.g., ICC-ES, COLA, etc.) may differ from those contained in this publication.

For information regarding updates and changes, please contact Hilti,Inc. (US) Technical Support at **1-800-879-8000** or Hilti (Canada) Corporation at **1-800-363-4458**.

1.2 APPROVALS/LISTINGS

Many Hilti anchoring products have listings or approvals such as International Code Council Evaluation Services Reports (ICC-ES ESR's) or Underwriters Laboratory (UL) listings. Listings and approvals are provided by independent third parties who evaluate products based on model building codes or various jurisdictional requirements. Product listings and approvals indicate that a product has been tested and evaluated based on a specific acceptance or test criteria.

Not all technical data contained in this document is based on a published approval or listing. Hilti may publish additional data beyond that contained in a report, i.e. for applications outside the scope of an available test criteria.

Approvals and listings have been indicated in the Anchor Fastening Technical Guide for reference. Acceptance of the product listings or approvals is subject to the authority having jurisdiction over the project. It is important to review the approval or listing to determine if the application or conditions expected for the project are included in the scope of the approval or listing.

1.3 UNITS

Technical data is provided in both fractional (imperial) and metric units. Metric values are provided using the International System of units (SI) in observance of the **Metric Conversion Act of 1975** as amended by the **Omnibus Trade and Competitiveness Act of 1988.** Data for metric products, such as the HSL and HDA anchors, is provided in SI units with conversions to imperial engineering units (inches, pounds, and so forth) given in parentheses. Data for fractional products (e.g. the KWIK Bolt 3) is provided in imperial engineering units with the SI metric conversions shown in parentheses. Additional information may be found in section 4.3.1 Metric Conversions and Equivalents, provided in this product technical guide.

1.4 OUR PURPOSE

We passionately create enthusiastic customers and build a better future!

Enthusiastic customers

We create success for our customers by identifying their needs and providing innovative and value-added solutions.

Build a better future

We embrace our responsibility towards society and environment.

1.5 OUR QUALITY SYSTEM

Certified Quality and
Environmental Systems
SQS
ISO 9001 / ISO 14001*
Reg. No. 12455
*ISO 14001 US Only

Hilti is one of a select group of North American companies to receive the ISO 9001 and ISO 14001 Certifications. This recognition of our commitment to quality ensures our customers that Hilti has the systems and procedures in place to maintain our position as the world market leader, and to continually evaluate and improve our performance.

That's total customer satisfaction!

For technical support, contact Hilti,Inc. (US) at 1-800-879-8000 or Hilti (Canada) Corporation at 1-800-363-4458.

2.0 ANCHOR FASTENING TECHNOLOGY

2.1 BASE MATERIALS

2.1.1 BASE MATERIALS FOR FASTENING

The wide variety of building materials used today provides different anchoring conditions for anchors. There is hardly a base material in or to which a fastening cannot be made with a Hilti product. However, the properties of the base material play a decisive role when selecting a suitable fastener/anchor and determining the load it can hold. It is the responsibility of the designer to carefully match the type of fastener with the base material to obtain the desired results. For base materials not listed, contact Hilti,Inc. (US) at 1-800-879-8000 or Hilti (Canada) Corporation at 1-800-363-4458.

2.1.2 CONCRETE

Concrete is a synthetic stone consisting of a mixture of cement, aggregates, and water. In many cases, special additives are used to influence or change certain properties. Concrete has a relatively high compressive strength compared to its tensile strength. Thus, steel reinforcing bars are frequently cast in concrete to carry tensile forces, and this combination is referred to as reinforced concrete.

Cement is a binding agent which combines with water and aggregates and hardens through the process of hydration to form concrete. Portland cement is the most commonly used cement and is available in several different types to meet specific design requirements (ASTM C150).

The aggregates used in concrete consist of both fine aggregate (usually sand) and coarse aggregate graded by particle size. Different types of aggregates can be used to obtain concrete with specific characteristics. Normal-weight concrete is generally made from crushed stone or gravel, while lightweight concrete is obtained using expanded clay, shale, slate, or blast-furnace slag. Lightweight concrete is used when it is desirable to reduce the dead load on a structure or to achieve a superior fire rating for a floor structure. When thermal insulating properties are a prime consideration, lightweight aggregates are manufactured from perlite, vermiculite, blast-furnace slag, clay or shale. Finally, sand lightweight concrete is obtained using lightweight aggregate and natural sand. In general, all concretes with a unit weight between 85 and 115 pcf are considered to be structural lightweight concretes. The ASTM specifications related to concrete type and weight can be summarized
as follows:

ASTM		
Concrete Type	**Aggregate Grading Specification**	**Concrete Unit Weight pcf**
Normal Weight	ASTM C33	145-155
Sand Lightweight	ASTM C330	105-115
All Lightweight	ASTM C 330	85-110
Lightweight Insulating Concrete	ASTM C 332	15-90

The type and mechanical properties of concrete aggregate have a major influence on the behavior of drill bits used to drill anchor holes. Harder aggregates, in fact, cause higher bit wear and reduced drilling performance.

The hardness of concrete aggregate can also affect the load capacity of power-actuated fasteners and anchors. Driven fasteners or studs can generally penetrate “soft” aggregates (shale or limestone), but hard aggregates (like granite) near the surface of the concrete can adversely affect the penetration of a fastener or stud and reduce its load capacity. The effect of aggregate mechanical properties on anchor performance is less well understood. In general, harder/denser aggregates (i.e. granite) tend to result in higher concrete cone breakout loads, whereas lightweight aggregates produce lower tension and shear capacities.

Concrete is typically assumed to crack under normal service load conditions or, more specifically, when tensile stresses imposed by loads or restraint conditions exceed its tensile strength. Crack width and distribution are generally controlled through the use of reinforcement. With consideration for the protection of the reinforcing steel, crack widths, per ACI 318, are assumed to be less than approximately 0.012 in (0.3 mm). Under seismic loading, flexural crack widths corresponding to the onset of reinforcing yield are assumed to be approximately 1-1/2 x static crack width = 0.02” (0.5 mm). Both ACI 318 and the International Building Code conservatively assume cracked concrete as the baseline condition for the design of cast-in-place and post-installed anchors since the existence of cracks in the vicinity of the anchor can result in a reduced ultimate load capacity and increased displacement at ultimate load compared to uncracked concrete conditions. Design for uncracked concrete conditions is permitted by the model Building Codes only for cases where it can be shown that cracking of the concrete at service load levels will not occur over the anchor service life. For cases involving design for seismic actions, post-installed anchors must be demonstrated as being suitable for use in cracked concrete as well as for seismic loading.

Values for the ultimate strength of fasteners in concrete are traditionally given in relation to the 28-day uniaxial compressive strength of the concrete (actual, not specified). Concrete that has cured for less than 28 days is referred to as green concrete. Aggregate type, cement replacements such as fly ash, and admixtures can affect the capacity of some fasteners, and this may not be reflected in the concrete strength as measured in a standard uniaxial compression test. In general, Hilti data reflects testing with common aggregates and cement types in plain, unreinforced concrete. In questionable cases, consult with Hilti Technical Services.

In view of the significantly lower strength of green concrete (less than 28-day cure), it is recommended that mechanical anchors not be placed/installed in concretes cured for less than 7 days, unless site testing is performed to verify the fastening capacity. If an anchor is installed in green concrete, but not loaded until the concrete has achieved full cure, the capacity of the anchor can be based on the strength of the concrete at the time of loading.

ACI 318 Section 17.1.2 and CSA A23.3 Section D.1.2 require adhesive anchors to be installed in concrete having a minimum age of 21 days at the time of anchor installation.
For adhesive anchors installed in concrete aged less than 21 days, it is recommended that the design engineer evaluate the anchor design based on the concrete strength at the time of installation and use a bond strength value for water saturated concrete. Site testing is recommended to verify the fastening capacity.

Cutting through concrete reinforcement when drilling holes for anchors should be avoided. If this is not possible, the responsible design engineer should be consulted first.

2.1.3 MASONRY MATERIALS

Masonry is a heterogeneous building material consisting of clay brick, concrete block or clay tile bonded together using joint mortar. The primary application for masonry is the construction of walls which are built by placing masonry components in horizontal rows (courses) and/or vertical rows (wythes). Masonry components can be manufactured in a wide variety of shapes, sizes, materials and both hollow and solid configurations. These variations require that the selection of an anchoring or fastening system be carefully matched to the application and type of masonry material being used. As a base material, masonry typically has a much lower strength than concrete. The behavior of the masonry components, as well as the geometry of their cavities and webs, has a considerable influence on the ultimate load capacity of the fastening.

When drilling holes for anchors in masonry with hollow cavities, care must be taken to avoid spalling on the inside of the face shell. This could greatly affect the performance of "toggle" type mechanical anchors whose length must be matched to the face shell thickness. To reduce the potential for spalling, unless otherwise specified, holes should be drilled with hammer drills set in rotation only mode (i.e. hammering action of the drill turned off).

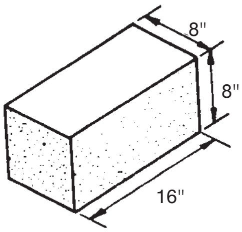
CONCRETE BLOCK

Concrete block is the term commonly used to refer to concrete masonry units (CMU) made from Portland cement, water and mineral aggregates. CMU blocks are manufactured in a variety of shapes and sizes using light-, medium-, and normal-weight aggregates. Both hollow and solid load bearing CMUs are manufactured in accordance with ASTM C90.

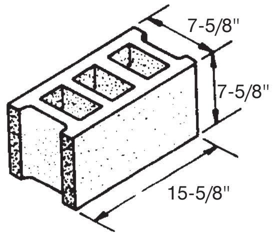
Nominal width of unit in. (mm)	Minimum face-shell thickness in. (mm)	Minimum web thickness in. (mm)
3 (76) and 4 (102)	3/4 (19)	3/4 (19)
6 (152)	1 (25)	3/4 (19)
8 (203) and greater	1-1/4 (32)	3/4 (19)

Adapted from ASTM C90 - 14 Table 1.

1 Average of measurements on three units when measured as described in Test Methods C140.



Nominal size
(usually fictitious)

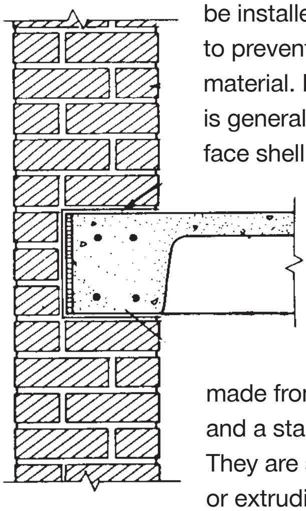


Modular size
(actual)

CMU sizes generally refer to the nominal width of the unit (6", 8", 10" etc.). Actual dimensions are nominal dimensions reduced by the thickness of the mortar joint.

CMU construction can be reinforced, whereby reinforcing bars are placed vertically in cells filled with grout to create a composite section analogous to reinforced concrete. If all cells, both unreinforced and reinforced, are filled with grout, the construction is referred to as fully grouted. If only the reinforced cells are grouted, the construction is referred to as partially grouted. Horizontal reinforcement may be placed in a wall via a bond beam, which is always grouted. Ladder reinforcement may also be placed in the mortar bed between courses. Grout typically conforms to ASTM C476 and has a minimum compressive strength of 2,000 psi. Concrete masonry units have a compressive strength which may range from 1,250 to over 4,800 psi, although the maximum specified compressive strength of the assembled masonry will generally not exceed 3,000 psi. Both chemical and mechanical anchors may be used in grouted CMU. If voids are present or suspected, mechanical anchors should not be used, and chemical anchors should only be installed in conjunction with a screen tube to prevent uncontrolled flow of the bonding material. In hollow masonry, anchor strength is generally assumed to be based on the face shell thickness, which can be variable.

CLAY BRICK



12" Brick Bearing Walls

Clay brick is the most extensively used type of masonry unit throughout the world. Bricks are prismatic masonry units made from a suitable mixture of soil, clay and a stabilizing agent (emulsified asphalt). They are shaped by molding, pressing, or extruding, and are fired at elevated temperature to meet the strength and durability requirements of ASTM C62 (solid brick) and C652 (hollow brick).

Depending upon the grade, clay masonry bricks can have a compressive strength ranging from 1,250 to over 25,000 psi. Grouted multi-wythe masonry construction typically consists of two wythes, each one unit masonry in thickness, separated by a space (collar joint) 1/2" to 4-1/2" wide, generally filled with grout. The wythes are connected with wall ties. This space may also be reinforced with vertical reinforcing bars. Solid brick masonry consists of abutting wythes interlaced with header courses. In general, chemical anchors are recommended for use in brick. In older unreinforced construction (URM), or where the condition of the masonry is unknown, it is advisable to use a screen tube to prevent unrestricted flow of the bonding material into voids.

MORTAR

Mortar is used to provide uniform bearing between masonry units and to bond individual units into a composite assemblage that will withstand the imposed loading conditions. Mortar consists of a mixture of cementitious material, aggregate and water proportionally combined in accordance with ASTM C270. Cement/lime mortar or masonry mortar (each in four types) are typically used under this Standard.

Mortar	Type	Average compressive strength at 28 days, minimum psi (MPa)
Cement-lime	M	2500 (17.2)
	S	1800 (12.4)
	N	750 (5.2)
	O	350 (2.4)
Masonry cement	M	2500 (17.2)
	S	1800 (12.4)
	N	750 (5.2)
	O	350 (2.4)

Since mortar plays a significant role in the structural integrity of a masonry wall, it is important to understand how post installed anchors interact with the structure. Within a masonry structure there are designated joint locations, and the proximity of a post-installed anchor or power-actuated fastener to one of these locations must be considered in the design of the anchorage. Product specific guidelines are provided within this technical guide.

GROUT

ACI defines grout as “a mixture of cementitious material and water, with or without aggregate, proportioned to produce a pourable consistency without segregation of the constituents”. The terms grout and mortar are frequently used interchangeably but are, in actuality, not the same. Grout need not contain aggregate (mortar contains fine aggregate), is supplied in a pourable consistency (mortar is not), and fills voids (mortar only bonds elements together).

In summary, grout is used to fill spaces or cavities and provide continuity between building elements. In some applications, grout will act in a structural capacity, such as in unreinforced masonry construction.

Grout, with respect to post-installed anchorages, is specified by the design official. When post-installed anchors are tested for the development of design values, the grout is specified according to applicable ASTM standards. Design engineers are encouraged to become familiar with the characteristics of the grout used in performance testing to better understand the applicability of the design loads published in this guide.

2.1.4 ADMIXTURES

Chemical admixtures are ingredients added to the basic components of concrete or mortar (cement, water, and aggregates) immediately before or during mixing. Chemical admixtures are used to enhance the properties of concrete and mortar in the plastic and hardened state. These properties may be modified to increase compressive and flexural strength, decrease permeability and improve durability, inhibit corrosion, reduce shrinkage, accelerate or retard initial set, increase slump and working properties, increase cement efficiency, improve the economy of the mixture, etc.

Testing of post-installed anchors is performed in concrete without admixtures. Designers should take into consideration the effects produced by admixtures on concrete when considering the use of post-installed anchors.

2.2 EVALUATION OF TEST DATA

2.2.1 Developing fastener performance data

State-of-the-art anchor design uses what is known as the Strength Design Method. By using the Strength Design Method, nominal strengths are first calculated for all the possible anchor failure modes. Subsequently, strength reduction factors are applied to each nominal strength to obtain a design strength. The controlling design strength is finally compared to a factored load. The provisions of ACI 318 Chapter 17 are the basis used for Strength Design.

Strength Design data for Hilti mechanical anchors in concrete is derived from testing as per the provisions of ACI 355.2 and ICC-ES AC193. Strength Design data for Hilti adhesive anchors in concrete is derived from testing as per the provisions of ACI 355.4 and ICC-ES AC308.

Beginning with IBC 2003, the IBC Building Codes have adopted the Strength Design Method for anchorage into concrete of both cast-in-place and post-installed anchors.

Another anchor design method known as "Allowable Stress Design" is still used as an alternative to the Strength Design provisions especially when used for anchoring into masonry base materials. Section 2.2.2 provides detailed explanations of the Allowable Stress Design provisions used by Hilti. Allowable Stress Design data for Hilti mechanical anchors is derived from testing based on ASTM E488, ICC-ES AC01 and AC106. Allowable Stress Design data for Hilti adhesive anchors is derived from testing based on ASTM E1512, ASTM E488, ICC-ES AC58 and AC60.

There are two methods of developing allowable loads;
(1) apply an appropriate safety factor to the mean ultimate load as determined from a given number of individual tests, or (2) apply a statistical method to the test data which relates the allowable working load to the performance variability of the fastening.

2.2.2 ALLOWABLE LOADS

Historically, allowable loads for anchors have been derived by applying a global safety factor to the average ultimate value of test results as shown in Eq. (2.2.1).

$$F_{all} = \frac{\overline{F}}{v} \qquad (2.2.1)$$

Where:

$\overline{F}$ = mean ultimate value of test data (population sample)
v = global safety factor

Global safety factors of 4 to 8 for post-installed anchors have been industry practice for nearly three decades. The global safety factor is assumed to cover expected variations in field installation conditions and in anchor performance from laboratory tests.

Note that global safety factors applied to the mean do not explicitly account for the coefficient of variation, i.e., all anchors are considered equal with respect to variability in the test data.

2.2.3 STATISTICAL EVALUATION OF DATA

Experience from a large number of tests on anchors has shown that ultimate loads generally approximate a normal Gaussian probability density function as shown in Fig. 2.2.1. This allows for the use of statistical evaluation techniques that relate the resistance to the system performance variability associated with a particular anchor.

The 5% fractile characteristic value has been adopted by the IBC as the basis for determining published design loads based on anchor testing results for Strength Design. There is a 90% probability that 95% of the test loads will exceed a 5% fractile value. The 5% fractile value is calculated by subtracting a certain number of standard deviations of the test results from the mean based on the number of trials. See Eq. (2.2.2) and the referenced statistical table by D. B. Owen. For a series of 5 trials, the 5% fractile value is calculated by multiplying the standard deviations by k = 3.401 and subtracting from the mean.

Owen, D.B., (1962) Handbook of Statistical Tables, Section 5.3. Reading: Addison-Wesley Publishing.

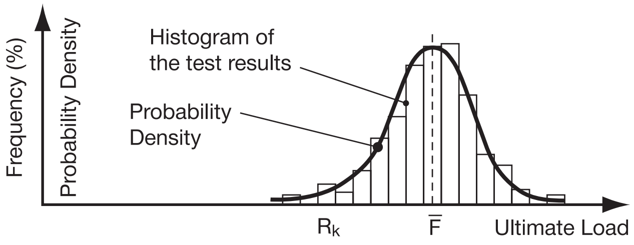


Fig. 2.2.1 Frequency distribution of anchor ultimate loads, demonstrating the significance of the 5% fractile

$$R_k = \overline{F} - k \cdot s = \overline{F}(1 - k \cdot cv) \qquad (2.2.2)$$

Where:

R_k = characteristic resistance of the tested anchor system
$\overline{F}$ = mean ultimate resistance of the tested anchor system
k = distribution value for test sample size n
s = standard deviation of the test data
cv = coefficient of variation = $\frac{s}{\overline{F}}$

Thus, test series with low standard deviations are rewarded with higher 5% fractile characteristic design values. This is typical of ductile steel failure modes.

Characteristic Strength Design loads may be converted to allowable loads. See Section 3.1.6.

3.0 ANCHORING SYSTEMS

3.1 ANCHOR PRINCIPLES AND DESIGN

3.1.1 DEFINITIONS

Adhesive anchor is a post-installed anchor that is inserted into a drilled hole in hardened concrete, masonry or stone. Loads are transferred to the base material by the bond between the anchor and the adhesive and the adhesive and the base material.

Anchor category is an assigned rating that corresponds to a specific strength reduction factor for concrete failure modes associated with anchors in tension. The anchor category is established based on the performance of the anchor in reliability tests.

Anchor group is a group of anchors of approximately equal effective embedment and stiffness where the maximum anchor spacing is less than the critical spacing.

Anchor reinforcement is reinforcement used to transfer the full design load from the anchors into the structural member.

Anchor spacing is centerline-to-centerline distance between loaded anchors.

Attachment is the structural assembly, external to the surface of the concrete, that transmits loads to or receives loads from the anchor.

Cast-in-place anchor is traditionally a headed bolt, headed stud or hooked bolt installed before placing concrete. Additionally, cast-in-place internally threaded inserts are a form of cast-in-place anchors.

Characteristic capacity is a statistical term indicating 90 percent confidence that there is 95 percent probability of the actual strength exceeding the nominal strength. This is also called the 5% fractile capacity.

Concrete breakout is a concrete failure mode that develops a cone or edge failure of the test member due to setting of the anchor or applied loads.

Concrete splitting failure is a concrete failure mode in which the concrete fractures along a plane passing through the axis of the anchor or anchors.

Cracked concrete is condition of concrete in which the anchor is located. See Section 2.1.2.

Critical spacing is minimum required spacing between loaded anchors to achieve full capacity.

Critical edge distance is minimum required edge distance to achieve full capacity.

Cure time is the elapsed time after mixing of the adhesive material components to achieve a state of hardening of the adhesive material in the drilled hole corresponding to the design mechanical properties and resistances. After the full cure time has elapsed, loads can be applied.

Displacement controlled expansion anchor is a post-installed anchor that is set by expansion against the side of the drilled hole through movement of an internal plug in the sleeve or through movement of the sleeve over an expansion element (plug). Once set, no further expansion can occur.

Ductile steel element are anchors designed to be governed by ductile yielding of the steel. This is determined by performing tension testing on coupons machined from the finished anchors. The minimum requirements are 14% elongation and 30% reduction of area.

Expansion anchor is a post-installed anchor that is inserted into a drilled hole in hardened concrete or masonry. Loads are transferred to and from the base material by bearing, friction or both.

Edge distance is distance from centerline of anchor to the free edge of base material in which the anchor is installed.

Effective embedment depth is the overall depth through which the anchor transfers force to or from the surrounding concrete. The effective embedment depth will normally be the depth of the concrete failure surface in tension applications. For cast-in headed anchor bolts and headed studs, the effective embedment depth is measured from the bearing contact surface of the head. For expansion anchors, it is taken as the distance from surface of base material to tip of expansion element(s).

Gel time is the elapsed time after mixing of the adhesive material components to onset of significant chemical reaction as characterized by an increase in viscosity. After the gel time has elapsed, the anchors must not be disturbed.

Minimum edge distance is the spacing from the centerline of the anchor to the edge of the base material required to minimize the likelihood of splitting of the base material during anchor installation.

Minimum spacing is distance between the centerlines of adjacent loaded anchors to minimize the likelihood of splitting of the base material during anchor installation.

Minimum member thickness is minimum required thickness of member in which anchor is embedded to minimize the likelihood of splitting of the base material.

Post-installed anchor is an anchor installed in hardened concrete and masonry. Expansion, undercut, and adhesive anchors are examples of post-installed anchors.

Projected area is the area on the free surface of the concrete member that is used to represent the larger base of the assumed rectilinear failure surface.

Pryout failure is a failure mode where anchors having limited embedment depth and loaded in shear exhibit sufficient rotation to produce a pryout fracture whereby the primary fracture surface develops behind the point of load application. This failure mode does not depend on the presence of free edges.

Pullout failure is a failure mode in which the anchor pulls out of the concrete without development of the full steel or concrete capacity.

Pull-through failure is a failure mode in which the anchor body pulls through the expansion mechanism without development of the full steel or concrete capacity.

Side face blowout strength is the strength of anchors with deeper embedment but thinner side cover corresponding to concrete spalling on the side face around the embedded head while no major breakout occurs at the top concrete surface.

Steel failure is a failure mode in which the steel anchor parts fracture.

Supplementary reinforcement is reinforcement that acts to restrain the potential concrete breakout area but is not designed to transfer the full design load from the anchors into the structural member.

Torque controlled expansion anchor is a post-installed expansion anchor that is set by the expansion of one or more sleeves or other elements against the sides of the drilled hole through the application of torque, which pulls the cone(s) into the expansion sleeve(s). After setting, tensile loading can cause additional expansion (follow-up expansion).

Undercut anchor is a post-installed anchor that derives tensile holding strength by the mechanical interlock provided by undercutting the concrete, achieved either by a special tool or by the anchor itself during installation.

3.1.2 ANCHORS IN CONCRETE AND MASONRY

Post-installed anchor bolts are used for a variety of construction anchoring applications including column baseplates, supporting mechanical and electric services, fixation of building facades and anchoring guardrails. Critical connections, i.e., those that are either safety-related or whose failure could result in significant financial loss, require robust anchor solutions capable of providing a verifiable and durable load path. In turn, the selection of a suitable anchor system and its incorporation in connection design requires a thorough understanding of the fundamental principles of anchoring. While a general overview is provided here, additional references can be found at the conclusion of this section.

3.1.3 ANCHOR WORKING PRINCIPLES

Anchors designed for use in concrete and masonry develop resistance to tension loading on the basis of one or more of the following mechanisms:

Friction: This is the mechanism used by most post-installed mechanical expansion anchors to resist tension loads, including the KWIK Bolt TZ, HSL-3 and HDI anchors. The frictional resistance resulting from expansion forces generated between the anchor and the wall of the drilled hole during setting of the anchor may also be supplemented by local deformation of the concrete. The frictional force is proportional to the magnitude of the expansion stresses generated by the anchor. Torque-controlled expansion anchors like the KWIK Bolt TZ and HSL-3 anchors use follow-up expansion to increase the expansion force in response to increases in tension loading beyond the service load level (preload) or to adjust for changes in the state of the base material (cracking).

Keying: Undercut anchors and, to a lesser degree, certain types of expansion anchors, rely on the interlock of the anchor with deformations in the hole wall to resist the applied tension loading. The (bearing) stresses developed in the base material at the interface with the anchor bearing surfaces can reach relatively high levels without crushing due to the triaxial nature of the state of stress. Undercut anchors like the Hilti HDA offer much greater resilience to variations in the base material conditions and represent the most robust solution for most anchoring needs.

Bonding (adhesion): Adhesive anchor systems utilize the bonding mechanism that takes place between the adhesive and the anchor element, and the adhesive and the concrete, to transfer the applied load from the anchor element into the concrete. The degree of bonding available is influenced by the condition of the hole wall at the time of anchor installation. Injection anchor systems like Hilti's HIT-HY 200 V3 offer unparalleled flexibility and high bond resistance for a wide variety of anchoring applications.

Hybrid anchor elements like the Hilti HIT-Z threaded rod combine the functionality of an adhesive anchor system with the working principle of a torque-controlled expansion anchor for increased reliability under adverse job-site conditions.

Shear resistance: Most anchors develop resistance to shear loading via bearing of the anchor element against the hole wall close to the surface of the base material. Shear loading may cause surface spalling resulting in significant flexural stresses and secondary tension in the anchor element.

3.1.4 ANCHOR BEHAVIOR UNDER LOAD

When loaded in tension to failure, anchors may exhibit one or more identifiable failure modes. These include:

- steel failure in tension
- anchor pullout or pull-through failure
- adhesive bond failure
- concrete breakout failure
- concrete splitting failure
- side-face blowout failure

Failure modes associated with anchors loaded to failure in shear may be characterized as follows:

- steel failure in shear/tension
- concrete edge breakout failure
- pryout failure

PRESTRESSING OF ANCHORS

In general, properly installed anchors do not exhibit noticeable deflection at the expected service load levels due to the application of the prescribed installation torque. External tension loading results in a reduction of the clamping force in the connection with little increase in the corresponding bolt tension force. Shear loads are resisted by a combination of bearing and friction resulting from the anchor preload forces.

At load levels beyond the clamping load, anchor deflections increase and the response of the anchor varies according to the anchor force-resisting mechanism. Expansion anchors capable of follow-up expansion show increased deflections corresponding to relative movement of the cone and expansion elements. Adhesive anchors exhibit a change in stiffness corresponding to loss of adhesion between the adhesive and the base material whereby tension resistance at increasing displacement levels is provided by friction between the uneven hole wall and the adhesive plug. In all cases, increasing stress levels in the anchor bolt/element result in increased anchor displacements.

LONG TERM BEHAVIOR

Following are some factors that can influence the long-term behavior of post-installed anchoring systems.

Adhesive anchoring systems:

- Pretensioning relaxation
- Chemical resistance/durability
- Creep
- Freeze/thaw conditions
- High temperature
- Fatigue
- Concrete cracking
- Corrosion
- Fire
- Seismic loading

Mechanical anchoring systems:

- Pretensioning relaxation
- Fatigue
- Concrete cracking
- Corrosion
- Fire
- Seismic Loading

All Hilti adhesive anchor systems suitable for use with the Strength Design Method have been tested for sustained loading conditions as per ACI 355.4 and ICC-ES Acceptance Criteria AC308.

3.1.5 ANCHOR DESIGN

The design of anchors is based on an assessment of the loading conditions and anchorage capacity. Strength design (SD), limit state design (LSD), and allowable stress design (ASD) methods are currently in use in North America for the design of anchors.

Strength Design: The Strength Design Method for anchor design has been incorporated into several codes such as IBC and ACI 318. The method assigns specific strength reduction factors to each of several possible failure modes, provides predictions for the strength associated with each failure mode, and compares the controlling strength with factored loads. The Strength Design Method is a more accurate estimate of anchor resistance as compared to the ASD approach. The Strength Design Method, as incorporated in ACI 318 Chapter 17, is discussed in Section 3.1.6. Strength Design is state-of-the-art and Hilti recommends its use where applicable.

Limit State Design: The limit state design method for anchor design is described and included in the CSA A23.3 Annex D. In principle, the method follows the strength design concept with the application of different strength reduction factors. The limit states design method generally results in a more accurate estimate of anchor resistance as compared to the ASD approach. This approach is discussed further in 3.1.7.

Allowable loads: Under the Allowable Stress Design Method, the allowable load, or resistance, is based on the application of a safety factor to the mean result of laboratory testing to failure, regardless of the controlling failure mode observed in the tests. The safety factor is intended to account for reasonably expected variations in loading. Adjustments for anchor spacing and edge distance are developed as individual factors based on testing of two- and four-anchor groups and single anchors near free edges. These factors are multiplied together for specific anchor layouts. This approach is discussed further in section 3.1.9. Allowable Stress Design is typically used today for masonry applications.

3.1.6 ACI 318 Chapter 17 Strength Design — SD (LRFD)

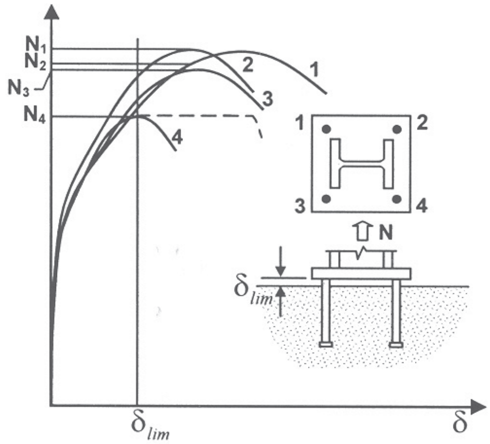
Strength Design of anchors is referenced in the provisions of ACI 355.2, ACI 355.4, ACI 318 Chapter 17 and the ICC-ES Acceptance Criteria AC193 for mechanical anchors and AC308 for adhesive anchors.

STRENGTH DESIGN (SD) TERMINOLOGY

Terminology used in the strength design provisions is consistent with the terminology of ACI 318 Chapter 2.

LOAD DISTRIBUTION

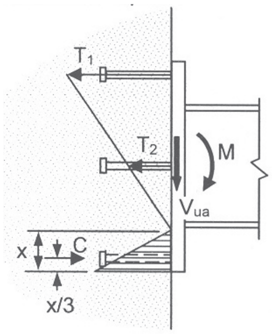
As per ACI 318 Section 17.2, load distribution should be determined on the basis of elastic analysis unless it can be shown that the nominal anchor strength is controlled by ductile steel elements. Where plastic analysis (assumption of fully yielded anchors) is used, compatibility of deformations must be checked.



Example of incompatibility of deformations (displacements)

In most cases, elastic analysis yields satisfactory results and is recommended. It should be noted, however, that the assumption of anchor load linearly proportional to the magnitude of the applied load and the distance from the neutral axis of the group is valid only if the attachment (e.g. baseplate) is sufficiently stiff in comparison to the axial stiffness of the anchors. For additional information on elastic load distribution in typical column baseplate assemblies, the reader is referred to Blodgett, O., Design of Welded Structures, The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

Note: Assuming a rigid base plate condition, Hilti's PROFIS Anchor analysis and design software performs a simplified finite element analysis to establish anchor load distribution on an elastic basis.



Example of elastic load distribution in a beam-wall connection

BOLT BENDING — STRENGTH DESIGN

ACI 318 does not consider the possibility of bolt bending in detail as part of the design criteria. When stand-off is not grouted, it is recommended to consider bolt bending as a possible failure mode in shear because it could be a controlling shear failure mode. Per the ETAG 001 Annex C Part 4.2.2.4, an additional check for shear load resulting from stand-off conditions can be performed when calculating nominal shear strengths.

$$V_s^M = \frac{\alpha_M \cdot M_s}{\ell}$$

whereby:

α_M = adjustment of bending moment associated with rotational restraint, where $1 \leq \alpha_M \leq 2$

M_S = resultant flexural resistance of single anchor

= $M_s^0 \left(1- \left(\frac{N_{ua}}{\Phi N_{sa}}\right)\right)$

M_s^0 = characteristic flexural resistance of single anchor

= $1.2 \cdot S \cdot f_{u,min}$

$f_{u,min}$ = minimum nominal ultimate tensile strength of anchor element

S = elastic section modulus of anchor bolt at concrete surface (a uniform cross section is assumed)

= $(\pi * d^3) / 32$

ℓ = internal lever arm adjusted for spalling of the concrete surface as follows:

= $z + (n \cdot d_o)$

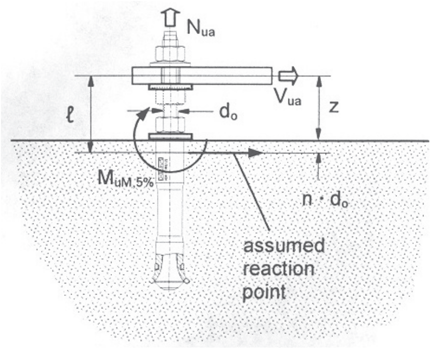
z = distance from center of base plate to surface of concrete (standoff distance)

d_o = anchor outside diameter at concrete surface

n = 0, for loading with clamping at the concrete surface as provided by a nut and washer assembly (required for mechanical anchors)

= 0.5, for loading without clamping at the concrete surface, e.g., adhesive anchor without nut and washer at concrete surface

Note that stand-off installations of post-installed mechanical anchors require a nut and bearing washer at the concrete surface as shown below for proper anchor function and to properly resist compression loads.



Determination of bolt bending — Strength Design

3.1.7 CSA A23.3 ANNEX D LIMIT STATE DESIGN

Limit State Design of anchors is referenced in the provisions of CSA A23.3 Annex D, which cover headed studs and bolts, hooked bolts and post-installed anchors that meet the assessment of ACI 355.2 and ACI 355.4. Furthermore, the suitability of post-installed anchors for use in concrete must be demonstrated by the ACI 355.2 and ACI 355.4 prequalification tests.

LOAD DISTRIBUTION

The provisions of CSA A23.3 Annex D and ACI 318 Chapter 17 are based on identical assumptions. Refer to Section 3.1.6.2 for more details.

3.1.8 HILTI SIMPLIFIED DESIGN TABLES

The Hilti Simplified Design Tables is not a new “method” of designing an anchor that is different than the provisions of ACI 318 Chapter 17 or CSA A23.3 Annex D. Rather, it is a series of pre-calculated tables and reduction factors meant to help the designer create a quick calculation of the capacity of the Hilti anchor system, and still be compliant with the codes and criteria of ACI and CSA.

The Hilti Simplified Design Tables are formatted similar to the Allowable Stress Design (ASD) tables and reduction factors which was a standard of practice for design of post-installed anchors.

The Hilti Simplified Design Tables combine the simplicity of performing a calculation according to the ASD method with the code-required testing, evaluation criteria and technical data in ACI 318 Chapter 17 and CSA Annex D.

SIMPLIFIED TABLES DATA DEVELOPMENT

The Simplified Tables have two table types. The single anchor capacity table and the reduction factor table.

Single anchor capacity tables show the design strength (for ACI) or factored resistance (for CSA) in tension and shear for a single anchor. This is the capacity of a single anchor with no edge distance or concrete thickness influences and is based on the assumptions outlined in the footnotes below each table.

Reduction factor tables are created by comparing the single anchor capacity to the capacity that includes the influence of a specific edge distance, spacing, or concrete thickness, using the equations of ACI 318 Chapter 17.

HILTI MECHANICAL ANCHORS OR HILTI HIT-Z(-R) ANCHOR RODS

The single anchor tension capacity is based on the lesser of concrete breakout strength or pullout strength:

ACI/AC308: $\Phi N_n = \min | \Phi N_{cb} ; \Phi N_{pn} |$
CSA: $N_r = \min | N_{cbr} ; N_{cpr} |$
$\Phi N_n = N_r$

The shear value is based on the pryout strength.

ACI/AC308: $\Phi V_n = \Phi V_{cp}$
CSA: $V_r = V_{cpr}$
$\Phi V_n = V_r$

Concrete breakout and pryout are calculated according to ACI 318 Chapter 17 and CSA A23.3 Annex D using the variables from product specific ICC-ES Evaluation Service Reports (ESR's). These values are equivalent.

Pullout for torque controlled adhesive anchors is not recognized in ACI or CSA, so this is determined from AC308 Section 3.3 and the value of $N_{p,uncr}$ or $N_{p,cr}$ from ESR-4868. This is a similar approach to mechanical anchor pullout strength. ACI and CSA values are equivalent.

HILTI ADHESIVE ANCHORS WITH STANDARD THREADED RODS, REBAR, AND HILTI HIS-(R)N INTERNALLY THREADED INSERTS

The single anchor tension capacity is based on the lesser of concrete breakout strength or bond strength:

ACI: $\Phi N_n = \min | \Phi N_{cb} ; \Phi N_a |$
CSA/ACI: $N_r = \min | N_{cbr} ; N_a |$
$\Phi N_n = N_r$

The shear value is based on the pryout strength.

ACI: $\Phi V_n = \Phi V_{cp}$
CSA/ACI: $V_r = V_{cpr}$
$\Phi V_n = V_r$

Concrete breakout, bond, and pryout are calculated according to ACI 318 Chapter 17 and CSA A23.3 Annex D using the variables from product specific ICC-ES Evaluation Service Reports (ESR's). These values are equivalent, however, the values will be calculated based on standard concrete compressive strengths specified in the US or Canada.

STEEL STRENGTH FOR ALL ELEMENTS

The steel strength is provided on a separate table and is based on calculations from ACI 318 Chapter 17 and CSA A23.3 Annex D. ACI and CSA have different reduction factors for steel strength, thus the values for both ACI and CSA are published.

How to calculate anchor capacity using simplified tables

The process for calculating the capacity of a single anchor or anchor group is similar to the ASD calculation process currently outlined in section 3.1.9 of this document.

The design strength (factored resistance) of an anchor is obtained as follows:

Tension:

ACI: $N_{des} = n \bullet \min | \Phi N_n \bullet f_{AN} \bullet f_{RN} ; \Phi N_{sa} |$

CSA: $N_{des} = n \bullet \min | N_r \bullet f_{AN} \bullet f_{RN} ; N_{sr} |$

Shear:

ACI: $V_{des} = n \bullet \min | \Phi V_n \bullet f_{AV} \bullet f_{RV} \bullet f_{HV} ; \Phi V_{sa} |$

CSA: $V_{des} = n \bullet \min | V_r \bullet f_{AV} \bullet f_{RV} \bullet f_{HV} ; V_{sr} |$

where:

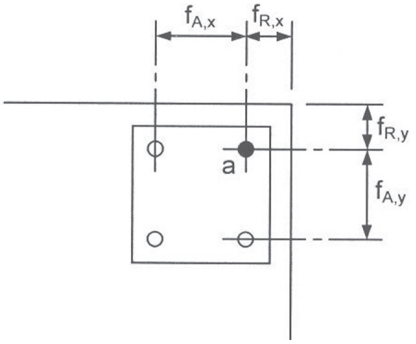
n = number of anchors
N_{des} = design resistance in tension
ΦN_n = design strength in tension considering concrete breakout, pullout, or bond failure (ACI)
ΦN_{sa} = design strength in tension considering steel failure (ACI)
N_r = factored resistance in tension considering concrete breakout, pullout, or bond failure (CSA)
N_{sr} = factored resistance in tension considering steel failure (CSA)
V_{des} = design resistance in shear
ΦV_n = design strength in shear considering concrete failure (ACI)
ΦV_{sa} = design strength in shear considering steel failure (ACI)
V_r = factored resistance in shear considering concrete failure (CSA)
V_{sr} = factored resistance in shear considering steel failure (CSA)
f_{AN} = adjustment factor for spacing in tension
f_{RN} = adjustment factor for edge distance in tension
f_{AV} = adjustment factor for spacing in shear
f_{RV} = adjustment factor for edge distance in shear
f_{HV} = adjustment factor for concrete thickness in shear (this is a new factor that ASD did not use previously)

Adjustment factors are applied for all applicable near edge and spacing conditions.

For example, the capacity in tension corresponding to the anchor group based on worst case anchor "a" in the figure below is evaluated as follows:

ACI: $N_{des} = 4 \bullet \Phi N_n \bullet f_{A,x} \bullet f_{A,y} \bullet f_{R,x} \bullet f_{R,y}$

CSA: $N_{des} = 4 \bullet N_r \bullet f_{A,x} \bullet f_{A,y} \bullet f_{R,x} \bullet f_{R,y}$



Note: designs are for orthogonal anchor bolt patterns and no reduction factor for the diagonally located adjacent anchor is required.

Where anchors are loaded simultaneously in tension and shear, interaction must be considered. The interaction equation is as follows:

ACI: $$\frac{N_{ua}}{N_{des}} + \frac{V_{ua}}{V_{des}} \leq 1.2$$

CSA: $$\frac{N_f}{N_{des}} + \frac{V_f}{V_{des}} \leq 1.2$$

where:

N_{ua} = Required strength in tension based on factored load combinations of ACI 318 Chapter 5.
V_{ua} = Required strength in shear based on factored load combinations of ACI 318 Chapter 5.
N_f = Required strength in tension based on factored load combinations of CSA A23.3 Chapter 8.
V_f = Required strength in shear based on factored load combinations of CSA A23.3 Chapter 8.

The full tension strength can be permitted if:

$$\text{ACI:} \quad \frac{V_{ua}}{V_{des}} \leq 0.2$$

$$\text{CSA:} \quad \frac{V_f}{V_{des}} \leq 0.2$$

The full shear strength can be permitted if:

$$\text{ACI:} \quad \frac{N_{ua}}{N_{des}} \leq 0.2$$

$$\text{CSA:} \quad \frac{N_f}{N_{des}} \leq 0.2$$

ALLOWABLE STRESS DESIGN (ASD)

The values of N_{des} and V_{des} developed from Section 3.1.6 are design strengths (factored resistances) and are to be compared to the required strength in tension and shear from factored load combinations of ACI 318 Chapter 5 or CSA A23.3 Chapter 8.

The design strength (factored resistance) can be converted to an ASD value as follows:

$$N_{des,ASD} = \frac{N_{des}}{\alpha_{ASD}}$$

$$V_{des,ASD} = \frac{V_{des}}{\alpha_{ASD}}$$

where:

α_{ASD} = Conversion factor calculated as a weighted average of the load factors for the controlling load combination.

An example for the calculation of α_{ASD} for ACI is as follows:

Strength design with controlling load combination:
$1.2D + 1.6L < \phi N_n$

Allowable stress design (ASD):
$1.0D + 1.0L < \phi N_n / \alpha_{ASD}$

Therefore, for an equivalent level of safety:
$\alpha_{ASD} = (1.2D + 1.6L) / (1.0D + 1.0L)$

If the dead load contribution is 40% and live load contribution is 60%, you will get:

$$\alpha_{ASD} = (1.2 \times 0.4 + 1.6 \times 0.6) / (1.0 \times 0.4 + 1.0 \times 0.6)$$

$$\alpha_{ASD} = 1.44$$

SEISMIC DESIGN

To determine the seismic design strength (factored resistance) a reduction factor, α_{seis}, is applied to the applicable table values. This value of α_{seis} will be in the footnotes of the relevant design tables.

The value of $\alpha_{N,seis}$ for tension is based on 0.75 times a reduction factor determined from testing. The total reduction is footnoted in the tables.

The value of $\alpha_{V,seis}$ for steel failure is based on testing and is typically only applied for shear. There is no additional 0.75 factor. The reduction is footnoted in the tables.

The factored load and associated seismic load combinations that will be compared to the design strength (factored resistance) can be determined from ACI or CSA provisions and national or local code requirements. An additional value for $\phi_{non\text{-}ductile}$ may be needed based on failure mode or ductility of the attached components.

SUSTAINED LOADS AND OVERHEAD USE

For adhesive anchors only, sustained loading is calculated by multiplying the value of ΦN_n or N_r by 0.55 and comparing the value to the tension dead load contribution (and any sustained live loads or other loads) of the factored load. Edge, spacing, and concrete thickness influences do not need to be accounted for when evaluating sustained loads.

ACCURACY OF THE SIMPLIFIED TABLES

Calculations using the Simplified Tables have the potential of providing a design strength (factored resistance) that is exactly what would be calculated using equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

The tables for the single anchor design strength (factored resistance) for concrete / bond / pullout failure or steel failure have the same values that will be computed using the provisions of ACI and CSA.

The load adjustment factors for edge distance influences are based on a single anchor near an edge. The load adjustment factors for spacing are determined from the influence of two adjacent anchors. Each reduction factor is calculated for the minimum value of either concrete or bond failure. When more than one edge distance and/or spacing condition exists, the load adjustment factors are multiplied together. This will result in a conservative design when compared to a full calculation based on ACI or CSA. Additionally, if the failure mode in the single anchor tables is controlled by concrete failure, and the reduction factor is controlled by bond failure, this will also give a conservative value (and vice versa).

The following is a general summary of the accuracy of the simplified tables:

- Single anchor tables have values equivalent to a calculation according to ACI or CSA.
- Since the table values, including load adjustment factors, are calculated using equations that are not linear, linear interpolation is not permitted. Use the smaller of the two table values listed. This provides a conservative value if the application falls between concrete compressive strengths, embedment depths, or spacing, edge distance, and concrete thickness.
- For one anchor near one edge, applying the edge distance factor typically provides accurate values provided the failure mode of the table values is the same. If the failure mode is not the same, the values are conservative.
- For two to four anchors in tension with no edge reductions, applying the spacing factors provides a value that is equivalent to the ACI and CSA calculated values, provided the controlling failure modes of the table values are the same. If the failure mode is not the same, the values are conservative.
- The spacing factor in shear is conservative when compared to two anchors with no edge distance considerations. This factor is based on spacing near an edge and can be conservative for installations away from the edge of the concrete member. Note: for less conservative results, it is possible to use the spacing factor in tension for this application if there is no edge distance to consider.
- The concrete thickness factor in shear is conservative when compared to an anchor with no edge influences. This factor is based on applications near an edge. In the middle of a concrete member this is conservative. Note: for less conservative results, this factor can be ignored if the application is not near an edge.

IMPORTANT NOTE:

For applications such as a four bolt or six bolt anchor pattern in a corner in a thin slab, the calculation can be up to 80% conservative when compared to a calculation according to ACI or CSA, and when using the PROFIS Engineering. It is always suggested to use the PROFIS Engineering or perform a calculation by hand using the provisions of ACI and CSA to optimize the design. This is especially true when the Simplified Table calculation does not provide a value that satisfies the design requirements. The fact that a Simplified Table calculation does not exceed a design load does not mean the Hilti anchor system will not fulfill the design requirements. Additional assistance can be given by your local Hilti representative.

LIMITATIONS USING SIMPLIFIED TABLES

There are additional limitations that the Simplified Tables do not consider:

- Load Combinations: Table values are meant to be used with the load combinations of ACI 318 Section 5.3 and CSA A23.3 Chapter 8. Other load combinations from other code sections are not considered.
- Supplementary Reinforcement: Table values, including reduction factors, are based on Condition B which does not consider the effects of supplementary reinforcement, nor is there an influence factor that can be applied to account for supplementary reinforcement.
- Eccentric loading: Currently, there is not a method for applying a factor to the tables to account for eccentric loading.
- Moments or Torsion: While a designer can apply a moment or torsion to the anchor system and obtain a specific load per anchor, the tables themselves do not have specific factors to account for moments or torsion applied to the anchor system.
- Standoff: Standoff is not considered in the steel design tables.
- Anchor layout: The Simplified Tables assume an orthogonal layout with no more than 2 nearby edges.

As stated above, while the Simplified Tables are limited in application, the designer can use the PROFIS Engineering which does account for the conditions noted above.

There may be additional applications not noted above. Contact Hilti with any questions for specific applications.

3.1.9 ALLOWABLE STRESS DESIGN (ASD)

ALLOWABLE STRESS DESIGN (ASD) TERMINOLOGY

A_{nom} = nominal bolt cross sectional area, in.^{2} (mm^2)

A_{sl} = cross sectional area of anchor sleeve, in.^{2} (mm^2)

A_{st} = tensile stress area of threaded part, in.^{2} (mm^2)

c = distance from anchor centerline to the closest free edge of base material, in. (mm)

c_{cr} = critical edge distance, in. (mm)

c_{min} = minimum edge distance, in. (mm)

d = anchor bolt diameter (shank diameter), in. (mm)

d_{bit} = nominal drill bit diameter, in. (mm)

d_h = diameter of clearance hole in attachment (e.g. baseplate), in. (mm)

d_{nom} = nominal anchor diameter, in. (mm)

d_o = anchor outside diameter (O.D.), in. (mm)

d_w = washer diameter, in. (mm)

f_A = adjustment factor for anchor spacing

f_c = concrete compressive strength as measured by testing of cylinders, psi (MPa)

f'_c = specified concrete compressive strength, psi (MPa)

f_{RN} = adjustment factor for edge distance, tension loading

f_{RV1} = adjustment factor for edge distance, shear loading perpendicular and towards free edge

f_{RV2} = adjustment factor for edge distance, shear loading parallel to free edge

f_{RV3} = adjustment factor for edge distance, shear loading perpendicular and away from free edge

f_y = specified reinforcing bar yield strength, psi (MPa)

F_y = specified bolt minimum yield strength, psi (MPa)

F_u = specified bolt minimum ultimate strength, psi (MPa)

h = thickness of member in which anchor is embedded as measured parallel to anchor axis, in. (mm)

h_{ef} = effective anchor embedment depth, in. (mm)

h_{min} = minimum member thickness, in. (mm)

h_{nom} = distance between base material surface and bottom of anchor (prior to setting is applicable), in. (mm)

h_o = depth of full diameter hole in base material, in. (mm)

ℓ = anchor embedded length, in. (mm)

ℓ_{th} = anchor useable thread length, in. (mm)

$M_{uM,5\%}$ = characteristic flexural resistance of anchor bolt (5% fractile) , in-lb (N·m)

N_{allow} = allowable tension load, lb (kN)

N_d = design tension load (unfactored), lb (kN)

N_{rec} = recommended tension load, lb (kN)

s = anchor axial spacing, in. (mm)

s_{cr} = critical spacing between adjacent loaded anchors, in. (mm)

s_{min} = minimum spacing between adjacent loaded anchors, in. (mm)

S = elastic section modulus of anchor bolt, in.^{3} (mm^3)

s_W = width of anchor nut across flats, in. (mm)

t_{fix} = maximum thickness of attachment (e.g. baseplate) to be fastened, in. (mm)

T_{inst} = recommended anchor installation torque, ft-lb (N·m)

T_{max} = maximum tightening torque, ft-lb (N·m)

V_{allow} = allowable shear load (based on mean value from tests and a global safety factor), lb (kN)

V_d = design shear load (unfactored), lb (kN)

V_{rec} = recommended shear load, lb (kN)

GENERAL REQUIREMENTS AND RECOMMENDED LOADS

In accordance with the general ASD principles, the design of anchors must satisfy the following conditions:

$N_{service} \le N_{rec}$
$V_{service} \le V_{rec}$

whereby $N_{service}$ and $V_{service}$ are the service tension and shear loads resulting from the governing load combinations (i.e. ASCE 7-10) and N_{rec} and V_{rec} are the recommended allowable loads for an anchor or a group of anchors.

The ASD method is currently referenced in masonry-related ICC-ES AC01, AC58, AC60, and AC106.

The recommended allowable loads for an anchor or a group of anchors are obtained as follows:

Tension: $N_{rec} = N_{allow} \cdot f_{RN} \cdot f_A$

Shear: $V_{rec} = V_{allow} \cdot f_{RV} \cdot f_A$

where:

N_{rec} = recommended tension load

N_{allow} = allowable load (based on the mean value from laboratory testing to failure and a global safety factor)

V_{rec} = recommended shear load

V_{allow} = allowable shear load

f_A = adjustment factor for anchor spacing

f_{RN} = adjustment factor for edge distance, tension loading

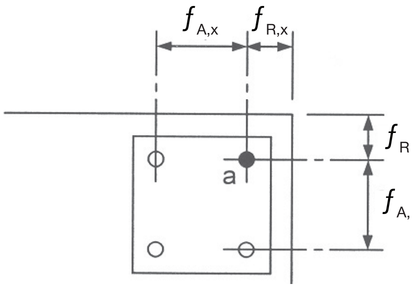
f_{RV1} = adjustment factor for edge distance, shear loading perpendicular and toward free edge

f_{RV2} = adjustment factor for edge distance, shear loading parallel to free edge

f_{RV3} = adjustment factor for edge distance, shear loading perpendicular and away from free edge

Adjustment factors are multiplicative and are applied for all edge and spacing conditions that are less than c_{cr} and s_{cr}, respectively.

For example, the recommended tension load corresponding to anchor "a" in the figure below is evaluated as follows:



$F_{rec,a} = F_{allow,a} \cdot f_{Rx} \cdot f_{Ry} \cdot f_{Ax} \cdot f_{Ay}$

Note that no reduction factor for the diagonally located adjacent anchor is required.

CRITICAL AND MINIMUM SPACING AND EDGE DISTANCE

Spacing adjustment factors are applicable for cases where the anchor spacing is such that:

$s_{min} \leq s < s_{cr}$

where:

s_{min} = minimum spacing between loaded anchors; and

s_{cr} = critical spacing between loaded anchors (anchor spacing equal to or greater than the one requiring a reduction factor)

Similarly, for near-edge anchors, the edge distance adjustment factor(s) are applicable for cases where the anchor edge distance is such that:

$c_{min} \leq c < c_{cr}$

where:

c_{min} = minimum edge distance; and

c_{cr} = critical edge distance (anchor edge distance equal to or greater than the one requiring a reduction factor)

INTERACTION — ASD

Where anchors are loaded simultaneously in tension and shear, interaction must be considered. The usual form of the interaction equation for anchors is as follows:

$$V_{rec} = \left[\frac{N_d}{N_{rec}}\right]^{\alpha} + \left[\frac{V_d}{V_{rec}}\right]^{\alpha} \leq 1.0$$

where:

N_d = design tension load (ASD);

V_d = design shear load (ASD); and

α = exponent, $1 \leq \alpha \leq 2$

The value used for α corresponds to the type of interaction equation being considered. A value of α = 1.0 corresponds to a straight line interaction equation, while a value of α = 5/3 corresponds to a parabolic interaction equation.

SHEAR LOAD WITH LEVER ARM (BOLT BENDING) — ASD

When shear load is applied to a stand-off connection, the anchor bolt is subjected to combined shear and bending, and a separate assessment of the standoff condition is appropriate. In the absence of other guidance, the recommended shear load associated with bolt bending for anchors subjected to shear loads applied at a standoff distance z may be evaluated as follows:

$$V_{rec} = \frac{\alpha_M \cdot M_{uM,5\%}}{1.7 \cdot \ell}$$

where:

α_M = adjustment of bending moment associated with rotational restraint, where $1 \leq \alpha_M \leq 2$

V_{rec} = recommended shear load corresponding to bending

$M_{uM,5\%}$ = characteristic flexural resistance of a single anchor corresponding to approximately 1/2 degree rotation

$$= 1.2 * S * f_{u,min}\left(1 - \frac{N_d}{N_{rec}}\right)$$

f_{uta} = minimum ultimate tensile strength of anchor

S = elastic section modulus of anchor bolt at concrete surface (a uniform cross section is assumed)

ℓ = internal lever arm adjusted for spalling of the surface concrete as follows:

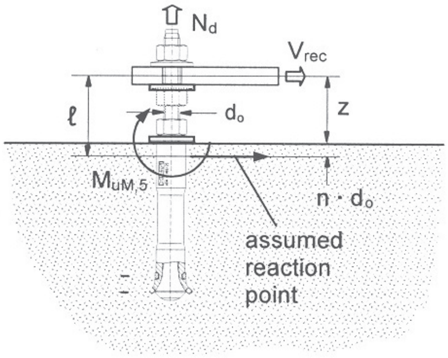
= $z + (n \cdot d_o)$

z = distance from center of base plate to surface of concrete (standoff distance)

d_0 = anchor outside diameter at concrete surface

n = 0, for static loading with clamping at the concrete surface as provided by a nut and washer assembly (required for mechanical anchors);

= 0.5, for static loading without clamping at the concrete surface, e.g., adhesive anchor without nut and washer at concrete surface



Determination of bolt bending — ASD

Note that stand-off installations of post-installed mechanical anchors require a nut and bearing washer at the concrete surface as shown above for proper anchor function.

INCREASE IN CAPACITY FOR SHORT-TERM LOADING — ASD

Some building codes allow a capacity (stress) increase of 1/3 when designing for short-term loading such as wind or seismic. The origin of the 1/3 increase is unclear as it relates to anchor design, but it is generally assumed to address two separate issues: 1) strain-rate effects, whereby the resistance of some materials is increased for transitory stress peaks, and 2) the lower probability of permanent and transitory loads occurring simultaneously.

While Hilti does not include the 1/3 increase in published capacities for anchors in concrete, it is the responsibility of the designer to determine the appropriateness of such a capacity increase under the applicable code.

3.1.10 TORQUING AND PRETENSIONING OF ANCHORS

Application of torque is intended to induce a tension force in the anchor bolt. It is therefore important that the torque-tension relationship associated with the anchor nut, washer and threaded anchor element be maintained as close to factory conditions as possible during anchor installation. This is best accomplished by keeping the anchor assembly in its packaging to prevent undue contamination with dust, oil, etc. prior to anchor installation. Note that damage to anchor threads as caused by attempts to re-straighten an anchor after installation, hammer impacts, etc., can significantly alter the torque-tension relationship and result in improper anchor function under load, including failure. Likewise, application of lubricants to the threads may generate excessive pretension loads in the anchor during torquing, which can also result in failure.

There are three possible reasons to apply torque to an anchor bolt in concrete or masonry:

1. To produce a clamping force, therefore eliminating gaps and play within the connected parts. Note that this clamping force is not assumed to be sufficient to permit the shear resistance of the anchorage to be determined on the basis of baseplate friction (i.e., as a slip-critical condition) owing to the relaxation of clamping forces over time.
2. To produce a pretension force in the anchor bolt which is resisted by a corresponding pre-compression in the base material (concrete or masonry). Pretension force serves to reduce anchor displacements under service load and may also serve to reduce the fatigue effects of cyclic loading.
3. To verify the anchorage will hold the tensile preload generated by the recommended torque. This helps reduce the likelihood of a grossly misinstalled anchor and/or completely unsuitable base material.

Anchor pretensioning forces dissipate over time due to relaxation in the concrete and, to a lesser degree, in the bolt threads. Re-torquing anchors can result in a higher level of residual prestress.

Anchor pretensioning should not be counted on for cases where cracking of the concrete may occur (i.e., earthquake loading).

3.1.11 DESIGN OF ANCHORS FOR FATIGUE

The design of structural elements to resist fatigue loading can have a significant effect on the connection design. The reader is referred to relevant standards for additional information on this subject. Design of anchors for fatigue should consider the following points:

1. The application of preload to prevent stress fluctuations in the anchor rod element may be complicated by gradual loss of preload over time, particularly in cases where cracking in the base material may occur, and the fact that many anchor designs do not provide sufficient gauge length to permit the development of a meaningful degree of preload strain.
2. Design of anchor groups for fatigue is often far more critical than the design of a single anchor due to the unequal distribution of loads. Load distribution is affected by anchor slip as well as by the degree of annular gap between the anchor and the baseplate and the specific location of the anchor with respect to the hole in the baseplate. It is therefore recommended that where anchor groups are to be subjected to significant fatigue loading, the annular gap between the anchors and the baseplate be eliminated through the use of weld washers, grout, or other means.
3. Secondary flexural stresses as generated by eccentricities or gaps in the connection may be critical to the fatigue behavior of the anchor.

3.1.12 DESIGN OF ANCHORS FOR FIRE

Building codes are generally silent on the need to design anchors specifically for fire conditions. It may be assumed, however, that structural connections to concrete or masonry involving sustained dead and live loads should be protected for fire exposure in the same manner as other structural steel elements, i.e., through the use of appropriate fireproofing materials, concrete cover, etc.

In some cases, it may be necessary to ascertain the length of time over which unprotected anchorages will survive fire exposure. The design of anchors for fire conditions is predicated on the availability of test data for the performance of anchors subjected to a standardized time-temperature curve (e.g., ASTM E 119, ISO 834) while under load.

3.1.13 DESIGN OF POST-INSTALLED REINFORCING BAR CONNECTIONS

Previous to this section, design of post-installed threaded rod and rebar have followed the anchoring provisions of ACI 318 Chapter 17 and CSA A23.3 Annex D. Another common and long-standing application of anchoring adhesives is the installation of deformed reinforcing bars in holes drilled in concrete to emulate the behavior of cast-in-place reinforcing bars.

This section is a supplement to the Hilti North America Post-Installed Reinforcing Bar Guide and is an alternative to considering the post-installed rebar as an "anchor". Refer to the Guide for a comprehensive description of post-installed reinforcing bar design with Hilti adhesive anchor systems. Contact Hilti Technical Services with questions.

Adhesive anchor systems are qualified in accordance with ICC-ES Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements (AC308). Hilti HIT-RE 500 V3 and HIT-HY 200 V3 adhesives are recognized for use with post-installed reinforcing bars in ICC-ES Evaluation Service Reports ESR-3814 and ESR-4868. Based on these recognitions, reinforcing bars installed with HIT-RE 500 V3 and HIT-HY 200 V3 may now be designed using two methods:

1. Development and splice length provisions in ACI 318 (Chapters 18 and 25) and CSA A23.3 (Chapters 12 and 21)
2. Anchoring to concrete provisions in ACI 318 Chapter 17 and CSA A23.3 Annex D.

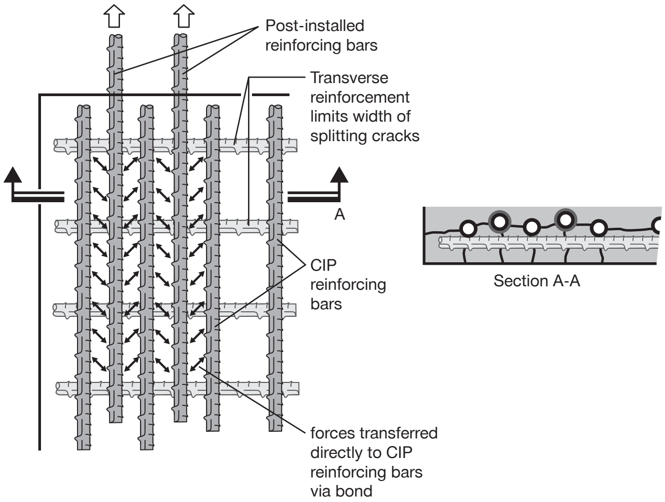
Within this section, development and splice lengths are provided according to ACI 318 Chapter 25 and CSA A23.3 Chapter 12 calculations (see item 1 above). In addition, embedment depths provided for anchorage calculations correspond to development of reinforcing bars following an approach outlined in a paper published in the ACI Structural Journal (see item 2 above).

Post-installed reinforcing bar installations in accordance with ACI 318 and CSA A23.3 can also be designed using Hilti's PROFIS Anchor and PROFIS Rebar software. You can access PROFIS Anchor and PROFIS Rebar at www.hilti.com.

DEVELOPMENT AND SPLICING USING ACI 318 CHAPTER 25 PROVISIONS

ACI 318 Chapter 25 contains provisions for reinforcing bar development and splice lengths in non-seismic applications. Development lengths are assumed to preclude concrete

concrete splitting and reinforcing bar pullout failure prior to "development" (attainment) of bar yield stress. Although the term "lap splice" implies direct transfer of stress from bar to bar, forces between bars are transferred via struts and hoop stresses in the concrete. The ICC-ES acceptance criteria for adhesive anchors in concrete, AC308, now includes procedures and requirements for the recognition of post-installed designed reinforcing using the development length provisions of ACI 318 Chapters 18 and 25.
Hilti HIT-RE 500 V3 and HIT-HY 200 V3 are recognized in ICC-ES ESR-3814 and ESR-4868, respectively, for this purpose.



Splicing of post-installed reinforcing bars

Tension development length: ACI 318 25.4.2.3

Under the conditions given in ESR-3814 and ESR-4868 as revised in July 2015, design of post-installed reinforcing bars with HIT-RE 500 V3 and HIT-HY 200 V3, respectively, may be performed using the applicable provisions of ACI 318 Chapters 18 and 25. The basic expression for tension development length in Chapter 25 is provided in the following equation as:

$$\ell_d = \left[\frac{3}{40\lambda}\frac{f_y}{\sqrt{f'_c}}\frac{\psi_t\,\psi_e\,\psi_s}{\frac{c_b+K_{tr}}{d_b}}\right]d_b$$

where the confinement term $(c_b + K_{tr})/d_b$ shall not be taken as greater than 2.5 and the design value of ℓ_d shall not be less than 12 inches per 25.4.2.1.

Note: Because the "top bar" factor, ψ_t, accounts for bar position effects in freshly poured concrete, it may be neglected for the drilled-in portion of post-installed bars. ψ_t must be applied where applicable for the freshly cast-in portion of new bars and for the spliced portions of existing cast-in-place bars.

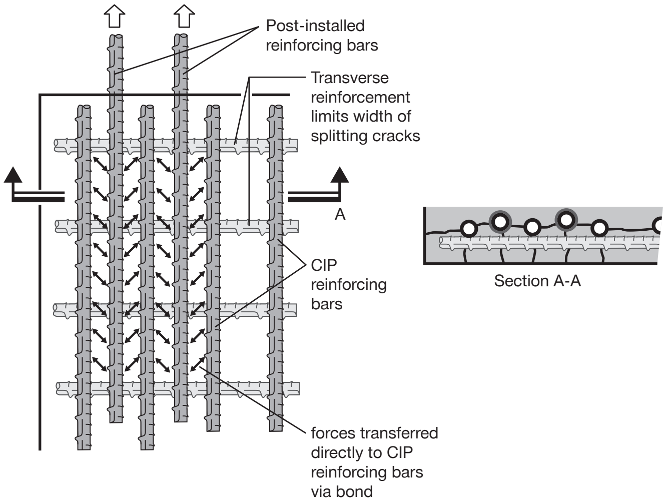
Tension lap splices: ACI 318 25.5.2

A Class B splice taken as the greater of $1.3\ell_d$ and 12 inches is required in all cases unless 1) the area of reinforcement provided is at least twice that determined by analysis over the entire length of the splice and 2) one-half or less of the total reinforcement is spliced within the lap length. Where 1) and 2) are satisfied, a Class A splice taken as the greater of 1.0ℓ and 12 inches may be used.

Table 89 in Sec. 3.2.3, and Table 83 in Sec. 3.2.4 provide a summary of calculated development and splice lengths for a range of concrete strengths for HIT-HY 200 V3 and HIT-RE 500 V3 for the specific case where the confinement term $(c_b + K_{tr})/d_b$ has been taken as the maximum value of 2.5. Refer to Chapter 6 of the Post-Installed Reinforcing Bar Guide and ESRs for additional design information relating to development length and lap splices.

DEVELOPMENT AND SPLICING USING CSA A23.3 CHAPTER 12 PROVISIONS

CSA A23.3 Chapter 12 contains provisions for reinforcing bar development and splice lengths in non-seismic applications analogous to those of ACI 318. While not formally recognized in ICC-ES ESRs, Hilti HIT-RE 500 V3 and HIT-HY 200 V3 is commonly used with the provisions of CSA A23.3 based on the testing performed in accordance with ICC-ES AC308. As with the design for ACI 318 Chapter 25, design of post-installed reinforcing bars with HIT-RE 500 V3 and HIT-HY 200 V3 may be performed equivalently to cast-in reinforcing bars using the applicable equations in CSA A23.3. The basic expression for tension development length is provided in the equation as follows:



Splicing of post-installed reinforcing bars

Tension development length: CSA A23.3 12.2.2 EQ 12-1

$$\ell_d = 1.15\,\frac{k_1\,k_2\,k_3\,k_4}{(d_{cs}+k_{tr})}\,\frac{f_y}{\sqrt{f'_c}}\,A_b$$

where the confinement term $(d_{cs} + K_{tr})$ shall not be taken greater than 2.5 and the design value of ℓ_d shall not be less than 300 mm per 12.2.1.

Note: Because the "top bar" factor, k_1, accounts for bar position effects in freshly poured concrete, it may be neglected for the drilled-in portion of post-installed bars. k_1 must be applied where applicable for the freshly cast-in portion of new bars and for the spliced portions of existing cast-in-place reinforcement.

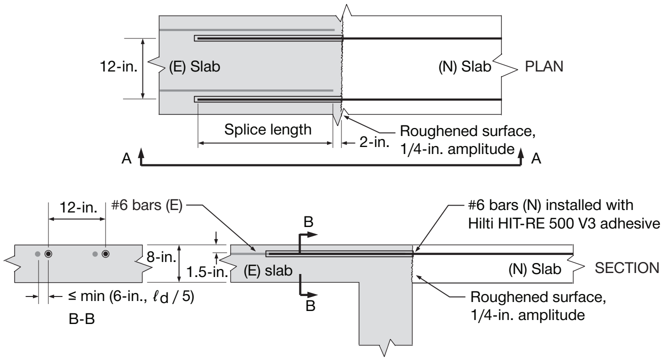
Tension lap splices: CSA A23.3 12.15.1

A Class B splice taken as the greater of $1.3\ell_d$ and 300 mm is required in all cases unless 1) the area of reinforcement provided is at least twice that determined by analysis over the entire length of the splice and 2) one-half or less of the total reinforcement is spliced within the lap length. Where 1) and 2) are satisfied, a Class A splice taken as the greater of $1.0\ell_d$ and 300 mm may be used.

Table 94 in Sec. 3.2.3, and Table 88 in Sec. 3.2.4 provides a summary of development and splice lengths for a range of concrete strengths for HIT-HY 200 V3 and HIT-RE 500 V3 according to CSA provisions for the specific case where the confinement term (d_{cs} +K_{tr}) has been taken as the maximum value of 2.5d_b. Refer to Chapter 6 of the Post- Installed Reinforcing Bar Guide and ESRs for additional design information relating to development length and lap splices.

Design example — development lengths for negative reinforcement slab extension

Requirement: Establish the embedment for post-installed reinforcing bars for a slab extension as shown in the figure below.



New-to-existing slab connection

Step 1: Parameters

Existing construction	(E) slab, 8-inch thick, 4000 psi normal weight concrete, Gr. 60 reinforcement, #6 bars at 12-inch on-center spacing. Note: other detailing not shown.
New construction	(N) slab, 8-inch thick, 5000 psi normal weight concrete, Gr. 60 reinforcement, #6 bars at 12-inch on-center spacing.

Step 2: Determine the development length for a Class B splice

Assuming K_{tr} is equal to zero (i.e., no transverse reinforcing present to restrain splitting), with 12–inch spacing and 1.5–inch cover, c_b = (1.5 + 0.625/2) = 1.875 inches and (c_b + K_{tr})/d_b = (1.875 + 0)/0.625 = 2.5. With (c_b + K_{tr})/d_b ≥ 2.5 and less than 12 inches of concrete in the slab member installed below existing bars, Table 89 in Sec. 3.2.4, applies to both existing and new reinforcement. From Table 83 in Sec. 3.2.4, the Class B splice length of a #6 bar in 4000 psi concrete is 22 inches.

Per ACI 318 25.5.1.3, the distance between a post-installed reinforcing bar and an existing cast-in-place reinforcing bar to which the post-installed bar is spliced shall be no greater than the lesser of 6 in. and one-fifth of the development length. For this example 22/5 = 4.5 in.

Step 3: Specification

Install #6 Gr. 60 reinforcing bars at 12 inches on center with a minimum 24-inch embedment (22-inch splice plus 2-inch end cover) using Hilti HIT-RE 500 V3 as shown in the figure above. Locate post-installed bars within 4-1/2 in. of existing bars to be spliced. Install in accordance with Hilti Instructions for Use. Do not damage existing reinforcing. Roughen interface to 1/4-inch amplitude prior to placement of post-installed bars.

Note: ACI 318 and ICC Evaluation Service Reports refer to the manufacturer instructions for use as the Manufacturer's Published Installation Instructions (MPII).

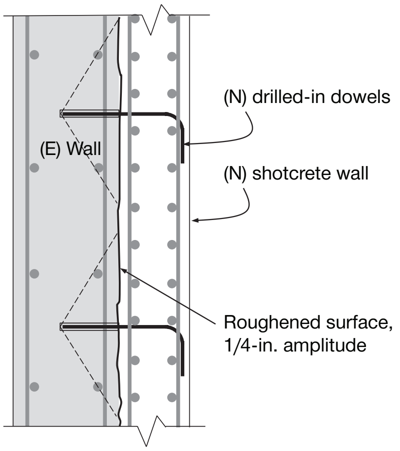
DEVELOPMENT OF POST-INSTALLED REINFORCING BARS BASED ON ACI 318 CHAPTER 17 AND CSA A23.3 ANNEX D ANCHORAGE PROVISIONS

ACI 318 Chapter 17 and CSA A23.3 Annex D contain design provisions for the determination of the tensile strength of post-installed adhesive anchors in concrete, whereby the strength is taken as the minimum of the resistances corresponding to steel rupture, concrete breakout, and bond failure at the adhesive-to-concrete interface. Since the establishment of development length is based on the assumption of the attainment of a minimum strength corresponding to yield of the bar, the design equations for anchorage can also be applied to this problem. Within the May-June 2013 issue of the ACI Structural Journal, “Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures” by Charney, Pal and Silva provides a methodology for establishing the bar embedment to develop the bar using the concepts of anchorage contained in ACI 318 Chapter 17. This methodology is similarly applicable to CSA A23.3 Annex D.

Note: This procedure is not addressed in ACI 318 or in CSA A23.3. As stated in Charney, et al., the assumptions made to ensure bar yield are a matter of judgment and may require unique determination for specific applications and conditions. For specific cases, contact Hilti.

The use of bond values corresponding to the assumption of uncracked vs. cracked concrete for the design of reinforcing bar embedment is a matter of judgment. The ACI 318 Chapter 25 development length provisions do not explicitly consider reduction of bond corresponding to cracking of the concrete that may arise in conjunction with structure loading, shrinkage, etc. Furthermore, while the development length provisions of the code appear to consider only the nominal yield strength of the bar, it may be prudent to provide sufficient embedment to develop the actual bar yield, generally assumed to be 125% of the nominal value. Tables 90 and 95 in Sec. 3.2.3, and Tables 84 and 89 in Sec. 3.2.4 provide calculated embedments to develop Gr. 60 rebar based on the application of anchor theory. For the development of these Tables, the strengths corresponding to the applicable limit states for single bars in tension for non-seismic applications (i.e., SDC A and B) in ACI 318 Chapter 17 are taken as follows:

$$N_{steel} = A_b\,(1.25\,f_y)$$
$$N_{breakout} = \phi_c k_{c,uncr} \sqrt{f'_c}\, h_{ef,breakout}^{1.5}$$
$$N_{bond} = \phi_b \tau_{k,cr/uncr}\, \pi d_b h_{ef,bond}$$



Section through a shotcrete onlay wall with post-installed dowels designed using anchor provisions whereby the concrete breakout and bond strengths with reduction factors applied are each set equal to the assumed bar yield strength. In CSA calculations, R for breakout and bond calculations is conservatively assumed to equal 1.0. The resulting expressions are solved for h_{ef} as follows:

As governed by single-bar concrete breakout strength:

$A_b 1.25 f_y = \phi_c k_{c,uncr} \sqrt{f'_c}\, h_{ef,breakout}^{1.5}$ yields

$$h_{ef,breakout} = \left(\frac{A_b\,(1.25\,f_y)}{\phi_c k_{c,uncr}\sqrt{f'_c}}\right)^{2/3}$$

with minimum c_a and s intended to preclude edge and spacing effects.

As governed by single-bar bond strength:

$A_{se,N} 1.25 f_y = \phi_b \tau_{k,uncr} \pi d_b h_{ef,bond}$ yields

$$h_{ef,bond} = \frac{A_b\,(1.25\,f_y)}{\phi_b \tau_{k,uncr} \pi d_a}$$

with minimum c_a and s intended to preclude edge and spacing effects.

The controlling embedment (in this case, the larger value of $h_{ef,breakout}$ and $h_{ef,bond}$), is reported in the table together with the accompanying edge distances and spacing values.

Note: ACI 318 17.3.2.3 states: "For adhesive anchors with embedment depths $4d_a \le h_{ef} \le 20d_a$ the bond strength requirements shall be considered satisfied by the design procedure of 17.4.5." In accordance with 17.3.2.3, ESR-3814 and ESR-4868 limit anchorage embedment depths to this range of values. These requirements recognize the limits of the uniform bond model adopted by ACI. Anchorage embedments published in the Hilti North American Product Technical Guide are based on assumptions that are intended to achieve development of the nominal yield stress in reinforcing bars. In some cases, the recommended bar embedment exceeds, by an acceptable margin, the 20 bar diameter limit established in ACI 318 Chapter 17 for the applicability of the uniform bond model. It is Hilti's view that the conservatism of the underlying assumptions, taken in aggregate, is sufficient to offset any reduction in the effective bond stress associated with these bond lengths. The designer may elect to employ alternate design assumptions for bar development based on the specific conditions for a given design.

Spacing: To account for the influence of nearby bars on the concrete resistance (breakout/bond failure), minimum spacing is calculated as the greater of $20d_b\,(\tau_{k,uncr}/1100\text{ psi})^{0.5}$ and $3h_{ef,breakout}$

Edge distance: To account for the effect of edge distance on the concrete resistance, minimum edge distance is calculated as the greater of $10d_b\,(\tau_{k,uncr}/1100\text{ psi})^{0.5}$ and $1.5h_{ef,breakout}$.

In addition, for uncracked concrete, the minimum edge distance may be governed by the value of c_{ac}, the critical edge distance for splitting failure where the design assumes uncracked concrete and where there is no reinforcing to control splitting cracks.

In this case, the value of c_{ac} is taken as:

$$c_{ac} = h_{ef}\left(\frac{\tau_{k,uncr}}{1160}\right)^{0.4} \quad 3.1 - 0.7\,\frac{h}{h_{ef}}$$

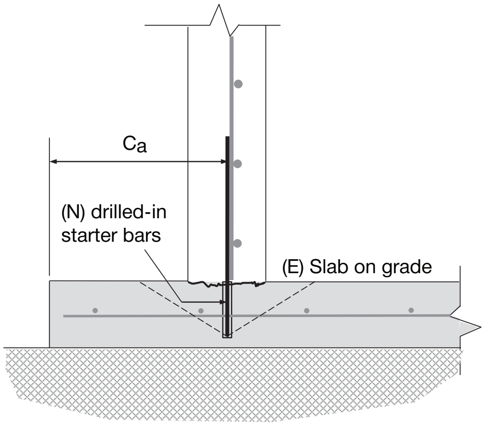
where $\frac{h}{h_{ef}} \le 2.4$ and

$\tau_{k,uncr}$ is the characteristic bond strength stated in the Evaluation Service Report and cannot be taken as larger than:

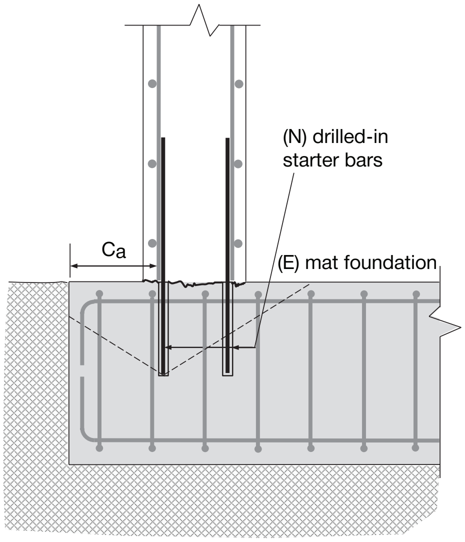
$$\tau_{k,uncr} = \frac{k_{c,uncr}\sqrt{h_{ef}\, f'_c}}{\pi \cdot d}$$

The application of c_{ac} to post-installed reinforcing bars in uncracked concrete is advisable where the EOR determines that splitting will be critical for the behavior of the connection at ultimate loads. The figure below represents two possible extremes for the calculation of edge distance. Condition I illustrates a bar anchored in a relatively thin and lightly reinforced slab. In this case, splitting is likely to be critical and the application of c_{ac} as calculated in the equation above is advisable. At the other extreme, Condition II is represented by bars embedded in a heavily reinforced foundation where the ratio of h to h_{ef} is large as judged by the EOR. In Condition II, splitting is unlikely to control the behavior and the c_{ac} term may be neglected. In all cases, proper judgment based on the loading and geometry of the connection should be applied.

Note: Tables 90 and 95 in Sec. 3.2.3, and Tables 84 and 89 in Sec. 3.2.4 provide suggested embedment depths, edge distances, and spacing values for the development of Grade 60 reinforcing bars. Bond strengths have not been reduced for seismic loading and a bar overstrength factor of 125% of nominal yield has been applied in the determination of the values provided. Bond strengths include reductions for sustained tension loading as provided in the applicable evaluation reports; however, no additional reduction in accordance with ACI 318 17.3.1.2 has been included. Where bars are used to resist sustained tension loading, increases in the tabulated embedment values may be appropriate. Consult Hilti Technical Services for further information.



Condition I: thin member, light or no reinforcing



Condition II: thick member, heavily reinforcing
Considerations for determination of minimum edge distance

DEVELOPMENT OF POST-INSTALLED WALL/ COLUMN STARTER BARS IN A LINEAR ARRAY BASED ON ACI 318 CHAPTER 17 AND CSA A23.3 ANNEX D ANCHORAGE PROVISIONS

Note: This procedure is not addressed in ACI 318 or in CSA A23.3. For additional information see May-June 2013 issue of the ACI Structural Journal, “Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures” by Charney, Pal and Silva. As addressed in this study, the assumptions made to ensure bar yield are a matter of judgment and may require unique determination for specific applications and conditions. For specific cases, contact Hilti.

In Tables 91 through 93 and 96 through 98 in Sec. 3.2.3, and Tables 85 through 87 and 90 through 92 in Sec. 3.2.4, the expressions presented in the study have been expanded to include the effects of set spacing of starter bars in a linear array at set spacings. To produce these tables A_{Nc} is defined by ACI 318, 17.4.2.1 and Fig. R17.4.2.1 (CSA A23.3 D.6.2.1 and Fig. D.7). A_{Na} is defined by ACI 318, 17.4.5.1 and Fig. R17.4.5.1 (CSA A23.3 D.6.5.1 and Fig. D.11). A_{Nco} and A_{Nao} are defined by Equations (17.4.2.1c) and (17.4.5.1c) (CSA Equations (D.5) and (D.22)), respectively. Inclusion of these terms permits the effects of edge distance to be considered on the concrete breakout and bond strengths. Using the relationships above, the equations below for h_{ef} for both breakout and bond can be found, the larger of which is taken as the final embedment depth.

$$N_{steel,m} = n_{bars} A_b (1.25 f_y)$$

$$N_{breakout,m} = \left(\frac{A_{Nc}}{A_{Nco}}\right) \phi_c k_{c,uncr} \sqrt{f'_c}\, h_{ef,breakout}^{1.5}$$

$$N_{bond,m} = \frac{A_{Na}}{A_{Nao}} \phi_b \tau_{k,uncr} \pi d_b h_{ef,bond}$$

whereby the concrete breakout and bond strengths with reduction factors applied are each set equal to the assumed bar yield strength and the resulting expressions are solved for h_{ef} as follows: As governed by multiple-bar breakout strength:

$$h_{ef,breakout} = \left(\frac{1\, A_{Nco}}{\phi_c A_{Nc}} \frac{n_{bars} A_b (1.25 f_y)}{k_{c,uncr} \quad f'_c}\right)^{2/3}$$

with minimum c_a intended to preclude edge effects.

Note: The term (A_{Nco} / A_{Nc}) depends on $h_{ef.}$ For this reason, the calculation of h_{ef} using the equation above may require iteration.

As governed by multiple-bar bond strength:

$$h_{ef,bond,m} = \frac{1\,A_{Nao}}{\phi_b A_{Na}} \; \frac{n_{bars} A_b \;(1.25\,f_y)}{\tau_{k,uncr} \pi d_a}$$

with minimum c_a intended to preclude edge effects.

In Equations (6) and (7), $\left(\frac{A_{Nco} \cdot n_{bars}}{A_{Nc}}\right)$ and $\left(\frac{A_{Nao} \cdot n_{bars}}{A_{Na}}\right)$ shall not be taken as less than 1.0.

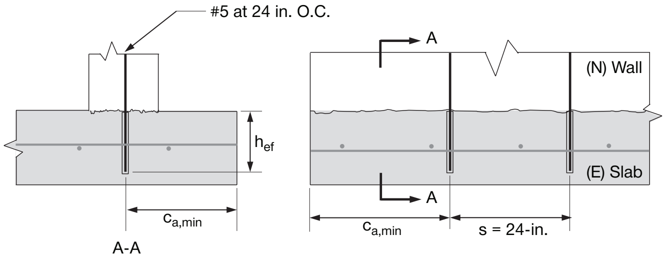
Note: Anchorage embedments published in the Hilti North American Product Technical Guide are based on assumptions that are intended to achieve development of 125% of the nominal yield stress in reinforcing bars. In some cases, the recommended bar embedment exceeds the 20 bar diameter limit established in ACI 318 Chapter 17 for the applicability of the uniform bond model. It is Hilti's view that the conservatism of the underlying assumptions, taken in aggregate, is sufficient to offset any reduction in the effective bond stress associated with these bond lengths. The designer may elect to employ alternate design assumptions for bar development based on the specific conditions for a given design.

Edge distance: To account for the effect of edge distance on the concrete resistance, minimum edge distance is calculated as the greater of $10d_b\,(\tau_{k,uncr}/1100\text{ psi})^{0.5}$ and $1.5h_{ef,breakout}$. In addition, for uncracked concrete, the minimum edge distance may be governed by the value of c_{ac}, the critical edge distance for splitting failure, where the design assumes uncracked concrete and there is no reinforcing to control splitting cracks.

General assumptions: Embedment depths in Tables 91 through 93 and 96 through 98 in Sec. 3.2.3, and Tables 85 through 87 and 90 through 92 in Sec. 3.2.4,are predicated on the assumptions that 1) edge distances are no less than c_{Na} and c_{ac} as defined by ACI 318 Chapter 17 and AC308, respectively, 2) all bars in the group are loaded equally, 3) uncracked concrete conditions apply, 4) that orthogonal bars are spaced far enough way to preclude edge and spacing effects, 5) bars are NOT subject to sustained tension, and 6) that the number of bars in a linear array, n_{bars}, is equal to 10.

Note: Tables 91 through 93 and 96 through 98 in Sec. 3.2.3, and Tables 85 through 87 and 90 through 92 in Sec. 3.2.4, provide calculated embedment depths, edge distances, and spacing values corresponding to the stated assumptions that are intended to develop 125% of nominal yield in Grade 60 reinforcing bars under non-earthquake conditions (i.e., SDC A and B). The use of other assumptions (e.g., bond values corresponding to cracked concrete or seismic loading, omission of the bar overstrength multiplier, etc.) will result in different embedment depths, spacings, and edge distances that may be appropriate for specific design conditions. Consult Hilti Technical Services for further information.

Design example — development of wall-to-slab starter bars in linear 24-inch-on-center array using anchor theory
Requirement: Provide post-installed starter bars for a new wall on an existing lightly reinforced slab-on-grade as shown in the figure below installed with HIT-RE 500-V3. Analysis indicates that there will be no cracking during service loading and no sustained tensile loads on the reinforcing bars.



Section views of wall-to-slab starter bars

Step 1: Establish requirements for the new bars

Existing construction	(E) 12-inch thick foundation,6000 psi normal weight concrete, Gr. 60 reinforcement.
New construction	(N) 10-inch wide wall as shown, 5000 psi normal weight concrete, Gr. 60 reinforcement, #5 bars at 24–inch on-center spacing.

Step 2: Determine the development length for the wall starter bars using anchor theory

From Table 85 in Sec. 3.2.4, a #5 bar with f'_c= 6000 psi produces h_{ef} = 9 inches with $c_a \geq 25$ inches.

Step 3: Specification

Gr. 60 #5 reinforcing bars installed at an 9-inch embedment with Hilti HIT-RE 500 V3 at 24-inch O.C. no less than 25 inches from all edges. Install per Hilti Instructions for Use. Do not damage existing reinforcing. Roughen interface to 1/4-inch amplitude prior to placement of post-installed bars.

Note: ACI 318 and ICC Evaluation Service Reports refer to the manufacturer instructions for use as the Manufacturer’s Published Installation Instructions (MPII).

3.2 ADHESIVE ANCHORING SYSTEMS

3.2.1 ADHESIVE ANCHORING SYSTEMS OVERVIEW

HILTI LEADS THE WAY WITH PRODUCTS AND EDUCATION

Hilti leads the way in sharing knowledge and experience by educating users on various aspects of Hilti adhesive anchoring systems. We know the importance of selecting the right adhesive anchor system for a specific application.

When comparing two adhesive anchor systems, users should give special consideration to the following key parameters:

- Moisture condition of the base material
- Allowable or preferred drilling method
- Base material condition (e.g. cracked concrete)
- Cure time
- Installation procedure
- Bond strength
- Temperature sensitivity
- Creep resistance
- Inspection requirements

FREQUENTLY ASKED QUESTIONS

What is creep?

Creep is the slow and continuous deformation of a material over time. All materials experience some sort of creep - concrete, steel, stone and adhesive anchor systems. In general, small deformations due to a constant sustained load are typical and creep is only problematic when excessive deformations occur.

- All current Hilti adhesive anchor systems passed the creep test requirements of either ICC-ES AC308 or ICC-ES AC58.

Does temperature have an effect on adhesive anchor performance?

Yes, temperature affects an adhesive anchor system throughout its lifetime - from storage to installation and throughout the life cycle of an anchor.

- Temperature is an important factor which influences an adhesive anchor system's strength, cure time, ease of installation and creep performance. Some adhesive anchoring systems are engineered for colder climates and others for warmer climates. High temperatures tend to soften adhesive materials, while cold temperatures might prevent a full cure of the adhesive. Both situations might lead to a reduction in bond strength. Each product will have a different low and high temperature threshold at installation and throughout the service life of the anchor.

How does installation affect adhesive anchors?

Proper installation is the single most user-influenced factor when it comes to an adhesive anchor system's bond strength and performance.

- Hilti is the only manufacturer that provides the entire solution from drilling and cleaning the hole to injecting adhesive into boreholes as deep as 125-in.

What are ICC-ES AC58 and ICC-ES AC308?

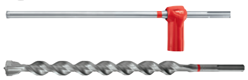
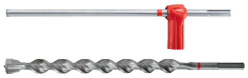
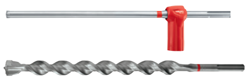
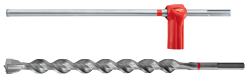
ICC-ES AC58 is an acceptance criteria published in 1995 used for evaluating adhesive anchor systems in concrete and masonry base materials. In 2005, ICC-ES AC308 was published for adhesive anchors in concrete, and ICC-ES AC58 was changed to only address masonry base materials. In general, AC308 improved the testing and assessment of adhesive anchor systems in concrete based on research on the behavior of these systems. AC58 is still the state-of-the-art with respect to adhesive anchor systems in masonry.

Hilti has maintained their focus on evaluating adhesive anchor systems to the highest standards. As such, Hilti maintains ICC-ES evaluation reports for adhesive anchors in concrete according to AC308 and in masonry according to AC58.

HILTI ADHESIVE ANCHORING SYSTEMS

To address the various conditions found on today's construction projects, Hilti offers the most complete selection of adhesive anchoring products. We call it the HIT Portfolio. No matter what application you have on the jobsite, Hilti has a product for you.

Every product in the HIT Portfolio was developed using the same stringent standards and is backed by the experience of the company that brought cartridge adhesive anchor systems to the world...Hilti.

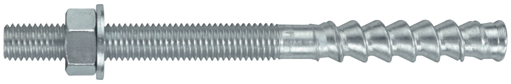
Adhesive anchors	Approved base materials		Drilling Method
HIT-HY 200 A/R V3 FAST CURE **Ultimate performance hybrid mortar for rebar connections and heavy anchoring** 	Uncracked concrete Cracked concrete Grout filled masonry	Seismic ICC ES NSF	SAFESET  [2]
HIT-RE 500 V3 SLOW CURE **Ultimate performance epoxy mortar for rebar connections and heavy anchoring** 	Uncracked concrete Cracked concrete	Seismic ICC ES NSF	SAFESET  [3] [4]
HIT-HY 100 FAST CURE **Premium hybrid mortar for anchoring in concrete and rebar connections** 	Uncracked concrete Cracked concrete Grout filled masonry	Seismic ICC ES IAPMO MEMBER NSF	SAFESET 
HIT-RE 100 SLOW CURE **Premium epoxy mortar for anchoring and rebar connections in concrete** 	Uncracked concrete Cracked concrete	Seismic ICC ES NSF	SAFESET 
HIT-HY 270 FAST CURE **The ideal adhesive anchor designed for virtually all masonry** 	Grout filled block Hollow block Brick Multi-wythe brick	Seismic[1] ICC ES	SAFESET 
HIT-HY 10+ FAST CURE **Economical injectable hybrid mortar for medium-duty fastenings in uncracked concrete and masonry** 	Concrete Grout filled block Hollow block Brick		
HIT-ICE ADHESIVE **Special mortar for low temperature fastening in concrete** 	Uncracked concrete Cracked concrete Grout filled block		SAFESET 

1 Seismic approval only for grout filled block and multi-wythe brick
2 Must be used with HIT-Z Anchor Rod
3 Approved for diamond drilling in cracked concrete with the use of a TE-YRT roughening tool and in uncracked concrete without the roughening tool
4 Diamond drilling in cracked concrete requires the use of a TE-YRT roughening tool

INTRODUCING HILTI SAFESET™ TECHNOLOGY

Reliably set anchors and rebar in cracked and uncracked concrete and grout filled masonry

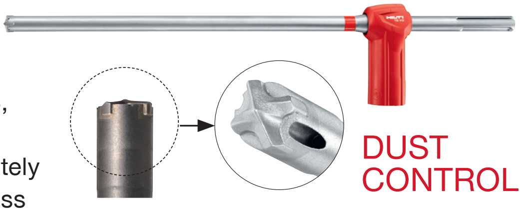
NO CLEANING REQUIRED



HIT-Z Anchor Rods

The new Hilti HIT-Z Anchor Rod with its cone-shaped helix works as a torque-controlled bonded anchor. This means that because of their shape, HIT-Z Anchor Rods are not affected by uncleaned, hammer-drilled holes in dry or water saturated concrete in base materials above 41°F (5°C) when used with HIT-HY 200 A/R V3. The benefits are clear: fewer steps and extremely high reliability in anchoring applications.

HOLES THAT CLEAN THEMSELVES



DUST CONTROL

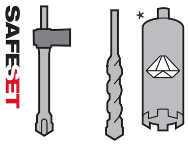
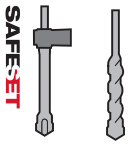
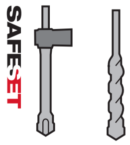
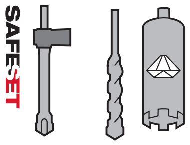
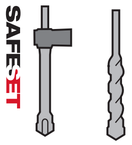
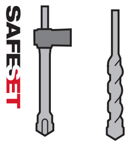
Hollow Drill Bits

Hilti TE-CD and TE-YD Hollow Drill Bits, in conjunction with HIT-HY 200 A/R V3, HIT-RE 500 V3, HIT-HY 100, HIT-RE 100, HIT-HY 270, and HIT-ICE and the Hilti VC 150 series or the VC 300 vacuums, make subsequent hole cleaning completely unnecessary. Dust is removed by the Vacuum System while drilling is in progress for more reliability and a virtually dustless working environment.

CORE DRILLED HOLES IN CRACKED CONCRETE

Roughening Tool

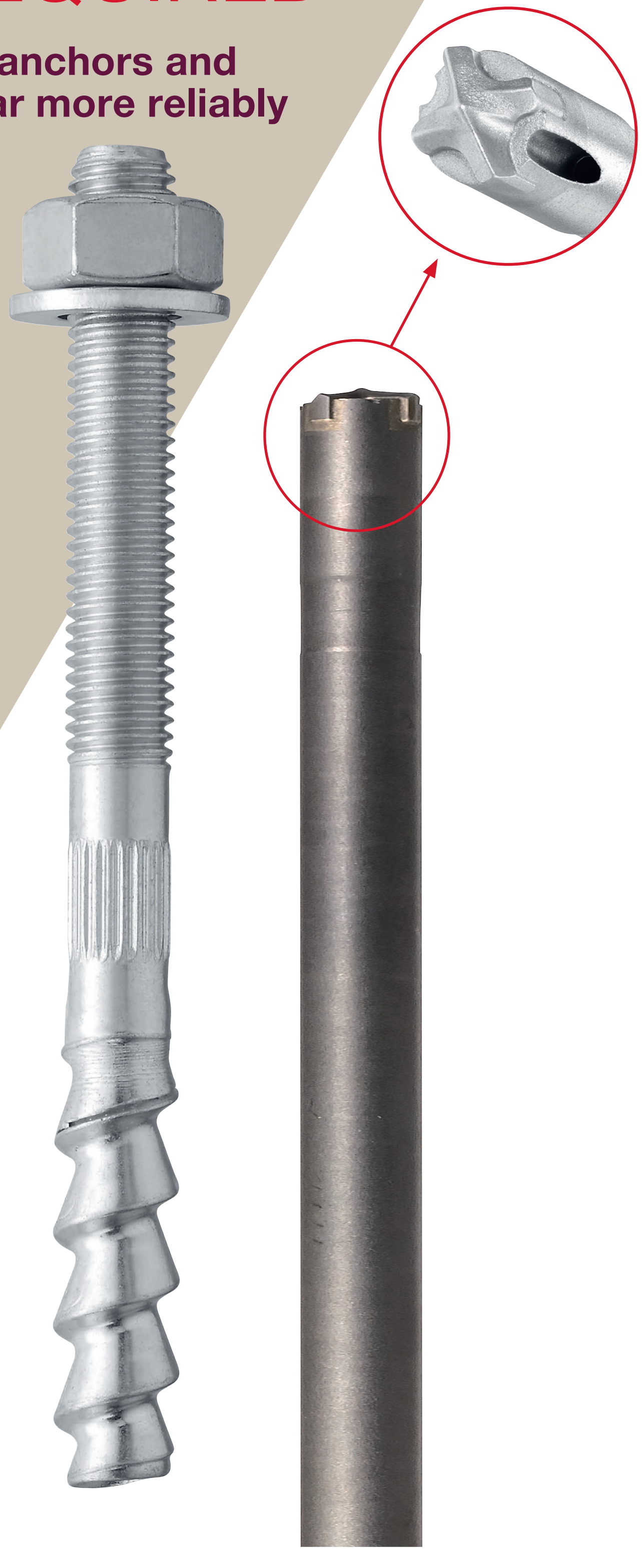
Hilti HIT-RE 500 V3 with the TE-YRT roughening tool in addition to the HIT-HY 200 A/R V3 adhesive with the HIT-Z rod are the only ICC-ES approved systems in cracked concrete to make installation in core drilled holes easier, more productive, and greater reliability.

	Fast cure portfolio			Slow cure portfolio		Masonry
	HIT-HY 200 A/R V3	**HIT-HY 100**	**HIT-ICE**	**HIT-RE 500 V3**	**HIT-RE 100**	**HIT-HY 270**
						
Proven performance						
ICC-ES/IAMPO Evaluation Report	ESR-4868, ESR-4878	ESR-3574 ES 547	N/A	ESR-3814	ESR-3829	ESR 4143, ESR 4144
Base material	Uncracked concrete, cracked concrete, Grout-filled CMU	Uncracked concrete, cracked concrete, Grout-filled CMU	Uncracked concrete, cracked concrete, Grout-filled CMU	Uncracked concrete, cracked concrete	Uncracked concrete, cracked concrete	All masonry
Recommended application	Anchor and rebar	Day-to-day anchor and rebar	Low temperature applications	Anchor and rebar	Day-to-day anchor and rebar	All anchoring and rebar in masonry
Gel time at 72˚F	HY-200-A V3: 4 min HY-200-R V3: 9 min	5 min	2.5 min	25 min	30 min	2 min
Cure time at 72˚F	HY-200-A V3: 30 min HY-200-R V3: 60 min	30 min	45 min	6.5 hours	12 hours	30 min
Drilling method						

*Diamond coring is an approved drilling method when used with the HIT-Z rod.

NO MANUAL HOLE CLEANING REQUIRED

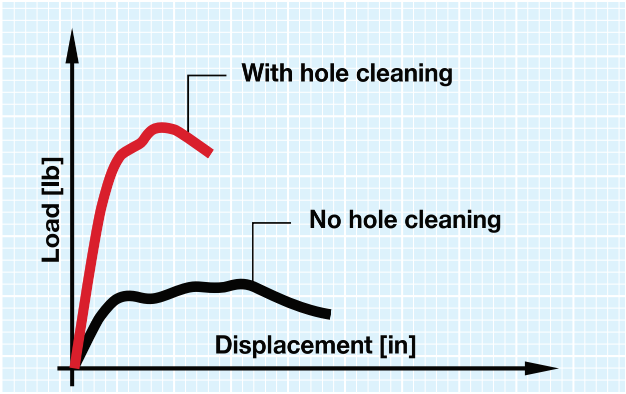
Set anchors and rebar more reliably



It's no secret that adhesive anchors encounter varying jobsite conditions. Hilti Injection Technology (HIT) is featured in our lineup of quality products to combat this issue. With Hilti SafeSet™ Technology, which includes either Hollow Drill Bits with the VC 150 or VC 300 vacuum cleaner or HIT-Z anchor rods, we are taking another giant leap forward by removing a step of the installation process entirely: there is no manual hole cleaning required.

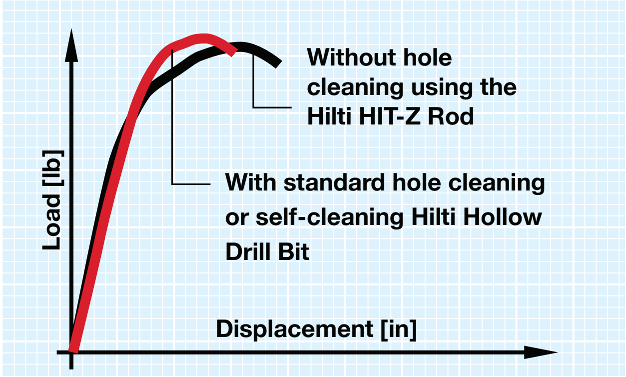
Potential effects of no hole cleaning

When a threaded rod or rebar is set with conventional injection adhesive, the load it's capable of taking may be very low if the hole is inadequately cleaned after drilling. The Hilti SafeSet™ system helps elminate a cleaning step while still providing excellent load values.



Hilti HIT-HY 200 V3 Injectable Adhesive with SafeSet™ Technology

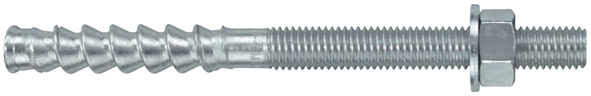
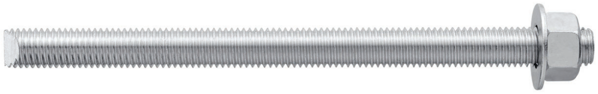
The new SafeSet™ System featuring HIT-HY 200 V3 allows a fastening point to take higher loads, as though the hole were cleaned using traditional installation methods.

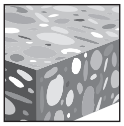


3.2.2 HIT-HY 200 A/R V3 ADHESIVE ANCHORING SYSTEM

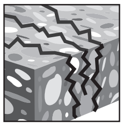
PRODUCT DESCRIPTION

HIT-HY 200 A/R V3 with HIT-Z rods, Threaded Rod, Rebar, and HIS-N/RN Inserts

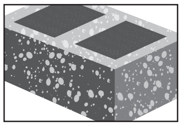
Anchor System		Features and Benefits
	Hilti HIT-HY 200-R V3 Cartridge	- Two great products with equal performance data - User can select product gel time suitability based on temperature of the base material and jobsite time requirements
	Hilti HIT-HY 200-A V3 Cartridge	- No hole cleaning requirement when installed with SafeSet™ hollow drill bit and vacuum technology - No hole cleaning requirement when installing HIT-Z anchor rods in dry or wet conditions with hammer-drilled holes
	Hilti HIT-Z Anchor Rod	- ICC-ES approved for cracked concrete and seismic service
	Hilti HAS Threaded Rod	- May be installed in diamond cored holes with HIT-Z anchor rod only when addition cleaning steps are employed
	Rebar	- ICC-ES approved for grout-filled concrete masonry
	Hilti HIS-N/RN	



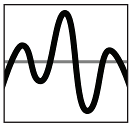
Uncracked concrete



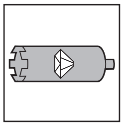
Cracked concrete



Grout-filled concrete masonry



Seismic Design Categories A-F



Diamond cored holes for Cracked and Uncracked Concrete

SAFESET

Hollow Drill Bit

Profis Anchor design software

Approvals/Listings	
ICC-ES (International Code Council)	ESR-4868 in concrete per ACI 318 Ch. 17 / ACI 355.4/ ICC-ES AC308 ESR-4878 in grout-filled CMU per ICC-ES AC58 ELC-4868 in concrete per CSA A23.3/ ACI 355.4
NSF/ANSI Std 61	Certification for use in potable water
European Technical Approval	ETA-11/0492, ETA-11/0493 ETA-12/0006, ETA-12/0028 ETA-12/0083, ETA-12/0084
City of Los Angeles	City of Los Angeles 2020 LABC Supplement (within ESR-4868 for Concrete) Research Report No. 26077 for Masonry
Florida Building Code	2020 Florida Building Code Supplement (within ESR-4868)
U.S. Green Building Council	LEED® Credit 4.1-Low Emitting Materials
Department of Transportation	Contact Hilti for various states

MATERIAL SPECIFICATIONS

For material specifications for anchor rods and inserts, please refer to section 3.2.8.

DESIGN DATA IN CONCRETE PER ACI 318

ACI 318 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-4868 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-4868 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

HIT-HY 200 V3 adhesive with HIT-Z and HIT-Z-R anchor rods

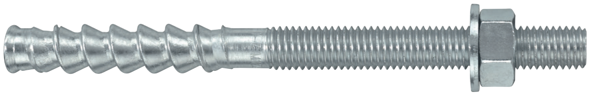
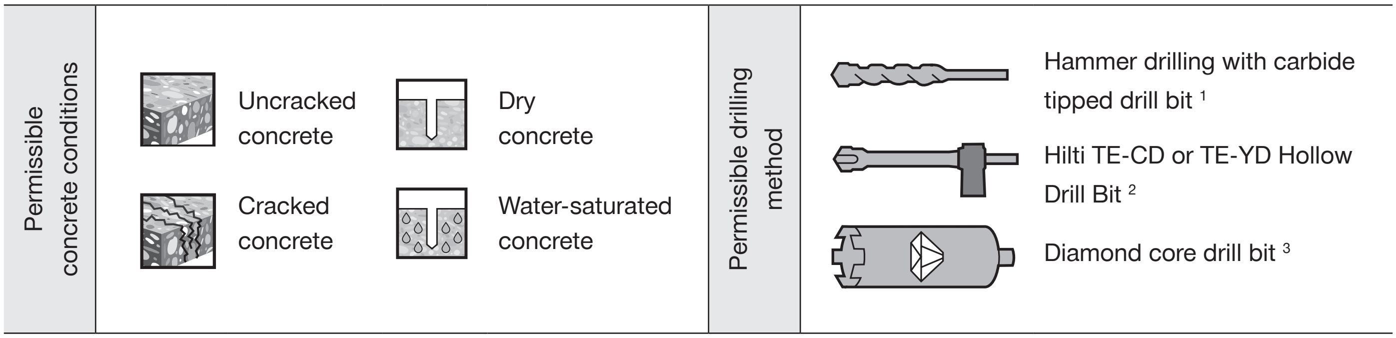


Figure 1 — Hilti HIT-Z and HIT-Z-R installation conditions

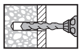
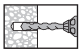


1 Anchor may be installed in a hole drilled with a carbide-tipped bit without cleaning the drilling dust from the hole. Temperature must be 41° F or higher. Drilling dust must be removed from the hole if the temperature is below 41° F. See Manufacturer's Published Installation Instructions (MPII).

2 When temperatures are below 41° F, TE-CD or TE-YD Hollow Drill Bits used with a Hilti vacuum cleaner are viable methods for removing drilling dust from the hole.

3 Holes drilled by diamond coring require cleaning with a water hose and compressed air. See MPII.

Table 1 — Specifications for Hilti HIT-Z and HIT-Z-R installed with Hilti HIT-HY 200 A/R V3 adhesive

Setting information		Symbol	Units	Nominal anchor diameter			
				3/8	1/2	5/8	3/4
Nominal bit diameter		d_o	in.	7/16	9/16	3/4	7/8
Effective embedment	minimum	$h_{ef,min}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-3/4 (95)	4 (102)
	maximum	$h_{ef,max}$	in. (mm)	4-1/2 (114)	6 (152)	7-1/2 (190)	8-1/2 (216)
Diameter of fixture hole	through-set		in.	1/2	5/8	13/16[1]	15/16[1]
	preset		in.	7/16	9/16	11/16	13/16
Installation torque	HIT-Z	T_{inst}	ft-lb (Nm)	15 (20)	30 (40)	60 (80)	110 (150)
	HIT-Z-R	T_{inst}	ft-lb (Nm)	30 (40)	65 (90)	125 (170)	165 (220)

1 Install using (2) washers. See Figure 3.

Figure 2 — Hilti HIT-Z and HIT-Z-R specfications

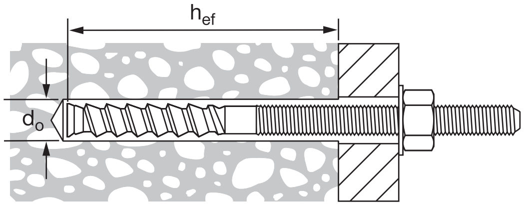


Figure 3 — Installation with (2) washers

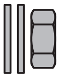


Table 2 — Hilti HIT-Z and HIT-Z-R anchor rod length and thread dimension

Size	ℓ Anchor length		ℓ_{helix} Helix length		Smooth shank length		Total thread length		Usable thread length		HIT-Z Length Code
	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	
3/8 x 3-3/8	3-3/8	(85)	2-1/4	(57)	3/8	(6)	13/16	(21)	5/16	(8)	D
3/8 x 4-3/8	4-3/8	(111)	2-1/4	(57)	5/16	(8)	1-13/16	(46)	1-5/16	(33)	F
3/8 x 5-1/8	5-1/8	(130)	2-1/4	(57)	5/16	(8)	2-9/16	(65)	2-1/16	(52)	H
3/8 x 6-3/8	6-3/8	(162)	2-1/4	(57)	5/16	(8)	3-13/16	(97)	3-5/16	(84)	J
1/2 x 4-1/2	4-1/2	(114)	2-1/2	(63)	5/16	(8)	1-11/16	(43)	1	(26)	F
1/2 x 6-1/2	6-1/2	(165)	2-1/2	(63)	5/16	(8)	3-11/16	(94)	3-1/16	(77)	J
1/2 x 7-3/4	7-3/4	(197)	2-1/2	(63)	5/16	(8)	4-15/16	(126)	4-5/16	(109)	M
5/8 x 6	6	(152)	3-5/8	(92)	7/16	(11)	1-15/16	(49)	1-1/8	(28)	I
5/8 x 8	8	(203)	3-5/8	(92)	7/16	(11)	3-15/16	(100)	3-1/8	(79)	M
5/8 x 9-1/2	9-1/2	(241)	3-5/8	(92)	1-15/16	(49)	3-15/16	(100)	3-1/8	(79)	P
3/4 x 6-1/2	6-1/2	(165)	4	(102)	5/16	(8)	2	(51)	1	(26)	K
3/4 x 8-1/2	8-1/2	(216)	4	(102)	7/16	(12)	4	(102)	3-1/16	(77)	N
3/4 x 9-3/4	9-3/4	(248)	4	(102)	1-11/16	(44)	4	(102)	3-1/16	(77)	Q

Figure 4 — Hilti HIT-Z and HIT-Z-R anchor rod length and thread dimension

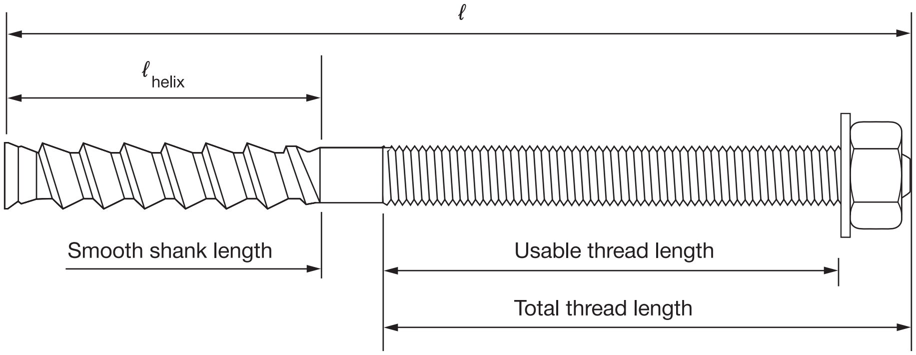


Table 3 — Hilti HIT-HY 200 A/R V3 design strength with concrete/pullout failure for Hilti HIT-Z(-R) rods in uncracked concrete[1,2,3,4,5,6,7,8,9,10]

Nominal anchor diameter in.	Effective embed. in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8	2-3/8 (60)	2,855 (12.7)	3,125 (13.9)	3,610 (16.1)	4,425 (19.7)	3,075 (13.7)	3,370 (15.0)	3,890 (17.3)	4,765 (21.2)
	3-3/8 (86)	4,835 (21.5)	5,170 (23.0)	5,170 (23.0)	5,170 (23.0)	10,415 (46.3)	11,410 (50.8)	13,175 (58.6)	16,135 (71.8)
	4-1/2 (114)	5,170 (23.0)	5,170 (23.0)	5,170 (23.0)	5,170 (23.0)	16,035 (71.3)	17,570 (78.2)	20,285 (90.2)	24,845 (110.5)
1/2	2-3/4 (70)	3,555 (15.8)	3,895 (17.3)	4,500 (20.0)	5,510 (24.5)	7,660 (34.1)	8,395 (37.3)	9,690 (43.1)	11,870 (52.8)
	4-1/2 (114)	7,445 (33.1)	7,615 (33.9)	7,615 (33.9)	7,615 (33.9)	16,035 (71.3)	17,570 (78.2)	20,285 (90.2)	24,845 (110.5)
	6 (152)	7,615 (33.9)	7,615 (33.9)	7,615 (33.9)	7,615 (33.9)	24,690 (109.8)	27,045 (120.3)	31,230 (138.9)	38,250 (170.1)
5/8	3-3/4 (95)	5,665 (25.2)	6,205 (27.6)	7,165 (31.9)	8,775 (39.0)	12,200 (54.3)	13,365 (59.5)	15,430 (68.6)	18,900 (84.1)
	5-5/8 (143)	10,405 (46.3)	11,400 (50.7)	13,165 (58.6)	13,905 (61.9)	22,415 (99.7)	24,550 (109.2)	28,350 (126.1)	34,720 (154.4)
	7-1/2 (191)	13,905 (61.9)	13,905 (61.9)	13,905 (61.9)	13,905 (61.9)	34,505 (153.5)	37,800 (168.1)	43,650 (194.2)	53,455 (237.8)
3/4	4 (102)	6,240 (27.8)	6,835 (30.4)	7,895 (35.1)	9,665 (43.0)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
	6-3/4 (171)	13,680 (60.9)	14,985 (66.7)	17,305 (77.0)	18,500 (82.3)	29,460 (131.0)	32,275 (143.6)	37,265 (165.8)	45,645 (203.0)
	8-1/2 (216)	18,500 (82.3)	18,500 (82.3)	18,500 (82.3)	18,500 (82.3)	41,635 (185.2)	45,605 (202.9)	52,660 (234.2)	64,500 (286.9)

Table 4 — Hilti HIT-HY 200 A/R V3 design strength with concrete/pullout failure for Hilti HIT-Z(-R) rods in cracked concrete[1,2,3,4,5,6,7,8,9,10]

Nominal anchor diameter in.	Effective embed. in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8	2-3/8 (60)	2,020 (9.0)	2,215 (9.9)	2,560 (11.4)	3,135 (13.9)	2,180 (9.7)	2,385 (10.6)	2,755 (12.3)	3,375 (15.0)
	3-3/8 (86)	3,425 (15.2)	3,755 (16.7)	4,335 (19.3)	5,170 (23.0)	7,380 (32.8)	8,085 (36.0)	9,335 (41.5)	11,430 (50.8)
	4-1/2 (114)	5,170 (23.0)	5,170 (23.0)	5,170 (23.0)	5,170 (23.0)	11,360 (50.5)	12,445 (55.4)	14,370 (63.9)	17,600 (78.3)
1/2	2-3/4 (70)	2,520 (11.2)	2,760 (12.3)	3,185 (14.2)	3,905 (17.4)	5,425 (24.1)	5,945 (26.4)	6,865 (30.5)	8,405 (37.4)
	4-1/2 (114)	5,275 (23.5)	5,780 (25.7)	6,670 (29.7)	7,110 (31.6)	11,360 (50.5)	12,445 (55.4)	14,370 (63.9)	17,600 (78.3)
	6 (152)	7,110 (31.6)	7,110 (31.6)	7,110 (31.6)	7,110 (31.6)	17,490 (77.8)	19,160 (85.2)	22,120 (98.4)	27,095 (120.5)
5/8	3-3/4 (95)	4,010 (17.8)	4,395 (19.5)	5,075 (22.6)	6,215 (27.6)	8,640 (38.4)	9,465 (42.1)	10,930 (48.6)	13,390 (59.6)
	5-5/8 (143)	7,370 (32.8)	8,075 (35.9)	9,325 (41.5)	11,420 (50.8)	15,875 (70.6)	17,390 (77.4)	20,080 (89.3)	24,595 (109.4)
	7-1/2 (191)	11,350 (50.5)	12,430 (55.3)	13,905 (61.9)	13,905 (61.9)	24,440 (108.7)	26,775 (119.1)	30,915 (137.5)	37,865 (168.4)
3/4	4 (102)	4,420 (19.7)	4,840 (21.5)	5,590 (24.9)	6,845 (30.4)	9,520 (42.3)	10,430 (46.4)	12,040 (53.6)	14,750 (65.6)
	6-3/4 (171)	9,690 (43.1)	10,615 (47.2)	12,255 (54.5)	15,010 (66.8)	20,870 (92.8)	22,860 (101.7)	26,395 (117.4)	32,330 (143.8)
	8-1/2 (216)	13,690 (60.9)	15,000 (66.7)	17,320 (77.0)	18,155 (80.8)	29,490 (131.2)	32,305 (143.7)	37,300 (165.9)	45,685 (203.2)

1 Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 10 - 17 as necessary to the above values. Compare to the steel values in table 5. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 1.0.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.90.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry and water saturated concrete conditions.

7 Tabular values are for short-term loads only. For sustained loads, see section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension only by the following reduction factors:
3/8-in diameter - $\alpha_{N,seis}$ = 0.705
1/2-in to 3/4-in diameter - $\alpha_{N,seis}$ = 0.75
See Section 3.1.8 for additional information on seismic applications.

10 Diamond core drilling with Hilti HIT-Z(-R) rods is permitted with no reduction in published data above.

Table 5 — Steel design strength for Hilti HIT-Z and HIT-Z-R rods [1,2]

Nominal anchor diameter in.	ACI 318 Chapter 17 Based Design					
	HIT-Z carbon steel rod			HIT-Z-R stainless steel rod		
	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic Shear[5] $\phi V_{sa,eq}$ lb (kN)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic Shear[5] $\phi V_{sa,eq}$ lb (kN)
3/8	4,750 (21.1)	1,930 (8.6)	1,255 (5.6)	4,750 (21.1)	2,630 (11.7)	2,080 (9.3)
1/2	8,695 (38.7)	3,530 (15.7)	2,295 (10.2)	8,695 (38.7)	4,815 (21.4)	3,610 (16.1)
5/8	13,850 (61.6)	5,625 (25.0)	3,655 (16.3)	13,850 (61.6)	7,670 (34.1)	4,985 (22.2)
3/4	20,455 (91.0)	8,310 (37.0)	5,400 (24.0)	20,455 (91.0)	11,330 (50.4)	7,365 (32.8)

[1] See section 3.1.8 to convert design strength value to ASD value.
[2] HIT-Z and HIT-Z-R rods are to be considered brittle steel elements.
[3] Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
[4] Shear values determined by static shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17.
[5] Seismic Shear = $\alpha_{V,seis}\ \phi_{Vsa}$: Reduction for seismic shear only. See section 3.1.8 for additional information on seismic applications.

Hilti HIT-Z(-R) rod permissible combinations of edge distance, anchor spacing, and concrete thickness

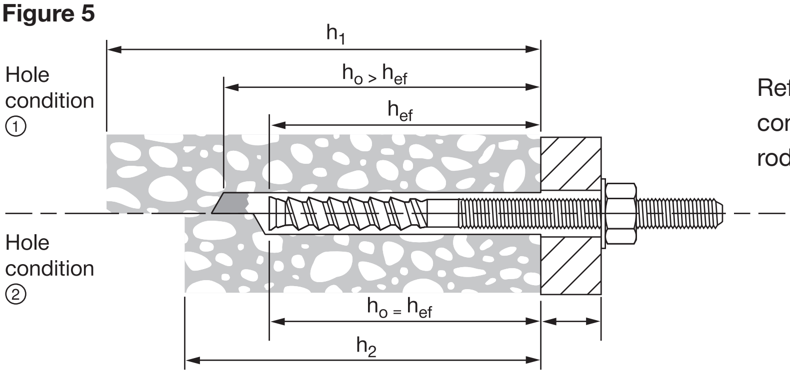
The Hilti HIT-Z and HIT-Z-R anchor rods produce higher expansion forces in the concrete slab when the installation torque is applied. This means that the anchor must be installed with larger edge distances and spacing when compared to standard threaded rod, to minimize the likelihood that the concrete slab will split during installation.

The permissible edge distance is based on the concrete condition (cracked or uncracked), the concrete thickness, and anchor spacing if designing for anchor groups. The permissible concrete thickness is dependent on whether or not the drill dust is removed during the anchor installation process.

Step 1: Check concrete thickness

When using Hilti HIT-Z and HIT-Z-R anchor rods, drilling dust does not need to be removed for optimum capacity when base material temperatures are greater than 41° F (5° C) and a hammer drill with a carbide tipped drill bit is used. However, concrete thickness can be reduced if the drilling dust is removed. The figure below shows both drilled hole conditions. **Drilled hole condition 1** illustrates the hole depth and concrete thickness when drilling dust is left in the hole. **Drilled hole condition 2** illustrates the corresponding reduction when drill dust is removed by using compressed air, Hilti TE-CD or TE-YD Hollow Drill Bits with a Hilti vacuum.

Figure 5

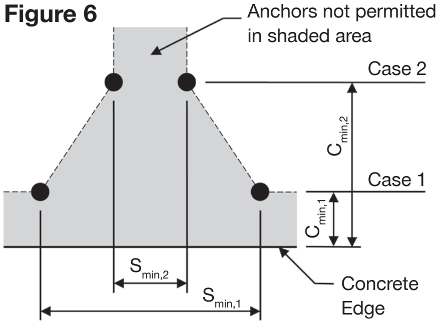


Refer to tables 6 to 9 in this section for the minimum concrete thicknesses associated with the Hilti HIT-Z(-R) rods based on diameter and drilled hole condition.

Step 2: Check edge distance and anchor spacing

Tables 6 to 9 in this section show the minimum edge distance and anchor spacing based on a specific concrete thickness and whether or not the design is for cracked or uncracked concrete. There are two cases of edge distance and anchor spacing combinations for each embedment and concrete condition (cracked or uncracked). **Case 1** is the minimum edge distance needed for one anchor or for two anchors with large anchor spacing. **Case 2** is the minimum anchor spacing that can be used, but the edge distance is increased to help prevent splitting. Linear interpolation can be used between **Case 1** and **Case 2** for any specific concrete thickness and concrete condition. See the following figure and calculation which can be used to determine specific edge distance and anchor spacing combinations.

Figure 6



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}(c - c_{min,2})$$

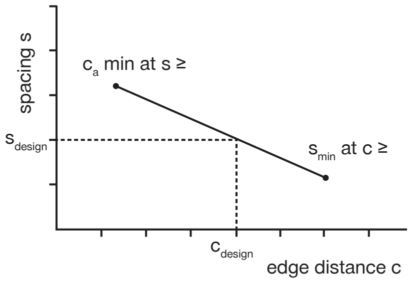


Table 6 — Minimum edge distance, spacing, and concrete thickness for 3/8-in. diameter Hilti HIT-Z and HIT-Z-R rods[1]

Nominal anchor diameter		d	in.	3/8								
Effective embedment		h_{ef}	in. (mm)	2-3/8 (60)			3-3/8 (86)			4-1/2 (114)		
Drilled hole condition		-	-	2 [2]	1 or 2		2 [2]	1 or 2		2 [2]	1 or 2	
Minimum concrete thickness		h	in. (mm)	4 (102)	4-5/8 (117)	5-3/4 (146)	4-5/8 (117)	5-5/8 (143)	6-3/8 (162)	5-3/4 (146)	6-3/4 (171)	7-3/8 (187)
Uncracked concrete	Minimum edge and spacing **Case 1**	$c_{min,1}$	in. (mm)	3-1/8 (79)	2-3/4 (70)	2-1/4 (57)	2-3/4 (70)	2-1/4 (57)	2 (51)	2-1/4 (57)	1-7/8 (48)	1-7/8 (48)
		$s_{min,1}$	in. (mm)	9-1/8 (232)	7-3/4 (197)	6-1/8 (156)	7-3/4 (197)	6-1/2 (165)	5-5/8 (143)	6-1/8 (156)	5-3/8 (137)	4-1/2 (114)
	Minimum edge and spacing **Case 2**	$c_{min,2}$	in. (mm)	5-5/8 (143)	4-3/4 (121)	3-3/4 (95)	4-3/4 (121)	3-7/8 (98)	3-1/4 (83)	3-3/4 (95)	3-1/8 (79)	2-3/4 (70)
		$s_{min,2}$	in. (mm)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)
Cracked concrete	Minimum edge and spacing **Case 1**	$c_{min,1}$	in. (mm)	2-1/8 (54)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)
		$s_{min,1}$	in. (mm)	6-3/8 (162)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	3-1/2 (89)	2-5/8 (67)	3-1/4 (83)	2 (51)	1-7/8 (48)
	Minimum edge and spacing **Case 2**	$c_{min,2}$	in. (mm)	3-5/8 (92)	3-1/8 (79)	2-3/8 (60)	3-1/8 (79)	2-1/2 (64)	2-1/8 (54)	2-3/8 (60)	2 (51)	1-7/8 (48)
		$s_{min,2}$	in. (mm)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)	1-7/8 (48)

Table 7 — Minimum edge distance, spacing, and concrete thickness for 1/2-in. diameter Hilti HIT-Z and HIT-Z-R rods[1]

Nominal anchor diameter		d	in.	1/2								
Effective embedment		h_{ef}	in. (mm)	2-3/4 (70)			4-1/2 (114)			6 (152)		
Drilled hole condition		-	-	2 [2]	1 or 2		2 [2]	1 or 2		2 [2]	1 or 2	
Minimum concrete thickness		h	in. (mm)	4 (102)	5 (127)	7-1/8 (181)	5-3/4 (146)	6-3/4 (171)	8-1/4 (210)	7-1/4 (184)	8-1/4 (210)	9-3/4 (248)
Uncracked Concrete	Minimum edge and spacing **Case 1**	$c_{min,1}$	in. (mm)	5-1/8 (130)	4-1/8 (105)	2-7/8 (73)	3-5/8 (92)	3 (76)	2-1/2 (64)	2-7/8 (73)	2-1/2 (64)	2-1/2 (64)
		$s_{min,1}$	in. (mm)	14-7/8 (378)	11-7/8 (302)	8-5/8 (219)	10-1/4 (260)	9 (229)	7-1/4 (184)	8-1/8 (206)	7-1/4 (184)	5 (127)
	Minimum edge and spacing **Case 2**	$c_{min,2}$	in. (mm)	9-1/4 (235)	7-1/4 (184)	4-7/8 (124)	6-1/4 (159)	5-1/4 (133)	4-1/8 (105)	4-3/4 (121)	4-1/8 (105)	3-3/8 (86)
		$s_{min,2}$	in. (mm)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)
Cracked Concrete	Minimum edge and spacing **Case 1**	$c_{min,1}$	in. (mm)	3-5/8 (92)	3 (76)	2-1/2 (64)	2-5/8 (67)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)
		$s_{min,1}$	in. (mm)	10-7/8 (276)	8-1/2 (216)	6 (152)	7-3/8 (187)	5-1/2 (140)	3-1/8 (79)	4-1/2 (114)	3-1/8 (79)	2-1/2 (64)
	Minimum edge and spacing **Case 2**	$c_{min,2}$	in. (mm)	6-1/2 (165)	5 (127)	3-1/4 (83)	4-1/4 (108)	3-1/2 (89)	2-3/4 (70)	3-1/4 (83)	2-3/4 (70)	2-1/2 (64)
		$s_{min,2}$	in. (mm)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)	2-1/2 (64)

[1] Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2.
Linear interpoloation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$, will determine the permissible spacing s as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}(c - c_{min,2})$$

[2] For shaded cells, drilling dust must be removed from drilled hole to justify minimum concrete thickness.

Table 8 — Minimum edge distance, spacing, and concrete thickness for 5/8-in. diameter Hilti HIT-Z and HIT-Z-R rods[1]

Nominal anchor diameter		d	in.	5/8								
Effective embedment		h_{ef}	in. (mm)	3-3/4 (95)			5-5/8 (143)			7-1/2 (191)		
Drilled hole condition		-	-	2[2]	1 or 2		2[2]	1 or 2		2[2]	1 or 2	
Minimum concrete thickness		h	in. (mm)	5-1/2 (140)	7-3/4 (197)	9-3/8 (238)	7-3/8 (187)	9-5/8 (244)	10-1/2 (267)	9-1/4 (235)	11-1/2 (292)	12-1/4 (311)
Uncracked concrete	Minimum edge and spacing **Case 1**	$c_{min,1}$	in. (mm)	6-1/4 (159)	4-1/2 (114)	3-3/4 (95)	4-5/8 (117)	3-5/8 (92)	3-1/4 (83)	3-3/4 (95)	3-1/8 (79)	3-1/8 (79)
		$s_{min,1}$	in. (mm)	18-3/8 (467)	12-7/8 (327)	10-5/8 (270)	13-7/8 (352)	10-3/8 (264)	9-3/4 (248)	10-7/8 (276)	8-3/8 (213)	7-3/8 (187)
	Minimum edge and spacing **Case 2**	$c_{min,2}$	in. (mm)	11-3/8 (289)	7-3/4 (197)	6-1/4 (159)	8-1/4 (210)	6-1/8 (156)	5-1/2 (140)	6-3/8 (162)	4-7/8 (124)	4-5/8 (117)
		$s_{min,2}$	in. (mm)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)
Cracked concrete	Minimum edge and spacing **Case 1**	$c_{min,1}$	in. (mm)	4-5/8 (117)	3-3/8 (86)	3-1/8 (79)	3-1/2 (89)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)
		$s_{min,1}$	in. (mm)	13-7/8 (352)	9-1/2 (241)	8-3/4 (222)	10-1/8 (257)	6-1/2 (165)	5-3/8 (137)	7-1/8 (181)	3-7/8 (98)	3-1/8 (79)
	Minimum edge and spacing **Case 2**	$c_{min,2}$	in. (mm)	8-1/4 (210)	5-1/2 (140)	4-3/8 (111)	5-7/8 (149)	4-1/4 (108)	3-7/8 (98)	4-1/2 (114)	3-3/8 (86)	3-1/8 (79)
		$s_{min,2}$	in. (mm)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)

Table 9 — Minimum edge distance, spacing, and concrete thickness for 3/4-in. diameter Hilti HIT-Z and HIT-Z-R rods[1]

Nominal anchor diameter		d	in.	3/4								
Effective embedment		h_{ef}	in. (mm)	4 (102)			6-3/4 (171)			8-1/2 (216)		
Drilled hole condition		-	-	2[2]	1 or 2		2[2]	1 or 2		2[2]	1 or 2	
Minimum concrete thickness		h	in. (mm)	5-3/4 (146)	8 (203)	11-1/2 (292)	8-1/2 (216)	10-3/4 (273)	13-1/8 (333)	10-1/4 (260)	12-1/2 (318)	14-1/2 (368)
Uncracked concrete	Minimum edge and spacing **Case 1**	$c_{min,1}$	in. (mm)	9-3/4 (248)	7 (178)	5 (127)	6-5/8 (168)	5-1/4 (133)	4-1/4 (108)	5-1/2 (140)	4-1/2 (114)	4 (102)
		$s_{min,1}$	in. (mm)	28-3/4 (730)	20-5/8 (524)	14 (356)	19-3/8 (492)	15-1/4 (387)	12-5/8 (321)	16 (406)	13-1/4 (337)	11 (279)
	Minimum edge and spacing **Case 2**	$c_{min,2}$	in. (mm)	18-1/8 (460)	12-5/8 (321)	8-1/2 (216)	11-7/8 (302)	9-1/8 (232)	7-1/4 (184)	9-5/8 (244)	7-3/4 (197)	6-1/2 (165)
		$s_{min,2}$	in. (mm)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)
Cracked concrete	Minimum edge and spacing **Case 1**	$c_{min,1}$	in. (mm)	7-1/4 (184)	5-1/4 (133)	4-1/8 (105)	5 (127)	4 (102)	3-3/4 (95)	4-1/8 (105)	3-3/4 (95)	3-3/4 (95)
		$s_{min,1}$	in. (mm)	21-3/4 (552)	15-1/2 (394)	12-1/4 (311)	14-1/2 (368)	11-3/8 (289)	9 (229)	12-1/8 (308)	8-3/4 (222)	6-1/2 (165)
	Minimum edge and spacing **Case 2**	$c_{min,2}$	in. (mm)	13-1/4 (337)	9-1/4 (235)	6 (152)	8-5/8 (219)	6-5/8 (168)	5-1/8 (130)	7 (178)	5-1/2 (140)	4-1/2 (114)
		$s_{min,2}$	in. (mm)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpoloation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$, will determine the permissible spacing s as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}(c - c_{min,2})$$

2 For shaded cells, drilling dust must be removed from drilled hole to justify minimum concrete thickness.

Table 10 — Load adjustment factors for 3/8-in. diameter Hilti HIT-Z and HIT-Z-R rods in uncracked concrete [1,2]

3/8-in. HIT-Z(-R) uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[4] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-7/8	(48)	0.63	0.59	0.57	n/a	n/a	0.21	0.57	0.53	0.52	n/a	n/a	0.05	n/a	n/a	0.10	n/a	n/a	n/a
	2	(51)	0.64	0.60	0.57	n/a	0.25	0.21	0.57	0.53	0.52	n/a	0.09	0.06	n/a	0.17	0.11	n/a	n/a	n/a
	2-1/4	(57)	0.66	0.61	0.58	0.38	0.26	0.22	0.58	0.54	0.53	0.33	0.10	0.07	0.38	0.21	0.13	n/a	n/a	n/a
	3	(76)	0.71	0.65	0.61	0.46	0.30	0.25	0.61	0.55	0.54	0.51	0.16	0.10	0.51	0.32	0.21	n/a	n/a	n/a
	4	(102)	0.78	0.70	0.65	0.59	0.36	0.29	0.64	0.57	0.55	0.79	0.24	0.16	0.79	0.44	0.29	0.76	n/a	n/a
	4-5/8	(117)	0.82	0.73	0.67	0.69	0.40	0.31	0.66	0.58	0.56	0.98	0.30	0.20	0.98	0.49	0.31	0.81	0.55	n/a
	5	(127)	0.85	0.75	0.69	0.74	0.43	0.33	0.68	0.58	0.56	1.00	0.34	0.22	1.00	0.52	0.33	0.84	0.57	n/a
	5-3/4	(146)	0.90	0.78	0.71	0.86	0.49	0.36	0.70	0.59	0.57	1.00	0.42	0.27	1.00	0.59	0.36	0.91	0.61	0.53
	6	(152)	0.92	0.80	0.72	0.89	0.51	0.38	0.71	0.60	0.57	1.00	0.45	0.29	1.00	0.62	0.38	0.92	0.63	0.54
	7	(178)	0.99	0.85	0.76	1.00	0.60	0.43	0.75	0.61	0.59		0.57	0.37		0.72	0.43	1.00	0.68	0.58
	8	(203)	1.00	0.90	0.80		0.69	0.49	0.79	0.63	0.60		0.69	0.45		0.83	0.49	1.00	0.72	0.63
	9	(229)	1.00	0.94	0.83		0.77	0.55	0.82	0.65	0.61		0.83	0.54		0.93	0.55		0.77	0.66
	10	(254)	1.00	0.99	0.87		0.86	0.61	0.86	0.66	0.62		0.97	0.63		1.00	0.63		0.81	0.70
	11	(279)		1.00	0.91		0.94	0.67	0.89	0.68	0.63		1.00	0.72			0.72		0.85	0.73
	12	(305)			0.94		1.00	0.73	0.93	0.70	0.65			0.83			0.83		0.88	0.77
	14	(356)			1.00			0.85	1.00	0.73	0.67			1.00			1.00		0.96	0.83
	16	(406)						0.98		0.76	0.70								1.00	0.88
	18	(457)						1.00		0.79	0.72									0.94
	24	(610)								0.89	0.79									1.00
	30	(762)								0.99	0.87									
	36	(914)								1.00	0.94									
	> 48	(1219)									1.00									

Table 11 — Load adjustment factors for 3/8-in. diameter Hilti HIT-Z and HIT-Z-R rods in cracked concrete [1,2]

3/8-in. HIT-Z(-R) cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[4] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-7/8	(48)	0.63	0.59	0.57	n/a	0.56	0.50	0.57	0.53	0.52	n/a	0.08	0.05	n/a	0.16	0.10	n/a	n/a	n/a
	2	(51)	0.64	0.60	0.57	n/a	0.57	0.51	0.57	0.53	0.52	n/a	0.09	0.06	n/a	0.17	0.11	n/a	n/a	n/a
	2-1/4	(57)	0.66	0.61	0.58	0.73	0.60	0.53	0.58	0.54	0.53	0.34	0.10	0.07	0.67	0.21	0.14	n/a	n/a	n/a
	3	(76)	0.71	0.65	0.61	0.88	0.70	0.60	0.61	0.55	0.54	0.52	0.16	0.10	0.88	0.32	0.21	n/a	n/a	n/a
	4	(102)	0.78	0.70	0.65	1.00	0.84	0.70	0.64	0.57	0.55	0.80	0.25	0.16	1.00	0.49	0.32	0.76	n/a	n/a
	4-5/8	(117)	0.82	0.73	0.67		0.93	0.76	0.67	0.58	0.56	0.99	0.31	0.20		0.61	0.40	0.81	0.55	n/a
	5	(127)	0.85	0.75	0.69		0.99	0.80	0.68	0.58	0.56	1.00	0.34	0.22		0.69	0.45	0.85	0.57	n/a
	5-3/4	(146)	0.90	0.78	0.71		1.00	0.88	0.71	0.59	0.57		0.42	0.28		0.85	0.55	0.91	0.61	0.53
	6	(152)	0.92	0.80	0.72			0.91	0.71	0.60	0.57		0.45	0.29		0.91	0.59	0.93	0.63	0.54
	7	(178)	0.99	0.85	0.76			1.00	0.75	0.61	0.59		0.57	0.37		1.00	0.74	1.00	0.68	0.59
	8	(203)	1.00	0.90	0.80				0.79	0.63	0.60		0.70	0.45			0.91		0.72	0.63
	9	(229)		0.94	0.83				0.82	0.65	0.61		0.83	0.54			1.00		0.77	0.67
	10	(254)		0.99	0.87				0.86	0.66	0.62		0.97	0.63					0.81	0.70
	11	(279)		1.00	0.91				0.89	0.68	0.64		1.00	0.73					0.85	0.74
	12	(305)			0.94				0.93	0.70	0.65			0.83					0.89	0.77
	14	(356)			1.00				1.00	0.73	0.67			1.00					0.96	0.83
	16	(406)								0.76	0.70								1.00	0.89
	18	(457)								0.79	0.72									0.94
	24	(610)								0.89	0.79									1.00
	30	(762)								0.99	0.87									
	36	(914)								1.00	0.94									
	> 48	(1219)									1.00									

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded area, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with figure 6 and table 6 of this section to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 12 — Load adjustment factors for 1/2-in. diameter Hilti HIT-Z and HIT-Z-R rods in uncracked concrete [1,2]

1/2-in. HIT-Z(-R) uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[4] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	2-3/4 (70)	4-1/2 (114)	6 (152)	2-3/4 (70)	4-1/2 (114)	6 (152)	2-3/4 (70)	4-1/2 (114)	6 (152)	2-3/4 (70)	4-1/2 (114)	6 (152)	2-3/4 (70)	4-1/2 (114)	6 (152)	2-3/4 (70)	4-1/2 (114)	6 (152)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	2-1/2	(64)	0.65	0.59	0.57	n/a	0.23	0.20	0.55	0.53	0.53	n/a	0.09	0.06	n/a	0.18	0.12	n/a	n/a	n/a
	2-7/8	(73)	0.67	0.61	0.58	0.35	0.24	0.21	0.56	0.54	0.53	0.22	0.11	0.07	0.35	0.22	0.15	n/a	n/a	n/a
	3	(76)	0.68	0.61	0.58	0.36	0.25	0.21	0.56	0.54	0.53	0.23	0.12	0.08	0.36	0.24	0.15	n/a	n/a	n/a
	3-1/2	(89)	0.71	0.63	0.60	0.40	0.27	0.22	0.57	0.55	0.54	0.29	0.15	0.10	0.40	0.30	0.19	n/a	n/a	n/a
	4	(102)	0.74	0.65	0.61	0.44	0.29	0.24	0.58	0.55	0.54	0.36	0.18	0.12	0.44	0.33	0.24	0.58	n/a	n/a
	4-1/2	(114)	0.77	0.67	0.63	0.50	0.31	0.25	0.59	0.56	0.55	0.42	0.22	0.14	0.50	0.35	0.25	0.61	n/a	n/a
	5	(127)	0.80	0.69	0.64	0.55	0.33	0.27	0.60	0.57	0.55	0.50	0.26	0.17	0.55	0.38	0.27	0.65	n/a	n/a
	5-1/2	(140)	0.83	0.70	0.65	0.61	0.35	0.28	0.62	0.57	0.56	0.57	0.30	0.19	0.61	0.40	0.28	0.68	n/a	n/a
	6	(152)	0.86	0.72	0.67	0.66	0.38	0.30	0.63	0.58	0.56	0.65	0.34	0.22	0.66	0.43	0.30	0.71	0.57	n/a
	7	(178)	0.92	0.76	0.69	0.77	0.43	0.33	0.65	0.59	0.57	0.82	0.42	0.28	0.82	0.49	0.33	0.77	0.61	n/a
	7-1/4	(184)	0.94	0.77	0.70	0.80	0.44	0.34	0.65	0.60	0.57	0.87	0.45	0.29	0.87	0.50	0.34	0.78	0.62	0.54
	8	(203)	0.98	0.80	0.72	0.88	0.49	0.36	0.67	0.61	0.58	1.00	0.52	0.34	1.00	0.56	0.36	0.82	0.66	0.57
	9	(229)	1.00	0.83	0.75	0.99	0.55	0.40	0.69	0.62	0.59	1.00	0.62	0.40	1.00	0.63	0.40	0.87	0.70	0.60
	10	(254)	1.00	0.87	0.78	1.00	0.61	0.44	0.71	0.63	0.60	1.00	0.72	0.47	1.00	0.72	0.47	0.92	0.73	0.64
	11	(279)	1.00	0.91	0.81		0.67	0.48	0.73	0.65	0.61		0.84	0.54		0.84	0.54	0.96	0.77	0.67
	12	(305)	1.00	0.94	0.83		0.73	0.53	0.75	0.66	0.62		0.95	0.62		0.95	0.62	1.00	0.80	0.70
	14	(356)	1.00	1.00	0.89		0.85	0.62	0.79	0.69	0.64		1.00	0.78		1.00	0.78		0.87	0.75
	16	(406)	1.00		0.94		0.98	0.70	0.83	0.72	0.66			0.95			0.95		0.93	0.80
	18	(457)			1.00		1.00	0.79	0.88	0.74	0.68			1.00			1.00		0.98	0.85
	24	(610)						1.00	1.00	0.82	0.74								1.00	0.98
	30	(762)								0.90	0.80									1.00
	36	(914)								0.98	0.86									
	> 48	(1219)								1.00	0.98									

Table 13 — Load adjustment factors for 1/2-in. diameter Hilti HIT-Z and HIT-Z-R rods in Cracked Concrete [1,2]

1/2-in. HIT-Z(-R) cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[4] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	2-3/4 (70)	4-1/2 (114)	6 (152)	2-3/4 (70)	4-1/2 (114)	6 (152)	2-3/4 (70)	4-1/2 (114)	6 (152)	2-3/4 (70)	4-1/2 (114)	6 (152)	2-3/4 (70)	4-1/2 (114)	6 (152)	2-3/4 (70)	4-1/2 (114)	6 (152)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	2-1/2	(64)	0.65	0.59	0.57	0.71	0.56	0.50	0.55	0.53	0.53	0.18	0.09	0.06	0.35	0.18	0.12	n/a	n/a	n/a
	2-7/8	(73)	0.67	0.61	0.58	0.77	0.59	0.53	0.56	0.54	0.53	0.22	0.11	0.07	0.44	0.23	0.15	n/a	n/a	n/a
	3	(76)	0.68	0.61	0.58	0.79	0.60	0.53	0.56	0.54	0.53	0.23	0.12	0.08	0.47	0.24	0.16	n/a	n/a	n/a
	3-1/2	(89)	0.71	0.63	0.60	0.88	0.65	0.57	0.57	0.55	0.54	0.29	0.15	0.10	0.59	0.30	0.20	n/a	n/a	n/a
	4	(102)	0.74	0.65	0.61	0.98	0.70	0.60	0.58	0.55	0.54	0.36	0.18	0.12	0.72	0.37	0.24	0.58	n/a	n/a
	4-1/2	(114)	0.77	0.67	0.63	1.00	0.75	0.64	0.59	0.56	0.55	0.43	0.22	0.14	0.86	0.44	0.29	0.62	n/a	n/a
	5	(127)	0.80	0.69	0.64	1.00	0.80	0.67	0.61	0.57	0.55	0.50	0.26	0.17	1.00	0.52	0.34	0.65	n/a	n/a
	5-1/2	(140)	0.83	0.70	0.65	1.00	0.86	0.71	0.62	0.57	0.56	0.58	0.30	0.19	1.00	0.60	0.39	0.68	n/a	n/a
	6	(152)	0.86	0.72	0.67	1.00	0.91	0.75	0.63	0.58	0.56	0.66	0.34	0.22	1.00	0.68	0.44	0.71	0.57	n/a
	7	(178)	0.92	0.76	0.69	1.00	1.00	0.83	0.65	0.59	0.57	0.83	0.43	0.28	1.00	0.86	0.56	0.77	0.62	n/a
	7-1/4	(184)	0.94	0.77	0.70			0.85	0.65	0.60	0.57	0.88	0.45	0.29		0.90	0.59	0.78	0.63	0.54
	8	(203)	0.98	0.80	0.72			0.91	0.67	0.61	0.58	1.00	0.52	0.34		1.00	0.68	0.82	0.66	0.57
	9	(229)	1.00	0.83	0.75			1.00	0.69	0.62	0.59		0.62	0.41			0.81	0.87	0.70	0.60
	10	(254)	1.00	0.87	0.78				0.71	0.64	0.60		0.73	0.47			0.95	0.92	0.74	0.64
	11	(279)	1.00	0.91	0.81				0.73	0.65	0.61		0.84	0.55			1.00	0.96	0.77	0.67
	12	(305)		0.94	0.83				0.75	0.66	0.62		0.96	0.62				1.00	0.81	0.70
	14	(356)		1.00	0.89				0.79	0.69	0.64		1.00	0.79					0.87	0.75
	16	(406)			0.94				0.84	0.72	0.66			0.96					0.93	0.81
	18	(457)			1.00				0.88	0.74	0.68			1.00					0.99	0.85
	24	(610)							1.00	0.82	0.74								1.00	0.99
	30	(762)								0.91	0.80									1.00
	36	(914)								0.99	0.87									
	> 48	(1219)								1.00	0.99									

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

[3] Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

▭ If a reduction factor value is in a shaded area, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with figure 6 and table 7 of this section to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 14 — Load adjustment factors for 5/8-in. diameter Hilti HIT-Z and HIT-Z-R rods in uncracked concrete [1,2]

5/8-in. HIT-Z(-R) uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[4] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}		in. (mm)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	3-1/8	(79)	0.64	0.59	0.57	n/a	n/a	0.20	0.55	0.54	0.53	n/a	n/a	0.07	n/a	n/a	0.13	n/a	n/a	n/a
	3-1/4	(83)	0.64	0.60	0.57	n/a	0.24	0.20	0.55	0.54	0.53	n/a	0.11	0.07	n/a	0.21	0.14	n/a	n/a	n/a
	3-3/4	(95)	0.67	0.61	0.58	0.34	0.25	0.21	0.56	0.54	0.53	0.23	0.13	0.09	0.34	0.27	0.17	n/a	n/a	n/a
	4	(102)	0.68	0.62	0.59	0.36	0.26	0.22	0.57	0.55	0.53	0.25	0.15	0.10	0.36	0.29	0.19	n/a	n/a	n/a
	5	(127)	0.72	0.65	0.61	0.42	0.29	0.24	0.58	0.56	0.54	0.36	0.21	0.13	0.42	0.38	0.24	n/a	n/a	n/a
	5-1/2	(140)	0.74	0.66	0.62	0.45	0.31	0.25	0.59	0.56	0.55	0.41	0.24	0.15	0.45	0.40	0.25	0.61	n/a	n/a
	6	(152)	0.77	0.68	0.63	0.49	0.33	0.26	0.60	0.57	0.55	0.47	0.27	0.18	0.49	0.42	0.26	0.63	n/a	n/a
	7	(178)	0.81	0.71	0.66	0.57	0.36	0.29	0.62	0.58	0.56	0.59	0.34	0.22	0.59	0.47	0.29	0.68	n/a	n/a
	7-3/8	(187)	0.83	0.72	0.66	0.60	0.38	0.30	0.62	0.59	0.56	0.64	0.37	0.24	0.64	0.49	0.30	0.70	0.58	n/a
	8	(203)	0.86	0.74	0.68	0.65	0.40	0.31	0.63	0.59	0.57	0.72	0.41	0.27	0.72	0.52	0.31	0.73	0.61	n/a
	9	(229)	0.90	0.77	0.70	0.73	0.45	0.34	0.65	0.60	0.58	0.86	0.50	0.32	0.86	0.58	0.34	0.78	0.65	n/a
	9-1/4	(235)	0.91	0.77	0.71	0.76	0.46	0.35	0.65	0.61	0.58	0.89	0.52	0.34	0.89	0.59	0.35	0.79	0.65	0.57
	10	(254)	0.94	0.80	0.72	0.82	0.50	0.37	0.67	0.62	0.59	1.00	0.58	0.38	1.00	0.64	0.38	0.82	0.68	0.59
	11	(279)	0.99	0.83	0.74	0.90	0.55	0.39	0.68	0.63	0.60	1.00	0.67	0.43	1.00	0.70	0.43	0.86	0.71	0.62
	12	(305)	1.00	0.86	0.77	0.98	0.60	0.43	0.70	0.64	0.60	1.00	0.76	0.50	1.00	0.77	0.50	0.90	0.75	0.65
	14	(356)	1.00	0.91	0.81	1.00	0.70	0.50	0.73	0.66	0.62		0.96	0.62		0.96	0.62	0.97	0.81	0.70
	16	(406)	1.00	0.97	0.86		0.80	0.57	0.77	0.69	0.64		1.00	0.76		1.00	0.76	1.00	0.86	0.75
	18	(457)	1.00	1.00	0.90		0.89	0.64	0.80	0.71	0.66			0.91			0.91		0.91	0.79
	24	(610)	1.00		1.00		1.00	0.86	0.90	0.78	0.71			1.00			1.00		1.00	0.91
	30	(762)						1.00	1.00	0.85	0.76									1.00
	36	(914)								0.92	0.81									
	> 48	(1219)								1.00	0.92									

Table 15 — Load adjustment factors for 5/8-in. diameter Hilti HIT-Z and HIT-Z-R rods in cracked concrete [1,2]

5/8-in. HIT-Z(-R) cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[4] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}		in. (mm)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)	3-3/4 (95)	5-5/8 (143)	7-1/2 (191)
Spacing (s) / Edge Distance (c_a) / Concrete thickness (h), - in. (mm)	3-1/8	(79)	0.64	0.59	0.57	0.67	0.56	0.50	0.55	0.54	0.53	0.18	0.10	0.07	0.35	0.20	0.13	n/a	n/a	n/a
	3-1/4	(83)	0.64	0.60	0.57	0.69	0.56	0.51	0.55	0.54	0.53	0.19	0.11	0.07	0.38	0.22	0.14	n/a	n/a	n/a
	3-3/4	(95)	0.67	0.61	0.58	0.75	0.60	0.53	0.56	0.54	0.53	0.23	0.13	0.09	0.47	0.27	0.17	n/a	n/a	n/a
	4	(102)	0.68	0.62	0.59	0.78	0.62	0.55	0.57	0.55	0.53	0.26	0.15	0.10	0.51	0.30	0.19	n/a	n/a	n/a
	5	(127)	0.72	0.65	0.61	0.91	0.70	0.60	0.58	0.56	0.54	0.36	0.21	0.13	0.72	0.41	0.27	n/a	n/a	n/a
	5-1/2	(140)	0.74	0.66	0.62	0.98	0.74	0.63	0.59	0.56	0.55	0.41	0.24	0.15	0.83	0.48	0.31	0.61	n/a	n/a
	6	(152)	0.77	0.68	0.63	1.00	0.78	0.66	0.60	0.57	0.55	0.47	0.27	0.18	0.94	0.54	0.35	0.64	n/a	n/a
	7	(178)	0.81	0.71	0.66	1.00	0.87	0.72	0.62	0.58	0.56	0.59	0.34	0.22	1.00	0.68	0.44	0.69	n/a	n/a
	7-3/8	(187)	0.83	0.72	0.66	1.00	0.90	0.74	0.62	0.59	0.56	0.64	0.37	0.24	1.00	0.74	0.48	0.70	0.59	n/a
	8	(203)	0.86	0.74	0.68	1.00	0.96	0.78	0.63	0.59	0.57	0.73	0.42	0.27	1.00	0.84	0.54	0.73	0.61	n/a
	9	(229)	0.90	0.77	0.70	1.00	1.00	0.85	0.65	0.60	0.58	0.87	0.50	0.32	1.00	1.00	0.65	0.78	0.65	n/a
	9-1/4	(235)	0.91	0.77	0.71			0.86	0.66	0.61	0.58	0.90	0.52	0.34			0.68	0.79	0.66	0.57
	10	(254)	0.94	0.80	0.72			0.91	0.67	0.62	0.59	1.00	0.58	0.38			0.76	0.82	0.68	0.59
	11	(279)	0.99	0.83	0.74			0.98	0.69	0.63	0.60		0.67	0.44			0.88	0.86	0.72	0.62
	12	(305)	1.00	0.86	0.77			1.00	0.70	0.64	0.60		0.77	0.50			1.00	0.90	0.75	0.65
	14	(356)	1.00	0.91	0.81				0.74	0.66	0.62		0.97	0.63			1.00	0.97	0.81	0.70
	16	(406)		0.97	0.86				0.77	0.69	0.64		1.00	0.77				1.00	0.86	0.75
	18	(457)		1.00	0.90				0.80	0.71	0.66			0.92					0.92	0.79
	24	(610)			1.00				0.90	0.78	0.71			1.00					1.00	0.92
	30	(762)							1.00	0.85	0.76									1.00
	36	(914)								0.92	0.81									
	> 48	(1219)								1.00	0.92									

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear applicable when $c < 3{*}h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded area, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with figure 6 and table 8 of this section to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 16 — Load adjustment factors for 3/4-in. diameter Hilti HIT-Z and HIT-Z-R rods in uncracked concrete [1,2]

3/4-in. HIT-Z(-R) uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	4 (102)	6-3/4 (171)	8-1/2 (216)	4 (102)	6-3/4 (171)	8-1/2 (216)	4 (102)	6-3/4 (171)	8-1/2 (216)	4 (102)	6-3/4 (171)	8-1/2 (216)	4 (102)	6-3/4 (171)	8-1/2 (216)	4 (102)	6-3/4 (171)	8-1/2 (216)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	3-3/4	(95)	0.66	0.59	0.57	n/a	n/a	n/a	0.56	0.54	0.53	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4	(102)	0.67	0.60	0.58	n/a	n/a	0.21	0.57	0.54	0.53	n/a	n/a	0.08	n/a	n/a	0.17	n/a	n/a	n/a
	4-1/8	(105)	0.67	0.60	0.58	n/a	n/a	0.21	0.57	0.54	0.53	n/a	n/a	0.09	n/a	n/a	0.18	n/a	n/a	n/a
	4-1/4	(108)	0.68	0.60	0.58	n/a	0.24	0.21	0.57	0.54	0.53	n/a	0.13	0.09	n/a	0.26	0.19	n/a	n/a	n/a
	5	(127)	0.71	0.62	0.60	0.39	0.26	0.23	0.58	0.55	0.54	0.35	0.17	0.12	0.39	0.32	0.23	n/a	n/a	n/a
	5-3/4	(146)	0.74	0.64	0.61	0.44	0.28	0.24	0.59	0.56	0.55	0.43	0.21	0.15	0.44	0.34	0.24	0.61	n/a	n/a
	6	(152)	0.75	0.65	0.62	0.45	0.28	0.24	0.60	0.56	0.55	0.45	0.22	0.16	0.45	0.35	0.24	0.63	n/a	n/a
	7	(178)	0.79	0.67	0.64	0.53	0.31	0.27	0.61	0.57	0.56	0.57	0.28	0.20	0.57	0.38	0.27	0.68	n/a	n/a
	8	(203)	0.83	0.70	0.66	0.60	0.34	0.29	0.63	0.58	0.56	0.70	0.34	0.24	0.70	0.42	0.29	0.72	n/a	n/a
	8-1/2	(216)	0.85	0.71	0.67	0.64	0.36	0.30	0.64	0.59	0.57	0.77	0.37	0.26	0.77	0.44	0.30	0.75	0.59	n/a
	9	(229)	0.88	0.72	0.68	0.68	0.37	0.31	0.65	0.59	0.57	0.83	0.40	0.29	0.83	0.45	0.31	0.77	0.60	n/a
	10	(254)	0.92	0.75	0.70	0.75	0.40	0.33	0.66	0.60	0.58	0.98	0.47	0.33	0.98	0.49	0.33	0.81	0.64	n/a
	10-1/4	(260)	0.93	0.75	0.70	0.77	0.41	0.34	0.67	0.60	0.58	1.00	0.49	0.35	1.00	0.50	0.35	0.82	0.64	0.57
	11	(279)	0.96	0.77	0.72	0.83	0.44	0.35	0.68	0.61	0.59	1.00	0.55	0.39	1.00	0.55	0.39	0.85	0.67	0.59
	12	(305)	1.00	0.80	0.74	0.90	0.48	0.38	0.70	0.62	0.60	1.00	0.62	0.44	1.00	0.62	0.44	0.89	0.70	0.62
	14	(356)	1.00	0.85	0.77	1.00	0.56	0.43	0.73	0.64	0.61	1.00	0.78	0.55	1.00	0.78	0.55	0.96	0.75	0.67
	16	(406)	1.00	0.90	0.81	1.00	0.64	0.50	0.76	0.66	0.63	1.00	0.96	0.68	1.00	0.96	0.68	1.00	0.80	0.72
	18	(457)	1.00	0.94	0.85	1.00	0.72	0.56	0.80	0.68	0.64	1.00	1.00	0.81	1.00	1.00	0.81		0.85	0.76
	24	(610)	1.00	1.00	0.97	1.00	0.97	0.75	0.89	0.74	0.69	1.00		1.00	1.00		1.00		0.99	0.88
	30	(762)	1.00		1.00		1.00	0.93	0.99	0.80	0.74								1.00	0.98
	36	(914)						1.00	1.00	0.86	0.79									1.00
	> 48	(1219)								0.99	0.89									

Table 17 — Load adjustment factors for 3/4-in. diameter Hilti HIT-Z and HIT-Z-R rods in cracked concrete [1,2]

3/4-in. HIT-Z(-R) cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	4 (102)	6-3/4 (171)	8-1/2 (216)	4 (102)	6-3/4 (171)	8-1/2 (216)	4 (102)	6-3/4 (171)	8-1/2 (216)	4 (102)	6-3/4 (171)	8-1/2 (216)	4 (102)	6-3/4 (171)	8-1/2 (216)	4 (102)	6-3/4 (171)	8-1/2 (216)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	3-3/4	(95)	0.66	0.59	0.57	n/a	0.56	0.51	0.56	0.54	0.53	n/a	0.11	0.08	n/a	0.22	0.16	n/a	n/a	n/a
	4	(102)	0.67	0.60	0.58	n/a	0.57	0.52	0.57	0.54	0.53	n/a	0.12	0.09	n/a	0.24	0.17	n/a	n/a	n/a
	4-1/8	(105)	0.67	0.60	0.58	0.76	0.58	0.53	0.57	0.54	0.53	0.26	0.13	0.09	0.52	0.25	0.18	n/a	n/a	n/a
	4-1/4	(108)	0.68	0.60	0.58	0.78	0.59	0.53	0.57	0.54	0.53	0.27	0.13	0.09	0.55	0.26	0.19	n/a	n/a	n/a
	5	(127)	0.71	0.62	0.60	0.87	0.63	0.57	0.58	0.55	0.54	0.35	0.17	0.12	0.70	0.34	0.24	n/a	n/a	n/a
	5-3/4	(146)	0.74	0.64	0.61	0.97	0.68	0.61	0.59	0.56	0.55	0.43	0.21	0.15	0.86	0.42	0.29	0.62	n/a	n/a
	6	(152)	0.75	0.65	0.62	1.00	0.70	0.62	0.60	0.56	0.55	0.46	0.22	0.16	0.92	0.44	0.31	0.63	n/a	n/a
	7	(178)	0.79	0.67	0.64	1.00	0.77	0.67	0.62	0.57	0.56	0.58	0.28	0.20	1.00	0.56	0.40	0.68	n/a	n/a
	8	(203)	0.83	0.70	0.66	1.00	0.84	0.72	0.63	0.58	0.56	0.70	0.34	0.24	1.00	0.68	0.48	0.73	n/a	n/a
	8-1/2	(216)	0.85	0.71	0.67	1.00	0.88	0.75	0.64	0.59	0.57	0.77	0.37	0.26	1.00	0.75	0.53	0.75	0.59	n/a
	9	(229)	0.88	0.72	0.68	1.00	0.91	0.78	0.65	0.59	0.57	0.84	0.41	0.29	1.00	0.82	0.58	0.77	0.61	n/a
	10	(254)	0.92	0.75	0.70	1.00	0.99	0.83	0.67	0.60	0.58	0.99	0.48	0.34	1.00	0.95	0.68	0.81	0.64	n/a
	10-1/4	(260)	0.93	0.75	0.70	1.00	1.00	0.85	0.67	0.60	0.58	1.00	0.50	0.35	1.00	0.99	0.70	0.82	0.65	0.58
	11	(279)	0.96	0.77	0.72	1.00		0.89	0.68	0.61	0.59	1.00	0.55	0.39	1.00	1.00	0.78	0.85	0.67	0.60
	12	(305)	1.00	0.80	0.74	1.00		0.95	0.70	0.62	0.60	1.00	0.63	0.44	1.00		0.89	0.89	0.70	0.62
	14	(356)	1.00	0.85	0.77	1.00		1.00	0.73	0.64	0.61	1.00	0.79	0.56	1.00		1.00	0.96	0.76	0.67
	16	(406)	1.00	0.90	0.81				0.76	0.66	0.63		0.97	0.68				1.00	0.81	0.72
	18	(457)	1.00	0.94	0.85				0.80	0.68	0.65		1.00	0.82					0.86	0.76
	24	(610)	1.00	1.00	0.97				0.90	0.74	0.69			1.00					0.99	0.88
	30	(762)			1.00				1.00	0.81	0.74								1.00	0.98
	36	(914)							1.00	0.87	0.79									1.00
	>48	(1219)								0.99	0.89									

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1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded area, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with figure 6 and table 9 of this section to calculate permissible edge distance, spacing and concrete thickness combinations.

Hilti HIT-HY 200 A/R V3 adhesive with deformed reinforcing bars (rebar)

Figure 7 — Rebar installation conditions

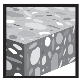
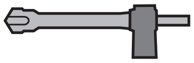
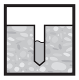
Permissible concrete conditions		Uncracked concrete		Dry concrete	Permissible drilling method		Hammer drilling with carbide tipped drill bit
		Cracked concrete		Water-saturated concrete			Hilti TE-CD or TE-YD Hollow Drill Bit
				Water-filled holes			

Figure 8 — Rebar installed with Hilti HIT-HY 200 A/R V3 adhesive

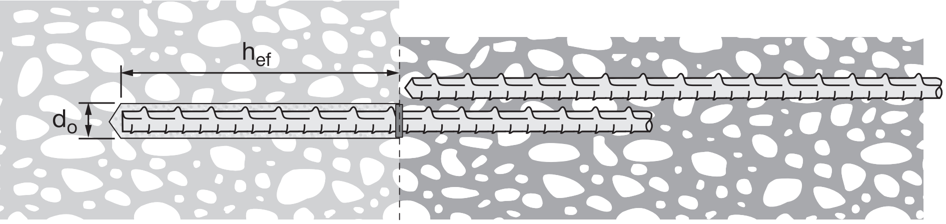


Table 18 — Specifications for rebar installed with Hilti HIT-HY 200 A/R V3 adhesive

Setting information		Symbol	Units	Rebar size							
				3	4	5	6	7	8	9	10
Nominal bit diameter		d_o	in.	1/2	5/8	3/4	7/8	1	1-1/8	1-3/8	1-1/2
Effective embedment	minimum	$h_{ef,min}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (79)	3-1/2 (89)	3-1/2 (89)	4 (102)	4-1/2 (114)	5 (127)
	maximum	$h_{ef,max}$	in. (mm)	7-1/2 (191)	10 (254)	12-1/2 (318)	15 (381)	17-1/2 (445)	20 (508)	22-1/2 (572)	25 (635)
Minimum concrete member thickness		h_{min}	in. (mm)	h_{ef} + 1-1/4 (h_{ef} + 30)	h_{ef} + 2d_o						
Minimum edge distance[1]		c_{min}	in. (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	5-5/8 (143)	6-1/4 (159)
Minimum anchor spacing		s_{min}	in. (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	5-5/8 (143)	6-1/4 (159)

[1] Edge distance of 1-3/4-inch (44mm) is permitted provided the rebar remains un-torqued.

Note: The installation specifications in table 18 above and the data in tables 19 through 37 pertain to the use of Hilti HIT-HY 200 A/R V3 with rebar designed as a post-installed anchor using the provisions of ACI 318 Chapter 17. For the use of Hilti HIT-HY 200 A/R V3 with rebar for typical development calculations according to ACI 318 Chapter 25 (formerly ACI 318-11 Chapter 12), refer to section 3.1.14 for the design method and tables 89 through 93 at the end of this section.

Table 19 — Hilti HIT-HY 200 A/R V3 adhesive design strength with concrete / bond failure for rebar in uncracked concrete [1,2,3,4,5,6,7,8,9]

Rebar size	Effective embedment in. (mm)	Tension — ϕN_n				Shear — ϕV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
#3	3-3/8 (86)	4,030 (17.9)	4,105 (18.3)	4,225 (18.8)	4,400 (19.6)	8,685 (38.6)	8,845 (39.3)	9,100 (40.5)	9,480 (42.2)
	4-1/2 (114)	5,375 (23.9)	5,475 (24.4)	5,635 (25.1)	5,865 (26.1)	11,580 (51.5)	11,790 (52.4)	12,135 (54.0)	12,640 (56.2)
	7-1/2 (191)	8,960 (39.9)	9,125 (40.6)	9,390 (41.8)	9,780 (43.5)	19,295 (85.8)	19,650 (87.4)	20,225 (90.0)	21,065 (93.7)
#4	4-1/2 (114)	7,170 (31.9)	7,300 (32.5)	7,510 (33.4)	7,825 (34.8)	15,440 (68.7)	15,720 (69.9)	16,180 (72.0)	16,850 (75.0)
	6 (152)	9,555 (42.5)	9,735 (43.3)	10,015 (44.5)	10,430 (46.4)	20,585 (91.6)	20,960 (93.2)	21,575 (96.0)	22,465 (99.9)
	10 (254)	15,930 (70.9)	16,220 (72.1)	16,695 (74.3)	17,385 (77.3)	34,305 (152.6)	34,935 (155.4)	35,955 (159.9)	37,445 (166.6)
#5	5-5/8 (143)	10,405 (46.3)	11,400 (50.7)	11,740 (52.2)	12,225 (54.4)	22,415 (99.7)	24,550 (109.2)	25,280 (112.5)	26,330 (117.1)
	7-1/2 (191)	14,930 (66.4)	15,205 (67.6)	15,650 (69.6)	16,300 (72.5)	32,160 (143.1)	32,755 (145.7)	33,710 (149.9)	35,105 (156.2)
	12-1/2 (318)	24,885 (110.7)	25,345 (112.7)	26,085 (116.0)	27,165 (120.8)	53,605 (238.4)	54,590 (242.8)	56,185 (249.9)	58,510 (260.3)
#6	6-3/4 (171)	13,680 (60.9)	14,985 (66.7)	16,905 (75.2)	17,600 (78.3)	29,460 (131.0)	32,275 (143.6)	36,405 (161.9)	37,915 (168.7)
	9 (229)	21,060 (93.7)	21,900 (97.4)	22,535 (100.2)	23,470 (104.4)	45,360 (201.8)	47,165 (209.8)	48,540 (215.9)	50,550 (224.9)
	15 (381)	35,840 (159.4)	36,495 (162.3)	37,560 (167.1)	39,115 (174.0)	77,190 (343.4)	78,610 (349.7)	80,905 (359.9)	84,250 (374.8)
#7	7-7/8 (200)	17,235 (76.7)	18,885 (84.0)	21,805 (97.0)	23,960 (106.6)	37,125 (165.1)	40,670 (180.9)	46,960 (208.9)	51,605 (229.5)
	10-1/2 (267)	26,540 (118.1)	29,070 (129.3)	30,675 (136.4)	31,945 (142.1)	57,160 (254.3)	62,615 (278.5)	66,070 (293.9)	68,805 (306.1)
	17-1/2 (445)	48,780 (217.0)	49,675 (221.0)	51,125 (227.4)	53,240 (236.8)	105,065 (467.4)	106,995 (475.9)	110,120 (489.8)	114,675 (510.1)
#8	9 (229)	21,060 (93.7)	23,070 (102.6)	26,640 (118.5)	31,295 (139.2)	45,360 (201.8)	49,690 (221.0)	57,375 (255.2)	67,400 (299.8)
	12 (305)	32,425 (144.2)	35,520 (158.0)	40,065 (178.2)	41,725 (185.6)	69,835 (310.6)	76,500 (340.3)	86,295 (383.9)	89,870 (399.8)
	20 (508)	63,710 (283.4)	64,885 (288.6)	66,775 (297.0)	69,540 (309.3)	137,225 (610.4)	139,750 (621.6)	143,830 (639.8)	149,780 (666.3)
#9	10-1/8 (257)	25,130 (111.8)	27,530 (122.5)	31,785 (141.4)	38,930 (173.2)	54,125 (240.8)	59,290 (263.7)	68,465 (304.5)	83,850 (373.0)
	13-1/2 (343)	38,690 (172.1)	42,380 (188.5)	48,940 (217.7)	52,805 (234.9)	83,330 (370.7)	91,285 (406.1)	105,405 (468.9)	113,740 (505.9)
	22-1/2 (572)	80,635 (358.7)	82,120 (365.3)	84,515 (375.9)	88,010 (391.5)	173,675 (772.5)	176,870 (786.8)	182,035 (809.7)	189,565 (843.2)
#10	11-1/4 (286)	29,430 (130.9)	32,240 (143.4)	37,230 (165.6)	45,595 (202.8)	63,395 (282.0)	69,445 (308.9)	80,185 (356.7)	98,205 (436.8)
	15 (381)	45,315 (201.6)	49,640 (220.8)	57,320 (255.0)	65,195 (290.0)	97,600 (434.1)	106,915 (475.6)	123,455 (549.2)	140,420 (624.6)
	25 (635)	97,500 (433.7)	101,380 (451.0)	104,340 (464.1)	108,655 (483.3)	210,000 (934.1)	218,360 (971.3)	224,730 (999.6)	234,030 (1041.0)

1 See section 3.1.8 for explanation on development of load values.

2 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 22 - 37 as necessary to the above values. Compare to the steel values in table 21.The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C).
For temperature range C: Max. short term temperature = 248° F (120° C), max. long term temperature = 162° F (72° C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength value by 0.68.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete, multiply design strength (factored resistance) by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 20 — Hilti HIT-HY 200 A/R V3 adhesive design strength with concrete / bond failure for rebar in cracked concrete[1,2,3,4,5,6,7,8,9]

		Tension — ϕN_n				Shear — ϕV_n			
Rebar size	Effective embedment in. (mm)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
#3	3-3/8 (86)	2,790 (12.4)	2,845 (12.7)	2,925 (13.0)	3,045 (13.5)	6,010 (26.7)	6,120 (27.2)	6,300 (28.0)	6,560 (29.2)
	4-1/2 (114)	3,720 (16.5)	3,790 (16.9)	3,900 (17.3)	4,060 (18.1)	8,015 (35.7)	8,165 (36.3)	8,400 (37.4)	8,750 (38.9)
	7-1/2 (191)	6,205 (27.6)	6,315 (28.1)	6,500 (28.9)	6,770 (30.1)	13,360 (59.4)	13,605 (60.5)	14,005 (62.3)	14,580 (64.9)
#4	4-1/2 (114)	4,960 (22.1)	5,055 (22.5)	5,200 (23.1)	5,415 (24.1)	10,690 (47.6)	10,885 (48.4)	11,200 (49.8)	11,665 (51.9)
	6 (152)	6,615 (29.4)	6,740 (30.0)	6,935 (30.8)	7,220 (32.1)	14,250 (63.4)	14,510 (64.5)	14,935 (66.4)	15,555 (69.2)
	10 (254)	11,025 (49.0)	11,230 (50.0)	11,560 (51.4)	12,035 (53.5)	23,750 (105.6)	24,185 (107.6)	24,895 (110.7)	25,925 (115.3)
#5	5-5/8 (143)	7,370 (32.8)	7,970 (35.5)	8,200 (36.5)	8,540 (38.0)	15,875 (70.6)	17,165 (76.4)	17,665 (78.6)	18,395 (81.8)
	7-1/2 (191)	10,435 (46.4)	10,625 (47.3)	10,935 (48.6)	11,390 (50.7)	22,470 (100.0)	22,885 (101.8)	23,555 (104.8)	24,530 (109.1)
	12-1/2 (318)	17,390 (77.4)	17,710 (78.8)	18,225 (81.1)	18,980 (84.4)	37,455 (166.6)	38,145 (169.7)	39,255 (174.6)	40,880 (181.8)
#6	6-3/4 (171)	9,690 (43.1)	10,615 (47.2)	11,810 (52.5)	12,300 (54.7)	20,870 (92.8)	22,860 (101.7)	25,440 (113.2)	26,490 (117.8)
	9 (229)	14,920 (66.4)	15,300 (68.1)	15,745 (70.0)	16,400 (73.0)	32,130 (142.9)	32,955 (146.6)	33,915 (150.9)	35,320 (157.1)
	15 (381)	25,040 (111.4)	25,500 (113.4)	26,245 (116.7)	27,330 (121.6)	53,935 (239.9)	54,925 (244.3)	56,530 (251.5)	58,870 (261.9)
#7	7-7/8 (200)	11,750 (52.3)	11,965 (53.2)	12,315 (54.8)	12,825 (57.0)	25,305 (112.6)	25,770 (114.6)	26,525 (118.0)	27,620 (122.9)
	10-1/2 (267)	15,665 (69.7)	15,955 (71.0)	16,420 (73.0)	17,100 (76.1)	33,740 (150.1)	34,360 (152.8)	35,365 (157.3)	36,830 (163.8)
	17-1/2 (445)	26,110 (116.1)	26,590 (118.3)	27,365 (121.7)	28,500 (126.8)	56,235 (250.1)	57,270 (254.7)	58,940 (262.2)	61,380 (273.0)
#8	9 (229)	14,920 (66.4)	15,720 (69.9)	16,180 (72.0)	16,850 (75.0)	32,130 (142.9)	33,860 (150.6)	34,850 (155.0)	36,295 (161.4)
	12 (305)	20,585 (91.6)	20,960 (93.2)	21,575 (96.0)	22,465 (99.9)	44,335 (197.2)	45,150 (200.8)	46,470 (206.7)	48,390 (215.2)
	20 (508)	34,305 (152.6)	34,935 (155.4)	35,955 (159.9)	37,445 (166.6)	73,890 (328.7)	75,250 (334.7)	77,445 (344.5)	80,650 (358.7)
#9	10-1/8 (257)	17,800 (79.2)	19,500 (86.7)	20,720 (92.2)	21,580 (96.0)	38,340 (170.5)	42,000 (186.8)	44,635 (198.5)	46,480 (206.8)
	13-1/2 (343)	26,360 (117.3)	26,845 (119.4)	27,630 (122.9)	28,775 (128.0)	56,780 (252.6)	57,825 (257.2)	59,510 (264.7)	61,975 (275.7)
	22-1/2 (572)	43,935 (195.4)	44,745 (199.0)	46,050 (204.8)	47,955 (213.3)	94,630 (420.9)	96,370 (428.7)	99,185 (441.2)	103,290 (459.5)
#10	11-1/4 (286)	20,850 (92.7)	22,840 (101.6)	25,585 (113.8)	26,640 (118.5)	44,905 (199.7)	49,190 (218.8)	55,105 (245.1)	57,385 (255.3)
	15 (381)	32,095 (142.8)	33,145 (147.4)	34,110 (151.7)	35,525 (158.0)	69,135 (307.5)	71,385 (317.5)	73,470 (326.8)	76,510 (340.3)
	25 (635)	54,240 (241.3)	55,240 (245.7)	56,850 (252.9)	59,205 (263.4)	116,830 (519.7)	118,980 (529.2)	122,450 (544.7)	127,515 (567.2)

[1] See section 3.1.8 for explanation on development of load values.

[2] See section 3.1.8 to convert design strength (factored resistance) value to ASD value.

[3] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[4] Apply spacing, edge distance, and concrete thickness factors in tables 22 - 37 as necessary to the above values. Compare to the steel values in table 21.The lesser of the values is to be used for the design.

[5] Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C).
For temperature range C: Max. short term temperature = 248° F (120° C), max. long term temperature = 162° F (72° C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

[6] Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength value by 0.68.

[7] Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.

[8] Tabular values are for normal-weight concrete only. For lightweight concrete, multiply design strength (factored resistance) by λ_a as follows:
For sand-lightweight, $\lambda_a = 0.51$. For all-lightweight, $\lambda_a = 0.45$.

[9] Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors:
#3 to #6 - $\alpha_{seis} = 0.60$, #7 - $\alpha_{seis} = 0.64$, #8 - $\alpha_{seis} = 0.68$, #9 - $\alpha_{seis} = 0.71$, #10 - $\alpha_{seis} = 0.75$
See section 3.1.8 for additional information on seismic applications.

Table 21 — Steel design strength for US rebar[1,2]

Rebar size	ASTM A615 Grade 40 [4]			ASTM A615 Grade 60 [4]			ASTM A706 Grade 60 [4]		
	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic[5] Shear $\phi V_{sa,eq}$ lb (kN)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic[5] Shear $\phi V_{sa,eq}$ lb (kN)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic[5] Shear $\phi V_{sa,eq}$ lb (kN)
#3	4,290 (19.1)	2,375 (10.6)	1,665 (7.4)	5,720 (25.4)	3,170 (14.1)	2,220 (9.9)	6,600 (29.4)	3,430 (15.3)	2,400 (10.7)
#4	7,800 (34.7)	4,320 (19.2)	3,025 (13.4)	10,400 (46.3)	5,760 (25.6)	4,030 (17.9)	12,000 (53.4)	6,240 (27.8)	4,370 (19.5)
#5	12,090 (53.8)	6,695 (29.8)	4,685 (20.9)	16,120 (71.7)	8,930 (39.7)	6,250 (27.8)	18,600 (82.7)	9,670 (43.0)	6,770 (30.1)
#6	17,160 (76.3)	9,505 (42.3)	6,655 (29.6)	22,880 (101.8)	12,670 (56.4)	8,870 (39.5)	26,400 (117.4)	13,730 (61.1)	9,610 (42.8)
#7	23,400 (104.1)	12,960 (57.6)	9,070 (40.3)	31,200 (138.8)	17,280 (76.9)	12,095 (53.8)	36,000 (160.1)	18,720 (83.3)	13,105 (58.3)
#8	30,810 (137.0)	17,065 (75.9)	11,945 (53.1)	41,080 (182.7)	22,750 (101.2)	15,925 (70.8)	47,400 (210.8)	24,650 (109.6)	17,255 (76.7)
#9	39,000 (173.5)	21,600 (96.1)	15,120 (67.3)	52,000 (231.3)	28,800 (128.1)	20,160 (89.7)	60,000 (266.9)	31,200 (138.8)	21,840 (97.2)
#10	49,530 (220.3)	27,430 (122.0)	19,200 (85.4)	66,040 (293.8)	36,575 (162.7)	25,605 (113.9)	76,200 (339.0)	39,625 (176.3)	27,740 (123.4)

1 See Section 3.1.8 to convert design strength value to ASD value.

2 ASTM A706 Grade 60 rebar are considered ductile steel elements. ASTM A615 Grade 40 and 60 rebar are considered brittle steel elements.

3 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

4 Shear = $\phi\ 0.60 A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

5 Seismic Shear = $\alpha_{V,seis} \phi V_{sa}$: Reduction for seismic shear only.

See section 3.1.8 for additional information on seismic applications.

Table 22 — Load adjustment factors for #3 rebar in uncracked concrete[1,2,3]

	#3 Rebar uncracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
	Embedment h_{ef} in.	(mm)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.31	0.23	0.13	n/a	n/a	n/a	0.08	0.06	0.04	0.17	0.13	0.08	n/a	n/a	n/a
	1-7/8	(48)	0.59	0.57	0.54	0.32	0.23	0.13	0.53	0.53	0.52	0.09	0.07	0.04	0.19	0.14	0.08	n/a	n/a	n/a
	2	(51)	0.60	0.57	0.54	0.33	0.24	0.14	0.54	0.53	0.52	0.10	0.08	0.05	0.21	0.16	0.09	n/a	n/a	n/a
	3	(76)	0.65	0.61	0.57	0.41	0.30	0.17	0.56	0.55	0.53	0.19	0.14	0.09	0.38	0.29	0.17	n/a	n/a	n/a
	4	(102)	0.70	0.65	0.59	0.49	0.36	0.21	0.57	0.56	0.54	0.29	0.22	0.13	0.50	0.41	0.26	n/a	n/a	n/a
	4-5/8	(117)	0.73	0.67	0.60	0.55	0.40	0.23	0.59	0.57	0.55	0.36	0.27	0.16	0.56	0.45	0.33	0.58	n/a	n/a
	5	(127)	0.75	0.69	0.61	0.59	0.43	0.25	0.59	0.58	0.55	0.41	0.31	0.18	0.60	0.47	0.34	0.61	n/a	n/a
	5-3/4	(146)	0.78	0.71	0.63	0.68	0.50	0.29	0.61	0.59	0.56	0.51	0.38	0.23	0.68	0.52	0.36	0.65	0.59	n/a
	6	(152)	0.80	0.72	0.63	0.71	0.52	0.30	0.61	0.59	0.56	0.54	0.40	0.24	0.71	0.53	0.37	0.66	0.60	n/a
	7	(178)	0.85	0.76	0.66	0.83	0.61	0.35	0.63	0.61	0.58	0.68	0.51	0.31	0.83	0.61	0.41	0.72	0.65	n/a
	8	(203)	0.90	0.80	0.68	0.95	0.69	0.40	0.65	0.62	0.59	0.83	0.62	0.37	0.95	0.69	0.44	0.77	0.70	n/a
	8-3/4	(222)	0.93	0.82	0.69	1.00	0.76	0.44	0.66	0.63	0.59	0.95	0.71	0.43	1.00	0.76	0.47	0.80	0.73	0.61
	9	(229)	0.94	0.83	0.70		0.78	0.45	0.67	0.64	0.60	0.99	0.74	0.45		0.78	0.48	0.81	0.74	0.62
	10	(254)	0.99	0.87	0.72		0.86	0.50	0.68	0.65	0.61	1.00	0.87	0.52		0.86	0.51	0.86	0.78	0.66
	11	(279)	1.00	0.91	0.74		0.95	0.55	0.70	0.67	0.62		1.00	0.60		0.95	0.55	0.90	0.82	0.69
	12	(305)		0.94	0.77		1.00	0.60	0.72	0.68	0.63			0.69		1.00	0.60	0.94	0.85	0.72
	14	(356)		1.00	0.81			0.70	0.76	0.71	0.65			0.86			0.70	1.00	0.92	0.78
	16	(406)			0.86			0.80	0.79	0.74	0.67			1.00			0.80		0.99	0.83
	18	(457)			0.90			0.90	0.83	0.77	0.69						0.90		1.00	0.88
	24	(610)			1.00			1.00	0.94	0.86	0.76						1.00			1.00
	30	(762)							1.00	0.96	0.82									
	36	(914)								1.00	0.89									
	> 48	(1219)									1.00									

Table 23 — Load adjustment factors for #3 rebar in cracked concrete[1,2,3]

	#3 Rebar cracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
	Embedment h_{ef} in.	(mm)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.54	0.49	0.43	n/a	n/a	n/a	0.09	0.07	0.04	0.18	0.13	0.08	n/a	n/a	n/a
	1-7/8	(48)	0.59	0.57	0.54	0.56	0.50	0.44	0.54	0.53	0.52	0.10	0.07	0.04	0.19	0.15	0.09	n/a	n/a	n/a
	2	(51)	0.60	0.57	0.54	0.57	0.51	0.44	0.54	0.53	0.52	0.11	0.08	0.05	0.21	0.16	0.10	n/a	n/a	n/a
	3	(76)	0.65	0.61	0.57	0.70	0.60	0.49	0.56	0.55	0.53	0.20	0.15	0.09	0.39	0.29	0.18	n/a	n/a	n/a
	4	(102)	0.70	0.65	0.59	0.84	0.70	0.55	0.58	0.56	0.54	0.30	0.23	0.14	0.61	0.45	0.27	n/a	n/a	n/a
	4-5/8	(117)	0.73	0.67	0.60	0.93	0.76	0.58	0.59	0.57	0.55	0.38	0.28	0.17	0.75	0.56	0.34	0.59	n/a	n/a
	5	(127)	0.75	0.69	0.61	0.99	0.80	0.60	0.59	0.58	0.56	0.42	0.32	0.19	0.85	0.63	0.38	0.61	n/a	n/a
	5-3/4	(146)	0.78	0.71	0.63	1.00	0.88	0.64	0.61	0.59	0.56	0.52	0.39	0.23	1.00	0.78	0.47	0.66	0.60	n/a
	6	(152)	0.80	0.72	0.63		0.91	0.66	0.61	0.59	0.57	0.56	0.42	0.25		0.83	0.50	0.67	0.61	n/a
	7	(178)	0.85	0.76	0.66		1.00	0.72	0.63	0.61	0.58	0.70	0.53	0.32		1.00	0.63	0.73	0.66	n/a
	8	(203)	0.90	0.80	0.68			0.78	0.65	0.62	0.59	0.86	0.64	0.39			0.77	0.78	0.70	n/a
	8-3/4	(222)	0.93	0.82	0.69			0.83	0.66	0.64	0.60	0.98	0.73	0.44			0.83	0.81	0.74	0.62
	9	(229)	0.94	0.83	0.70			0.85	0.67	0.64	0.60	1.00	0.77	0.46			0.85	0.82	0.75	0.63
	10	(254)	0.99	0.87	0.72			0.91	0.69	0.66	0.61		0.90	0.54			0.91	0.87	0.79	0.66
	11	(279)	1.00	0.91	0.74			0.98	0.71	0.67	0.62		1.00	0.62			0.98	0.91	0.83	0.70
	12	(305)		0.94	0.77			1.00	0.73	0.69	0.63			0.71			1.00	0.95	0.86	0.73
	14	(356)		1.00	0.81				0.76	0.72	0.65			0.89				1.00	0.93	0.79
	16	(406)			0.86				0.80	0.75	0.68			1.00					1.00	0.84
	18	(457)			0.90				0.84	0.78	0.70									0.89
	24	(610)			1.00				0.95	0.87	0.76									1.00
	30	(762)							1.00	0.97	0.83									
	36	(914)								1.00	0.90									
	> 48	(1219)									1.00									

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3 * h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{HV} = 1.0$.

Table 24 — Load adjustment factors for #4 rebar in uncracked concrete[1,2,3]

#4 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.27	0.20	0.12	n/a	n/a	n/a	0.06	0.04	0.02	0.11	0.08	0.05	n/a	n/a	n/a
	2-1/2	(64)	0.59	0.57	0.54	0.31	0.23	0.13	0.53	0.53	0.52	0.09	0.07	0.04	0.19	0.14	0.08	n/a	n/a	n/a
	3	(76)	0.61	0.58	0.55	0.34	0.25	0.14	0.54	0.53	0.52	0.12	0.09	0.06	0.25	0.19	0.11	n/a	n/a	n/a
	4	(102)	0.65	0.61	0.57	0.39	0.29	0.17	0.56	0.55	0.53	0.19	0.14	0.09	0.38	0.29	0.17	n/a	n/a	n/a
	5	(127)	0.69	0.64	0.58	0.46	0.33	0.20	0.57	0.56	0.54	0.27	0.20	0.12	0.47	0.38	0.24	n/a	n/a	n/a
	5-3/4	(146)	0.71	0.66	0.60	0.51	0.37	0.22	0.58	0.57	0.55	0.33	0.25	0.15	0.52	0.42	0.30	0.56	n/a	n/a
	6	(152)	0.72	0.67	0.60	0.52	0.38	0.22	0.58	0.57	0.55	0.35	0.26	0.16	0.53	0.43	0.31	0.58	n/a	n/a
	7	(178)	0.76	0.69	0.62	0.61	0.44	0.26	0.60	0.58	0.56	0.44	0.33	0.20	0.61	0.47	0.34	0.62	n/a	n/a
	7-1/4	(184)	0.77	0.70	0.62	0.63	0.46	0.27	0.60	0.58	0.56	0.46	0.35	0.21	0.63	0.49	0.35	0.63	0.57	n/a
	8	(203)	0.80	0.72	0.63	0.69	0.51	0.30	0.61	0.59	0.56	0.54	0.40	0.24	0.69	0.52	0.37	0.66	0.60	n/a
	9	(229)	0.83	0.75	0.65	0.78	0.57	0.33	0.62	0.60	0.57	0.64	0.48	0.29	0.78	0.57	0.39	0.70	0.64	n/a
	10	(254)	0.87	0.78	0.67	0.86	0.63	0.37	0.64	0.61	0.58	0.75	0.56	0.34	0.86	0.63	0.42	0.74	0.67	n/a
	11-1/4	(286)	0.92	0.81	0.69	0.97	0.71	0.42	0.66	0.63	0.59	0.90	0.67	0.40	0.97	0.71	0.45	0.79	0.72	0.60
	12	(305)	0.94	0.83	0.70	1.00	0.76	0.45	0.67	0.64	0.60	0.99	0.74	0.45	1.00	0.76	0.47	0.81	0.74	0.62
	14	(356)	1.00	0.89	0.73		0.89	0.52	0.69	0.66	0.61	1.00	0.94	0.56		0.89	0.53	0.88	0.80	0.67
	16	(406)		0.94	0.77		1.00	0.59	0.72	0.68	0.63		1.00	0.69		1.00	0.59	0.94	0.85	0.72
	18	(457)		1.00	0.80			0.67	0.75	0.70	0.65			0.82			0.67	1.00	0.91	0.76
	20	(508)			0.83			0.74	0.78	0.73	0.66			0.96			0.74		0.95	0.81
	22	(559)			0.87			0.82	0.80	0.75	0.68			1.00			0.82		1.00	0.84
	24	(610)			0.90			0.89	0.83	0.77	0.69						0.89			0.88
	30	(762)			1.00			1.00	0.91	0.84	0.74						1.00			0.99
	36	(914)							1.00	0.91	0.79									1.00
	>48	(1219)								1.00	0.89									

Table 25 — Load adjustment factors for #4 rebar in cracked concrete[1,2,3]

#4 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.49	0.45	0.41	n/a	n/a	n/a	0.06	0.04	0.03	0.11	0.09	0.05	n/a	n/a	n/a
	2-1/2	(64)	0.59	0.57	0.54	0.56	0.50	0.44	0.54	0.53	0.52	0.10	0.07	0.04	0.19	0.15	0.09	n/a	n/a	n/a
	3	(76)	0.61	0.58	0.55	0.60	0.53	0.46	0.54	0.53	0.52	0.13	0.10	0.06	0.26	0.19	0.11	n/a	n/a	n/a
	4	(102)	0.65	0.61	0.57	0.70	0.60	0.49	0.56	0.55	0.53	0.20	0.15	0.09	0.39	0.29	0.18	n/a	n/a	n/a
	5	(127)	0.69	0.64	0.58	0.80	0.67	0.53	0.57	0.56	0.54	0.27	0.21	0.12	0.55	0.41	0.25	n/a	n/a	n/a
	5-3/4	(146)	0.71	0.66	0.60	0.88	0.73	0.56	0.58	0.57	0.55	0.34	0.25	0.15	0.68	0.51	0.30	0.57	n/a	n/a
	6	(152)	0.72	0.67	0.60	0.91	0.75	0.57	0.58	0.57	0.55	0.36	0.27	0.16	0.72	0.54	0.32	0.58	n/a	n/a
	7	(178)	0.76	0.69	0.62	1.00	0.83	0.62	0.60	0.58	0.56	0.46	0.34	0.20	0.91	0.68	0.41	0.63	n/a	n/a
	7-1/4	(184)	0.77	0.70	0.62		0.85	0.63	0.60	0.58	0.56	0.48	0.36	0.22	0.96	0.72	0.43	0.64	0.58	n/a
	8	(203)	0.80	0.72	0.63		0.91	0.66	0.61	0.59	0.57	0.56	0.42	0.25	1.00	0.83	0.50	0.67	0.61	n/a
	9	(229)	0.83	0.75	0.65		1.00	0.70	0.63	0.60	0.57	0.66	0.50	0.30		1.00	0.60	0.71	0.65	n/a
	10	(254)	0.87	0.78	0.67			0.75	0.64	0.62	0.58	0.78	0.58	0.35			0.70	0.75	0.68	n/a
	11-1/4	(286)	0.92	0.81	0.69			0.81	0.66	0.63	0.59	0.93	0.70	0.42			0.81	0.80	0.72	0.61
	12	(305)	0.94	0.83	0.70			0.85	0.67	0.64	0.60	1.00	0.77	0.46			0.85	0.82	0.75	0.63
	14	(356)	1.00	0.89	0.73			0.95	0.70	0.66	0.62		0.97	0.58			0.95	0.89	0.81	0.68
	16	(406)		0.94	0.77			1.00	0.73	0.69	0.63		1.00	0.71			1.00	0.95	0.86	0.73
	18	(457)		1.00	0.80				0.75	0.71	0.65			0.84				1.00	0.91	0.77
	20	(508)			0.83				0.78	0.73	0.67			0.99					0.96	0.81
	22	(559)			0.87				0.81	0.76	0.68			1.00					1.00	0.85
	24	(610)			0.90				0.84	0.78	0.70									0.89
	30	(762)			1.00				0.92	0.85	0.75									1.00
	36	(914)							1.00	0.92	0.80									
	>48	(1219)								1.00	0.90									

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 26 — Load adjustment factors for #5 rebar in uncracked concrete[1,2,3]

#5 Rebar uncracked Concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}		in.	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2
		(mm)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.25	0.18	0.11	n/a	n/a	n/a	0.04	0.03	0.02	0.08	0.06	0.04	n/a	n/a	n/a
	3-1/8	(79)	0.59	0.57	0.54	0.31	0.23	0.13	0.54	0.53	0.52	0.10	0.07	0.04	0.20	0.14	0.08	n/a	n/a	n/a
	4	(102)	0.62	0.59	0.55	0.35	0.25	0.15	0.55	0.54	0.53	0.15	0.10	0.06	0.29	0.20	0.12	n/a	n/a	n/a
	5	(127)	0.65	0.61	0.57	0.39	0.29	0.17	0.56	0.55	0.53	0.21	0.14	0.09	0.41	0.29	0.17	n/a	n/a	n/a
	6	(152)	0.68	0.63	0.58	0.44	0.32	0.19	0.57	0.55	0.54	0.27	0.19	0.11	0.45	0.38	0.23	n/a	n/a	n/a
	7	(178)	0.71	0.66	0.59	0.49	0.36	0.21	0.58	0.56	0.55	0.34	0.24	0.14	0.50	0.41	0.28	n/a	n/a	n/a
	7-1/8	(181)	0.71	0.66	0.60	0.50	0.37	0.22	0.58	0.56	0.55	0.35	0.24	0.15	0.51	0.41	0.29	0.57	n/a	n/a
	8	(203)	0.74	0.68	0.61	0.55	0.40	0.24	0.59	0.57	0.55	0.41	0.29	0.17	0.56	0.44	0.33	0.61	n/a	n/a
	9	(229)	0.77	0.70	0.62	0.62	0.46	0.27	0.60	0.58	0.56	0.50	0.35	0.21	0.62	0.48	0.35	0.65	0.57	n/a
	10	(254)	0.80	0.72	0.63	0.69	0.51	0.30	0.62	0.59	0.56	0.58	0.40	0.24	0.69	0.52	0.37	0.68	0.60	n/a
	11	(279)	0.83	0.74	0.65	0.76	0.56	0.33	0.63	0.60	0.57	0.67	0.47	0.28	0.76	0.56	0.39	0.71	0.63	n/a
	12	(305)	0.86	0.77	0.66	0.83	0.61	0.36	0.64	0.61	0.58	0.76	0.53	0.32	0.83	0.61	0.41	0.75	0.66	n/a
	14	(356)	0.91	0.81	0.69	0.96	0.71	0.41	0.66	0.63	0.59	0.96	0.67	0.40	0.96	0.71	0.45	0.81	0.71	0.60
	16	(406)	0.97	0.86	0.71	1.00	0.81	0.47	0.69	0.65	0.60	1.00	0.82	0.49	1.00	0.81	0.49	0.86	0.76	0.64
	18	(457)	1.00	0.90	0.74		0.91	0.53	0.71	0.66	0.62		0.98	0.59		0.91	0.54	0.91	0.81	0.68
	20	(508)		0.94	0.77		1.00	0.59	0.73	0.68	0.63		1.00	0.69		1.00	0.59	0.96	0.85	0.72
	22	(559)		0.99	0.79			0.65	0.75	0.70	0.64			0.79			0.65	1.00	0.90	0.76
	24	(610)		1.00	0.82			0.71	0.78	0.72	0.66			0.90			0.71		0.94	0.79
	26	(660)			0.85			0.77	0.80	0.74	0.67			1.00			0.77		0.97	0.82
	28	(711)			0.87			0.83	0.82	0.76	0.68						0.83		1.00	0.85
	30	(762)			0.90			0.89	0.85	0.77	0.69						0.89			0.88
	36	(914)			0.98			1.00	0.92	0.83	0.73						1.00			0.97
	> 48	(1219)			1.00				1.00	0.94	0.81									1.00

Table 27 — Load adjustment factors for #5 rebar in cracked concrete[1,2,3]

#5 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}		in.	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2
		(mm)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.46	0.43	0.40	n/a	n/a	n/a	0.04	0.03	0.02	0.09	0.06	0.04	n/a	n/a	n/a
	3-1/8	(79)	0.59	0.57	0.54	0.56	0.50	0.44	0.54	0.53	0.52	0.10	0.07	0.04	0.20	0.14	0.09	n/a	n/a	n/a
	4	(102)	0.62	0.59	0.55	0.62	0.55	0.46	0.55	0.54	0.53	0.15	0.10	0.06	0.30	0.21	0.13	n/a	n/a	n/a
	5	(127)	0.65	0.61	0.57	0.70	0.60	0.49	0.56	0.55	0.53	0.21	0.15	0.09	0.41	0.29	0.18	n/a	n/a	n/a
	6	(152)	0.68	0.63	0.58	0.78	0.66	0.53	0.57	0.56	0.54	0.27	0.19	0.12	0.54	0.38	0.23	n/a	n/a	n/a
	7	(178)	0.71	0.66	0.59	0.87	0.72	0.56	0.58	0.56	0.55	0.34	0.24	0.15	0.68	0.48	0.29	n/a	n/a	n/a
	7-1/8	(181)	0.71	0.66	0.60	0.88	0.73	0.56	0.58	0.57	0.55	0.35	0.25	0.15	0.70	0.50	0.30	0.58	n/a	n/a
	8	(203)	0.74	0.68	0.61	0.96	0.78	0.59	0.59	0.57	0.55	0.42	0.30	0.18	0.84	0.59	0.35	0.61	n/a	n/a
	9	(229)	0.77	0.70	0.62	1.00	0.85	0.62	0.60	0.58	0.56	0.50	0.35	0.21	1.00	0.71	0.42	0.65	0.58	n/a
	10	(254)	0.80	0.72	0.63		0.91	0.66	0.62	0.59	0.57	0.58	0.41	0.25		0.83	0.50	0.68	0.61	n/a
	11	(279)	0.83	0.74	0.65		0.98	0.69	0.63	0.60	0.57	0.67	0.48	0.29		0.95	0.57	0.72	0.64	n/a
	12	(305)	0.86	0.77	0.66		1.00	0.73	0.64	0.61	0.58	0.77	0.54	0.33		1.00	0.65	0.75	0.67	n/a
	14	(356)	0.91	0.81	0.69			0.81	0.66	0.63	0.59	0.97	0.68	0.41			0.81	0.81	0.72	0.61
	16	(406)	0.97	0.86	0.71			0.89	0.69	0.65	0.61	1.00	0.84	0.50			0.89	0.86	0.77	0.65
	18	(457)	1.00	0.90	0.74			0.97	0.71	0.67	0.62		1.00	0.60			0.97	0.92	0.82	0.69
	20	(508)		0.94	0.77			1.00	0.73	0.68	0.63			0.70			1.00	0.97	0.86	0.73
	22	(559)		0.99	0.79				0.76	0.70	0.64			0.81				1.00	0.90	0.76
	24	(610)		1.00	0.82				0.78	0.72	0.66			0.92					0.94	0.79
	26	(660)			0.85				0.80	0.74	0.67			1.00					0.98	0.83
	28	(711)			0.87				0.83	0.76	0.68								1.00	0.86
	30	(762)			0.90				0.85	0.78	0.70									0.89
	36	(914)			0.98				0.92	0.83	0.74									0.97
	> 48	(1219)			1.00				1.00	0.94	0.82									1.00

[1] Linear interpolation not permitted.

[2] Shaded area with reduced edge distance is permitted provided rebar has no installation torque.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3 * h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{HV} = 1.0$.

Table 28 — Load adjustment factors for #6 rebar in uncracked concrete[1,2,3]

#6 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.24	0.18	0.10	n/a	n/a	n/a	0.03	0.02	0.01	0.07	0.05	0.03	n/a	n/a	n/a
	3-3/4	(95)	0.59	0.57	0.54	0.31	0.23	0.13	0.54	0.53	0.52	0.11	0.07	0.04	0.22	0.14	0.08	n/a	n/a	n/a
	4	(102)	0.60	0.57	0.54	0.32	0.23	0.14	0.54	0.53	0.52	0.12	0.08	0.05	0.24	0.16	0.09	n/a	n/a	n/a
	5	(127)	0.62	0.59	0.56	0.35	0.26	0.15	0.55	0.54	0.53	0.17	0.11	0.06	0.33	0.22	0.13	n/a	n/a	n/a
	6	(152)	0.65	0.61	0.57	0.39	0.29	0.17	0.56	0.55	0.53	0.22	0.14	0.08	0.41	0.29	0.17	n/a	n/a	n/a
	7	(178)	0.67	0.63	0.58	0.43	0.32	0.19	0.57	0.55	0.54	0.28	0.18	0.11	0.45	0.36	0.21	n/a	n/a	n/a
	8	(203)	0.70	0.65	0.59	0.48	0.35	0.20	0.58	0.56	0.54	0.34	0.22	0.13	0.49	0.40	0.26	n/a	n/a	n/a
	8-1/2	(216)	0.71	0.66	0.59	0.50	0.37	0.21	0.59	0.56	0.55	0.37	0.24	0.14	0.51	0.41	0.28	0.59	n/a	n/a
	9	(229)	0.72	0.67	0.60	0.52	0.38	0.22	0.59	0.57	0.55	0.40	0.26	0.15	0.53	0.43	0.31	0.60	n/a	n/a
	10	(254)	0.75	0.69	0.61	0.57	0.42	0.25	0.60	0.58	0.55	0.47	0.31	0.18	0.57	0.46	0.33	0.64	n/a	n/a
	10-3/4	(273)	0.77	0.70	0.62	0.62	0.45	0.27	0.61	0.58	0.56	0.53	0.34	0.20	0.62	0.48	0.35	0.66	0.57	n/a
	12	(305)	0.80	0.72	0.63	0.69	0.51	0.30	0.62	0.59	0.56	0.62	0.40	0.24	0.69	0.52	0.37	0.70	0.60	n/a
	14	(356)	0.85	0.76	0.66	0.80	0.59	0.35	0.64	0.61	0.57	0.78	0.51	0.30	0.80	0.59	0.40	0.75	0.65	n/a
	16	(406)	0.90	0.80	0.68	0.92	0.67	0.39	0.66	0.62	0.59	0.96	0.62	0.37	0.92	0.67	0.43	0.80	0.70	n/a
	16-3/4	(425)	0.91	0.81	0.69	0.96	0.71	0.41	0.67	0.63	0.59	1.00	0.67	0.39	0.96	0.71	0.45	0.82	0.71	0.60
	18	(457)	0.94	0.83	0.70	1.00	0.76	0.44	0.68	0.64	0.60		0.74	0.44	1.00	0.76	0.47	0.85	0.74	0.62
	20	(508)	0.99	0.87	0.72		0.84	0.49	0.70	0.65	0.61		0.87	0.51		0.84	0.51	0.90	0.78	0.65
	22	(559)	1.00	0.91	0.74		0.93	0.54	0.72	0.67	0.62		1.00	0.59		0.93	0.55	0.94	0.82	0.68
	24	(610)		0.94	0.77		1.00	0.59	0.74	0.68	0.63			0.67		1.00	0.59	0.99	0.85	0.72
	26	(660)		0.98	0.79			0.64	0.76	0.70	0.64			0.76			0.64	1.00	0.89	0.74
	28	(711)		1.00	0.81			0.69	0.78	0.71	0.65			0.85			0.69		0.92	0.77
	30	(762)			0.83			0.74	0.80	0.73	0.66			0.94			0.74		0.95	0.80
	36	(914)			0.90			0.89	0.86	0.77	0.69			1.00			0.89		1.00	0.88
	> 48	(1219)			1.00			1.00	0.99	0.86	0.76						1.00			1.00

Table 29 — Load adjustment factors for #6 rebar in cracked concrete[1,2,3]

#6 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.44	0.42	0.39	n/a	n/a	n/a	0.03	0.02	0.01	0.07	0.05	0.03	n/a	n/a	n/a
	3-3/4	(95)	0.59	0.57	0.54	0.56	0.50	0.44	0.54	0.53	0.52	0.11	0.07	0.04	0.22	0.14	0.08	n/a	n/a	n/a
	4	(102)	0.60	0.57	0.54	0.57	0.51	0.44	0.54	0.53	0.52	0.12	0.08	0.05	0.24	0.16	0.09	n/a	n/a	n/a
	5	(127)	0.62	0.59	0.56	0.63	0.56	0.47	0.55	0.54	0.53	0.17	0.11	0.07	0.34	0.22	0.13	n/a	n/a	n/a
	6	(152)	0.65	0.61	0.57	0.70	0.60	0.49	0.56	0.55	0.53	0.22	0.14	0.09	0.44	0.29	0.17	n/a	n/a	n/a
	7	(178)	0.67	0.63	0.58	0.77	0.65	0.52	0.57	0.55	0.54	0.28	0.18	0.11	0.56	0.36	0.22	n/a	n/a	n/a
	8	(203)	0.70	0.65	0.59	0.84	0.70	0.55	0.58	0.56	0.54	0.34	0.22	0.13	0.68	0.44	0.26	n/a	n/a	n/a
	8-1/2	(216)	0.71	0.66	0.59	0.88	0.72	0.56	0.59	0.56	0.55	0.37	0.24	0.14	0.75	0.49	0.29	0.59	n/a	n/a
	9	(229)	0.72	0.67	0.60	0.91	0.75	0.57	0.59	0.57	0.55	0.41	0.26	0.16	0.82	0.53	0.32	0.61	n/a	n/a
	10	(254)	0.75	0.69	0.61	0.99	0.80	0.60	0.60	0.58	0.55	0.48	0.31	0.18	0.95	0.62	0.37	0.64	n/a	n/a
	10-3/4	(273)	0.77	0.70	0.62	1.00	0.84	0.62	0.61	0.58	0.56	0.53	0.35	0.21	1.00	0.69	0.41	0.66	0.57	n/a
	12	(305)	0.80	0.72	0.63		0.91	0.66	0.62	0.59	0.56	0.63	0.41	0.24		0.82	0.49	0.70	0.61	n/a
	14	(356)	0.85	0.76	0.66		1.00	0.72	0.64	0.61	0.58	0.79	0.51	0.31		1.00	0.61	0.76	0.65	n/a
	16	(406)	0.90	0.80	0.68			0.78	0.66	0.62	0.59	0.97	0.63	0.37			0.75	0.81	0.70	n/a
	16-3/4	(425)	0.91	0.81	0.69			0.81	0.67	0.63	0.59	1.00	0.67	0.40			0.80	0.83	0.72	0.60
	18	(457)	0.94	0.83	0.70			0.85	0.68	0.64	0.60		0.75	0.45			0.85	0.86	0.74	0.62
	20	(508)	0.99	0.87	0.72			0.91	0.70	0.65	0.61		0.88	0.52			0.91	0.90	0.78	0.66
	22	(559)	1.00	0.91	0.74			0.98	0.72	0.67	0.62		1.00	0.60			0.98	0.95	0.82	0.69
	24	(610)		0.94	0.77			1.00	0.74	0.68	0.63			0.69			1.00	0.99	0.86	0.72
	26	(660)		0.98	0.79				0.76	0.70	0.64			0.77				1.00	0.89	0.75
	28	(711)		1.00	0.81				0.79	0.71	0.65			0.87					0.92	0.78
	30	(762)			0.83				0.81	0.73	0.66			0.96					0.96	0.81
	36	(914)			0.90				0.87	0.77	0.69			1.00					1.00	0.88
	> 48	(1219)			1.00				0.99	0.87	0.76									1.00

[1] Linear interpolation not permitted.

[2] Shaded area with reduced edge distance is permitted provided rebar has no installation torque.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3{*}h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{HV} = 1.0$.

Table 30 — Load adjustment factors for #7 rebar in uncracked concrete[1,2,3]

#7 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.23	0.17	0.10	n/a	n/a	n/a	0.03	0.02	0.01	0.05	0.04	0.02	n/a	n/a	n/a
	4-3/8	(111)	0.59	0.57	0.54	0.31	0.23	0.13	0.54	0.53	0.52	0.11	0.07	0.04	0.22	0.14	0.08	n/a	n/a	n/a
	5	(127)	0.61	0.58	0.55	0.33	0.24	0.14	0.54	0.53	0.52	0.13	0.09	0.05	0.27	0.17	0.09	n/a	n/a	n/a
	6	(152)	0.63	0.60	0.56	0.36	0.26	0.15	0.55	0.54	0.53	0.17	0.11	0.06	0.35	0.23	0.12	n/a	n/a	n/a
	7	(178)	0.65	0.61	0.57	0.39	0.29	0.17	0.56	0.55	0.53	0.22	0.14	0.08	0.40	0.29	0.16	n/a	n/a	n/a
	8	(203)	0.67	0.63	0.58	0.43	0.31	0.18	0.57	0.55	0.53	0.27	0.17	0.09	0.44	0.35	0.19	n/a	n/a	n/a
	9	(229)	0.69	0.64	0.59	0.46	0.34	0.20	0.58	0.56	0.54	0.32	0.21	0.11	0.47	0.39	0.23	n/a	n/a	n/a
	9-7/8	(251)	0.71	0.66	0.59	0.49	0.36	0.21	0.59	0.56	0.54	0.37	0.24	0.13	0.51	0.41	0.26	0.59	n/a	n/a
	10	(254)	0.71	0.66	0.60	0.50	0.37	0.22	0.59	0.57	0.54	0.38	0.24	0.13	0.51	0.41	0.27	0.59	n/a	n/a
	11	(279)	0.73	0.67	0.60	0.54	0.40	0.23	0.60	0.57	0.55	0.43	0.28	0.15	0.55	0.44	0.31	0.62	n/a	n/a
	12	(305)	0.75	0.69	0.61	0.59	0.43	0.25	0.60	0.58	0.55	0.49	0.32	0.17	0.59	0.46	0.34	0.65	n/a	n/a
	12-1/2	(318)	0.76	0.70	0.62	0.61	0.45	0.26	0.61	0.58	0.55	0.52	0.34	0.19	0.61	0.48	0.35	0.66	0.57	n/a
	14	(356)	0.80	0.72	0.63	0.69	0.50	0.30	0.62	0.59	0.56	0.62	0.40	0.22	0.69	0.52	0.37	0.70	0.60	n/a
	16	(406)	0.84	0.75	0.65	0.78	0.58	0.34	0.64	0.60	0.57	0.76	0.49	0.27	0.78	0.58	0.39	0.75	0.65	n/a
	18	(457)	0.88	0.79	0.67	0.88	0.65	0.38	0.66	0.62	0.58	0.91	0.59	0.32	0.88	0.65	0.42	0.79	0.68	n/a
	19-1/2	(495)	0.91	0.81	0.69	0.96	0.70	0.41	0.67	0.63	0.58	1.00	0.66	0.36	0.96	0.70	0.45	0.82	0.71	0.58
	20	(508)	0.92	0.82	0.69	0.98	0.72	0.42	0.67	0.63	0.59		0.69	0.38	0.98	0.72	0.45	0.83	0.72	0.59
	22	(559)	0.97	0.85	0.71	1.00	0.79	0.46	0.69	0.64	0.60		0.80	0.43	1.00	0.79	0.48	0.87	0.76	0.62
	24	(610)	1.00	0.88	0.73		0.87	0.51	0.71	0.66	0.60		0.91	0.49		0.87	0.52	0.91	0.79	0.65
	26	(660)		0.91	0.75		0.94	0.55	0.73	0.67	0.61		1.00	0.56		0.94	0.55	0.95	0.82	0.67
	28	(711)		0.94	0.77		1.00	0.59	0.74	0.68	0.62			0.62		1.00	0.59	0.99	0.85	0.70
	30	(762)		0.98	0.79			0.63	0.76	0.70	0.63			0.69			0.63	1.00	0.88	0.72
	36	(914)		1.00	0.84			0.76	0.81	0.73	0.66			0.91			0.76		0.97	0.79
	> 48	(1219)			0.96			1.00	0.92	0.81	0.71			1.00			1.00		1.00	0.91

Table 31 — Load adjustment factors for #7 rebar in cracked concrete[1,2,3]

#7 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.43	0.41	0.38	n/a	n/a	n/a	0.03	0.02	0.01	0.06	0.04	0.03	n/a	n/a	n/a
	4-3/8	(111)	0.59	0.57	0.54	0.56	0.50	0.44	0.54	0.53	0.52	0.11	0.09	0.05	0.23	0.17	0.10	n/a	n/a	n/a
	5	(127)	0.61	0.58	0.55	0.59	0.52	0.45	0.54	0.54	0.53	0.14	0.10	0.06	0.28	0.21	0.13	n/a	n/a	n/a
	6	(152)	0.63	0.60	0.56	0.64	0.56	0.47	0.55	0.54	0.53	0.18	0.14	0.08	0.37	0.27	0.16	n/a	n/a	n/a
	7	(178)	0.65	0.61	0.57	0.70	0.60	0.49	0.56	0.55	0.54	0.23	0.17	0.10	0.46	0.35	0.21	n/a	n/a	n/a
	8	(203)	0.67	0.63	0.58	0.76	0.64	0.52	0.57	0.56	0.54	0.28	0.21	0.13	0.56	0.42	0.25	n/a	n/a	n/a
	9	(229)	0.69	0.64	0.59	0.82	0.68	0.54	0.58	0.57	0.55	0.34	0.25	0.15	0.67	0.50	0.30	n/a	n/a	n/a
	9-7/8	(251)	0.71	0.66	0.59	0.87	0.72	0.56	0.59	0.57	0.55	0.39	0.29	0.17	0.77	0.58	0.35	0.59	n/a	n/a
	10	(254)	0.71	0.66	0.60	0.88	0.73	0.56	0.59	0.57	0.55	0.39	0.30	0.18	0.79	0.59	0.35	0.60	n/a	n/a
	11	(279)	0.73	0.67	0.60	0.95	0.77	0.59	0.60	0.58	0.56	0.45	0.34	0.20	0.91	0.68	0.41	0.63	n/a	n/a
	12	(305)	0.75	0.69	0.61	1.00	0.82	0.61	0.61	0.59	0.56	0.52	0.39	0.23	1.00	0.78	0.47	0.66	n/a	n/a
	12-1/2	(318)	0.76	0.70	0.62		0.84	0.62	0.61	0.59	0.57	0.55	0.41	0.25		0.83	0.50	0.67	0.61	n/a
	14	(356)	0.80	0.72	0.63		0.91	0.66	0.63	0.60	0.57	0.65	0.49	0.29		0.91	0.59	0.71	0.64	n/a
	16	(406)	0.84	0.75	0.65		1.00	0.71	0.64	0.62	0.58	0.80	0.60	0.36		1.00	0.71	0.76	0.69	n/a
	18	(457)	0.88	0.79	0.67			0.76	0.66	0.63	0.59	0.95	0.71	0.43			0.76	0.80	0.73	n/a
	19-1/2	(495)	0.91	0.81	0.69			0.80	0.67	0.64	0.60	1.00	0.80	0.48			0.80	0.84	0.76	0.64
	20	(508)	0.92	0.82	0.69			0.82	0.68	0.65	0.61		0.84	0.50			0.82	0.85	0.77	0.65
	22	(559)	0.97	0.85	0.71			0.87	0.70	0.66	0.62		0.96	0.58			0.87	0.89	0.81	0.68
	24	(610)	1.00	0.88	0.73			0.93	0.71	0.68	0.63		1.00	0.66			0.93	0.93	0.84	0.71
	26	(660)		0.91	0.75			0.99	0.73	0.69	0.64			0.74			0.99	0.96	0.88	0.74
	28	(711)		0.94	0.77			1.00	0.75	0.71	0.65			0.83			1.00	1.00	0.91	0.77
	30	(762)		0.98	0.79				0.77	0.72	0.66			0.92				1.00	0.94	0.79
	36	(914)		1.00	0.84				0.82	0.77	0.69			1.00					1.00	0.87
	> 48	(1219)			0.96				0.93	0.85	0.75									1.00

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{HV} = 1.0$.

Table 32 — Load adjustment factors for #8 rebar in uncracked concrete[1,2,3]

	#8 Rebar uncracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
	Embedment h_{ef} in.	(mm)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.23	0.17	0.10	n/a	n/a	n/a	0.02	0.01	0.01	0.05	0.03	0.01	n/a	n/a	n/a
	5	(127)	0.59	0.57	0.54	0.31	0.23	0.13	0.54	0.53	0.52	0.11	0.07	0.04	0.22	0.14	0.07	n/a	n/a	n/a
	6	(152)	0.61	0.58	0.55	0.33	0.25	0.14	0.55	0.53	0.52	0.14	0.09	0.05	0.29	0.19	0.09	n/a	n/a	n/a
	7	(178)	0.63	0.60	0.56	0.36	0.27	0.16	0.55	0.54	0.53	0.18	0.12	0.06	0.36	0.23	0.12	n/a	n/a	n/a
	8	(203)	0.65	0.61	0.57	0.39	0.29	0.17	0.56	0.55	0.53	0.22	0.14	0.07	0.40	0.29	0.15	n/a	n/a	n/a
	9	(229)	0.67	0.63	0.58	0.42	0.31	0.18	0.57	0.55	0.53	0.26	0.17	0.09	0.43	0.34	0.17	n/a	n/a	n/a
	10	(254)	0.69	0.64	0.58	0.45	0.33	0.20	0.58	0.56	0.54	0.31	0.20	0.10	0.46	0.38	0.20	n/a	n/a	n/a
	11	(279)	0.70	0.65	0.59	0.48	0.36	0.21	0.58	0.56	0.54	0.35	0.23	0.12	0.50	0.40	0.23	n/a	n/a	n/a
	11-1/4	(286)	0.71	0.66	0.59	0.49	0.36	0.21	0.59	0.56	0.54	0.37	0.24	0.12	0.50	0.41	0.24	0.58	n/a	n/a
	12	(305)	0.72	0.67	0.60	0.52	0.38	0.22	0.59	0.57	0.54	0.40	0.26	0.13	0.53	0.43	0.27	0.60	n/a	n/a
	13	(330)	0.74	0.68	0.61	0.56	0.41	0.24	0.60	0.57	0.55	0.46	0.30	0.15	0.56	0.45	0.30	0.63	n/a	n/a
	14	(356)	0.76	0.69	0.62	0.60	0.44	0.26	0.61	0.58	0.55	0.51	0.33	0.17	0.60	0.47	0.34	0.65	n/a	n/a
	14-1/4	(362)	0.76	0.70	0.62	0.61	0.45	0.26	0.61	0.58	0.55	0.52	0.34	0.17	0.61	0.48	0.34	0.66	0.57	n/a
	16	(406)	0.80	0.72	0.63	0.69	0.50	0.30	0.62	0.59	0.56	0.62	0.40	0.21	0.69	0.52	0.37	0.70	0.60	n/a
	18	(457)	0.83	0.75	0.65	0.77	0.57	0.33	0.64	0.60	0.57	0.74	0.48	0.25	0.77	0.57	0.39	0.74	0.64	n/a
	20	(508)	0.87	0.78	0.67	0.86	0.63	0.37	0.65	0.61	0.57	0.87	0.56	0.29	0.86	0.63	0.42	0.78	0.67	n/a
	22	(559)	0.91	0.81	0.68	0.94	0.69	0.41	0.67	0.63	0.58	1.00	0.65	0.33	0.94	0.69	0.44	0.82	0.71	n/a
	22-1/4	(565)	0.91	0.81	0.69	0.95	0.70	0.41	0.67	0.63	0.58		0.66	0.34	0.95	0.70	0.45	0.82	0.71	0.57
	24	(610)	0.94	0.83	0.70	1.00	0.76	0.44	0.68	0.64	0.59		0.74	0.38	1.00	0.76	0.47	0.85	0.74	0.59
	26	(660)	0.98	0.86	0.72		0.82	0.48	0.70	0.65	0.59		0.84	0.43		0.82	0.50	0.89	0.77	0.61
	28	(711)	1.00	0.89	0.73		0.88	0.52	0.71	0.66	0.60		0.94	0.48		0.88	0.53	0.92	0.80	0.64
	30	(762)		0.92	0.75		0.95	0.55	0.73	0.67	0.61		1.00	0.53		0.95	0.55	0.95	0.83	0.66
	36	(914)		1.00	0.80		1.00	0.67	0.77	0.70	0.63			0.69		1.00	0.67	1.00	0.91	0.72
	> 48	(1219)			0.90			0.89	0.86	0.77	0.67			1.00			0.89		1.00	0.83

Table 33 — Load adjustment factors for #8 rebar in cracked concrete[1,2,3]

	#8 Rebar cracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
	Embedment h_{ef} in.	(mm)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.42	0.40	0.38	n/a	n/a	n/a	0.02	0.02	0.01	0.05	0.03	0.02	n/a	n/a	n/a
	5	(127)	0.59	0.57	0.54	0.56	0.50	0.44	0.54	0.53	0.52	0.11	0.08	0.05	0.22	0.16	0.10	n/a	n/a	n/a
	6	(152)	0.61	0.58	0.55	0.60	0.53	0.46	0.55	0.54	0.53	0.14	0.10	0.06	0.29	0.21	0.13	n/a	n/a	n/a
	7	(178)	0.63	0.60	0.56	0.65	0.57	0.47	0.55	0.54	0.53	0.18	0.13	0.08	0.36	0.26	0.16	n/a	n/a	n/a
	8	(203)	0.65	0.61	0.57	0.70	0.60	0.49	0.56	0.55	0.54	0.22	0.16	0.10	0.44	0.32	0.19	n/a	n/a	n/a
	9	(229)	0.67	0.63	0.58	0.75	0.64	0.51	0.57	0.56	0.54	0.26	0.19	0.12	0.53	0.38	0.23	n/a	n/a	n/a
	10	(254)	0.69	0.64	0.58	0.80	0.67	0.53	0.58	0.56	0.54	0.31	0.22	0.13	0.62	0.45	0.27	n/a	n/a	n/a
	11	(279)	0.70	0.65	0.59	0.86	0.71	0.55	0.58	0.57	0.55	0.36	0.26	0.16	0.72	0.52	0.31	n/a	n/a	n/a
	11-1/4	(286)	0.71	0.66	0.59	0.87	0.72	0.56	0.59	0.57	0.55	0.37	0.27	0.16	0.74	0.54	0.32	0.59	n/a	n/a
	12	(305)	0.72	0.67	0.60	0.91	0.75	0.57	0.59	0.57	0.55	0.41	0.30	0.18	0.82	0.59	0.35	0.61	n/a	n/a
	13	(330)	0.74	0.68	0.61	0.97	0.79	0.59	0.60	0.58	0.56	0.46	0.33	0.20	0.92	0.67	0.40	0.63	n/a	n/a
	14	(356)	0.76	0.69	0.62	1.00	0.83	0.62	0.61	0.59	0.56	0.51	0.37	0.22	1.00	0.74	0.45	0.65	n/a	n/a
	14-1/4	(362)	0.76	0.70	0.62		0.84	0.62	0.61	0.59	0.56	0.53	0.38	0.23		0.76	0.46	0.66	0.59	n/a
	16	(406)	0.80	0.72	0.63		0.91	0.66	0.62	0.60	0.57	0.63	0.45	0.27		0.91	0.55	0.70	0.63	n/a
	18	(457)	0.83	0.75	0.65		1.00	0.70	0.64	0.61	0.58	0.75	0.54	0.33		1.00	0.65	0.74	0.67	n/a
	20	(508)	0.87	0.78	0.67			0.75	0.65	0.62	0.59	0.88	0.64	0.38			0.75	0.78	0.70	n/a
	22	(559)	0.91	0.81	0.68			0.80	0.67	0.64	0.60	1.00	0.73	0.44			0.80	0.82	0.74	n/a
	22-1/4	(565)	0.91	0.81	0.69			0.80	0.67	0.64	0.60		0.75	0.45			0.80	0.82	0.74	0.62
	24	(610)	0.94	0.83	0.70			0.85	0.68	0.65	0.61		0.84	0.50			0.85	0.86	0.77	0.65
	26	(660)	0.98	0.86	0.72			0.90	0.70	0.66	0.61		0.94	0.57			0.90	0.89	0.80	0.68
	28	(711)	1.00	0.89	0.73			0.95	0.71	0.67	0.62		1.00	0.63			0.95	0.92	0.83	0.70
	30	(762)		0.92	0.75			1.00	0.73	0.68	0.63			0.70			1.00	0.96	0.86	0.73
	36	(914)		1.00	0.80				0.77	0.72	0.66			0.92				1.00	0.94	0.79
	> 48	(1219)			0.90				0.87	0.80	0.71			1.00					1.00	0.92

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*h_{ef}. f_{AV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{AV} = f_{AN}.
5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{HV} = 1.0.

Table 34 — Load adjustment factors for #9 rebar in uncracked concrete[1,2,3]

#9 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.22	0.16	0.10	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.02	0.01	n/a	n/a	n/a
	5-5/8	(143)	0.59	0.57	0.54	0.31	0.23	0.13	0.54	0.53	0.52	0.11	0.07	0.03	0.22	0.14	0.07	n/a	n/a	n/a
	6	(152)	0.60	0.57	0.54	0.32	0.23	0.14	0.54	0.53	0.52	0.12	0.08	0.04	0.24	0.16	0.07	n/a	n/a	n/a
	7	(178)	0.62	0.59	0.55	0.34	0.25	0.15	0.55	0.54	0.52	0.15	0.10	0.05	0.30	0.20	0.09	n/a	n/a	n/a
	8	(203)	0.63	0.60	0.56	0.37	0.27	0.16	0.55	0.54	0.52	0.18	0.12	0.06	0.37	0.24	0.11	n/a	n/a	n/a
	9	(229)	0.65	0.61	0.57	0.40	0.29	0.17	0.56	0.55	0.53	0.22	0.14	0.07	0.41	0.29	0.14	n/a	n/a	n/a
	10	(254)	0.66	0.62	0.57	0.42	0.31	0.18	0.57	0.55	0.53	0.26	0.17	0.08	0.44	0.33	0.16	n/a	n/a	n/a
	11	(279)	0.68	0.64	0.58	0.45	0.33	0.19	0.57	0.56	0.53	0.30	0.19	0.09	0.46	0.38	0.19	n/a	n/a	n/a
	12	(305)	0.70	0.65	0.59	0.48	0.35	0.20	0.58	0.56	0.54	0.34	0.22	0.11	0.49	0.40	0.21	n/a	n/a	n/a
	12-7/8	(327)	0.71	0.66	0.60	0.51	0.37	0.22	0.59	0.57	0.54	0.38	0.24	0.12	0.52	0.42	0.23	0.59	n/a	n/a
	13	(330)	0.71	0.66	0.60	0.51	0.37	0.22	0.59	0.57	0.54	0.38	0.25	0.12	0.52	0.42	0.24	0.59	n/a	n/a
	14	(356)	0.73	0.67	0.60	0.54	0.39	0.23	0.59	0.57	0.54	0.43	0.28	0.13	0.55	0.44	0.27	0.61	n/a	n/a
	16	(406)	0.76	0.70	0.62	0.62	0.45	0.26	0.61	0.58	0.55	0.52	0.34	0.16	0.62	0.48	0.33	0.66	n/a	n/a
	16-1/4	(413)	0.77	0.70	0.62	0.63	0.46	0.27	0.61	0.58	0.55	0.53	0.35	0.17	0.63	0.48	0.33	0.66	0.57	n/a
	18	(457)	0.80	0.72	0.63	0.69	0.51	0.30	0.62	0.59	0.56	0.62	0.40	0.19	0.69	0.52	0.37	0.70	0.60	n/a
	20	(508)	0.83	0.75	0.65	0.77	0.56	0.33	0.63	0.60	0.56	0.73	0.47	0.23	0.77	0.56	0.39	0.73	0.64	n/a
	22	(559)	0.86	0.77	0.66	0.85	0.62	0.36	0.65	0.61	0.57	0.84	0.55	0.26	0.85	0.62	0.41	0.77	0.67	n/a
	24	(610)	0.90	0.80	0.68	0.93	0.68	0.40	0.66	0.62	0.57	0.96	0.62	0.30	0.93	0.68	0.43	0.80	0.70	n/a
	25-1/4	(641)	0.92	0.81	0.69	0.97	0.71	0.42	0.67	0.63	0.58	1.00	0.67	0.32	0.97	0.71	0.45	0.83	0.71	0.56
	26	(660)	0.93	0.82	0.69	1.00	0.73	0.43	0.68	0.63	0.58		0.70	0.34	1.00	0.73	0.46	0.84	0.73	0.57
	28	(711)	0.96	0.85	0.71		0.79	0.46	0.69	0.64	0.59		0.78	0.38		0.79	0.48	0.87	0.75	0.59
	30	(762)	0.99	0.87	0.72		0.84	0.49	0.70	0.65	0.59		0.87	0.42		0.84	0.51	0.90	0.78	0.61
	36	(914)	1.00	0.94	0.77		1.00	0.59	0.74	0.68	0.61		1.00	0.55		1.00	0.59	0.99	0.85	0.67
	> 48	(1219)		1.00	0.86			0.79	0.82	0.74	0.65			0.84			0.79	1.00	0.99	0.77

Table 35 — Load adjustment factors for #9 rebar in cracked concrete[1,2,3]

#9 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.41	0.39	0.38	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.03	0.02	n/a	n/a	n/a
	5-5/8	(143)	0.59	0.57	0.54	0.56	0.50	0.44	0.54	0.53	0.52	0.11	0.07	0.04	0.22	0.15	0.09	n/a	n/a	n/a
	6	(152)	0.60	0.57	0.54	0.57	0.51	0.44	0.54	0.53	0.52	0.12	0.08	0.05	0.24	0.16	0.10	n/a	n/a	n/a
	7	(178)	0.62	0.59	0.55	0.61	0.54	0.46	0.55	0.54	0.53	0.15	0.10	0.06	0.30	0.21	0.12	n/a	n/a	n/a
	8	(203)	0.63	0.60	0.56	0.65	0.57	0.48	0.55	0.54	0.53	0.19	0.13	0.08	0.37	0.25	0.15	n/a	n/a	n/a
	9	(229)	0.65	0.61	0.57	0.70	0.60	0.49	0.56	0.55	0.53	0.22	0.15	0.09	0.44	0.30	0.18	n/a	n/a	n/a
	10	(254)	0.66	0.62	0.57	0.74	0.63	0.51	0.57	0.55	0.54	0.26	0.18	0.11	0.52	0.35	0.21	n/a	n/a	n/a
	11	(279)	0.68	0.64	0.58	0.79	0.67	0.53	0.57	0.56	0.54	0.30	0.20	0.12	0.60	0.40	0.24	n/a	n/a	n/a
	12	(305)	0.70	0.65	0.59	0.84	0.70	0.55	0.58	0.56	0.54	0.34	0.23	0.14	0.68	0.46	0.28	n/a	n/a	n/a
	12-7/8	(327)	0.71	0.66	0.60	0.88	0.73	0.56	0.59	0.57	0.55	0.38	0.26	0.15	0.76	0.51	0.31	0.59	n/a	n/a
	13	(330)	0.71	0.66	0.60	0.89	0.73	0.56	0.59	0.57	0.55	0.39	0.26	0.16	0.77	0.52	0.31	0.59	n/a	n/a
	14	(356)	0.73	0.67	0.60	0.94	0.77	0.58	0.60	0.57	0.55	0.43	0.29	0.17	0.86	0.58	0.35	0.62	n/a	n/a
	16	(406)	0.76	0.70	0.62	1.00	0.84	0.62	0.61	0.58	0.56	0.53	0.36	0.21	1.00	0.71	0.43	0.66	n/a	n/a
	16-1/4	(413)	0.77	0.70	0.62		0.85	0.63	0.61	0.58	0.56	0.54	0.36	0.22		0.73	0.44	0.66	0.58	n/a
	18	(457)	0.80	0.72	0.63		0.91	0.66	0.62	0.59	0.57	0.63	0.42	0.25		0.85	0.51	0.70	0.61	n/a
	20	(508)	0.83	0.75	0.65		0.99	0.70	0.64	0.60	0.57	0.73	0.50	0.30		0.99	0.60	0.74	0.65	n/a
	22	(559)	0.86	0.77	0.66		1.00	0.74	0.65	0.61	0.58	0.85	0.57	0.34		1.00	0.69	0.77	0.68	n/a
	24	(610)	0.90	0.80	0.68			0.78	0.66	0.63	0.59	0.97	0.65	0.39			0.78	0.81	0.71	n/a
	25-1/4	(641)	0.92	0.81	0.69			0.81	0.67	0.63	0.59	1.00	0.70	0.42			0.81	0.83	0.73	0.61
	26	(660)	0.93	0.82	0.69			0.82	0.68	0.64	0.60		0.74	0.44			0.82	0.84	0.74	0.62
	28	(711)	0.96	0.85	0.71			0.87	0.69	0.65	0.60		0.82	0.49			0.87	0.87	0.76	0.65
	30	(762)	0.99	0.87	0.72			0.91	0.70	0.66	0.61		0.91	0.55			0.91	0.90	0.79	0.67
	36	(914)	1.00	0.94	0.77			1.00	0.74	0.69	0.63		1.00	0.72			1.00	0.99	0.87	0.73
	> 48	(1219)		1.00	0.86				0.83	0.75	0.68			1.00				1.00	1.00	0.84

[1] Linear interpolation not permitted.

[2] Shaded area with reduced edge distance is permitted provided rebar has no installation torque.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3{*}h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{HV} = 1.0$.

Table 36 — Load adjustment factors for #10 rebar in uncracked concrete [1,2,3]

#10 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.22	0.16	0.09	n/a	n/a	n/a	0.02	0.01	0.00	0.03	0.02	0.01	n/a	n/a	n/a
	6-1/4	(159)	0.59	0.57	0.54	0.32	0.23	0.13	0.54	0.53	0.52	0.11	0.07	0.03	0.22	0.14	0.07	n/a	n/a	n/a
	7	(178)	0.60	0.58	0.55	0.33	0.24	0.14	0.54	0.53	0.52	0.13	0.08	0.04	0.26	0.17	0.08	n/a	n/a	n/a
	8	(203)	0.62	0.59	0.55	0.36	0.25	0.15	0.55	0.54	0.52	0.16	0.10	0.05	0.31	0.20	0.10	n/a	n/a	n/a
	9	(229)	0.63	0.60	0.56	0.38	0.27	0.16	0.55	0.54	0.52	0.19	0.12	0.06	0.38	0.24	0.11	n/a	n/a	n/a
	10	(254)	0.65	0.61	0.57	0.40	0.29	0.17	0.56	0.55	0.53	0.22	0.14	0.07	0.42	0.29	0.13	n/a	n/a	n/a
	11	(279)	0.66	0.62	0.57	0.43	0.31	0.18	0.57	0.55	0.53	0.25	0.16	0.08	0.44	0.33	0.15	n/a	n/a	n/a
	12	(305)	0.68	0.63	0.58	0.45	0.32	0.19	0.57	0.55	0.53	0.29	0.19	0.09	0.47	0.38	0.17	n/a	n/a	n/a
	13	(330)	0.69	0.64	0.59	0.48	0.34	0.20	0.58	0.56	0.54	0.33	0.21	0.10	0.49	0.39	0.20	n/a	n/a	n/a
	14	(356)	0.71	0.66	0.59	0.51	0.36	0.21	0.59	0.56	0.54	0.36	0.24	0.11	0.52	0.41	0.22	n/a	n/a	n/a
	14-1/4	(362)	0.71	0.66	0.60	0.51	0.37	0.22	0.59	0.56	0.54	0.37	0.24	0.11	0.53	0.41	0.23	0.59	n/a	n/a
	15	(381)	0.72	0.67	0.60	0.54	0.38	0.22	0.59	0.57	0.54	0.40	0.26	0.12	0.55	0.43	0.24	0.60	n/a	n/a
	16	(406)	0.74	0.68	0.61	0.57	0.40	0.24	0.60	0.57	0.54	0.45	0.29	0.13	0.57	0.44	0.27	0.62	n/a	n/a
	17	(432)	0.75	0.69	0.61	0.60	0.43	0.25	0.60	0.58	0.55	0.49	0.32	0.15	0.60	0.46	0.29	0.64	n/a	n/a
	18	(457)	0.77	0.70	0.62	0.64	0.46	0.27	0.61	0.58	0.55	0.53	0.35	0.16	0.64	0.48	0.32	0.66	0.57	n/a
	20	(508)	0.80	0.72	0.63	0.71	0.51	0.30	0.62	0.59	0.55	0.62	0.40	0.19	0.71	0.52	0.37	0.70	0.60	n/a
	22	(559)	0.83	0.74	0.65	0.78	0.56	0.33	0.63	0.60	0.56	0.72	0.47	0.22	0.78	0.56	0.39	0.73	0.63	n/a
	24	(610)	0.86	0.77	0.66	0.85	0.61	0.36	0.65	0.61	0.57	0.82	0.53	0.25	0.85	0.61	0.41	0.76	0.66	n/a
	26	(660)	0.89	0.79	0.67	0.92	0.66	0.39	0.66	0.62	0.57	0.92	0.60	0.28	0.92	0.66	0.43	0.79	0.69	n/a
	28	(711)	0.91	0.81	0.69	0.99	0.71	0.41	0.67	0.63	0.58	1.00	0.67	0.31	0.99	0.71	0.45	0.82	0.71	0.55
	30	(762)	0.94	0.83	0.70	1.00	0.76	0.44	0.68	0.64	0.58		0.74	0.35	1.00	0.76	0.47	0.85	0.74	0.57
	36	(914)	1.00	0.90	0.74		0.91	0.53	0.72	0.66	0.60		0.98	0.45		0.91	0.54	0.94	0.81	0.63
	> 48	(1219)		1.00	0.82		1.00	0.71	0.79	0.72	0.63		1.00	0.70		1.00	0.71	1.00	0.94	0.72

Table 37 — Load adjustment factors for #10 rebar in cracked concrete [1,2,3]

#10 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.40	0.39	0.37	n/a	n/a	n/a	0.02	0.01	0.01	0.03	0.02	0.01	n/a	n/a	n/a
	6-1/4	(159)	0.59	0.57	0.54	0.56	0.50	0.44	0.54	0.53	0.52	0.11	0.07	0.04	0.22	0.14	0.08	n/a	n/a	n/a
	7	(178)	0.60	0.58	0.55	0.58	0.52	0.45	0.54	0.53	0.52	0.13	0.08	0.05	0.26	0.17	0.10	n/a	n/a	n/a
	8	(203)	0.62	0.59	0.55	0.62	0.55	0.46	0.55	0.54	0.53	0.16	0.10	0.06	0.32	0.21	0.12	n/a	n/a	n/a
	9	(229)	0.63	0.60	0.56	0.66	0.57	0.48	0.55	0.54	0.53	0.19	0.12	0.07	0.38	0.25	0.15	n/a	n/a	n/a
	10	(254)	0.65	0.61	0.57	0.70	0.60	0.49	0.56	0.55	0.53	0.22	0.14	0.09	0.44	0.29	0.17	n/a	n/a	n/a
	11	(279)	0.66	0.62	0.57	0.74	0.63	0.51	0.57	0.55	0.54	0.26	0.17	0.10	0.51	0.33	0.20	n/a	n/a	n/a
	12	(305)	0.68	0.63	0.58	0.78	0.66	0.53	0.57	0.55	0.54	0.29	0.19	0.11	0.58	0.38	0.22	n/a	n/a	n/a
	13	(330)	0.69	0.64	0.59	0.82	0.69	0.54	0.58	0.56	0.54	0.33	0.21	0.13	0.66	0.43	0.25	n/a	n/a	n/a
	14	(356)	0.71	0.66	0.59	0.87	0.72	0.56	0.59	0.56	0.55	0.37	0.24	0.14	0.73	0.48	0.28	n/a	n/a	n/a
	14-1/4	(362)	0.71	0.66	0.60	0.88	0.73	0.56	0.59	0.57	0.55	0.38	0.25	0.15	0.75	0.49	0.29	0.59	n/a	n/a
	15	(381)	0.72	0.67	0.60	0.91	0.75	0.57	0.59	0.57	0.55	0.41	0.26	0.16	0.82	0.53	0.31	0.61	n/a	n/a
	16	(406)	0.74	0.68	0.61	0.96	0.78	0.59	0.60	0.57	0.55	0.45	0.29	0.17	0.90	0.58	0.35	0.63	n/a	n/a
	17	(432)	0.75	0.69	0.61	1.00	0.81	0.61	0.60	0.58	0.55	0.49	0.32	0.19	0.98	0.64	0.38	0.64	n/a	n/a
	18	(457)	0.77	0.70	0.62		0.85	0.62	0.61	0.58	0.56	0.54	0.35	0.21	1.00	0.70	0.41	0.66	0.57	n/a
	20	(508)	0.80	0.72	0.63		0.91	0.66	0.62	0.59	0.56	0.63	0.41	0.24		0.82	0.48	0.70	0.61	n/a
	22	(559)	0.83	0.74	0.65		0.98	0.69	0.63	0.60	0.57	0.72	0.47	0.28		0.94	0.56	0.73	0.63	n/a
	24	(610)	0.86	0.77	0.66		1.00	0.73	0.65	0.61	0.58	0.82	0.54	0.32		1.00	0.63	0.77	0.66	n/a
	26	(660)	0.89	0.79	0.67			0.77	0.66	0.62	0.58	0.93	0.60	0.36			0.71	0.80	0.69	n/a
	28	(711)	0.91	0.81	0.69			0.81	0.67	0.63	0.59	1.00	0.68	0.40			0.80	0.83	0.72	0.60
	30	(762)	0.94	0.83	0.70			0.85	0.68	0.64	0.60		0.75	0.44			0.85	0.86	0.74	0.62
	36	(914)	1.00	0.90	0.74			0.97	0.72	0.66	0.62		0.98	0.58			0.97	0.94	0.81	0.68
	> 48	(1219)		1.00	0.82			1.00	0.79	0.72	0.65		1.00	0.90			1.00	1.00	0.94	0.79

[1] Linear interpolation not permitted.

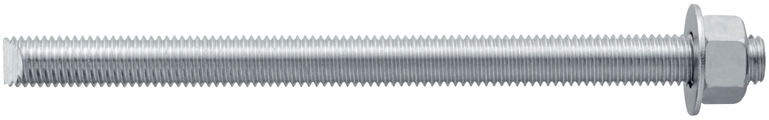
[2] Shaded area with reduced edge distance is permitted provided rebar has no installation torque.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when c < 3*h_{ef}. f_{AV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{AV} = f_{AN}.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{HV} = 1.0.

HIT-HY 200 V3 Adhesive with HAS Threaded Rod



Hilti HAS threaded rod

Figure 9 — Hilti HAS threaded rod installation conditions

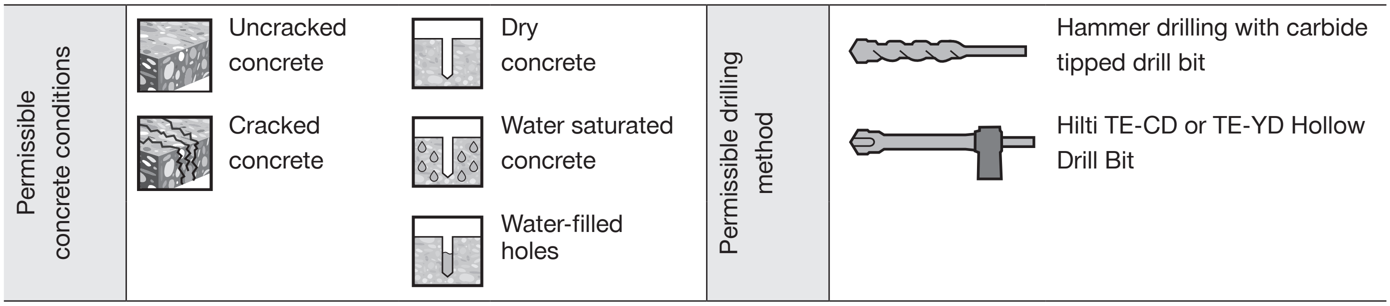
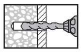
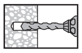


Table 38 — Hilti HAS threaded rod specifications

Setting information		Symbol	Units	Nominal rod diameter, d						
				3/8	1/2	5/8	3/4	7/8	1	1-1/4
Nominal bit diameter		d_o	in.	7/16	9/16	3/4	7/8	1	1-1/8	1-3/8
Effective embedment	minimum	$h_{ef,min}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (79)	3-1/2 (89)	3-1/2 (89)	4 (102)	5 (127)
	maximum	$h_{ef,max}$	in. (mm)	7-1/2 (191)	10 (254)	12-1/2 (318)	15 (381)	17-1/2 (445)	20 (508)	25 (635)
Diameter of fixture hole	through-set		in.	1/2	5/8	13/16[1]	15/16[1]	1-1/8[1]	1-1/4[1]	1-1/2[1]
Diameter of fixture hole	preset		in.	7/16	9/16	11/16	13/16	15/16	1-1/8	1-3/8
Installation torque		T_{inst}	ft-lb (Nm)	15 (20)	30 (40)	60 (80)	100 (136)	125 (169)	150 (203)	200 (271)
Minimum concrete thickness		h_{min}	in. (mm)	h_{ef}+1-1/4 (h_{ef}+30)		$h_{ef}+2d_o$				
Minimum edge distance		c_{min}	in. (mm)	1-3/4 (45)	1-3/4 (45)	2[2] (50)[2]	2-1/8[2] (55)[2]	2-1/4[2] (60)[2]	2-3/4[2] (70)[2]	3-1/8[2] (80)[2]
Minimum anchor spacing		s_{min}	in. (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/4 (111)	5 (127)	6-1/4 (159)

[1] Install using (2) washers. See Figure 11.

[2] Edge distance of 1-3/4-inch (44mm) is permitted provided the installation torque is reduced to 0.30 T_{inst} for 5d < s < 16-in. and to 0.5 T_{inst} for s > 16-in.

Figure 10 — Hilti HAS threaded rods

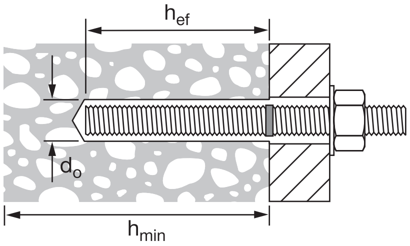


Figure 11 — Installation with (2) washers

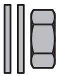


Table 39 — Hilti HIT-HY 200 V3 adhesive design strength with concrete / bond failure for threaded rod in uncracked concrete [1,2,3,4,5,6,7,8,9]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8	2-3/8 (60)	2,855 (12.7)	3,125 (13.9)	3,610 (16.1)	4,405 (19.6)	3,075 (13.7)	3,370 (15.0)	3,890 (17.3)	4,745 (21.1)
	3-3/8 (86)	4,835 (21.5)	5,300 (23.6)	6,015 (26.8)	6,260 (27.8)	10,415 (46.3)	11,410 (50.8)	12,950 (57.6)	13,490 (60.0)
	4-1/2 (114)	7,445 (33.1)	7,790 (34.7)	8,020 (35.7)	8,350 (37.1)	16,035 (71.3)	16,780 (74.6)	17,270 (76.8)	17,985 (80.0)
	7-1/2 (191)	12,750 (56.7)	12,985 (57.8)	13,365 (59.5)	13,915 (61.9)	27,460 (122.1)	27,965 (124.4)	28,785 (128.0)	29,975 (133.3)
1/2	2-3/4 (70)	3,555 (15.8)	3,895 (17.3)	4,500 (20.0)	5,510 (24.5)	7,660 (34.1)	8,395 (37.3)	9,690 (43.1)	11,870 (52.8)
	4-1/2 (114)	7,445 (33.1)	8,155 (36.3)	9,420 (41.9)	11,135 (49.5)	16,035 (71.3)	17,570 (78.2)	20,285 (90.2)	23,980 (106.7)
	6 (152)	11,465 (51.0)	12,560 (55.9)	14,255 (63.4)	14,845 (66.0)	24,690 (109.8)	27,045 (120.3)	30,700 (136.6)	31,970 (142.2)
	10 (254)	22,665 (100.8)	23,085 (102.7)	23,755 (105.7)	24,740 (110.0)	48,820 (217.2)	49,720 (221.2)	51,170 (227.6)	53,285 (237.0)
5/8	3-1/8 (79)	4,310 (19.2)	4,720 (21.0)	5,450 (24.2)	6,675 (29.7)	9,280 (41.3)	10,165 (45.2)	11,740 (52.2)	14,380 (64.0)
	5-5/8 (143)	10,405 (46.3)	11,400 (50.7)	13,165 (58.6)	16,120 (71.7)	22,415 (99.7)	24,550 (109.2)	28,350 (126.1)	34,720 (154.4)
	7-1/2 (191)	16,020 (71.3)	17,550 (78.1)	20,265 (90.1)	23,195 (103.2)	34,505 (153.5)	37,800 (168.1)	43,650 (194.2)	49,955 (222.2)
	12-1/2 (318)	34,470 (153.3)	36,070 (160.4)	37,120 (165.1)	38,655 (171.9)	74,245 (330.3)	77,685 (345.6)	79,955 (355.7)	83,260 (370.4)
3/4	3-1/2 (89)	5,105 (22.7)	5,595 (24.9)	6,460 (28.7)	7,910 (35.2)	11,000 (48.9)	12,050 (53.6)	13,915 (61.9)	17,040 (75.8)
	6-3/4 (171)	13,680 (60.9)	14,985 (66.7)	17,305 (77.0)	21,190 (94.3)	29,460 (131.0)	32,275 (143.6)	37,265 (165.8)	45,645 (203.0)
	9 (229)	21,060 (93.7)	23,070 (102.6)	26,640 (118.5)	32,625 (145.1)	45,360 (201.8)	49,690 (221.0)	57,375 (255.2)	70,270 (312.6)
	15 (381)	45,315 (201.6)	49,640 (220.8)	53,455 (237.8)	55,665 (247.6)	97,600 (434.1)	106,915 (475.6)	115,130 (512.1)	119,895 (533.3)
7/8	3-1/2 (89)	5,105 (22.7)	5,595 (24.9)	6,460 (28.7)	7,910 (35.2)	11,000 (48.9)	12,050 (53.6)	13,915 (61.9)	17,040 (75.8)
	7-7/8 (200)	17,235 (76.7)	18,885 (84.0)	21,805 (97.0)	26,705 (118.8)	37,125 (165.1)	40,670 (180.9)	46,960 (208.9)	57,515 (255.8)
	10-1/2 (267)	26,540 (118.1)	29,070 (129.3)	33,570 (149.3)	41,115 (182.9)	57,160 (254.3)	62,615 (278.5)	72,300 (321.6)	88,550 (393.9)
	17-1/2 (445)	57,100 (254.0)	62,550 (278.2)	72,230 (321.3)	75,770 (337.0)	122,990 (547.1)	134,730 (599.3)	155,570 (692.0)	163,190 (725.9)
1	4 (102)	6,240 (27.8)	6,835 (30.4)	7,895 (35.1)	9,665 (43.0)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
	9 (229)	21,060 (93.7)	23,070 (102.6)	26,640 (118.5)	32,625 (145.1)	45,360 (201.8)	49,690 (221.0)	57,375 (255.2)	70,270 (312.6)
	12 (305)	32,425 (144.2)	35,520 (158.0)	41,015 (182.4)	50,230 (223.4)	69,835 (310.6)	76,500 (340.3)	88,335 (392.9)	108,190 (481.3)
	20 (508)	69,765 (310.3)	76,425 (340.0)	88,245 (392.5)	98,960 (440.2)	150,265 (668.4)	164,605 (732.2)	190,070 (845.5)	213,150 (948.1)
1-1/4	5 (127)	8,720 (38.8)	9,555 (42.5)	11,030 (49.1)	13,510 (60.1)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)
	11-1/4 (286)	29,430 (130.9)	32,240 (143.4)	37,230 (165.6)	45,595 (202.8)	63,395 (282.0)	69,445 (308.9)	80,185 (356.7)	98,205 (436.8)
	15 (381)	45,315 (201.6)	49,640 (220.8)	57,320 (255.0)	70,200 (312.3)	97,600 (434.1)	106,915 (475.6)	123,455 (549.2)	151,200 (672.6)
	25 (635)	97,500 (433.7)	106,805 (475.1)	123,330 (548.6)	151,045 (671.9)	210,000 (934.1)	230,045 (1023.3)	265,630 (1181.6)	325,330 (1447.1)

1 See section 3.1.8 for explanation on development of load values.

2 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 42 - 55 as necessary to the above values. Compare to the steel values in table 41. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C).
For temperature range C: Max. short term temperature = 248° F (120° C), max. long term temperature = 162° F (72° C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength value by 0.42.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete, multiply design strength (factored resistance) by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 40 — Hilti HIT-HY 200 V3 adhesive design strength with concrete / bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8	2-3/8 (60)	1,900 (8.5)	1,935 (8.6)	1,990 (8.9)	2,075 (9.2)	2,045 (9.1)	2,085 (9.3)	2,145 (9.5)	2,235 (9.9)
	3-3/8 (86)	2,700 (12.0)	2,750 (12.2)	2,830 (12.6)	2,950 (13.1)	5,815 (25.9)	5,925 (26.4)	6,095 (27.1)	6,350 (28.2)
	4-1/2 (114)	3,600 (16.0)	3,665 (16.3)	3,775 (16.8)	3,930 (17.5)	7,755 (34.5)	7,900 (35.1)	8,130 (36.2)	8,465 (37.7)
	7-1/2 (191)	6,000 (26.7)	6,110 (27.2)	6,290 (28.0)	6,550 (29.1)	12,925 (57.5)	13,165 (58.6)	13,550 (60.3)	14,110 (62.8)
1/2	2-3/4 (70)	2,520 (11.2)	2,760 (12.3)	3,185 (14.2)	3,480 (15.5)	5,425 (24.1)	5,945 (26.4)	6,865 (30.5)	7,490 (33.3)
	4-1/2 (114)	5,215 (23.2)	5,310 (23.6)	5,465 (24.3)	5,690 (25.3)	11,230 (50.0)	11,440 (50.9)	11,770 (52.4)	12,260 (54.5)
	6 (152)	6,955 (30.9)	7,080 (31.5)	7,290 (32.4)	7,590 (33.8)	14,975 (66.6)	15,250 (67.8)	15,695 (69.8)	16,345 (72.7)
	10 (254)	11,590 (51.6)	11,800 (52.5)	12,145 (54.0)	12,650 (56.3)	24,960 (111.0)	25,420 (113.1)	26,160 (116.4)	27,245 (121.2)
5/8	3-1/8 (79)	3,050 (13.6)	3,345 (14.9)	3,860 (17.2)	4,730 (21.0)	6,575 (29.2)	7,200 (32.0)	8,315 (37.0)	10,185 (45.3)
	5-5/8 (143)	7,370 (32.8)	8,075 (35.9)	8,805 (39.2)	9,170 (40.8)	15,875 (70.6)	17,390 (77.4)	18,960 (84.3)	19,745 (87.8)
	7-1/2 (191)	11,200 (49.8)	11,405 (50.7)	11,740 (52.2)	12,225 (54.4)	24,120 (107.3)	24,565 (109.3)	25,280 (112.5)	26,330 (117.1)
	12-1/2 (318)	18,665 (83.0)	19,010 (84.6)	19,565 (87.0)	20,375 (90.6)	40,205 (178.8)	40,940 (182.1)	42,135 (187.4)	43,880 (195.2)
3/4	3-1/2 (89)	3,620 (16.1)	3,965 (17.6)	4,575 (20.4)	5,605 (24.9)	7,790 (34.7)	8,535 (38.0)	9,855 (43.8)	12,070 (53.7)
	6-3/4 (171)	9,690 (43.1)	10,615 (47.2)	12,255 (54.5)	14,215 (63.2)	20,870 (92.8)	22,860 (101.7)	26,395 (117.4)	30,620 (136.2)
	9 (229)	14,920 (66.4)	16,340 (72.7)	18,205 (81.0)	18,955 (84.3)	32,130 (142.9)	35,195 (156.6)	39,205 (174.4)	40,830 (181.6)
	15 (381)	28,945 (128.8)	29,480 (131.1)	30,340 (135.0)	31,595 (140.5)	62,345 (277.3)	63,490 (282.4)	65,345 (290.7)	68,050 (302.7)
7/8	3-1/2 (89)	3,620 (16.1)	3,965 (17.6)	4,575 (20.4)	5,605 (24.9)	7,790 (34.7)	8,535 (38.0)	9,855 (43.8)	12,070 (53.7)
	7-7/8 (200)	12,210 (54.3)	13,375 (59.5)	15,445 (68.7)	18,915 (84.1)	26,300 (117.0)	28,810 (128.2)	33,265 (148.0)	40,740 (181.2)
	10-1/2 (267)	18,800 (83.6)	20,590 (91.6)	23,780 (105.8)	26,415 (117.5)	40,490 (180.1)	44,355 (197.3)	51,215 (227.8)	56,895 (253.1)
	17-1/2 (445)	40,335 (179.4)	41,080 (182.7)	42,280 (188.1)	44,025 (195.8)	86,880 (386.5)	88,475 (393.6)	91,060 (405.1)	94,830 (421.8)
1	4 (102)	4,420 (19.7)	4,840 (21.5)	5,590 (24.9)	6,845 (30.4)	9,520 (42.3)	10,430 (46.4)	12,040 (53.6)	14,750 (65.6)
	9 (229)	14,920 (66.4)	16,340 (72.7)	18,870 (83.9)	23,110 (102.8)	32,130 (142.9)	35,195 (156.6)	40,640 (180.8)	49,775 (221.4)
	12 (305)	22,965 (102.2)	25,160 (111.9)	29,050 (129.2)	35,440 (157.6)	49,465 (220.0)	54,190 (241.0)	62,570 (278.3)	76,330 (339.5)
	20 (508)	49,415 (219.8)	54,135 (240.8)	56,720 (252.3)	59,065 (262.7)	106,435 (473.4)	116,595 (518.6)	122,160 (543.4)	127,215 (565.9)
1-1/4	5 (127)	6,175 (27.5)	6,765 (30.1)	7,815 (34.8)	9,570 (42.6)	13,305 (59.2)	14,575 (64.8)	16,830 (74.9)	20,610 (91.7)
	11-1/4 (286)	20,850 (92.7)	22,840 (101.6)	26,370 (117.3)	32,295 (143.7)	44,905 (199.7)	49,190 (218.8)	56,800 (252.7)	69,565 (309.4)
	15 (381)	32,095 (142.8)	35,160 (156.4)	40,600 (180.6)	49,725 (221.2)	69,135 (307.5)	75,730 (336.9)	87,445 (389.0)	107,100 (476.4)
	25 (635)	69,060 (307.2)	75,655 (336.5)	87,360 (388.6)	96,120 (427.6)	148,750 (661.7)	162,945 (724.8)	188,155 (837.0)	207,030 (920.9)

[1] See section 3.1.8 for explanation on development of load values.

[2] See section 3.1.8 to convert design strength (factored resistance) value to ASD value.

[3] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[4] Apply spacing, edge distance, and concrete thickness factors in tables 42 - 55 as necessary to the above values. Compare to the steel values in table 41. The lesser of the values is to be used for the design.

[5] Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C).
For temperature range C: Max. short term temperature = 248° F (120° C), max. long term temperature = 162° F (72° C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

[6] Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength value by 0.42.

[7] Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.

[8] Tabular values are for normal-weight concrete only. For lightweight concrete, multiply design strength (factored resistance) by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

[9] Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors:
3/8-in diameter - α_{seis} = 0.66
1/2-in, 5/8-in, and 1-1/4-in diameter - α_{seis} =0.74
3/4-in and 7/8-in diameter - α_{seis} = 0.75
1-in diameter - α_{seis} = 0.71
See section 3.1.8 for additional information on seismic applications.

Table 41 — Steel design strength for Hilti HAS threaded rods for use with ACI 318 Chapter 17

Nominal anchor diameter in.	HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr. 36[4,6]			HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6]			HAS-B-105 and HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6]			HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4]		
	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)
3/8	3,370 (15.0)	1,750 (7.8)	1,050 (4.7)	4,360 (19.4)	2,270 (10.1)	1,590 (7.1)	7,270 (32.3)	3,780 (16.8)	2,645 (11.8)	5,040 (22.4)	2,790 (12.4)	1,955 (8.7)
1/2	6,175 (27.5)	3,210 (14.3)	1,925 (8.6)	7,985 (35.5)	4,150 (18.5)	2,905 (12.9)	13,305 (59.2)	6,920 (30.8)	4,845 (21.6)	9,225 (41.0)	5,110 (22.7)	3,575 (15.9)
5/8	9,835 (43.7)	5,110 (22.7)	3,065 (13.6)	12,715 (56.6)	6,610 (29.4)	4,625 (20.6)	21,190 (94.3)	11,020 (49.0)	7,715 (34.3)	14,690 (65.3)	8,135 (36.2)	5,695 (25.3)
3/4	14,550 (64.7)	7,565 (33.7)	4,540 (20.2)	18,820 (83.7)	9,785 (43.5)	6,850 (30.5)	31,360 (139.5)	16,310 (72.6)	11,415 (50.8)	18,485 (82.2)	10,235 (45.5)	7,165 (31.9)
7/8	20,085 (89.3)	10,445 (46.5)	6,265 (27.9)	25,975 (115.5)	13,505 (60.1)	9,455 (42.1)	43,285 (192.5)	22,510 (100.1)	15,755 (70.1)	25,510 (113.5)	14,125 (62.8)	9,890 (44.0)
1	26,350 (117.2)	13,700 (60.9)	8,220 (36.6)	34,075 (151.6)	17,720 (78.8)	12,405 (55.2)	56,785 (252.6)	29,530 (131.4)	20,670 (91.9)	33,465 (148.9)	18,535 (82.4)	12,975 (57.7)
1-1/4	42,160 (187.5)	21,920 (97.5)	13,150 (58.5)	54,515 (242.5)	28,345 (126.1)	19,840 (88.3)	90,855 (404.1)	47,245 (210.2)	33,070 (147.1)	41,430 (184.3)	21,545 (95.8)	12,925 (57.5)

1 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 17.4.1.2

2 Shear = $\phi 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 17.5.1.2b.

3 Seismic Shear = $\alpha_{V,seis} \phi V_{sa}$: Reduction factor for seismic shear only. See ACI 318 for additional information on seismic applications.

4 HAS-V, HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).

5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.

6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

Table 42 — Load adjustment factors for 3/8-in. diameter threaded rods in uncracked concrete[1,2,3]

3/8-in. threaded rods uncracked concrete	Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
													⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef} in. (mm)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)																								
1-3/4 (44)	n/a	n/a	n/a	n/a	0.35	0.28	0.22	0.13	n/a	n/a	n/a	n/a	0.23	0.07	0.05	0.03	0.35	0.14	0.09	0.05	n/a	n/a	n/a	n/a
1-7/8 (48)	0.58	0.58	0.57	0.54	0.36	0.29	0.22	0.13	0.57	0.53	0.52	0.52	0.25	0.08	0.05	0.03	0.36	0.16	0.10	0.06	n/a	n/a	n/a	n/a
2 (51)	0.59	0.59	0.57	0.54	0.37	0.30	0.23	0.13	0.57	0.53	0.52	0.52	0.28	0.09	0.06	0.03	0.37	0.17	0.11	0.07	n/a	n/a	n/a	n/a
3 (76)	0.63	0.63	0.61	0.57	0.48	0.36	0.28	0.16	0.61	0.55	0.54	0.53	0.51	0.16	0.10	0.06	0.48	0.32	0.21	0.12	n/a	n/a	n/a	n/a
3-5/8 (92)	0.66	0.66	0.63	0.58	0.56	0.41	0.31	0.18	0.63	0.56	0.54	0.53	0.68	0.21	0.14	0.08	0.56	0.41	0.27	0.16	0.72	n/a	n/a	n/a
4 (102)	0.68	0.68	0.65	0.59	0.62	0.44	0.33	0.19	0.64	0.57	0.55	0.53	0.79	0.24	0.16	0.09	0.62	0.44	0.32	0.19	0.75	n/a	n/a	n/a
4-5/8 (117)	0.71	0.71	0.67	0.60	0.71	0.49	0.36	0.21	0.66	0.58	0.56	0.54	0.98	0.30	0.20	0.12	0.71	0.49	0.36	0.21	0.81	0.55	n/a	n/a
5 (127)	0.72	0.72	0.69	0.61	0.77	0.52	0.38	0.22	0.68	0.58	0.56	0.54	1.00	0.34	0.22	0.13	0.77	0.52	0.38	0.22	0.84	0.57	n/a	n/a
5-3/4 (146)	0.76	0.76	0.71	0.63	0.89	0.59	0.43	0.25	0.70	0.59	0.57	0.55		0.42	0.27	0.16	0.89	0.59	0.43	0.25	0.91	0.61	0.53	n/a
6 (152)	0.77	0.77	0.72	0.63	0.93	0.62	0.45	0.26	0.71	0.60	0.57	0.55		0.45	0.29	0.17	0.93	0.62	0.45	0.26	0.92	0.63	0.54	n/a
7 (178)	0.81	0.81	0.76	0.66	1.00	0.72	0.53	0.30	0.75	0.61	0.59	0.56		0.57	0.37	0.21	1.00	0.72	0.53	0.30	1.00	0.68	0.58	n/a
8 (203)	0.86	0.86	0.80	0.68		0.82	0.60	0.35	0.79	0.63	0.60	0.57		0.69	0.45	0.26		0.82	0.60	0.35		0.72	0.63	n/a
8-3/4 (222)	0.89	0.89	0.82	0.69		0.90	0.66	0.38	0.81	0.64	0.61	0.57		0.79	0.51	0.30		0.90	0.66	0.38		0.76	0.65	0.55
9 (229)	0.90	0.90	0.83	0.70		0.93	0.68	0.39	0.82	0.65	0.61	0.58		0.83	0.54	0.31		0.93	0.68	0.39		0.77	0.66	0.55
10 (254)	0.95	0.95	0.87	0.72		1.00	0.75	0.43	0.86	0.66	0.62	0.59		0.97	0.63	0.37		1.00	0.75	0.43		0.81	0.70	0.58
11 (279)	0.99	0.99	0.91	0.74			0.83	0.48	0.89	0.68	0.63	0.59		1.00	0.72	0.42			0.83	0.48		0.85	0.73	0.61
12 (305)	1.00	1.00	0.94	0.77			0.90	0.52	0.93	0.70	0.65	0.60			0.83	0.48			0.90	0.52		0.88	0.77	0.64
14 (356)		1.00	1.00	0.81			1.00	0.61	1.00	0.73	0.67	0.62			1.00	0.61			1.00	0.61		0.96	0.83	0.69
16 (406)				0.86				0.70		0.76	0.70	0.64				0.74				0.70		1.00	0.88	0.74
18 (457)				0.90				0.78		0.79	0.72	0.65				0.89				0.78			0.94	0.78
24 (610)				1.00				1.00		0.89	0.79	0.70				1.00				1.00			1.00	0.91
30 (762)										0.99	0.87	0.76												1.00
36 (914)										1.00	0.94	0.81												
>48 (1219)											1.00	0.91												

Table 43 — Load adjustment factors for 3/8-in. diameter threaded rods in cracked concrete[1,2,3]

3/8-in. threaded rods cracked concrete	Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
													⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef} in. (mm)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)																								
1-3/4 (44)	n/a	n/a	n/a	n/a	0.52	0.52	0.49	0.43	n/a	n/a	n/a	n/a	0.25	0.09	0.07	0.04	0.49	0.18	0.14	0.08	n/a	n/a	n/a	n/a
1-7/8 (48)	0.58	0.58	0.57	0.54	0.54	0.54	0.50	0.44	0.57	0.54	0.53	0.52	0.27	0.10	0.08	0.05	0.54	0.20	0.15	0.09	n/a	n/a	n/a	n/a
2 (51)	0.59	0.59	0.57	0.54	0.55	0.55	0.51	0.44	0.57	0.54	0.53	0.52	0.30	0.11	0.08	0.05	0.55	0.22	0.17	0.10	n/a	n/a	n/a	n/a
3 (76)	0.63	0.63	0.61	0.57	0.66	0.66	0.60	0.49	0.61	0.56	0.55	0.53	0.55	0.20	0.15	0.09	0.66	0.41	0.30	0.18	n/a	n/a	n/a	n/a
3-5/8 (92)	0.66	0.66	0.63	0.58	0.74	0.74	0.66	0.53	0.64	0.57	0.56	0.54	0.73	0.27	0.20	0.12	0.74	0.54	0.40	0.24	0.74	n/a	n/a	n/a
4 (102)	0.68	0.68	0.65	0.59	0.79	0.79	0.70	0.55	0.65	0.58	0.56	0.55	0.85	0.31	0.23	0.14	0.79	0.63	0.47	0.28	0.77	n/a	n/a	n/a
4-5/8 (117)	0.71	0.71	0.67	0.60	0.87	0.87	0.76	0.58	0.67	0.59	0.57	0.55	1.00	0.39	0.29	0.17	0.87	0.78	0.58	0.35	0.83	0.60	n/a	n/a
5 (127)	0.72	0.72	0.69	0.61	0.92	0.92	0.80	0.60	0.69	0.60	0.58	0.56		0.44	0.33	0.20	0.92	0.87	0.66	0.39	0.86	0.62	n/a	n/a
5-3/4 (146)	0.76	0.76	0.71	0.63	1.00	1.00	0.88	0.64	0.71	0.61	0.59	0.56		0.54	0.40	0.24	1.00	1.00	0.81	0.49	0.93	0.66	0.60	n/a
6 (152)	0.77	0.77	0.72	0.63			0.91	0.66	0.72	0.62	0.60	0.57		0.57	0.43	0.26			0.86	0.52	0.95	0.68	0.62	n/a
7 (178)	0.81	0.81	0.76	0.66			1.00	0.72	0.76	0.63	0.61	0.58		0.72	0.54	0.33			1.00	0.65	1.00	0.73	0.67	n/a
8 (203)	0.86	0.86	0.80	0.68				0.78	0.80	0.65	0.63	0.59		0.88	0.66	0.40				0.78		0.78	0.71	n/a
8-3/4 (222)	0.89	0.89	0.82	0.69				0.83	0.83	0.67	0.64	0.60		1.00	0.76	0.46				0.83		0.82	0.74	0.63
9 (229)	0.90	0.90	0.83	0.70				0.85	0.84	0.67	0.64	0.60			0.79	0.47				0.85		0.83	0.76	0.64
10 (254)	0.95	0.95	0.87	0.72				0.91	0.87	0.69	0.66	0.61			0.93	0.56				0.91		0.88	0.80	0.67
11 (279)	0.99	0.99	0.91	0.74				0.98	0.91	0.71	0.67	0.62			1.00	0.64				0.98		0.92	0.84	0.70
12 (305)	1.00	1.00	0.94	0.77				1.00	0.95	0.73	0.69	0.64				0.73				1.00		0.96	0.87	0.74
14 (356)			1.00	0.81					1.00	0.77	0.72	0.66				0.92						1.00	0.94	0.79
16 (406)				0.86						0.81	0.75	0.68				1.00							1.00	0.85
18 (457)				0.90						0.85	0.79	0.70												0.90
24 (610)				1.00						0.96	0.88	0.77												1.00
30 (762)										1.00	0.98	0.84												
36 (914)											1.00	0.91												
>48 (1219)												1.00												

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{HV} = 1.0$.

Table 44 — Load adjustment factors for 1/2-in. diameter threaded rods in uncracked concrete[1,2,3]

1/2-in. threaded rods uncracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
														⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Embedment h_{ef}	in. (mm)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4 (44)	n/a	n/a	n/a	n/a	0.34	0.25	0.19	0.11	n/a	n/a	n/a	n/a	0.10	0.05	0.03	0.02	0.21	0.11	0.07	0.03	n/a	n/a	n/a	n/a
	2-1/2 (64)	0.58	0.58	0.57	0.54	0.41	0.28	0.22	0.13	0.55	0.53	0.53	0.52	0.18	0.09	0.06	0.03	0.35	0.18	0.12	0.06	n/a	n/a	n/a	n/a
	3 (76)	0.60	0.60	0.58	0.55	0.46	0.30	0.24	0.14	0.56	0.54	0.53	0.52	0.23	0.12	0.08	0.04	0.46	0.24	0.15	0.08	n/a	n/a	n/a	n/a
	4 (102)	0.63	0.63	0.61	0.57	0.57	0.35	0.27	0.16	0.58	0.55	0.54	0.53	0.36	0.18	0.12	0.06	0.57	0.35	0.24	0.12	0.58	n/a	n/a	n/a
	5 (127)	0.67	0.67	0.64	0.58	0.71	0.41	0.31	0.18	0.60	0.57	0.55	0.53	0.50	0.26	0.17	0.08	0.71	0.41	0.31	0.17	0.65	n/a	n/a	n/a
	5-3/4 (146)	0.69	0.69	0.66	0.60	0.81	0.45	0.34	0.20	0.62	0.58	0.56	0.54	0.61	0.32	0.21	0.10	0.81	0.45	0.34	0.20	0.69	0.56	n/a	n/a
	6 (152)	0.70	0.70	0.67	0.60	0.85	0.46	0.35	0.20	0.63	0.58	0.56	0.54	0.65	0.34	0.22	0.11	0.85	0.46	0.35	0.20	0.71	0.57	n/a	n/a
	7 (178)	0.74	0.74	0.69	0.62	0.96	0.53	0.39	0.23	0.65	0.59	0.57	0.54	0.82	0.42	0.28	0.14	0.96	0.53	0.39	0.23	0.77	0.61	n/a	n/a
	7-1/4 (184)	0.74	0.74	0.70	0.62	0.98	0.54	0.40	0.23	0.65	0.60	0.57	0.55	0.87	0.45	0.29	0.15	0.98	0.54	0.40	0.23	0.78	0.62	0.54	n/a
	8 (203)	0.77	0.77	0.72	0.63	1.00	0.60	0.44	0.26	0.67	0.61	0.58	0.55	1.00	0.52	0.34	0.17	1.00	0.60	0.44	0.26	0.82	0.66	0.57	n/a
	9 (229)	0.80	0.80	0.75	0.65		0.68	0.50	0.29	0.69	0.62	0.59	0.56		0.62	0.40	0.20		0.68	0.50	0.29	0.87	0.70	0.60	n/a
	10 (254)	0.84	0.84	0.78	0.67		0.75	0.55	0.32	0.71	0.63	0.60	0.56		0.72	0.47	0.24		0.75	0.55	0.32	0.92	0.73	0.64	n/a
	11-1/4 (286)	0.88	0.88	0.81	0.69		0.84	0.62	0.36	0.74	0.65	0.61	0.57		0.86	0.56	0.28		0.84	0.62	0.36	0.97	0.78	0.67	0.54
	12 (305)	0.90	0.90	0.83	0.70		0.90	0.66	0.39	0.75	0.66	0.62	0.58		0.95	0.62	0.31		0.90	0.66	0.39	1.00	0.80	0.70	0.55
	14 (356)	0.97	0.97	0.89	0.73		1.00	0.77	0.45	0.79	0.69	0.64	0.59		1.00	0.78	0.39		1.00	0.77	0.45		0.87	0.75	0.60
	16 (406)	1.00	1.00	0.94	0.77			0.88	0.52	0.83	0.72	0.66	0.60			0.95	0.48			0.88	0.52		0.93	0.80	0.64
	18 (457)			1.00	0.80			0.99	0.58	0.88	0.74	0.68	0.62			1.00	0.58			0.99	0.58		0.98	0.85	0.68
	20 (508)				0.83			1.00	0.64	0.92	0.77	0.70	0.63				0.67			1.00	0.64		1.00	0.90	0.72
	22 (559)				0.87				0.71	0.96	0.80	0.72	0.64				0.78				0.71			0.94	0.75
	24 (610)				0.90				0.77	1.00	0.82	0.74	0.65				0.89				0.77			0.98	0.78
	30 (762)				1.00				0.97		0.90	0.80	0.69				1.00				0.97			1.00	0.88
	36 (914)								1.00		0.98	0.86	0.73								1.00				0.96
	>48 (1219)										1.00	0.98	0.81												1.00

Table 45 — Load adjustment factors for 1/2-in. diameter threaded rods in cracked concrete[1,2,3]

1/2-in. threaded rods cracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
														⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Embedment h_{ef}	in. (mm)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4 (44)	n/a	n/a	n/a	n/a	0.48	0.48	0.45	0.41	n/a	n/a	n/a	n/a	0.10	0.05	0.04	0.02	0.21	0.11	0.08	0.05	n/a	n/a	n/a	n/a
	2-1/2 (64)	0.58	0.58	0.57	0.54	0.54	0.54	0.50	0.44	0.55	0.53	0.53	0.52	0.18	0.09	0.07	0.04	0.35	0.19	0.14	0.08	n/a	n/a	n/a	n/a
	3 (76)	0.60	0.60	0.58	0.55	0.58	0.58	0.53	0.46	0.56	0.54	0.53	0.52	0.23	0.12	0.09	0.06	0.47	0.25	0.18	0.11	n/a	n/a	n/a	n/a
	4 (102)	0.63	0.63	0.61	0.57	0.66	0.66	0.60	0.49	0.58	0.55	0.55	0.53	0.36	0.19	0.14	0.09	0.66	0.38	0.28	0.17	0.58	n/a	n/a	n/a
	5 (127)	0.67	0.67	0.64	0.58	0.76	0.76	0.67	0.53	0.61	0.57	0.56	0.54	0.50	0.26	0.20	0.12	0.76	0.53	0.40	0.24	0.65	n/a	n/a	n/a
	5-3/4 (146)	0.69	0.69	0.66	0.60	0.83	0.83	0.73	0.56	0.62	0.58	0.57	0.55	0.62	0.33	0.24	0.15	0.83	0.65	0.49	0.29	0.70	0.56	n/a	n/a
	6 (152)	0.70	0.70	0.67	0.60	0.85	0.85	0.75	0.57	0.63	0.58	0.57	0.55	0.66	0.35	0.26	0.16	0.85	0.70	0.52	0.31	0.71	0.57	n/a	n/a
	7 (178)	0.74	0.74	0.69	0.62	0.96	0.96	0.83	0.62	0.65	0.60	0.58	0.56	0.83	0.44	0.33	0.20	0.96	0.88	0.66	0.39	0.77	0.62	n/a	n/a
	7-1/4 (184)	0.74	0.74	0.70	0.62	0.98	0.98	0.85	0.63	0.65	0.60	0.58	0.56	0.88	0.46	0.35	0.21	0.98	0.92	0.69	0.42	0.78	0.63	0.57	n/a
	8 (203)	0.77	0.77	0.72	0.63	1.00	1.00	0.91	0.66	0.67	0.61	0.59	0.56	1.00	0.54	0.40	0.24	1.00	1.00	0.80	0.48	0.82	0.66	0.60	n/a
	9 (229)	0.80	0.80	0.75	0.65			1.00	0.70	0.69	0.62	0.60	0.57		0.64	0.48	0.29			0.96	0.58	0.87	0.70	0.64	n/a
	10 (254)	0.84	0.84	0.78	0.67				0.75	0.71	0.64	0.61	0.58		0.75	0.56	0.34			1.00	0.67	0.92	0.74	0.67	n/a
	11-1/4 (286)	0.88	0.88	0.81	0.69				0.81	0.74	0.65	0.63	0.59		0.89	0.67	0.40				0.80	0.97	0.79	0.71	0.60
	12 (305)	0.90	0.90	0.83	0.70				0.85	0.75	0.66	0.64	0.60		0.98	0.74	0.44				0.85	1.00	0.81	0.74	0.62
	14 (356)	0.97	0.97	0.89	0.73				0.95	0.79	0.69	0.66	0.61		1.00	0.93	0.56				0.95		0.88	0.80	0.67
	16 (406)	1.00	1.00	0.94	0.77				1.00	0.84	0.72	0.68	0.63			1.00	0.68				1.00		0.94	0.85	0.72
	18 (457)			1.00	0.80					0.88	0.75	0.70	0.65				0.81						0.99	0.90	0.76
	20 (508)				0.83					0.92	0.77	0.73	0.66				0.95						1.00	0.95	0.80
	22 (559)				0.87					0.96	0.80	0.75	0.68				1.00							1.00	0.84
	24 (610)				0.90					1.00	0.83	0.77	0.69												0.88
	30 (762)				1.00						0.91	0.84	0.74												0.98
	36 (914)										0.99	0.91	0.79												1.00
	>48 (1219)										1.00	1.00	0.89												

[1] Linear interpolation not permitted

[2] Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 46 — Load adjustment factors for 5/8-in. diameter threaded rods in uncracked concrete[1,2,3]

5/8-in. threaded rods uncracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear ⊥ Toward edge f_{RV}				Edge distance in shear ǁ To and away from edge f_{RV}				Concrete thickness factor in shear[5] f_{HV}			
Embedment h_{ef}	in.	3-1/8	5-5/8	7-1/2	12-1/2	3-1/8	5-5/8	7-1/2	12-1/2	3-1/8	5-5/8	7-1/2	12-1/2	3-1/8	5-5/8	7-1/2	12-1/2	3-1/8	5-5/8	7-1/2	12-1/2	3-1/8	5-5/8	7-1/2	12-1/2
	(mm)	(79)	(143)	(191)	(318)	(79)	(143)	(191)	(318)	(79)	(143)	(191)	(318)	(79)	(143)	(191)	(318)	(79)	(143)	(191)	(318)	(79)	(143)	(191)	(318)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm) 1-3/4	(44)	n/a	n/a	n/a	n/a	0.35	0.24	0.18	0.11	n/a	n/a	n/a	n/a	0.09	0.04	0.03	0.01	0.19	0.08	0.06	0.03	n/a	n/a	n/a	n/a
2	(51)	n/a	n/a	n/a	n/a	0.37	0.25	0.19	0.11	n/a	n/a	n/a	n/a	0.11	0.05	0.03	0.02	0.23	0.10	0.07	0.03	n/a	n/a	n/a	n/a
3-1/8	(79)	0.58	0.58	0.57	0.54	0.47	0.29	0.22	0.13	0.56	0.54	0.53	0.52	0.22	0.10	0.07	0.03	0.45	0.20	0.13	0.06	n/a	n/a	n/a	n/a
4	(102)	0.61	0.61	0.59	0.55	0.56	0.32	0.24	0.14	0.58	0.55	0.53	0.52	0.32	0.15	0.10	0.04	0.56	0.29	0.19	0.09	n/a	n/a	n/a	n/a
4-5/8	(117)	0.62	0.62	0.60	0.56	0.62	0.35	0.26	0.15	0.59	0.55	0.54	0.52	0.40	0.18	0.12	0.06	0.62	0.35	0.24	0.11	0.60	n/a	n/a	n/a
5	(127)	0.63	0.63	0.61	0.57	0.66	0.36	0.27	0.16	0.60	0.56	0.54	0.53	0.45	0.21	0.13	0.06	0.66	0.36	0.27	0.12	0.63	n/a	n/a	n/a
6	(152)	0.66	0.66	0.63	0.58	0.74	0.41	0.30	0.18	0.62	0.57	0.55	0.53	0.59	0.27	0.18	0.08	0.74	0.41	0.30	0.16	0.69	n/a	n/a	n/a
7	(178)	0.69	0.69	0.66	0.59	0.81	0.45	0.33	0.19	0.64	0.58	0.56	0.54	0.75	0.34	0.22	0.10	0.81	0.45	0.33	0.19	0.74	n/a	n/a	n/a
7-1/8	(181)	0.69	0.69	0.66	0.60	0.82	0.46	0.34	0.20	0.64	0.58	0.56	0.54	0.77	0.35	0.23	0.11	0.82	0.46	0.34	0.20	0.75	0.57	n/a	n/a
8	(203)	0.72	0.72	0.68	0.61	0.89	0.50	0.36	0.21	0.66	0.59	0.57	0.54	0.91	0.41	0.27	0.13	0.89	0.50	0.36	0.21	0.79	0.61	n/a	n/a
9	(229)	0.74	0.74	0.70	0.62	0.98	0.56	0.40	0.23	0.68	0.60	0.58	0.55	1.00	0.50	0.32	0.15	0.98	0.56	0.40	0.23	0.84	0.65	0.56	n/a
10	(254)	0.77	0.77	0.72	0.63	1.00	0.62	0.44	0.26	0.70	0.62	0.59	0.55		0.58	0.38	0.18	1.00	0.62	0.44	0.26	0.89	0.68	0.59	n/a
11	(279)	0.80	0.80	0.74	0.65		0.68	0.48	0.28	0.72	0.63	0.60	0.56		0.67	0.43	0.20		0.68	0.48	0.28	0.93	0.71	0.62	n/a
12	(305)	0.82	0.82	0.77	0.66		0.74	0.53	0.31	0.74	0.64	0.60	0.56		0.76	0.50	0.23		0.74	0.53	0.31	0.97	0.75	0.65	n/a
14	(356)	0.88	0.88	0.81	0.69		0.86	0.62	0.36	0.77	0.66	0.62	0.57		0.96	0.62	0.29		0.86	0.62	0.36	1.00	0.81	0.70	0.54
16	(406)	0.93	0.93	0.86	0.71		0.99	0.70	0.41	0.81	0.69	0.64	0.58		1.00	0.76	0.35		0.99	0.70	0.41		0.86	0.75	0.58
18	(457)	0.99	0.99	0.90	0.74		1.00	0.79	0.46	0.85	0.71	0.66	0.59			0.91	0.42		1.00	0.79	0.46		0.91	0.79	0.61
20	(508)	1.00	1.00	0.94	0.77			0.88	0.51	0.89	0.73	0.67	0.60			1.00	0.50			0.88	0.51		0.96	0.83	0.65
22	(559)			0.99	0.79			0.97	0.57	0.93	0.75	0.69	0.61				0.57			0.97	0.57		1.00	0.87	0.68
24	(610)			1.00	0.82			1.00	0.62	0.97	0.78	0.71	0.63				0.65			1.00	0.62			0.91	0.71
26	(660)				0.85				0.67	1.00	0.80	0.73	0.64				0.73				0.67			0.95	0.74
28	(711)				0.87				0.72		0.82	0.74	0.65				0.82				0.72			0.99	0.76
30	(762)				0.90				0.77		0.85	0.76	0.66				0.91				0.77			1.00	0.79
36	(914)				0.98				0.93		0.92	0.81	0.69				1.00				0.93				0.87
> 48	(1219)				1.00				1.00		1.00	0.92	0.75								1.00				1.00

Table 47 — Load adjustment factors for 5/8-in. diameter threaded rods in cracked concrete[1,2,3]

5/8-in. threaded rods cracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear ⊥ Toward edge f_{RV}				Edge distance in shear ǁ To and away from edge f_{RV}				Concrete thickness factor in shear[5] f_{HV}			
Embedment h_{ef}	in.	3-1/8	5-5/8	7-1/2	12-1/2	3-1/8	5-5/8	7-1/2	12-1/2	3-1/8	5-5/8	7-1/2	12-1/2	3-1/8	5-5/8	7-1/2	12-1/2	3-1/8	5-5/8	7-1/2	12-1/2	3-1/8	5-5/8	7-1/2	12-1/2
	(mm)	(79)	(143)	(191)	(318)	(79)	(143)	(191)	(318)	(79)	(143)	(191)	(318)	(79)	(143)	(191)	(318)	(79)	(143)	(191)	(318)	(79)	(143)	(191)	(318)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm) 1-3/4	(44)	n/a	n/a	n/a	n/a	0.45	0.45	0.43	0.40	n/a	n/a	n/a	n/a	0.09	0.04	0.03	0.02	0.19	0.09	0.06	0.03	n/a	n/a	n/a	n/a
2	(51)	n/a	n/a	n/a	n/a	0.46	0.46	0.44	0.41	n/a	n/a	n/a	n/a	0.11	0.05	0.03	0.02	0.23	0.10	0.07	0.04	n/a	n/a	n/a	n/a
3-1/8	(79)	0.58	0.58	0.57	0.54	0.54	0.54	0.50	0.44	0.56	0.54	0.53	0.52	0.22	0.10	0.07	0.04	0.45	0.20	0.13	0.08	n/a	n/a	n/a	n/a
4	(102)	0.61	0.61	0.59	0.55	0.59	0.59	0.55	0.46	0.58	0.55	0.53	0.52	0.33	0.15	0.10	0.06	0.59	0.30	0.19	0.12	n/a	n/a	n/a	n/a
4-5/8	(117)	0.62	0.62	0.60	0.56	0.64	0.64	0.58	0.48	0.59	0.55	0.54	0.53	0.40	0.18	0.12	0.07	0.64	0.37	0.24	0.14	0.60	n/a	n/a	n/a
5	(127)	0.63	0.63	0.61	0.57	0.66	0.66	0.60	0.49	0.60	0.56	0.54	0.53	0.45	0.21	0.13	0.08	0.66	0.41	0.27	0.16	0.63	n/a	n/a	n/a
6	(152)	0.66	0.66	0.63	0.58	0.74	0.74	0.66	0.53	0.62	0.57	0.55	0.54	0.60	0.27	0.18	0.11	0.74	0.54	0.35	0.21	0.69	n/a	n/a	n/a
7	(178)	0.69	0.69	0.66	0.59	0.81	0.81	0.72	0.56	0.64	0.58	0.56	0.54	0.75	0.34	0.22	0.13	0.81	0.68	0.45	0.27	0.74	n/a	n/a	n/a
7-1/8	(181)	0.69	0.69	0.66	0.60	0.82	0.82	0.73	0.56	0.64	0.58	0.56	0.54	0.77	0.35	0.23	0.14	0.82	0.70	0.46	0.27	0.75	0.58	n/a	n/a
8	(203)	0.72	0.72	0.68	0.61	0.89	0.89	0.78	0.59	0.66	0.59	0.57	0.55	0.92	0.42	0.27	0.16	0.89	0.84	0.54	0.33	0.79	0.61	n/a	n/a
9	(229)	0.74	0.74	0.70	0.62	0.98	0.98	0.85	0.62	0.68	0.60	0.58	0.56	1.00	0.50	0.32	0.19	0.98	0.98	0.65	0.39	0.84	0.65	0.56	n/a
10	(254)	0.77	0.77	0.72	0.63	1.00	1.00	0.91	0.66	0.70	0.62	0.59	0.56		0.58	0.38	0.23	1.00	1.00	0.76	0.46	0.89	0.68	0.59	n/a
11	(279)	0.80	0.80	0.74	0.65			0.98	0.69	0.72	0.63	0.60	0.57		0.67	0.44	0.26			0.88	0.53	0.93	0.72	0.62	n/a
12	(305)	0.82	0.82	0.77	0.66			1.00	0.73	0.74	0.64	0.60	0.57		0.77	0.50	0.30			1.00	0.60	0.97	0.75	0.65	n/a
14	(356)	0.88	0.88	0.81	0.69				0.81	0.78	0.66	0.62	0.59		0.97	0.63	0.38				0.76	1.00	0.81	0.70	0.59
16	(406)	0.93	0.93	0.86	0.71				0.89	0.82	0.69	0.64	0.60		1.00	0.77	0.46				0.89		0.86	0.75	0.63
18	(457)	0.99	0.99	0.90	0.74				0.97	0.85	0.71	0.66	0.61			0.92	0.55				0.97		0.92	0.79	0.67
20	(508)	1.00	1.00	0.94	0.77				1.00	0.89	0.73	0.67	0.62			1.00	0.64				1.00		0.97	0.84	0.71
22	(559)	1.00		0.99	0.79					0.93	0.76	0.69	0.64				0.74						1.00	0.88	0.74
24	(610)	1.00		1.00	0.82					0.97	0.78	0.71	0.65				0.85							0.92	0.77
26	(660)	1.00			0.85					1.00	0.80	0.73	0.66				0.96							0.95	0.80
28	(711)	1.00			0.87						0.83	0.74	0.67				1.00							0.99	0.83
30	(762)	1.00			0.90						0.85	0.76	0.69											1.00	0.86
36	(914)	1.00			0.98						0.92	0.81	0.72											1.00	0.95
> 48	(1219)	1.00			1.00						1.00	0.92	0.80												1.00

[1] Linear interpolation not permitted

[2] Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 48 — Load adjustment factors for 3/4-in. diameter threaded rods in uncracked concrete[1,2,3]

3/4-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}	in.	(mm)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.35	0.24	0.18	0.10	n/a	n/a	n/a	n/a	0.09	0.03	0.02	0.01	0.17	0.07	0.05	0.02	n/a	n/a	n/a	n/a
	2-1/8	(54)	n/a	n/a	n/a	n/a	0.38	0.25	0.19	0.11	n/a	n/a	n/a	n/a	0.11	0.05	0.03	0.01	0.23	0.09	0.06	0.03	n/a	n/a	n/a	n/a
	3-3/4	(95)	0.58	0.58	0.57	0.54	0.52	0.30	0.22	0.13	0.57	0.54	0.53	0.52	0.27	0.11	0.07	0.03	0.52	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	4	(102)	0.59	0.59	0.57	0.54	0.54	0.31	0.23	0.13	0.57	0.54	0.53	0.52	0.29	0.12	0.08	0.04	0.54	0.24	0.16	0.07	n/a	n/a	n/a	n/a
	5	(127)	0.61	0.61	0.59	0.56	0.60	0.34	0.25	0.14	0.59	0.55	0.54	0.52	0.41	0.17	0.11	0.05	0.60	0.33	0.22	0.10	n/a	n/a	n/a	n/a
	5-1/4	(133)	0.62	0.62	0.60	0.56	0.62	0.35	0.25	0.15	0.60	0.55	0.54	0.52	0.44	0.18	0.12	0.05	0.62	0.35	0.23	0.11	0.62	n/a	n/a	n/a
	6	(152)	0.63	0.63	0.61	0.57	0.66	0.38	0.27	0.16	0.61	0.56	0.55	0.53	0.54	0.22	0.14	0.07	0.66	0.38	0.27	0.13	0.66	n/a	n/a	n/a
	7	(178)	0.66	0.66	0.63	0.58	0.72	0.41	0.30	0.17	0.63	0.57	0.55	0.53	0.68	0.28	0.18	0.08	0.72	0.41	0.30	0.17	0.72	n/a	n/a	n/a
	8	(203)	0.68	0.68	0.65	0.59	0.79	0.45	0.32	0.19	0.65	0.58	0.56	0.54	0.83	0.34	0.22	0.10	0.79	0.45	0.32	0.19	0.77	n/a	n/a	n/a
	8-1/2	(216)	0.69	0.69	0.66	0.59	0.82	0.47	0.34	0.20	0.66	0.59	0.56	0.54	0.91	0.37	0.24	0.11	0.82	0.47	0.34	0.20	0.79	0.59	n/a	n/a
	9	(229)	0.70	0.70	0.67	0.60	0.85	0.49	0.35	0.20	0.67	0.59	0.57	0.54	0.99	0.40	0.26	0.12	0.85	0.49	0.35	0.20	0.81	0.60	n/a	n/a
	10	(254)	0.72	0.72	0.69	0.61	0.92	0.53	0.38	0.22	0.68	0.60	0.58	0.55	1.00	0.47	0.31	0.14	0.92	0.53	0.38	0.22	0.86	0.64	n/a	n/a
	10-3/4	(273)	0.74	0.74	0.70	0.62	0.97	0.57	0.40	0.23	0.70	0.61	0.58	0.55		0.53	0.34	0.16	0.97	0.57	0.40	0.23	0.89	0.66	0.57	n/a
	12	(305)	0.77	0.77	0.72	0.63	1.00	0.64	0.44	0.26	0.72	0.62	0.59	0.55		0.62	0.40	0.19	1.00	0.64	0.44	0.26	0.94	0.70	0.60	n/a
	14	(356)	0.81	0.81	0.76	0.66		0.74	0.52	0.30	0.76	0.64	0.61	0.56		0.78	0.51	0.24		0.74	0.52	0.30	1.00	0.75	0.65	n/a
	16	(406)	0.86	0.86	0.80	0.68		0.85	0.59	0.34	0.79	0.66	0.62	0.57		0.96	0.62	0.29		0.85	0.59	0.34		0.80	0.70	n/a
	16-3/4	(425)	0.88	0.88	0.81	0.69		0.89	0.62	0.36	0.81	0.67	0.63	0.58		1.00	0.67	0.31		0.89	0.62	0.36		0.82	0.71	0.55
	18	(457)	0.90	0.90	0.83	0.70		0.96	0.66	0.39	0.83	0.68	0.64	0.58			0.74	0.35		0.96	0.66	0.39		0.85	0.74	0.57
	20	(508)	0.95	0.95	0.87	0.72		1.00	0.74	0.43	0.87	0.70	0.65	0.59			0.87	0.40		1.00	0.74	0.43		0.90	0.78	0.60
	22	(559)	0.99	0.99	0.91	0.74			0.81	0.47	0.91	0.72	0.67	0.60			1.00	0.47			0.81	0.47		0.94	0.82	0.63
	24	(610)	1.00	1.00	0.94	0.77			0.89	0.51	0.94	0.74	0.68	0.61				0.53			0.89	0.51		0.99	0.85	0.66
	26	(660)			0.98	0.79			0.96	0.56	0.98	0.76	0.70	0.62				0.60			0.96	0.56		1.00	0.89	0.69
	28	(711)			1.00	0.81			1.00	0.60	1.00	0.78	0.71	0.63				0.67			1.00	0.60			0.92	0.71
	30	(762)				0.83				0.64		0.80	0.73	0.64				0.74				0.64			0.95	0.74
	36	(914)				0.90				0.77		0.86	0.77	0.66				0.98				0.77			1.00	0.81
	> 48	(1219)				1.00				1.00		0.99	0.86	0.72				1.00				1.00			1.00	0.94

Table 49 — Load adjustment factors for 3/4-in. diameter threaded rods in cracked concrete[1,2,3]

3/4-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}	in.	(mm)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.43	0.43	0.42	0.39	n/a	n/a	n/a	n/a	0.09	0.03	0.02	0.01	0.17	0.07	0.05	0.02	n/a	n/a	n/a	n/a
	2-1/8	(54)	n/a	n/a	n/a	n/a	0.45	0.45	0.43	0.40	n/a	n/a	n/a	n/a	0.11	0.05	0.03	0.02	0.23	0.09	0.06	0.03	n/a	n/a	n/a	n/a
	3-3/4	(95)	0.58	0.58	0.57	0.54	0.54	0.54	0.50	0.44	0.57	0.54	0.53	0.52	0.27	0.11	0.07	0.04	0.54	0.22	0.14	0.08	n/a	n/a	n/a	n/a
	4	(102)	0.59	0.59	0.57	0.54	0.55	0.55	0.51	0.44	0.57	0.54	0.53	0.52	0.30	0.12	0.08	0.04	0.55	0.24	0.16	0.08	n/a	n/a	n/a	n/a
	5	(127)	0.61	0.61	0.59	0.56	0.60	0.60	0.56	0.47	0.59	0.55	0.54	0.53	0.41	0.17	0.11	0.06	0.60	0.34	0.22	0.12	n/a	n/a	n/a	n/a
	5-1/4	(133)	0.62	0.62	0.60	0.56	0.62	0.62	0.57	0.47	0.60	0.55	0.54	0.53	0.45	0.18	0.12	0.06	0.62	0.36	0.24	0.13	0.62	n/a	n/a	n/a
	6	(152)	0.63	0.63	0.61	0.57	0.66	0.66	0.60	0.49	0.61	0.56	0.55	0.53	0.54	0.22	0.14	0.08	0.66	0.44	0.29	0.15	0.67	n/a	n/a	n/a
	7	(178)	0.66	0.66	0.63	0.58	0.72	0.72	0.65	0.52	0.63	0.57	0.55	0.54	0.69	0.28	0.18	0.10	0.72	0.56	0.36	0.19	0.72	n/a	n/a	n/a
	8	(203)	0.68	0.68	0.65	0.59	0.79	0.79	0.70	0.55	0.65	0.58	0.56	0.54	0.84	0.34	0.22	0.12	0.79	0.68	0.44	0.24	0.77	n/a	n/a	n/a
	8-1/2	(216)	0.69	0.69	0.66	0.59	0.82	0.82	0.72	0.56	0.66	0.59	0.56	0.54	0.92	0.37	0.24	0.13	0.82	0.75	0.49	0.26	0.79	0.59	n/a	n/a
	9	(229)	0.70	0.70	0.67	0.60	0.85	0.85	0.75	0.57	0.67	0.59	0.57	0.55	1.00	0.41	0.26	0.14	0.85	0.82	0.53	0.28	0.82	0.61	n/a	n/a
	10	(254)	0.72	0.72	0.69	0.61	0.92	0.92	0.80	0.60	0.69	0.60	0.58	0.55		0.48	0.31	0.17	0.92	0.92	0.62	0.33	0.86	0.64	n/a	n/a
	10-3/4	(273)	0.74	0.74	0.70	0.62	0.97	0.97	0.84	0.62	0.70	0.61	0.58	0.55		0.53	0.35	0.18	0.97	0.97	0.69	0.37	0.89	0.66	0.57	n/a
	12	(305)	0.77	0.77	0.72	0.63	1.00	1.00	0.91	0.66	0.72	0.62	0.59	0.56		0.63	0.41	0.22	1.00	1.00	0.82	0.44	0.94	0.70	0.61	n/a
	14	(356)	0.81	0.81	0.76	0.66			1.00	0.72	0.76	0.64	0.61	0.57		0.79	0.51	0.27		1.00	1.00	0.55	1.00	0.76	0.65	n/a
	16	(406)	0.86	0.86	0.80	0.68				0.78	0.80	0.66	0.62	0.58		0.97	0.63	0.34				0.67		0.81	0.70	n/a
	16-3/4	(425)	0.88	0.88	0.81	0.69				0.81	0.81	0.67	0.63	0.58		1.00	0.67	0.36				0.72		0.83	0.72	0.58
	18	(457)	0.90	0.90	0.83	0.70				0.85	0.83	0.68	0.64	0.59			0.75	0.40				0.80		0.86	0.74	0.60
	20	(508)	0.95	0.95	0.87	0.72				0.91	0.87	0.70	0.65	0.60			0.88	0.47				0.91		0.90	0.78	0.63
	22	(559)	0.99	0.99	0.91	0.74				0.98	0.91	0.72	0.67	0.61			1.00	0.54				0.98		0.95	0.82	0.67
	24	(610)	1.00	1.00	0.94	0.77				1.00	0.94	0.74	0.68	0.62				0.62				1.00		0.99	0.86	0.69
	26	(660)			0.98	0.79					0.98	0.76	0.70	0.63				0.69						1.00	0.89	0.72
	28	(711)			1.00	0.81					1.00	0.79	0.71	0.64				0.78							0.92	0.75
	30	(762)				0.83						0.81	0.73	0.65				0.86							0.96	0.78
	36	(914)				0.90						0.87	0.77	0.68				1.00							1.00	0.85
	> 48	(1219)				1.00						0.99	0.87	0.74												0.98

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[1] Linear interpolation not permitted

[2] Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 50 — Load adjustment factors for 7/8-in. diameter threaded rods in uncracked concrete[1,2,3]

7/8-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				|| To and away from edge f_{RV}							
Embedment h_{ef}	in.	(mm)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.39	0.24	0.18	0.10	n/a	n/a	n/a	n/a	0.09	0.03	0.02	0.01	0.18	0.05	0.04	0.02	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	n/a	n/a	n/a	0.43	0.25	0.19	0.11	n/a	n/a	n/a	n/a	0.13	0.04	0.03	0.01	0.26	0.08	0.05	0.02	n/a	n/a	n/a	n/a
	4-3/8	(111)	0.58	0.58	0.57	0.54	0.54	0.31	0.23	0.13	0.58	0.54	0.53	0.52	0.35	0.11	0.07	0.03	0.54	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	5	(127)	0.60	0.60	0.58	0.55	0.56	0.33	0.24	0.13	0.59	0.54	0.53	0.52	0.43	0.13	0.09	0.04	0.56	0.27	0.17	0.08	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.61	0.61	0.59	0.55	0.59	0.34	0.25	0.14	0.60	0.55	0.54	0.52	0.50	0.15	0.10	0.05	0.59	0.31	0.20	0.09	0.65	n/a	n/a	n/a
	6	(152)	0.62	0.62	0.60	0.56	0.61	0.36	0.26	0.15	0.61	0.55	0.54	0.52	0.57	0.17	0.11	0.05	0.61	0.35	0.23	0.11	0.68	n/a	n/a	n/a
	7	(178)	0.63	0.63	0.61	0.57	0.66	0.39	0.28	0.16	0.63	0.56	0.55	0.53	0.71	0.22	0.14	0.07	0.66	0.39	0.28	0.13	0.73	n/a	n/a	n/a
	8	(203)	0.65	0.65	0.63	0.58	0.72	0.42	0.30	0.17	0.65	0.57	0.55	0.53	0.87	0.27	0.17	0.08	0.72	0.42	0.30	0.16	0.78	n/a	n/a	n/a
	9	(229)	0.67	0.67	0.64	0.59	0.77	0.45	0.33	0.18	0.67	0.58	0.56	0.54	1.00	0.32	0.21	0.10	0.77	0.45	0.33	0.18	0.83	n/a	n/a	n/a
	9-7/8	(251)	0.69	0.69	0.66	0.59	0.82	0.48	0.35	0.19	0.69	0.59	0.56	0.54		0.37	0.24	0.11	0.82	0.48	0.35	0.19	0.87	0.59	n/a	n/a
	10	(254)	0.69	0.69	0.66	0.60	0.82	0.49	0.35	0.20	0.69	0.59	0.57	0.54		0.38	0.24	0.11	0.82	0.49	0.35	0.20	0.87	0.59	n/a	n/a
	11	(279)	0.71	0.71	0.67	0.60	0.88	0.52	0.37	0.21	0.71	0.60	0.57	0.54		0.43	0.28	0.13	0.88	0.52	0.37	0.21	0.91	0.62	n/a	n/a
	12	(305)	0.73	0.73	0.69	0.61	0.94	0.56	0.40	0.22	0.73	0.60	0.58	0.55		0.49	0.32	0.15	0.94	0.56	0.40	0.22	0.95	0.65	n/a	n/a
	12-1/2	(318)	0.74	0.74	0.70	0.62	0.97	0.59	0.41	0.23	0.74	0.61	0.58	0.55		0.52	0.34	0.16	0.97	0.59	0.41	0.23	0.97	0.66	0.57	n/a
	14	(356)	0.77	0.77	0.72	0.63	1.00	0.66	0.46	0.26	0.77	0.62	0.59	0.55		0.62	0.40	0.19	1.00	0.66	0.46	0.26	1.00	0.70	0.60	n/a
	16	(406)	0.81	0.81	0.75	0.65		0.75	0.52	0.29	0.80	0.64	0.60	0.56		0.76	0.49	0.23	1.00	0.75	0.52	0.29		0.75	0.65	n/a
	18	(457)	0.85	0.85	0.79	0.67		0.84	0.59	0.33	0.84	0.66	0.62	0.57		0.91	0.59	0.27	1.00	0.84	0.59	0.33		0.79	0.68	n/a
	19-1/2	(495)	0.88	0.88	0.81	0.69		0.92	0.64	0.36	0.87	0.67	0.63	0.58		1.00	0.66	0.31	1.00	0.92	0.64	0.36		0.82	0.71	0.55
	20	(508)	0.89	0.89	0.82	0.69		0.94	0.65	0.37	0.88	0.67	0.63	0.58			0.69	0.32	1.00	0.94	0.65	0.37		0.83	0.72	0.56
	22	(559)	0.92	0.92	0.85	0.71		1.00	0.72	0.40	0.92	0.69	0.64	0.59			0.80	0.37		1.00	0.72	0.40		0.87	0.76	0.59
	24	(610)	0.96	0.96	0.88	0.73			0.78	0.44	0.96	0.71	0.66	0.59			0.91	0.42			0.78	0.44		0.91	0.79	0.61
	26	(660)	1.00	1.00	0.91	0.75			0.85	0.48	0.99	0.73	0.67	0.60			1.00	0.48			0.85	0.48		0.95	0.82	0.64
	28	(711)			0.94	0.77			0.91	0.51	1.00	0.74	0.68	0.61				0.53			0.91	0.51		0.99	0.85	0.66
	30	(762)			0.98	0.79			0.98	0.55		0.76	0.70	0.62				0.59			0.98	0.55		1.00	0.88	0.68
	36	(914)			1.00	0.84			1.00	0.66		0.81	0.73	0.64				0.77			1.00	0.66			0.97	0.75
	> 48	(1219)				0.96				0.88		0.92	0.81	0.69				1.00				0.88			1.00	0.87

Table 51 — Load adjustment factors for 7/8-in. diameter threaded rods in cracked concrete[1,2,3]

7/8-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				|| To and away from edge f_{RV}							
Embedment h_{ef}	in.	(mm)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	3-1/2 (89)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.42	0.42	0.41	0.38	n/a	n/a	n/a	n/a	0.09	0.03	0.02	0.01	0.18	0.06	0.04	0.02	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	n/a	n/a	n/a	0.44	0.44	0.42	0.39	n/a	n/a	n/a	n/a	0.13	0.04	0.03	0.01	0.26	0.08	0.05	0.03	n/a	n/a	n/a	n/a
	4-3/8	(111)	0.58	0.58	0.57	0.54	0.54	0.54	0.50	0.44	0.58	0.54	0.53	0.52	0.36	0.11	0.07	0.03	0.54	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	5	(127)	0.60	0.60	0.58	0.55	0.56	0.56	0.52	0.45	0.60	0.54	0.53	0.52	0.43	0.13	0.09	0.04	0.56	0.27	0.17	0.08	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.61	0.61	0.59	0.55	0.59	0.59	0.54	0.46	0.61	0.55	0.54	0.52	0.50	0.15	0.10	0.05	0.59	0.31	0.20	0.10	0.65	n/a	n/a	n/a
	6	(152)	0.62	0.62	0.60	0.56	0.61	0.61	0.56	0.47	0.61	0.55	0.54	0.52	0.57	0.18	0.11	0.06	0.61	0.35	0.23	0.11	0.68	n/a	n/a	n/a
	7	(178)	0.63	0.63	0.61	0.57	0.66	0.66	0.60	0.49	0.63	0.56	0.55	0.53	0.72	0.22	0.14	0.07	0.66	0.44	0.29	0.14	0.73	n/a	n/a	n/a
	8	(203)	0.65	0.65	0.63	0.58	0.72	0.72	0.64	0.52	0.65	0.57	0.55	0.53	0.88	0.27	0.18	0.09	0.72	0.54	0.35	0.17	0.78	n/a	n/a	n/a
	9	(229)	0.67	0.67	0.64	0.59	0.77	0.77	0.68	0.54	0.67	0.58	0.56	0.54	1.00	0.32	0.21	0.10	0.77	0.65	0.42	0.20	0.83	n/a	n/a	n/a
	9-7/8	(251)	0.69	0.69	0.66	0.59	0.82	0.82	0.72	0.56	0.69	0.59	0.56	0.54		0.37	0.24	0.12	0.82	0.74	0.48	0.23	0.87	0.59	n/a	n/a
	10	(254)	0.69	0.69	0.66	0.60	0.82	0.82	0.73	0.56	0.69	0.59	0.57	0.54		0.38	0.25	0.12	0.82	0.76	0.49	0.24	0.87	0.59	n/a	n/a
	11	(279)	0.71	0.71	0.67	0.60	0.88	0.88	0.77	0.59	0.71	0.60	0.57	0.54		0.44	0.28	0.14	0.88	0.87	0.57	0.28	0.92	0.62	n/a	n/a
	12	(305)	0.73	0.73	0.69	0.61	0.94	0.94	0.82	0.61	0.73	0.60	0.58	0.55		0.50	0.32	0.16	0.94	0.94	0.65	0.31	0.96	0.65	n/a	n/a
	12-1/2	(318)	0.74	0.74	0.70	0.62	0.97	0.97	0.84	0.62	0.74	0.61	0.58	0.55		0.53	0.34	0.17	0.97	0.97	0.69	0.33	0.98	0.66	0.57	n/a
	14	(356)	0.77	0.77	0.72	0.63	1.00	1.00	0.91	0.66	0.77	0.62	0.59	0.56		0.63	0.41	0.20	1.00	1.00	0.82	0.40	1.00	0.70	0.61	n/a
	16	(406)	0.81	0.81	0.75	0.65			1.00	0.71	0.81	0.64	0.60	0.56		0.77	0.50	0.24			1.00	0.48		0.75	0.65	n/a
	18	(457)	0.85	0.85	0.79	0.67				0.76	0.84	0.66	0.62	0.57		0.91	0.59	0.29				0.58		0.79	0.69	n/a
	19-1/2	(495)	0.88	0.88	0.81	0.69				0.80	0.87	0.67	0.63	0.58		1.00	0.67	0.32				0.65		0.82	0.71	0.56
	20	(508)	0.89	0.89	0.82	0.69				0.82	0.88	0.67	0.63	0.58			0.70	0.34				0.67		0.84	0.72	0.57
	22	(559)	0.92	0.92	0.85	0.71				0.87	0.92	0.69	0.64	0.59			0.80	0.39				0.78		0.88	0.76	0.60
	24	(610)	0.96	0.96	0.88	0.73				0.93	0.96	0.71	0.66	0.60			0.91	0.44				0.89		0.92	0.79	0.62
	26	(660)	1.00	1.00	0.91	0.75				0.99	1.00	0.73	0.67	0.61			1.00	0.50				0.99		0.95	0.82	0.65
	28	(711)			0.94	0.77				1.00		0.74	0.68	0.61				0.56				1.00		0.99	0.86	0.67
	30	(762)			0.98	0.79						0.76	0.70	0.62				0.62						1.00	0.89	0.70
	36	(914)			1.00	0.84						0.81	0.74	0.65				0.81							0.97	0.76
	> 48	(1219)				0.96						0.92	0.81	0.69				1.00							1.00	0.88

[1] Linear interpolation not permitted

[2] Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for $5d \le s \le 16$-in. and to 0.5 T_{max} for $s > 16$-in.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \ge 3*h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \ge 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 52 — Load adjustment factors for 1-in. diameter threaded rods in uncracked concrete[1,2,3]

1-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}		in.	4	9	12	20	4	9	12	20	4	9	12	20	4	9	12	20	4	9	12	20	4	9	12	20
		(mm)	(102)	(229)	(305)	(508)	(102)	(229)	(305)	(508)	(102)	(229)	(305)	(508)	(102)	(229)	(305)	(508)	(102)	(229)	(305)	(508)	(102)	(229)	(305)	(508)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.38	0.24	0.18	0.10	n/a	n/a	n/a	n/a	0.08	0.02	0.01	0.01	0.15	0.05	0.03	0.01	n/a	n/a	n/a	n/a
	2-3/4	(70)	n/a	n/a	n/a	n/a	0.45	0.26	0.19	0.11	n/a	n/a	n/a	n/a	0.15	0.04	0.03	0.01	0.30	0.09	0.06	0.03	n/a	n/a	n/a	n/a
	5	(127)	0.58	0.58	0.57	0.54	0.54	0.32	0.23	0.13	0.59	0.54	0.53	0.52	0.37	0.11	0.07	0.03	0.54	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	6	(152)	0.60	0.60	0.58	0.55	0.58	0.34	0.25	0.14	0.60	0.55	0.53	0.52	0.48	0.14	0.09	0.04	0.58	0.29	0.19	0.09	n/a	n/a	n/a	n/a
	6-1/4	(159)	0.61	0.61	0.59	0.55	0.59	0.35	0.25	0.14	0.61	0.55	0.54	0.52	0.51	0.15	0.10	0.05	0.59	0.30	0.20	0.09	0.65	n/a	n/a	n/a
	7	(178)	0.62	0.62	0.60	0.56	0.62	0.37	0.27	0.15	0.62	0.55	0.54	0.52	0.61	0.18	0.12	0.05	0.62	0.36	0.23	0.11	0.69	n/a	n/a	n/a
	8	(203)	0.63	0.63	0.61	0.57	0.66	0.40	0.29	0.16	0.64	0.56	0.55	0.53	0.74	0.22	0.14	0.07	0.66	0.40	0.29	0.13	0.74	n/a	n/a	n/a
	9	(229)	0.65	0.65	0.63	0.58	0.71	0.43	0.31	0.17	0.65	0.57	0.55	0.53	0.89	0.26	0.17	0.08	0.71	0.43	0.31	0.16	0.78	n/a	n/a	n/a
	10	(254)	0.67	0.67	0.64	0.58	0.76	0.46	0.33	0.18	0.67	0.58	0.56	0.53	1.00	0.31	0.20	0.09	0.76	0.46	0.33	0.18	0.83	n/a	n/a	n/a
	11	(279)	0.69	0.69	0.65	0.59	0.80	0.49	0.35	0.19	0.69	0.58	0.56	0.54		0.35	0.23	0.11	0.80	0.49	0.35	0.19	0.87	n/a	n/a	n/a
	11-1/4	(286)	0.69	0.69	0.66	0.59	0.82	0.50	0.35	0.19	0.69	0.59	0.56	0.54		0.37	0.24	0.11	0.82	0.50	0.35	0.19	0.88	0.58	n/a	n/a
	12	(305)	0.70	0.70	0.67	0.60	0.85	0.52	0.37	0.20	0.70	0.59	0.57	0.54		0.40	0.26	0.12	0.85	0.52	0.37	0.20	0.91	0.60	n/a	n/a
	13	(330)	0.72	0.72	0.68	0.61	0.90	0.55	0.39	0.22	0.72	0.60	0.57	0.54		0.46	0.30	0.14	0.90	0.55	0.39	0.22	0.94	0.63	n/a	n/a
	14	(356)	0.74	0.74	0.69	0.62	0.96	0.59	0.41	0.23	0.74	0.61	0.58	0.55		0.51	0.33	0.15	0.96	0.59	0.41	0.23	0.98	0.65	n/a	n/a
	14-1/4	(362)	0.74	0.74	0.70	0.62	0.97	0.60	0.42	0.23	0.74	0.61	0.58	0.55		0.52	0.34	0.16	0.97	0.60	0.42	0.23	0.99	0.66	0.57	n/a
	16	(406)	0.77	0.77	0.72	0.63	1.00	0.67	0.47	0.26	0.77	0.62	0.59	0.55		0.62	0.40	0.19	1.00	0.67	0.47	0.26	1.00	0.70	0.60	n/a
	18	(457)	0.80	0.80	0.75	0.65		0.76	0.53	0.29	0.81	0.64	0.60	0.56		0.74	0.48	0.22		0.76	0.53	0.29		0.74	0.64	n/a
	20	(508)	0.84	0.84	0.78	0.67		0.84	0.58	0.32	0.84	0.65	0.61	0.57		0.87	0.56	0.26		0.84	0.58	0.32		0.78	0.67	n/a
	22	(559)	0.87	0.87	0.81	0.68		0.93	0.64	0.35	0.88	0.67	0.63	0.58		1.00	0.65	0.30		0.93	0.64	0.35		0.82	0.71	n/a
	22-1/4	(565)	0.87	0.87	0.81	0.69		0.94	0.65	0.36	0.88	0.67	0.63	0.58			0.66	0.31		0.94	0.65	0.36		0.82	0.71	0.55
	24	(610)	0.90	0.90	0.83	0.70		1.00	0.70	0.39	0.91	0.68	0.64	0.58			0.74	0.35		1.00	0.70	0.39		0.85	0.74	0.57
	26	(660)	0.94	0.94	0.86	0.72			0.76	0.42	0.94	0.70	0.65	0.59			0.84	0.39			0.76	0.42		0.89	0.77	0.60
	28	(711)	0.97	0.97	0.89	0.73			0.82	0.45	0.98	0.71	0.66	0.60			0.94	0.43			0.82	0.45		0.92	0.80	0.62
	30	(762)	1.00	1.00	0.92	0.75			0.88	0.48	1.00	0.73	0.67	0.60			1.00	0.48			0.88	0.48		0.95	0.83	0.64
	36	(914)			1.00	0.80			1.00	0.58		0.77	0.70	0.62				0.63			1.00	0.58		1.00	0.91	0.70
	> 48	(1219)				0.90				0.77		0.86	0.77	0.66				0.98				0.77			1.00	0.81

Table 53 — Load adjustment factors for 1-in. diameter threaded rods in cracked concrete[1,2,3]

1-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}		in.	4	9	12	20	4	9	12	20	4	9	12	20	4	9	12	20	4	9	12	20	4	9	12	20
		(mm)	(102)	(229)	(305)	(508)	(102)	(229)	(305)	(508)	(102)	(229)	(305)	(508)	(102)	(229)	(305)	(508)	(102)	(229)	(305)	(508)	(102)	(229)	(305)	(508)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.41	0.41	0.40	0.38	n/a	n/a	n/a	n/a	0.08	0.02	0.01	0.01	0.15	0.05	0.03	0.01	n/a	n/a	n/a	n/a
	2-3/4	(70)	n/a	n/a	n/a	n/a	0.45	0.45	0.43	0.40	n/a	n/a	n/a	n/a	0.15	0.04	0.03	0.01	0.30	0.09	0.06	0.03	n/a	n/a	n/a	n/a
	5	(127)	0.58	0.58	0.57	0.54	0.54	0.54	0.50	0.44	0.59	0.54	0.53	0.52	0.37	0.11	0.07	0.03	0.54	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	6	(152)	0.60	0.60	0.58	0.55	0.58	0.58	0.53	0.46	0.60	0.55	0.53	0.52	0.49	0.14	0.09	0.04	0.58	0.29	0.19	0.09	n/a	n/a	n/a	n/a
	6-1/4	(159)	0.61	0.61	0.59	0.55	0.59	0.59	0.54	0.46	0.61	0.55	0.54	0.52	0.52	0.15	0.10	0.05	0.59	0.31	0.20	0.09	0.66	n/a	n/a	n/a
	7	(178)	0.62	0.62	0.60	0.56	0.62	0.62	0.57	0.47	0.62	0.55	0.54	0.52	0.61	0.18	0.12	0.05	0.62	0.36	0.24	0.11	0.69	n/a	n/a	n/a
	8	(203)	0.63	0.63	0.61	0.57	0.66	0.66	0.60	0.49	0.64	0.56	0.55	0.53	0.75	0.22	0.14	0.07	0.66	0.44	0.29	0.13	0.74	n/a	n/a	n/a
	9	(229)	0.65	0.65	0.63	0.58	0.71	0.71	0.64	0.51	0.65	0.57	0.55	0.53	0.89	0.26	0.17	0.08	0.71	0.53	0.34	0.16	0.79	n/a	n/a	n/a
	10	(254)	0.67	0.67	0.64	0.58	0.76	0.76	0.67	0.53	0.67	0.58	0.56	0.53	1.00	0.31	0.20	0.09	0.76	0.62	0.40	0.19	0.83	n/a	n/a	n/a
	11	(279)	0.69	0.69	0.65	0.59	0.80	0.80	0.71	0.55	0.69	0.58	0.56	0.54		0.36	0.23	0.11	0.80	0.72	0.46	0.22	0.87	n/a	n/a	n/a
	11-1/4	(286)	0.69	0.69	0.66	0.59	0.82	0.82	0.72	0.56	0.69	0.59	0.56	0.54		0.37	0.24	0.11	0.82	0.74	0.48	0.22	0.88	0.59	n/a	n/a
	12	(305)	0.70	0.70	0.67	0.60	0.85	0.85	0.75	0.57	0.71	0.59	0.57	0.54		0.41	0.26	0.12	0.85	0.82	0.53	0.25	0.91	0.61	n/a	n/a
	13	(330)	0.72	0.72	0.68	0.61	0.90	0.90	0.79	0.59	0.72	0.60	0.57	0.54		0.46	0.30	0.14	0.90	0.90	0.60	0.28	0.95	0.63	n/a	n/a
	14	(356)	0.74	0.74	0.69	0.62	0.96	0.96	0.83	0.62	0.74	0.61	0.58	0.55		0.51	0.33	0.16	0.96	0.96	0.67	0.31	0.98	0.65	n/a	n/a
	14-1/4	(362)	0.74	0.74	0.70	0.62	0.97	0.97	0.84	0.62	0.74	0.61	0.58	0.55		0.53	0.34	0.16	0.97	0.97	0.69	0.32	0.99	0.66	0.57	n/a
	16	(406)	0.77	0.77	0.72	0.63	1.00	1.00	0.91	0.66	0.77	0.62	0.59	0.55		0.63	0.41	0.19	1.00	1.00	0.82	0.38	1.00	0.70	0.61	n/a
	18	(457)	0.80	0.80	0.75	0.65			1.00	0.70	0.81	0.64	0.60	0.56		0.75	0.49	0.23			0.97	0.45		0.74	0.64	n/a
	20	(508)	0.84	0.84	0.78	0.67				0.75	0.84	0.65	0.61	0.57		0.88	0.57	0.26			1.00	0.53		0.78	0.68	n/a
	22	(559)	0.87	0.87	0.81	0.68				0.80	0.88	0.67	0.63	0.58		1.00	0.66	0.31				0.61		0.82	0.71	n/a
	22-1/4	(565)	0.87	0.87	0.81	0.69				0.80	0.88	0.67	0.63	0.58			0.67	0.31				0.62		0.82	0.71	0.55
	24	(610)	0.90	0.90	0.83	0.70				0.85	0.91	0.68	0.64	0.58			0.75	0.35				0.70		0.86	0.74	0.57
	26	(660)	0.94	0.94	0.86	0.72				0.90	0.95	0.70	0.65	0.59			0.84	0.39				0.78		0.89	0.77	0.60
	28	(711)	0.97	0.97	0.89	0.73				0.95	0.98	0.71	0.66	0.60			0.94	0.44				0.88		0.92	0.80	0.62
	30	(762)	1.00	1.00	0.92	0.75				1.00	1.00	0.73	0.67	0.60			1.00	0.49				0.97		0.96	0.83	0.64
	36	(914)			1.00	0.80						0.77	0.71	0.62				0.64				1.00		1.00	0.91	0.70
	> 48	(1219)				0.90						0.87	0.77	0.66				0.98							1.00	0.81

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{HV} = 1.0$.

Table 54 — Load adjustment factors for 1-1/4-in. diameter threaded rods in uncracked concrete[1,2,3]

1-1/4-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Embedment h_{ef}	in.	(mm)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	11-1/4 (286)	25 (635)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.37	0.24	0.18	0.10	n/a	n/a	n/a	n/a	0.05	0.02	0.01	0.00	0.11	0.03	0.02	0.01	n/a	n/a	n/a	n/a
	3-1/8	(79)	n/a	n/a	n/a	n/a	0.44	0.27	0.20	0.11	n/a	n/a	n/a	n/a	0.13	0.04	0.02	0.01	0.26	0.08	0.05	0.02	n/a	n/a	n/a	n/a
	6-1/4	(159)	0.58	0.58	0.57	0.54	0.54	0.33	0.24	0.13	0.59	0.54	0.53	0.52	0.37	0.11	0.07	0.03	0.54	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	7	(178)	0.59	0.59	0.58	0.55	0.56	0.35	0.25	0.13	0.60	0.54	0.53	0.52	0.43	0.13	0.08	0.04	0.56	0.26	0.17	0.08	n/a	n/a	n/a	n/a
	8	(203)	0.61	0.61	0.59	0.55	0.59	0.37	0.27	0.14	0.61	0.55	0.54	0.52	0.53	0.16	0.10	0.05	0.59	0.31	0.20	0.10	0.66	n/a	n/a	n/a
	9	(229)	0.62	0.62	0.60	0.56	0.63	0.39	0.28	0.15	0.62	0.55	0.54	0.52	0.63	0.19	0.12	0.06	0.63	0.38	0.24	0.11	0.70	n/a	n/a	n/a
	10	(254)	0.63	0.63	0.61	0.57	0.66	0.41	0.30	0.16	0.64	0.56	0.55	0.53	0.74	0.22	0.14	0.07	0.66	0.41	0.29	0.13	0.74	n/a	n/a	n/a
	11	(279)	0.65	0.65	0.62	0.57	0.70	0.44	0.32	0.17	0.65	0.57	0.55	0.53	0.86	0.25	0.16	0.08	0.70	0.44	0.32	0.15	0.78	n/a	n/a	n/a
	12	(305)	0.66	0.66	0.63	0.58	0.74	0.46	0.33	0.18	0.66	0.57	0.55	0.53	0.98	0.29	0.19	0.09	0.74	0.46	0.33	0.17	0.81	n/a	n/a	n/a
	13	(330)	0.68	0.68	0.64	0.59	0.77	0.49	0.35	0.19	0.68	0.58	0.56	0.54	1.00	0.33	0.21	0.10	0.77	0.49	0.35	0.19	0.84	n/a	n/a	n/a
	14	(356)	0.69	0.69	0.66	0.59	0.81	0.52	0.37	0.20	0.69	0.59	0.56	0.54		0.36	0.24	0.11	0.81	0.52	0.37	0.20	0.87	0.58	n/a	n/a
	14-1/4	(362)	0.69	0.69	0.66	0.60	0.82	0.52	0.37	0.20	0.69	0.59	0.56	0.54		0.37	0.24	0.11	0.82	0.52	0.37	0.20	0.88	0.59	n/a	n/a
	15	(381)	0.70	0.70	0.67	0.60	0.85	0.54	0.39	0.20	0.70	0.59	0.57	0.54		0.40	0.26	0.12	0.85	0.54	0.39	0.20	0.91	0.60	n/a	n/a
	16	(406)	0.72	0.72	0.68	0.61	0.89	0.57	0.40	0.21	0.72	0.60	0.57	0.54		0.45	0.29	0.13	0.89	0.57	0.40	0.21	0.94	0.62	n/a	n/a
	17	(432)	0.73	0.73	0.69	0.61	0.93	0.60	0.42	0.22	0.73	0.60	0.58	0.55		0.49	0.32	0.15	0.93	0.60	0.42	0.22	0.96	0.64	n/a	n/a
	18	(457)	0.74	0.74	0.70	0.62	0.98	0.63	0.44	0.23	0.75	0.61	0.58	0.55		0.53	0.35	0.16	0.98	0.63	0.44	0.23	0.99	0.66	0.57	n/a
	20	(508)	0.77	0.77	0.72	0.63	1.00	0.70	0.49	0.26	0.77	0.62	0.59	0.55		0.62	0.40	0.19	1.00	0.70	0.49	0.26	1.00	0.70	0.60	n/a
	22	(559)	0.80	0.80	0.74	0.65		0.77	0.54	0.28	0.80	0.63	0.60	0.56		0.72	0.47	0.22		0.77	0.54	0.28		0.73	0.63	n/a
	24	(610)	0.82	0.82	0.77	0.66		0.84	0.59	0.31	0.83	0.65	0.61	0.57		0.82	0.53	0.25		0.84	0.59	0.31		0.76	0.66	n/a
	26	(660)	0.85	0.85	0.79	0.67		0.91	0.64	0.34	0.86	0.66	0.62	0.57		0.92	0.60	0.28		0.91	0.64	0.34		0.79	0.69	n/a
	28	(711)	0.88	0.88	0.81	0.69		0.98	0.68	0.36	0.88	0.67	0.63	0.58		1.00	0.67	0.31		0.98	0.68	0.36		0.82	0.71	0.55
	30	(762)	0.90	0.90	0.83	0.70		1.00	0.73	0.39	0.91	0.68	0.64	0.58			0.74	0.35		1.00	0.73	0.39		0.85	0.74	0.57
	36	(914)	0.99	0.99	0.90	0.74			0.88	0.47	0.99	0.72	0.66	0.60			0.98	0.45			0.88	0.47		0.94	0.81	0.63
	> 48	(1219)	1.00	1.00	1.00	0.82			1.00	0.62	1.00	0.79	0.72	0.63			1.00	0.70			1.00	0.62		1.00	0.94	0.72

Table 55 — Load adjustment factors for 1-1/4-in. diameter threaded rods in cracked concrete[1,2,3]

1-1/4-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Embedment h_{ef}	in.	(mm)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	11-1/4 (286)	25 (635)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.40	0.40	0.39	0.37	n/a	n/a	n/a	n/a	0.05	0.02	0.01	0.00	0.11	0.03	0.02	0.01	n/a	n/a	n/a	n/a
	3-1/8	(79)	n/a	n/a	n/a	n/a	0.44	0.44	0.42	0.39	n/a	n/a	n/a	n/a	0.13	0.04	0.03	0.01	0.26	0.08	0.05	0.02	n/a	n/a	n/a	n/a
	6-1/4	(159)	0.58	0.58	0.57	0.54	0.54	0.54	0.50	0.44	0.59	0.54	0.53	0.52	0.37	0.11	0.07	0.03	0.54	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	7	(178)	0.59	0.59	0.58	0.55	0.56	0.56	0.52	0.45	0.60	0.54	0.53	0.52	0.44	0.13	0.08	0.04	0.56	0.26	0.17	0.08	n/a	n/a	n/a	n/a
	8	(203)	0.61	0.61	0.59	0.55	0.59	0.59	0.55	0.46	0.61	0.55	0.54	0.52	0.54	0.16	0.10	0.05	0.59	0.32	0.21	0.10	0.66	n/a	n/a	n/a
	9	(229)	0.62	0.62	0.60	0.56	0.63	0.63	0.57	0.48	0.62	0.55	0.54	0.52	0.64	0.19	0.12	0.06	0.63	0.38	0.25	0.11	0.70	n/a	n/a	n/a
	10	(254)	0.63	0.63	0.61	0.57	0.66	0.66	0.60	0.49	0.64	0.56	0.55	0.53	0.75	0.22	0.14	0.07	0.66	0.44	0.29	0.13	0.74	n/a	n/a	n/a
	11	(279)	0.65	0.65	0.62	0.57	0.70	0.70	0.63	0.51	0.65	0.57	0.55	0.53	0.86	0.26	0.17	0.08	0.70	0.51	0.33	0.15	0.78	n/a	n/a	n/a
	12	(305)	0.66	0.66	0.63	0.58	0.74	0.74	0.66	0.53	0.66	0.57	0.55	0.53	0.98	0.29	0.19	0.09	0.74	0.58	0.38	0.18	0.81	n/a	n/a	n/a
	13	(330)	0.68	0.68	0.64	0.59	0.77	0.77	0.69	0.54	0.68	0.58	0.56	0.54	1.00	0.33	0.21	0.10	0.77	0.66	0.43	0.20	0.85	n/a	n/a	n/a
	14	(356)	0.69	0.69	0.66	0.59	0.81	0.81	0.72	0.56	0.69	0.59	0.56	0.54		0.37	0.24	0.11	0.81	0.73	0.48	0.22	0.88	0.58	n/a	n/a
	14-1/4	(362)	0.69	0.69	0.66	0.60	0.82	0.82	0.73	0.56	0.70	0.59	0.57	0.54		0.38	0.25	0.11	0.82	0.75	0.49	0.23	0.89	0.59	n/a	n/a
	15	(381)	0.70	0.70	0.67	0.60	0.85	0.85	0.75	0.57	0.71	0.59	0.57	0.54		0.41	0.26	0.12	0.85	0.82	0.53	0.25	0.91	0.61	n/a	n/a
	16	(406)	0.72	0.72	0.68	0.61	0.89	0.89	0.78	0.59	0.72	0.60	0.57	0.54		0.45	0.29	0.14	0.89	0.89	0.58	0.27	0.94	0.63	n/a	n/a
	17	(432)	0.73	0.73	0.69	0.61	0.93	0.93	0.81	0.61	0.73	0.60	0.58	0.55		0.49	0.32	0.15	0.93	0.93	0.64	0.30	0.97	0.64	n/a	n/a
	18	(457)	0.74	0.74	0.70	0.62	0.98	0.98	0.85	0.62	0.75	0.61	0.58	0.55		0.54	0.35	0.16	0.98	0.98	0.70	0.32	0.99	0.66	0.57	n/a
	20	(508)	0.77	0.77	0.72	0.63	1.00	1.00	0.91	0.66	0.77	0.62	0.59	0.55		0.63	0.41	0.19	1.00	1.00	0.82	0.38	1.00	0.70	0.61	n/a
	22	(559)	0.80	0.80	0.74	0.65			0.98	0.69	0.80	0.63	0.60	0.56		0.72	0.47	0.22			0.94	0.44		0.73	0.63	n/a
	24	(610)	0.82	0.82	0.77	0.66			1.00	0.73	0.83	0.65	0.61	0.57		0.82	0.54	0.25			1.00	0.50		0.77	0.66	n/a
	26	(660)	0.85	0.85	0.79	0.67				0.77	0.86	0.66	0.62	0.57		0.93	0.60	0.28				0.56		0.80	0.69	n/a
	28	(711)	0.88	0.88	0.81	0.69				0.81	0.88	0.67	0.63	0.58		1.00	0.68	0.31				0.63		0.83	0.72	0.55
	30	(762)	0.90	0.90	0.83	0.70				0.85	0.91	0.68	0.64	0.58			0.75	0.35				0.70		0.86	0.74	0.57
	36	(914)	0.99	0.99	0.90	0.74				0.97	0.99	0.72	0.66	0.60			0.98	0.46				0.91		0.94	0.81	0.63
	> 48	(1219)	1.00	1.00	1.00	0.82				1.00	1.00	0.79	0.72	0.63			1.00	0.70				1.00		1.00	0.94	0.73

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{HV} = 1.0$.

HIT-HY 200 V3 with HIS-N Inserts

Figure 12 — Hilti HIS-N and HIS-RN internally threaded insert installation conditions

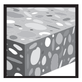
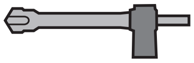
Permissible concrete conditions		Uncracked concrete		Dry concrete	Permissible Drilling Method		Hammer drilling with carbide tipped drill bit
		Cracked concrete		Water saturated concrete			Hilti TE-CD or TE-YD Hollow Drill Bit

Table 56 — Hilti HIS-N and HIS-RN specifications

Setting information		Symbol	Units	Thread size			
				3/8-16 UNC	1/2-13 UNC	5/8-11 UNC	3/4-10 UNC
Outside diameter of insert			in.	0.65	0.81	1.00	1.09
Nominal bit diameter		d_o	in.	11/16	7/8	1-1/8	1-1/4
Effective embedment		h_{ef}	in. (mm)	4-3/8 (110)	5 (125)	6-3/4 (170)	8-1/8 (205)
Thread engagement	minimum	h_s	in.	3/8	1/2	5/8	3/4
	maximum		in.	15/16	1-3/16	1-1/2	1-7/8
Installation torque		T_{inst}	ft-lb (Nm)	15 (20)	30 (40)	60 (81)	100 (136)
Minimum concrete thickness		h_{min}	in. (mm)	5.9 (150)	6.7 (170)	9.1 (230)	10.6 (270)
Minimum edge distance		c_{min}	in (mm)	3-1/4 (83)	4 (102)	5 (127)	5-1/2 (140)
Minimum anchor spacing		s_{min}	in (mm)	3-1/4 (83)	4 (102)	5 (127)	5-1/2 (140)

Figure 13 — Hilti HIS-N and HIS-RN specifications

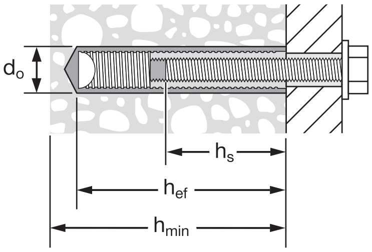


Table 57 — Hilti HIT-HY 200 V3 adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2,3,4,5,6,7,8,9]

Thread size	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8-16 UNC	4-3/8 (111)	7,140 (31.8)	7,820 (34.8)	9,030 (40.2)	11,060 (49.2)	15,375 (68.4)	16,840 (74.9)	19,445 (86.5)	23,815 (105.9)
1/2-13 UNC	5 (127)	8,720 (38.8)	9,555 (42.5)	11,030 (49.1)	13,510 (60.1)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)
5/8-11 UNC	6-3/4 (171)	13,680 (60.9)	14,985 (66.7)	17,305 (77.0)	21,190 (94.3)	29,460 (131.0)	32,275 (143.6)	37,265 (165.8)	45,645 (203.0)
3/4-10 UNC	8-1/8 (206)	18,065 (80.4)	19,790 (88.0)	22,850 (101.6)	27,985 (124.5)	38,910 (173.1)	42,620 (189.6)	49,215 (218.9)	60,275 (268.1)

Table 58 — Hilti HIT-HY 200 V3 adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2,3,4,5,6,7,8,9]

Thread size	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8-16 UNC	4-3/8 (111)	5,050 (22.5)	5,335 (23.7)	5,815 (25.9)	6,570 (29.2)	10,880 (48.4)	11,495 (51.1)	12,530 (55.7)	14,150 (62.9)
1/2-13 UNC	5 (127)	6,175 (27.5)	6,765 (30.1)	7,815 (34.8)	9,570 (42.6)	13,305 (59.2)	14,575 (64.8)	16,830 (74.9)	20,610 (91.7)
5/8-11 UNC	6-3/4 (171)	9,690 (43.1)	10,615 (47.2)	12,255 (54.5)	15,010 (66.8)	20,870 (92.8)	22,860 (101.7)	26,395 (117.4)	32,330 (143.8)
3/4-10 UNC	8-1/8 (206)	12,795 (56.9)	14,015 (62.3)	16,185 (72.0)	19,825 (88.2)	27,560 (122.6)	30,190 (134.3)	34,860 (155.1)	42,695 (189.9)

1 See section 3.1.8 for explanation on development of load values.
2 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 60 - 61 as necessary to the above values. Compare to the steel values in table 59. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C) multiply above values by 0.92.
For temperature range C: Max. short term temperature = 248° F (120° C), max. long term temperature = 162° F (72° C) multiply above values by 0.78.
Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength (factored resistance) by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.69. See section 3.1.8 for additional information on seismic applications.

Table 59 — Steel design strength for steel bolt and cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

Thread size	ASTM A193 B7			ASTM A193 Grade B8M stainless steel		
	Tensile[4] ϕN_{sa} lb (kN)	Shear[5] ϕV_{sa} lb (kN)	Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN)	Tensile[4] ϕN_{sa} lb (kN)	Shear[5] ϕV_{sa} lb (kN)	Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN)
3/8-16 UNC	6,300 (28.0)	3,490 (15.5)	2,445 (10.9)	5,540 (24.6)	3,070 (13.7)	2,150 (9.6)
1/2-13 UNC	11,530 (51.3)	6,385 (28.4)	4,470 (19.9)	10,145 (45.1)	5,620 (25.0)	3,935 (17.5)
5/8-11 UNC	18,365 (81.7)	10,170 (45.2)	7,120 (31.6)	16,160 (71.9)	8,950 (39.8)	6,265 (27.9)
3/4-10 UNC	27,180 (120.9)	15,055 (67.0)	10,540 (46.9)	23,915 (106.4)	13,245 (58.9)	9,270 (41.2)

1 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.
2 Hilti HIS-N and HIS-RN inserts with steel bolts are to be considered brittle steel elements.
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.
4 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
5 Shear values determined by static shear tests with $\phi V_{sa} \leq \phi$ 0.60 $A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.
6 Seismic Shear = $\alpha_{V,seis}\ \phi_{Vsa}$: Reduction for seismic shear only. See section 3.1.8 for additional information on seismic applications.

Table 60 — Load adjustment Factors for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3]

HIS-N and HIS-RN all diameters uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Thread Size		in.	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4
Embedment		in.	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8
h_{ef}		(mm)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)
Spacing (s) / Edge distanc (c_a) / Concrete thickness (h), - in. (mm)	3-1/4	(83)	0.59	n/a	n/a	n/a	0.36	n/a	n/a	n/a	0.55	n/a	n/a	n/a	0.15	n/a	n/a	n/a	0.31	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4	(102)	0.61	0.59	n/a	n/a	0.41	0.40	n/a	n/a	0.56	0.55	n/a	n/a	0.21	0.19	n/a	n/a	0.41	0.38	n/a	n/a	n/a	n/a	n/a	n/a
	5	(127)	0.64	0.61	0.59	n/a	0.47	0.45	0.39	n/a	0.57	0.57	0.55	n/a	0.29	0.26	0.17	n/a	0.47	0.45	0.33	n/a	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.65	0.62	0.60	0.59	0.50	0.48	0.41	0.37	0.58	0.58	0.56	0.55	0.34	0.30	0.19	0.15	0.50	0.48	0.39	0.29	n/a	n/a	n/a	n/a
	6	(152)	0.67	0.63	0.61	0.60	0.53	0.51	0.43	0.39	0.59	0.58	0.56	0.55	0.39	0.35	0.22	0.17	0.53	0.51	0.43	0.33	0.60	n/a	n/a	n/a
	7	(178)	0.69	0.66	0.63	0.62	0.61	0.57	0.48	0.42	0.60	0.60	0.57	0.56	0.49	0.43	0.28	0.21	0.61	0.57	0.48	0.42	0.64	0.62	n/a	n/a
	8	(203)	0.72	0.68	0.64	0.63	0.70	0.65	0.52	0.45	0.62	0.61	0.58	0.57	0.60	0.53	0.34	0.26	0.70	0.65	0.52	0.45	0.69	0.66	n/a	n/a
	9	(229)	0.75	0.70	0.66	0.65	0.78	0.73	0.57	0.49	0.63	0.62	0.59	0.58	0.71	0.63	0.40	0.31	0.78	0.73	0.57	0.49	0.73	0.70	n/a	n/a
	10	(254)	0.78	0.72	0.68	0.66	0.87	0.81	0.62	0.53	0.65	0.64	0.60	0.58	0.83	0.74	0.47	0.36	0.87	0.81	0.62	0.53	0.77	0.74	0.64	n/a
	11	(279)	0.80	0.74	0.70	0.68	0.96	0.89	0.68	0.56	0.66	0.65	0.61	0.59	0.96	0.86	0.55	0.41	0.96	0.89	0.68	0.56	0.81	0.78	0.67	0.61
	12	(305)	0.83	0.77	0.72	0.70	1.00	0.97	0.74	0.60	0.68	0.66	0.62	0.60	1.00	0.98	0.62	0.47	1.00	0.97	0.74	0.60	0.84	0.81	0.70	0.64
	14	(356)	0.89	0.81	0.75	0.73		1.00	0.86	0.70	0.71	0.69	0.64	0.62		1.00	0.78	0.59		1.00	0.86	0.70	0.91	0.87	0.75	0.69
	16	(406)	0.94	0.86	0.79	0.76			0.98	0.80	0.74	0.72	0.66	0.63			0.96	0.73			0.98	0.80	0.97	0.94	0.80	0.73
	18	(457)	1.00	0.90	0.82	0.80			1.00	0.90	0.77	0.75	0.68	0.65			1.00	0.87			1.00	0.90	1.00	0.99	0.85	0.78
	24	(610)		1.00	0.93	0.90				1.00	0.85	0.83	0.74	0.70				1.00				1.00		1.00	0.99	0.90
	30	(762)			1.00	0.99					0.94	0.91	0.80	0.75											1.00	1.00
	36	(914)				1.00					1.00	0.99	0.86	0.80												1.00
	> 48	(1219)										1.00	0.99	0.90												

Table 61 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3]

HIS-N and HIS-RN all diameters cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Thread Size		in.	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4
Embedment		in.	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8
h_{ef}		(mm)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)
Spacing (s) / Edge distanc (c_a) / Concrete thickness (h), - in. (mm)	3-1/4	(83)	0.59	n/a	n/a	n/a	0.55	n/a	n/a	n/a	0.55	n/a	n/a	n/a	0.16	n/a	n/a	n/a	0.31	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4	(102)	0.61	0.59	n/a	n/a	0.60	0.55	n/a	n/a	0.56	0.55	n/a	n/a	0.21	0.19	n/a	n/a	0.43	0.38	n/a	n/a	n/a	n/a	n/a	n/a
	5	(127)	0.64	0.61	0.59	n/a	0.67	0.60	0.55	n/a	0.57	0.57	0.55	n/a	0.30	0.26	0.17	n/a	0.59	0.53	0.34	n/a	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.65	0.62	0.60	0.59	0.71	0.63	0.57	0.55	0.58	0.58	0.56	0.55	0.34	0.31	0.19	0.15	0.69	0.61	0.39	0.29	n/a	n/a	n/a	n/a
	6	(152)	0.67	0.63	0.61	0.60	0.75	0.66	0.59	0.57	0.59	0.58	0.56	0.55	0.39	0.35	0.22	0.17	0.75	0.66	0.44	0.34	0.60	n/a	n/a	n/a
	7	(178)	0.69	0.66	0.63	0.62	0.83	0.72	0.64	0.61	0.60	0.60	0.57	0.56	0.49	0.44	0.28	0.21	0.83	0.72	0.56	0.42	0.64	0.62	n/a	n/a
	8	(203)	0.72	0.68	0.64	0.63	0.91	0.78	0.69	0.66	0.62	0.61	0.58	0.57	0.60	0.54	0.34	0.26	0.91	0.78	0.68	0.52	0.69	0.66	n/a	n/a
	9	(229)	0.75	0.70	0.66	0.65	1.00	0.85	0.74	0.70	0.63	0.62	0.59	0.58	0.72	0.64	0.41	0.31	1.00	0.85	0.74	0.62	0.73	0.70	n/a	n/a
	10	(254)	0.78	0.72	0.68	0.66		0.91	0.79	0.75	0.65	0.64	0.60	0.58	0.84	0.75	0.48	0.36		0.91	0.79	0.72	0.77	0.74	0.64	n/a
	11	(279)	0.80	0.74	0.70	0.68		0.98	0.84	0.79	0.66	0.65	0.61	0.59	0.97	0.86	0.55	0.42		0.98	0.84	0.79	0.81	0.78	0.67	0.61
	12	(305)	0.83	0.77	0.72	0.70		1.00	0.89	0.84	0.68	0.66	0.62	0.60	1.00	0.98	0.63	0.48		1.00	0.89	0.84	0.84	0.81	0.70	0.64
	14	(356)	0.89	0.81	0.75	0.73			1.00	0.94	0.71	0.69	0.64	0.62		1.00	0.79	0.60			1.00	0.94	0.91	0.88	0.76	0.69
	16	(406)	0.94	0.86	0.79	0.76				1.00	0.74	0.72	0.66	0.64			0.97	0.73				1.00	0.97	0.94	0.81	0.74
	18	(457)	1.00	0.90	0.82	0.80					0.77	0.75	0.68	0.65			1.00	0.87					1.00	0.99	0.86	0.78
	24	(610)		1.00	0.93	0.90					0.86	0.83	0.74	0.70				1.00						1.00	0.99	0.90
	30	(762)			1.00	0.99					0.95	0.91	0.81	0.75											1.00	1.00
	36	(914)				1.00					1.00	0.99	0.87	0.80												
	> 48	(1219)										1.00	0.99	0.91												

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

DESIGN DATA IN CONCRETE PER CSA A23.

CSA A23.3 Annex D design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-4868 and ELC-4868. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

Table 62 — Steel factored resistance for Hilti HIT-Z and HIT-Z-R anchor rods[1]

Nominal anchor diameter in.	HIT-Z Carbon Steel Rod[2]			HIT-Z-R Stainless Steel Rod[2]		
	Tensile N_{sar}[3] lb (kN)	Shear V_{sar}[4] lb (kN)	Seismic shear $V_{sar,eq}$[5] lb (kN)	Tensile N_{sar}[3] lb (kN)	Shear V_{sar}[4] lb (kN)	Seismic shear $V_{sar,eq}$[5] lb (kN)
3/8	4,345 (19.3)	1,775 (7.9)	1,155 (5.1)	4,345 (19.3)	2,420 (10.8)	1,910 (8.5)
1/2	7,960 (35.4)	3,250 (14.5)	2,115 (9.4)	7,960 (35.4)	4,435 (19.7)	3,325 (14.8)
5/8	12,675 (56.4)	5,180 (23.0)	3,365 (15.0)	12,675 (56.4)	7,065 (31.4)	4,590 (20.4)
3/4	18,725 (83.3)	7,650 (34.0)	4,975 (22.1)	18,725 (83.3)	10,435 (46.4)	6,785 (30.2)

1 See section 3.1.8 to convert design strength value to ASD value.

2 HIT-Z and HIT-Z-R anchor rods are considered brittle steel elements.

3 Tensile = $A_{se,N}$ ϕ_s f_{uta} R as noted in CSA A23.3 Annex D.

4 Shear values determined by static shear tests with $V_{sar} \le A_{se,V}$ ϕ_s 0.60 f_{uta} R as noted in CSA A23.3 Annex D.

5 Seismic Shear = $\alpha_{V,seis}$ V_{sar} : Reduction factor for seismic shear only. See section 3.1.8 for additional information on seismic applications.

HIT-HY 200 A/R V3 Adhesive with Hilti HIT-Z anchor rods

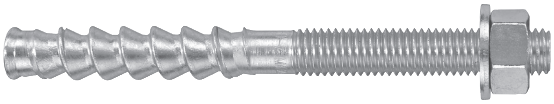


Table 63 — Hilti HIT-HY 200 A/R V3 design information with Hilti HIT-Z and HIT-R-Z anchor rods in hammer drilled holes or diamond core drilled holes in accordance with CSA A23.3[1]

	Design parameter	Symbol	Units	Nominal rod diameter (in.)				Ref
				3/8	1/2	5/8	3/4	A23.3-14
	Nominal anchor diameter	d_a	mm	9.5	12.7	15.9	19.1	
	Effective minimum embedment[2]	h_{ef}	mm	60	70	95	102	
	Effective maximum embedment[2]	h_{ef}	mm	114	152	190	216	
	Minimum concrete thickness[3]	h_{min}	mm	See tables 6 to 9 of this section or table 8 of ESR-4868				
	Critical edge distance	c_{ac}	–	See section 4.1.10.1 of ESR-4868				
	Minimum edge distance[4]	c_{ac}	–	See tables 6 to 9 of this section or table 8 of ESR-4868				
	Minimum anchor spacing[4]	s_{min}	–					
	Coeff. for factored concrete breakout resistance, uncracked concrete[5]	$k_{c,uncr}$	–	10				D.6.2.2
	Coeff. for factored concrete breakout resistance, cracked concrete[5]	$k_{c,cr}$	–	7				D.6.2.2
	Concrete material resistance factor	ϕ_c	–	0.65				8.4.2
	Resistance modification factor for tension and shear, concrete failure modes, Condition B[4]	R_{conc}	–	1.00				D.5.3(c)
Temp range A[7]	Characteristic pullout resistance in cracked concrete	$N_{p,cr}$	lb (kN)	7,952 (35.4)	10,936 (48.6)	21,391 (95.2)	27,930 (124.2)	D.6.3.1
	Characteristic pullout resistance in uncracked concrete	$N_{p,uncr}$	lb (kN)	7,952 (35.4)	11,719 (52.1)	21,391 (95.2)	28,460 (126.6)	D.6.3.1
Temp range B[7]	Characteristic pullout resistance in cracked concrete	$N_{p,cr}$	lb (kN)	7,952 (35.4)	10,936 (48.6)	21,391 (95.2)	27,930 (124.2)	D.6.3.1
	Characteristic pullout resistance in uncracked concrete	$N_{p,uncr}$	lb (kN)	7,952 (35.4)	11,719 (52.1)	21,391 (95.2)	28,460 (126.6)	D.6.3.1
Temp range C[7]	Characteristic pullout resistance in cracked concrete	$N_{p,cr}$	lb (kN)	7,182 (31.9)	9,877 (43.9)	19,321 (85.9)	25,277 (112.4)	D.6.3.1
	Characteristic pullout resistance in uncracked concrete	$N_{p,uncr}$	lb (kN)	7,182 (31.9)	10,585 (47.1)	19,321 (85.9)	25,705 (114.3)	D.6.3.1
	Reduction for seismic tension	$\alpha_{N,seis}$	–	0.94	1.0			
Permissible installation conditions	Resistance modification factor tension and shear, pullout failure dry concrete	Anchor category	–	1				D.5.3 (c)
		R_{dry}	–	1.00				
	Resistance modification factor tension and shear, pullout failure water-saturated concrete	Anchor category	–	1				D.5.3 (c)
		R_{ws}	–	1.00				

1 Design information in this table is taken from ICC-ES ESR-4868, tables 8 and 10, and converted for use with CSA A23.3 Annex D.
2 See figure 2 of this section.
3 See figure 5 of this section.
4 See figure 6 of this section.
5 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
6 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
7 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

Table 64 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/pullout failure for Hilti HIT-Z and HIT-Z-R anchor rods in uncracked concrete[1,2,3,4,5,6,7,8, 9,10]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	2-3/8 (60)	3,060 (13.6)	3,425 (15.2)	3,750 (16.7)	4,330 (19.3)	3,060 (13.6)	3,425 (15.2)	3,750 (16.7)	4,330 (19.3)
	3-3/8 (86)	5,175 (23.0)	5,175 (23.0)	5,175 (23.0)	5,175 (23.0)	10,375 (46.1)	11,600 (51.6)	12,705 (56.5)	14,670 (65.3)
	4-1/2 (114)	5,175 (23.0)	5,175 (23.0)	5,175 (23.0)	5,175 (23.0)	15,970 (71.0)	17,855 (79.4)	19,560 (87.0)	22,585 (100.5)
1/2	2-3/4 (70)	3,815 (17.0)	4,265 (19.0)	4,670 (20.8)	5,395 (24.0)	7,630 (33.9)	8,530 (37.9)	9,345 (41.6)	10,790 (48.0)
	4-1/2 (114)	7,615 (33.9)	7,615 (33.9)	7,615 (33.9)	7,615 (33.9)	15,970 (71.0)	17,855 (79.4)	19,560 (87.0)	22,585 (100.5)
	6 (152)	7,615 (33.9)	7,615 (33.9)	7,615 (33.9)	7,615 (33.9)	24,590 (109.4)	27,490 (122.3)	30,115 (134.0)	34,775 (154.7)
5/8	3-3/4 (95)	6,075 (27.0)	6,790 (30.2)	7,440 (33.1)	8,590 (38.2)	12,150 (54.0)	13,585 (60.4)	14,880 (66.2)	17,185 (76.4)
	5-5/8 (143)	11,160 (49.6)	12,480 (55.5)	13,670 (60.8)	13,895 (61.8)	22,320 (99.3)	24,955 (111.0)	27,335 (121.6)	31,565 (140.4)
	7-1/2 (191)	13,895 (61.8)	13,895 (61.8)	13,895 (61.8)	13,895 (61.8)	34,365 (152.9)	38,420 (170.9)	42,090 (187.2)	48,600 (216.2)
3/4	4 (102)	6,690 (29.8)	7,480 (33.3)	8,195 (36.5)	9,465 (42.1)	13,385 (59.5)	14,965 (66.6)	16,395 (72.9)	18,930 (84.2)
	6-3/4 (171)	14,670 (65.3)	16,400 (73.0)	17,970 (79.9)	18,500 (82.3)	29,340 (130.5)	32,805 (145.9)	35,935 (159.8)	41,495 (184.6)
	8-1/2 (216)	18,500 (82.3)	18,500 (82.3)	18,500 (82.3)	18,500 (82.3)	41,460 (184.4)	46,355 (206.2)	50,780 (225.9)	58,635 (260.8)

Table 65 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/pullout failure for Hilti HIT-Z and HIT-Z-R anchor rods in cracked concrete[1,2,3,4,5,6,7,8,9,10]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	2-3/8 (60)	2,145 (9.5)	2,395 (10.7)	2,625 (11.7)	3,030 (13.5)	2,145 (9.5)	2,395 (10.7)	2,625 (11.7)	3,030 (13.5)
	3-3/8 (86)	3,630 (16.2)	4,060 (18.1)	4,445 (19.8)	5,135 (22.8)	7,260 (32.3)	8,120 (36.1)	8,895 (39.6)	10,270 (45.7)
	4-1/2 (114)	5,175 (23.0)	5,175 (23.0)	5,175 (23.0)	5,175 (23.0)	11,180 (49.7)	12,500 (55.6)	13,695 (60.9)	15,810 (70.3)
1/2	2-3/4 (70)	2,670 (11.9)	2,985 (13.3)	3,270 (14.5)	3,775 (16.8)	5,340 (23.8)	5,970 (26.6)	6,540 (29.1)	7,555 (33.6)
	4-1/2 (114)	5,590 (24.9)	6,250 (27.8)	6,845 (30.5)	7,100 (31.6)	11,180 (49.7)	12,500 (55.6)	13,695 (60.9)	15,810 (70.3)
	6 (152)	7,100 (31.6)	7,100 (31.6)	7,100 (31.6)	7,100 (31.6)	17,215 (76.6)	19,245 (85.6)	21,080 (93.8)	24,340 (108.3)
5/8	3-3/4 (95)	4,250 (18.9)	4,755 (21.1)	5,210 (23.2)	6,015 (26.8)	8,505 (37.8)	9,510 (42.3)	10,415 (46.3)	12,030 (53.5)
	5-5/8 (143)	7,810 (34.8)	8,735 (38.9)	9,570 (42.6)	11,050 (49.1)	15,625 (69.5)	17,470 (77.7)	19,135 (85.1)	22,095 (98.3)
	7-1/2 (191)	12,030 (53.5)	13,445 (59.8)	13,895 (61.8)	13,895 (61.8)	24,055 (107.0)	26,895 (119.6)	29,460 (131.1)	34,020 (151.3)
3/4	4 (102)	4,685 (20.8)	5,240 (23.3)	5,740 (25.5)	6,625 (29.5)	9,370 (41.7)	10,475 (46.6)	11,475 (51.0)	13,250 (58.9)
	6-3/4 (171)	10,270 (45.7)	11,480 (51.1)	12,575 (55.9)	14,525 (64.6)	20,540 (91.4)	22,965 (102.1)	25,155 (111.9)	29,045 (129.2)
	8-1/2 (216)	14,510 (64.6)	16,225 (72.2)	17,775 (79.1)	18,150 (80.7)	29,025 (129.1)	32,450 (144.3)	35,545 (158.1)	41,045 (182.6)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 10 - 17 as necessary to the above values. Compare to the steel values in table 62. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C). For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 1.00. For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.90. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by la as follows: For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension only by the following reduction factors:
3/8-in diameter - $\alpha_{N,seis}$ = 0.705 1/2-in to 3/4-in diameter - $\alpha_{N,seis}$ = 0.75
See section 3.1.8 for additional information on seismic applications.
10 Hilti HIT-Z(-R) rods may be installed in diamond cored holes with no reduction in published data above.

HIT-HY 200 A/R V3 Adhesive with Deformed Reinforcing Bars (Rebar)

Table 66 — Steel factored resistance for CA rebar[1]

Rebar size	CSA-G30.18 Grade 400[2]		
	Tensile N_{sar}[3] lb (kN)	Shear V_{sar}[4] lb (kN)	Seismic shear $V_{sar,eq}$[5] lb (kN)
10M	7,245 (32.2)	4,035 (17.9)	2,825 (12.6)
15M	14,525 (64.6)	8,090 (36.0)	5,665 (25.2)
20M	21,570 (95.9)	12,020 (53.5)	8,415 (37.4)
25M	36,025 (160.2)	20,070 (89.3)	14,050 (62.5)
30M	50,715 (225.6)	28,255 (125.7)	19,780 (88.0)

1 See section 3.1.8 to convert design strength value to ASD value.

2 CSA-G30.18 Grade 400 rebar are considered ductile steel elements.

3 Tensile = $A_{se,N}$ ϕ_s f_{uta} R as noted in CSA A23.3 Annex D.

4 Shear = $A_{se,V}$ ϕ_s 0.60 f_{uta} R as noted in CSA A23.3 Annex D.

5 Seismic Shear = $\alpha_{V,seis}$ V_{sar} : Reduction factor for seismic shear only. See CSA A23.3 Annex D for additional information on seismic applications.

Table 67 — Specifications for CA rebar installed with Hilti HIT-HY 200 A/R V3 adhesive

Setting information		Symbol	Units	Rebar size				
				10M	15M	20M	25M	30M
Nominal bit size		d_o	in.	9/16	3/4	1	1-1/4	1-1/2
Effective embedment	minimum	$h_{ef,min}$	mm	70	80	90	101	120
	maximum	$h_{ef,max}$	mm	226	320	390	504	598
Minimum concrete member thickness		h_{min}	mm	h_{ef} + 30	h_{ef} + $2d_o$			

Note: The installation specifications in table 67 above and the data in tables 66 through 80 pertain to the use of Hilti HIT-HY 200 V3 with rebar designed as a post-installed anchor using the provisions of CSA A23.3 Annex D. For the use of Hilti HIT-HY 200 V3 with rebar for typical development calculations according to CSA A23.3 Chapter 12, refer to section 3.1.8 for the design method and tables 94 through 98 at the end of this section.

Table 68 — Hilti HIT-HY 200 A/R V3 adhesive design information with CA rebar in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

Design parameter		Symbol	Units	Rebar size					Ref
				10M	15M	20M	25M	30M	A23.3-14
Rebar diameter		d_a	mm	11.3	16.0	19.5	25.2	29.9	
Effective minimum embedment[2]		$h_{ef,min}$	mm	70	80	90	101	120	
Effective maximum embedment[2]		$h_{ef,max}$	mm	226	320	390	504	598	
Minimum concrete thickness[2]		h_{min}	mm	h_{ef} + 30	h_{ef} + $2d_o$				
Critical edge distance		c_{ac}	–	$2h_{ef}$					
Minimum edge distance[3]		c_{min}	mm	57	80	98	126	150	
Minimum rebar spacing		s_{min}	mm	57	80	98	126	150	
Coeff. for factored conc. breakout resistance, uncracked concrete[4]		$k_{c,uncr}$	–	10					D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete[4]		$k_{c,cr}$	–	7					D.6.2.2
Concrete material resistance factor		$A_{se,N}$	–	0.65					8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]		ϕ_s	–	1.00					D.5.3(c)
Temp range A[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	1,075 (7.4)	1,085 (7.5)	1,095 (7.6)	840 (5.8)	850 (5.9)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	1,560 (10.8)	1,560 (10.8)	1,560 (10.8)	1,560 (10.8)	1,560 (10.8)	D.6.5.2
Temp range B[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	990 (6.8)	995 (6.9)	1,005 (6.9)	775 (5.3)	780 (5.4)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	1,435 (9.9)	1,435 (9.9)	1,435 (9.9)	1,435 (9.9)	1,435 (9.9)	D.6.5.2
Temp range C[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	845 (5.8)	850 (5.9)	860 (5.9)	660 (4.6)	670 (4.6)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	1,230 (8.5)	1,230 (8.5)	1,230 (8.5)	1,230 (8.5)	1,230 (8.5)	D.6.5.2
Reduction for seismic tension		$\alpha_{N,seis}$	–	0.80			0.85	0.97	
Permissible installation conditions[5]	Resistance modification factor tension & shear, bond failure dry and water saturated concrete	Anchor category	–	1					D.5.3 (c)
		R_{dry}, R_{ws}	–	1.00					
	Resistance modification factor tension & shear, bond failure water-filled concrete	Anchor category	–	3					D.5.3 (c)
		R_{wf}	–	0.75					

1 Design information in this table is taken from ELC-4868, tables 16 and 17, for use with CSA A23.3 Annex D.

2 See figure 8 of this section.

3 Minimum edge distance may be reduced to 45mm provided rebar remains untorqued. See ELC-4868 Installation Torque Subject to Edge Distance section.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F 55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

8 For water-filled holes, multiply characteristic bond stress by 0.97.

Table 69 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/bond failure for CA rebar in uncracked concrete[1,2,3,4,5,6,7,8,9]

Rebar size	Effective embedment in. (mm)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
10M	4-1/2 (115)	6,515 (29.0)	6,665 (29.6)	6,785 (30.2)	6,985 (31.1)	13,030 (58.0)	13,325 (59.3)	13,570 (60.4)	13,965 (62.1)
	7-1/16 (180)	10,200 (45.4)	10,430 (46.4)	10,620 (47.2)	10,930 (48.6)	20,395 (90.7)	20,855 (92.8)	21,240 (94.5)	21,860 (97.2)
	8-7/8 (226)	12,805 (57.0)	13,095 (58.2)	13,335 (59.3)	13,725 (61.0)	25,610 (113.9)	26,185 (116.5)	26,670 (118.6)	27,450 (122.1)
15M	5-11/16 (145)	11,410 (50.8)	11,895 (52.9)	12,115 (53.9)	12,465 (55.5)	22,820 (101.5)	23,790 (105.8)	24,230 (107.8)	24,935 (110.9)
	9-13/16 (250)	20,055 (89.2)	20,510 (91.2)	20,885 (92.9)	21,495 (95.6)	40,110 (178.4)	41,015 (182.5)	41,770 (185.8)	42,990 (191.2)
	12-5/8 (320)	25,670 (114.2)	26,250 (116.8)	26,735 (118.9)	27,515 (122.4)	51,345 (228.4)	52,500 (233.5)	53,470 (237.8)	55,030 (244.8)
20M	7-7/8 (200)	18,485 (82.2)	19,995 (88.9)	20,365 (90.6)	20,960 (93.2)	36,965 (164.4)	39,990 (177.9)	40,730 (181.2)	41,915 (186.5)
	14 (355)	34,710 (154.4)	35,495 (157.9)	36,145 (160.8)	37,200 (165.5)	69,420 (308.8)	70,985 (315.8)	72,290 (321.6)	74,400 (331.0)
	15-3/8 (390)	38,130 (169.6)	38,990 (173.4)	39,710 (176.6)	40,870 (181.8)	76,265 (339.2)	77,985 (346.9)	79,420 (353.3)	81,735 (363.6)
25M	9-1/16 (230)	22,795 (101.4)	25,485 (113.4)	27,920 (124.2)	31,145 (138.5)	45,590 (202.8)	50,970 (226.7)	55,835 (248.4)	62,295 (277.1)
	15-15/16 (405)	51,175 (227.6)	52,330 (232.8)	53,290 (237.0)	54,845 (244.0)	102,345 (455.3)	104,655 (465.5)	106,580 (474.1)	109,690 (487.9)
	19-13/16 (504)	63,680 (283.3)	65,120 (289.7)	66,315 (295.0)	68,255 (303.6)	127,365 (566.5)	130,240 (579.3)	132,635 (590.0)	136,505 (607.2)
30M	10-1/4 (260)	27,395 (121.9)	30,630 (136.3)	33,555 (149.3)	38,745 (172.3)	54,795 (243.7)	61,260 (272.5)	67,110 (298.5)	77,490 (344.7)
	17-15/16 (455)	63,425 (282.1)	69,750 (310.3)	71,035 (316.0)	73,110 (325.2)	126,850 (564.3)	139,505 (620.5)	142,070 (632.0)	146,220 (650.4)
	23-9/16 (598)	89,650 (398.8)	91,675 (407.8)	93,360 (415.3)	96,085 (427.4)	179,305 (797.6)	183,350 (815.6)	186,725 (830.6)	192,170 (854.8)

[1] See Section 3.1.8 for explanation on development of load values.

[2] See Section 3.1.8 to convert design strength value to ASD value.

[3] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[4] Apply spacing, edge distance, and concrete thickness factors in tables 71 - 80 as necessary to the above values. Compare to the steel values in table 66. The lesser of the values is to be used for the design.

[5] Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.82. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

[6] Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength (factored resistance) by 0.73.

[7] Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

[8] Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

[9] Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 70 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/bond failure for CA rebar in cracked concrete[1,2,3,4,5,6,7,8,9]

Rebar size	Effective embedment in. (mm)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
10M	4-1/2 (115)	4,490 (20.0)	4,590 (20.4)	4,675 (20.8)	4,810 (21.4)	8,980 (39.9)	9,185 (40.8)	9,350 (41.6)	9,625 (42.8)
	7-1/16 (180)	7,030 (31.3)	7,185 (32.0)	7,320 (32.6)	7,530 (33.5)	14,055 (62.5)	14,375 (63.9)	14,635 (65.1)	15,065 (67.0)
	8-7/8 (226)	8,825 (39.3)	9,025 (40.1)	9,190 (40.9)	9,455 (42.1)	17,650 (78.5)	18,045 (80.3)	18,380 (81.7)	18,915 (84.1)
15M	5-11/16 (145)	7,985 (35.5)	8,275 (36.8)	8,425 (37.5)	8,670 (38.6)	15,975 (71.1)	16,545 (73.6)	16,850 (75.0)	17,345 (77.1)
	9-13/16 (250)	13,950 (62.0)	14,265 (63.4)	14,525 (64.6)	14,950 (66.5)	27,900 (124.1)	28,530 (126.9)	29,055 (129.2)	29,900 (133.0)
	12-5/8 (320)	17,855 (79.4)	18,260 (81.2)	18,595 (82.7)	19,135 (85.1)	35,710 (158.8)	36,515 (162.4)	37,190 (165.4)	38,275 (170.2)
20M	7-7/8 (200)	12,940 (57.6)	14,035 (62.4)	14,295 (63.6)	14,710 (65.4)	25,875 (115.1)	28,070 (124.9)	28,590 (127.2)	29,420 (130.9)
	14 (355)	24,365 (108.4)	24,915 (110.8)	25,370 (112.9)	26,110 (116.2)	48,725 (216.7)	49,825 (221.6)	50,745 (225.7)	52,225 (232.3)
	15-3/8 (390)	26,765 (119.1)	27,370 (121.7)	27,875 (124.0)	28,685 (127.6)	53,530 (238.1)	54,740 (243.5)	55,745 (248.0)	57,375 (255.2)
25M	9-1/16 (230)	15,650 (69.6)	16,000 (71.2)	16,295 (72.5)	16,770 (74.6)	31,295 (139.2)	32,005 (142.4)	32,590 (145.0)	33,545 (149.2)
	15-15/16 (405)	27,555 (122.6)	28,175 (125.3)	28,695 (127.6)	29,530 (131.4)	55,110 (245.1)	56,355 (250.7)	57,390 (255.3)	59,065 (262.7)
	19-13/16 (504)	34,290 (152.5)	35,065 (156.0)	35,710 (158.8)	36,750 (163.5)	68,580 (305.1)	70,130 (311.9)	71,420 (317.7)	73,505 (327.0)
30M	10-1/4 (260)	19,180 (85.3)	21,440 (95.4)	22,115 (98.4)	22,765 (101.3)	38,355 (170.6)	42,885 (190.8)	44,235 (196.8)	45,525 (202.5)
	17-15/16 (455)	37,165 (165.3)	38,005 (169.1)	38,705 (172.2)	39,835 (177.2)	74,335 (330.7)	76,010 (338.1)	77,410 (344.3)	79,670 (354.4)
	23-9/16 (598)	48,850 (217.3)	49,950 (222.2)	50,870 (226.3)	52,355 (232.9)	97,695 (434.6)	99,900 (444.4)	101,740 (452.6)	104,710 (465.8)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 71 - 80 as necessary to the above values. Compare to the steel values in table 66. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.82. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength (factored resistance) by 0.73.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors:
10M to 20M - α_{seis} = 0.60, 25M - α_{seis} = 0.64, 30M - α_{seis} = 0.73
See section 3.1.8 for additional information on seismic applications.

Table 71 — Load adjustment factors for 10M rebar in uncracked concrete[1,2,3]

10M Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}			4-1/2	7-1/16	8-7/8	4-1/2	7-1/16	8-7/8	4-1/2	7-1/16	8-8/9	4-1/2	7-1/16	8-7/8	4-1/2	7-1/16	8-7/8	4-1/2	7-1/16	8-7/8
	in.	(mm)	(115)	(180)	(226)	(115)	(180)	(226)	(115)	(180)	(226)	(115)	(180)	(226)	(115)	(180)	(226)	(115)	(180)	(226)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.25	0.15	0.12	n/a	n/a	n/a	0.06	0.04	0.03	0.12	0.08	0.06	n/a	n/a	n/a
	2-3/16	(55)	0.58	0.55	0.54	0.27	0.17	0.13	0.53	0.52	0.52	0.09	0.05	0.04	0.17	0.11	0.09	n/a	n/a	n/a
	3	(76)	0.61	0.57	0.56	0.31	0.20	0.15	0.54	0.53	0.53	0.14	0.09	0.07	0.28	0.18	0.14	n/a	n/a	n/a
	4	(102)	0.65	0.59	0.57	0.37	0.23	0.18	0.56	0.54	0.54	0.22	0.14	0.11	0.40	0.28	0.22	n/a	n/a	n/a
	5	(127)	0.68	0.62	0.59	0.44	0.27	0.21	0.57	0.56	0.55	0.30	0.19	0.15	0.46	0.35	0.31	n/a	n/a	n/a
	5-11/16	(145)	0.71	0.63	0.61	0.49	0.30	0.24	0.59	0.56	0.55	0.37	0.23	0.19	0.51	0.37	0.33	0.58	n/a	n/a
	6	(152)	0.72	0.64	0.61	0.51	0.32	0.25	0.59	0.57	0.56	0.40	0.25	0.20	0.53	0.38	0.34	0.60	n/a	n/a
	7	(178)	0.76	0.66	0.63	0.60	0.37	0.29	0.60	0.58	0.57	0.50	0.32	0.25	0.60	0.42	0.36	0.65	n/a	n/a
	8	(203)	0.79	0.69	0.65	0.68	0.42	0.33	0.62	0.59	0.58	0.61	0.39	0.31	0.68	0.46	0.39	0.69	n/a	n/a
	8-1/4	(210)	0.80	0.69	0.65	0.71	0.44	0.35	0.62	0.59	0.58	0.64	0.41	0.33	0.71	0.47	0.40	0.70	0.61	n/a
	9	(229)	0.83	0.71	0.67	0.77	0.48	0.38	0.63	0.60	0.59	0.73	0.47	0.37	0.77	0.50	0.42	0.73	0.63	n/a
	10-1/16	(256)	0.87	0.74	0.69	0.86	0.53	0.42	0.65	0.61	0.60	0.86	0.55	0.44	0.86	0.54	0.45	0.78	0.67	0.62
	11	(279)	0.90	0.76	0.71	0.94	0.58	0.46	0.66	0.62	0.61	0.98	0.63	0.50	0.94	0.58	0.48	0.81	0.70	0.65
	12	(305)	0.94	0.78	0.72	1.00	0.64	0.50	0.68	0.63	0.61	1.00	0.72	0.57	1.00	0.64	0.51	0.85	0.73	0.68
	14	(356)	1.00	0.83	0.76		0.74	0.59	0.71	0.66	0.63		0.90	0.72		0.74	0.59	0.92	0.79	0.73
	16	(406)		0.88	0.80		0.85	0.67	0.74	0.68	0.65		1.00	0.88		0.85	0.67	0.98	0.84	0.78
	18	(457)		0.92	0.84		0.96	0.75	0.77	0.70	0.67			1.00		0.96	0.75	1.00	0.89	0.83
	24	(610)		1.00	0.95		1.00	1.00	0.86	0.77	0.73					1.00	1.00		1.00	0.96
	30	(762)			1.00				0.95	0.83	0.79									1.00
	36	(914)							1.00	0.90	0.84									
	> 48	(1219)								1.00	0.96									

Table 72 — Load adjustment factors for 10M rebar in cracked concrete[1,2,3]

10M Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}			4-1/2	7-1/16	8-7/8	4-1/2	7-1/16	8-7/8	4-1/2	7-1/16	8-8/9	4-1/2	7-1/16	8-7/8	4-1/2	7-1/16	8-7/8	4-1/2	7-1/16	8-7/8
	in.	(mm)	(115)	(180)	(226)	(115)	(180)	(226)	(115)	(180)	(226)	(115)	(180)	(226)	(115)	(180)	(226)	(115)	(180)	(226)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.49	0.44	0.42	n/a	n/a	n/a	0.06	0.04	0.03	0.13	0.08	0.07	n/a	n/a	n/a
	2-3/16	(55)	0.58	0.55	0.54	0.52	0.46	0.43	0.53	0.52	0.52	0.09	0.06	0.05	0.18	0.11	0.09	n/a	n/a	n/a
	3	(76)	0.61	0.57	0.56	0.60	0.50	0.47	0.55	0.53	0.53	0.15	0.09	0.07	0.29	0.19	0.15	n/a	n/a	n/a
	4	(102)	0.65	0.59	0.57	0.70	0.56	0.51	0.56	0.55	0.54	0.22	0.14	0.11	0.45	0.29	0.23	n/a	n/a	n/a
	5	(127)	0.68	0.62	0.59	0.80	0.62	0.56	0.58	0.56	0.55	0.31	0.20	0.16	0.62	0.40	0.32	n/a	n/a	n/a
	5-11/16	(145)	0.71	0.63	0.61	0.88	0.66	0.59	0.59	0.56	0.56	0.38	0.24	0.19	0.76	0.49	0.39	0.59	n/a	n/a
	6	(152)	0.72	0.64	0.61	0.91	0.68	0.61	0.59	0.57	0.56	0.41	0.26	0.21	0.82	0.52	0.42	0.61	n/a	n/a
	7	(178)	0.76	0.66	0.63	1.00	0.74	0.65	0.61	0.58	0.57	0.52	0.33	0.26	1.00	0.66	0.53	0.66	n/a	n/a
	8	(203)	0.79	0.69	0.65		0.81	0.70	0.62	0.59	0.58	0.63	0.40	0.32		0.81	0.64	0.70	n/a	n/a
	8-1/4	(210)	0.80	0.69	0.65		0.83	0.72	0.63	0.59	0.58	0.66	0.42	0.34		0.83	0.68	0.71	0.61	n/a
	9	(229)	0.83	0.71	0.67		0.88	0.76	0.64	0.60	0.59	0.75	0.48	0.38		0.88	0.76	0.74	0.64	n/a
	10-1/16	(256)	0.87	0.74	0.69		0.96	0.81	0.65	0.61	0.60	0.89	0.57	0.46		0.96	0.81	0.79	0.68	0.63
	11	(279)	0.90	0.76	0.71		1.00	0.86	0.67	0.63	0.61	1.00	0.65	0.52		1.00	0.86	0.82	0.71	0.66
	12	(305)	0.94	0.78	0.72			0.92	0.68	0.64	0.62		0.74	0.59			0.92	0.86	0.74	0.69
	14	(356)	1.00	0.83	0.76			1.00	0.71	0.66	0.64		0.94	0.74			1.00	0.93	0.80	0.74
	16	(406)		0.88	0.80				0.75	0.68	0.66		1.00	0.91				0.99	0.85	0.79
	18	(457)		0.92	0.84				0.78	0.70	0.68			1.00				1.00	0.91	0.84
	24	(610)		1.00	0.95				0.87	0.77	0.73								1.00	0.97
	30	(762)			1.00				0.96	0.84	0.79									1.00
	36	(914)							1.00	0.91	0.85									
	> 48	(1219)								1.00	0.97									

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 73 — Load adjustment factors for 15M rebar in uncracked concrete[1,2,3]

15M Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}			5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8
	in.	(mm)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.25	0.14	0.11	n/a	n/a	n/a	0.04	0.02	0.02	0.08	0.05	0.04	n/a	n/a	n/a
	3-1/8	(80)	0.59	0.55	0.54	0.31	0.17	0.13	0.54	0.53	0.52	0.10	0.06	0.05	0.20	0.12	0.09	n/a	n/a	n/a
	4	(102)	0.62	0.57	0.55	0.35	0.19	0.15	0.55	0.53	0.53	0.14	0.08	0.07	0.29	0.17	0.13	n/a	n/a	n/a
	5	(127)	0.65	0.58	0.57	0.39	0.22	0.17	0.56	0.54	0.53	0.20	0.12	0.09	0.40	0.23	0.18	n/a	n/a	n/a
	6	(152)	0.68	0.60	0.58	0.44	0.25	0.19	0.57	0.55	0.54	0.27	0.15	0.12	0.45	0.31	0.24	n/a	n/a	n/a
	7	(178)	0.70	0.62	0.59	0.49	0.27	0.21	0.58	0.56	0.55	0.33	0.19	0.15	0.50	0.35	0.30	n/a	n/a	n/a
	7-1/4	(184)	0.71	0.62	0.60	0.50	0.28	0.22	0.58	0.56	0.55	0.35	0.20	0.16	0.51	0.35	0.31	0.58	n/a	n/a
	8	(203)	0.73	0.64	0.61	0.54	0.30	0.24	0.59	0.56	0.55	0.41	0.24	0.18	0.55	0.37	0.33	0.61	n/a	n/a
	9	(229)	0.76	0.65	0.62	0.61	0.34	0.26	0.60	0.57	0.56	0.49	0.28	0.22	0.61	0.40	0.35	0.64	n/a	n/a
	10	(254)	0.79	0.67	0.63	0.68	0.38	0.29	0.61	0.58	0.57	0.57	0.33	0.26	0.68	0.43	0.37	0.68	n/a	n/a
	11-3/8	(289)	0.83	0.69	0.65	0.77	0.43	0.33	0.63	0.59	0.58	0.69	0.40	0.31	0.77	0.46	0.39	0.72	0.60	n/a
	12	(305)	0.85	0.70	0.66	0.81	0.46	0.35	0.64	0.60	0.58	0.75	0.43	0.34	0.81	0.48	0.40	0.74	0.62	n/a
	14-1/8	(359)	0.91	0.74	0.69	0.96	0.54	0.42	0.66	0.61	0.60	0.96	0.55	0.43	0.96	0.54	0.45	0.81	0.67	0.62
	16	(406)	0.97	0.77	0.71	1.00	0.61	0.47	0.68	0.63	0.61	1.00	0.67	0.52	1.00	0.61	0.49	0.86	0.71	0.66
	18	(457)	1.00	0.80	0.74		0.68	0.53	0.71	0.64	0.62		0.80	0.62		0.68	0.54	0.91	0.76	0.70
	20	(508)		0.84	0.76		0.76	0.59	0.73	0.66	0.63		0.93	0.73		0.76	0.59	0.96	0.80	0.73
	22	(559)		0.87	0.79		0.84	0.65	0.75	0.67	0.65		1.00	0.84		0.84	0.65	1.00	0.84	0.77
	24	(610)		0.91	0.82		0.91	0.71	0.78	0.69	0.66			0.96		0.91	0.71		0.87	0.80
	30	(762)		1.00	0.90		1.00	0.88	0.84	0.74	0.70			1.00		1.00	0.88		0.98	0.90
	36	(914)			0.98			1.00	0.91	0.79	0.74						1.00		1.00	0.99
	> 48	(1219)			1.00				1.00	0.88	0.82									1.00

Table 74 — Load adjustment factors for 15M rebar in cracked concrete[1,2,3]

15M Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}			5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8
	in.	(mm)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.46	0.41	0.40	n/a	n/a	n/a	0.04	0.02	0.02	0.09	0.05	0.04	n/a	n/a	n/a
	3-1/8	(80)	0.59	0.55	0.54	0.55	0.46	0.44	0.54	0.53	0.52	0.10	0.06	0.05	0.21	0.12	0.09	n/a	n/a	n/a
	4	(102)	0.62	0.57	0.55	0.62	0.50	0.46	0.55	0.53	0.53	0.15	0.09	0.07	0.30	0.17	0.13	n/a	n/a	n/a
	5	(127)	0.65	0.58	0.57	0.69	0.54	0.49	0.56	0.54	0.53	0.21	0.12	0.09	0.41	0.24	0.19	n/a	n/a	n/a
	6	(152)	0.68	0.60	0.58	0.77	0.58	0.52	0.57	0.55	0.54	0.27	0.16	0.12	0.54	0.31	0.25	n/a	n/a	n/a
	7	(178)	0.70	0.62	0.59	0.86	0.62	0.56	0.58	0.56	0.55	0.34	0.20	0.15	0.68	0.40	0.31	n/a	n/a	n/a
	7-1/4	(184)	0.71	0.62	0.60	0.88	0.63	0.56	0.58	0.56	0.55	0.36	0.21	0.16	0.72	0.42	0.33	0.58	n/a	n/a
	8	(203)	0.73	0.64	0.61	0.95	0.66	0.59	0.59	0.56	0.55	0.42	0.24	0.19	0.84	0.48	0.38	0.61	n/a	n/a
	9	(229)	0.76	0.65	0.62	1.00	0.71	0.62	0.60	0.57	0.56	0.50	0.29	0.23	1.00	0.58	0.45	0.65	n/a	n/a
	10	(254)	0.79	0.67	0.63		0.76	0.66	0.62	0.58	0.57	0.58	0.34	0.26		0.68	0.53	0.68	n/a	n/a
	11-3/8	(289)	0.83	0.69	0.65		0.82	0.71	0.63	0.59	0.58	0.71	0.41	0.32		0.82	0.64	0.73	0.61	n/a
	12	(305)	0.85	0.70	0.66		0.86	0.73	0.64	0.60	0.58	0.77	0.44	0.35		0.86	0.70	0.75	0.62	n/a
	14-1/8	(359)	0.91	0.74	0.69		0.97	0.81	0.66	0.61	0.60	0.98	0.57	0.44		0.97	0.81	0.81	0.68	0.62
	16	(406)	0.97	0.77	0.71		1.00	0.88	0.69	0.63	0.61	1.00	0.69	0.54		1.00	0.88	0.86	0.72	0.66
	18	(457)	1.00	0.80	0.74			0.96	0.71	0.65	0.62		0.82	0.64			0.96	0.92	0.76	0.70
	20	(508)		0.84	0.76			1.00	0.73	0.66	0.64		0.96	0.75			1.00	0.96	0.80	0.74
	22	(559)		0.87	0.79				0.76	0.68	0.65		1.00	0.86				1.00	0.84	0.78
	24	(610)		0.91	0.82				0.78	0.69	0.66			0.98					0.88	0.81
	30	(762)		1.00	0.90				0.85	0.74	0.71			1.00					0.99	0.91
	36	(914)			0.98				0.92	0.79	0.75								1.00	0.99
	> 48	(1219)			1.00				1.00	0.89	0.83									1.00

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 75 — Load adjustment factors for 20M rebar in uncracked concrete[1,2,3]

	20M Rebar uncracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
	Embedment h_{ef}		7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8
	in.	(mm)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.21	0.11	0.10	n/a	n/a	n/a	0.03	0.01	0.01	0.06	0.03	0.03	n/a	n/a	n/a
	3-7/8	(98)	0.58	0.55	0.54	0.27	0.15	0.13	0.53	0.52	0.52	0.09	0.05	0.04	0.18	0.10	0.09	n/a	n/a	n/a
	4	(102)	0.58	0.55	0.54	0.27	0.15	0.13	0.53	0.52	0.52	0.10	0.05	0.05	0.19	0.10	0.09	n/a	n/a	n/a
	5	(127)	0.61	0.56	0.55	0.30	0.17	0.15	0.54	0.53	0.53	0.13	0.07	0.07	0.27	0.14	0.13	n/a	n/a	n/a
	6	(152)	0.63	0.57	0.57	0.34	0.18	0.17	0.55	0.53	0.53	0.17	0.09	0.09	0.35	0.19	0.17	n/a	n/a	n/a
	7	(178)	0.65	0.58	0.58	0.37	0.20	0.18	0.56	0.54	0.54	0.22	0.12	0.11	0.41	0.24	0.22	n/a	n/a	n/a
	8	(203)	0.67	0.60	0.59	0.41	0.22	0.20	0.57	0.55	0.54	0.27	0.15	0.13	0.44	0.29	0.26	n/a	n/a	n/a
	9	(229)	0.69	0.61	0.60	0.45	0.24	0.22	0.58	0.55	0.55	0.32	0.17	0.16	0.47	0.33	0.32	n/a	n/a	n/a
	10	(254)	0.71	0.62	0.61	0.49	0.27	0.24	0.59	0.56	0.55	0.38	0.20	0.18	0.51	0.35	0.33	0.59	n/a	n/a
	11	(279)	0.73	0.63	0.62	0.54	0.29	0.27	0.60	0.56	0.56	0.43	0.23	0.21	0.55	0.37	0.35	0.62	n/a	n/a
	12	(305)	0.75	0.64	0.63	0.59	0.32	0.29	0.60	0.57	0.56	0.49	0.27	0.24	0.59	0.38	0.36	0.65	n/a	n/a
	14	(356)	0.80	0.67	0.65	0.69	0.37	0.34	0.62	0.58	0.58	0.62	0.34	0.31	0.69	0.42	0.40	0.70	n/a	n/a
	16	(406)	0.84	0.69	0.67	0.78	0.43	0.39	0.64	0.59	0.59	0.76	0.41	0.37	0.78	0.46	0.43	0.74	0.61	n/a
	18	(457)	0.88	0.71	0.70	0.88	0.48	0.44	0.66	0.60	0.60	0.91	0.49	0.45	0.88	0.50	0.46	0.79	0.64	0.62
	20	(508)	0.92	0.74	0.72	0.98	0.53	0.48	0.67	0.62	0.61	1.00	0.57	0.52	0.98	0.54	0.50	0.83	0.68	0.66
	22	(559)	0.97	0.76	0.74	1.00	0.59	0.53	0.69	0.63	0.62		0.66	0.60	1.00	0.59	0.54	0.87	0.71	0.69
	24	(610)	1.00	0.79	0.76		0.64	0.58	0.71	0.64	0.63		0.76	0.69		0.64	0.58	0.91	0.74	0.72
	26	(660)		0.81	0.78		0.69	0.63	0.73	0.65	0.64		0.85	0.78		0.69	0.63	0.95	0.77	0.75
	28	(711)		0.83	0.80		0.75	0.68	0.74	0.66	0.65		0.95	0.87		0.75	0.68	0.99	0.80	0.78
	30	(762)		0.86	0.83		0.80	0.73	0.76	0.67	0.66		1.00	0.96		0.80	0.73	1.00	0.83	0.81
	36	(914)		0.93	0.89		0.96	0.87	0.81	0.71	0.69			1.00		0.96	0.87		0.91	0.88
	> 48	(1219)		1.00	1.00		1.00	1.00	0.92	0.78	0.76					1.00	1.00		1.00	1.00

Table 76 — Load adjustment factors for 20M rebar in cracked concrete[1,2,3]

	20M Rebar cracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
	Embedment h_{ef}		7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8
	in.	(mm)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.43	0.39	0.39	n/a	n/a	n/a	0.03	0.02	0.01	0.06	0.03	0.03	n/a	n/a	n/a
	3-7/8	(98)	0.58	0.55	0.54	0.53	0.45	0.44	0.53	0.52	0.52	0.09	0.05	0.05	0.18	0.10	0.09	n/a	n/a	n/a
	4	(102)	0.58	0.55	0.54	0.54	0.45	0.44	0.54	0.52	0.52	0.10	0.05	0.05	0.19	0.10	0.10	n/a	n/a	n/a
	5	(127)	0.61	0.56	0.55	0.59	0.48	0.47	0.54	0.53	0.53	0.14	0.07	0.07	0.27	0.15	0.13	n/a	n/a	n/a
	6	(152)	0.63	0.57	0.57	0.64	0.51	0.49	0.55	0.53	0.53	0.18	0.10	0.09	0.36	0.19	0.17	n/a	n/a	n/a
	7	(178)	0.65	0.58	0.58	0.70	0.53	0.52	0.56	0.54	0.54	0.22	0.12	0.11	0.45	0.24	0.22	n/a	n/a	n/a
	8	(203)	0.67	0.60	0.59	0.76	0.56	0.54	0.57	0.55	0.54	0.27	0.15	0.13	0.55	0.30	0.27	n/a	n/a	n/a
	9	(229)	0.69	0.61	0.60	0.82	0.59	0.57	0.58	0.55	0.55	0.33	0.18	0.16	0.65	0.35	0.32	n/a	n/a	n/a
	10	(254)	0.71	0.62	0.61	0.88	0.62	0.60	0.59	0.56	0.55	0.38	0.21	0.19	0.77	0.41	0.38	0.59	n/a	n/a
	11	(279)	0.73	0.63	0.62	0.95	0.65	0.62	0.60	0.56	0.56	0.44	0.24	0.22	0.88	0.48	0.43	0.62	n/a	n/a
	12	(305)	0.75	0.64	0.63	1.00	0.69	0.65	0.61	0.57	0.57	0.50	0.27	0.25	1.00	0.54	0.49	0.65	n/a	n/a
	14	(356)	0.80	0.67	0.65		0.75	0.71	0.62	0.58	0.58	0.64	0.34	0.31		0.68	0.62	0.70	n/a	n/a
	16	(406)	0.84	0.69	0.67		0.82	0.77	0.64	0.59	0.59	0.77	0.42	0.38		0.82	0.76	0.75	0.61	n/a
	18	(457)	0.88	0.71	0.70		0.89	0.83	0.66	0.60	0.60	0.93	0.50	0.45		0.89	0.83	0.80	0.65	0.63
	20	(508)	0.92	0.74	0.72		0.96	0.90	0.68	0.62	0.61	1.00	0.58	0.53		0.96	0.90	0.84	0.68	0.66
	22	(559)	0.97	0.76	0.74		1.00	0.96	0.69	0.63	0.62		0.67	0.61		1.00	0.96	0.88	0.72	0.69
	24	(610)	1.00	0.79	0.76			1.00	0.71	0.64	0.63		0.77	0.70			1.00	0.92	0.75	0.72
	26	(660)		0.81	0.78				0.73	0.65	0.64		0.87	0.79				0.96	0.78	0.75
	28	(711)		0.83	0.80				0.75	0.66	0.65		0.97	0.88				0.99	0.81	0.78
	30	(762)		0.86	0.83				0.76	0.67	0.66		1.00	0.98				1.00	0.84	0.81
	36	(914)		0.93	0.89				0.82	0.71	0.70			1.00					0.92	0.89
	> 48	(1219)		1.00	1.00				0.92	0.78	0.76								1.00	1.00

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.

4 Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{HV} = 1.0$.

Table 77 — Load adjustment factors for 25M rebar in uncracked concrete[1,2,3]

25M Rebar uncracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To and away from edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
Embedment h_{ef} in. Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	(mm)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)
1-3/4	(44)	n/a	n/a	n/a	0.22	0.12	0.10	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.02	0.02	n/a	n/a	n/a
5	(127)	0.59	0.55	0.54	0.30	0.17	0.13	0.54	0.52	0.52	0.11	0.05	0.04	0.22	0.10	0.08	n/a	n/a	n/a
6	(152)	0.61	0.56	0.55	0.33	0.18	0.14	0.55	0.53	0.52	0.14	0.06	0.05	0.28	0.13	0.10	n/a	n/a	n/a
7	(178)	0.63	0.57	0.56	0.36	0.20	0.16	0.55	0.53	0.53	0.18	0.08	0.06	0.36	0.16	0.13	n/a	n/a	n/a
8	(203)	0.65	0.58	0.57	0.39	0.21	0.17	0.56	0.54	0.53	0.22	0.10	0.08	0.41	0.20	0.16	n/a	n/a	n/a
9	(229)	0.67	0.59	0.58	0.42	0.23	0.18	0.57	0.54	0.53	0.26	0.12	0.09	0.44	0.24	0.19	n/a	n/a	n/a
10	(254)	0.68	0.60	0.58	0.45	0.25	0.20	0.58	0.54	0.54	0.30	0.14	0.11	0.47	0.28	0.22	n/a	n/a	n/a
11-9/16	(294)	0.71	0.62	0.60	0.50	0.28	0.22	0.59	0.55	0.54	0.38	0.17	0.14	0.52	0.34	0.28	0.59	n/a	n/a
12	(305)	0.72	0.63	0.60	0.52	0.28	0.23	0.59	0.55	0.55	0.40	0.18	0.15	0.53	0.36	0.29	0.60	n/a	n/a
14	(356)	0.76	0.65	0.62	0.60	0.33	0.26	0.61	0.56	0.55	0.50	0.23	0.18	0.60	0.39	0.34	0.65	n/a	n/a
16	(406)	0.79	0.67	0.63	0.69	0.38	0.30	0.62	0.57	0.56	0.62	0.28	0.22	0.69	0.42	0.37	0.69	n/a	n/a
18	(457)	0.83	0.69	0.65	0.77	0.42	0.34	0.64	0.58	0.57	0.74	0.33	0.27	0.77	0.46	0.39	0.74	n/a	n/a
18-7/16	(469)	0.84	0.69	0.66	0.79	0.43	0.35	0.64	0.58	0.57	0.76	0.35	0.28	0.79	0.46	0.40	0.75	0.57	n/a
20	(508)	0.87	0.71	0.67	0.86	0.47	0.37	0.65	0.59	0.58	0.86	0.39	0.31	0.86	0.49	0.42	0.78	0.60	n/a
22-3/8	(568)	0.91	0.73	0.69	0.96	0.53	0.42	0.67	0.60	0.59	1.00	0.46	0.37	0.96	0.53	0.45	0.82	0.63	0.59
24	(610)	0.94	0.75	0.70	1.00	0.56	0.45	0.68	0.61	0.59		0.51	0.41	1.00	0.56	0.47	0.85	0.65	0.61
26	(660)	0.98	0.77	0.72		0.61	0.49	0.70	0.62	0.60		0.58	0.46		0.61	0.50	0.89	0.68	0.63
28	(711)	1.00	0.79	0.74		0.66	0.52	0.71	0.62	0.61		0.65	0.52		0.66	0.53	0.92	0.71	0.66
30	(762)		0.81	0.75		0.71	0.56	0.73	0.63	0.62		0.72	0.58		0.71	0.56	0.95	0.73	0.68
36	(914)		0.88	0.80		0.85	0.67	0.77	0.66	0.64		0.94	0.76		0.85	0.67	1.00	0.80	0.74
> 48	(1219)		1.00	0.90		1.00	0.90	0.86	0.71	0.68		1.00	1.00		1.00	0.90		0.92	0.86

Table 78 — Load adjustment factors for 25M rebar in cracked concrete[1,2,3]

25M Rebar cracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To and away from edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
Embedment h_{ef} in. Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	(mm)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)
1-3/4	(44)	n/a	n/a	n/a	0.42	0.39	0.38	n/a	n/a	n/a	0.02	0.01	0.01	0.05	0.03	0.02	n/a	n/a	n/a
5	(127)	0.59	0.55	0.54	0.55	0.46	0.44	0.54	0.53	0.52	0.11	0.06	0.05	0.23	0.13	0.10	n/a	n/a	n/a
6	(152)	0.61	0.56	0.55	0.60	0.48	0.46	0.55	0.53	0.53	0.15	0.08	0.07	0.30	0.17	0.14	n/a	n/a	n/a
7	(178)	0.63	0.57	0.56	0.65	0.51	0.48	0.55	0.54	0.53	0.19	0.11	0.09	0.38	0.21	0.17	n/a	n/a	n/a
8	(203)	0.65	0.58	0.57	0.70	0.53	0.50	0.56	0.54	0.54	0.23	0.13	0.11	0.46	0.26	0.21	n/a	n/a	n/a
9	(229)	0.67	0.59	0.58	0.75	0.56	0.51	0.57	0.55	0.54	0.27	0.16	0.13	0.55	0.31	0.25	n/a	n/a	n/a
10	(254)	0.68	0.60	0.58	0.80	0.59	0.53	0.58	0.55	0.55	0.32	0.18	0.15	0.64	0.37	0.29	n/a	n/a	n/a
11-9/16	(294)	0.71	0.62	0.60	0.89	0.63	0.57	0.59	0.56	0.55	0.40	0.23	0.18	0.80	0.46	0.37	0.60	n/a	n/a
12	(305)	0.72	0.63	0.60	0.91	0.64	0.58	0.59	0.56	0.56	0.42	0.24	0.19	0.85	0.48	0.39	0.61	n/a	n/a
14	(356)	0.76	0.65	0.62	1.00	0.69	0.62	0.61	0.58	0.56	0.53	0.30	0.24	1.00	0.61	0.49	0.66	n/a	n/a
16	(406)	0.79	0.67	0.63		0.75	0.66	0.63	0.59	0.57	0.65	0.37	0.30		0.74	0.59	0.71	n/a	n/a
18	(457)	0.83	0.69	0.65		0.81	0.71	0.64	0.60	0.58	0.78	0.44	0.35		0.81	0.71	0.75	n/a	n/a
18-7/16	(469)	0.84	0.69	0.66		0.83	0.72	0.64	0.60	0.59	0.81	0.46	0.37		0.83	0.72	0.76	0.63	n/a
20	(508)	0.87	0.71	0.67		0.87	0.75	0.66	0.61	0.59	0.91	0.52	0.42		0.87	0.75	0.79	0.66	n/a
22-3/8	(568)	0.91	0.73	0.69		0.95	0.81	0.68	0.62	0.60	1.00	0.61	0.49		0.95	0.81	0.84	0.69	0.64
24	(610)	0.94	0.75	0.70		1.00	0.85	0.69	0.63	0.61		0.68	0.55		1.00	0.85	0.87	0.72	0.67
26	(660)	0.98	0.77	0.72			0.90	0.70	0.64	0.62		0.77	0.62			0.90	0.90	0.75	0.69
28	(711)	1.00	0.79	0.74			0.95	0.72	0.65	0.63		0.86	0.69			0.95	0.94	0.78	0.72
30	(762)		0.81	0.75			1.00	0.73	0.66	0.64		0.95	0.76			1.00	0.97	0.80	0.75
36	(914)		0.88	0.80				0.78	0.69	0.67		1.00	1.00				1.00	0.88	0.82
> 48	(1219)		1.00	0.90				0.88	0.76	0.72								1.00	0.94

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.

4 Spacing factor reduction in shear applicable when $c < 3{*}h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{HV} = 1.0$.

Table 79 — Load adjustment factors for 30M rebar in uncracked concrete[1,2,3]

30M Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.23	0.13	0.09	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.02	0.01	n/a	n/a	n/a
	5-7/8	(150)	0.60	0.55	0.54	0.33	0.18	0.13	0.54	0.52	0.52	0.12	0.05	0.04	0.23	0.10	0.07	n/a	n/a	n/a
	6	(152)	0.60	0.56	0.54	0.33	0.18	0.13	0.54	0.52	0.52	0.12	0.05	0.04	0.24	0.10	0.07	n/a	n/a	n/a
	7	(178)	0.61	0.57	0.55	0.36	0.19	0.14	0.55	0.53	0.52	0.15	0.06	0.05	0.30	0.13	0.09	n/a	n/a	n/a
	8	(203)	0.63	0.57	0.56	0.38	0.20	0.15	0.55	0.53	0.52	0.18	0.08	0.06	0.36	0.16	0.11	n/a	n/a	n/a
	9	(229)	0.65	0.58	0.56	0.41	0.22	0.16	0.56	0.53	0.53	0.22	0.09	0.07	0.42	0.19	0.13	n/a	n/a	n/a
	10	(254)	0.66	0.59	0.57	0.44	0.23	0.18	0.57	0.54	0.53	0.25	0.11	0.08	0.45	0.22	0.16	n/a	n/a	n/a
	11	(279)	0.68	0.60	0.58	0.46	0.25	0.19	0.57	0.54	0.53	0.29	0.13	0.09	0.47	0.25	0.18	n/a	n/a	n/a
	12	(305)	0.70	0.61	0.58	0.49	0.26	0.20	0.58	0.55	0.54	0.33	0.14	0.10	0.50	0.29	0.21	n/a	n/a	n/a
	13-1/4	(337)	0.72	0.62	0.59	0.53	0.28	0.21	0.59	0.55	0.54	0.39	0.17	0.12	0.54	0.33	0.24	0.60	n/a	n/a
	14	(356)	0.73	0.63	0.60	0.55	0.30	0.22	0.59	0.55	0.54	0.42	0.18	0.13	0.56	0.36	0.26	0.61	n/a	n/a
	16	(406)	0.76	0.65	0.61	0.63	0.34	0.25	0.61	0.56	0.55	0.51	0.22	0.16	0.63	0.40	0.32	0.65	n/a	n/a
	18	(457)	0.79	0.67	0.63	0.71	0.38	0.28	0.62	0.57	0.56	0.61	0.26	0.19	0.71	0.42	0.36	0.69	n/a	n/a
	20	(508)	0.83	0.69	0.64	0.79	0.42	0.32	0.63	0.58	0.56	0.72	0.31	0.22	0.79	0.45	0.38	0.73	n/a	n/a
	20-7/8	(531)	0.84	0.69	0.65	0.82	0.44	0.33	0.64	0.58	0.56	0.77	0.33	0.24	0.82	0.47	0.39	0.75	n/a	n/a
	22	(559)	0.86	0.70	0.66	0.87	0.46	0.35	0.65	0.58	0.57	0.83	0.36	0.26	0.87	0.49	0.40	0.77	0.58	n/a
	24	(610)	0.89	0.72	0.67	0.94	0.50	0.38	0.66	0.59	0.57	0.94	0.41	0.29	0.94	0.52	0.42	0.80	0.61	n/a
	26-9/16	(675)	0.93	0.75	0.69	1.00	0.56	0.42	0.68	0.60	0.58	1.00	0.47	0.34	1.00	0.56	0.45	0.84	0.64	0.57
	28	(711)	0.96	0.76	0.70		0.59	0.44	0.69	0.61	0.59		0.51	0.37		0.59	0.47	0.86	0.65	0.59
	30	(762)	0.99	0.78	0.71		0.63	0.47	0.70	0.61	0.59		0.57	0.41		0.63	0.49	0.89	0.68	0.61
	36	(914)	1.00	0.83	0.75		0.76	0.57	0.74	0.64	0.61		0.75	0.54		0.76	0.57	0.98	0.74	0.66
	> 48	(1219)		0.95	0.84		1.00	0.76	0.82	0.68	0.65		1.00	0.83		1.00	0.76	1.00	0.86	0.77

Table 80 — Load adjustment factors for 30M rebar in cracked concrete[1,2,3]

30M Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.41	0.38	0.38	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.02	0.02	n/a	n/a	n/a
	5-7/8	(150)	0.60	0.55	0.54	0.56	0.47	0.44	0.54	0.53	0.52	0.12	0.06	0.05	0.23	0.12	0.09	n/a	n/a	n/a
	6	(152)	0.60	0.56	0.54	0.57	0.47	0.44	0.54	0.53	0.52	0.12	0.06	0.05	0.24	0.13	0.10	n/a	n/a	n/a
	7	(178)	0.61	0.57	0.55	0.61	0.49	0.46	0.55	0.53	0.53	0.15	0.08	0.06	0.30	0.16	0.12	n/a	n/a	n/a
	8	(203)	0.63	0.57	0.56	0.65	0.51	0.47	0.55	0.54	0.53	0.19	0.10	0.07	0.37	0.19	0.15	n/a	n/a	n/a
	9	(229)	0.65	0.58	0.56	0.69	0.53	0.49	0.56	0.54	0.53	0.22	0.12	0.09	0.44	0.23	0.18	n/a	n/a	n/a
	10	(254)	0.66	0.59	0.57	0.74	0.56	0.50	0.57	0.54	0.54	0.26	0.14	0.10	0.52	0.27	0.21	n/a	n/a	n/a
	11	(279)	0.68	0.60	0.58	0.79	0.58	0.52	0.57	0.55	0.54	0.30	0.16	0.12	0.60	0.31	0.24	n/a	n/a	n/a
	12	(305)	0.70	0.61	0.58	0.83	0.60	0.54	0.58	0.55	0.54	0.34	0.18	0.14	0.68	0.36	0.27	n/a	n/a	n/a
	13-1/4	(337)	0.72	0.62	0.59	0.89	0.63	0.56	0.59	0.56	0.55	0.40	0.21	0.16	0.79	0.41	0.32	0.60	n/a	n/a
	14	(356)	0.73	0.63	0.60	0.93	0.65	0.57	0.59	0.56	0.55	0.43	0.22	0.17	0.86	0.45	0.34	0.62	n/a	n/a
	16	(406)	0.76	0.65	0.61	1.00	0.70	0.61	0.61	0.57	0.56	0.52	0.27	0.21	1.00	0.55	0.42	0.66	n/a	n/a
	18	(457)	0.79	0.67	0.63		0.75	0.64	0.62	0.58	0.57	0.62	0.33	0.25		0.65	0.50	0.70	n/a	n/a
	20	(508)	0.83	0.69	0.64		0.81	0.68	0.64	0.59	0.57	0.73	0.38	0.29		0.77	0.58	0.74	n/a	n/a
	20-7/8	(531)	0.84	0.69	0.65		0.83	0.70	0.64	0.59	0.58	0.78	0.41	0.31		0.82	0.62	0.75	n/a	n/a
	22	(559)	0.86	0.70	0.66		0.86	0.72	0.65	0.60	0.58	0.84	0.44	0.34		0.86	0.67	0.77	0.62	n/a
	24	(610)	0.89	0.72	0.67		0.92	0.76	0.66	0.61	0.59	0.96	0.50	0.38		0.92	0.76	0.81	0.65	n/a
	26-9/16	(675)	0.93	0.75	0.69		0.99	0.81	0.68	0.62	0.60	1.00	0.59	0.45		0.99	0.81	0.85	0.68	0.62
	28	(711)	0.96	0.76	0.70		1.00	0.84	0.69	0.62	0.60		0.63	0.48		1.00	0.84	0.87	0.70	0.64
	30	(762)	0.99	0.78	0.71			0.88	0.70	0.63	0.61		0.70	0.54			0.88	0.90	0.73	0.66
	36	(914)	1.00	0.83	0.75			1.00	0.74	0.66	0.63		0.93	0.70			1.00	0.99	0.80	0.73
	> 48	(1219)		0.95	0.84				0.82	0.71	0.68		1.00	1.00				1.00	0.92	0.84

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.

4 Spacing factor reduction in shear applicable when c < 3*h_{ef}. f_{AV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{AV} = f_{AN}.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{HV} = 1.0.

HIT-HY 200 A/R V3 Adhesive with Hilti HAS Threaded Rod

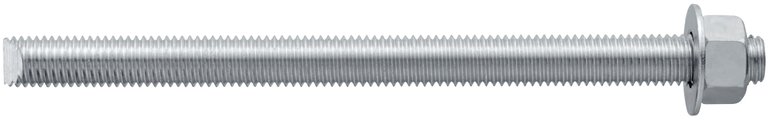


Table 81 — Steel factored resistance for Hilti HAS threaded rods for use with CSA A23.3 Annex D

Nominal anchor diameter in.	HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr.36[4,6]			HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6]			HAS-B-105 / HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6]			HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4]		
	Tensile[1] ϕN_{sar} lb (kN)	Shear[2] ϕV_{sar} lb (kN)	Seismic Shear[3] $\phi V_{sar,eq}$ lb (kN)	Tensile[1] ϕN_{sar} lb (kN)	Shear[2] ϕV_{sar} lb (kN)	Seismic Shear[3] $\phi V_{sar,eq}$ lb (kN)	Tensile[1] ϕN_{sar} lb (kN)	Shear[2] ϕV_{sar} lb (kN)	Seismic Shear[3] $\phi V_{sar,eq}$ lb (kN)	Tensile[1] ϕN_{sar} lb (kN)	Shear[2] ϕV_{sar} lb (kN)	Seismic Shear[3] $\phi V_{sar,eq}$ lb (kN)
3/8	3,055 (13.6)	1,720 (7.7)	1,030 (4.6)	3,955 (17.6)	2,225 (9.9)	1,560 (6.9)	6,570 (29.2)	3,695 (16.4)	2,585 (11.5)	4,610 (20.5)	2,570 (11.4)	1,800 (8.0)
1/2	5,595 (24.9)	3,150 (14.0)	1,890 (8.4)	7,240 (32.2)	4,070 (18.1)	2,850 (12.7)	12,035 (53.5)	6,765 (30.1)	4,735 (21.1)	8,445 (37.6)	4,705 (20.9)	3,295 (14.7)
5/8	8,915 (39.7)	5,015 (22.3)	3,010 (13.4)	11,525 (51.3)	6,485 (28.8)	4,540 (20.2)	19,160 (85.2)	10,780 (48.0)	7,545 (33.6)	13,445 (59.8)	7,490 (33.3)	5,245 (23.3)
3/4	13,190 (58.7)	7,420 (33.0)	4,450 (19.8)	17,060 (75.9)	9,600 (42.7)	6,720 (29.9)	28,365 (126.2)	15,955 (71.0)	11,170 (49.7)	16,920 (75.3)	9,425 (41.9)	6,600 (29.4)
7/8	18,210 (81.0)	10,245 (45.6)	6,145 (27.3)	23,550 (104.8)	13,245 (58.9)	9,270 (41.2)	39,150 (174.1)	22,020 (97.9)	15,415 (68.6)	23,350 (103.9)	13,010 (57.9)	9,105 (40.5)
1	23,890 (106.3)	13,440 (59.8)	8,065 (35.9)	30,890 (137.4)	17,380 (77.3)	12,165 (54.1)	51,360 (228.5)	28,890 (128.5)	20,225 (90.0)	30,635 (136.3)	17,065 (75.9)	11,945 (53.1)
1-1/4	38,225 (170.0)	21,500 (95.6)	12,900 (57.4)	49,425 (219.9)	27,800 (123.7)	19,460 (86.6)	82,175 (365.5)	46,220 (205.6)	32,355 (143.9)	37,565 (167.1)	21,130 (94.0)	12,680 (56.4)

[1] Tensile = $A_{se,N} \phi f_{uta} R$ as noted in CSA A23.3 Eq. D.2.
[2] Shear = $A_{se,V} \phi 0.60 f_{uta} R$ as noted in CSA A23.3 Eq. D.31.
[3] Seismic Shear = $\alpha_{V,seis} V_{sar}$: Reduction factor for seismic shear only. See CSA A23.3 Annex D for additional information on seismic applications.
[4] HAS-V, HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).
[5] HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.
[6] 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

Table 82 — Hilti HIT-HY 200 V3 design information with Hilti HAS threaded rods in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

Design parameter		Symbol	Units	Nominal rod diameter (in.)							Ref
				3/8	1/2	5/8	3/4	7/8	1	1-1/4	A23.3-14
Nominal anchor Diameter		d_a	mm	9.5	12.7	15.9	19.1	22.2	25.4	31.8	
Effective minimum embedment[2]		$h_{ef,min}$	mm	60	70	79	89	89	102	127	
Effective maximum embedment[2]		$h_{ef,max}$	mm	191	254	318	381	445	508	635	
Minimum concrete thickness[2]		h_{min}	mm	h_{ef} + 30		h_{ef} + $2d_0$					
Critical edge distance		c_{ac}		$2h_{ef}$							
Minimum edge distance		c_{min}	mm	45	45	50[3]	55[3]	60[3]	70[3]	80[3]	
Minimum anchor spacing		s_{min}	mm	48	64	79	95	111	127	159	
Coeff. for factored conc. breakout resistance, uncracked concrete[4]		$k_{c,uncr}$	–	10							D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete[4]		$k_{c,cr}$	–	7							D.6.2.2
Concrete material resistance factor		ϕ_c	–	0.65							8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]		R_{conc}	–	1.00							
Temp. range A[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	1,045 (7.2)	1,135 (7.7)	1,170 (8.2)	1,260 (8.4)	1,290 (8.6)	1,325 (8.7)	1,380 (9.1)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	2,220 (15.3)	2,220 (15.3)	2,220 (15.3)	2,220 (15.3)	2,220 (15.3)	2,220 (15.3)	2,220 (15.3)	D.6.5.2
Temp. range B[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	1,045 (7.2)	1,135 (7.7)	1,170 (8.2)	1,260 (8.4)	1,290 (8.6)	1,325 (8.7)	1,380 (9.1)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	2,220 (15.3)	2,220 (15.3)	2,220 (15.3)	2,220 (15.3)	2,220 (15.3)	2,220 (15.3)	2,220 (15.3)	D.6.5.2
Temp. range C[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	885 (6.1)	930 (6.3)	960 (6.7)	1,035 (6.9)	1,055 (7.3)	1,085 (7.1)	1,130 (7.4)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	1,820 (12.6)	1,820 (12.6)	1,820 (12.6)	1,820 (12.6)	1,820 (12.6)	1,820 (12.6)	1,820 (12.6)	D.6.5.2
Reduction for seismic tension		$\alpha_{N,seis}$	–	0.88	0.99		1.0		0.95	0.99	
Permissible installation conditions	Resistance modification factor tension & shear, bond failure dry and water saturated concrete	Anchor category	–	1							D.5.3 (c)
		R_{dry} ,R_{ws}	–	1.00							
	Resistance modification factor tension & shear, bond failure water-filled concrete	Anchor category	–	3							D.5.3 (c)
		R_{wf}	–	0.75							

1 Design information in this table is taken from ELC-4868, tables 8 and 10 for use with CSA A23.3 Annex D.

2 See figure 10 of this section.

3 Minimum edge distance may be reduced to 45mm ≤ c_{ai} < 5d provided T_{inst} is reduced. See ELC-4868 Installation Torque Subject to Edge Distance section.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2,500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

8 For water-filled holes, multiply characteristic bond stress by 0.61.

Table 83 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8,9]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	2-3/8 (60)	3,060 (13.6)	3,425 (15.2)	3,750 (16.7)	4,330 (19.3)	3,060 (13.6)	3,425 (15.2)	3,750 (16.7)	4,330 (19.3)
	3-3/8 (86)	5,185 (23.1)	5,800 (25.8)	6,065 (27.0)	6,245 (27.8)	10,375 (46.1)	11,600 (51.6)	12,135 (54.0)	12,490 (55.6)
	4-1/2 (114)	7,770 (34.6)	7,945 (35.3)	8,090 (36.0)	8,325 (37.0)	15,535 (69.1)	15,885 (70.7)	16,180 (72.0)	16,650 (74.1)
	7-1/2 (191)	12,945 (57.6)	13,240 (58.9)	13,485 (60.0)	13,875 (61.7)	25,895 (115.2)	26,480 (117.8)	26,965 (119.9)	27,755 (123.5)
1/2	2-3/4 (70)	3,815 (17.0)	4,265 (19.0)	4,670 (20.8)	5,395 (24.0)	7,630 (33.9)	8,530 (37.9)	9,345 (41.6)	10,790 (48.0)
	4-1/2 (114)	7,985 (35.5)	8,930 (39.7)	9,780 (43.5)	11,100 (49.4)	15,970 (71.0)	17,855 (79.4)	19,560 (87.0)	22,200 (98.8)
	6 (152)	12,295 (54.7)	13,745 (61.1)	14,380 (64.0)	14,800 (65.8)	24,590 (109.4)	27,490 (122.3)	28,765 (127.9)	29,605 (131.7)
	10 (254)	23,015 (102.4)	23,535 (104.7)	23,970 (106.6)	24,670 (109.7)	46,035 (204.8)	47,075 (209.4)	47,940 (213.2)	49,340 (219.5)
5/8	3-1/8 (79)	4,620 (20.6)	5,165 (23.0)	5,660 (25.2)	6,535 (29.1)	9,245 (41.1)	10,335 (46.0)	11,320 (50.4)	13,070 (58.1)
	5-5/8 (143)	11,160 (49.6)	12,480 (55.5)	13,670 (60.8)	15,785 (70.2)	22,320 (99.3)	24,955 (111.0)	27,335 (121.6)	31,565 (140.4)
	7-1/2 (191)	17,185 (76.4)	19,210 (85.5)	21,045 (93.6)	23,125 (102.9)	34,365 (152.9)	38,420 (170.9)	42,090 (187.2)	46,255 (205.8)
	12-1/2 (318)	35,965 (160.0)	36,775 (163.6)	37,450 (166.6)	38,545 (171.5)	71,930 (320.0)	73,550 (327.2)	74,905 (333.2)	77,090 (342.9)
3/4	3-1/2 (89)	5,480 (24.4)	6,125 (27.2)	6,710 (29.8)	7,745 (34.5)	10,955 (48.7)	12,250 (54.5)	13,420 (59.7)	15,495 (68.9)
	6-3/4 (171)	14,670 (65.3)	16,400 (73.0)	17,970 (79.9)	20,745 (92.3)	29,340 (130.5)	32,805 (145.9)	35,935 (159.8)	41,495 (184.6)
	9 (229)	22,585 (100.5)	25,255 (112.3)	27,665 (123.1)	31,945 (142.1)	45,175 (200.9)	50,505 (224.7)	55,325 (246.1)	63,885 (284.2)
	15 (381)	48,600 (216.2)	52,955 (235.6)	53,930 (239.9)	55,505 (246.9)	97,200 (432.4)	105,915 (471.1)	107,865 (479.8)	111,010 (493.8)
7/8	3-1/2 (89)	5,480 (24.4)	6,125 (27.2)	6,710 (29.8)	7,745 (34.5)	10,955 (48.7)	12,250 (54.5)	13,420 (59.7)	15,495 (68.9)
	7-7/8 (200)	18,485 (82.2)	20,670 (91.9)	22,640 (100.7)	26,145 (116.3)	36,975 (164.5)	41,340 (183.9)	45,285 (201.4)	52,290 (232.6)
	10-1/2 (267)	28,465 (126.6)	31,820 (141.6)	34,860 (155.1)	40,255 (179.1)	56,925 (253.2)	63,645 (283.1)	69,720 (310.1)	80,505 (358.1)
	17-1/2 (445)	61,240 (272.4)	68,470 (304.6)	73,405 (326.5)	75,550 (336.1)	122,485 (544.8)	136,940 (609.1)	146,815 (653.1)	151,100 (672.1)
1	4 (102)	6,690 (29.8)	7,480 (33.3)	8,195 (36.5)	9,465 (42.1)	13,385 (59.5)	14,965 (66.6)	16,395 (72.9)	18,930 (84.2)
	9 (229)	22,585 (100.5)	25,255 (112.3)	27,665 (123.1)	31,945 (142.1)	45,175 (200.9)	50,505 (224.7)	55,325 (246.1)	63,885 (284.2)
	12 (305)	34,775 (154.7)	38,880 (172.9)	42,590 (189.5)	49,180 (218.8)	69,550 (309.4)	77,760 (345.9)	85,180 (378.9)	98,360 (437.5)
	20 (508)	74,825 (332.8)	83,655 (372.1)	91,640 (407.6)	98,675 (438.9)	149,650 (665.7)	167,310 (744.2)	183,280 (815.3)	197,355 (877.9)
1-1/4	5 (127)	9,355 (41.6)	10,455 (46.5)	11,455 (51.0)	13,225 (58.8)	18,705 (83.2)	20,915 (93.0)	22,910 (101.9)	26,455 (117.7)
	11-1/4 (286)	31,565 (140.4)	35,290 (157.0)	38,660 (172.0)	44,640 (198.6)	63,135 (280.8)	70,585 (314.0)	77,320 (343.9)	89,285 (397.1)
	15 (381)	48,600 (216.2)	54,335 (241.7)	59,520 (264.8)	68,730 (305.7)	97,200 (432.4)	108,670 (483.4)	119,045 (529.5)	137,460 (611.4)
	25 (635)	104,570 (465.1)	116,910 (520.0)	128,070 (569.7)	147,885 (657.8)	209,140 (930.3)	233,825 (1040.1)	256,140 (1139.4)	295,765 (1315.6)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 42 - 55 as necessary to the above values. Compare to the steel values in table 81. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength (factored resistance) by 0.46.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51.
For all-lightweight, λ_a = 0.45
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 84 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete / bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8,9]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (5,800 psi) lb (kN)
3/8	2-3/8 (60)	1,930 (8.6)	1,975 (8.8)	2,010 (8.9)	2,070 (9.2)	1,930 (8.6)	1,975 (8.8)	2,010 (8.9)	2,070 (9.2)
	3-3/8 (86)	2,745 (12.2)	2,805 (12.5)	2,855 (12.7)	2,940 (13.1)	5,485 (24.4)	5,610 (24.9)	5,710 (25.4)	5,880 (26.1)
	4-1/2 (114)	3,655 (16.3)	3,740 (16.6)	3,810 (16.9)	3,920 (17.4)	7,315 (32.5)	7,480 (33.3)	7,615 (33.9)	7,840 (34.9)
	7-1/2 (191)	6,095 (27.1)	6,230 (27.7)	6,345 (28.2)	6,530 (29.1)	12,190 (54.2)	12,465 (55.4)	12,695 (56.5)	13,065 (58.1)
1/2	2-3/4 (70)	2,670 (11.9)	2,985 (13.3)	3,270 (14.5)	3,470 (15.4)	5,340 (23.8)	5,970 (26.6)	6,540 (29.1)	6,935 (30.9)
	4-1/2 (114)	5,295 (23.6)	5,415 (24.1)	5,515 (24.5)	5,675 (25.2)	10,590 (47.1)	10,830 (48.2)	11,030 (49.1)	11,350 (50.5)
	6 (152)	7,060 (31.4)	7,220 (32.1)	7,355 (32.7)	7,565 (33.7)	14,120 (62.8)	14,440 (64.2)	14,705 (65.4)	15,135 (67.3)
	10 (254)	11,770 (52.3)	12,035 (53.5)	12,255 (54.5)	12,610 (56.1)	23,535 (104.7)	24,065 (107.1)	24,510 (109.0)	25,225 (112.2)
5/8	3-1/8 (79)	3,235 (14.4)	3,615 (16.1)	3,960 (17.6)	4,575 (20.4)	6,470 (28.8)	7,235 (32.2)	7,925 (35.2)	9,150 (40.7)
	5-5/8 (143)	7,810 (34.8)	8,720 (38.8)	8,880 (39.5)	9,140 (40.7)	15,625 (69.5)	17,445 (77.6)	17,765 (79.0)	18,285 (81.3)
	7-1/2 (191)	11,370 (50.6)	11,630 (51.7)	11,845 (52.7)	12,190 (54.2)	22,745 (101.2)	23,260 (103.5)	23,685 (105.4)	24,375 (108.4)
	12-1/2 (318)	18,955 (84.3)	19,380 (86.2)	19,740 (87.8)	20,315 (90.4)	37,910 (168.6)	38,765 (172.4)	39,475 (175.6)	40,630 (180.7)
3/4	3-1/2 (89)	3,835 (17.1)	4,285 (19.1)	4,695 (20.9)	5,425 (24.1)	7,670 (34.1)	8,575 (38.1)	9,390 (41.8)	10,845 (48.2)
	6-3/4 (171)	10,270 (45.7)	11,480 (51.1)	12,575 (55.9)	14,175 (63.1)	20,540 (91.4)	22,965 (102.1)	25,155 (111.9)	28,355 (126.1)
	9 (229)	15,810 (70.3)	17,675 (78.6)	18,365 (81.7)	18,900 (84.1)	31,620 (140.7)	35,355 (157.3)	36,730 (163.4)	37,805 (168.2)
	15 (381)	29,395 (130.7)	30,055 (133.7)	30,610 (136.2)	31,505 (140.1)	58,785 (261.5)	60,115 (267.4)	61,220 (272.3)	63,005 (280.3)
7/8	3-1/2 (89)	3,835 (17.1)	4,285 (19.1)	4,695 (20.9)	5,425 (24.1)	7,670 (34.1)	8,575 (38.1)	9,390 (41.8)	10,845 (48.2)
	7-7/8 (200)	12,940 (57.6)	14,470 (64.4)	15,850 (70.5)	18,300 (81.4)	25,880 (115.1)	28,935 (128.7)	31,700 (141.0)	36,605 (162.8)
	10-1/2 (267)	19,925 (88.6)	22,275 (99.1)	24,400 (108.5)	26,340 (117.2)	39,850 (177.3)	44,550 (198.2)	48,805 (217.1)	52,680 (234.3)
	17-1/2 (445)	40,960 (182.2)	41,885 (186.3)	42,655 (189.7)	43,900 (195.3)	81,920 (364.4)	83,770 (372.6)	85,310 (379.5)	87,800 (390.6)
1	4 (102)	4,685 (20.8)	5,240 (23.3)	5,740 (25.5)	6,625 (29.5)	9,370 (41.7)	10,475 (46.6)	11,475 (51.0)	13,250 (58.9)
	9 (229)	15,810 (70.3)	17,675 (78.6)	19,365 (86.1)	22,360 (99.5)	31,620 (140.7)	35,355 (157.3)	38,730 (172.3)	44,720 (198.9)
	12 (305)	24,340 (108.3)	27,215 (121.1)	29,815 (132.6)	34,425 (153.1)	48,685 (216.6)	54,430 (242.1)	59,625 (265.2)	68,850 (306.3)
	20 (508)	52,375 (233.0)	56,190 (249.9)	57,225 (254.5)	58,895 (262.0)	104,755 (466.0)	112,380 (499.9)	114,450 (509.1)	117,790 (524.0)
1-1/4	5 (127)	6,545 (29.1)	7,320 (32.6)	8,020 (35.7)	9,260 (41.2)	13,095 (58.2)	14,640 (65.1)	16,035 (71.3)	18,520 (82.4)
	11-1/4 (286)	22,095 (98.3)	24,705 (109.9)	27,060 (120.4)	31,250 (139.0)	44,195 (196.6)	49,410 (219.8)	54,125 (240.8)	62,500 (278.0)
	15 (381)	34,020 (151.3)	38,035 (169.2)	41,665 (185.3)	48,110 (214.0)	68,040 (302.7)	76,070 (338.4)	83,330 (370.7)	96,220 (428.0)
	25 (635)	73,200 (325.6)	81,840 (364.0)	89,650 (398.8)	95,845 (426.3)	146,395 (651.2)	163,675 (728.1)	179,300 (797.6)	191,685 (852.7)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 42 - 55 as necessary to the above values. Compare to the steel values in table 81. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength (factored resistance) by 0.46.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by la as follows: For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors:
3/8-in diameter - α_{seis} = 0.66, 1/2-in, 5/8-in, and 1-1/4-in diameter - α_{seis} = 0.74, 3/4-in and 7/8-in diameter - α_{seis} = 0.75
See section 3.1.8 for additional information on seismic applications.

HIT-HY 200 A/R V3 Adhesive with Hilti HIS-N and HIS-RN internally threaded inserts

Table 85 — Steel factored resistance for steel bolt/cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

Thread size	ASTM A193 B7			ASTM A193 Grade B8M Stainless Steel		
	Tensile[4] N_{sar} lb (kN)	Shear[5] V_{sar} lb (kN)	Seismic Shear[6] $V_{sar,eq}$ lb (kN)	Tensile[4] N_{sar} lb (kN)	Shear[5] V_{sar} lb (kN)	Seismic Shear[6] $V_{sar,eq}$ lb (kN)
3/8-16 UNC	5,765 (25.6)	3,215 (14.3)	2,250 (10.0)	5,070 (22.6)	2,825 (12.6)	1,975 (8.8)
1/2-13 UNC	9,635 (42.9)	5,880 (26.2)	4,115 (18.3)	9,290 (41.3)	5,175 (23.0)	3,620 (16.1)
5/8-11 UNC	16,020 (71.3)	9,365 (41.7)	6,555 (29.2)	14,790 (65.8)	8,240 (36.7)	5,770 (25.7)
3/4-10 UNC	16,280 (72.4)	13,860 (61.7)	9,700 (43.1)	21,895 (97.4)	12,195 (54.2)	8,535 (38.0)

1 See Section 3.1.8 to convert design strength value to ASD value.

2 Hilti HIS-N and HIS-RN inserts with steel bolts are considered brittle steel elements.

3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.

4 Tensile = $A_{se,N}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.

5 Shear = $A_{se,V}\ \phi_s\ 0.60\ f_{uta}$ R as noted in CSA A23.3 Annex D. For 3/8-in diameter insert, shear = $A_{se,V}\ \phi_s\ 0.50\ f_{uta}$ R.

6 Seismic Shear = $\alpha_{V,seis}\ V_{sar}$: Reduction factor for seismic shear only. See section 3.1.8 for additional information on seismic applications.

Table 86 — Hilti HIT-HY 200 A/R V3 design information with Hilti HIS-N and HIS-RN internally threaded inserts in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

	Design parameter	Symbol	Units	Nominal bolt/cap screw diameter (in.)				Ref
				3/8	1/2	5/8	3/4	A23.3-14
	HIS insert outside diameter	D	mm	16.5	20.5	25.4	27.6	
	Effective embedment[2]	h_{ef}	mm	110	125	170	205	
	Minimum concrete thickness[2]	h_{min}	mm	150	170	230	270	
	Critical edge distance	c_{ac}	–	$2h_{ef}$				
	Minimum edge distance	c_{min}	mm	83	102	127	140	
	Minimum anchor spacing	S_{min}	mm	83	102	127	140	
	Coeff. for factored concrete breakout resistance, uncracked concrete[3]	$k_{c,uncr}$	–	10				D.6.2.2
	Coeff. for factored concrete breakout resistance, cracked concrete[3]	$k_{c,cr}$	–	7				D.6.2.2
	Concrete material resistance factor	ϕ_c	–	0.65				8.4.2
	Resistance modification factor for tension and shear, concrete failure modes, Condition B[4]	R_{conc}	–	1.00				D.5.3 (c)
Temp range A[5]	Characteristic pullout resistance in cracked concrete[6]	τ_{cr}	psi (MPa)	870 (6.0)	890 (6.1)	910 (6.3)	920 (6.3)	D.6.5.2
	Characteristic pullout resistance in uncracked concrete[6]	τ_{uncr}	psi (MPa)	1,950 (13.4)	1,950 (13.4)	1,950 (13.4)	1,950 (13.4)	D.6.5.2
Temp range B[5]	Characteristic pullout resistance in cracked concrete[6]	τ_{cr}	psi (MPa)	870 (6.0)	890 (6.1)	910 (6.3)	92 (0.6)	D.6.5.2
	Characteristic pullout resistance in uncracked concrete[6]	τ_{uncr}	psi (MPa)	1,950 (13.4)	1,950 (13.4)	1,950 (13.4)	1,950 (13.4)	D.6.5.2
Temp range C[5]	Characteristic pullout resistance in cracked concrete[6]	τ_{cr}	psi (MPa)	715 (4.9)	730 (5.0)	750 (5.2)	755 (5.2)	D.6.5.2
	Characteristic pullout resistance in uncracked concrete[6]	τ_{uncr}	psi (MPa)	1,600 (11.0)	1,600 (11.0)	1,600 (11.0)	1,600 (11.0)	D.6.5.2
	Reduction for seismic tension	$\alpha_{N,seis}$	–	0.92				
Permissible installation conditions	Resistance modification factor tension and shear, pullout failure dry concrete	Anch cat	–	1				D.5.3 (c)
		R_{dry}	–	1.00				
	Resistance modification factor tension and shear, pullout failure water-saturated concrete	Anch cat	–	1				D.5.3 (c)
		R_{ws}	–	1.0				

1 Design information in this table is taken from ELC-4868, tables 19 and 20, for use with CSA A23.3 Annex D.

2 See figure 13 of this section.

3 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Bond strength values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

Table 87 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8,9]

Thread size	Effective embedment in. (mm)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8-16 UNC	4-3/8	7,540	8,430	9,235	10,660	15,080	16,860	18,470	21,325
	(110)	(33.5)	(37.5)	(41.1)	(47.4)	(67.1)	(75.0)	(82.1)	(94.9)
1/2-13 UNC	5	9,135	10,210	11,185	12,915	18,265	20,420	22,370	25,830
	(125)	(40.6)	(45.4)	(49.8)	(57.5)	(81.3)	(90.8)	(99.5)	(114.9)
5/8-11 UNC	6-3/4	14,485	16,195	17,740	20,485	28,970	32,390	35,480	40,970
	(170)	(64.4)	(72.0)	(78.9)	(91.1)	(128.9)	(144.1)	(157.8)	(182.2)
3/4-10 UNC	8-1/8	19,180	21,445	23,490	27,125	38,360	42,890	46,985	54,255
	(205)	(85.3)	(95.4)	(104.5)	(120.7)	(170.6)	(190.8)	(209.0)	(241.3)

Table 88 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9]

Thread size	Effective embedment in. (mm)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8-16 UNC	4-3/8	5,235	5,595	5,910	6,445	10,470	11,190	11,820	12,885
	(110)	(23.3)	(24.9)	(26.3)	(28.7)	(46.6)	(49.8)	(52.6)	(57.3)
1/2-13 UNC	5	6,395	7,150	7,830	9,040	12,785	14,295	15,660	18,080
	(125)	(28.4)	(31.8)	(34.8)	(40.2)	(56.9)	(63.6)	(69.7)	(80.4)
5/8-11 UNC	6-3/4	10,140	11,335	12,420	14,340	20,280	22,675	24,835	28,680
	(170)	(45.1)	(50.4)	(55.2)	(63.8)	(90.2)	(100.9)	(110.5)	(127.6)
3/4-10 UNC	8-1/8	13,425	15,010	16,445	18,990	26,855	30,025	32,890	37,975
	(205)	(59.7)	(66.8)	(73.1)	(84.5)	(119.5)	(133.5)	(146.3)	(168.9)

[1] See Section 3.1.8 for explanation on development of load values.

[2] See Section 3.1.8 to convert design strength value to ASD value.

[3] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[4] Apply spacing, edge distance, and concrete thickness factors in tables 60 - 61 as necessary to the above values. Compare to the steel values in table 85. The lesser of the values is to be used for the design.

[5] Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.92.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.78.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

[6] Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength value by 0.85.

[7] Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

[8] Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

[9] Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors:
For all insert diameters - α_{seis} = 0.69
See section 3.1.8 for additional information on seismic applications.

POST-INSTALLED REBAR DESIGN IN CONCRETE PER ACI 318

Development and splicing of post-installed reinforcement

Calculations for post-installed rebar for typical development lengths may be done according to ACI 318 Chapter 25 (formerly ACI 318-11 Chapter 12) and CSA A23.3 Chapter 12 for adhesive anchors tested and approved in accordance with AC 308. This section contains tables for the data provided in ICC Evaluation Services ESR-4868. Refer to section 3.1.14 and the Hilti North America Post-Installed Reinforcing Bar Guide for the design method.

Table 89 — Calculated tension development and Class B splice lengths for Grade 60 bars in walls, slabs, columns, and footings per ACI 318 Chapter 25 for Hilti HIT-HY 200 A/R V3 — SDC A and B only[3,4,5,6,7,8]

	System					f'_c = 2,500 psi		f'_c = 3,000 psi		f'_c = 4,000 psi		f'_c = 6,000 psi	
Rebar size	HIT-HY 200-A V3	HIT-HY 200-R V3	$\frac{c_b + K_{tr}}{d_b}$	Minimum edge dist. in.[1]	Minimum spacing in.[2]	ℓ_d in.	Class B splice in.	ℓ_d in.	Class B splice in.	ℓ_d in.	Class B splice in.	ℓ_d in.	Class B splice in.
#3	◐	◐	2.5	2-1/4	2	12	14	12	13	12	12	12	12
#4	◐	◐		2-3/4	2-1/2	14	19	13	17	12	15	12	12
#5	◐	◐		3	3-1/4	18	23	16	21	14	18	12	15
#6	■	◐		3-3/4	3-3/4	22	28	20	26	17	22	14	18
#7	■	◐		4-1/2	4-1/2	32	41	29	37	25	32	20	26
#8	■	◐		5	5	36	47	33	43	28	37	23	30
#9	■	◐		5-1/4	5-3/4	41	53	37	48	32	42	26	34
#10	■	◐		5-3/4	6-1/2	46	59	42	54	36	47	30	38

◐ Applicable for use with special installation provisions and installation temperature restrictions to account for short gel time with deep embedment depth. See the Instruction For Use (IFU), packaged with the product for special installation parameters.

■ Not recommended due to limited gel time of adhesive.

1 Edge distances are determined using the minimum cover specified by ESR-4868 with an additional 6% of the development length per suggestions for drilling without an aid per Hilti Post-Installed Reinforcing Bar Guide Section 3.3. Smaller edge distances may be possible, for which development and splice lengths may need to be recalculated. For further information on required cover see ACI 318, Sec. 20.6.1.3; see Sec. 2.2 for determination of c_b.

2 Spacing values represent those producing c_b =5 d_b rounded up to the nearest 1/4 in. Smaller spacing values may be possible, for which development and splice lengths may need to be recalculated. For further information on required spacing see ACI 318 Sec. 25.2; see Sec. 2.2 for determination of c_b.

3 ψ_t = 1.0 See ACI 318, Sec. 25.4.2.4.

4 ψ_e = 1.0 for non-epoxy coated bars. See ACI 318, Sec. 25.4.2.4.

5 ψ_s = 0.8 for #6 bars and smaller bars, 1.0 for #7 and larger bars. See ACI 318, Sec. 25.4.2.4.

6 Values are for normal weight concrete. For sand-lightweight concrete, multiply development and splice lengths by 1.18, for all-lightweight concrete multiply development and splice lengths by 1.33. See ACI 318 Sec. 19.2.4.

7 Development and splice length values are for static design. Seismic design development and splice lengths can be found in ACI 318 18.8.5 for special moment frames and ACI 318 18.10.2.3 for special structural walls. For further information about reinforcement in seismic design, see ACI 318 Ch. 18.

8 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples.

Table 90 — Suggested embedment, edge distance, and spacing (see figure below) to develop 125% of f_y in Grade 60 bars based on ACI 318 Chapter 17 - SDC A and B only[1,2,3,4,5,6,7]

	f'_c = 2,500 psi				f'_c = 3,000 psi				f'_c = 4,000 psi				f'_c = 6,000 psi			
	Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} in.	Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} in.	Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} in.	Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} in.
Rebar size		Cond. I	Cond. II			Cond. I	Cond. II			Cond. I	Cond. II			Cond. I	Cond. II	
#3	7	18	8	15	7	18	7	14	7	18	7	13	7	17	6	11
#4	10	25	11	22	10	25	11	21	9	24	10	19	9	24	9	17
#5	12	31	15	29	12	31	14	28	12	30	13	25	11	29	11	22
#6	14	37	19	37	14	36	18	35	14	36	16	32	13	35	14	28
#7	17	43	23	45	16	42	22	43	16	41	20	39	15	40	17	34
#8	19	49	27	54	19	49	26	51	18	48	23	47	18	47	21	41
#9	21	55	32	63	21	54	30	60	20	54	27	54	20	52	24	48
#10	25	65	37	74	24	62	35	70	23	60	32	64	22	59	28	56

1 For additional information see May-June 2013 issue of the ACI Structural Journal, "Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures" by Charney, Pal and Silva.

2 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Additional reductions per ACI 318, 17.3.1.2 for sustained loading conditions are not included and as such these suggested embedments are not intended for sustained tension load applications. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the unbolded and bolded tabulated hef values by 0.80 and 0.86, respectively. Reduction factors for non-sustained loading and no bar overstrength may be combined.

3 c_a and s are the minimum edge distance and bar spacing (from bar centerline) associated with the tabulated embedments. Refer to sec. 3.1.14 for applicability of edge distance "Condition I" and "Condition II."

4 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

5 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868 Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

6 Values are for normal weight concrete. For lightweight concrete contact Hilti.

7 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

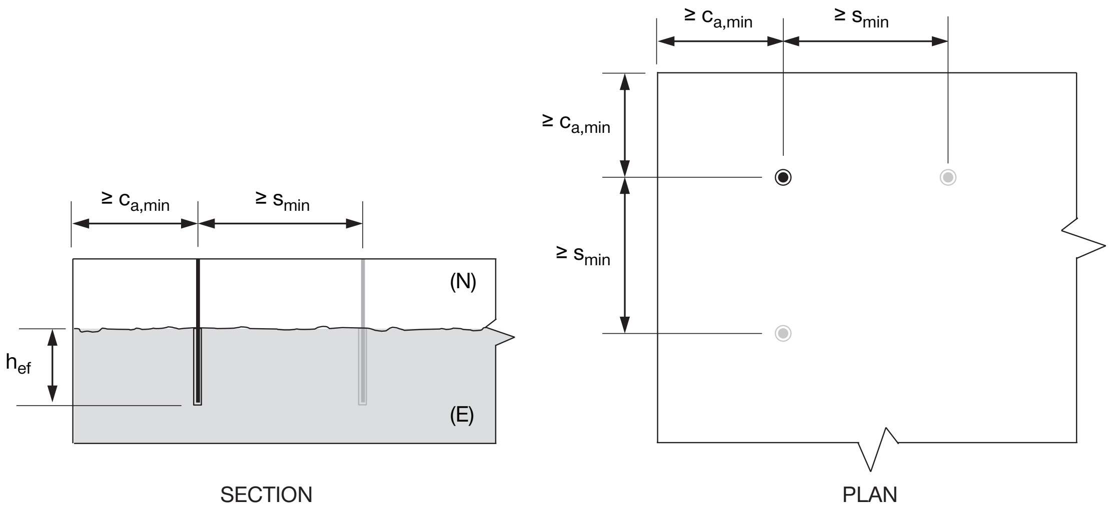


Illustration of Table 90 dimensions

Table 91 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of f_y in Grade 60 wall/column starter bars in a linear array with bar spacing = 24 inches - SDC A and B only[1,2,3,4,5,6]

Rebar size	Linear spacing s in.	f'_c = 2,500 psi			f'_c = 3,000 psi			f'_c = 4,000 psi			f'_c = 6,000 psi		
		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.	
			Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II
#3	24	7	18	8	7	18	7	7	18	7	7	17	6
#4		10	25	12	10	25	11	9	24	10	9	24	9
#5		13	33	19	12	31	17	12	30	15	11	29	12
#6		21	55	32	19	49	28	15	40	23	13	35	18
#7		32	83	47	28	75	42	23	62	35	18	48	26

1 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated h_{ef} values by 0.86.

2 c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 24 in. Refer to sec. 3.1.14 for applicability of edge distance “Condition I” and “Condition II.”

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-] Tables 12 and 13 assuming dry concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for detailed explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

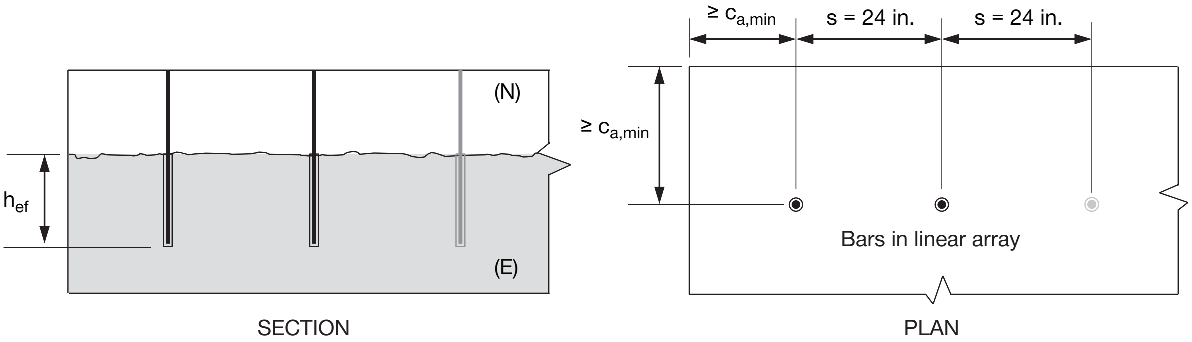


Illustration of Table 91 dimensions

Table 92 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of f_y in Grade 60 wall/column starter bars in a linear array with bar spacing = 18 inches - SDC A and B only[1,2,3,4,5,6]

Rebar size	Linear spacing s in.	f'_c = 2,500 psi			f'_c = 3,000 psi			f'_c = 4,000 psi			f'_c = 6,000 psi		
		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.	
			Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II
#3	18	7	18	8	7	18	7	7	18	7	7	17	6
#4		10	25	14	10	25	13	9	24	12	9	24	10
#5		18	47	27	16	41	24	13	34	19	11	29	15

1 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated h_{ef} values by 0.86.

2 c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 18 in. Refer to sec. 3.1.14 for applicability of edge distance “Condition I” and “Condition II.”

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for detailed explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

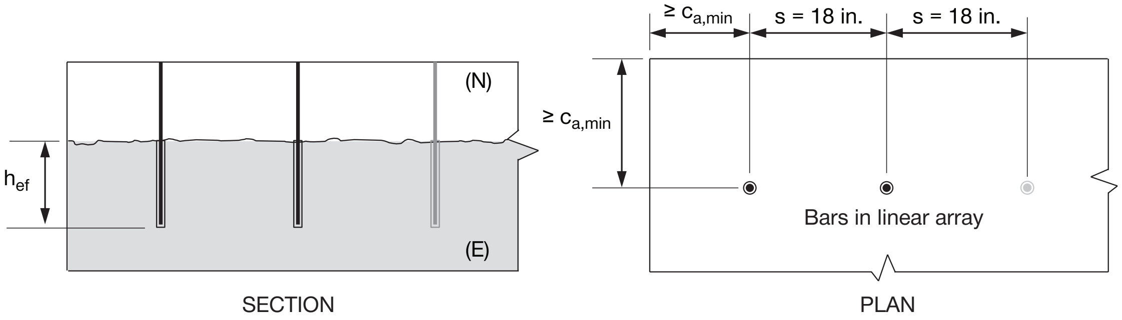


Illustration of Table 92 dimensions

Table 93 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of f_y in Grade 60 wall/column starter bars in a linear array with bar spacing = 12 inches - SDC A and B only[1,2,3,4,5,6]

Rebar size	Linear spacing s in.	f'_c = 2,500 psi			f'_c = 3,000 psi			f'_c = 4,000 psi			f'_c = 6,000 psi		
		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.	
			Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II
#3	12	7	18	10	7	18	9	7	18	8	7	17	7
#4		–	–	–	13	35	20	11	29	16	9	24	13

[1] h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated h_{ef} values by 0.86.

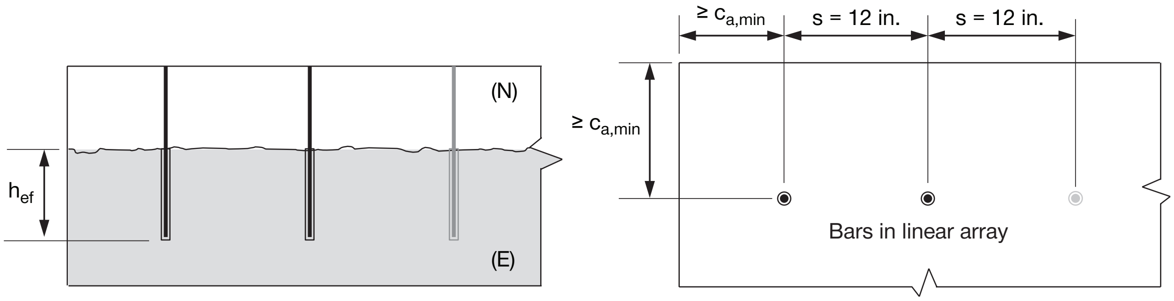
[2] c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 12 in. Refer to sec. 3.1.14 for applicability of edge distance "Condition I" and "Condition II."

[3] Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

[4] Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

[5] Values are for normal weight concrete. For lightweight concrete contact Hilti.

[6] Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.



SECTION

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Illustration of Table 93 dimensions

Table 94 — Calculated tension development and splice lengths for Canadian 400 MPa bars in walls, slabs, columns, and footings per CSA A23.3 for Hilti HIT-HY 200 A/R V3 — non-seismic design only[3,4,5,6,7,8]

Rebar size	System		$d_{cs} + K_{tr}$	Minimum edge dist. mm[1]	Minimum spacing mm[2]	f'_c = 20 MPa		f'_c = 25 MPa		f'_c = 30 MPa		f'_c = 40 MPa	
	HIT-HY 200-A V3	HIT-HY 200-R V3				ℓ_d mm	Class B splice mm	ℓ_d mm	Class B splice mm	ℓ_d mm	Class B splice mm	ℓ_d mm	Class B splice mm
10M	◐	◐	$2.5d_b$	60	50	300	380	300	340	300	310	300	300
15M	◐	◐		70	75	410	540	370	480	340	440	300	380
20M	◐	◐		80	100	510	660	450	590	410	540	360	460
25M	■	◐		120	125	820	1,060	730	950	670	870	580	750
30M	■	◐		130	150	960	1,250	860	1,120	790	1,020	680	890

◐ Applicable for use with special installation provisions and installation temperature restrictions to account for short gel time with deep embedment depth. See Instructions for Use (IFU) for special installation parameters.

■ Not recommended due to limited gel time of adhesive.

1 Edge distances are determined using the minimum cover specified by ESR-4868 with an additional 6% of the development length per suggestions for drilling without an aid per Hilti Post-Installed Reinforcing Bar Guide Section 3.3. Smaller edge distances may be possible, for which development and splice lengths may need to be recalculated. For further information on required cover see CSA A23.1-14 Table 17; see Sec. 3.2 for determination of d_{cs}.

2 Spacing values represent those producing c_b $5d_b$. Smaller spacing values may be possible, for which development and splice lengths may need to be recalculated. For further information on required spacing see CSA A23.1 Sec. 6.6.5.2; see Sec. 3.2 for determination of d_{cs}.

3 k_1 and k_2 as defined by CSA A23.3 12.2.4 (a) and (b), are taken as 1.0 for post-installed reinforcing bars. For additional information see May-June 2013 issue of the ACI Structural Journal, "Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures" by Charney, Pal and Silva.

4 k_4 = 0.8 for 20M bars and smaller bars, 1.0 for 25M and larger bars. See CSA A23.3 12.2.4 (d).

5 K_{tr} is assumed to equal zero.

6 Values are for normal weight concrete. For lightweight concrete, multiply development and splice lengths by 1.3.

7 Development and splice length values are for static design. For tension development and splice lengths of bars in joints, see CSA A23.3 21.3.3.5. For further information about reinforcement in seismic design, see CSA A23.3 Ch. 21.

8 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples.

Table 95 — Suggested embedment, edge distance, and spacing (see figure below) to develop 125% of f_y in Canadian 400 MPa bars based on CSA A23.3 Annex D — non-seismic design only[1,2,3,4,5,6,7]

Rebar size	f'_c = 20 MPa				f'_c = 25 MPa				f'_c = 30 MPa				f'_c = 40 MPa			
	Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Min. spacing s_{min} mm	Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Min. spacing s_{min} mm	Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Min. spacing s_{min} mm	Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Min. spacing s_{min} mm
		Cond. I	Cond. II			Cond. I	Cond. II			Cond. I	Cond. II			Cond. I	Cond. II	
10M	200	520	220	440	200	510	200	400	200	510	190	380	190	500	180	350
15M	280	740	350	690	280	730	320	640	270	720	300	600	270	710	280	550
20M	350	910	450	900	340	890	420	840	330	880	400	790	320	870	360	720
25M	450	1,170	630	1,260	440	1,150	590	1,170	430	1,140	560	1,110	420	1,120	500	1,000
30M	530	1,390	790	1,580	520	1,360	740	1,470	510	1,350	690	1,380	490	1,320	630	1,260

1 For additional information see May-June 2013 issue of the ACI Structural Journal, “Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures” by Charney, Pal and Silva.

2 h_{ef} is the calculated bar embedment uncracked based on bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Additional reductions per ACI 318 17.3.1.2 for sustained loading conditions are not included and as such these suggested embedments are not intended for sustained tension load applications. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the unbolded and bolded tabulated h_{ef} values by 0.80 and 0.86, respectively.

3 c_a and s are the minimum edge distance and bar spacing (from bar centerline) associated with the tabulated embedments. Refer to sec. 3.1.14 for applicability of edge distance “Condition I” and “Condition II.”

4 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

5 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868 Tables 20 and 21 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

6 Values are for normal weight concrete. For lightweight concrete contact Hilti.

7 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

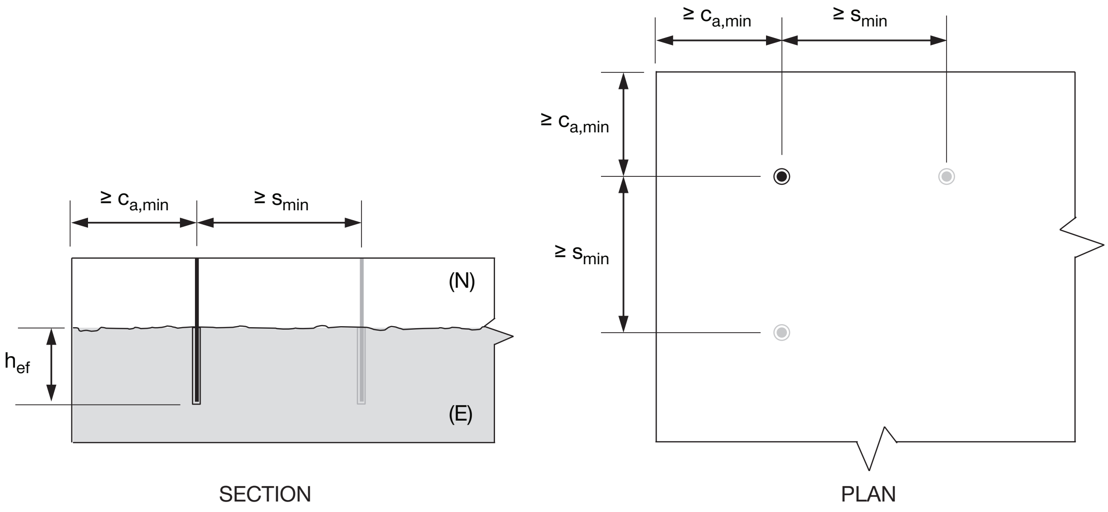

Illustration of Table 95 dimensions

Table 96 — Suggested embedment and edge distance (see figure below) based on CSA A23.3 Annex D to develop 125% of f_y in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 600 millimeters - non-seismic design only[1,2,3,4,5,6]

		f'_c = 20 MPa			f'_c = 25 MPa			f'_c = 30 MPa			f'_c = 40 MPa		
		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm	
Rebar size	Linear spacing s mm		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II
10M	600	200	520	220	200	510	200	200	510	190	190	500	180
15M		280	740	420	280	730	350	270	720	300	270	710	280
20M		510	1,340	760	430	1,150	650	380	1,010	570	320	870	460

1 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated h_{ef} values by 0.86.

2 c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 600 mm. Refer to sec. 3.1.14 for applicability of edge distance "Condition I" and "Condition II."

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

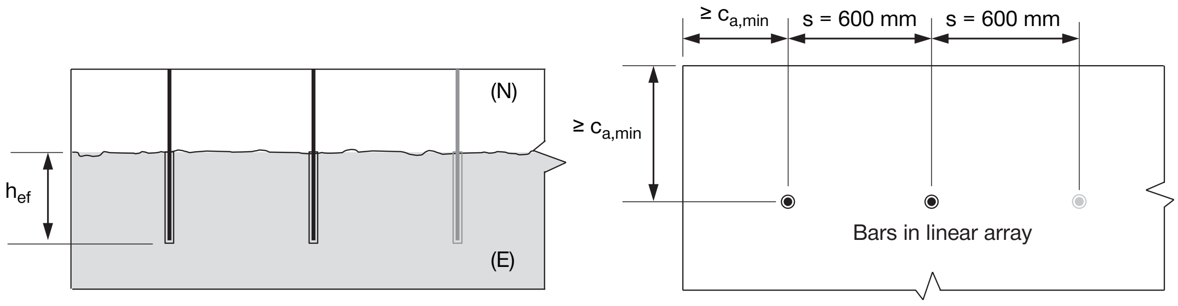

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Illustration of Table 96 dimensions

Table 97 — Suggested embedment and edge distance (see figure below) based on CSA A23.3 Annex D to develop 125% of f_y in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 450 millimeters - non-seismic design only[1,2,3,4,5,6]

Rebar size	Linear spacing s mm	f'_c = 20 MPa			f'_c = 25 MPa			f'_c = 30 MPa			f'_c = 40 MPa		
		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm	
			Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II
10M	450	200	520	220	200	510	200	200	510	190	190	500	180
15M		390	1,040	590	340	890	500	300	790	440	270	710	360

1 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated h_{ef} values by 0.86.

2 c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 450 mm. Refer to sec. 3.1.14 for applicability of edge distance “Condition I” and “Condition II.”

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868 Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

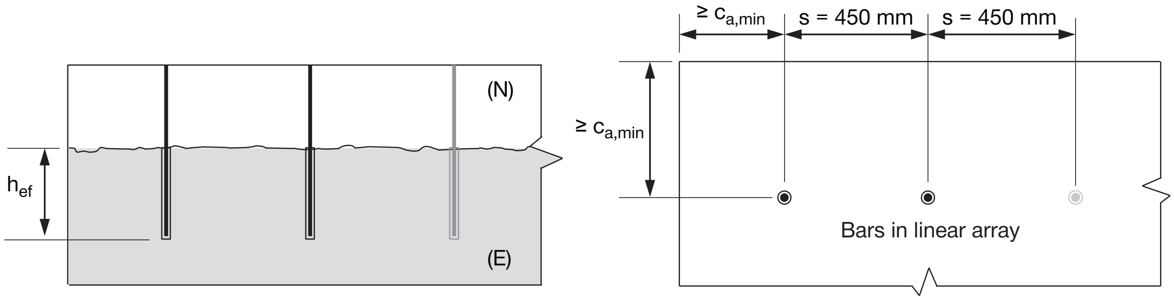

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Illustration of Table 97 dimensions

Table 98 — Suggested embedment and edge distance (see figure below) based on CSA A23.3 Annex D to develop 125% of f_y in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 300 millimeters - non-seismic design only[1,2,3,4,5,6]

		f'_c = 20 MPa			f'_c = 25 MPa			f'_c = 30 MPa			f'_c = 40 MPa		
		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm	
Rebar size	Linear spacing s mm		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II
10M	300	240	610	350	200	520	300	200	510	260	190	500	210

1 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

2 c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 300 mm. Refer to sec. 3.1.14 for applicability of edge distance "Condition I" and "Condition II."

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868 Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

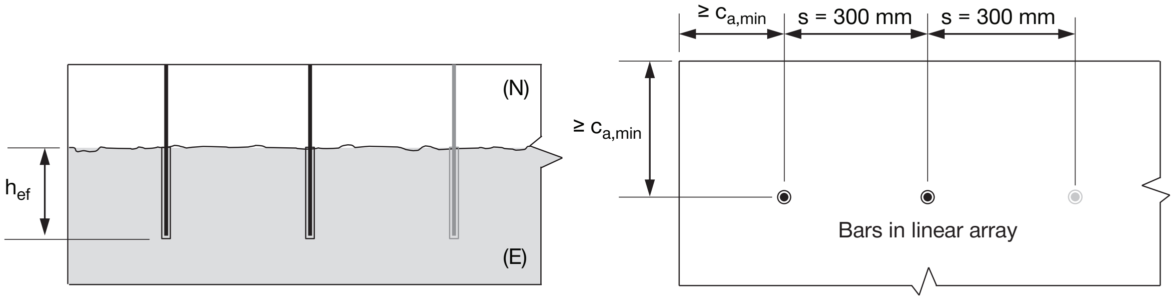

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Illustration of Table 98 dimensions

DESIGN DATA IN MASONRY

Hilti HIT-HY 200 A/R V3 adhesive in grout-filled CMU with Hilti HAS threaded rod , Deformed Reinforcing Bar (Rebar), and Hilti HIT-Z(-R) anchor rods

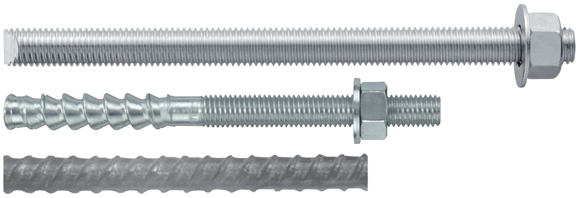


Figure 9 — Hilti HAS threaded rod installation conditions

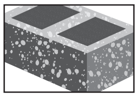
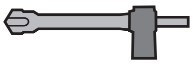
Permissible Base Materials		Grout-filled concrete masonry	Permissible drilling method		Hammer drilling with carbide tipped drill bit
					Hilti TE-CD or TE-YD Hollow Drill Bit

Table 99 — Hilti HIT-HY 200 A/R V3 allowable adhesive bond tension loads for threaded rods, HIT-Z(-R) anchor rods, and reinforcing bars in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]

Nominal anchor diameter in.	Rebar Size	Effective embedment in. (mm)[11]	Tension lb (kN)	Spacing[9] Critical s_{cr} in. (mm)	Spacing[9] Minimum s_{min} in. (mm)	Spacing[9] Load Reduction Factor @ s_{min}[12]	Edge distance[10] Critical c_{cr} in. (mm)	Edge distance[10] Minimum c_{min} in. (mm)	Edge distance[10] Load Reduction Factor @ c_{min}[12]
3/8	No. 3	3 3/8 (86)	960 (4.3)	13.5 (343)	4 (102)	0.60	12 (305)	4 (102)	0.58
1/2	No. 4	4 1/2 (114)	1,520 (6.8)	18 (457)		0.60	20 (508)		0.70
5/8	No. 5	5 5/8 (143)	1,810 (8.1)	22.5 (572)		0.50	20 (508)		0.82
3/4	No. 6	6 3/4 (171)	2,215 (9.9)	27 (686)		0.50	20 (508)		0.68

Table 100 — Hilti HIT-HY 200 A/R V3 allowable adhesive bond shear loads for threaded rods, HIT-Z(-R) anchor rods, and reinforcing bars in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]

Nominal anchor diameter in.	Rebar Size	Effective embedment in. (mm)[11]	Shear lb (kN)	Spacing[9] Critical s_{cr} in. (mm)	Spacing[9] Minimum s_{min} in. (mm)	Spacing[9] Load Reduction Factor @ s_{min}[12]	Edge distance[10] Critical c_{cr} in. (mm)	Edge distance[10] Minimum c_{min} in. (mm)	Edge distance[10] Load Reduction Factor @ c_{min}[12] Load ⊥ to edge	Edge distance[10] Load Reduction Factor @ c_{min}[12] Load ll edge
3/8	No. 3	3 3/8 (86)	825 (3.7)	13.5 (343)	4 (102)	0.56	12 (305)	4 (102)	0.60	0.72
1/2	No. 4	4 1/2 (114)	1,240 (5.5)	18 (457)		0.50	12 (305)		0.44	0.85
5/8	No. 5	5 5/8 (143)	2,120 (9.4)	22.5 (572)		0.50	20 (508)		0.22	0.71
3/4	No. 6	6 3/4 (171)	2,480 (11.0)	27 (686)		0.50	20 (508)		0.19	0.71

[1] All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

[2] Anchors may be installed in any location in the face of the masonry wall including cell, web, and mortar joints. Anchors are limited to one per masonry cell.

[3] Linear interpolation of load values between minimum spacing (s_{min}) and critical spacing (s_{cr}) and between minimum edge distance (c_{min}) and critical edge distance (c_{cr}) is permitted.

[4] Concrete masonry thickness must be equal to or greater than 1.5 times the anchor embedment depth. EXCEPTION: the 5/8-inch- and the 3/4-inch diameter anchors (No. 5 and No. 6 bars) may be installed in minimum nominally 8-inch thick concrete masonry.

[5] When using the basic load combinations in accordance with IBC Section 1605.3.1, tabulated allowable loads must not be increased for seismic or wind loading When using the alternative basic load combinations in IBC Section 1605.3.2 that include seismic or wind loads, tabulated allowable loads may be increased by 33-1/3 percent, or the alternative basic load combinations may be reduced by a factor of 0.75.

[6] Allowable loads must be the lesser of the adjusted masonry or bond tabulated values and the steel values given in tables 102 and 103.

[7] Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 14.

[8] For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

[9] The critical spacing, s_{cr}, is the anchor spacing where full load values may be used. The minimum spacing, s_{min}, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

[10] The critical edge distance, c_{cr}, is the edge distance where full load values may be used. The minimum edge distance, c_{min}, is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to the closest edge.

[11] Embedment depth is measured from the outside face of the concrete masonry unit.

[12] Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than s_{cr} and c_{cr} must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

Table 101 — Hilti HIT-HY 200 A/R V3 allowable adhesive bond loads for threaded rods and reinforcing bars in the top of grout-filled concrete masonry walls[1,2,3,4,5,6,7]

Nominal anchor diameter or rebar size	Effective embedment in. (mm)	Edge distance in. (mm)[8]	Minimum end distance in. (mm)	Tension lb (kN)	Shear load lb (kN)[9]	
					Load parallel to edge of masonry wall	Load perpendicular to edge of masonry wall
1/2"	4 -1/2 (114)	1 3/4 (44)	8 (203)	685 (3.0)	775 (3.4)	285 (1.3)
		4 (102)		880 (3.9)	1,156 (5.1)	480 (2.1)
5/8"	5 -5/8 (143)	1 3/4 (44)		830 (3.7)	890 (4.0)	315 (1.4)
		4 (102)		980 (4.4)	1,315 (5.8)	625 (2.8)
#4	4 -1/2 (114)	1 3/4 (44)		770 (3.4)	605 (2.7)	235 (1.0)
#5	5 -5/8 (143)			795 (3.5)	720 (3.2)	295 (1.3)

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

2 When using the basic load combinations in accordance with IBC Section 1605.3.1 or the alternative basic load combinations in IBC Section 1605.3.2. Tabulated allowable loads must not be increased for seismic or wind loading.

3 One anchor shall be permitted to be installed in each concrete block.

4 Anchors are not permitted to be installed in a head joint, flange or web of the concrete masonry unit.

5 Allowable loads must be the lesser of the adjusted masonry or bond tabulated values and the steel values given in tables 102 and 103.

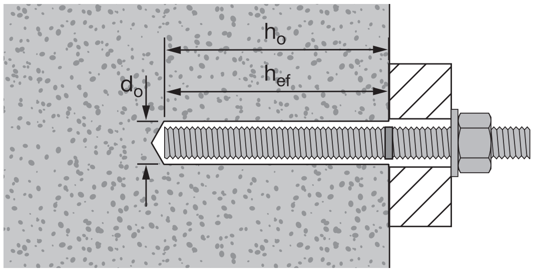
6 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 14.

7 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \le 1$

8 The tabulated edge distance is measured from the anchor centerline to the edge of the concrete block. See figure below.

9 Linear interpolation of load values between the two tabulated edge distances is permitted.

Hilti HIT-HY 200 A/R V3 specifications for HAS threaded rod in grout-filled masonry walls



Edge and end distances for threaded rods and reinforcing bars installed in the top of grout-filled CMU

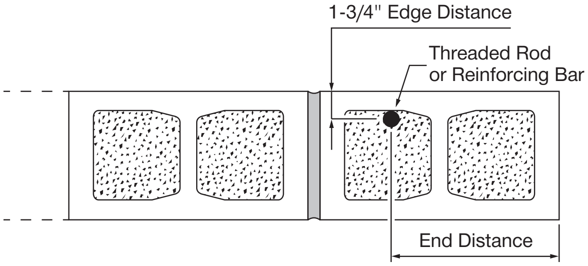


Table 102 — Hilti HIT-HY 200 A/R V3 allowable tension and shear values for threaded rods based on steel strength[1,2,3]

Anchor diameter in.	Tension lb (kN)						Shear lb (kN)					
	ISO 898 class 5.8	ASTM A36	ASTM A307	ASTM A193 B7	ASTM F593 CW (316/304)	HIT-(Z(-R)	ISO 898 class 5.8	ASTM A36	ASTM A307	ASTM A193 B7	ASTM F593 CW (316/304)	HIT-(Z(-R)
3/8	2,640 (11.7)	2,115 (9.4)	2,185 (9.7)	4,555 (20.3)	3,645 (16.2)	3,430 (15.3)	1,360 (6.0)	1,090 (4.8)	1,125 (5.0)	2,345 (10.4)	1,875 (8.3)	1,770 (7.9)
1/2	4,700 (20.9)	3,755 (16.7)	3,885 (17.3)	8,100 (36.0)	6,480 (28.8)	6,100 (27.1)	2,420 (10.8)	1,935 (8.6)	2,000 (8.9)	4,170 (18.5)	3,335 (14.8)	3,145 (14.0)
5/8	7,340 (32.6)	5,870 (26.1)	6,075 (27.0)	12,655 (56.3)	10,125 (45.0)	9,535 (42.4)	3,780 (16.8)	3,025 (13.5)	3,130 (13.9)	6,520 (29.0)	5,215 (23.2)	4,915 (21.9)
3/4	10,570 (47.0)	8,455 (37.6)	8,750 (38.9)	18,225 (81.1)	12,390 (55.1)	13,735 (61.1)	5,445 (24.2)	4,355 (19.4)	4,505 (20.0)	9,390 (41.8)	6,385 (28.4)	7,075 (31.5)

Table 103 — Hilti HIT-HIT-HY 200 A/R V3 allowable tension and shear values for reinforcing bars based on steel strength[1,2,3]

Rebar size	Tension lb (kN)	Shear lb (kN)
	ASTM A615, GRADE 60	ASTM A615, GRADE 60
#3	3,270 (14.5)	1,685 (7.5)
#4	5,940 (26.4)	3,060 (13.6)
#5	9,205 (40.9)	4,745 (21.1)
#6	13,070 (58.1)	6,730 (29.9)

1 Allowable load used in the design must be the lesser of bond values and tabulated steel values.

2 The allowable tension and shear values for threaded rods to resist short term loads, such as wind or seismic, must be calculated in accordance with the appropriate IBC Sections.

3 Allowable steel loads are based on tension and shear stresses equal to 0.33 x Fu and 0.17 x Fu , respectively.

Table 104 — Hilti HIT-HY 200 A/R V3 allowable adhesive bond tension loads for HIS-N inserts in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]

			Spacing[9]			Edge Distance[10]		
Thread size in.	Effective embedment in. (mm)[11]	Tension lb (kN)	Critical s_{cr} in. (mm)	Minimum s_{min} in. (mm)	Load Reduction Factor @ s_{min}[12]	Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load Reduction Factor @ c_{min}[12]
3/8-16 UNC	4 3/8 (111)	1,355 (6.0)	17 (432)	4 (102)	0.68	12 (305)	4 (102)	0.81
1/2-13 UNC	5 (127)	1,640 (7.3)	20 (508)		0.68	20 (508)		0.74

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

2 Anchors may be installed in any location in the face of the masonry wall including cell, web, and mortar joints. Anchors are limited to one per masonry cell.

3 Linear interpolation of load values between minimum spacing (s_{min}) and critical spacing (s_{cr}) and between minimum edge distance (c_{min}) and critical edge distance (c_{cr}) is permitted.

4 Concrete masonry thickness must be equal to or greater than 1.5 times the anchor embedment depth.

5 When using the basic load combinations in accordance with IBC Section 1605.3.1, tabulated allowable loads must not be increased for seismic or wind loading When using the alternative basic load combinations in IBC Section 1605.3.2 that include seismic or wind loads, tabulated allowable loads may be increased by 33-1/3 percent, or the alternative basic load combinations may be reduced by a factor of 0.75.

6 Allowable loads must be the lesser of the adjusted masonry or bond tabulated values and the steel values given in tables 102 and 103.

7 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 14.

8 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

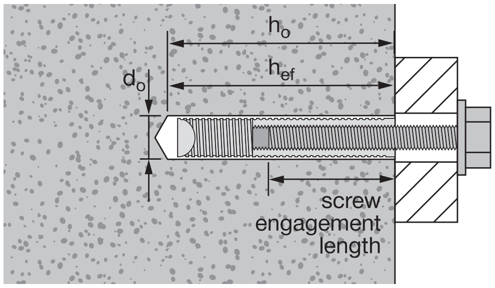
9 The critical spacing, s_{cr}, is the anchor spacing where full load values may be used. The minimum spacing, s_{min}, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

10 The critical edge distance, c_{cr}, is the edge distance where full load values may be used. The minimum edge distance, c_{min}, is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to the closest edge.

11 Embedment depth is measured from the outside face of the concrete masonry unit.

12 Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than s_{cr} and c_{cr} must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

Hilti HIT-HY 200 A/R V3 specifications for HIS-N inserts in grout-filled masonry walls



Allowable anchor installation locations in the face of grout-filled concrete block

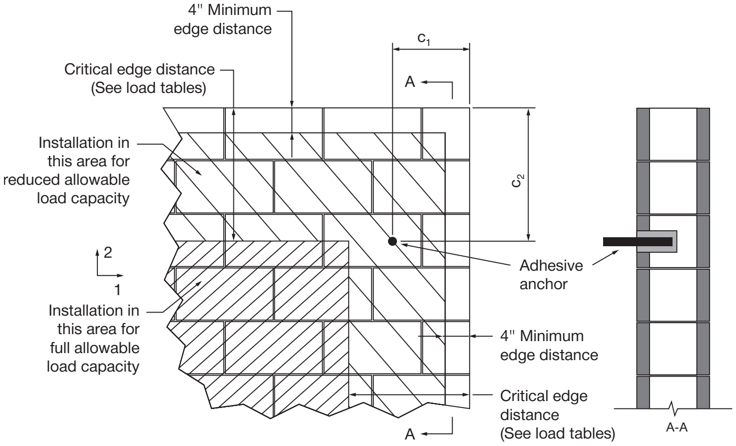


Table 105 — Hilti HIT-HY 200 A/R V3 allowable adhesive bond shear loads for HIS-N inserts in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]

			Spacing[9]			Edge Distance[10]			
								Load Reduction Factor @ c_{min}[12]	
Thread size in.	Effective embedment in. (mm)[11]	Shear lb (kN)	Critical s_{cr} in. (mm)	Minimum s_{min} in. (mm)	Load Reduction Factor @ s_{min}[12]	Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load perpendicular to edge	Load parallel to edge
3/8-16 UNC	4 3/8 (111)	1,045 (4.6)	17.0 (432)	4 (102)	0.56	12 (305)	4 (102)	0.65	1.00
1/2-13 UNC	5 (127)	1,730 (7.7)	20 (508)		0.50	20 (508)		0.36	0.91

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

2 Anchors may be installed in any location in the face of the masonry wall including cell, web, and mortar joints. Anchors are limited to one per masonry cell.

3 Linear interpolation of load values between minimum spacing (s_{min}) and critical spacing (s_{cr}) and between minimum edge distance (c_{min}) and critical edge distance (c_{cr}) is permitted.

4 Concrete masonry thickness must be equal to or greater than 1.5 times the anchor embedment depth.

5 When using the basic load combinations in accordance with IBC Section 1605.3.1, tabulated allowable loads must not be increased for seismic or wind loading When using the alternative basic load combinations in IBC Section 1605.3.2 that include seismic or wind loads, tabulated allowable loads may be increased by 33-1/3 percent, or the alternative basic load combinations may be reduced by a factor of 0.75.

6 Allowable loads must be the lesser of the adjusted masonry or bond tabulated values and the steel values given in tables 102 and 103.

7 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 14.

8 For combined loading: ($T_{applied}$ / $T_{allowable}$) + ($V_{applied}$ / $V_{allowable}$) ≤ 1

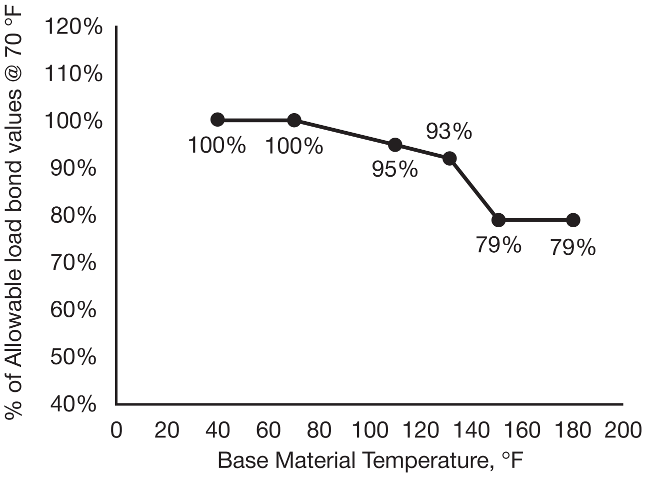
9 The critical spacing, s_{cr}, is the anchor spacing where full load values may be used. The minimum spacing, s_{min}, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

10 The critical edge distance, c_{cr}, is the edge distance where full load values may be used. The minimum edge distance, c_{min}, is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to the closest edge.

11 Embedment depth is measured from the outside face of the concrete masonry unit.

12 Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than s_{cr} and c_{cr} must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

Figure 14 — Influence of in-service temperature on bond strength[1]



1 Test procedure involves the concrete being held at the elevated temperature for 24 hours then removing it from the controlled environment and testing to failure.

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

MATERIAL SPECIFICATIONS

Figure 15 — Hilti HIT-HY 200 A/R V3 adhesive cure time and working time (approx.)

HIT-HY 200-A					
		HAS HIS-N Rebar		HIT-Z[1]	
[°C]	[°F]	t_{work}	t_{cure}	t_{work}	t_{cure}
-10...-5	14...23	1.5 h	7 h	–	–
-4...0	24...32	50 min	4 h	–	–
1...5	33...41	25 min	2 h	–	–
6...10	42...50	15 min	1.25 h	15 min	1.25 h
11...20	51...68	7 min	45 min	7 min	45 min
21...30	69...86	4 min	30 min	4 min	30 min
31...40	87...104	3 min	30 min	3 min	30 min

HIT-HY 200-R					
		HAS HIS-N Rebar		HIT-Z[1]	
[°C]	[°F]	t_{work}	t_{cure}	t_{work}	t_{cure}
-10...-5	14...23	3 h	20 h	–	–
-4...0	24...32	2 h	8 h	–	–
1...5	33...41	1 h	4 h	–	–
6...10	42...50	40 min	2.5 h	40 min	2.5 h
11...20	51...68	15 min	1.5 h	15 min	1.5 h
21...30	69...86	9 min	1 h	9 min	1 h
31...40	87...104	6 min	1 h	6 min	1 h

[1] It is permitted to install Hilti HIT-HY 200 V3 with HIT-Z anchor rod down to 14° F (-10° C) provided the drilled hole has the drilling dust fully removed. This can be done with Hilti TE-CD or TE-YD hollow drill bit or with cleaning procedures used with standard threaded rod.

Resistance of cured Hilti HIT-HY 200 A/R V3 to chemicals

Chemical		Behavior
Acetic acid	10%	+
Acetone		●
Ammonia	5%	+
Benzyl alcohol		–
Hydrochloric acid	10%	●
Chlorinated lime	10%	+
Citric acid	10%	+
Concrete plasticizer		+
De-icing salt (Calcium chloride)		+
Demineralized water		+
Diesel fuel		+
Drilling dust suspension pH 13.2		+
Ethanol	96%	–
Ethylacetate		–
Formic acid	10%	+
Formwork oil		+
Gasoline		+
Glycole		●
Hydrogen peroxide	10%	●
Lactic acid	10%	+
Maschinery oil		+
Methylethylketon		●
Nitric acid	10%	●
Phosphoric acid	10%	+
Potassium Hydroxide pH 13.2		+
Sea water		+
Sewage sludge		+
Sodium carbonate 10%	10%	+
Sodium hypochlorite 2%	2%	+
Sulphuric acid	10%	+
	30%	+
Toluene		●
Xylene		●

Key: – non-resistant
+ resistant
● limited resistance

Samples of the HIT-HY 200 A/R V3 adhesive were immersed in the various chemical compounds for up to one year. At the end of the test period, the samples were analyzed. Any samples showing no visible damage and having less than a 25% reduction in bending (flexural) strength were classified as “Resistant.” Samples that had slight damage, such as small cracks, chips, etc. or reduction in bending strength of 25% or more were classified as “Limited Resistance” (i.e. exposed for 48 hours or less until chemical is cleaned up). Samples that were heavily damaged or destroyed were classified as “Non-Resistant.”

Note: In actual use, the majority of the adhesive is encased in the base material, leaving very little surface area exposed.

ORDERING INFORMATION

HIT-Z anchor rod

Description	Bit dia. (in.)	Min. embed. (in.)	Qty
HIT-Z 3/8 x 3-3/8	7/16	2-3/8	40
HIT-Z 3/8 x 4 3/8	7/16	2-3/8	40
HIT-Z 3/8 x 5 1/8	7/16	2-3/8	40
HIT-Z 3/8 x 6 3/8	7/16	2-3/8	40
HIT-Z 1/2 x 4 1/2	9/16	2-3/4	20
HIT-Z 1/2 x 6 ½	9/16	2-3/4	20
HIT-Z 1/2 x 8	9/16	2-3/4	20
HIT-Z 5/8 x 6	3/4	3-3/4	12
HIT-Z 5/8 x 8	3/4	3-3/4	12
HIT-Z 5/8 x 9 1/2	3/4	3-3/4	12
HIT-Z 3/4 x 6-1/2	7/8	4	6
HIT-Z 3/4 x 8 1/2	7/8	4	6
HIT-Z 3/4 x 9 ¾	7/8	4	6

HIT-HY 200-A V3

HIT-HY 200-R V3

HIT-HY 200-A V3 (accelerated working time)

Description	Package contents	Qty
HIT-HY 200-A V3 (11.1 fl oz/330 ml)	Includes (1) foil pack with (1) mixer and 3/8 filler tube per pack	1
HIT-HY 200-A V3 Master Carton (11.1 fl oz/330 ml)	Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack	25
HIT-HY 200-A V3 Combo (11.1 fl oz/330 ml)	Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 Manual Dispenser	25
HIT-HY 200-A V3 Master Carton (16.9 fl oz/500 ml)	Includes (1) master carton containing (20) foil packs with (1) mixer and 3/8 filler tube per pack	20
HIT-HY 200-A V3 Combo (16.9 fl oz/500 ml)	Includes (2) master cartons containing (20) foil packs each with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 Manual Dispenser	40
HIT-RE-M Static Mixer	For use with HIT-HY 200-A V3 cartridges	1

HIT-HY 200-R V3 (regular working time)

Description	Package contents	Qty
HIT-HY 200-R V3 (11.1 fl oz/330 ml)	Includes (1) foil pack with (1) mixer and 3/8 filler tube per pack	1
HIT-HY 200-R V3 Master Carton (11.1 fl oz/330 ml)	Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack	25
HIT-HY 200-R V3 Combo (11.1 fl oz/330 ml)	Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 manual dispenser	25
HIT-HY 200-R V3 Master Carton (16.9 fl oz/500 ml)	Includes (1) master carton containing (20) foil packs with (1) mixer and 3/8 filler tube per pack	20
HIT-HY 200-R V3 Combo (16.9 fl oz/500 ml)	Includes (2) master cartons containing (20) foil packs each with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 manual dispenser	40
HIT-RE-M Static Mixer	For use with HIT-HY 200-R V3 cartridges	1

TE-CD Hollow Drill Bits

Order Description	Working length (in.)
Hollow Drill Bit TE-CD 1/2-13	8
Hollow Drill Bit TE-CD 9/16-14	9-1/2
Hollow Drill Bit TE-CD 5/8-14	9-1/2
Hollow Drill Bit TE-CD 3/4-14	9-1/2
Hollow Drill Bit TE-CD 16-A (Replacement collar)	

TE-YD Hollow Drill Bits

Order Description	Working Length (in.)
Hollow Drill Bit TE-YD 3/4-24	15-1/2
Hollow Drill Bit TE-YD 7/8-24	15-1/2
Hollow Drill Bit TE-YD 1-24	15-1/2
Hollow Drill Bit TE-YD 1 1/8-24	15-1/2
Hollow Drill Bit TE-YD 25-A (Replacement collar)	

For ordering information on anchor rods and inserts, dispensers, hole cleaning equipment and other accessories, see section 3.2.9.

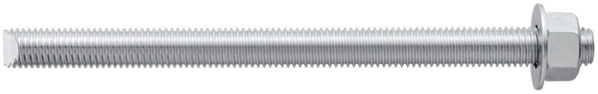
3.2.3 HIT-RE 500 V3 EPOXY ADHESIVE ANCHORING SYSTEM

PRODUCT DESCRIPTION

HIT-RE 500 V3 with Threaded Rod, Rebar, and HIS-N/RN Inserts

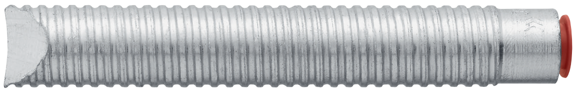
Anchor System

Hilti HIT-RE 500 V3 Cartridge



Hilti HAS Threaded Rods

Rebar



Hilti HIS-N

Features and Benefits

- Superior bond performance in both cracked and uncracked concrete
- Seismic qualified in accordance with ICC-ES Acceptance Criteria AC308 and ACI 355.4
- No hole cleaning requirement when installed with SafeSet™ hollow drill bit and Hilti vacuum technology
- ICC-ES approved for cracked concrete and seismic service
- May be installed in diamond cored holes in cracked and uncracked concrete including all seismic zones concrete using the Safe-Set™ system using the TE-YRT Roughening tool
- Use underwater up to 165 ft (50 m)
- Meets requirements of ASTM C881-14, Type I, II, IV, and V, Grade 3, Class A, B, and C.
- Meets requirements of AASHTO specification M235, Type I, II, IV, and V, Grade 3, Class A, B, and C
- Technical data available for larger diameters, oversized holes, deeper embedments. Contact Hilti Technical Services for additional information

Uncracked concrete

Cracked concrete

Seismic design categories A-F

Diamond cored holes for cracked and uncracked concrete

Hollow drill bit Roughening tool

Profis anchor design software

Approvals/Listings	
ICC-ES (International Code Council)	ESR-3814 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC308 ELC-3814 in concrete per CSA A23.3 / ACI 355.2
NSF/ANSI Std 61	Certification for use in potable water
European Technical Approval	ETA-16/0142, ETA-16/0143, ETA-16/0180
City of Los Angeles	City of Los Angeles 2017 LABC Supplement (within ESR-3814)
Florida Building Code	2017 FBC Supplement (within ESR-1814)
U.S. Green Building Council	LEED® Credit 4.1-Low Emitting Materials
Department of Transportation	Contact Hilti for various states

MATERIAL SPECIFICATIONS

Table 1 — Material properties of fully cured Hilti HIT-RE 500 V3

Bond Strength ASTM C882-13A[1] 2 day cure 14 day cure	 10.8 MPa 11.7 MPa	 1,560 psi 1,690 psi
Compressive Strength ASTM D695-10[1]	82.7 MPa	12,000 psi
Compressive Modulus ASTM D695-10[1]	2,600 MPa	0.38 x 10^6 psi
Tensile Strength 7 day ASTM D638-14	49.3 MPa	7,150 psi
Elongation at break ASTM D638-14	1.1%	1.1%
Heat Deflection Temperature ASTM D648-07	50°C	122°F
Absorption ASTM D570-98	0.18%	0.18%
Linear Coefficient of Shrinkage on Cure ASTM D2566-86	0.008	0.008

[1] Minimum values obtained as the result of tests at 35°F, 50°F, 75°F and 110°F.

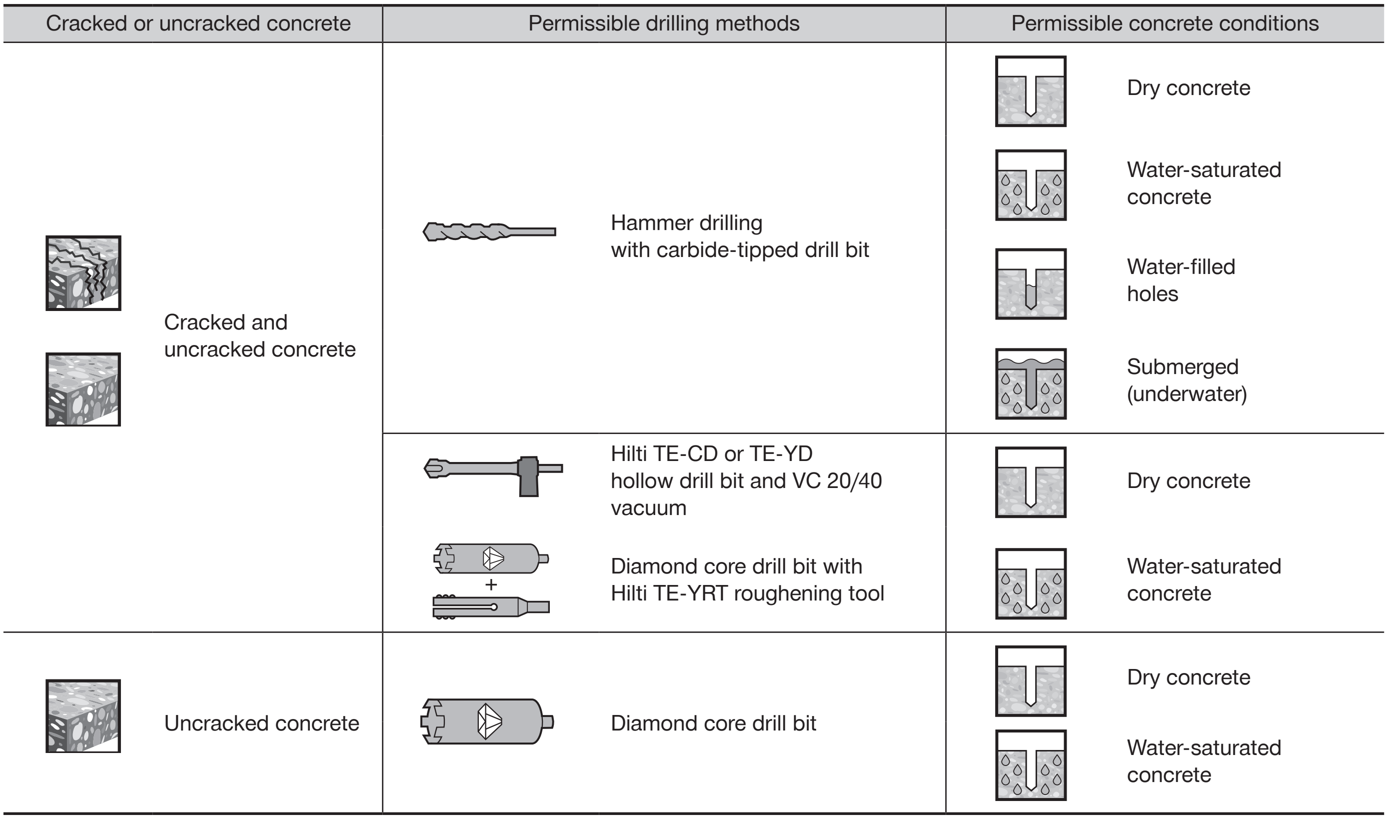
DESIGN DATA IN CONCRETE FOR ACI 318

ACI 318 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the strength design parameters and variables of ESR-3814 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to Section 3.1.8. Data tables from ESR-3814 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

HIT-RE 500 V3 adhesive with deformed reinforcing bars (rebar)

Figure 1 — Rebar installed with Hilti HIT-RE 500 V3 adhesive



Cracked or uncracked concrete	Permissible drilling methods	Permissible concrete conditions
Cracked and uncracked concrete	Hammer drilling with carbide-tipped drill bit	Dry concrete Water-saturated concrete Water-filled holes Submerged (underwater)
	Hilti TE-CD or TE-YD hollow drill bit and VC 20/40 vacuum Diamond core drill bit with Hilti TE-YRT roughening tool	Dry concrete Water-saturated concrete
Uncracked concrete	Diamond core drill bit	Dry concrete Water-saturated concrete

Figure 2 — Rebar installed with Hilti HIT-RE 500 V3 adhesive

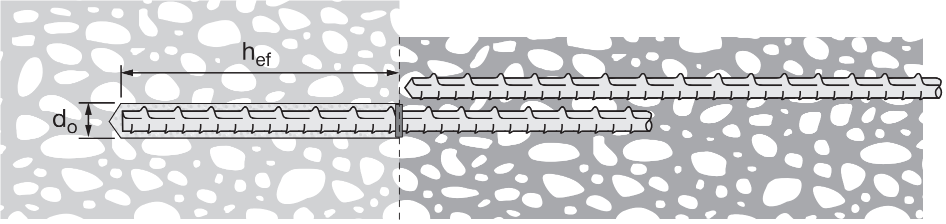


Table 2 — Specifications for rebar installed with Hilti HIT-RE 500 V3 adhesive

Setting information		Symbol	Units	Rebar size							
				#3	#4	#5	#6	#7	#8	#9	#10
Nominal bit diameter		d_o	in.	1/2	5/8	3/4	7/8	1	1-1/8	1-3/8	1-1/2
Effective embedment	minimum	$h_{ef,min}$	in. (mm)	2-3/8 (60)	2-3/8 (60)	3 (76)	3 (76)	3-3/8 (85)	4 (102)	4-1/2 (114)	5 (127)
	maximum	$h_{ef,max}$	in. (mm)	7-1/2 (191)	10 (254)	12-1/2 (318)	15 (381)	17-1/2 (445)	20 (508)	22-1/2 (572)	25 (635)
Minimum concrete member thickness		h_{min}	in. (mm)	h_{ef} + 1-1/4 (h_{ef} + 30)	(h_{ef} + 2d_o)						
Minimum edge distance[1]		c_{min}	in. (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	5-5/8 (143)	6-1/4 (159)
Minimum anchor spacing		s_{min}	in. (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	5-5/8 (143)	6-1/4 (159)

[1] Edge distance of 1-3/4-inch (44mm) is permitted provided the rebar remains un-torqued.

Note: The installation specifications in table 2 above and the data in tables 3 through 23 pertain to the use of Hilti HIT-RE 500 V3 with rebar designed as a post-installed anchor using the provisions of ACI 318 Chapter 17. For the use of Hilti HIT-RE 500 V3 with rebar for typical development calculations according to ACI 318 Chapter 25 (formerly ACI 318-11 Chapter 12), refer to section 3.1.14 for the design method and tables 83 through 87 in section 3.2.4.3.8.

Table 3 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for US rebar in uncracked concrete [1,2,3,4,5,6,7,8,9,11]

Rebar size	Effective embedment in. (mm)	Tension — ϕN_n				Shear — ϕV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
#3	3-3/8 (86)	4,575 (20.4)	4,790 (21.3)	5,145 (22.9)	5,695 (25.3)	9,855 (43.8)	10,310 (45.9)	11,080 (49.3)	12,265 (54.6)
	4-1/2 (114)	6,100 (27.1)	6,385 (28.4)	6,860 (30.5)	7,590 (33.8)	13,135 (58.4)	13,750 (61.2)	14,775 (65.7)	16,350 (72.7)
	7-1/2 (191)	10,165 (45.2)	10,640 (47.3)	11,435 (50.9)	12,655 (56.3)	21,895 (97.4)	22,915 (101.9)	24,625 (109.5)	27,250 (121.2)
#4	4-1/2 (114)	7,445 (33.1)	8,155 (36.3)	8,990 (40.0)	9,950 (44.3)	16,035 (71.3)	17,570 (78.2)	19,365 (86.1)	21,430 (95.3)
	6 (152)	10,660 (47.4)	11,155 (49.6)	11,990 (53.3)	13,265 (59.0)	22,960 (102.1)	24,030 (106.9)	25,820 (114.9)	28,575 (127.1)
	10 (254)	17,765 (79.0)	18,595 (82.7)	19,980 (88.9)	22,110 (98.3)	38,265 (170.2)	40,050 (178.2)	43,035 (191.4)	47,625 (211.8)
#5[10]	5-5/8 (143)	10,405 (46.3)	11,400 (50.7)	13,165 (58.6)	15,370 (68.4)	22,415 (99.7)	24,550 (109.2)	28,350 (126.1)	33,105 (147.3)
	7-1/2 (191)	16,020 (71.3)	17,230 (76.6)	18,515 (82.4)	20,490 (91.1)	34,505 (153.5)	37,115 (165.1)	39,880 (177.4)	44,135 (196.3)
	12-1/2 (318)	27,440 (122.1)	28,720 (127.8)	30,860 (137.3)	34,155 (151.9)	59,100 (262.9)	61,855 (275.1)	66,470 (295.7)	73,560 (327.2)
#6[10]	6-3/4 (171)	13,680 (60.9)	14,985 (66.7)	17,305 (77.0)	21,190 (94.3)	29,460 (131.0)	32,275 (143.6)	37,265 (165.8)	45,645 (203.0)
	9 (229)	21,060 (93.7)	23,070 (102.6)	26,200 (116.5)	28,995 (129.0)	45,360 (201.8)	49,690 (221.0)	56,430 (251.0)	62,450 (277.8)
	15 (381)	38,825 (172.7)	40,635 (180.8)	43,665 (194.2)	48,325 (215.0)	83,620 (372.0)	87,520 (389.3)	94,045 (418.3)	104,080 (463.0)
#7[10]	7-7/8 (200)	17,235 (76.7)	18,885 (84.0)	21,805 (97.0)	26,705 (118.8)	37,125 (165.1)	40,670 (180.9)	46,960 (208.9)	57,515 (255.8)
	10-1/2 (267)	26,540 (118.1)	29,070 (129.3)	33,570 (149.3)	38,995 (173.5)	57,160 (254.3)	62,615 (278.5)	72,300 (321.6)	83,995 (373.6)
	17-1/2 (445)	52,220 (232.3)	54,655 (243.1)	58,730 (261.2)	64,995 (289.1)	112,470 (500.3)	117,715 (523.6)	126,495 (562.7)	139,990 (622.7)
#8[10]	9 (229)	21,060 (93.7)	23,070 (102.6)	26,640 (118.5)	32,625 (145.1)	45,360 (201.8)	49,690 (221.0)	57,375 (255.2)	70,270 (312.6)
	12 (305)	32,425 (144.2)	35,520 (158.0)	41,015 (182.4)	50,020 (222.5)	69,835 (310.6)	76,500 (340.3)	88,335 (392.9)	107,735 (479.2)
	20 (508)	66,980 (297.9)	70,100 (311.8)	75,330 (335.1)	83,365 (370.8)	144,260 (641.7)	150,990 (671.6)	162,250 (721.7)	179,560 (798.7)
#9[10]	10-1/8 (257)	25,130 (111.8)	27,530 (122.5)	31,785 (141.4)	38,930 (173.2)	54,125 (240.8)	59,290 (263.7)	68,465 (304.5)	83,850 (373.0)
	13-1/2 (343)	38,690 (172.1)	42,380 (188.5)	48,940 (217.7)	59,940 (266.6)	83,330 (370.7)	91,285 (406.1)	105,405 (468.9)	129,095 (574.2)
	22-1/2 (572)	83,245 (370.3)	87,640 (389.8)	94,175 (418.9)	104,225 (463.6)	179,300 (797.6)	188,765 (839.7)	202,840 (902.3)	224,480 (998.5)
#10	11-1/4 (286)	29,430 (130.9)	32,240 (143.4)	37,230 (165.6)	45,595 (202.8)	63,395 (282.0)	69,445 (308.9)	80,185 (356.7)	98,205 (436.8)
	15 (381)	45,315 (201.6)	49,640 (220.8)	57,320 (255.0)	70,200 (312.3)	97,600 (434.1)	106,915 (475.6)	123,455 (549.2)	151,200 (672.6)
	25 (635)	97,500 (433.7)	106,195 (472.4)	114,115 (507.6)	126,290 (561.8)	210,000 (934.1)	228,730 (1017.4)	245,785 (1093.3)	272,005 (1209.9)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 8-23 as necessary to the above values. Compare to the steel values in table 7. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete and water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.45.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. For diamond core drilling, except as indicated in note 10, multiply above values by 0.55.
Diamond core drilling is not permitted for the water-filled or under-water (submerged) applications.
10 Diamond core drilling with the Hilti TE-YRT roughening tool is permitted for #5, #6, #7, #8, and #9 rebar in dry and water-saturated concrete. See Table 5
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 4 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for US rebar in cracked concrete[1,2,3,4,5,6,7,8,9,11]

		Tension — ϕN_n				Shear — ϕV_n			
Rebar size	Effective embedment in. (mm)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
#3	3-3/8 (86)	3,425 (15.2)	3,585 (15.9)	3,745 (16.7)	3,980 (17.7)	7,380 (32.8)	7,725 (34.4)	8,065 (35.9)	8,570 (38.1)
	4-1/2 (114)	4,650 (20.7)	4,780 (21.3)	4,990 (22.2)	5,305 (23.6)	10,020 (44.6)	10,300 (45.8)	10,750 (47.8)	11,425 (50.8)
	7-1/2 (191)	7,755 (34.5)	7,970 (35.5)	8,320 (37.0)	8,840 (39.3)	16,700 (74.3)	17,165 (76.4)	17,920 (79.7)	19,045 (84.7)
#4	4-1/2 (114)	5,275 (23.5)	5,780 (25.7)	6,670 (29.7)	7,125 (31.7)	11,360 (50.5)	12,445 (55.4)	14,370 (63.9)	15,345 (68.3)
	6 (152)	8,120 (36.1)	8,560 (38.1)	8,940 (39.8)	9,500 (42.3)	17,490 (77.8)	18,440 (82.0)	19,255 (85.7)	20,465 (91.0)
	10 (254)	13,885 (61.8)	14,270 (63.5)	14,900 (66.3)	15,835 (70.4)	29,910 (133.0)	30,735 (136.7)	32,095 (142.8)	34,105 (151.7)
#5[10]	5-5/8 (143)	7,370 (32.8)	8,075 (35.9)	9,325 (41.5)	11,380 (50.6)	15,875 (70.6)	17,390 (77.4)	20,080 (89.3)	24,510 (109.0)
	7-1/2 (191)	11,350 (50.5)	12,430 (55.3)	14,275 (63.5)	15,170 (67.5)	24,440 (108.7)	26,775 (119.1)	30,750 (136.8)	32,680 (145.4)
	12-1/2 (318)	22,175 (98.6)	22,790 (101.4)	23,795 (105.8)	25,285 (112.5)	47,760 (212.4)	49,085 (218.3)	51,250 (228.0)	54,465 (242.3)
#6[10]	6-3/4 (171)	9,690 (43.1)	10,615 (47.2)	12,255 (54.5)	15,010 (66.8)	20,870 (92.8)	22,860 (101.7)	26,395 (117.4)	32,330 (143.8)
	9 (229)	14,920 (66.4)	16,340 (72.7)	18,870 (83.9)	22,160 (98.6)	32,130 (142.9)	35,195 (156.6)	40,640 (180.8)	47,735 (212.3)
	15 (381)	32,095 (142.8)	33,290 (148.1)	34,760 (154.6)	36,935 (164.3)	69,135 (307.5)	71,700 (318.9)	74,865 (333.0)	79,560 (353.9)
#7[10]	7-7/8 (200)	12,210 (54.3)	13,375 (59.5)	15,445 (68.7)	18,915 (84.1)	26,300 (117.0)	28,810 (128.2)	33,265 (148.0)	40,740 (181.2)
	10-1/2 (267)	18,800 (83.6)	20,590 (91.6)	23,780 (105.8)	29,120 (129.5)	40,490 (180.1)	44,355 (197.3)	51,215 (227.8)	62,725 (279.0)
	17-1/2 (445)	40,445 (179.9)	44,310 (197.1)	47,310 (210.4)	50,275 (223.6)	87,115 (387.5)	95,430 (424.5)	101,895 (453.2)	108,285 (481.7)
#8[10]	9 (229)	14,920 (66.4)	16,340 (72.7)	18,870 (83.9)	23,110 (102.8)	32,130 (142.9)	35,195 (156.6)	40,640 (180.8)	49,775 (221.4)
	12 (305)	22,965 (102.2)	25,160 (111.9)	29,050 (129.2)	35,580 (158.3)	49,465 (220.0)	54,190 (241.0)	62,570 (278.3)	76,635 (340.9)
	20 (508)	49,415 (219.8)	54,135 (240.8)	62,230 (276.8)	66,130 (294.2)	106,435 (473.4)	116,595 (518.6)	134,035 (596.2)	142,440 (633.6)
#9[10]	10-1/8 (257)	17,800 (79.2)	19,500 (86.7)	22,515 (100.2)	27,575 (122.7)	38,340 (170.5)	42,000 (186.8)	48,495 (215.7)	59,395 (264.2)
	13-1/2 (343)	27,405 (121.9)	30,020 (133.5)	34,665 (154.2)	42,455 (188.8)	59,025 (262.6)	64,660 (287.6)	74,665 (332.1)	91,445 (406.8)
	22-1/2 (572)	58,965 (262.3)	64,595 (287.3)	74,585 (331.8)	81,930 (364.4)	127,005 (564.9)	139,125 (618.9)	160,650 (714.6)	176,465 (785.0)
#10	11-1/4 (286)	20,850 (92.7)	22,840 (101.6)	26,370 (117.3)	32,295 (143.7)	44,905 (199.7)	49,190 (218.8)	56,800 (252.7)	69,565 (309.4)
	15 (381)	32,095 (142.8)	35,160 (156.4)	40,600 (180.6)	49,725 (221.2)	69,135 (307.5)	75,730 (336.9)	87,445 (389.0)	107,100 (476.4)
	25 (635)	69,060 (307.2)	75,655 (336.5)	87,360 (388.6)	97,510 (433.7)	148,750 (661.7)	162,945 (724.8)	188,155 (837.0)	210,020 (934.2)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 8-23 as necessary to the above values. Compare to the steel values in table 7. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete and water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.45.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete except as indicated in note 10.

10 Diamond core drilling with the Hilti TE-YRT roughening tool is permitted for #5, #6, #7, #8, and #9 rebar in dry and water-saturated concrete. See Table 6

11 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.68. See section 3.1.8 for additional information on seismic applications.

Table 5 — Hilti HIT-RE 500 V3 for Core Drilled Holes with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for US rebar in uncracked concrete[1,2,3,4,5,6,7,8,9]

Rebar size	Effective embedment in. (mm)	Tension — ϕN_n				Shear — ϕV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
#5	5-5/8 (143)	10,405 (46.3)	11,400 (50.7)	12,350 (54.9)	12,350 (54.9)	22,415 (99.7)	24,550 (109.2)	26,595 (118.3)	26,595 (118.3)
	7-1/2 (191)	16,020 (71.3)	16,465 (73.2)	16,465 (73.2)	16,465 (73.2)	34,505 (153.5)	35,460 (157.7)	35,460 (157.7)	35,460 (157.7)
	12-1/2 (318)	27,440 (122.1)	27,440 (122.1)	27,440 (122.1)	27,440 (122.1)	59,100 (262.9)	59,100 (262.9)	59,100 (262.9)	59,100 (262.9)
#6	6-3/4 (171)	13,680 (60.9)	14,985 (66.7)	17,305 (77.0)	17,470 (77.7)	29,460 (131.0)	32,275 (143.6)	37,265 (165.8)	37,630 (167.4)
	9 (229)	21,060 (93.7)	23,070 (102.6)	23,295 (103.6)	23,295 (103.6)	45,360 (201.8)	49,690 (221.0)	50,175 (223.2)	50,175 (223.2)
	11-1/4 (286)	29,120 (129.5)	29,120 (129.5)	29,120 (129.5)	29,120 (129.5)	62,715 (279.0)	62,715 (279.0)	62,715 (279.0)	62,715 (279.0)
#7	7-7/8 (200)	17,235 (76.7)	18,885 (84.0)	21,805 (97.0)	23,500 (104.5)	37,125 (165.1)	40,670 (180.9)	46,960 (208.9)	50,610 (225.1)
	10-1/2 (267)	26,540 (118.1)	29,070 (129.3)	31,330 (139.4)	31,330 (139.4)	57,160 (254.3)	62,615 (278.5)	67,485 (300.2)	67,485 (300.2)
	17-1/2 (445)	52,220 (232.3)	52,220 (232.3)	52,220 (232.3)	52,220 (232.3)	112,470 (500.3)	112,470 (500.3)	112,470 (500.3)	112,470 (500.3)
#8	9 (229)	21,060 (93.7)	23,070 (102.6)	26,640 (118.5)	30,140 (134.1)	45,360 (201.8)	49,690 (221.0)	57,375 (255.2)	64,920 (288.8)
	12 (305)	32,425 (144.2)	35,520 (158.0)	40,185 (178.8)	40,185 (178.8)	69,835 (310.6)	76,500 (340.3)	86,555 (385.0)	86,555 (385.0)
	20 (508)	66,980 (297.9)	66,980 (297.9)	66,980 (297.9)	66,980 (297.9)	144,260 (641.7)	144,260 (641.7)	144,260 (641.7)	144,260 (641.7)
#9	10-1/8 (257)	25,130 (111.8)	27,530 (122.5)	31,785 (141.4)	37,680 (167.6)	54,125 (240.8)	59,290 (263.7)	68,465 (304.5)	81,160 (361.0)
	13-1/2 (343)	38,690 (172.1)	42,380 (188.5)	48,940 (217.7)	50,240 (223.5)	83,330 (370.7)	91,285 (406.1)	105,405 (468.9)	108,215 (481.4)
	22-1/2 (572)	83,245 (370.3)	83,735 (372.5)	83,735 (372.5)	83,735 (372.5)	179,300 (797.6)	180,355 (802.3)	180,355 (802.3)	180,355 (802.3)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 8 - 23 as necessary to the above values. Compare to the steel values in table 7. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete and water-saturated concrete conditions.
Water-filled and submerged (under water) applications are not permitted for this hole preparation method.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 6 — Hilti HIT-RE 500 V3 for Core Drilled Holes with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for US rebar in cracked concrete[1,2,3,4,5,6,7,8,9]

		Tension — ϕN_n				Shear — ϕV_n			
Rebar size	Effective embedment in. (mm)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
#5	5-5/8 (143)	6,965 (31.0)	6,965 (31.0)	6,965 (31.0)	6,965 (31.0)	15,000 (66.7)	15,000 (66.7)	15,000 (66.7)	15,000 (66.7)
	7-1/2 (191)	9,285 (41.3)	9,285 (41.3)	9,285 (41.3)	9,285 (41.3)	20,000 (89.0)	20,000 (89.0)	20,000 (89.0)	20,000 (89.0)
	12-1/2 (318)	15,475 (68.8)	15,475 (68.8)	15,475 (68.8)	15,475 (68.8)	33,330 (148.3)	33,330 (148.3)	33,330 (148.3)	33,330 (148.3)
#6	6-3/4 (171)	9,690 (43.1)	10,235 (45.5)	10,235 (45.5)	10,235 (45.5)	20,870 (92.8)	22,045 (98.1)	22,045 (98.1)	22,045 (98.1)
	9 (229)	13,645 (60.7)	13,645 (60.7)	13,645 (60.7)	13,645 (60.7)	29,390 (130.7)	29,390 (130.7)	29,390 (130.7)	29,390 (130.7)
	11-1/4 (286)	17,055 (75.9)	17,055 (75.9)	17,055 (75.9)	17,055 (75.9)	36,740 (163.4)	36,740 (163.4)	36,740 (163.4)	36,740 (163.4)
#7	7-7/8 (200)	12,210 (54.3)	13,375 (59.5)	13,930 (62.0)	13,930 (62.0)	26,300 (117.0)	28,810 (128.2)	30,005 (133.5)	30,005 (133.5)
	10-1/2 (267)	18,575 (82.6)	18,575 (82.6)	18,575 (82.6)	18,575 (82.6)	40,005 (178.0)	40,005 (178.0)	40,005 (178.0)	40,005 (178.0)
	17-1/2 (445)	30,955 (137.7)	30,955 (137.7)	30,955 (137.7)	30,955 (137.7)	66,675 (296.6)	66,675 (296.6)	66,675 (296.6)	66,675 (296.6)
#8	9 (229)	14,920 (66.4)	16,340 (72.7)	18,285 (81.3)	18,285 (81.3)	32,130 (142.9)	35,195 (156.6)	39,385 (175.2)	39,385 (175.2)
	12 (305)	22,965 (102.2)	24,380 (108.4)	24,380 (108.4)	24,380 (108.4)	49,465 (220.0)	52,515 (233.6)	52,515 (233.6)	52,515 (233.6)
	20 (508)	40,635 (180.8)	40,635 (180.8)	40,635 (180.8)	40,635 (180.8)	87,525 (389.3)	87,525 (389.3)	87,525 (389.3)	87,525 (389.3)
#9	10-1/8 (257)	17,800 (79.2)	19,500 (86.7)	22,515 (100.2)	22,560 (100.4)	38,340 (170.5)	42,000 (186.8)	48,495 (215.7)	48,595 (216.2)
	13-1/2 (343)	27,405 (121.9)	30,020 (133.5)	30,085 (133.8)	30,085 (133.8)	59,025 (262.6)	64,660 (287.6)	64,795 (288.2)	64,795 (288.2)
	22-1/2 (572)	50,140 (223.0)	50,140 (223.0)	50,140 (223.0)	50,140 (223.0)	107,990 (480.4)	107,990 (480.4)	107,990 (480.4)	107,990 (480.4)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 8 - 23 as necessary to the above values. Compare to the steel values in table 7. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C). For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete and water-saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.68. See section 3.1.8 for additional information on seismic applications.

Table 7 — Steel design strength for US rebar[1]

	ASTM A 615 Grade 40[2]			ASTM A 615 Grade 60[2]			ASTM A 706 Grade 60[2]		
Rebar size	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic Shear[5] $\phi V_{sa,eq}$ lb (kN)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic Shear[5] $\phi V_{sa,eq}$ lb (kN)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic Shear[5] $\phi V_{sa,eq}$ lb (kN)
#3	4,290 (19.1)	2,375 (10.6)	1,665 (7.4)	5,720 (25.4)	3,170 (14.1)	2,220 (9.9)	6,600 (29.4)	3,430 (15.3)	2,400 (10.7)
#4	7,800 (34.7)	4,320 (19.2)	3,025 (13.5)	10,400 (46.3)	5,760 (25.6)	4,030 (17.9)	12,000 (53.4)	6,240 (27.8)	4,370 (19.4)
#5	12,090 (53.8)	6,695 (29.8)	4,685 (20.8)	16,120 (71.7)	8,930 (39.7)	6,250 (27.8)	18,600 (82.7)	9,670 (43.0)	6,770 (30.1)
#6	17,160 (76.3)	9,505 (42.3)	6,655 (29.6)	22,880 (101.8)	12,670 (56.4)	8,870 (39.5)	26,400 (117.4)	13,730 (61.1)	9,610 (42.7)
#7	23,400 (104.1)	12,960 (57.6)	9,070 (40.3)	31,200 (138.8)	17,280 (76.9)	12,095 (53.8)	36,000 (160.1)	18,720 (83.3)	13,105 (58.3)
#8	30,810 (137.0)	17,065 (75.9)	11,945 (53.1)	41,080 (182.7)	22,750 (101.2)	15,925 (70.8)	47,400 (210.8)	24,650 (109.6)	17,255 (76.8)
#9	39,000 (173.5)	21,600 (96.1)	15,120 (67.3)	52,000 (231.3)	28,800 (128.1)	20,160 (89.7)	60,000 (266.9)	31,200 (138.8)	21,840 (97.1)
#10	49,530 (220.3)	27,430 (122.0)	19,200 (85.4)	66,040 (293.8)	36,575 (162.7)	25,605 (113.9)	76,200 (339.0)	39,625 (176.3)	27,740 (123.4)

1 See Section 3.1.8 to convert design strength value to ASD value.

2 ASTM A706 Grade 60 rebar are considered ductile steel elements. ASTM A 615 Grade 40 and 60 rebar are considered brittle steel elements.

3 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17

4 Shear = $\phi\ 0.60 A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17

5 Seismic Shear = $\alpha_{V,seis} \phi V_{sa}$: Reduction for seismic shear only. See section 3.1.8 for additional information on seismic applications.

Table 8 — Load adjustment factors for #3 rebar in uncracked concrete[1,2,3]

#3 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ‖ To and away from edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
Embedment		in.	3-3/8	4-1/2	7-1/2	3-3/8	4-1/2	7-1/2	3-3/8	4-1/2	7-1/2	3-3/8	4-1/2	7-1/2	3-3/8	4-1/2	7-1/2	3-3/8	4-1/2	7-1/2
h_{ef}		(mm)	(86)	(114)	(191)	(86)	(114)	(191)	(86)	(114)	(191)	(86)	(114)	(191)	(86)	(114)	(191)	(86)	(114)	(191)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.29	0.22	0.13	n/a	n/a	n/a	0.07	0.06	0.03	0.15	0.11	0.07	n/a	n/a	n/a
	1-7/8	(48)	0.59	0.57	0.54	0.30	0.22	0.13	0.53	0.53	0.52	0.08	0.06	0.04	0.17	0.12	0.07	n/a	n/a	n/a
	2	(51)	0.59	0.57	0.54	0.31	0.23	0.13	0.53	0.53	0.52	0.09	0.07	0.04	0.18	0.14	0.08	n/a	n/a	n/a
	3	(76)	0.64	0.61	0.57	0.38	0.28	0.16	0.55	0.54	0.53	0.17	0.13	0.08	0.34	0.25	0.15	n/a	n/a	n/a
	4	(102)	0.69	0.65	0.59	0.45	0.33	0.19	0.57	0.56	0.54	0.26	0.19	0.12	0.45	0.33	0.19	n/a	n/a	n/a
	4-5/8	(117)	0.72	0.67	0.60	0.50	0.37	0.22	0.58	0.56	0.55	0.32	0.24	0.14	0.50	0.37	0.22	0.56	n/a	n/a
	5	(127)	0.74	0.69	0.61	0.54	0.39	0.23	0.58	0.57	0.55	0.36	0.27	0.16	0.54	0.39	0.23	0.58	n/a	n/a
	5-3/4	(146)	0.77	0.71	0.63	0.61	0.45	0.26	0.60	0.58	0.56	0.45	0.33	0.20	0.61	0.45	0.26	0.62	0.57	n/a
	6	(152)	0.78	0.72	0.63	0.64	0.47	0.27	0.60	0.58	0.56	0.47	0.36	0.21	0.64	0.47	0.27	0.64	0.58	n/a
	7	(178)	0.83	0.76	0.66	0.75	0.54	0.32	0.62	0.60	0.57	0.60	0.45	0.27	0.75	0.54	0.32	0.69	0.63	n/a
	8	(203)	0.88	0.80	0.68	0.85	0.62	0.36	0.64	0.61	0.58	0.73	0.55	0.33	0.85	0.62	0.36	0.74	0.67	n/a
	8-3/4	(222)	0.91	0.82	0.69	0.93	0.68	0.39	0.65	0.62	0.59	0.84	0.63	0.38	0.93	0.68	0.39	0.77	0.70	0.59
	9	(229)	0.92	0.83	0.70	0.96	0.70	0.41	0.65	0.63	0.59	0.87	0.65	0.39	0.96	0.70	0.41	0.78	0.71	0.60
	10	(254)	0.97	0.87	0.72	1.00	0.78	0.45	0.67	0.64	0.60	1.00	0.77	0.46	1.00	0.78	0.45	0.82	0.75	0.63
	11	(279)	1.00	0.91	0.74		0.85	0.50	0.69	0.65	0.61		0.88	0.53		0.85	0.50	0.86	0.78	0.66
	12	(305)		0.94	0.77		0.93	0.54	0.70	0.67	0.62		1.00	0.60		0.93	0.54	0.90	0.82	0.69
	14	(356)		1.00	0.81		1.00	0.63	0.74	0.70	0.64			0.76		1.00	0.63	0.97	0.88	0.75
	16	(406)			0.86			0.72	0.77	0.72	0.66			0.93			0.72	1.00	0.95	0.80
	18	(457)			0.90			0.81	0.80	0.75	0.68			1.00			0.81		1.00	0.85
	24	(610)			1.00			1.00	0.91	0.83	0.74						1.00			0.98
	30	(762)							1.00	0.92	0.80									1.00
	36	(914)								1.00	0.86									
	> 48	(1219)									0.98									

Table 9 — Load adjustment factors for #3 rebar in cracked concrete[1,2,3]

#3 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ‖ To and away from edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
Embedment		in.	3-3/8	4-1/2	7-1/2	3-3/8	4-1/2	7-1/2	3-3/8	4-1/2	7-1/2	3-3/8	4-1/2	7-1/2	3-3/8	4-1/2	7-1/2	3-3/8	4-1/2	7-1/2
h_{ef}		(mm)	(86)	(114)	(191)	(86)	(114)	(191)	(86)	(114)	(191)	(86)	(114)	(191)	(86)	(114)	(191)	(86)	(114)	(191)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.53	0.49	0.43	n/a	n/a	n/a	0.07	0.05	0.03	0.14	0.11	0.06	n/a	n/a	n/a
	1-7/8	(48)	0.59	0.57	0.54	0.55	0.50	0.44	0.53	0.53	0.52	0.08	0.06	0.03	0.16	0.12	0.07	n/a	n/a	n/a
	2	(51)	0.59	0.57	0.54	0.56	0.51	0.44	0.53	0.53	0.52	0.09	0.06	0.04	0.17	0.13	0.08	n/a	n/a	n/a
	3	(76)	0.64	0.61	0.57	0.68	0.60	0.49	0.55	0.54	0.53	0.16	0.12	0.07	0.32	0.24	0.14	n/a	n/a	n/a
	4	(102)	0.69	0.65	0.59	0.81	0.70	0.55	0.57	0.55	0.54	0.25	0.18	0.11	0.49	0.36	0.22	n/a	n/a	n/a
	4-5/8	(117)	0.72	0.67	0.60	0.90	0.76	0.58	0.58	0.56	0.54	0.31	0.23	0.14	0.61	0.45	0.27	0.55	n/a	n/a
	5	(127)	0.74	0.69	0.61	0.95	0.80	0.60	0.58	0.57	0.55	0.34	0.25	0.15	0.69	0.51	0.30	0.57	n/a	n/a
	5-3/4	(146)	0.77	0.71	0.63	1.00	0.88	0.64	0.59	0.58	0.55	0.42	0.31	0.19	0.85	0.63	0.38	0.61	0.55	n/a
	6	(152)	0.78	0.72	0.63		0.91	0.66	0.60	0.58	0.56	0.45	0.33	0.20	0.91	0.67	0.40	0.63	0.57	n/a
	7	(178)	0.83	0.76	0.66		1.00	0.72	0.61	0.59	0.57	0.57	0.42	0.25	1.00	0.84	0.50	0.68	0.61	n/a
	8	(203)	0.88	0.80	0.68			0.78	0.63	0.61	0.58	0.70	0.51	0.31		1.00	0.62	0.72	0.65	n/a
	8-3/4	(222)	0.91	0.82	0.69			0.83	0.64	0.62	0.58	0.80	0.59	0.35			0.70	0.76	0.68	0.58
	9	(229)	0.92	0.83	0.70			0.85	0.65	0.62	0.59	0.83	0.61	0.37			0.74	0.77	0.69	0.58
	10	(254)	0.97	0.87	0.72			0.91	0.66	0.63	0.60	0.97	0.72	0.43			0.86	0.81	0.73	0.62
	11	(279)	1.00	0.91	0.74			0.98	0.68	0.65	0.60	1.00	0.83	0.50			0.98	0.85	0.77	0.65
	12	(305)		0.94	0.77			1.00	0.70	0.66	0.61		0.94	0.57			1.00	0.89	0.80	0.68
	14	(356)		1.00	0.81				0.73	0.69	0.63		1.00	0.71				0.96	0.86	0.73
	16	(406)			0.86				0.76	0.71	0.65			0.87				1.00	0.92	0.78
	18	(457)			0.90				0.79	0.74	0.67			1.00					0.98	0.83
	24	(610)			1.00				0.89	0.82	0.73			1.00					1.00	0.96
	30	(762)							0.99	0.90	0.79			1.00						1.00
	36	(914)							1.00	0.98	0.84			1.00						
	> 48	(1219)								1.00	0.96			1.00						

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 10 — Load adjustment factors for #4 rebar in uncracked concrete[1,2,3]

#4 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.26	0.20	0.11	n/a	n/a	n/a	0.05	0.04	0.02	0.11	0.07	0.04	n/a	n/a	n/a
	2-1/2	(64)	0.59	0.57	0.54	0.29	0.22	0.13	0.53	0.53	0.52	0.09	0.06	0.04	0.18	0.13	0.08	n/a	n/a	n/a
	3	(76)	0.61	0.58	0.55	0.32	0.24	0.14	0.54	0.53	0.52	0.12	0.08	0.05	0.24	0.17	0.10	n/a	n/a	n/a
	4	(102)	0.64	0.61	0.57	0.37	0.28	0.16	0.55	0.54	0.53	0.18	0.13	0.08	0.37	0.26	0.15	n/a	n/a	n/a
	5	(127)	0.68	0.64	0.58	0.42	0.32	0.18	0.57	0.55	0.54	0.26	0.18	0.11	0.42	0.32	0.18	n/a	n/a	n/a
	5-3/4	(146)	0.70	0.66	0.60	0.47	0.35	0.20	0.58	0.56	0.54	0.32	0.22	0.13	0.47	0.35	0.20	0.56	n/a	n/a
	6	(152)	0.71	0.67	0.60	0.48	0.36	0.21	0.58	0.56	0.55	0.34	0.24	0.14	0.48	0.36	0.21	0.57	n/a	n/a
	7	(178)	0.75	0.69	0.62	0.55	0.40	0.24	0.59	0.57	0.55	0.42	0.30	0.18	0.55	0.40	0.24	0.61	n/a	n/a
	7-1/4	(184)	0.76	0.70	0.62	0.57	0.42	0.24	0.60	0.58	0.55	0.45	0.31	0.19	0.57	0.42	0.24	0.62	0.55	n/a
	8	(203)	0.79	0.72	0.63	0.63	0.46	0.27	0.61	0.58	0.56	0.52	0.36	0.22	0.63	0.46	0.27	0.66	0.58	n/a
	9	(229)	0.82	0.75	0.65	0.70	0.52	0.30	0.62	0.60	0.57	0.62	0.43	0.26	0.70	0.52	0.30	0.70	0.62	n/a
	10	(254)	0.86	0.78	0.67	0.78	0.57	0.34	0.63	0.61	0.58	0.72	0.51	0.30	0.78	0.57	0.34	0.73	0.65	n/a
	11-1/4	(286)	0.90	0.81	0.69	0.88	0.65	0.38	0.65	0.62	0.58	0.86	0.60	0.36	0.88	0.65	0.38	0.78	0.69	0.58
	12	(305)	0.93	0.83	0.70	0.94	0.69	0.40	0.66	0.63	0.59	0.95	0.67	0.40	0.94	0.69	0.40	0.80	0.71	0.60
	14	(356)	1.00	0.89	0.73	1.00	0.80	0.47	0.69	0.65	0.61	1.00	0.84	0.50	1.00	0.80	0.47	0.87	0.77	0.65
	16	(406)		0.94	0.77		0.92	0.54	0.72	0.67	0.62		1.00	0.61		0.92	0.54	0.93	0.82	0.69
	18	(457)		1.00	0.80		1.00	0.60	0.74	0.69	0.64			0.73		1.00	0.60	0.98	0.87	0.74
	20	(508)			0.83			0.67	0.77	0.71	0.65			0.86			0.67	1.00	0.92	0.78
	22	(559)			0.87			0.74	0.80	0.73	0.67			0.99			0.74		0.97	0.81
	24	(610)			0.90			0.81	0.82	0.75	0.68			1.00			0.81		1.00	0.85
	30	(762)			1.00			1.00	0.90	0.82	0.73						1.00			0.95
	36	(914)							0.98	0.88	0.77									1.00
	> 48	(1219)							1.00	1.00	0.86									

Table 11 — Load adjustment factors for #4 rebar in cracked concrete[1,2,3]

#4 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.48	0.45	0.41	n/a	n/a	n/a	0.05	0.03	0.02	0.11	0.07	0.04	n/a	n/a	n/a
	2-1/2	(64)	0.59	0.57	0.54	0.55	0.50	0.44	0.53	0.53	0.52	0.09	0.06	0.03	0.18	0.12	0.07	n/a	n/a	n/a
	3	(76)	0.61	0.58	0.55	0.59	0.53	0.46	0.54	0.53	0.52	0.12	0.08	0.05	0.24	0.16	0.09	n/a	n/a	n/a
	4	(102)	0.64	0.61	0.57	0.68	0.60	0.49	0.55	0.54	0.53	0.18	0.12	0.07	0.37	0.24	0.14	n/a	n/a	n/a
	5	(127)	0.68	0.64	0.58	0.78	0.67	0.53	0.57	0.55	0.54	0.26	0.17	0.10	0.52	0.34	0.20	n/a	n/a	n/a
	5-3/4	(146)	0.70	0.66	0.60	0.86	0.73	0.56	0.58	0.56	0.54	0.32	0.21	0.12	0.64	0.41	0.24	0.56	n/a	n/a
	6	(152)	0.71	0.67	0.60	0.89	0.75	0.57	0.58	0.56	0.54	0.34	0.22	0.13	0.68	0.44	0.26	0.57	n/a	n/a
	7	(178)	0.75	0.69	0.62	1.00	0.83	0.62	0.59	0.57	0.55	0.43	0.28	0.16	0.86	0.56	0.33	0.62	n/a	n/a
	7-1/4	(184)	0.76	0.70	0.62		0.85	0.63	0.60	0.57	0.55	0.45	0.29	0.17	0.90	0.59	0.34	0.63	0.54	n/a
	8	(203)	0.79	0.72	0.63		0.91	0.66	0.61	0.58	0.56	0.52	0.34	0.20	1.00	0.68	0.40	0.66	0.57	n/a
	9	(229)	0.82	0.75	0.65		1.00	0.70	0.62	0.59	0.56	0.62	0.41	0.24		0.81	0.47	0.70	0.60	n/a
	10	(254)	0.86	0.78	0.67			0.75	0.64	0.60	0.57	0.73	0.47	0.28		0.95	0.56	0.74	0.64	n/a
	11-1/4	(286)	0.90	0.81	0.69			0.81	0.65	0.61	0.58	0.87	0.57	0.33		1.00	0.66	0.78	0.68	0.56
	12	(305)	0.93	0.83	0.70			0.85	0.66	0.62	0.59	0.96	0.62	0.36			0.73	0.81	0.70	0.58
	14	(356)	1.00	0.89	0.73			0.95	0.69	0.64	0.60	1.00	0.79	0.46			0.92	0.87	0.75	0.63
	16	(406)		0.94	0.77			1.00	0.72	0.66	0.61		0.96	0.56			1.00	0.93	0.81	0.67
	18	(457)		1.00	0.80				0.74	0.68	0.63		1.00	0.67				0.99	0.85	0.71
	20	(508)			0.83				0.77	0.70	0.64			0.79				1.00	0.90	0.75
	22	(559)			0.87				0.80	0.72	0.66			0.91					0.94	0.79
	24	(610)			0.90				0.82	0.74	0.67			1.00					0.99	0.83
	30	(762)			1.00				0.91	0.80	0.71								1.00	0.92
	36	(914)							0.99	0.87	0.76									1.00
	> 48	(1219)							1.00	0.99	0.84									

[1] Linear interpolation not permitted.

[2] Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 12 — Load adjustment factors for #5 rebar in uncracked concrete[1,2,3]

#5 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment		in.	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2
h_{ef}		(mm)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.24	0.18	0.11	n/a	n/a	n/a	0.04	0.03	0.02	0.08	0.06	0.03	n/a	n/a	n/a
	3-1/8	(79)	0.59	0.57	0.54	0.29	0.22	0.13	0.54	0.53	0.52	0.10	0.07	0.04	0.20	0.13	0.08	n/a	n/a	n/a
	4	(102)	0.61	0.59	0.55	0.33	0.25	0.14	0.55	0.53	0.52	0.15	0.10	0.06	0.29	0.19	0.11	n/a	n/a	n/a
	5	(127)	0.64	0.61	0.57	0.37	0.28	0.16	0.56	0.54	0.53	0.21	0.13	0.08	0.37	0.27	0.16	n/a	n/a	n/a
	6	(152)	0.67	0.63	0.58	0.41	0.31	0.18	0.57	0.55	0.54	0.27	0.18	0.10	0.41	0.31	0.18	n/a	n/a	n/a
	7	(178)	0.70	0.66	0.59	0.46	0.34	0.20	0.58	0.56	0.54	0.34	0.22	0.13	0.46	0.34	0.20	n/a	n/a	n/a
	7-1/8	(181)	0.70	0.66	0.60	0.46	0.34	0.20	0.58	0.56	0.54	0.35	0.23	0.13	0.46	0.34	0.20	0.57	n/a	n/a
	8	(203)	0.73	0.68	0.61	0.51	0.38	0.22	0.59	0.57	0.55	0.41	0.27	0.16	0.51	0.38	0.22	0.61	n/a	n/a
	9	(229)	0.76	0.70	0.62	0.56	0.41	0.24	0.60	0.58	0.55	0.50	0.32	0.19	0.56	0.41	0.24	0.65	0.56	n/a
	10	(254)	0.79	0.72	0.63	0.63	0.46	0.27	0.62	0.59	0.56	0.58	0.38	0.22	0.63	0.46	0.27	0.68	0.59	n/a
	11	(279)	0.82	0.74	0.65	0.69	0.51	0.30	0.63	0.60	0.57	0.67	0.43	0.25	0.69	0.51	0.30	0.71	0.62	n/a
	12	(305)	0.84	0.77	0.66	0.75	0.55	0.32	0.64	0.60	0.57	0.76	0.50	0.29	0.75	0.55	0.32	0.75	0.65	n/a
	14	(356)	0.90	0.81	0.69	0.88	0.64	0.38	0.66	0.62	0.59	0.96	0.62	0.36	0.88	0.64	0.38	0.81	0.70	0.58
	16	(406)	0.96	0.86	0.71	1.00	0.74	0.43	0.69	0.64	0.60	1.00	0.76	0.45	1.00	0.74	0.43	0.86	0.75	0.62
	18	(457)	1.00	0.90	0.74		0.83	0.49	0.71	0.66	0.61		0.91	0.53		0.83	0.49	0.91	0.79	0.66
	20	(508)		0.94	0.77		0.92	0.54	0.73	0.67	0.62		1.00	0.62		0.92	0.54	0.96	0.83	0.70
	22	(559)		0.99	0.79		1.00	0.59	0.75	0.69	0.63			0.72		1.00	0.59	1.00	0.87	0.73
	24	(610)		1.00	0.82			0.65	0.78	0.71	0.65			0.82			0.65		0.91	0.76
	26	(660)			0.85			0.70	0.80	0.73	0.66			0.92			0.70		0.95	0.79
	28	(711)			0.87			0.75	0.82	0.74	0.67			1.00			0.75		0.99	0.82
	30	(762)			0.90			0.81	0.85	0.76	0.68						0.81		1.00	0.85
	36	(914)			0.98			0.97	0.92	0.81	0.72						0.97			0.94
	> 48	(1219)			1.00			1.00	1.00	0.92	0.79						1.00			1.00

Table 13 — Load adjustment factors for #5 rebar in cracked concrete[1,2,3]

#5 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment		in.	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2	5-5/8	7-1/2	12-1/2
h_{ef}		(mm)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)	(143)	(191)	(318)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.46	0.43	0.40	n/a	n/a	n/a	0.04	0.03	0.01	0.09	0.06	0.03	n/a	n/a	n/a
	3-1/8	(79)	0.59	0.57	0.54	0.55	0.50	0.44	0.54	0.53	0.52	0.10	0.07	0.03	0.20	0.13	0.07	n/a	n/a	n/a
	4	(102)	0.61	0.59	0.55	0.61	0.55	0.46	0.55	0.53	0.52	0.15	0.10	0.05	0.30	0.19	0.10	n/a	n/a	n/a
	5	(127)	0.64	0.61	0.57	0.69	0.60	0.49	0.56	0.54	0.53	0.21	0.13	0.07	0.41	0.27	0.14	n/a	n/a	n/a
	6	(152)	0.67	0.63	0.58	0.77	0.66	0.53	0.57	0.55	0.53	0.27	0.18	0.09	0.54	0.35	0.18	n/a	n/a	n/a
	7	(178)	0.70	0.66	0.59	0.85	0.72	0.56	0.58	0.56	0.54	0.34	0.22	0.11	0.68	0.44	0.23	n/a	n/a	n/a
	7-1/8	(181)	0.70	0.66	0.60	0.86	0.73	0.56	0.58	0.56	0.54	0.35	0.23	0.12	0.70	0.46	0.23	0.58	n/a	n/a
	8	(203)	0.73	0.68	0.61	0.93	0.78	0.59	0.59	0.57	0.54	0.42	0.27	0.14	0.84	0.54	0.28	0.61	n/a	n/a
	9	(229)	0.76	0.70	0.62	1.00	0.85	0.62	0.60	0.58	0.55	0.50	0.32	0.17	1.00	0.65	0.33	0.65	0.56	n/a
	10	(254)	0.79	0.72	0.63		0.91	0.66	0.62	0.59	0.56	0.58	0.38	0.19		0.76	0.39	0.68	0.59	n/a
	11	(279)	0.82	0.74	0.65		0.98	0.69	0.63	0.60	0.56	0.67	0.44	0.22		0.88	0.45	0.72	0.62	n/a
	12	(305)	0.84	0.77	0.66		1.00	0.73	0.64	0.60	0.57	0.77	0.50	0.26		1.00	0.51	0.75	0.65	n/a
	14	(356)	0.90	0.81	0.69			0.81	0.66	0.62	0.58	0.97	0.63	0.32			0.64	0.81	0.70	0.56
	16	(406)	0.96	0.86	0.71			0.89	0.69	0.64	0.59	1.00	0.77	0.39			0.79	0.86	0.75	0.60
	18	(457)	1.00	0.90	0.74			0.97	0.71	0.66	0.60		0.92	0.47			0.94	0.92	0.79	0.63
	20	(508)		0.94	0.77			1.00	0.73	0.67	0.61		1.00	0.55			1.00	0.97	0.84	0.67
	22	(559)		0.99	0.79				0.76	0.69	0.62			0.63				1.00	0.88	0.70
	24	(610)		1.00	0.82				0.78	0.71	0.63			0.72					0.92	0.73
	26	(660)			0.85				0.80	0.73	0.65			0.81					0.95	0.76
	28	(711)			0.87				0.83	0.74	0.66			0.91					0.99	0.79
	30	(762)			0.90				0.85	0.76	0.67			1.00					1.00	0.82
	36	(914)			0.98				0.92	0.81	0.70									0.90
	> 48	(1219)			1.00				1.00	0.92	0.77									1.00

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 14 — Load adjustment factors for #6 rebar in uncracked concrete[1,2,3]

#6 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ‖ To and away from edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
Embedment h_{ef}	in. (mm)		6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.24	0.18	0.10	n/a	n/a	n/a	0.03	0.02	0.01	0.07	0.05	0.02	n/a	n/a	n/a
	3-3/4	(95)	0.59	0.57	0.54	0.30	0.22	0.13	0.54	0.53	0.52	0.11	0.07	0.04	0.22	0.14	0.08	n/a	n/a	n/a
	4	(102)	0.60	0.57	0.54	0.31	0.23	0.13	0.54	0.53	0.52	0.12	0.08	0.04	0.24	0.16	0.08	n/a	n/a	n/a
	5	(127)	0.62	0.59	0.56	0.34	0.25	0.15	0.55	0.54	0.53	0.17	0.11	0.06	0.33	0.22	0.12	n/a	n/a	n/a
	6	(152)	0.64	0.61	0.57	0.38	0.28	0.16	0.56	0.55	0.53	0.22	0.14	0.08	0.38	0.28	0.16	n/a	n/a	n/a
	7	(178)	0.67	0.63	0.58	0.41	0.30	0.18	0.57	0.55	0.54	0.28	0.18	0.10	0.41	0.30	0.18	n/a	n/a	n/a
	8	(203)	0.69	0.65	0.59	0.45	0.33	0.19	0.58	0.56	0.54	0.34	0.22	0.12	0.45	0.33	0.19	n/a	n/a	n/a
	8-1/2	(216)	0.70	0.66	0.59	0.47	0.34	0.20	0.59	0.56	0.54	0.37	0.24	0.13	0.47	0.34	0.20	0.59	n/a	n/a
	9	(229)	0.72	0.67	0.60	0.49	0.36	0.21	0.59	0.57	0.55	0.40	0.26	0.14	0.49	0.36	0.21	0.60	n/a	n/a
	10	(254)	0.74	0.69	0.61	0.53	0.39	0.23	0.60	0.58	0.55	0.47	0.31	0.17	0.53	0.39	0.23	0.64	n/a	n/a
	10-3/4	(273)	0.76	0.70	0.62	0.57	0.41	0.24	0.61	0.58	0.55	0.53	0.34	0.19	0.57	0.41	0.24	0.66	0.57	n/a
	12	(305)	0.79	0.72	0.63	0.64	0.46	0.27	0.62	0.59	0.56	0.62	0.40	0.22	0.64	0.46	0.27	0.70	0.60	n/a
	14	(356)	0.84	0.76	0.66	0.74	0.54	0.32	0.64	0.61	0.57	0.78	0.51	0.28	0.74	0.54	0.32	0.75	0.65	n/a
	16	(406)	0.89	0.80	0.68	0.85	0.62	0.36	0.66	0.62	0.58	0.96	0.62	0.34	0.85	0.62	0.36	0.80	0.70	n/a
	16-3/4	(425)	0.90	0.81	0.69	0.89	0.65	0.38	0.67	0.63	0.58	1.00	0.67	0.36	0.89	0.65	0.38	0.82	0.71	0.58
	18	(457)	0.93	0.83	0.70	0.96	0.69	0.41	0.68	0.64	0.59		0.74	0.40	0.96	0.69	0.41	0.85	0.74	0.60
	20	(508)	0.98	0.87	0.72	1.00	0.77	0.45	0.70	0.65	0.60		0.87	0.47	1.00	0.77	0.45	0.90	0.78	0.64
	22	(559)	1.00	0.91	0.74		0.85	0.50	0.72	0.67	0.61		1.00	0.54		0.85	0.50	0.94	0.82	0.67
	24	(610)		0.94	0.77		0.93	0.54	0.74	0.68	0.62			0.62		0.93	0.54	0.99	0.85	0.70
	26	(660)		0.98	0.79		1.00	0.59	0.76	0.70	0.63			0.70		1.00	0.59	1.00	0.89	0.72
	28	(711)		1.00	0.81			0.63	0.78	0.71	0.64			0.78			0.63		0.92	0.75
	30	(762)			0.83			0.68	0.80	0.73	0.65			0.87			0.68		0.95	0.78
	36	(914)			0.90			0.81	0.86	0.77	0.68			1.00			0.81		1.00	0.85
	> 48	(1219)			1.00			1.00	0.99	0.86	0.74						1.00			0.98

Table 15 — Load adjustment factors for #6 rebar in cracked concrete[1,2,3]

#6 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ‖ To and away from edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
Embedment h_{ef}	in. (mm)		6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.44	0.42	0.39	n/a	n/a	n/a	0.03	0.02	0.01	0.07	0.05	0.02	n/a	n/a	n/a
	3-3/4	(95)	0.59	0.57	0.54	0.55	0.50	0.44	0.54	0.53	0.52	0.11	0.07	0.03	0.22	0.14	0.07	n/a	n/a	n/a
	4	(102)	0.60	0.57	0.54	0.57	0.51	0.44	0.54	0.53	0.52	0.12	0.08	0.04	0.24	0.16	0.07	n/a	n/a	n/a
	5	(127)	0.62	0.59	0.56	0.63	0.56	0.47	0.55	0.54	0.52	0.17	0.11	0.05	0.34	0.22	0.10	n/a	n/a	n/a
	6	(152)	0.64	0.61	0.57	0.69	0.60	0.49	0.56	0.55	0.53	0.22	0.14	0.07	0.44	0.29	0.13	n/a	n/a	n/a
	7	(178)	0.67	0.63	0.58	0.76	0.65	0.52	0.57	0.55	0.53	0.28	0.18	0.08	0.56	0.36	0.17	n/a	n/a	n/a
	8	(203)	0.69	0.65	0.59	0.82	0.70	0.55	0.58	0.56	0.54	0.34	0.22	0.10	0.68	0.44	0.21	n/a	n/a	n/a
	8-1/2	(216)	0.70	0.66	0.59	0.86	0.72	0.56	0.59	0.56	0.54	0.37	0.24	0.11	0.75	0.49	0.23	0.59	n/a	n/a
	9	(229)	0.72	0.67	0.60	0.90	0.75	0.57	0.59	0.57	0.54	0.41	0.26	0.12	0.82	0.53	0.25	0.61	n/a	n/a
	10	(254)	0.74	0.69	0.61	0.97	0.80	0.60	0.60	0.58	0.55	0.48	0.31	0.14	0.95	0.62	0.29	0.64	n/a	n/a
	10-3/4	(273)	0.76	0.70	0.62	1.00	0.84	0.62	0.61	0.58	0.55	0.53	0.35	0.16	1.00	0.69	0.32	0.66	0.57	n/a
	12	(305)	0.79	0.72	0.63		0.91	0.66	0.62	0.59	0.55	0.63	0.41	0.19		0.82	0.38	0.70	0.61	n/a
	14	(356)	0.84	0.76	0.66		1.00	0.72	0.64	0.61	0.56	0.79	0.51	0.24		1.00	0.48	0.76	0.65	n/a
	16	(406)	0.89	0.80	0.68			0.78	0.66	0.62	0.57	0.97	0.63	0.29			0.58	0.81	0.70	n/a
	16-3/4	(425)	0.90	0.81	0.69			0.81	0.67	0.63	0.58	1.00	0.67	0.31			0.62	0.83	0.72	0.55
	18	(457)	0.93	0.83	0.70			0.85	0.68	0.64	0.58		0.75	0.35			0.70	0.86	0.74	0.57
	20	(508)	0.98	0.87	0.72			0.91	0.70	0.65	0.59		0.88	0.41			0.82	0.90	0.78	0.61
	22	(559)	1.00	0.91	0.74			0.98	0.72	0.67	0.60		1.00	0.47			0.94	0.95	0.82	0.63
	24	(610)		0.94	0.77			1.00	0.74	0.68	0.61			0.54			1.00	0.99	0.86	0.66
	26	(660)		0.98	0.79				0.76	0.70	0.62			0.60				1.00	0.89	0.69
	28	(711)		1.00	0.81				0.79	0.71	0.63			0.68					0.92	0.72
	30	(762)			0.83				0.81	0.73	0.64			0.75					0.96	0.74
	36	(914)			0.90				0.87	0.77	0.66			0.98					1.00	0.81
	> 48	(1219)			1.00				0.99	0.87	0.72			1.00						0.94

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{HV} = 1.0$.

Table 16 — Load adjustment factors for #7 rebar in uncracked concrete[1,2,3]

#7 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in. (mm)		7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.24	0.17	0.10	n/a	n/a	n/a	0.03	0.02	0.01	0.05	0.04	0.02	n/a	n/a	n/a
	4-3/8	(111)	0.59	0.57	0.54	0.31	0.22	0.13	0.54	0.53	0.52	0.11	0.07	0.04	0.22	0.14	0.07	n/a	n/a	n/a
	5	(127)	0.60	0.58	0.55	0.33	0.23	0.14	0.54	0.53	0.52	0.13	0.09	0.04	0.27	0.17	0.09	n/a	n/a	n/a
	6	(152)	0.62	0.60	0.56	0.36	0.25	0.15	0.55	0.54	0.52	0.17	0.11	0.06	0.35	0.23	0.12	n/a	n/a	n/a
	7	(178)	0.65	0.61	0.57	0.39	0.28	0.16	0.56	0.55	0.53	0.22	0.14	0.07	0.39	0.28	0.15	n/a	n/a	n/a
	8	(203)	0.67	0.63	0.58	0.42	0.30	0.18	0.57	0.55	0.53	0.27	0.17	0.09	0.42	0.30	0.18	n/a	n/a	n/a
	9	(229)	0.69	0.64	0.59	0.45	0.32	0.19	0.58	0.56	0.54	0.32	0.21	0.11	0.45	0.32	0.19	n/a	n/a	n/a
	9-7/8	(251)	0.71	0.66	0.59	0.48	0.34	0.20	0.59	0.56	0.54	0.37	0.24	0.12	0.48	0.34	0.20	0.59	n/a	n/a
	10	(254)	0.71	0.66	0.60	0.49	0.35	0.20	0.59	0.57	0.54	0.38	0.24	0.12	0.49	0.35	0.20	0.59	n/a	n/a
	11	(279)	0.73	0.67	0.60	0.52	0.37	0.22	0.60	0.57	0.55	0.43	0.28	0.14	0.52	0.37	0.22	0.62	n/a	n/a
	12	(305)	0.75	0.69	0.61	0.56	0.40	0.23	0.60	0.58	0.55	0.49	0.32	0.16	0.56	0.40	0.23	0.65	n/a	n/a
	12-1/2	(318)	0.76	0.70	0.62	0.59	0.41	0.24	0.61	0.58	0.55	0.52	0.34	0.17	0.59	0.41	0.24	0.66	0.57	n/a
	14	(356)	0.79	0.72	0.63	0.66	0.46	0.27	0.62	0.59	0.56	0.62	0.40	0.21	0.66	0.46	0.27	0.70	0.60	n/a
	16	(406)	0.83	0.75	0.65	0.75	0.53	0.31	0.64	0.60	0.57	0.76	0.49	0.25	0.75	0.53	0.31	0.75	0.65	n/a
	18	(457)	0.87	0.79	0.67	0.84	0.60	0.35	0.66	0.62	0.57	0.91	0.59	0.30	0.84	0.60	0.35	0.79	0.68	n/a
	19-1/2	(495)	0.91	0.81	0.69	0.92	0.65	0.38	0.67	0.63	0.58	1.00	0.66	0.34	0.92	0.65	0.38	0.82	0.71	0.57
	20	(508)	0.92	0.82	0.69	0.94	0.66	0.39	0.67	0.63	0.58		0.69	0.35	0.94	0.66	0.39	0.83	0.72	0.58
	22	(559)	0.96	0.85	0.71	1.00	0.73	0.43	0.69	0.64	0.59		0.80	0.40	1.00	0.73	0.43	0.87	0.76	0.60
	24	(610)	1.00	0.88	0.73		0.80	0.47	0.71	0.66	0.60		0.91	0.46		0.80	0.47	0.91	0.79	0.63
	26	(660)		0.91	0.75		0.86	0.51	0.73	0.67	0.61		1.00	0.52		0.86	0.51	0.95	0.82	0.66
	28	(711)		0.94	0.77		0.93	0.54	0.74	0.68	0.62			0.58		0.93	0.54	0.99	0.85	0.68
	30	(762)		0.98	0.79		1.00	0.58	0.76	0.70	0.62			0.64		1.00	0.58	1.00	0.88	0.71
	36	(914)		1.00	0.84			0.70	0.81	0.73	0.65			0.85			0.70		0.97	0.77
	> 48	(1219)			0.96			0.93	0.92	0.81	0.70			1.00			0.93		1.00	0.89

Table 17 — Load adjustment factors for #7 rebar in cracked concrete[1,2,3]

#7 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in. (mm)		7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.43	0.41	0.38	n/a	n/a	n/a	0.03	0.02	0.01	0.06	0.04	0.02	n/a	n/a	n/a
	4-3/8	(111)	0.59	0.57	0.54	0.55	0.50	0.44	0.54	0.53	0.52	0.11	0.07	0.03	0.22	0.14	0.07	n/a	n/a	n/a
	5	(127)	0.60	0.58	0.55	0.58	0.52	0.45	0.54	0.53	0.52	0.13	0.09	0.04	0.27	0.17	0.08	n/a	n/a	n/a
	6	(152)	0.62	0.60	0.56	0.64	0.56	0.47	0.55	0.54	0.52	0.18	0.11	0.05	0.35	0.23	0.11	n/a	n/a	n/a
	7	(178)	0.65	0.61	0.57	0.69	0.60	0.49	0.56	0.55	0.53	0.22	0.14	0.07	0.44	0.29	0.13	n/a	n/a	n/a
	8	(203)	0.67	0.63	0.58	0.75	0.64	0.52	0.57	0.55	0.53	0.27	0.18	0.08	0.54	0.35	0.16	n/a	n/a	n/a
	9	(229)	0.69	0.64	0.59	0.81	0.68	0.54	0.58	0.56	0.54	0.32	0.21	0.10	0.65	0.42	0.20	n/a	n/a	n/a
	9-7/8	(251)	0.71	0.66	0.59	0.86	0.72	0.56	0.59	0.56	0.54	0.37	0.24	0.11	0.74	0.48	0.22	0.59	n/a	n/a
	10	(254)	0.71	0.66	0.60	0.87	0.73	0.56	0.59	0.57	0.54	0.38	0.25	0.11	0.76	0.49	0.23	0.59	n/a	n/a
	11	(279)	0.73	0.67	0.60	0.93	0.77	0.59	0.60	0.57	0.54	0.44	0.28	0.13	0.87	0.57	0.26	0.62	n/a	n/a
	12	(305)	0.75	0.69	0.61	1.00	0.82	0.61	0.60	0.58	0.55	0.50	0.32	0.15	1.00	0.65	0.30	0.65	n/a	n/a
	12-1/2	(318)	0.76	0.70	0.62		0.84	0.62	0.61	0.58	0.55	0.53	0.34	0.16		0.69	0.32	0.66	0.57	n/a
	14	(356)	0.79	0.72	0.63		0.91	0.66	0.62	0.59	0.55	0.63	0.41	0.19		0.82	0.38	0.70	0.61	n/a
	16	(406)	0.83	0.75	0.65		1.00	0.71	0.64	0.60	0.56	0.77	0.50	0.23		1.00	0.46	0.75	0.65	n/a
	18	(457)	0.87	0.79	0.67			0.76	0.66	0.62	0.57	0.91	0.59	0.28			0.55	0.79	0.69	n/a
	19-1/2	(495)	0.91	0.81	0.69			0.80	0.67	0.63	0.58	1.00	0.67	0.31			0.62	0.82	0.71	0.55
	20	(508)	0.92	0.82	0.69			0.82	0.67	0.63	0.58		0.70	0.32			0.65	0.84	0.72	0.56
	22	(559)	0.96	0.85	0.71			0.87	0.69	0.64	0.59		0.80	0.37			0.75	0.88	0.76	0.59
	24	(610)	1.00	0.88	0.73			0.93	0.71	0.66	0.59		0.91	0.43			0.85	0.92	0.79	0.61
	26	(660)		0.91	0.75			0.99	0.73	0.67	0.60		1.00	0.48			0.96	0.95	0.82	0.64
	28	(711)		0.94	0.77			1.00	0.74	0.68	0.61			0.54			1.00	0.99	0.86	0.66
	30	(762)		0.98	0.79				0.76	0.70	0.62			0.59				1.00	0.89	0.69
	36	(914)		1.00	0.84				0.81	0.74	0.64			0.78					0.97	0.75
	> 48	(1219)			0.96				0.92	0.81	0.69			1.00					1.00	0.87

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{HV} = 1.0$.

Table 18 — Load adjustment factors for #8 rebar in uncracked concrete[1,2,3]

#8 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}		in.	9	12	20	9	12	20	9	12	20	9	12	20	9	12	20	9	12	20
		(mm)	(229)	(305)	(508)	(229)	(305)	(508)	(229)	(305)	(508)	(229)	(305)	(508)	(229)	(305)	(508)	(229)	(305)	(508)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.24	0.17	0.10	n/a	n/a	n/a	0.02	0.01	0.01	0.05	0.03	0.01	n/a	n/a	n/a
	5	(127)	0.59	0.57	0.54	0.32	0.22	0.13	0.54	0.53	0.52	0.11	0.07	0.03	0.22	0.14	0.07	n/a	n/a	n/a
	6	(152)	0.61	0.58	0.55	0.34	0.24	0.14	0.55	0.53	0.52	0.14	0.09	0.04	0.29	0.19	0.09	n/a	n/a	n/a
	7	(178)	0.63	0.60	0.56	0.37	0.26	0.15	0.55	0.54	0.52	0.18	0.12	0.06	0.36	0.23	0.11	n/a	n/a	n/a
	8	(203)	0.65	0.61	0.57	0.40	0.28	0.16	0.56	0.55	0.53	0.22	0.14	0.07	0.40	0.28	0.14	n/a	n/a	n/a
	9	(229)	0.67	0.63	0.58	0.43	0.30	0.17	0.57	0.55	0.53	0.26	0.17	0.08	0.43	0.30	0.17	n/a	n/a	n/a
	10	(254)	0.68	0.64	0.58	0.46	0.32	0.19	0.58	0.56	0.54	0.31	0.20	0.10	0.46	0.32	0.19	n/a	n/a	n/a
	11	(279)	0.70	0.65	0.59	0.49	0.34	0.20	0.58	0.56	0.54	0.35	0.23	0.11	0.49	0.34	0.20	n/a	n/a	n/a
	11-1/4	(286)	0.71	0.66	0.59	0.50	0.34	0.20	0.59	0.56	0.54	0.37	0.24	0.12	0.50	0.34	0.20	0.58	n/a	n/a
	12	(305)	0.72	0.67	0.60	0.52	0.36	0.21	0.59	0.57	0.54	0.40	0.26	0.13	0.52	0.36	0.21	0.60	n/a	n/a
	13	(330)	0.74	0.68	0.61	0.55	0.38	0.22	0.60	0.57	0.55	0.46	0.30	0.14	0.55	0.38	0.22	0.63	n/a	n/a
	14	(356)	0.76	0.69	0.62	0.59	0.41	0.24	0.61	0.58	0.55	0.51	0.33	0.16	0.59	0.41	0.24	0.65	n/a	n/a
	14-1/4	(362)	0.76	0.70	0.62	0.60	0.42	0.24	0.61	0.58	0.55	0.52	0.34	0.16	0.60	0.42	0.24	0.66	0.57	n/a
	16	(406)	0.79	0.72	0.63	0.67	0.47	0.27	0.62	0.59	0.56	0.62	0.40	0.20	0.67	0.47	0.27	0.70	0.60	n/a
	18	(457)	0.83	0.75	0.65	0.76	0.53	0.31	0.64	0.60	0.56	0.74	0.48	0.23	0.76	0.53	0.31	0.74	0.64	n/a
	20	(508)	0.87	0.78	0.67	0.84	0.58	0.34	0.65	0.61	0.57	0.87	0.56	0.27	0.84	0.58	0.34	0.78	0.67	n/a
	22	(559)	0.90	0.81	0.68	0.93	0.64	0.38	0.67	0.63	0.58	1.00	0.65	0.32	0.93	0.64	0.38	0.82	0.71	n/a
	22-1/4	(565)	0.91	0.81	0.69	0.94	0.65	0.38	0.67	0.63	0.58		0.66	0.32	0.94	0.65	0.38	0.82	0.71	0.56
	24	(610)	0.94	0.83	0.70	1.00	0.70	0.41	0.68	0.64	0.58		0.74	0.36	1.00	0.70	0.41	0.85	0.74	0.58
	26	(660)	0.98	0.86	0.72		0.76	0.45	0.70	0.65	0.59		0.84	0.41		0.76	0.45	0.89	0.77	0.60
	28	(711)	1.00	0.89	0.73		0.82	0.48	0.71	0.66	0.60		0.94	0.45		0.82	0.48	0.92	0.80	0.63
	30	(762)		0.92	0.75		0.88	0.51	0.73	0.67	0.61		1.00	0.50		0.88	0.51	0.95	0.83	0.65
	36	(914)		1.00	0.80		1.00	0.62	0.77	0.70	0.63			0.66		1.00	0.62	1.00	0.91	0.71
	> 48	(1219)			0.90			0.82	0.86	0.77	0.67			1.00			0.82		1.00	0.82

Table 19 — Load adjustment factors for #8 rebar in cracked concrete[1,2,3]

#8 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}		in.	9	12	20	9	12	20	9	12	20	9	12	20	9	12	20	9	12	20
		(mm)	(229)	(305)	(508)	(229)	(305)	(508)	(229)	(305)	(508)	(229)	(305)	(508)	(229)	(305)	(508)	(229)	(305)	(508)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.42	0.40	0.38	n/a	n/a	n/a	0.02	0.01	0.01	0.05	0.03	0.01	n/a	n/a	n/a
	5	(127)	0.59	0.57	0.54	0.55	0.50	0.44	0.54	0.53	0.52	0.11	0.07	0.03	0.22	0.14	0.07	n/a	n/a	n/a
	6	(152)	0.61	0.58	0.55	0.60	0.53	0.46	0.55	0.53	0.52	0.14	0.09	0.04	0.29	0.19	0.09	n/a	n/a	n/a
	7	(178)	0.63	0.60	0.56	0.65	0.57	0.47	0.55	0.54	0.52	0.18	0.12	0.05	0.36	0.24	0.11	n/a	n/a	n/a
	8	(203)	0.65	0.61	0.57	0.70	0.60	0.49	0.56	0.55	0.53	0.22	0.14	0.07	0.44	0.29	0.13	n/a	n/a	n/a
	9	(229)	0.67	0.63	0.58	0.75	0.64	0.51	0.57	0.55	0.53	0.26	0.17	0.08	0.53	0.34	0.16	n/a	n/a	n/a
	10	(254)	0.68	0.64	0.58	0.80	0.67	0.53	0.58	0.56	0.53	0.31	0.20	0.09	0.62	0.40	0.19	n/a	n/a	n/a
	11	(279)	0.70	0.65	0.59	0.85	0.71	0.55	0.58	0.56	0.54	0.36	0.23	0.11	0.72	0.46	0.22	n/a	n/a	n/a
	11-1/4	(286)	0.71	0.66	0.59	0.87	0.72	0.56	0.59	0.56	0.54	0.37	0.24	0.11	0.74	0.48	0.22	0.59	n/a	n/a
	12	(305)	0.72	0.67	0.60	0.91	0.75	0.57	0.59	0.57	0.54	0.41	0.26	0.12	0.82	0.53	0.25	0.61	n/a	n/a
	13	(330)	0.74	0.68	0.61	0.96	0.79	0.59	0.60	0.57	0.54	0.46	0.30	0.14	0.92	0.60	0.28	0.63	n/a	n/a
	14	(356)	0.76	0.69	0.62	1.00	0.83	0.62	0.61	0.58	0.55	0.51	0.33	0.16	1.00	0.67	0.31	0.65	n/a	n/a
	14-1/4	(362)	0.76	0.70	0.62		0.84	0.62	0.61	0.58	0.55	0.53	0.34	0.16		0.69	0.32	0.66	0.57	n/a
	16	(406)	0.79	0.72	0.63		0.91	0.66	0.62	0.59	0.55	0.63	0.41	0.19		0.82	0.38	0.70	0.61	n/a
	18	(457)	0.83	0.75	0.65		1.00	0.70	0.64	0.60	0.56	0.75	0.49	0.23		0.97	0.45	0.74	0.64	n/a
	20	(508)	0.87	0.78	0.67			0.75	0.65	0.61	0.57	0.88	0.57	0.26		1.00	0.53	0.78	0.68	n/a
	22	(559)	0.90	0.81	0.68			0.80	0.67	0.63	0.58	1.00	0.66	0.31			0.61	0.82	0.71	n/a
	22-1/4	(565)	0.91	0.81	0.69			0.80	0.67	0.63	0.58		0.67	0.31			0.62	0.82	0.71	0.55
	24	(610)	0.94	0.83	0.70			0.85	0.68	0.64	0.58		0.75	0.35			0.70	0.86	0.74	0.57
	26	(660)	0.98	0.86	0.72			0.90	0.70	0.65	0.59		0.84	0.39			0.78	0.89	0.77	0.60
	28	(711)	1.00	0.89	0.73			0.95	0.71	0.66	0.60		0.94	0.44			0.88	0.92	0.80	0.62
	30	(762)		0.92	0.75			1.00	0.73	0.67	0.60		1.00	0.49			0.97	0.96	0.83	0.64
	36	(914)		1.00	0.80				0.77	0.71	0.62			0.64			1.00	1.00	0.91	0.70
	> 48	(1219)			0.90				0.87	0.77	0.66			0.98					1.00	0.81

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 20 — Load adjustment factors for #9 rebar in uncracked concrete[1,2,3]

#9 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment		in.	10-1/8	13-1/2	22-1/2	10-1/8	13-1/2	22-1/2	10-1/8	13-1/2	22-1/2	10-1/8	13-1/2	22-1/2	10-1/8	13-1/2	22-1/2	10-1/8	13-1/2	22-1/2
h_{ef}		(mm)	(257)	(343)	(572)	(257)	(343)	(572)	(257)	(343)	(572)	(257)	(343)	(572)	(257)	(343)	(572)	(257)	(343)	(572)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.24	0.17	0.10	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.02	0.01	n/a	n/a	n/a
	5-5/8	(143)	0.59	0.57	0.54	0.33	0.23	0.13	0.54	0.53	0.52	0.11	0.07	0.03	0.22	0.14	0.07	n/a	n/a	n/a
	6	(152)	0.60	0.57	0.54	0.33	0.23	0.13	0.54	0.53	0.52	0.12	0.08	0.04	0.24	0.16	0.07	n/a	n/a	n/a
	7	(178)	0.61	0.59	0.55	0.36	0.25	0.14	0.55	0.54	0.52	0.15	0.10	0.05	0.30	0.20	0.09	n/a	n/a	n/a
	8	(203)	0.63	0.60	0.56	0.38	0.27	0.15	0.55	0.54	0.52	0.18	0.12	0.06	0.37	0.24	0.11	n/a	n/a	n/a
	9	(229)	0.65	0.61	0.57	0.41	0.28	0.16	0.56	0.55	0.53	0.22	0.14	0.07	0.41	0.28	0.13	n/a	n/a	n/a
	10	(254)	0.66	0.62	0.57	0.44	0.30	0.17	0.57	0.55	0.53	0.26	0.17	0.08	0.44	0.30	0.16	n/a	n/a	n/a
	11	(279)	0.68	0.64	0.58	0.46	0.32	0.18	0.57	0.56	0.53	0.30	0.19	0.09	0.46	0.32	0.18	n/a	n/a	n/a
	12	(305)	0.70	0.65	0.59	0.49	0.34	0.20	0.58	0.56	0.54	0.34	0.22	0.10	0.49	0.34	0.20	n/a	n/a	n/a
	12-7/8	(327)	0.71	0.66	0.60	0.52	0.36	0.21	0.59	0.57	0.54	0.38	0.24	0.11	0.52	0.36	0.21	0.59	n/a	n/a
	13	(330)	0.71	0.66	0.60	0.52	0.36	0.21	0.59	0.57	0.54	0.38	0.25	0.12	0.52	0.36	0.21	0.59	n/a	n/a
	14	(356)	0.73	0.67	0.60	0.55	0.38	0.22	0.59	0.57	0.54	0.43	0.28	0.13	0.55	0.38	0.22	0.61	n/a	n/a
	16	(406)	0.76	0.70	0.62	0.62	0.43	0.25	0.61	0.58	0.55	0.52	0.34	0.16	0.62	0.43	0.25	0.66	n/a	n/a
	16-1/4	(413)	0.77	0.70	0.62	0.63	0.43	0.25	0.61	0.58	0.55	0.53	0.35	0.16	0.63	0.43	0.25	0.66	0.57	n/a
	18	(457)	0.80	0.72	0.63	0.69	0.48	0.28	0.62	0.59	0.55	0.62	0.40	0.19	0.69	0.48	0.28	0.70	0.60	n/a
	20	(508)	0.83	0.75	0.65	0.77	0.54	0.31	0.63	0.60	0.56	0.73	0.47	0.22	0.77	0.54	0.31	0.73	0.64	n/a
	22	(559)	0.86	0.77	0.66	0.85	0.59	0.34	0.65	0.61	0.57	0.84	0.55	0.25	0.85	0.59	0.34	0.77	0.67	n/a
	24	(610)	0.89	0.80	0.68	0.93	0.64	0.37	0.66	0.62	0.57	0.96	0.62	0.29	0.93	0.64	0.37	0.80	0.70	n/a
	25-1/4	(641)	0.91	0.81	0.69	0.97	0.68	0.39	0.67	0.63	0.58	1.00	0.67	0.31	0.97	0.68	0.39	0.83	0.71	0.55
	26	(660)	0.93	0.82	0.69	1.00	0.70	0.40	0.68	0.63	0.58		0.70	0.33	1.00	0.70	0.40	0.84	0.73	0.56
	28	(711)	0.96	0.85	0.71		0.75	0.43	0.69	0.64	0.59		0.78	0.36		0.75	0.43	0.87	0.75	0.58
	30	(762)	0.99	0.87	0.72		0.80	0.46	0.70	0.65	0.59		0.87	0.40		0.80	0.46	0.90	0.78	0.60
	36	(914)	1.00	0.94	0.77		0.96	0.55	0.74	0.68	0.61		1.00	0.53		0.96	0.55	0.99	0.85	0.66
	> 48	(1219)		1.00	0.86		1.00	0.74	0.82	0.74	0.65			0.82		1.00	0.74	1.00	0.99	0.76

Table 21 — Load adjustment factors for #9 rebar in cracked concrete[1,2,3]

#9 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment		in.	10-1/8	13-1/2	22-1/2	10-1/8	13-1/2	22-1/2	10-1/8	13-1/2	22-1/2	10-1/8	13-1/2	22-1/2	10-1/8	13-1/2	22-1/2	10-1/8	13-1/2	22-1/2
h_{ef}		(mm)	(257)	(343)	(572)	(257)	(343)	(572)	(257)	(343)	(572)	(257)	(343)	(572)	(257)	(343)	(572)	(257)	(343)	(572)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.41	0.39	0.38	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.02	0.01	n/a	n/a	n/a
	5-5/8	(143)	0.59	0.57	0.54	0.56	0.50	0.44	0.54	0.53	0.52	0.11	0.07	0.03	0.22	0.14	0.07	n/a	n/a	n/a
	6	(152)	0.60	0.57	0.54	0.57	0.51	0.44	0.54	0.53	0.52	0.12	0.08	0.04	0.24	0.16	0.07	n/a	n/a	n/a
	7	(178)	0.61	0.59	0.55	0.61	0.54	0.46	0.55	0.54	0.52	0.15	0.10	0.05	0.30	0.20	0.09	n/a	n/a	n/a
	8	(203)	0.63	0.60	0.56	0.65	0.57	0.48	0.55	0.54	0.52	0.19	0.12	0.06	0.37	0.24	0.11	n/a	n/a	n/a
	9	(229)	0.65	0.61	0.57	0.70	0.60	0.49	0.56	0.55	0.53	0.22	0.14	0.07	0.44	0.29	0.13	n/a	n/a	n/a
	10	(254)	0.66	0.62	0.57	0.74	0.63	0.51	0.57	0.55	0.53	0.26	0.17	0.08	0.52	0.34	0.16	n/a	n/a	n/a
	11	(279)	0.68	0.64	0.58	0.79	0.67	0.53	0.57	0.56	0.53	0.30	0.19	0.09	0.60	0.39	0.18	n/a	n/a	n/a
	12	(305)	0.70	0.65	0.59	0.84	0.70	0.55	0.58	0.56	0.54	0.34	0.22	0.10	0.68	0.44	0.21	n/a	n/a	n/a
	12-7/8	(327)	0.71	0.66	0.60	0.88	0.73	0.56	0.59	0.57	0.54	0.38	0.25	0.11	0.76	0.49	0.23	0.59	n/a	n/a
	13	(330)	0.71	0.66	0.60	0.89	0.73	0.56	0.59	0.57	0.54	0.39	0.25	0.12	0.77	0.50	0.23	0.59	n/a	n/a
	14	(356)	0.73	0.67	0.60	0.94	0.77	0.58	0.60	0.57	0.54	0.43	0.28	0.13	0.86	0.56	0.26	0.62	n/a	n/a
	16	(406)	0.76	0.70	0.62	1.00	0.84	0.62	0.61	0.58	0.55	0.53	0.34	0.16	1.00	0.68	0.32	0.66	n/a	n/a
	16-1/4	(413)	0.77	0.70	0.62	1.00	0.85	0.63	0.61	0.58	0.55	0.54	0.35	0.16	1.00	0.70	0.32	0.66	0.58	n/a
	18	(457)	0.80	0.72	0.63	1.00	0.91	0.66	0.62	0.59	0.55	0.63	0.41	0.19	1.00	0.82	0.38	0.70	0.61	n/a
	20	(508)	0.83	0.75	0.65	1.00	0.99	0.70	0.64	0.60	0.56	0.73	0.48	0.22	1.00	0.95	0.44	0.74	0.64	n/a
	22	(559)	0.86	0.77	0.66	1.00	1.00	0.74	0.65	0.61	0.57	0.85	0.55	0.26	1.00	1.00	0.51	0.77	0.67	n/a
	24	(610)	0.89	0.80	0.68	1.00	1.00	0.78	0.66	0.62	0.57	0.97	0.63	0.29	1.00	1.00	0.58	0.81	0.70	n/a
	25-1/4	(641)	0.91	0.81	0.69	1.00	1.00	0.81	0.67	0.63	0.58	1.00	0.68	0.31	1.00	1.00	0.63	0.83	0.72	0.56
	26	(660)	0.93	0.82	0.69	1.00	1.00	0.82	0.68	0.63	0.58	1.00	0.71	0.33	1.00	1.00	0.66	0.84	0.73	0.56
	28	(711)	0.96	0.85	0.71	1.00	1.00	0.87	0.69	0.64	0.59	1.00	0.79	0.37	1.00	1.00	0.73	0.87	0.76	0.58
	30	(762)	0.99	0.87	0.72	1.00	1.00	0.91	0.70	0.65	0.59	1.00	0.88	0.41	1.00	1.00	0.82	0.90	0.78	0.61
	36	(914)	1.00	0.94	0.77	1.00	1.00	1.00	0.74	0.68	0.61	1.00	1.00	0.54	1.00	1.00	1.00	0.99	0.86	0.66
	> 48	(1219)	1.00	1.00	0.86	1.00	1.00	1.00	0.83	0.74	0.65	1.00	1.00	0.82	1.00	1.00	1.00	1.00	0.99	0.77

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when c < 3*h_{ef}. f_{AV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{AV} = f_{AN}.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{HV} = 1.0.

Table 22 — Load adjustment factors for #10 rebar in uncracked concrete[1,2,3]

#10 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.24	0.17	0.09	n/a	n/a	n/a	0.02	0.01	0.00	0.03	0.02	0.01	n/a	n/a	n/a
	6-1/4	(159)	0.59	0.57	0.54	0.33	0.23	0.13	0.54	0.53	0.52	0.11	0.07	0.03	0.22	0.14	0.07	n/a	n/a	n/a
	7	(178)	0.60	0.58	0.55	0.35	0.24	0.14	0.54	0.53	0.52	0.13	0.08	0.04	0.26	0.17	0.08	n/a	n/a	n/a
	8	(203)	0.62	0.59	0.55	0.37	0.26	0.15	0.55	0.54	0.52	0.16	0.10	0.05	0.31	0.20	0.10	n/a	n/a	n/a
	9	(229)	0.63	0.60	0.56	0.39	0.27	0.15	0.55	0.54	0.52	0.19	0.12	0.06	0.38	0.24	0.11	n/a	n/a	n/a
	10	(254)	0.65	0.61	0.57	0.42	0.29	0.16	0.56	0.55	0.53	0.22	0.14	0.07	0.42	0.29	0.13	n/a	n/a	n/a
	11	(279)	0.66	0.62	0.57	0.44	0.31	0.17	0.57	0.55	0.53	0.25	0.16	0.08	0.44	0.31	0.15	n/a	n/a	n/a
	12	(305)	0.68	0.63	0.58	0.47	0.32	0.18	0.57	0.55	0.53	0.29	0.19	0.09	0.47	0.32	0.17	n/a	n/a	n/a
	13	(330)	0.69	0.64	0.59	0.49	0.34	0.19	0.58	0.56	0.54	0.33	0.21	0.10	0.49	0.34	0.19	n/a	n/a	n/a
	14	(356)	0.71	0.66	0.59	0.52	0.36	0.20	0.59	0.56	0.54	0.36	0.24	0.11	0.52	0.36	0.20	n/a	n/a	n/a
	14-1/4	(362)	0.71	0.66	0.60	0.52	0.36	0.21	0.59	0.56	0.54	0.37	0.24	0.11	0.52	0.36	0.21	0.59	n/a	n/a
	15	(381)	0.72	0.67	0.60	0.54	0.38	0.21	0.59	0.57	0.54	0.40	0.26	0.12	0.54	0.38	0.21	0.60	n/a	n/a
	16	(406)	0.74	0.68	0.61	0.57	0.40	0.22	0.60	0.57	0.54	0.45	0.29	0.13	0.57	0.40	0.22	0.62	n/a	n/a
	17	(432)	0.75	0.69	0.61	0.60	0.42	0.24	0.60	0.58	0.55	0.49	0.32	0.15	0.60	0.42	0.24	0.64	n/a	n/a
	18	(457)	0.77	0.70	0.62	0.64	0.44	0.25	0.61	0.58	0.55	0.53	0.35	0.16	0.64	0.44	0.25	0.66	0.57	n/a
	20	(508)	0.80	0.72	0.63	0.71	0.49	0.28	0.62	0.59	0.55	0.62	0.40	0.19	0.71	0.49	0.28	0.70	0.60	n/a
	22	(559)	0.83	0.74	0.65	0.78	0.54	0.31	0.63	0.60	0.56	0.72	0.47	0.22	0.78	0.54	0.31	0.73	0.63	n/a
	24	(610)	0.86	0.77	0.66	0.85	0.59	0.33	0.65	0.61	0.57	0.82	0.53	0.25	0.85	0.59	0.33	0.76	0.66	n/a
	26	(660)	0.89	0.79	0.67	0.92	0.64	0.36	0.66	0.62	0.57	0.92	0.60	0.28	0.92	0.64	0.36	0.79	0.69	n/a
	28	(711)	0.91	0.81	0.69	0.99	0.69	0.39	0.67	0.63	0.58	1.00	0.67	0.31	0.99	0.69	0.39	0.82	0.71	0.55
	30	(762)	0.94	0.83	0.70	1.00	0.74	0.42	0.68	0.64	0.58		0.74	0.35	1.00	0.74	0.42	0.85	0.74	0.57
	36	(914)	1.00	0.90	0.74		0.88	0.50	0.72	0.66	0.60		0.98	0.45		0.88	0.50	0.94	0.81	0.63
	> 48	(1219)		1.00	0.82		1.00	0.67	0.79	0.72	0.63		1.00	0.70		1.00	0.67	1.00	0.94	0.72

Table 23 — Load adjustment factors for #10 rebar in cracked concrete[1,2,3]

#10 Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)
Spacing (s) / edge eistance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.40	0.39	0.37	n/a	n/a	n/a	0.02	0.01	0.00	0.03	0.02	0.01	n/a	n/a	n/a
	6-1/4	(159)	0.59	0.57	0.54	0.56	0.50	0.44	0.54	0.53	0.52	0.11	0.07	0.03	0.22	0.14	0.07	n/a	n/a	n/a
	7	(178)	0.60	0.58	0.55	0.58	0.52	0.45	0.54	0.53	0.52	0.13	0.08	0.04	0.26	0.17	0.08	n/a	n/a	n/a
	8	(203)	0.62	0.59	0.55	0.62	0.55	0.46	0.55	0.54	0.52	0.16	0.10	0.05	0.32	0.21	0.10	n/a	n/a	n/a
	9	(229)	0.63	0.60	0.56	0.66	0.57	0.48	0.55	0.54	0.52	0.19	0.12	0.06	0.38	0.25	0.11	n/a	n/a	n/a
	10	(254)	0.65	0.61	0.57	0.70	0.60	0.49	0.56	0.55	0.53	0.22	0.14	0.07	0.44	0.29	0.13	n/a	n/a	n/a
	11	(279)	0.66	0.62	0.57	0.74	0.63	0.51	0.57	0.55	0.53	0.26	0.17	0.08	0.51	0.33	0.15	n/a	n/a	n/a
	12	(305)	0.68	0.63	0.58	0.78	0.66	0.53	0.57	0.55	0.53	0.29	0.19	0.09	0.58	0.38	0.18	n/a	n/a	n/a
	13	(330)	0.69	0.64	0.59	0.82	0.69	0.54	0.58	0.56	0.54	0.33	0.21	0.10	0.66	0.43	0.20	n/a	n/a	n/a
	14	(356)	0.71	0.66	0.59	0.87	0.72	0.56	0.59	0.56	0.54	0.37	0.24	0.11	0.73	0.48	0.22	n/a	n/a	n/a
	14-1/4	(362)	0.71	0.66	0.60	0.88	0.73	0.56	0.59	0.57	0.54	0.38	0.25	0.11	0.75	0.49	0.23	0.59	n/a	n/a
	15	(381)	0.72	0.67	0.60	0.91	0.75	0.57	0.59	0.57	0.54	0.41	0.26	0.12	0.82	0.53	0.25	0.61	n/a	n/a
	16	(406)	0.74	0.68	0.61	0.96	0.78	0.59	0.60	0.57	0.54	0.45	0.29	0.14	0.90	0.58	0.27	0.63	n/a	n/a
	17	(432)	0.75	0.69	0.61	1.00	0.81	0.61	0.60	0.58	0.55	0.49	0.32	0.15	0.98	0.64	0.30	0.64	n/a	n/a
	18	(457)	0.77	0.70	0.62		0.85	0.62	0.61	0.58	0.55	0.54	0.35	0.16	1.00	0.70	0.32	0.66	0.57	n/a
	20	(508)	0.80	0.72	0.63		0.91	0.66	0.62	0.59	0.55	0.63	0.41	0.19		0.82	0.38	0.70	0.61	n/a
	22	(559)	0.83	0.74	0.65		0.98	0.69	0.63	0.60	0.56	0.72	0.47	0.22		0.94	0.44	0.73	0.63	n/a
	24	(610)	0.86	0.77	0.66		1.00	0.73	0.65	0.61	0.57	0.82	0.54	0.25		1.00	0.50	0.77	0.66	n/a
	26	(660)	0.89	0.79	0.67			0.77	0.66	0.62	0.57	0.93	0.60	0.28			0.56	0.80	0.69	n/a
	28	(711)	0.91	0.81	0.69			0.81	0.67	0.63	0.58	1.00	0.68	0.31			0.63	0.83	0.72	0.55
	30	(762)	0.94	0.83	0.70			0.85	0.68	0.64	0.58		0.75	0.35			0.70	0.86	0.74	0.57
	36	(914)	1.00	0.90	0.74			0.97	0.72	0.66	0.60		0.98	0.46			0.91	0.94	0.81	0.63
	> 48	(1219)		1.00	0.82			1.00	0.79	0.72	0.63		1.00	0.70			1.00	1.00	0.94	0.73

[1] Linear interpolation not permitted.

[2] Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3 \cdot h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3 \cdot h_{ef}$. If $c \geq 3 \cdot h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3 \cdot h_{ef}$. If $c \geq 3 \cdot h_{ef}$, then $f_{HV} = 1.0$.

HIT-RE 500 V3 adhesive with HAS threaded rod

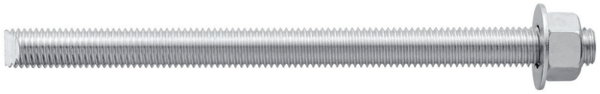


Figure 4 — Hilti HAS threaded rod installation conditions

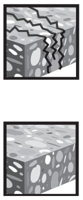
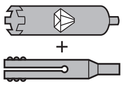
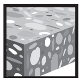
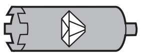
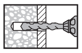
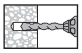
Cracked or uncracked concrete	Permissible drilling methods	Permissible concrete conditions
 Cracked and uncracked concrete	 Hammer drilling with carbide-tipped drill bit	Dry concrete Water-saturated concrete Water-filled holes Submerged (underwater)
	 Hilti TE-CD or TE-YD hollow drill bit and VC 20/40 Vacuum  Diamond core drill bit with Hilti TE-YRT roughening tool	Dry concrete Water-saturated concrete
 Uncracked concrete	 Diamond core drill bit	Dry concrete Water-saturated concrete

Table 24 — Hilti HAS threaded rod installation specifications

Setting information		Symbol	Units	Nominal rod diameter, d						
				3/8	1/2	5/8	3/4	7/8	1	1-1/4
Nominal bit diameter		d_o	in.	7/16	9/16	3/4	7/8	1	1-1/8	1-3/8
Effective embedment	minimum	$h_{ef,min}$	in.	2-3/8	2-3/4	3-1/8	3-1/2	3-1/2	4	5
			(mm)	(60)	(70)	(79)	(89)	(89)	(102)	(127)
	maximum	$h_{ef,max}$	in.	7-1/2	10	12-1/2	15	17-1/2	20	25
			(mm)	(191)	(254)	(318)	(381)	(445)	(508)	(635)
Diameter of fixture hole	through-set		in.	1/2	5/8	13/16[1]	15/16[1]	1-1/8[1]	1-1/4[1]	1-1/2[1]
	preset		in.	7/16	9/16	11/16	13/16	15/16	1-1/8	1-3/8
Installation torque		T_{inst}	ft-lb	15	30	60	100	125	150	200
			(Nm)	(20)	(40)	(80)	(136)	(169)	(203)	(271)
Minimum concrete thickness		h_{min}	in.	h_{ef}+1-1/4		$h_{ef}+2d_o$				
			(mm)	(h_{ef}+30)						
Minimum edge distance[2]		c_{min}	in.	1-7/8	2-1/2	3-1/8	3-3/4	4-3/8	5	6-1/4
			(mm)	(48)	(64)	(79)	(95)	(111)	(127)	(159)
Minimum anchor spacing		s_{min}	in.	1-7/8	2-1/2	3-1/8	3-3/4	4-3/8	5	6-1/4
			(mm)	(48)	(64)	(79)	(95)	(111)	(127)	(159)

[1] Install using (2) washers. See Figure 5.

[2] Edge distance of 1-3/4-inch (44mm) is permitted provided the installation torque is reduced to 0.30 T_{inst} for 5d < s < 16-in. and to 0.5T_{inst} for s >16-in.

Figure 4 — Hilti HAS threaded rods

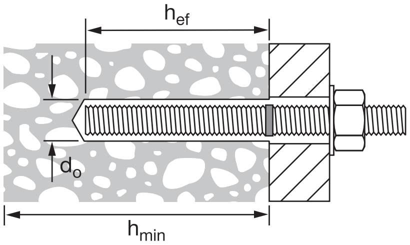


Figure 5 — Installation with (2) washers

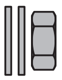


Table 25 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8,9,11]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8	2-3/8 (60)	2,855 (12.7)	3,125 (13.9)	3,610 (16.1)	4,425 (19.7)	3,075 (13.7)	3,370 (15.0)	3,890 (17.3)	4,765 (21.2)
	3-3/8 (86)	4,835 (21.5)	5,300 (23.6)	6,115 (27.2)	7,490 (33.3)	10,415 (46.3)	11,410 (50.8)	13,175 (58.6)	16,135 (71.8)
	4-1/2 (114)	7,445 (33.1)	8,155 (36.3)	9,225 (41.0)	10,210 (45.4)	16,035 (71.3)	17,570 (78.2)	19,865 (88.4)	21,985 (97.8)
	7-1/2 (191)	13,670 (60.8)	14,305 (63.6)	15,375 (68.4)	17,015 (75.7)	29,440 (131.0)	30,815 (137.1)	33,110 (147.3)	36,645 (163.0)
1/2	2-3/4 (70)	3,555 (15.8)	3,895 (17.3)	4,500 (20.0)	5,510 (24.5)	7,660 (34.1)	8,395 (37.3)	9,690 (43.1)	11,870 (52.8)
	4-1/2 (114)	7,445 (33.1)	8,155 (36.3)	9,420 (41.9)	11,535 (51.3)	16,035 (71.3)	17,570 (78.2)	20,285 (90.2)	24,845 (110.5)
	6 (152)	11,465 (51.0)	12,560 (55.9)	14,500 (64.5)	17,535 (78.0)	24,690 (109.8)	27,045 (120.3)	31,230 (138.9)	37,775 (168.0)
	10 (254)	23,485 (104.5)	24,580 (109.3)	26,410 (117.5)	29,230 (130.0)	50,580 (225.0)	52,940 (235.5)	56,885 (253.0)	62,955 (280.0)
5/8[10]	3-1/8 (79)	4,310 (19.2)	4,720 (21.0)	5,450 (24.2)	6,675 (29.7)	9,280 (41.3)	10,165 (45.2)	11,740 (52.2)	14,380 (64.0)
	5-5/8 (143)	10,405 (46.3)	11,400 (50.7)	13,165 (58.6)	16,120 (71.7)	22,415 (99.7)	24,550 (109.2)	28,350 (126.1)	34,720 (154.4)
	7-1/2 (191)	16,020 (71.3)	17,550 (78.1)	20,265 (90.1)	24,820 (110.4)	34,505 (153.5)	37,800 (168.1)	43,650 (194.2)	53,455 (237.8)
	12-1/2 (318)	34,470 (153.3)	36,900 (164.1)	39,655 (176.4)	43,885 (195.2)	74,245 (330.3)	79,480 (353.5)	85,405 (379.9)	94,520 (420.4)
3/4[10]	3-1/2 (89)	5,105 (22.7)	5,595 (24.9)	6,460 (28.7)	7,910 (35.2)	11,000 (48.9)	12,050 (53.6)	13,915 (61.9)	17,040 (75.8)
	6-3/4 (171)	13,680 (60.9)	14,985 (66.7)	17,305 (77.0)	21,190 (94.3)	29,460 (131.0)	32,275 (143.6)	37,265 (165.8)	45,645 (203.0)
	9 (229)	21,060 (93.7)	23,070 (102.6)	26,640 (118.5)	32,625 (145.1)	45,360 (201.8)	49,690 (221.0)	57,375 (255.2)	70,270 (312.6)
	15 (381)	45,315 (201.6)	49,640 (220.8)	55,035 (244.8)	60,905 (270.9)	97,600 (434.1)	106,915 (475.6)	118,535 (527.3)	131,180 (583.5)
7/8[10]	3-1/2 (89)	5,105 (22.7)	5,595 (24.9)	6,460 (28.7)	7,910 (35.2)	11,000 (48.9)	12,050 (53.6)	13,915 (61.9)	17,040 (75.8)
	7-7/8 (200)	17,235 (76.7)	18,885 (84.0)	21,805 (97.0)	26,705 (118.8)	37,125 (165.1)	40,670 (180.9)	46,960 (208.9)	57,515 (255.8)
	10-1/2 (267)	26,540 (118.1)	29,070 (129.3)	33,570 (149.3)	41,115 (182.9)	57,160 (254.3)	62,615 (278.5)	72,300 (321.6)	88,550 (393.9)
	17-1/2 (445)	57,100 (254.0)	62,550 (278.2)	71,740 (319.1)	79,395 (353.2)	122,990 (547.1)	134,730 (599.3)	154,520 (687.3)	171,005 (760.7)
1[10]	4 (102)	6,240 (27.8)	6,835 (30.4)	7,895 (35.1)	9,665 (43.0)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
	9 (229)	21,060 (93.7)	23,070 (102.6)	26,640 (118.5)	32,625 (145.1)	45,360 (201.8)	49,690 (221.0)	57,375 (255.2)	70,270 (312.6)
	12 (305)	32,425 (144.2)	35,520 (158.0)	41,015 (182.4)	50,230 (223.4)	69,835 (310.6)	76,500 (340.3)	88,335 (392.9)	108,190 (481.3)
	20 (508)	69,765 (310.3)	76,425 (340.0)	88,245 (392.5)	99,635 (443.2)	150,265 (668.4)	164,605 (732.2)	190,070 (845.5)	214,595 (954.6)
1-1/4[10]	5 (127)	8,720 (38.8)	9,555 (42.5)	11,030 (49.1)	13,510 (60.1)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)
	11-1/4 (286)	29,430 (130.9)	32,240 (143.4)	37,230 (165.6)	45,595 (202.8)	63,395 (282.0)	69,445 (308.9)	80,185 (356.7)	98,205 (436.8)
	15 (381)	45,315 (201.6)	49,640 (220.8)	57,320 (255.0)	70,200 (312.3)	97,600 (434.1)	106,915 (475.6)	123,455 (549.2)	151,200 (672.6)
	25 (635)	97,500 (433.7)	106,805 (475.1)	123,330 (548.6)	142,175 (632.4)	210,000 (934.1)	230,045 (1023.3)	265,630 (1181.6)	306,220 (1362.1)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength (factored resistance) value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in Tables 30-41 as necessary to the above values. Compare to the steel values in Table 29.
The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry or water saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.45.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. For diamond core drilling, except as indicated in note 10, multiply above values by 0.55.
Diamond core drilling is not permitted for water-filled or underwater (submerged) applications.

10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 5/8", 3/4", 7/8", 1", and 1 1/4" diameter anchors for dry and water-saturated concrete conditions.
See Table 27.

11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 26 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8,9,11]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8	2-3/8 (60)	2,020 (9.0)	2,215 (9.9)	2,500 (11.1)	2,655 (11.8)	2,180 (9.7)	2,385 (10.6)	2,690 (12.0)	2,860 (12.7)
	3-3/8 (86)	3,310 (14.7)	3,400 (15.1)	3,550 (15.8)	3,770 (16.8)	7,125 (31.7)	7,325 (32.6)	7,645 (34.0)	8,125 (36.1)
	4-1/2 (114)	4,410 (19.6)	4,535 (20.2)	4,735 (21.1)	5,030 (22.4)	9,500 (42.3)	9,765 (43.4)	10,195 (45.3)	10,835 (48.2)
	7-1/2 (191)	7,350 (32.7)	7,555 (33.6)	7,890 (35.1)	8,385 (37.3)	15,835 (70.4)	16,275 (72.4)	16,990 (75.6)	18,055 (80.3)
1/2	2-3/4 (70)	2,520 (11.2)	2,760 (12.3)	3,185 (14.2)	3,905 (17.4)	5,425 (24.1)	5,945 (26.4)	6,865 (30.5)	8,405 (37.4)
	4-1/2 (114)	5,275 (23.5)	5,780 (25.7)	6,260 (27.8)	6,655 (29.6)	11,360 (50.5)	12,445 (55.4)	13,485 (60.0)	14,330 (63.7)
	6 (152)	7,780 (34.6)	7,995 (35.6)	8,350 (37.1)	8,870 (39.5)	16,755 (74.5)	17,220 (76.6)	17,980 (80.0)	19,110 (85.0)
	10 (254)	12,965 (57.7)	13,325 (59.3)	13,915 (61.9)	14,785 (65.8)	27,930 (124.2)	28,705 (127.7)	29,970 (133.3)	31,850 (141.7)
5/8[10]	3-1/8 (79)	3,050 (13.6)	3,345 (14.9)	3,860 (17.2)	4,730 (21.0)	6,575 (29.2)	7,200 (32.0)	8,315 (37.0)	10,185 (45.3)
	5-5/8 (143)	7,370 (32.8)	8,075 (35.9)	9,325 (41.5)	10,315 (45.9)	15,875 (70.6)	17,390 (77.4)	20,080 (89.3)	22,215 (98.8)
	7-1/2 (191)	11,350 (50.5)	12,395 (55.1)	12,940 (57.6)	13,755 (61.2)	24,440 (108.7)	26,695 (118.7)	27,875 (124.0)	29,620 (131.8)
	12-1/2 (318)	20,100 (89.4)	20,660 (91.9)	21,570 (95.9)	22,920 (102.0)	43,295 (192.6)	44,495 (197.9)	46,460 (206.7)	49,370 (219.6)
3/4[10]	3-1/2 (89)	3,620 (16.1)	3,965 (17.6)	4,575 (20.4)	5,605 (24.9)	7,790 (34.7)	8,535 (38.0)	9,855 (43.8)	12,070 (53.7)
	6-3/4 (171)	9,690 (43.1)	10,615 (47.2)	12,255 (54.5)	14,735 (65.5)	20,870 (92.8)	22,860 (101.7)	26,395 (117.4)	31,740 (141.2)
	9 (229)	14,920 (66.4)	16,340 (72.7)	18,490 (82.2)	19,650 (87.4)	32,130 (142.9)	35,195 (156.6)	39,820 (177.1)	42,320 (188.2)
	15 (381)	28,715 (127.7)	29,510 (131.3)	30,815 (137.1)	32,745 (145.7)	61,850 (275.1)	63,565 (282.7)	66,370 (295.2)	70,530 (313.7)
7/8[10]	3-1/2 (89)	3,620 (16.1)	3,965 (17.6)	4,575 (20.4)	5,605 (24.9)	7,790 (34.7)	8,535 (38.0)	9,855 (43.8)	12,070 (53.7)
	7-7/8 (200)	12,210 (54.3)	13,375 (59.5)	15,445 (68.7)	18,915 (84.1)	26,300 (117.0)	28,810 (128.2)	33,265 (148.0)	40,740 (181.2)
	10-1/2 (267)	18,800 (83.6)	20,590 (91.6)	23,780 (105.8)	26,530 (118.0)	40,490 (180.1)	44,355 (197.3)	51,215 (227.8)	57,140 (254.2)
	17-1/2 (445)	38,775 (172.5)	39,850 (177.3)	41,605 (185.1)	44,215 (196.7)	83,510 (371.5)	85,825 (381.8)	89,610 (398.6)	95,230 (423.6)
1[10]	4 (102)	4,420 (19.7)	4,840 (21.5)	5,590 (24.9)	6,845 (30.4)	9,520 (42.3)	10,430 (46.4)	12,040 (53.6)	14,750 (65.6)
	9 (229)	14,920 (66.4)	16,340 (72.7)	18,870 (83.9)	23,110 (102.8)	32,130 (142.9)	35,195 (156.6)	40,640 (180.8)	49,775 (221.4)
	12 (305)	22,965 (102.2)	25,160 (111.9)	29,050 (129.2)	34,650 (154.1)	49,465 (220.0)	54,190 (241.0)	62,570 (278.3)	74,630 (332.0)
	20 (508)	49,415 (219.8)	52,045 (231.5)	54,340 (241.7)	57,750 (256.9)	106,435 (473.4)	112,100 (498.6)	117,045 (520.6)	124,385 (553.3)
1-1/4[10]	5 (127)	6,175 (27.5)	6,765 (30.1)	7,815 (34.8)	9,570 (42.6)	13,305 (59.2)	14,575 (64.8)	16,830 (74.9)	20,610 (91.7)
	11-1/4 (286)	20,850 (92.7)	22,840 (101.6)	26,370 (117.3)	32,295 (143.7)	44,905 (199.7)	49,190 (218.8)	56,800 (252.7)	69,565 (309.4)
	15 (381)	32,095 (142.8)	35,160 (156.4)	40,600 (180.6)	49,725 (221.2)	69,135 (307.5)	75,730 (336.9)	87,445 (389.0)	107,100 (476.4)
	25 (635)	69,060 (307.2)	75,655 (336.5)	80,800 (359.4)	85,865 (381.9)	148,750 (661.7)	162,945 (724.8)	174,030 (774.1)	184,945 (822.7)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 30-41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry or water saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.44.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete conditions except as indicated in note 10.

10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 5/8" 3/4", 7/8", 1", and 1 1/4" diameter anchors for dry and water-saturated concrete conditions. See Table 28

11 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} indicated below.
See section 3.1.8 for additional information on seismic applications.
3/8-in. diameter - α_{seis} = 0.69
1/2-in. diameter - α_{seis} = 0.70
5/8-in. diameter - α_{seis} = 0.71
3/4-in. diameter and larger - α_{seis} = 0.75

Table 27 — Hilti HIT-RE 500 V3 for Core Drilled Holes with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8,9]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
5/8	3-1/8 (79)	4,310 (19.2)	4,720 (21.0)	5,450 (24.2)	6,675 (29.7)	9,280 (41.3)	10,165 (45.2)	11,740 (52.2)	14,380 (64.0)
	5-5/8 (143)	10,405 (46.3)	11,400 (50.7)	13,165 (58.6)	15,865 (70.6)	22,415 (99.7)	24,550 (109.2)	28,350 (126.1)	34,170 (152.0)
	7-1/2 (191)	16,020 (71.3)	17,550 (78.1)	20,265 (90.1)	21,155 (94.1)	34,505 (153.5)	37,800 (168.1)	43,650 (194.2)	45,565 (202.7)
	12-1/2 (318)	34,470 (153.3)	35,255 (156.8)	35,255 (156.8)	35,255 (156.8)	74,245 (330.3)	75,940 (337.8)	75,940 (337.8)	75,940 (337.8)
3/4	3-1/2 (89)	5,105 (22.7)	5,595 (24.9)	6,460 (28.7)	7,910 (35.2)	11,000 (48.9)	12,050 (53.6)	13,915 (61.9)	17,040 (75.8)
	6-3/4 (171)	13,680 (60.9)	14,985 (66.7)	17,305 (77.0)	21,190 (94.3)	29,460 (131.0)	32,275 (143.6)	37,265 (165.8)	45,645 (203.0)
	9 (229)	21,060 (93.7)	23,070 (102.6)	26,640 (118.5)	29,360 (130.6)	45,360 (201.8)	49,690 (221.0)	57,375 (255.2)	63,235 (281.3)
	11-1/4 (286)	29,430 (130.9)	32,240 (143.4)	36,700 (163.2)	36,700 (163.2)	63,395 (282.0)	69,445 (308.9)	79,045 (351.6)	79,045 (351.6)
7/8	3-1/2 (89)	5,105 (22.7)	5,595 (24.9)	6,460 (28.7)	7,910 (35.2)	11,000 (48.9)	12,050 (53.6)	13,915 (61.9)	17,040 (75.8)
	7-7/8 (200)	17,235 (76.7)	18,885 (84.0)	21,805 (97.0)	26,705 (118.8)	37,125 (165.1)	40,670 (180.9)	46,960 (208.9)	57,515 (255.8)
	10-1/2 (267)	26,540 (118.1)	29,070 (129.3)	33,570 (149.3)	38,275 (170.3)	57,160 (254.3)	62,615 (278.5)	72,300 (321.6)	82,435 (366.7)
	17-1/2 (445)	57,100 (254.0)	62,550 (278.2)	63,790 (283.8)	63,790 (283.8)	122,990 (547.1)	134,730 (599.3)	137,390 (611.1)	137,390 (611.1)
1	4 (102)	6,240 (27.8)	6,835 (30.4)	7,895 (35.1)	9,665 (43.0)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
	9 (229)	21,060 (93.7)	23,070 (102.6)	26,640 (118.5)	32,625 (145.1)	45,360 (201.8)	49,690 (221.0)	57,375 (255.2)	70,270 (312.6)
	12 (305)	32,425 (144.2)	35,520 (158.0)	41,015 (182.4)	48,030 (213.6)	69,835 (310.6)	76,500 (340.3)	88,335 (392.9)	103,445 (460.1)
	20 (508)	69,765 (310.3)	76,425 (340.0)	80,050 (356.1)	80,050 (356.1)	150,265 (668.4)	164,605 (732.2)	172,410 (766.9)	172,410 (766.9)
1-1/4	5 (127)	8,720 (38.8)	9,555 (42.5)	11,030 (49.1)	13,510 (60.1)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)
	11-1/4 (286)	29,430 (130.9)	32,240 (143.4)	37,230 (165.6)	45,595 (202.8)	63,395 (282.0)	69,445 (308.9)	80,185 (356.7)	98,205 (436.8)
	15 (381)	45,315 (201.6)	49,640 (220.8)	57,320 (255.0)	68,535 (304.9)	97,600 (434.1)	106,915 (475.6)	123,455 (549.2)	147,615 (656.6)
	25 (635)	97,500 (433.7)	106,805 (475.1)	114,225 (508.1)	114,225 (508.1)	210,000 (934.1)	230,045 (1023.3)	246,025 (1094.4)	246,025 (1094.4)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 30-41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry or water saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 28 — Hilti HIT-RE 500 V3 for Core Drilled Holes with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8,9]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
5/8	3-1/8 (79)	3,050 (13.6)	3,345 (14.9)	3,510 (15.6)	3,510 (15.6)	6,575 (29.2)	7,200 (32.0)	7,560 (33.6)	7,560 (33.6)
	5-5/8 (143)	6,320 (28.1)	6,320 (28.1)	6,320 (28.1)	6,320 (28.1)	13,605 (60.5)	13,605 (60.5)	13,605 (60.5)	13,605 (60.5)
	7-1/2 (191)	8,425 (37.5)	8,425 (37.5)	8,425 (37.5)	8,425 (37.5)	18,145 (80.7)	18,145 (80.7)	18,145 (80.7)	18,145 (80.7)
	12-1/2 (318)	14,040 (62.5)	14,040 (62.5)	14,040 (62.5)	14,040 (62.5)	30,240 (134.5)	30,240 (134.5)	30,240 (134.5)	30,240 (134.5)
3/4	3-1/2 (89)	3,620 (16.1)	3,965 (17.6)	4,575 (20.4)	4,690 (20.9)	7,790 (34.7)	8,535 (38.0)	9,855 (43.8)	10,100 (44.9)
	6-3/4 (171)	9,045 (40.2)	9,045 (40.2)	9,045 (40.2)	9,045 (40.2)	19,485 (86.7)	19,485 (86.7)	19,485 (86.7)	19,485 (86.7)
	9 (229)	12,060 (53.6)	12,060 (53.6)	12,060 (53.6)	12,060 (53.6)	25,975 (115.5)	25,975 (115.5)	25,975 (115.5)	25,975 (115.5)
	11-1/4 (286)	15,075 (67.1)	15,075 (67.1)	15,075 (67.1)	15,075 (67.1)	32,470 (144.4)	32,470 (144.4)	32,470 (144.4)	32,470 (144.4)
7/8	3-1/2 (89)	3,620 (16.1)	3,965 (17.6)	4,575 (20.4)	5,440 (24.2)	7,790 (34.7)	8,535 (38.0)	9,855 (43.8)	11,720 (52.1)
	7-7/8 (200)	12,210 (54.3)	12,240 (54.4)	12,240 (54.4)	12,240 (54.4)	26,300 (117.0)	26,365 (117.3)	26,365 (117.3)	26,365 (117.3)
	10-1/2 (267)	16,320 (72.6)	16,320 (72.6)	16,320 (72.6)	16,320 (72.6)	35,155 (156.4)	35,155 (156.4)	35,155 (156.4)	35,155 (156.4)
	17-1/2 (445)	27,205 (121.0)	27,205 (121.0)	27,205 (121.0)	27,205 (121.0)	58,595 (260.6)	58,595 (260.6)	58,595 (260.6)	58,595 (260.6)
1	4 (102)	4,420 (19.7)	4,840 (21.5)	5,590 (24.9)	6,845 (30.4)	9,520 (42.3)	10,430 (46.4)	12,040 (53.6)	14,750 (65.6)
	9 (229)	14,920 (66.4)	15,990 (71.1)	15,990 (71.1)	15,990 (71.1)	32,130 (142.9)	34,440 (153.2)	34,440 (153.2)	34,440 (153.2)
	12 (305)	21,320 (94.8)	21,320 (94.8)	21,320 (94.8)	21,320 (94.8)	45,920 (204.3)	45,920 (204.3)	45,920 (204.3)	45,920 (204.3)
	20 (508)	35,530 (158.0)	35,530 (158.0)	35,530 (158.0)	35,530 (158.0)	76,530 (340.4)	76,530 (340.4)	76,530 (340.4)	76,530 (340.4)
1-1/4	5 (127)	6,175 (27.5)	6,765 (30.1)	7,815 (34.8)	9,570 (42.6)	13,305 (59.2)	14,575 (64.8)	16,830 (74.9)	20,610 (91.7)
	11-1/4 (286)	20,850 (92.7)	22,840 (101.6)	23,690 (105.4)	23,690 (105.4)	44,905 (199.7)	49,190 (218.8)	51,025 (227.0)	51,025 (227.0)
	15 (381)	31,590 (140.5)	31,590 (140.5)	31,590 (140.5)	31,590 (140.5)	68,035 (302.6)	68,035 (302.6)	68,035 (302.6)	68,035 (302.6)
	25 (635)	52,645 (234.2)	52,645 (234.2)	52,645 (234.2)	52,645 (234.2)	113,390 (504.4)	113,390 (504.4)	113,390 (504.4)	113,390 (504.4)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 30-41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry or water saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis}=0.75. See section 3.1.8 for additional information on seismic applications.

Table 29 — Steel design strength for Hilti HAS threaded rods for use with ACI 318 Chapter 17

Nominal anchor diameter in.	HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr.36[4,6]			HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6]			HAS-B-105 / HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6]			HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4]		
	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)
3/8	3,370 (15.0)	1,750 (7.8)	1,050 (4.7)	4,360 (19.4)	2,270 (10.1)	2,270 (10.1)	7,270 (32.3)	3,780 (16.8)	3,780 (16.8)	5,040 (22.4)	2,790 (12.4)	2,230 (9.9)
1/2	6,175 (27.5)	3,210 (14.3)	1,925 (8.6)	7,985 (35.5)	4,150 (18.5)	4,150 (18.5)	13,305 (59.2)	6,920 (30.8)	6,920 (30.8)	9,225 (41.0)	5,110 (22.7)	4,090 (18.2)
5/8	9,835 (43.7)	5,110 (22.7)	3,065 (13.6)	12,715 (56.6)	6,610 (29.4)	6,610 (29.4)	21,190 (94.3)	11,020 (49.0)	11,020 (49.0)	14,690 (65.3)	8,135 (36.2)	6,510 (29.0)
3/4	14,550 (64.7)	7,565 (33.7)	4,540 (20.2)	18,820 (83.7)	9,785 (43.5)	9,785 (43.5)	31,360 (139.5)	16,310 (72.6)	16,310 (72.6)	18,485 (82.2)	10,235 (45.5)	8,190 (36.4)
7/8	20,085 (89.3)	10,445 (46.5)	6,265 (27.9)	25,975 (115.5)	13,505 (60.1)	13,505 (60.1)	43,285 (192.5)	22,510 (100.1)	22,510 (100.1)	25,510 (113.5)	14,125 (62.8)	11,300 (50.3)
1	26,350 (117.2)	13,700 (60.9)	8,220 (36.6)	34,075 (151.6)	17,720 (78.8)	17,720 (78.8)	56,785 (252.6)	29,530 (131.4)	29,530 (131.4)	33,465 (148.9)	18,535 (82.4)	14,830 (66.0)
1-1/4	42,160 (187.5)	21,920 (97.5)	13,150 (58.5)	54,515 (242.5)	28,345 (126.1)	28,345 (126.1)	90,855 (404.1)	47,245 (210.2)	47,245 (210.2)	41,430 (184.3)	21,545 (95.8)	17,235 (76.7)

1 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 17.4.1.2

2 Shear = $\phi\ 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 17.5.1.2b.

3 Seismic Shear = $\alpha_{V,seis} \phi V_{sa}$: Reduction factor for seismic shear only. See ACI 318 for additional information on seismic applications.

4 HAS-V, HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).

5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.

6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

Table 30 — Load adjustment factors for 3/8-in. diameter threaded rods in uncracked concrete[1,2,3]

3/8-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Embedment		in.	2-3/8	3-3/8	4-1/2	7-1/2	2-3/8	3-3/8	4-1/2	7-1/2	2-3/8	3-3/8	4-1/2	7-1/2	2-3/8	3-3/8	4-1/2	7-1/2	2-3/8	3-3/8	4-1/2	7-1/2	2-3/8	3-3/8	4-1/2	7-1/2
h_{ef}		(mm)	(60)	(86)	(114)	(191)	(60)	(86)	(114)	(191)	(60)	(86)	(114)	(191)	(60)	(86)	(114)	(191)	(60)	(86)	(114)	(191)	(60)	(86)	(114)	(191)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.35	0.26	0.21	0.12	n/a	n/a	n/a	n/a	0.23	0.07	0.05	0.03	0.35	0.14	0.09	0.05	n/a	n/a	n/a	n/a
	1-7/8	(48)	0.58	0.58	0.57	0.54	0.36	0.27	0.22	0.13	0.57	0.53	0.52	0.52	0.25	0.08	0.05	0.03	0.36	0.16	0.10	0.06	n/a	n/a	n/a	n/a
	2	(51)	0.58	0.58	0.57	0.54	0.37	0.28	0.23	0.13	0.57	0.53	0.52	0.52	0.28	0.09	0.06	0.03	0.37	0.17	0.11	0.06	n/a	n/a	n/a	n/a
	3	(76)	0.62	0.62	0.61	0.57	0.48	0.34	0.27	0.16	0.61	0.55	0.54	0.52	0.51	0.16	0.10	0.06	0.48	0.32	0.21	0.11	n/a	n/a	n/a	n/a
	3-5/8	(92)	0.65	0.65	0.63	0.58	0.56	0.38	0.30	0.17	0.63	0.56	0.54	0.53	0.68	0.21	0.14	0.07	0.56	0.38	0.27	0.15	0.72	n/a	n/a	n/a
	4	(102)	0.66	0.66	0.65	0.59	0.62	0.41	0.31	0.18	0.64	0.57	0.55	0.53	0.79	0.24	0.16	0.09	0.62	0.41	0.31	0.17	0.75	n/a	n/a	n/a
	4-5/8	(117)	0.69	0.69	0.67	0.60	0.71	0.45	0.35	0.20	0.66	0.58	0.56	0.54	0.98	0.30	0.20	0.11	0.71	0.45	0.35	0.20	0.81	0.55	n/a	n/a
	5	(127)	0.70	0.70	0.69	0.61	0.77	0.48	0.36	0.21	0.68	0.58	0.56	0.54	1.00	0.34	0.22	0.12	0.77	0.48	0.36	0.21	0.84	0.57	n/a	n/a
	5-3/4	(146)	0.73	0.73	0.71	0.63	0.89	0.55	0.40	0.23	0.70	0.59	0.57	0.55		0.42	0.27	0.15	0.89	0.55	0.40	0.23	0.91	0.61	0.53	n/a
	6	(152)	0.74	0.74	0.72	0.63	0.92	0.58	0.42	0.24	0.71	0.60	0.57	0.55		0.45	0.29	0.16	0.92	0.58	0.42	0.24	0.92	0.63	0.54	n/a
	7	(178)	0.78	0.78	0.76	0.66	1.00	0.67	0.48	0.28	0.75	0.61	0.59	0.56		0.57	0.37	0.20	1.00	0.67	0.48	0.28	1.00	0.68	0.58	n/a
	8	(203)	0.82	0.82	0.80	0.68		0.77	0.55	0.32	0.79	0.63	0.60	0.57		0.69	0.45	0.24		0.77	0.55	0.32		0.72	0.63	n/a
	8-3/4	(222)	0.86	0.86	0.82	0.69		0.84	0.61	0.35	0.81	0.64	0.61	0.57		0.79	0.51	0.28		0.84	0.61	0.35		0.76	0.65	0.53
	9	(229)	0.87	0.87	0.83	0.70		0.86	0.62	0.36	0.82	0.65	0.61	0.57		0.83	0.54	0.29		0.86	0.62	0.36		0.77	0.66	0.54
	10	(254)	0.91	0.91	0.87	0.72		0.96	0.69	0.40	0.86	0.66	0.62	0.58		0.97	0.63	0.34		0.96	0.69	0.40		0.81	0.70	0.57
	11	(279)	0.95	0.95	0.91	0.74		1.00	0.76	0.44	0.89	0.68	0.63	0.59		1.00	0.72	0.39		1.00	0.76	0.44		0.85	0.73	0.60
	12	(305)	0.99	0.99	0.94	0.77			0.83	0.48	0.93	0.70	0.65	0.60			0.83	0.45			0.83	0.48		0.88	0.77	0.63
	14	(356)	1.00	1.00	1.00	0.81			0.97	0.56	1.00	0.73	0.67	0.61			1.00	0.57			0.97	0.56		0.96	0.83	0.68
	16	(406)				0.86			1.00	0.64		0.76	0.70	0.63				0.69			1.00	0.64		1.00	0.88	0.72
	18	(457)				0.90				0.72		0.79	0.72	0.65				0.83				0.72			0.94	0.77
	24	(610)				1.00				0.96		0.89	0.79	0.70				1.00				0.96			1.00	0.88
	30	(762)								1.00		0.99	0.87	0.74								1.00				0.99
	36	(914)										1.00	0.94	0.79												1.00
	> 48	(1219)											1.00	0.89												

Table 31 — Load adjustment factors for 3/8-in. diameter threaded rods in cracked concrete[1,2,3]

3/8-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Embedment		in.	2-3/8	3-3/8	4-1/2	7-1/2	2-3/8	3-3/8	4-1/2	7-1/2	2-3/8	3-3/8	4-1/2	7-1/2	2-3/8	3-3/8	4-1/2	7-1/2	2-3/8	3-3/8	4-1/2	7-1/2	2-3/8	3-3/8	4-1/2	7-1/2
h_{ef}		(mm)	(60)	(86)	(114)	(191)	(60)	(86)	(114)	(191)	(60)	(86)	(114)	(191)	(60)	(86)	(114)	(191)	(60)	(86)	(114)	(191)	(60)	(86)	(114)	(191)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.50	0.50	0.49	0.43	n/a	n/a	n/a	n/a	0.23	0.07	0.06	0.03	0.46	0.15	0.11	0.07	n/a	n/a	n/a	n/a
	1-7/8	(48)	0.58	0.58	0.57	0.54	0.52	0.52	0.50	0.44	0.57	0.53	0.53	0.52	0.26	0.08	0.06	0.04	0.51	0.16	0.12	0.07	n/a	n/a	n/a	n/a
	2	(51)	0.58	0.58	0.57	0.54	0.53	0.53	0.51	0.44	0.57	0.53	0.53	0.52	0.28	0.09	0.07	0.04	0.53	0.18	0.14	0.08	n/a	n/a	n/a	n/a
	3	(76)	0.62	0.62	0.61	0.57	0.63	0.63	0.60	0.49	0.61	0.55	0.54	0.53	0.52	0.17	0.12	0.07	0.63	0.33	0.25	0.15	n/a	n/a	n/a	n/a
	3-5/8	(92)	0.65	0.65	0.63	0.58	0.70	0.70	0.66	0.53	0.63	0.56	0.55	0.54	0.69	0.22	0.17	0.10	0.70	0.44	0.33	0.20	0.72	n/a	n/a	n/a
	4	(102)	0.66	0.66	0.65	0.59	0.74	0.74	0.70	0.55	0.64	0.57	0.56	0.54	0.80	0.26	0.19	0.11	0.74	0.51	0.38	0.23	0.76	n/a	n/a	n/a
	4-5/8	(117)	0.69	0.69	0.67	0.60	0.81	0.81	0.76	0.58	0.67	0.58	0.56	0.55	0.99	0.32	0.24	0.14	0.81	0.63	0.48	0.29	0.81	0.56	n/a	n/a
	5	(127)	0.70	0.70	0.69	0.61	0.86	0.86	0.80	0.60	0.68	0.58	0.57	0.55	1.00	0.36	0.27	0.16	0.86	0.71	0.54	0.32	0.85	0.58	n/a	n/a
	5-3/4	(146)	0.73	0.73	0.71	0.63	0.95	0.95	0.88	0.64	0.71	0.60	0.58	0.56		0.44	0.33	0.20	0.95	0.88	0.66	0.40	0.91	0.62	0.56	n/a
	6	(152)	0.74	0.74	0.72	0.63	0.98	0.98	0.91	0.66	0.71	0.60	0.58	0.56		0.47	0.35	0.21	0.98	0.94	0.70	0.42	0.93	0.63	0.58	n/a
	7	(178)	0.78	0.78	0.76	0.66	1.00	1.00	1.00	0.72	0.75	0.62	0.60	0.57		0.59	0.44	0.27	1.00	1.00	0.89	0.53	1.00	0.69	0.62	n/a
	8	(203)	0.82	0.82	0.80	0.68				0.78	0.79	0.63	0.61	0.58		0.72	0.54	0.32			1.00	0.65		0.73	0.67	n/a
	8-3/4	(222)	0.86	0.86	0.82	0.69				0.83	0.81	0.65	0.62	0.59		0.83	0.62	0.37				0.74		0.77	0.70	0.59
	9	(229)	0.87	0.87	0.83	0.70				0.85	0.82	0.65	0.62	0.59		0.86	0.65	0.39				0.78		0.78	0.71	0.60
	10	(254)	0.91	0.91	0.87	0.72				0.91	0.86	0.67	0.64	0.60		1.00	0.76	0.45				0.91		0.82	0.74	0.63
	11	(279)	0.95	0.95	0.91	0.74				0.98	0.89	0.68	0.65	0.61			0.87	0.52				0.98		0.86	0.78	0.66
	12	(305)	0.99	0.99	0.94	0.77				1.00	0.93	0.70	0.67	0.62			1.00	0.60				1.00		0.90	0.82	0.69
	14	(356)	1.00	1.00	1.00	0.81					1.00	0.73	0.69	0.64				0.75						0.97	0.88	0.74
	16	(406)				0.86						0.77	0.72	0.66				0.92						1.00	0.94	0.79
	18	(457)				0.90						0.80	0.75	0.68				1.00							1.00	0.84
	24	(610)				1.00						0.90	0.83	0.74												0.97
	30	(762)										1.00	0.92	0.80												1.00
	36	(914)											1.00	0.85												
	> 48	(1219)												0.97												

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3 * h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{HV} = 1.0$.

Table 32 — Load adjustment factors for 1/2-in. diameter threaded rods in uncracked concrete[1,2,3]

1/2-in. threaded rods uncracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
														⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}	in.	2-3/4	4-1/2	6	10	2-3/4	4-1/2	6	10	2-3/4	4-1/2	6	10	2-3/4	4-1/2	6	10	2-3/4	4-1/2	6	10	2-3/4	4-1/2	6	10
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	(mm)	(70)	(114)	(152)	(254)	(70)	(114)	(152)	(254)	(70)	(114)	(152)	(254)	(70)	(114)	(152)	(254)	(70)	(114)	(152)	(254)	(70)	(114)	(152)	(254)
1-3/4	(44)	n/a	n/a	n/a	n/a	0.34	0.24	0.19	0.11	n/a	n/a	n/a	n/a	0.10	0.05	0.03	0.02	0.21	0.11	0.07	0.03	n/a	n/a	n/a	n/a
2-1/2	(64)	0.58	0.58	0.57	0.54	0.41	0.28	0.22	0.13	0.55	0.53	0.53	0.52	0.18	0.09	0.06	0.03	0.35	0.18	0.12	0.06	n/a	n/a	n/a	n/a
3	(76)	0.59	0.59	0.58	0.55	0.46	0.30	0.23	0.14	0.56	0.54	0.53	0.52	0.23	0.12	0.08	0.04	0.46	0.24	0.15	0.08	n/a	n/a	n/a	n/a
4	(102)	0.62	0.62	0.61	0.57	0.57	0.35	0.26	0.15	0.58	0.55	0.54	0.53	0.36	0.18	0.12	0.06	0.57	0.35	0.24	0.12	0.58	n/a	n/a	n/a
5	(127)	0.65	0.65	0.64	0.58	0.71	0.40	0.30	0.17	0.60	0.57	0.55	0.53	0.50	0.26	0.17	0.08	0.71	0.40	0.31	0.16	0.65	n/a	n/a	n/a
5-3/4	(146)	0.68	0.68	0.66	0.60	0.78	0.44	0.33	0.19	0.62	0.58	0.56	0.54	0.61	0.32	0.21	0.10	0.81	0.44	0.34	0.20	0.69	0.56	n/a	n/a
6	(152)	0.69	0.69	0.67	0.60	0.80	0.46	0.33	0.20	0.63	0.58	0.56	0.54	0.65	0.34	0.22	0.11	0.85	0.46	0.35	0.21	0.71	0.57	n/a	n/a
7	(178)	0.72	0.72	0.69	0.62	0.90	0.52	0.37	0.22	0.65	0.59	0.57	0.54	0.82	0.42	0.28	0.13	0.99	0.52	0.38	0.27	0.77	0.61	n/a	n/a
7-1/4	(184)	0.72	0.72	0.70	0.62	0.92	0.54	0.38	0.22	0.65	0.60	0.57	0.55	0.87	0.45	0.29	0.14	1.00	0.54	0.39	0.28	0.78	0.62	0.54	n/a
8	(203)	0.75	0.75	0.72	0.63	0.99	0.59	0.41	0.24	0.67	0.61	0.58	0.55	1.00	0.52	0.34	0.16		0.59	0.42	0.30	0.82	0.66	0.57	n/a
9	(229)	0.78	0.78	0.75	0.65	1.00	0.67	0.46	0.27	0.69	0.62	0.59	0.56		0.62	0.40	0.20		0.67	0.46	0.32	0.87	0.70	0.60	n/a
10	(254)	0.81	0.81	0.78	0.67		0.74	0.52	0.30	0.71	0.63	0.60	0.56		0.72	0.47	0.23		0.74	0.52	0.34	0.92	0.73	0.64	n/a
11-1/4	(286)	0.85	0.85	0.81	0.69		0.83	0.58	0.34	0.74	0.65	0.61	0.57		0.86	0.56	0.27		0.83	0.58	0.37	0.97	0.78	0.67	0.53
12	(305)	0.87	0.87	0.83	0.70		0.89	0.62	0.36	0.75	0.66	0.62	0.58		0.95	0.62	0.30		0.89	0.62	0.38	1.00	0.80	0.70	0.55
14	(356)	0.93	0.93	0.89	0.73		1.00	0.72	0.42	0.79	0.69	0.64	0.59		1.00	0.78	0.38		1.00	0.72	0.43		0.87	0.75	0.59
16	(406)	1.00	1.00	0.94	0.77			0.82	0.48	0.83	0.72	0.66	0.60			0.95	0.47			0.82	0.48		0.93	0.80	0.63
18	(457)			1.00	0.80			0.93	0.54	0.88	0.74	0.68	0.61			1.00	0.56			0.93	0.54		0.98	0.85	0.67
20	(508)				0.83			1.00	0.60	0.92	0.77	0.70	0.63				0.65			1.00	0.60		1.00	0.90	0.71
22	(559)				0.87				0.66	0.96	0.80	0.72	0.64				0.75				0.66			0.94	0.74
24	(610)				0.90				0.72	1.00	0.82	0.74	0.65				0.85				0.72			0.98	0.77
30	(762)				1.00				0.90		0.90	0.80	0.69				1.00				0.90			1.00	0.87
36	(914)								1.00		0.98	0.86	0.73								1.00				0.95
> 48	(1219)										1.00	0.98	0.80												1.00

Table 33 — Load adjustment factors for 1/2-in. diameter threaded rods in cracked concrete[1,2,3]

1/2-in. threaded rods cracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
														⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}	in.	2-3/4	4-1/2	6	10	2-3/4	4-1/2	6	10	2-3/4	4-1/2	6	10	2-3/4	4-1/2	6	10	2-3/4	4-1/2	6	10	2-3/4	4-1/2	6	10
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	(mm)	(70)	(114)	(152)	(254)	(70)	(114)	(152)	(254)	(70)	(114)	(152)	(254)	(70)	(114)	(152)	(254)	(70)	(114)	(152)	(254)	(70)	(114)	(152)	(254)
1-3/4	(44)	n/a	n/a	n/a	n/a	0.47	0.47	0.45	0.41	n/a	n/a	n/a	n/a	0.10	0.05	0.04	0.02	0.21	0.11	0.07	0.04	n/a	n/a	n/a	n/a
2-1/2	(64)	0.58	0.58	0.57	0.54	0.52	0.52	0.50	0.44	0.55	0.53	0.53	0.52	0.18	0.09	0.06	0.04	0.35	0.18	0.12	0.07	n/a	n/a	n/a	n/a
3	(76)	0.59	0.59	0.58	0.55	0.56	0.56	0.53	0.46	0.56	0.54	0.53	0.52	0.23	0.12	0.08	0.05	0.47	0.24	0.16	0.10	n/a	n/a	n/a	n/a
4	(102)	0.62	0.62	0.61	0.57	0.63	0.63	0.60	0.49	0.58	0.55	0.54	0.53	0.36	0.18	0.13	0.08	0.72	0.37	0.25	0.15	0.58	n/a	n/a	n/a
5	(127)	0.65	0.65	0.64	0.58	0.72	0.72	0.67	0.53	0.61	0.57	0.55	0.54	0.50	0.26	0.18	0.11	1.00	0.52	0.35	0.21	0.65	n/a	n/a	n/a
5-3/4	(146)	0.68	0.68	0.66	0.60	0.78	0.78	0.73	0.56	0.62	0.58	0.56	0.54	0.62	0.32	0.22	0.13		0.64	0.43	0.26	0.70	0.56	n/a	n/a
6	(152)	0.69	0.69	0.67	0.60	0.80	0.80	0.75	0.57	0.63	0.58	0.56	0.54	0.66	0.34	0.23	0.14		0.68	0.46	0.28	0.71	0.57	n/a	n/a
7	(178)	0.72	0.72	0.69	0.62	0.90	0.90	0.83	0.62	0.65	0.59	0.57	0.55	0.83	0.43	0.29	0.17		0.86	0.58	0.35	0.77	0.62	n/a	n/a
7-1/4	(184)	0.72	0.72	0.70	0.62	0.92	0.92	0.85	0.63	0.65	0.60	0.58	0.55	0.88	0.45	0.31	0.18		0.90	0.61	0.37	0.78	0.63	0.55	n/a
8	(203)	0.75	0.75	0.72	0.63	0.99	0.99	0.91	0.66	0.67	0.61	0.58	0.56	1.00	0.52	0.35	0.21		1.00	0.71	0.43	0.82	0.66	0.58	n/a
9	(229)	0.78	0.78	0.75	0.65	1.00	1.00	1.00	0.70	0.69	0.62	0.59	0.57		0.62	0.42	0.25			0.85	0.51	0.87	0.70	0.61	n/a
10	(254)	0.81	0.81	0.78	0.67				0.75	0.71	0.64	0.60	0.57		0.73	0.50	0.30			0.99	0.59	0.92	0.74	0.65	n/a
11-1/4	(286)	0.85	0.85	0.81	0.69				0.81	0.74	0.65	0.62	0.58		0.87	0.59	0.35			1.00	0.71	0.97	0.78	0.69	0.58
12	(305)	0.87	0.87	0.83	0.70				0.85	0.75	0.66	0.63	0.59		0.96	0.65	0.39				0.78	1.00	0.81	0.71	0.60
14	(356)	0.93	0.93	0.89	0.73				0.95	0.79	0.69	0.65	0.60		1.00	0.82	0.49				0.95		0.87	0.76	0.64
16	(406)	1.00	1.00	0.94	0.77				1.00	0.84	0.72	0.67	0.62			1.00	0.60				1.00		0.93	0.82	0.69
18	(457)			1.00	0.80					0.88	0.74	0.69	0.63				0.72						0.99	0.87	0.73
20	(508)				0.83					0.92	0.77	0.71	0.65				0.84						1.00	0.91	0.77
22	(559)				0.87					0.96	0.80	0.73	0.66				0.97							0.96	0.81
24	(610)				0.90					1.00	0.82	0.75	0.68				1.00							1.00	0.84
30	(762)				1.00						0.91	0.81	0.72												0.94
36	(914)										0.99	0.88	0.77												1.00
> 48	(1219)										1.00	1.00	0.86												

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{HV} = 1.0$.

Table 34 — Load adjustment factors for 5/8-in. diameter threaded rods in uncracked concrete[1,2,3]

5/8-in. threaded rods uncracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
														⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}	in. (mm)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4 (44)	n/a	n/a	n/a	n/a	0.35	0.24	0.19	0.11	n/a	n/a	n/a	n/a	0.09	0.04	0.03	0.01	0.19	0.08	0.06	0.03	n/a	n/a	n/a	n/a
	3-1/8 (79)	0.58	0.58	0.57	0.54	0.47	0.29	0.22	0.13	0.56	0.54	0.53	0.52	0.22	0.10	0.07	0.03	0.45	0.20	0.13	0.06	n/a	n/a	n/a	n/a
	4 (102)	0.60	0.60	0.59	0.55	0.56	0.32	0.24	0.14	0.58	0.55	0.53	0.52	0.32	0.15	0.10	0.04	0.56	0.29	0.19	0.09	n/a	n/a	n/a	n/a
	4-5/8 (117)	0.62	0.62	0.60	0.56	0.62	0.35	0.26	0.15	0.59	0.55	0.54	0.52	0.40	0.18	0.12	0.06	0.62	0.35	0.24	0.11	0.60	n/a	n/a	n/a
	5 (127)	0.63	0.63	0.61	0.57	0.64	0.36	0.27	0.16	0.60	0.56	0.54	0.53	0.45	0.21	0.13	0.06	0.67	0.36	0.27	0.12	0.63	n/a	n/a	n/a
	6 (152)	0.65	0.65	0.63	0.58	0.71	0.41	0.30	0.17	0.62	0.57	0.55	0.53	0.59	0.27	0.18	0.08	0.80	0.41	0.32	0.16	0.69	n/a	n/a	n/a
	7 (178)	0.68	0.68	0.66	0.59	0.78	0.45	0.33	0.19	0.64	0.58	0.56	0.54	0.75	0.34	0.22	0.10	0.94	0.45	0.35	0.21	0.74	n/a	n/a	n/a
	7-1/8 (181)	0.68	0.68	0.66	0.60	0.79	0.46	0.33	0.19	0.64	0.58	0.56	0.54	0.77	0.35	0.23	0.11	0.95	0.46	0.35	0.21	0.75	0.57	n/a	n/a
	8 (203)	0.70	0.70	0.68	0.61	0.85	0.50	0.36	0.21	0.66	0.59	0.57	0.54	0.91	0.41	0.27	0.13	1.00	0.50	0.38	0.25	0.79	0.61	n/a	n/a
	9 (229)	0.73	0.73	0.70	0.62	0.93	0.56	0.39	0.22	0.68	0.60	0.58	0.55	1.00	0.50	0.32	0.15		0.56	0.41	0.29	0.84	0.65	0.56	n/a
	10 (254)	0.75	0.75	0.72	0.63	1.00	0.62	0.43	0.24	0.70	0.62	0.59	0.55		0.58	0.38	0.18		0.62	0.44	0.30	0.89	0.68	0.59	n/a
	11 (279)	0.78	0.78	0.74	0.65		0.68	0.47	0.27	0.72	0.63	0.60	0.56		0.67	0.43	0.20		0.68	0.47	0.32	0.93	0.71	0.62	n/a
	12 (305)	0.80	0.80	0.77	0.66		0.74	0.51	0.29	0.74	0.64	0.60	0.56		0.76	0.50	0.23		0.74	0.51	0.34	0.97	0.75	0.65	n/a
	14 (356)	0.85	0.85	0.81	0.69		0.86	0.60	0.34	0.77	0.66	0.62	0.57		0.96	0.62	0.29		0.86	0.60	0.37	1.00	0.81	0.70	0.54
	16 (406)	0.90	0.90	0.86	0.71		0.99	0.68	0.39	0.81	0.69	0.64	0.58		1.00	0.76	0.35		0.99	0.68	0.41		0.86	0.75	0.58
	18 (457)	0.96	0.96	0.90	0.74		1.00	0.77	0.44	0.85	0.71	0.66	0.59			0.91	0.42		1.00	0.77	0.44		0.91	0.79	0.61
	20 (508)	1.00	1.00	0.94	0.77			0.86	0.49	0.89	0.73	0.67	0.60			1.00	0.50			0.86	0.49		0.96	0.83	0.65
	22 (559)			0.99	0.79			0.94	0.54	0.93	0.75	0.69	0.61				0.57			0.94	0.54		1.00	0.87	0.68
	24 (610)			1.00	0.82			1.00	0.59	0.97	0.78	0.71	0.63				0.65			1.00	0.59			0.91	0.71
	26 (660)				0.85				0.64	1.00	0.80	0.73	0.64				0.73				0.64			0.95	0.74
	28 (711)				0.87				0.68		0.82	0.74	0.65				0.82				0.68			0.99	0.76
	30 (762)				0.90				0.73		0.85	0.76	0.66				0.91				0.73			1.00	0.79
	36 (914)				0.98				0.88		0.92	0.81	0.69				1.00				0.88				0.87
	> 48 (1219)				1.00				1.00		1.00	0.92	0.75								1.00				1.00

Table 35 — Load adjustment factors for 5/8-in. diameter threaded rods in cracked concrete[1,2,3]

5/8-in. threaded rods cracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
														⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}	in. (mm)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4 (44)	n/a	n/a	n/a	n/a	0.44	0.44	0.43	0.40	n/a	n/a	n/a	n/a	0.09	0.04	0.03	0.02	0.19	0.09	0.06	0.03	n/a	n/a	n/a	n/a
	3-1/8 (79)	0.58	0.58	0.57	0.54	0.52	0.52	0.50	0.44	0.56	0.54	0.53	0.52	0.22	0.10	0.07	0.04	0.45	0.20	0.13	0.07	n/a	n/a	n/a	n/a
	4 (102)	0.60	0.60	0.59	0.55	0.58	0.58	0.55	0.46	0.58	0.55	0.53	0.52	0.33	0.15	0.10	0.05	0.65	0.30	0.19	0.11	n/a	n/a	n/a	n/a
	4-5/8 (117)	0.62	0.62	0.60	0.56	0.62	0.62	0.58	0.48	0.59	0.55	0.54	0.53	0.40	0.18	0.12	0.07	0.81	0.37	0.24	0.13	0.60	n/a	n/a	n/a
	5 (127)	0.63	0.63	0.61	0.57	0.64	0.64	0.60	0.49	0.60	0.56	0.54	0.53	0.45	0.21	0.13	0.08	0.91	0.41	0.27	0.15	0.63	n/a	n/a	n/a
	6 (152)	0.65	0.65	0.63	0.58	0.71	0.71	0.66	0.53	0.62	0.57	0.55	0.54	0.60	0.27	0.18	0.10	1.00	0.54	0.35	0.20	0.69	n/a	n/a	n/a
	7 (178)	0.68	0.68	0.66	0.59	0.78	0.78	0.72	0.56	0.64	0.58	0.56	0.54	0.75	0.34	0.22	0.13		0.68	0.44	0.25	0.74	n/a	n/a	n/a
	7-1/8 (181)	0.68	0.68	0.66	0.60	0.79	0.79	0.73	0.56	0.64	0.58	0.56	0.54	0.77	0.35	0.23	0.13		0.70	0.46	0.26	0.75	0.58	n/a	n/a
	8 (203)	0.70	0.70	0.68	0.61	0.85	0.85	0.78	0.59	0.66	0.59	0.57	0.55	0.92	0.42	0.27	0.15		0.84	0.54	0.31	0.79	0.61	n/a	n/a
	9 (229)	0.73	0.73	0.70	0.62	0.93	0.93	0.85	0.62	0.68	0.60	0.58	0.55	1.00	0.50	0.32	0.18		1.00	0.65	0.37	0.84	0.65	0.56	n/a
	10 (254)	0.75	0.75	0.72	0.63	1.00	1.00	0.91	0.66	0.70	0.62	0.59	0.56		0.58	0.38	0.21			0.76	0.43	0.89	0.68	0.59	n/a
	11 (279)	0.78	0.78	0.74	0.65			0.98	0.69	0.72	0.63	0.60	0.57		0.67	0.44	0.25			0.88	0.49	0.93	0.72	0.62	n/a
	12 (305)	0.80	0.80	0.77	0.66			1.00	0.73	0.74	0.64	0.60	0.57		0.77	0.50	0.28			1.00	0.56	0.97	0.75	0.65	n/a
	14 (356)	0.85	0.85	0.81	0.69				0.81	0.78	0.66	0.62	0.58		0.97	0.63	0.36				0.71	1.00	0.81	0.70	0.58
	16 (406)	0.90	0.90	0.86	0.71				0.89	0.82	0.69	0.64	0.60		1.00	0.77	0.43				0.87		0.86	0.75	0.62
	18 (457)	0.96	0.96	0.90	0.74				0.97	0.85	0.71	0.66	0.61			0.92	0.52				0.97		0.92	0.79	0.66
	20 (508)	1.00	1.00	0.94	0.77				1.00	0.89	0.73	0.67	0.62			1.00	0.61				1.00		0.97	0.84	0.69
	22 (559)			0.99	0.79					0.93	0.76	0.69	0.63				0.70						1.00	0.88	0.72
	24 (610)			1.00	0.82					0.97	0.78	0.71	0.64				0.80							0.92	0.76
	26 (660)				0.85					1.00	0.80	0.73	0.66				0.90							0.95	0.79
	28 (711)				0.87						0.83	0.74	0.67				1.00							0.99	0.82
	30 (762)				0.90						0.85	0.76	0.68											1.00	0.85
	36 (914)				0.98						0.92	0.81	0.71												0.93
	> 48 (1219)				1.00						1.00	0.92	0.79												1.00

[1] Linear interpolation not permitted

[2] Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3 {*} h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3 {*} h_{ef}$. If $c \geq 3 {*} h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3 {*} h_{ef}$. If $c \geq 3 {*} h_{ef}$, then $f_{HV} = 1.0$.

Table 36 — Load adjustment factors for 3/4-in. diameter threaded rods in uncracked concrete[1,2,3]

3/4-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Embedment h_{ef}	in.	(mm)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.35	0.24	0.18	0.10	n/a	n/a	n/a	n/a	0.09	0.03	0.02	0.01	0.17	0.07	0.05	0.02	n/a	n/a	n/a	n/a
	3-3/4	(95)	0.58	0.58	0.57	0.54	0.52	0.30	0.23	0.13	0.57	0.54	0.53	0.52	0.27	0.11	0.07	0.03	0.52	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	4	(102)	0.59	0.59	0.57	0.54	0.54	0.31	0.23	0.13	0.57	0.54	0.53	0.52	0.29	0.12	0.08	0.04	0.54	0.24	0.16	0.07	n/a	n/a	n/a	n/a
	5	(127)	0.61	0.61	0.59	0.56	0.59	0.34	0.25	0.14	0.59	0.55	0.54	0.52	0.41	0.17	0.11	0.05	0.64	0.33	0.22	0.10	n/a	n/a	n/a	n/a
	5-1/4	(133)	0.61	0.61	0.60	0.56	0.61	0.35	0.26	0.15	0.60	0.55	0.54	0.52	0.44	0.18	0.12	0.05	0.66	0.35	0.23	0.11	0.62	n/a	n/a	n/a
	6	(152)	0.63	0.63	0.61	0.57	0.65	0.38	0.28	0.16	0.61	0.56	0.55	0.53	0.54	0.22	0.14	0.07	0.76	0.38	0.29	0.13	0.66	n/a	n/a	n/a
	7	(178)	0.65	0.65	0.63	0.58	0.70	0.41	0.30	0.17	0.63	0.57	0.55	0.53	0.68	0.28	0.18	0.08	0.89	0.41	0.32	0.17	0.72	n/a	n/a	n/a
	8	(203)	0.67	0.67	0.65	0.59	0.76	0.45	0.33	0.18	0.65	0.58	0.56	0.54	0.83	0.34	0.22	0.10	1.00	0.45	0.35	0.20	0.77	n/a	n/a	n/a
	8-1/2	(216)	0.68	0.68	0.66	0.59	0.79	0.47	0.34	0.19	0.66	0.59	0.56	0.54	0.91	0.37	0.24	0.11		0.47	0.36	0.22	0.79	0.59	n/a	n/a
	9	(229)	0.69	0.69	0.67	0.60	0.83	0.49	0.35	0.20	0.67	0.59	0.57	0.54	0.99	0.40	0.26	0.12		0.49	0.37	0.24	0.81	0.60	n/a	n/a
	10	(254)	0.71	0.71	0.69	0.61	0.89	0.53	0.38	0.21	0.68	0.60	0.58	0.55	1.00	0.47	0.31	0.14		0.53	0.40	0.28	0.86	0.64	n/a	n/a
	10-3/4	(273)	0.73	0.73	0.70	0.62	0.94	0.57	0.40	0.23	0.70	0.61	0.58	0.55		0.53	0.34	0.16		0.57	0.42	0.29	0.89	0.66	0.57	n/a
	12	(305)	0.76	0.76	0.72	0.63	1.00	0.64	0.44	0.25	0.72	0.62	0.59	0.55		0.62	0.40	0.19		0.64	0.45	0.31	0.94	0.70	0.60	n/a
	14	(356)	0.80	0.80	0.76	0.66		0.74	0.52	0.29	0.76	0.64	0.61	0.56		0.78	0.51	0.24		0.74	0.52	0.33	1.00	0.75	0.65	n/a
	16	(406)	0.84	0.84	0.80	0.68		0.85	0.59	0.33	0.79	0.66	0.62	0.57		0.96	0.62	0.29		0.85	0.59	0.36		0.80	0.70	n/a
	16-3/4	(425)	0.86	0.86	0.81	0.69		0.89	0.62	0.35	0.81	0.67	0.63	0.58		1.00	0.67	0.31		0.89	0.62	0.37		0.82	0.71	0.55
	18	(457)	0.89	0.89	0.83	0.70		0.96	0.66	0.37	0.83	0.68	0.64	0.58			0.74	0.35		0.96	0.66	0.39		0.85	0.74	0.57
	20	(508)	0.93	0.93	0.87	0.72		1.00	0.74	0.41	0.87	0.70	0.65	0.59			0.87	0.40		1.00	0.74	0.42		0.90	0.78	0.60
	22	(559)	0.97	0.97	0.91	0.74			0.81	0.45	0.91	0.72	0.67	0.60			1.00	0.47			0.81	0.46		0.94	0.82	0.63
	24	(610)	1.00	1.00	0.94	0.77			0.89	0.50	0.94	0.74	0.68	0.61				0.53			0.89	0.50		0.99	0.85	0.66
	26	(660)			0.98	0.79			0.96	0.54	0.98	0.76	0.70	0.62				0.60			0.96	0.54		1.00	0.89	0.69
	28	(711)			1.00	0.81			1.00	0.58	1.00	0.78	0.71	0.63				0.67			1.00	0.58			0.92	0.71
	30	(762)				0.83				0.62		0.80	0.73	0.64				0.74				0.62			0.95	0.74
	36	(914)				0.90				0.74		0.86	0.77	0.66				0.98				0.74			1.00	0.81
	> 48	(1219)				1.00				0.99		0.99	0.86	0.72				1.00				0.99				0.94

Table 37 — Load adjustment factors for 3/4-in. diameter threaded rods in cracked concrete[1,2,3]

3/4-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Embedment h_{ef}	in.	(mm)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)	3-1/2 (89)	6-3/4 (171)	9 (229)	15 (381)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.43	0.43	0.42	0.39	n/a	n/a	n/a	n/a	0.09	0.03	0.02	0.01	0.17	0.07	0.05	0.02	n/a	n/a	n/a	n/a
	3-3/4	(95)	0.58	0.58	0.57	0.54	0.53	0.53	0.50	0.44	0.57	0.54	0.53	0.52	0.27	0.11	0.07	0.04	0.54	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	4	(102)	0.59	0.59	0.57	0.54	0.54	0.54	0.51	0.44	0.57	0.54	0.53	0.52	0.30	0.12	0.08	0.04	0.59	0.24	0.16	0.08	n/a	n/a	n/a	n/a
	5	(127)	0.61	0.61	0.59	0.56	0.59	0.59	0.56	0.47	0.59	0.55	0.54	0.52	0.41	0.17	0.11	0.06	0.83	0.34	0.22	0.11	n/a	n/a	n/a	n/a
	5-1/4	(133)	0.61	0.61	0.60	0.56	0.61	0.61	0.57	0.47	0.60	0.55	0.54	0.53	0.45	0.18	0.12	0.06	0.89	0.36	0.24	0.12	0.62	n/a	n/a	n/a
	6	(152)	0.63	0.63	0.61	0.57	0.65	0.65	0.60	0.49	0.61	0.56	0.55	0.53	0.54	0.22	0.14	0.07	1.00	0.44	0.29	0.15	0.67	n/a	n/a	n/a
	7	(178)	0.65	0.65	0.63	0.58	0.70	0.70	0.65	0.52	0.63	0.57	0.55	0.53	0.69	0.28	0.18	0.09		0.56	0.36	0.19	0.72	n/a	n/a	n/a
	8	(203)	0.67	0.67	0.65	0.59	0.76	0.76	0.70	0.55	0.65	0.58	0.56	0.54	0.84	0.34	0.22	0.12		0.68	0.44	0.23	0.77	n/a	n/a	n/a
	8-1/2	(216)	0.68	0.68	0.66	0.59	0.79	0.79	0.72	0.56	0.66	0.59	0.56	0.54	0.92	0.37	0.24	0.13		0.75	0.49	0.25	0.79	0.59	n/a	n/a
	9	(229)	0.69	0.69	0.67	0.60	0.83	0.83	0.75	0.57	0.67	0.59	0.57	0.54	1.00	0.41	0.26	0.14		0.82	0.53	0.28	0.82	0.61	n/a	n/a
	10	(254)	0.71	0.71	0.69	0.61	0.89	0.89	0.80	0.60	0.69	0.60	0.58	0.55		0.48	0.31	0.16		0.95	0.62	0.32	0.86	0.64	n/a	n/a
	10-3/4	(273)	0.73	0.73	0.70	0.62	0.94	0.94	0.84	0.62	0.70	0.61	0.58	0.55		0.53	0.35	0.18		1.00	0.69	0.36	0.89	0.66	0.57	n/a
	12	(305)	0.76	0.76	0.72	0.63	1.00	1.00	0.91	0.66	0.72	0.62	0.59	0.56		0.63	0.41	0.21			0.82	0.42	0.94	0.70	0.61	n/a
	14	(356)	0.80	0.80	0.76	0.66			1.00	0.72	0.76	0.64	0.61	0.57		0.79	0.51	0.27			1.00	0.53	1.00	0.76	0.65	n/a
	16	(406)	0.84	0.84	0.80	0.68				0.78	0.80	0.66	0.62	0.58		0.97	0.63	0.33				0.65		0.81	0.70	n/a
	16-3/4	(425)	0.86	0.86	0.81	0.69				0.81	0.81	0.67	0.63	0.58		1.00	0.67	0.35				0.70		0.83	0.72	0.57
	18	(457)	0.89	0.89	0.83	0.70				0.85	0.83	0.68	0.64	0.59			0.75	0.39				0.78		0.86	0.74	0.60
	20	(508)	0.93	0.93	0.87	0.72				0.91	0.87	0.70	0.65	0.60			0.88	0.46				0.91		0.90	0.78	0.63
	22	(559)	0.97	0.97	0.91	0.74				0.98	0.91	0.72	0.67	0.61			1.00	0.53				0.98		0.95	0.82	0.66
	24	(610)	1.00	1.00	0.94	0.77				1.00	0.94	0.74	0.68	0.62				0.60				1.00		0.99	0.86	0.69
	26	(660)			0.98	0.79					0.98	0.76	0.70	0.63				0.68						1.00	0.89	0.72
	28	(711)			1.00	0.81					1.00	0.79	0.71	0.64				0.75							0.92	0.74
	30	(762)				0.83						0.81	0.73	0.65				0.84							0.96	0.77
	36	(914)				0.90						0.87	0.77	0.68				1.00							1.00	0.84
	> 48	(1219)				1.00						0.99	0.87	0.74												0.97

[1] Linear interpolation not permitted.

[2] Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

[3] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when c < 3*h_{ef}. f_{AV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{AV} = f_{AN}.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{HV} = 1.0.

Table 38 — Load adjustment factors for 7/8-in. diameter threaded rods in uncracked concrete[1,2,3]

7/8-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment		in.	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2
h_{ef}		(mm)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.39	0.24	0.18	0.10	n/a	n/a	n/a	n/a	0.09	0.03	0.02	0.01	0.18	0.05	0.04	0.02	n/a	n/a	n/a	n/a
	4-3/8	(111)	0.58	0.58	0.57	0.54	0.53	0.31	0.23	0.13	0.58	0.54	0.53	0.52	0.35	0.11	0.07	0.03	0.63	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	5	(127)	0.59	0.59	0.58	0.55	0.56	0.33	0.24	0.13	0.59	0.54	0.53	0.52	0.43	0.13	0.09	0.04	0.70	0.27	0.17	0.08	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.60	0.60	0.59	0.55	0.58	0.34	0.25	0.14	0.60	0.55	0.54	0.52	0.50	0.15	0.10	0.05	0.76	0.31	0.20	0.09	0.65	n/a	n/a	n/a
	6	(152)	0.61	0.61	0.60	0.56	0.61	0.36	0.26	0.15	0.61	0.55	0.54	0.52	0.57	0.17	0.11	0.05	0.83	0.35	0.23	0.11	0.68	n/a	n/a	n/a
	7	(178)	0.63	0.63	0.61	0.57	0.65	0.39	0.28	0.16	0.63	0.56	0.55	0.53	0.71	0.22	0.14	0.07	0.97	0.39	0.29	0.13	0.73	n/a	n/a	n/a
	8	(203)	0.65	0.65	0.63	0.58	0.71	0.42	0.31	0.17	0.65	0.57	0.55	0.53	0.87	0.27	0.17	0.08	1.00	0.42	0.33	0.16	0.78	n/a	n/a	n/a
	9	(229)	0.67	0.67	0.64	0.59	0.76	0.45	0.33	0.18	0.67	0.58	0.56	0.54	1.00	0.32	0.21	0.10		0.45	0.35	0.19	0.83	n/a	n/a	n/a
	9-7/8	(251)	0.69	0.69	0.66	0.59	0.80	0.48	0.35	0.19	0.69	0.59	0.56	0.54		0.37	0.24	0.11		0.48	0.37	0.22	0.87	0.59	n/a	n/a
	10	(254)	0.69	0.69	0.66	0.60	0.81	0.49	0.35	0.19	0.69	0.59	0.57	0.54		0.38	0.24	0.11		0.49	0.37	0.23	0.87	0.59	n/a	n/a
	11	(279)	0.71	0.71	0.67	0.60	0.87	0.52	0.38	0.21	0.71	0.60	0.57	0.54		0.43	0.28	0.13		0.52	0.40	0.26	0.91	0.62	n/a	n/a
	12	(305)	0.73	0.73	0.69	0.61	0.92	0.56	0.40	0.22	0.73	0.60	0.58	0.55		0.49	0.32	0.15		0.56	0.42	0.29	0.95	0.65	n/a	n/a
	12-1/2	(318)	0.74	0.74	0.70	0.62	0.95	0.59	0.41	0.23	0.74	0.61	0.58	0.55		0.52	0.34	0.16		0.59	0.43	0.29	0.97	0.66	0.57	n/a
	14	(356)	0.76	0.76	0.72	0.63	1.00	0.66	0.46	0.25	0.77	0.62	0.59	0.55		0.62	0.40	0.19		0.66	0.47	0.31	1.00	0.70	0.60	n/a
	16	(406)	0.80	0.80	0.75	0.65		0.75	0.52	0.29	0.80	0.64	0.60	0.56		0.76	0.49	0.23		0.75	0.52	0.34		0.75	0.65	n/a
	18	(457)	0.84	0.84	0.79	0.67		0.84	0.59	0.32	0.84	0.66	0.62	0.57		0.91	0.59	0.27		0.84	0.59	0.36		0.79	0.68	n/a
	19-1/2	(495)	0.87	0.87	0.81	0.69		0.92	0.64	0.35	0.87	0.67	0.63	0.58		1.00	0.66	0.31		0.92	0.64	0.38		0.82	0.71	0.55
	20	(508)	0.88	0.88	0.82	0.69		0.94	0.65	0.36	0.88	0.67	0.63	0.58			0.69	0.32		0.94	0.65	0.39		0.83	0.72	0.56
	22	(559)	0.91	0.91	0.85	0.71		1.00	0.72	0.40	0.92	0.69	0.64	0.59			0.80	0.37		1.00	0.72	0.41		0.87	0.76	0.59
	24	(610)	0.95	0.95	0.88	0.73			0.78	0.43	0.96	0.71	0.66	0.59			0.91	0.42			0.78	0.44		0.91	0.79	0.61
	26	(660)	0.99	0.99	0.91	0.75			0.85	0.47	0.99	0.73	0.67	0.60			1.00	0.48			0.85	0.47		0.95	0.82	0.64
	28	(711)	1.00	1.00	0.94	0.77			0.91	0.50	1.00	0.74	0.68	0.61				0.53			0.91	0.50		0.99	0.85	0.66
	30	(762)			0.98	0.79			0.98	0.54		0.76	0.70	0.62				0.59			0.98	0.54		1.00	0.88	0.68
	36	(914)			1.00	0.84			1.00	0.65		0.81	0.73	0.64				0.77			1.00	0.65			0.97	0.75
	> 48	(1219)				0.96				0.86		0.92	0.81	0.69				1.00				0.86			1.00	0.87

Table 39 — Load adjustment factors for 7/8-in. diameter threaded rods in cracked concrete[1,2,3]

7/8-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment		in.	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2
h_{ef}		(mm)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.42	0.42	0.41	0.38	n/a	n/a	n/a	n/a	0.09	0.03	0.02	0.01	0.18	0.06	0.04	0.02	n/a	n/a	n/a	n/a
	4-3/8	(111)	0.58	0.58	0.57	0.54	0.53	0.53	0.50	0.44	0.58	0.54	0.53	0.52	0.36	0.11	0.07	0.03	0.71	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	5	(127)	0.59	0.59	0.58	0.55	0.56	0.56	0.52	0.45	0.60	0.54	0.53	0.52	0.43	0.13	0.09	0.04	0.87	0.27	0.17	0.08	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.60	0.60	0.59	0.55	0.58	0.58	0.54	0.46	0.61	0.55	0.54	0.52	0.50	0.15	0.10	0.05	1.00	0.31	0.20	0.10	0.65	n/a	n/a	n/a
	6	(152)	0.61	0.61	0.60	0.56	0.61	0.61	0.56	0.47	0.61	0.55	0.54	0.52	0.57	0.18	0.11	0.06		0.35	0.23	0.11	0.68	n/a	n/a	n/a
	7	(178)	0.63	0.63	0.61	0.57	0.65	0.65	0.60	0.49	0.63	0.56	0.55	0.53	0.72	0.22	0.14	0.07		0.44	0.29	0.14	0.73	n/a	n/a	n/a
	8	(203)	0.65	0.65	0.63	0.58	0.71	0.71	0.64	0.52	0.65	0.57	0.55	0.53	0.88	0.27	0.18	0.09		0.54	0.35	0.17	0.78	n/a	n/a	n/a
	9	(229)	0.67	0.67	0.64	0.59	0.76	0.76	0.68	0.54	0.67	0.58	0.56	0.54	1.00	0.32	0.21	0.10		0.65	0.42	0.20	0.83	n/a	n/a	n/a
	9-7/8	(251)	0.69	0.69	0.66	0.59	0.80	0.80	0.72	0.56	0.69	0.59	0.56	0.54		0.37	0.24	0.12		0.74	0.48	0.23	0.87	0.59	n/a	n/a
	10	(254)	0.69	0.69	0.66	0.60	0.81	0.81	0.73	0.56	0.69	0.59	0.57	0.54		0.38	0.25	0.12		0.76	0.49	0.24	0.87	0.59	n/a	n/a
	11	(279)	0.71	0.71	0.67	0.60	0.87	0.87	0.77	0.59	0.71	0.60	0.57	0.54		0.44	0.28	0.14		0.87	0.57	0.28	0.92	0.62	n/a	n/a
	12	(305)	0.73	0.73	0.69	0.61	0.92	0.92	0.82	0.61	0.73	0.60	0.58	0.55		0.50	0.32	0.16		1.00	0.65	0.31	0.96	0.65	n/a	n/a
	12-1/2	(318)	0.74	0.74	0.70	0.62	0.95	0.95	0.84	0.62	0.74	0.61	0.58	0.55		0.53	0.34	0.17			0.69	0.33	0.98	0.66	0.57	n/a
	14	(356)	0.76	0.76	0.72	0.63	1.00	1.00	0.91	0.66	0.77	0.62	0.59	0.56		0.63	0.41	0.20			0.82	0.40	1.00	0.70	0.61	n/a
	16	(406)	0.80	0.80	0.75	0.65			1.00	0.71	0.81	0.64	0.60	0.56		0.77	0.50	0.24			1.00	0.48		0.75	0.65	n/a
	18	(457)	0.84	0.84	0.79	0.67				0.76	0.84	0.66	0.62	0.57		0.91	0.59	0.29				0.58		0.79	0.69	n/a
	19-1/2	(495)	0.87	0.87	0.81	0.69				0.80	0.87	0.67	0.63	0.58		1.00	0.67	0.32				0.65		0.82	0.71	0.56
	20	(508)	0.88	0.88	0.82	0.69				0.82	0.88	0.67	0.63	0.58			0.70	0.34				0.67		0.84	0.72	0.57
	22	(559)	0.91	0.91	0.85	0.71				0.87	0.92	0.69	0.64	0.59			0.80	0.39				0.78		0.88	0.76	0.60
	24	(610)	0.95	0.95	0.88	0.73				0.93	0.96	0.71	0.66	0.60			0.91	0.44				0.89		0.92	0.79	0.62
	26	(660)	0.99	0.99	0.91	0.75				0.99	1.00	0.73	0.67	0.61			1.00	0.50				0.99		0.95	0.82	0.65
	28	(711)	1.00	1.00	0.94	0.77				1.00		0.74	0.68	0.61				0.56				1.00		0.99	0.86	0.67
	30	(762)			0.98	0.79						0.76	0.70	0.62				0.62						1.00	0.89	0.70
	36	(914)			1.00	0.84						0.81	0.74	0.65				0.81							0.97	0.76
	> 48	(1219)				0.96						0.92	0.81	0.69				1.00							1.00	0.88

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for $5d \le s \le 16$-in. and to 0.5 T_{max} for $s > 16$-in.

3 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3{*}h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \ge 3{*}h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \ge 3{*}h_{ef}$, then $f_{HV} = 1.0$.

Table 40 — Load adjustment factors for 1-in. diameter threaded rods in uncracked concrete[1,2,3]

1-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}		in. (mm)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.38	0.24	0.18	0.10	n/a	n/a	n/a	n/a	0.08	0.02	0.01	0.01	0.15	0.05	0.03	0.01	n/a	n/a	n/a	n/a
	5	(127)	0.58	0.58	0.57	0.54	0.53	0.32	0.23	0.13	0.59	0.54	0.53	0.52	0.37	0.11	0.07	0.03	0.65	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	6	(152)	0.60	0.60	0.58	0.55	0.58	0.34	0.25	0.14	0.60	0.55	0.53	0.52	0.48	0.14	0.09	0.04	0.74	0.29	0.19	0.09	n/a	n/a	n/a	n/a
	6-1/4	(159)	0.60	0.60	0.59	0.55	0.59	0.35	0.26	0.14	0.61	0.55	0.54	0.52	0.51	0.15	0.10	0.05	0.77	0.30	0.20	0.09	0.65	n/a	n/a	n/a
	7	(178)	0.62	0.62	0.60	0.56	0.62	0.37	0.27	0.15	0.62	0.55	0.54	0.52	0.61	0.18	0.12	0.05	0.87	0.36	0.23	0.11	0.69	n/a	n/a	n/a
	8	(203)	0.63	0.63	0.61	0.57	0.66	0.40	0.29	0.16	0.64	0.56	0.55	0.53	0.74	0.22	0.14	0.07	0.99	0.40	0.29	0.13	0.74	n/a	n/a	n/a
	9	(229)	0.65	0.65	0.63	0.58	0.71	0.43	0.31	0.17	0.65	0.57	0.55	0.53	0.89	0.26	0.17	0.08	1.00	0.43	0.34	0.16	0.78	n/a	n/a	n/a
	10	(254)	0.67	0.67	0.64	0.58	0.75	0.46	0.33	0.18	0.67	0.58	0.56	0.53	1.00	0.31	0.20	0.09		0.46	0.35	0.19	0.83	n/a	n/a	n/a
	11	(279)	0.68	0.68	0.65	0.59	0.80	0.49	0.35	0.19	0.69	0.58	0.56	0.54		0.35	0.23	0.11		0.49	0.37	0.21	0.87	n/a	n/a	n/a
	11-1/4	(286)	0.69	0.69	0.66	0.59	0.81	0.50	0.35	0.19	0.69	0.59	0.56	0.54		0.37	0.24	0.11		0.50	0.38	0.22	0.88	0.58	n/a	n/a
	12	(305)	0.70	0.70	0.67	0.60	0.85	0.52	0.37	0.20	0.70	0.59	0.57	0.54		0.40	0.26	0.12		0.52	0.39	0.24	0.91	0.60	n/a	n/a
	13	(330)	0.72	0.72	0.68	0.61	0.90	0.55	0.39	0.21	0.72	0.60	0.57	0.54		0.46	0.30	0.14		0.55	0.42	0.28	0.94	0.63	n/a	n/a
	14	(356)	0.73	0.73	0.69	0.62	0.95	0.59	0.41	0.23	0.74	0.61	0.58	0.55		0.51	0.33	0.15		0.59	0.44	0.30	0.98	0.65	n/a	n/a
	14-1/4	(362)	0.74	0.74	0.70	0.62	0.97	0.60	0.42	0.23	0.74	0.61	0.58	0.55		0.52	0.34	0.16		0.60	0.44	0.30	0.99	0.66	0.57	n/a
	16	(406)	0.77	0.77	0.72	0.63	1.00	0.67	0.47	0.26	0.77	0.62	0.59	0.55		0.62	0.40	0.19		0.67	0.48	0.32	1.00	0.70	0.60	n/a
	18	(457)	0.80	0.80	0.75	0.65		0.76	0.53	0.29	0.81	0.64	0.60	0.56		0.74	0.48	0.22		0.76	0.53	0.34		0.74	0.64	n/a
	20	(508)	0.84	0.84	0.78	0.67		0.84	0.58	0.32	0.84	0.65	0.61	0.57		0.87	0.56	0.26		0.84	0.58	0.36		0.78	0.67	n/a
	22	(559)	0.87	0.87	0.81	0.68		0.93	0.64	0.35	0.88	0.67	0.63	0.58		1.00	0.65	0.30		0.93	0.64	0.38		0.82	0.71	n/a
	22-1/4	(565)	0.87	0.87	0.81	0.69		0.94	0.65	0.36	0.88	0.67	0.63	0.58			0.66	0.31		0.94	0.65	0.39		0.82	0.71	0.55
	24	(610)	0.90	0.90	0.83	0.70		1.00	0.70	0.38	0.91	0.68	0.64	0.58			0.74	0.35		1.00	0.70	0.41		0.85	0.74	0.57
	26	(660)	0.94	0.94	0.86	0.72			0.76	0.42	0.94	0.70	0.65	0.59			0.84	0.39			0.76	0.43		0.89	0.77	0.60
	28	(711)	0.97	0.97	0.89	0.73			0.82	0.45	0.98	0.71	0.66	0.60			0.94	0.43			0.82	0.45		0.92	0.80	0.62
	30	(762)	1.00	1.00	0.92	0.75			0.88	0.48	1.00	0.73	0.67	0.60			1.00	0.48			0.88	0.48		0.95	0.83	0.64
	36	(914)			1.00	0.80			1.00	0.58		0.77	0.70	0.62				0.63			1.00	0.58		1.00	0.91	0.70
	> 48	(1219)				0.90				0.77		0.86	0.77	0.66				0.98				0.77			1.00	0.81

Table 41 — Load adjustment factors for 1-in. diameter threaded rods in cracked concrete[1,2,3]

1-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}		in. (mm)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.41	0.41	0.40	0.38	n/a	n/a	n/a	n/a	0.08	0.02	0.01	0.01	0.15	0.05	0.03	0.01	n/a	n/a	n/a	n/a
	5	(127)	0.58	0.58	0.57	0.54	0.53	0.53	0.50	0.44	0.59	0.54	0.53	0.52	0.37	0.11	0.07	0.03	0.74	0.22	0.14	0.07	n/a	n/a	n/a	n/a
	6	(152)	0.60	0.60	0.58	0.55	0.58	0.58	0.53	0.46	0.60	0.55	0.53	0.52	0.49	0.14	0.09	0.04	0.97	0.29	0.19	0.09	n/a	n/a	n/a	n/a
	6-1/4	(159)	0.60	0.60	0.59	0.55	0.59	0.59	0.54	0.46	0.61	0.55	0.54	0.52	0.52	0.15	0.10	0.05	1.00	0.31	0.20	0.09	0.66	n/a	n/a	n/a
	7	(178)	0.62	0.62	0.60	0.56	0.62	0.62	0.57	0.47	0.62	0.55	0.54	0.52	0.61	0.18	0.12	0.05		0.36	0.24	0.11	0.69	n/a	n/a	n/a
	8	(203)	0.63	0.63	0.61	0.57	0.66	0.66	0.60	0.49	0.64	0.56	0.55	0.53	0.75	0.22	0.14	0.07		0.44	0.29	0.13	0.74	n/a	n/a	n/a
	9	(229)	0.65	0.65	0.63	0.58	0.71	0.71	0.64	0.51	0.65	0.57	0.55	0.53	0.89	0.26	0.17	0.08		0.53	0.34	0.16	0.79	n/a	n/a	n/a
	10	(254)	0.67	0.67	0.64	0.58	0.75	0.75	0.67	0.53	0.67	0.58	0.56	0.53	1.00	0.31	0.20	0.09		0.62	0.40	0.19	0.83	n/a	n/a	n/a
	11	(279)	0.68	0.68	0.65	0.59	0.80	0.80	0.71	0.55	0.69	0.58	0.56	0.54		0.36	0.23	0.11		0.72	0.46	0.22	0.87	n/a	n/a	n/a
	11-1/4	(286)	0.69	0.69	0.66	0.59	0.81	0.81	0.72	0.56	0.69	0.59	0.56	0.54		0.37	0.24	0.11		0.74	0.48	0.22	0.88	0.59	n/a	n/a
	12	(305)	0.70	0.70	0.67	0.60	0.85	0.85	0.75	0.57	0.71	0.59	0.57	0.54		0.41	0.26	0.12		0.82	0.53	0.25	0.91	0.61	n/a	n/a
	13	(330)	0.72	0.72	0.68	0.61	0.90	0.90	0.79	0.59	0.72	0.60	0.57	0.54		0.46	0.30	0.14		0.92	0.60	0.28	0.95	0.63	n/a	n/a
	14	(356)	0.73	0.73	0.69	0.62	0.95	0.95	0.83	0.62	0.74	0.61	0.58	0.55		0.51	0.33	0.16		1.00	0.67	0.31	0.98	0.65	n/a	n/a
	14-1/4	(362)	0.74	0.74	0.70	0.62	0.97	0.97	0.84	0.62	0.74	0.61	0.58	0.55		0.53	0.34	0.16			0.69	0.32	0.99	0.66	0.57	n/a
	16	(406)	0.77	0.77	0.72	0.63	1.00	1.00	0.91	0.66	0.77	0.62	0.59	0.55		0.63	0.41	0.19			0.82	0.38	1.00	0.70	0.61	n/a
	18	(457)	0.80	0.80	0.75	0.65			1.00	0.70	0.81	0.64	0.60	0.56		0.75	0.49	0.23			0.97	0.45		0.74	0.64	n/a
	20	(508)	0.84	0.84	0.78	0.67				0.75	0.84	0.65	0.61	0.57		0.88	0.57	0.26			1.00	0.53		0.78	0.68	n/a
	22	(559)	0.87	0.87	0.81	0.68				0.80	0.88	0.67	0.63	0.58		1.00	0.66	0.31				0.61		0.82	0.71	n/a
	22-1/4	(565)	0.87	0.87	0.81	0.69				0.80	0.88	0.67	0.63	0.58			0.67	0.31				0.62		0.82	0.71	0.55
	24	(610)	0.90	0.90	0.83	0.70				0.85	0.91	0.68	0.64	0.58			0.75	0.35				0.70		0.86	0.74	0.57
	26	(660)	0.94	0.94	0.86	0.72				0.90	0.95	0.70	0.65	0.59			0.84	0.39				0.78		0.89	0.77	0.60
	28	(711)	0.97	0.97	0.89	0.73				0.95	0.98	0.71	0.66	0.60			0.94	0.44				0.88		0.92	0.80	0.62
	30	(762)	1.00	1.00	0.92	0.75				1.00	1.00	0.73	0.67	0.60			1.00	0.49				0.97		0.96	0.83	0.64
	36	(914)			1.00	0.80						0.77	0.71	0.62				0.64				1.00		1.00	0.91	0.70
	> 48	(1219)				0.90						0.87	0.77	0.66				0.98							1.00	0.81

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3{*}h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{HV} = 1.0$.

Table 42 — Load adjustment factors for 1-1/4-in. diameter threaded rods in uncracked concrete[1,2,3]

1-1/4-in. threaded rods uncracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
														⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}	in.	5	11-1/4	15	25	5	11-1/4	15	25	5	11-1/4	15	25	5	11-1/4	15	25	5	11-1/4	15	25	5	11-1/4	15	25
	(mm)	(127)	(286)	(381)	(635)	(127)	(286)	(381)	(635)	(127)	(286)	(381)	(635)	(127)	(286)	(381)	(635)	(127)	(286)	(381)	(635)	(127)	(286)	(381)	(635)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h), - in. (mm)																									
1-3/4	(44)	n/a	n/a	n/a	n/a	0.37	0.24	0.17	0.09	n/a	n/a	n/a	n/a	0.05	0.02	0.01	0.00	0.11	0.03	0.02	0.01	n/a	n/a	n/a	n/a
6-1/4	(159)	0.59	0.59	0.57	0.54	0.54	0.33	0.24	0.13	0.59	0.54	0.53	0.52	0.37	0.11	0.07	0.03	0.67	0.22	0.14	0.07	n/a	n/a	n/a	n/a
7	(178)	0.60	0.60	0.58	0.55	0.57	0.35	0.25	0.13	0.60	0.54	0.53	0.52	0.43	0.13	0.08	0.04	0.73	0.26	0.17	0.08	n/a	n/a	n/a	n/a
8	(203)	0.61	0.61	0.59	0.55	0.61	0.37	0.26	0.14	0.61	0.55	0.54	0.52	0.53	0.16	0.10	0.05	0.82	0.31	0.20	0.10	0.66	n/a	n/a	n/a
9	(229)	0.63	0.63	0.60	0.56	0.64	0.39	0.28	0.15	0.62	0.55	0.54	0.52	0.63	0.19	0.12	0.06	0.93	0.38	0.24	0.11	0.70	n/a	n/a	n/a
10	(254)	0.64	0.64	0.61	0.57	0.68	0.41	0.29	0.16	0.64	0.56	0.55	0.53	0.74	0.22	0.14	0.07	1.00	0.41	0.29	0.13	0.74	n/a	n/a	n/a
11	(279)	0.65	0.65	0.62	0.57	0.72	0.44	0.31	0.17	0.65	0.57	0.55	0.53	0.86	0.25	0.16	0.08		0.44	0.33	0.15	0.78	n/a	n/a	n/a
12	(305)	0.67	0.67	0.63	0.58	0.76	0.46	0.33	0.18	0.66	0.57	0.55	0.53	0.98	0.29	0.19	0.09		0.46	0.36	0.17	0.81	n/a	n/a	n/a
13	(330)	0.68	0.68	0.64	0.59	0.80	0.49	0.35	0.19	0.68	0.58	0.56	0.54	1.00	0.33	0.21	0.10		0.49	0.38	0.20	0.84	n/a	n/a	n/a
14	(356)	0.70	0.70	0.66	0.59	0.84	0.52	0.36	0.20	0.69	0.59	0.56	0.54		0.36	0.24	0.11		0.52	0.40	0.22	0.87	0.58	n/a	n/a
14-1/4	(362)	0.70	0.70	0.66	0.60	0.85	0.52	0.37	0.20	0.69	0.59	0.56	0.54		0.37	0.24	0.11		0.52	0.40	0.23	0.88	0.59	n/a	n/a
15	(381)	0.71	0.71	0.67	0.60	0.88	0.54	0.38	0.21	0.70	0.59	0.57	0.54		0.40	0.26	0.12		0.54	0.41	0.24	0.91	0.60	n/a	n/a
16	(406)	0.72	0.72	0.68	0.61	0.92	0.57	0.40	0.22	0.72	0.60	0.57	0.54		0.45	0.29	0.13		0.57	0.43	0.27	0.94	0.62	n/a	n/a
17	(432)	0.74	0.74	0.69	0.61	0.96	0.60	0.42	0.23	0.73	0.60	0.58	0.55		0.49	0.32	0.15		0.60	0.45	0.29	0.96	0.64	n/a	n/a
18	(457)	0.75	0.75	0.70	0.62	1.00	0.63	0.44	0.24	0.75	0.61	0.58	0.55		0.53	0.35	0.16		0.63	0.47	0.31	0.99	0.66	0.57	n/a
20	(508)	0.78	0.78	0.72	0.63		0.70	0.49	0.27	0.77	0.62	0.59	0.55		0.62	0.40	0.19		0.70	0.50	0.33	1.00	0.70	0.60	n/a
22	(559)	0.81	0.81	0.74	0.65		0.77	0.54	0.29	0.80	0.63	0.60	0.56		0.72	0.47	0.22		0.77	0.54	0.35		0.73	0.63	n/a
24	(610)	0.84	0.84	0.77	0.66		0.84	0.59	0.32	0.83	0.65	0.61	0.57		0.82	0.53	0.25		0.84	0.59	0.36		0.76	0.66	n/a
26	(660)	0.87	0.87	0.79	0.67		0.91	0.64	0.34	0.86	0.66	0.62	0.57		0.92	0.60	0.28		0.91	0.64	0.38		0.79	0.69	n/a
28	(711)	0.89	0.89	0.81	0.69		0.98	0.68	0.37	0.88	0.67	0.63	0.58		1.00	0.67	0.31		0.98	0.68	0.40		0.82	0.71	0.55
30	(762)	0.92	0.92	0.83	0.70		1.00	0.73	0.40	0.91	0.68	0.64	0.58			0.74	0.35		1.00	0.73	0.42		0.85	0.74	0.57
36	(914)	1.00	1.00	0.90	0.74			0.88	0.48	0.99	0.72	0.66	0.60			0.98	0.45			0.88	0.48		0.94	0.81	0.63
> 48	(1219)			1.00	0.82			1.00	0.64	1.00	0.79	0.72	0.63			1.00	0.70			1.00	0.64		1.00	0.94	0.72

Table 43 — Load adjustment factors for 1-1/4-in. diameter threaded rods in cracked concrete[1,2,3]

1-1/4-in. threaded rods cracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
														⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}	in.	5	11-1/4	15	25	5	11-1/4	15	25	5	11-1/4	15	25	5	11-1/4	15	25	5	11-1/4	15	25	5	11-1/4	15	25
	(mm)	(127)	(286)	(381)	(635)	(127)	(286)	(381)	(635)	(127)	(286)	(381)	(635)	(127)	(286)	(381)	(635)	(127)	(286)	(381)	(635)	(127)	(286)	(381)	(635)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h), - in. (mm)																									
1-3/4	(44)	n/a	n/a	n/a	n/a	0.40	0.40	0.39	0.37	n/a	n/a	n/a	n/a	0.05	0.02	0.01	0.00	0.11	0.03	0.02	0.01	n/a	n/a	n/a	n/a
6-1/4	(159)	0.59	0.59	0.57	0.54	0.54	0.54	0.50	0.44	0.59	0.54	0.53	0.52	0.37	0.11	0.07	0.03	0.74	0.22	0.14	0.07	n/a	n/a	n/a	n/a
7	(178)	0.60	0.60	0.58	0.55	0.57	0.57	0.52	0.45	0.60	0.54	0.53	0.52	0.44	0.13	0.08	0.04	0.88	0.26	0.17	0.08	n/a	n/a	n/a	n/a
8	(203)	0.61	0.61	0.59	0.55	0.61	0.61	0.55	0.46	0.61	0.55	0.54	0.52	0.54	0.16	0.10	0.05	1.00	0.32	0.21	0.10	0.66	n/a	n/a	n/a
9	(229)	0.63	0.63	0.60	0.56	0.64	0.64	0.57	0.48	0.62	0.55	0.54	0.52	0.64	0.19	0.12	0.06		0.38	0.25	0.11	0.70	n/a	n/a	n/a
10	(254)	0.64	0.64	0.61	0.57	0.68	0.68	0.60	0.49	0.64	0.56	0.55	0.53	0.75	0.22	0.14	0.07		0.44	0.29	0.13	0.74	n/a	n/a	n/a
11	(279)	0.65	0.65	0.62	0.57	0.72	0.72	0.63	0.51	0.65	0.57	0.55	0.53	0.86	0.26	0.17	0.08		0.51	0.33	0.15	0.78	n/a	n/a	n/a
12	(305)	0.67	0.67	0.63	0.58	0.76	0.76	0.66	0.53	0.66	0.57	0.55	0.53	0.98	0.29	0.19	0.09		0.58	0.38	0.18	0.81	n/a	n/a	n/a
13	(330)	0.68	0.68	0.64	0.59	0.80	0.80	0.69	0.54	0.68	0.58	0.56	0.54	1.00	0.33	0.21	0.10		0.66	0.43	0.20	0.85	n/a	n/a	n/a
14	(356)	0.70	0.70	0.66	0.59	0.84	0.84	0.72	0.56	0.69	0.59	0.56	0.54		0.37	0.24	0.11		0.73	0.48	0.22	0.88	0.58	n/a	n/a
14-1/4	(362)	0.70	0.70	0.66	0.60	0.85	0.85	0.73	0.56	0.70	0.59	0.57	0.54		0.38	0.25	0.11		0.75	0.49	0.23	0.89	0.59	n/a	n/a
15	(381)	0.71	0.71	0.67	0.60	0.88	0.88	0.75	0.57	0.71	0.59	0.57	0.54		0.41	0.26	0.12		0.82	0.53	0.25	0.91	0.61	n/a	n/a
16	(406)	0.72	0.72	0.68	0.61	0.92	0.92	0.78	0.59	0.72	0.60	0.57	0.54		0.45	0.29	0.14		0.90	0.58	0.27	0.94	0.63	n/a	n/a
17	(432)	0.74	0.74	0.69	0.61	0.96	0.96	0.81	0.61	0.73	0.60	0.58	0.55		0.49	0.32	0.15		0.98	0.64	0.30	0.97	0.64	n/a	n/a
18	(457)	0.75	0.75	0.70	0.62	1.00	1.00	0.85	0.62	0.75	0.61	0.58	0.55		0.54	0.35	0.16		1.00	0.70	0.32	0.99	0.66	0.57	n/a
20	(508)	0.78	0.78	0.72	0.63			0.91	0.66	0.77	0.62	0.59	0.55		0.63	0.41	0.19			0.82	0.38	1.00	0.70	0.61	n/a
22	(559)	0.81	0.81	0.74	0.65			0.98	0.69	0.80	0.63	0.60	0.56		0.72	0.47	0.22			0.94	0.44		0.73	0.63	n/a
24	(610)	0.84	0.84	0.77	0.66			1.00	0.73	0.83	0.65	0.61	0.57		0.82	0.54	0.25			1.00	0.50		0.77	0.66	n/a
26	(660)	0.87	0.87	0.79	0.67				0.77	0.86	0.66	0.62	0.57		0.93	0.60	0.28				0.56		0.80	0.69	n/a
28	(711)	0.89	0.89	0.81	0.69				0.81	0.88	0.67	0.63	0.58		1.00	0.68	0.31				0.63		0.83	0.72	0.55
30	(762)	0.92	0.92	0.83	0.70				0.85	0.91	0.68	0.64	0.58			0.75	0.35				0.70		0.86	0.74	0.57
36	(914)	1.00	1.00	0.90	0.74				0.97	0.99	0.72	0.66	0.60			0.98	0.46				0.91		0.94	0.81	0.63
> 48	(1219)			1.00	0.82				1.00	1.00	0.79	0.72	0.63			1.00	0.70				1.00		1.00	0.94	0.73

[1] Linear interpolation not permitted.

[2] Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

[3] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3 * h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{HV} = 1.0$.

HIT-RE 500 V3 adhesive with HIS-N and HIS-RN internally threaded insert

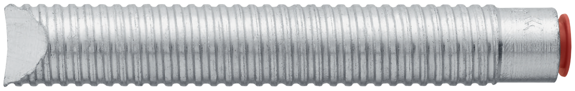


Figure 7 — Hilti HIS-N and HIS-RN internally threaded insert installation conditions

Cracked or uncracked concrete	Permissible drilling methods	Permissible concrete conditions
Cracked and uncracked concrete	Hammer drilling with carbide-tipped drill bit	Dry concrete Water-saturated concrete Water-filled holes Submerged (underwater)
	Hilti TE-CD or TE-YD hollow drill bit Diamond core drill bit with Hilti TE-YRT roughening tool	Dry concrete Water-saturated concrete
Uncracked concrete	Diamond core drill bit	Dry concrete Water-saturated concrete

Table 44 — HIS-N and HIS-RN specifications

Setting information	Symbol	Units	Thread size			
			3/8-16 UNC	1/2-13 UNC	5/8-11 UNC	3/4-10 UNC
Outside diameter of insert		in.	0.65	0.81	1.00	1.09
Nominal bit diameter	d_o	in.	11/16	7/8	1-1/8	1-1/4
Effective embedment	h_{ef}	in.	4-3/8	5	6-3/4	8-1/8
		(mm)	(110)	(125)	(170)	(205)
Thread engagement minimum	h_s	in.	3/8	1/2	5/8	3/4
maximum		in.	15/16	1-3/16	1-1/2	1-7/8
Installation torque	T_{inst}	ft-lb	15	30	60	100
		(Nm)	(20)	(40)	(81)	(136)
Minimum concrete thickness	h_{min}	in.	5.9	6.7	9.1	10.6
		(mm)	(150)	(170)	(230)	(270)
Minimum edge distance	c_{min}	in	3-1/4	4	5	5-1/2
		(mm)	(83)	(102)	(127)	(140)
Minimum anchor spacing	s_{min}	in	3-1/4	4	5	5-1/2
		(mm)	(83)	(102)	(127)	(140)

Figure 8 — Hilti HIS-N and HIS-RN specifications

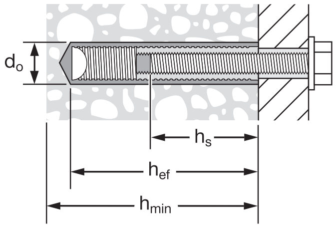


Table 45 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8,9,11]

		Tension — ΦN_n				Shear — ΦV_n			
Thread size	Effective embedment in. (mm)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8-16 UNC	4-3/8 (111)	7,140 (31.8)	7,820 (34.8)	9,030 (40.2)	11,060 (49.2)	15,375 (68.4)	16,840 (74.9)	19,445 (86.5)	23,815 (105.9)
1/2-13[10] UNC	5 (127)	8,720 (38.8)	9,555 (42.5)	11,030 (49.1)	13,510 (60.1)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)
5/8-11[10] UNC	6-3/4 (171)	13,680 (60.9)	14,985 (66.7)	17,305 (77.0)	21,190 (94.3)	29,460 (131.0)	32,275 (143.6)	37,265 (165.8)	45,645 (203.0)
3/4-10[10] UNC	8-1/8 (206)	18,065 (80.4)	19,790 (88.0)	22,850 (101.6)	27,985 (124.5)	38,910 (173.1)	42,620 (189.6)	49,215 (218.9)	60,275 (268.1)

Table 46 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9,11]

		Tension — ΦN_n				Shear — ΦV_n			
Thread size	Effective embedment in. (mm)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8-16 UNC	4-3/8 (111)	5,055 (22.5)	5,540 (24.6)	6,395 (28.4)	7,085 (31.5)	10,890 (48.4)	11,930 (53.1)	13,775 (61.3)	15,260 (67.9)
1/2-13[10] UNC	5 (127)	6,175 (27.5)	6,765 (30.1)	7,815 (34.8)	9,570 (42.6)	13,305 (59.2)	14,575 (64.8)	16,830 (74.9)	20,610 (91.7)
5/8-11[10] UNC	6-3/4 (171)	9,690 (43.1)	10,615 (47.2)	12,255 (54.5)	15,010 (66.8)	20,870 (92.8)	22,860 (101.7)	26,395 (117.4)	32,330 (143.8)
3/4-10[10] UNC	8-1/8 (206)	12,795 (56.9)	14,015 (62.3)	16,185 (72.0)	19,825 (88.2)	27,560 (122.6)	30,190 (134.3)	34,860 (155.1)	42,695 (189.9)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength (factored resistance) value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 50 and 51 as necessary to the above values. Compare to the steel values in table 49.
The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C) multiply above values by 0.69
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete and water saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.52.
For submerged (under water) applications multiply design strength by 0.46.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete except as indicated in note 10. For diamond core drilling in uncracked concrete, except as indicated in note 10, multiply the above values by 0.57. Diamond core drilling is not permitted for water-filled or under-water (submerged) applications in uncracked concrete.

10 Diamond core drilling is permitted in uncracked and cracked concrete with use of the Hilti TE-YRT roughening tool for 1/2-13 UNC, 5/8-11 UNC, and 3/4-10 UNC anchors in dry and water-saturated concrete. See Tables 47 and 48.

11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.75. See section 3.1.8 for additional information on seismic applications.

Table 47 — Hilti HIT-RE 500 V3 in Core Drilled Holes roughened with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8]

Thread size	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
1/2-13 UNC	5 (127)	8,720 (38.8)	9,555 (42.5)	11,030 (49.1)	13,510 (60.1)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)
5/8-11 UNC	6-3/4 (171)	13,680 (60.9)	14,985 (66.7)	17,305 (77.0)	21,190 (94.3)	29,460 (131.0)	32,275 (143.6)	37,265 (165.8)	45,645 (203.0)
3/4-10 UNC	8-1/8 (206)	18,065 (80.4)	19,790 (88.0)	22,850 (101.6)	27,985 (124.5)	38,910 (173.1)	42,620 (189.6)	49,215 (218.9)	60,275 (268.1)

Table 48 — Hilti HIT-RE 500 V3 in Core Drilled Holes roughened with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9]

Thread size	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
1/2-13 UNC	5 (127)	6,175 (27.5)	6,205 (27.6)	6,205 (27.6)	6,205 (27.6)	13,305 (59.2)	13,360 (59.4)	13,360 (59.4)	13,360 (59.4)
5/8-11 UNC	6-3/4 (171)	9,690 (43.1)	10,340 (46.0)	10,340 (46.0)	10,340 (46.0)	20,870 (92.8)	22,265 (99.0)	22,265 (99.0)	22,265 (99.0)
3/4-10 UNC	8-1/8 (206)	12,795 (56.9)	13,565 (60.3)	13,565 (60.3)	13,565 (60.3)	27,560 (122.6)	29,215 (130.0)	29,215 (130.0)	29,215 (130.0)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength (factored resistance) value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 50 and 51 as necessary to the above values. Compare to the steel values in table 49. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C) multiply above values by 0.69
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete and water saturated concrete conditions. Water-filled and submerged (underwater) applications are not permitted for this hole preparation method.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.75. See section 3.1.8 for additional information on seismic applications.

Table 49 — Steel design strength for steel bolt / cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

Thread size	ASTM A 193 B7			ASTM A 193 Grade B8M stainless steel		
	Tensile[4] ϕN_{sa} lb (kN)	Shear[5] ϕV_{sa} lb (kN)	Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN)	Tensile[4] ϕN_{sa} lb (kN)	Shear[5] ϕV_{sa} lb (kN)	Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN)
3/8-16 UNC	6,300 (28.0)	3,490 (15.5)	2,445 (10.9)	5,540 (24.6)	3,070 (13.7)	2,150 (9.6)
1/2-13 UNC	10,525 (46.8)	6,385 (28.4)	4,470 (19.9)	10,145 (45.1)	5,620 (25.0)	3,935 (17.5)
5/8-11 UNC	17,500 (77.8)	10,170 (45.2)	7,120 (31.7)	16,160 (71.9)	8,950 (39.8)	6,265 (27.9)
3/4-10 UNC	17,785 (79.1)	15,055 (67.0)	10,540 (46.9)	23,915 (106.4)	13,245 (58.9)	9,270 (41.2)

1 See Section 3.1.8 to convert design strength value to ASD value.

2 Hilti HIS-N and HIS-RN inserts with steel bolts are considered brittle steel elements.

3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.

4 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

5 Shear = $\phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.

6 Seismic Shear = $\alpha_{V,seis}\ \phi\ V_{sa}$: Reduction for seismic shear only. See section 3.1.8 for additional information on seismic applications.

Table 50 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2]

HIS-N and HIS-RN all diameters uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[3] f_{AV}				Edge Distance in Shear								Concrete thickness factor in shear[4] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Internal diameter	in.	(mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)
Embedment h_{ef}	in.	(mm)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	3-1/4	(83)	0.59	n/a	n/a	n/a	0.36	n/a	n/a	n/a	0.55	n/a	n/a	n/a	0.15	n/a	n/a	n/a	0.31	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4	(102)	0.61	0.59	n/a	n/a	0.41	0.40	n/a	n/a	0.56	0.55	n/a	n/a	0.21	0.19	n/a	n/a	0.41	0.38	n/a	n/a	n/a	n/a	n/a	n/a
	5	(127)	0.64	0.61	0.59	n/a	0.47	0.45	0.39	n/a	0.57	0.57	0.55	n/a	0.29	0.26	0.17	n/a	0.47	0.45	0.33	n/a	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.65	0.62	0.60	0.59	0.50	0.48	0.41	0.37	0.58	0.58	0.56	0.55	0.34	0.30	0.19	0.15	0.50	0.48	0.39	0.29	n/a	n/a	n/a	n/a
	6	(152)	0.66	0.63	0.61	0.60	0.53	0.51	0.43	0.39	0.59	0.58	0.56	0.55	0.39	0.35	0.22	0.17	0.53	0.51	0.43	0.33	0.60	n/a	n/a	n/a
	7	(178)	0.69	0.65	0.62	0.61	0.61	0.57	0.48	0.42	0.60	0.60	0.57	0.56	0.49	0.43	0.28	0.21	0.61	0.57	0.48	0.42	0.64	0.62	n/a	n/a
	8	(203)	0.72	0.67	0.64	0.63	0.70	0.65	0.52	0.45	0.62	0.61	0.58	0.57	0.60	0.53	0.34	0.26	0.70	0.65	0.52	0.45	0.69	0.66	n/a	n/a
	9	(229)	0.74	0.70	0.66	0.65	0.78	0.73	0.57	0.49	0.63	0.62	0.59	0.58	0.71	0.63	0.40	0.31	0.78	0.73	0.57	0.49	0.73	0.70	n/a	n/a
	10	(254)	0.77	0.72	0.68	0.66	0.87	0.81	0.62	0.53	0.65	0.64	0.60	0.58	0.83	0.74	0.47	0.36	0.87	0.81	0.62	0.53	0.77	0.74	0.64	n/a
	11	(279)	0.80	0.74	0.69	0.68	0.96	0.89	0.68	0.56	0.66	0.65	0.61	0.59	0.96	0.86	0.55	0.41	0.96	0.89	0.68	0.56	0.81	0.78	0.67	0.61
	12	(305)	0.82	0.76	0.71	0.69	1.00	0.97	0.74	0.60	0.68	0.66	0.62	0.60	1.00	0.98	0.62	0.47	1.00	0.97	0.74	0.60	0.84	0.81	0.70	0.64
	14	(356)	0.88	0.80	0.75	0.73		1.00	0.86	0.70	0.71	0.69	0.64	0.62		1.00	0.78	0.59		1.00	0.86	0.70	0.91	0.87	0.75	0.69
	16	(406)	0.93	0.85	0.78	0.76			0.98	0.80	0.74	0.72	0.66	0.63			0.96	0.73			0.98	0.80	0.97	0.94	0.80	0.73
	18	(457)	0.99	0.89	0.82	0.79			1.00	0.90	0.77	0.75	0.68	0.65			1.00	0.87			1.00	0.90	1.00	0.99	0.85	0.78
	24	(610)	1.00	1.00	0.92	0.89				1.00	0.85	0.83	0.74	0.70				1.00				1.00		1.00	0.99	0.90
	30	(762)			1.00	0.98					0.94	0.91	0.80	0.75											1.00	1.00
	36	(914)				1.00					1.00	0.99	0.86	0.80												
	> 48	(1219)											0.99	0.90												

Table 51 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2]

HIS-N and HIS-RN all diameters cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[3] f_{AV}				Edge Distance in Shear								Concrete thickness factor in shear[4] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To and away from edge f_{RV}							
Internal diameter	in.	(mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)
Embedment h_{ef}	in.	(mm)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	3-1/4	(83)	0.59	n/a	n/a	n/a	0.54	n/a	n/a	n/a	0.55	n/a	n/a	n/a	0.16	n/a	n/a	n/a	0.31	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4	(102)	0.61	0.59	n/a	n/a	0.59	0.54	n/a	n/a	0.56	0.55	n/a	n/a	0.21	0.19	n/a	n/a	0.42	0.38	n/a	n/a	n/a	n/a	n/a	n/a
	5	(127)	0.64	0.61	0.59	n/a	0.66	0.60	0.54	n/a	0.57	0.57	0.55	n/a	0.30	0.26	0.17	n/a	0.59	0.53	0.34	n/a	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.65	0.62	0.60	0.59	0.70	0.62	0.57	0.55	0.58	0.58	0.56	0.55	0.34	0.31	0.19	0.15	0.69	0.61	0.39	0.29	n/a	n/a	n/a	n/a
	6	(152)	0.66	0.63	0.61	0.60	0.74	0.65	0.59	0.57	0.59	0.58	0.56	0.55	0.39	0.35	0.22	0.17	0.74	0.65	0.44	0.34	0.60	n/a	n/a	n/a
	7	(178)	0.69	0.65	0.62	0.61	0.81	0.71	0.63	0.61	0.60	0.60	0.57	0.56	0.49	0.44	0.28	0.21	0.81	0.71	0.56	0.42	0.64	0.62	n/a	n/a
	8	(203)	0.72	0.67	0.64	0.63	0.89	0.77	0.68	0.65	0.62	0.61	0.58	0.57	0.60	0.54	0.34	0.26	0.89	0.77	0.68	0.52	0.69	0.66	n/a	n/a
	9	(229)	0.74	0.70	0.66	0.65	0.98	0.83	0.73	0.69	0.63	0.62	0.59	0.58	0.72	0.64	0.41	0.31	0.98	0.83	0.73	0.62	0.73	0.70	n/a	n/a
	10	(254)	0.77	0.72	0.68	0.66	1.00	0.90	0.78	0.73	0.65	0.64	0.60	0.58	0.84	0.75	0.48	0.36	1.00	0.90	0.78	0.72	0.77	0.74	0.64	n/a
	11	(279)	0.80	0.74	0.69	0.68		0.96	0.83	0.78	0.66	0.65	0.61	0.59	0.97	0.86	0.55	0.42		0.96	0.83	0.78	0.81	0.78	0.67	0.61
	12	(305)	0.82	0.76	0.71	0.69		1.00	0.88	0.83	0.68	0.66	0.62	0.60	1.00	0.98	0.63	0.48		1.00	0.88	0.83	0.84	0.81	0.70	0.64
	14	(356)	0.88	0.80	0.75	0.73			0.99	0.92	0.71	0.69	0.64	0.62		1.00	0.79	0.60			0.99	0.92	0.91	0.88	0.76	0.69
	16	(406)	0.93	0.85	0.78	0.76			1.00	1.00	0.74	0.72	0.66	0.64			0.97	0.73			1.00	1.00	0.97	0.94	0.81	0.74
	18	(457)	0.99	0.89	0.82	0.79					0.77	0.75	0.68	0.65			1.00	0.87					1.00	0.99	0.86	0.78
	24	(610)	1.00	1.00	0.92	0.89					0.86	0.83	0.74	0.70				1.00						1.00	0.99	0.90
	30	(762)			1.00	0.98					0.95	0.91	0.81	0.75											1.00	1.00
	36	(914)				1.00					1.00	0.99	0.87	0.80												
	> 48	(1219)										1.00	0.99	0.91												

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

DESIGN DATA IN CONCRETE PER CSA A23.3

CSA A23.3 Annex D design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-3814 and ELC-3814. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

HIT-RE 500 V3 adhesive with Deformed Reinforcing Bars (Rebar)

Table 52 — Specifications for CA rebar installed with Hilti HIT-RE 500 V3

Setting information		Symbol	Units	Rebar size				
				10M	15M	20M	25M	30M
Nominal bit diameter		d_o	in.	9/16	3/4	1	1-1/4	1-1/2
Effective embedment	minimum	$h_{ef,min}$	mm	60	80	90	100	120
	maximum	$h_{ef,max}$	mm	226	320	390	504	598
Minimum concrete member thickness		h_{min}	mm	h_{ef}+ 30	h_{ef}+ 2d_o			

Note: The installation specifications in table 52 above and the data in tables 53 through 67 pertain to the use of Hilti HIT-RE 500 V3 with rebar designed as a post-installed anchor using the provisions of CSA A23.3 Annex D. For the use of Hilti HIT-RE 500 V3 with rebar for typical development calculations according to CSA A23.3 Chapter 12, refer to section 3.1.8 for the design method and tables 88 through 92 in section 3.2.4.

Table 53 — Steel factored resistance for CA rebar[1]

Rebar size	CSA-G30.18 Grade 400[2]		
	Tensile[3] N_{sar} lb (kN)	Shear[4] V_{sar} lb (kN)	Seismic shear[5] $V_{sar,eq}$ lb (kN)
10M	7,245 (32.2)	4,035 (17.9)	2,825 (12.6)
15M	14,525 (64.6)	8,090 (36.0)	5,665 (25.2)
20M	21,570 (95.9)	12,020 (53.5)	8,415 (37.4)
25M	36,025 (160.2)	20,070 (89.3)	14,050 (62.5)
30M	50,715 (225.6)	28,255 (125.7)	19,780 (88.0)

1 See Section 3.1.8 to convert design strength value to ASD value.
2 CSA-G30.18 Grade 400 rebar are considered ductile steel elements.
3 Tensile = $A_{se,N}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D
4 Shear = $A_{se,V}\ \phi_s$ 0.60 f_{uta} R as noted in CSA A23.3 Annex D.
5 Seismic Shear = $\alpha_{V,seis}\ V_{sar}$: Reduction factor for seismic shear only.
See section 3.1.8 for additional information on seismic applications.

Table 54 — Hilti HIT-RE 500 V3 adhesive design information with CA rebar in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

Design parameter		Symbol	Units	Rebar size					Ref
				10M	15M	20M	25M	30M	A23.3-14
Anchor O.D.		d_a	–	11.3	16.0	19.5	25.2	29.9	
Effective minimum embedment[2]		h_{ef}	–	60	80	90	101	120	
Effective maximum embedment[2]		h_{ef}	–	226	320	390	504	598	
Min. concrete thickness[2]		h_{min}	–	h_{ef} + 30	$h_{ef} + 2d_0$				
Critical edge distance		c_{ac}	–	$2h_{ef}$					
Minimum edge distance[3]		c_{min}	–	57	80	98	126	150	
Minimum anchor spacing		s_{min}	–	57	80	98	126	150	
Coeff. for factored conc. breakout resistance, uncracked concrete[4]		$k_{c,uncr}$	–	10					D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete[4]		$k_{c,cr}$	–	7					D.6.2.2
Concrete material resistance factor		ϕc	–	0.65					8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]		R_{conc}	–	1.00					D.5.3(c)
Dry concrete and water saturated									
Temp. range A[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	1,360 (9.4)	1,390 (9.6)	1,410 (9.7)	1,420 (9.8)	1,380 (9.5)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	1,760 (12.1)	1,720 (11.9)	1,690 (11.7)	1,650 (11.4)	1,610 (11.1)	D.6.5.2
Temp. range B[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	940 (6.5)	960 (6.6)	970 (6.7)	980 (6.8)	950 (6.6)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	1,210 (8.3)	1,190 (8.2)	1,170 (8.1)	1,140 (7.9)	1,110 (7.7)	D.6.5.2
Anchor category, dry concrete		–	–	1	1	1	1	1	D.5.3(c)
Resistance modification factor		R_{dry}	–	1.00	1.00	1.00	1.00	1.00	
Water-filled hole									
Temp. range A[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	1,010 (7.0)	1,040 (7.2)	1,060 (7.3)	1,080 (7.4)	1,060 (7.3)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	1,300 (9.0)	1,280 (8.8)	1,270 (8.8)	1,250 (8.6)	1,240 (8.6)	D.6.5.2
Temp. range B[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	700 (4.8)	720 (5.0)	730 (5.0)	740 (5.1)	730 (5.0)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	900 (6.2)	890 (6.1)	880 (6.1)	860 (5.9)	850 (5.9)	D.6.5.2
Anchor category, water-filled hole		–	–	3	3	3	3	3	D.5.3(c)
Resistance modification factor		R_{wf}	–	0.75	0.75	0.75	0.75	0.75	
Underwater application									
Temp. range A[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	880 (6.1)	920 (6.3)	940 (6.5)	980 (6.8)	960 (6.6)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	1,130 (7.8)	1,140 (7.9)	1,140 (7.9)	1,140 (7.9)	1,130 (7.8)	D.6.5.2
Temp. range B[6]	Characteristic bond stress in cracked concrete[7,8]	τ_{cr}	psi (MPa)	610 (4.2)	630 (4.3)	650 (4.5)	680 (4.7)	660 (4.6)	D.6.5.2
	Characteristic bond stress in uncracked concrete[7,8]	τ_{uncr}	psi (MPa)	780 (5.4)	790 (5.4)	780 (5.4)	780 (5.4)	780 (5.4)	D.6.5.2
Anchor category, underwater		–	–	3	3	3	3	3	D.5.3(c)
Resistance modification factor		R_{uw}	–	0.75	0.75	0.75	0.75	0.75	
Resistance for seismic tension		$\alpha_{N,seis}$	–	0.90	0.90	0.90	0.90	0.90	

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018,, table 23 and 24, and converted for use with CSA A23.3 Annex D.

2 See figure 2 of section 3.2.4.3.1.

3 Minimum edge distance may be reduced to 45mm provided rebar remains untorqued. See ESR-3814 section 4.1.9.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond stress values corresponding to concrete compressive stress f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of $(f'_c/2{,}500)^{0.25}$ [for SI: $(f'_c/17.2)^{0.25}$] for uncracked concrete and $(f'c/2{,}500)^{0.15}$ [for SI: $(f'c/17.2)^{0.15}$] for cracked concrete.

8 For structures assigned to Seismic Design Categories C, D, E, or F, bond stress values must be multiplied by $\alpha_{N,seis}$.

Table 55 — Hilti HIT-RE 500 V3 adhesive design information with CA rebar in diamond core drilled holes in accordance with CSA A23.3 Annex D[1]

Design parameter	Symbol	Units	Rebar size					Ref
			10M	15M	20M	25M	30M	A23.3-14
Anchor O.D.	d_a	–	11.3	16.0	19.5	25.2	29.9	
Effective minimum embedment[2]	h_{ef}	–	60	80	90	101	120	
Effective maximum embedment[2]	h_{ef}	–	226	320	390	504	598	
Min. concrete thickness[2]	h_{min}	–	h_{ef} + 30	$h_{ef} + 2d_0$				
Critical edge distance	c_{ac}	–	$2h_{ef}$					
Minimum edge distance[3]	c_{min}	–	57	80	98	126	150	
Minimum anchor spacing	s_{min}	–	57	80	98	126	150	
Coeff. for factored conc. breakout resistance, uncracked concrete[4]	$k_{c,uncr}$	–	10					D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete[4]	$k_{c,cr}$	–	7					D.6.2.2
Concrete material resistance factor	ϕc	–	0.65					8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]	R_{conc}	–	1.00					D.5.3(c)
Dry concrete and water saturated concrete								
Temp. range A[6] Characteristic bond stress in cracked concrete[7]	τ_{uncr}	psi (MPa)	1,150 (7.9)	1,150 (7.9)	1,150 (7.9)	1,150 (7.9)	1,150 (7.9)	D.6.5.2
Temp. range B[6] Characteristic bond stress in uncracked concrete[7]	τ_{uncr}	psi (MPa)	800 (5.5)	800 (5.5)	800 (5.5)	800 (5.5)	800 (5.5)	D.6.5.2
Anchor category, dry concrete	–	–	2	3	3	3	3	D.5.3(c)
Resistance modification factor	R_{dry}	–	0.85	0.75	0.75	0.75	0.75	

1 Design information in this table is taken from ELC-3814, dated April 2018, table 23 and 25B, and converted for use with CSA A23.3 Annex D.

2 See figure 2 of section 3.2.4.3.1.

3 Minimum edge distance may be reduced to 45mm provided rebar remains untorqued. See ESR-3814 section 4.1.9.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond stress values correspond to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of $(f'_c/2{,}500)^{0.25}$ [for SI: $(f'_c / 17.2)^{0.25}$] for uncracked concrete.

Table 56 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete/bond failure for CA rebar in uncracked concrete[1,2,3,4,5,6,7,8,9,11]

Rebar size	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
10M	4-1/2	7,520	7,950	8,320	8,940	15,040	15,900	16,645	17,885
	(115)	(33.4)	(35.4)	(37.0)	(39.8)	(66.9)	(70.7)	(74.0)	(79.6)
	7-1/16	11,770	12,445	13,025	13,995	23,540	24,890	26,050	27,990
	(180)	(52.4)	(55.4)	(57.9)	(62.3)	(104.7)	(110.7)	(115.9)	(124.5)
	8-7/8	14,775	15,625	16,355	17,575	29,555	31,250	32,705	35,145
	(226)	(65.7)	(69.5)	(72.7)	(78.2)	(131.5)	(139.0)	(145.5)	(156.3)
15M[10]	5-11/16	11,410	12,755	13,975	15,600	22,820	25,515	27,950	31,205
	(145)	(50.8)	(56.7)	(62.2)	(69.4)	(101.5)	(113.5)	(124.3)	(138.8)
	9-13/16	22,620	23,915	25,030	26,900	45,240	47,835	50,065	53,800
	(250)	(100.6)	(106.4)	(111.3)	(119.7)	(201.2)	(212.8)	(222.7)	(239.3)
	12-5/8	28,950	30,615	32,040	34,430	57,905	61,225	64,080	68,860
	(320)	(128.8)	(136.2)	(142.5)	(153.2)	(257.6)	(272.3)	(285.1)	(306.3)
20M[10]	7-7/8	18,485	20,665	22,640	25,770	36,965	41,330	45,275	51,540
	(200)	(82.2)	(91.9)	(100.7)	(114.6)	(164.4)	(183.8)	(201.4)	(229.3)
	14	38,460	40,670	42,565	45,740	76,925	81,340	85,130	91,480
	(355)	(171.1)	(180.9)	(189.3)	(203.5)	(342.2)	(361.8)	(378.7)	(406.9)
	15-3/8	42,255	44,680	46,760	50,250	84,510	89,355	93,525	100,500
	(390)	(188.0)	(198.7)	(208.0)	(223.5)	(375.9)	(397.5)	(416.0)	(447.0)
25M	9-1/16	22,795	25,485	27,920	32,235	45,590	50,970	55,835	64,475
	(230)	(101.4)	(113.4)	(124.2)	(143.4)	(202.8)	(226.7)	(248.4)	(286.8)
	15-15/16	53,265	58,540	61,270	65,840	106,525	117,080	122,540	131,680
	(405)	(236.9)	(260.4)	(272.5)	(292.9)	(473.9)	(520.8)	(545.1)	(585.7)
	19-13/16	68,895	72,850	76,245	81,935	137,795	145,700	152,495	163,865
	(504)	(306.5)	(324.1)	(339.2)	(364.5)	(612.9)	(648.1)	(678.3)	(728.9)
30M	10-1/4	27,395	30,630	33,555	38,745	54,795	61,260	67,110	77,490
	(260)	(121.9)	(136.3)	(149.3)	(172.3)	(243.7)	(272.5)	(298.5)	(344.7)
	17-15/16	63,425	70,910	77,680	85,635	126,850	141,825	155,360	171,270
	(455)	(282.1)	(315.4)	(345.5)	(380.9)	(564.3)	(630.9)	(691.1)	(761.8)
	23-9/16	94,640	100,070	104,740	112,550	189,285	200,145	209,475	225,100
	(598)	(421.0)	(445.1)	(465.9)	(500.6)	(842.0)	(890.3)	(931.8)	(1001.3)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 61-70 as necessary to the above values. Compare to the steel values in table 53. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete and water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.45.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. For diamond core drilling, except as indicated in note 10, multiply above values by 0.48.
Diamond core drilling is not permitted for the water-filled or under-water (submerged) applications.

10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 15M and 20M diameter anchors for dry and water-saturated concrete conditions. See Table 59.

11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 57 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete/bond failure for CA rebar in cracked concrete[1,2,3,4,5,6,7,8,9]

Rebar size	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
10M	4-1/2	5,640	5,920	6,080	6,350	11,285	11,835	12,165	12,700
	(115)	(25.1)	(26.3)	(27.1)	(28.2)	(50.2)	(52.7)	(54.1)	(56.5)
	7-1/16	8,960	9,265	9,520	9,940	17,915	18,525	19,040	19,880
	(180)	(39.8)	(41.2)	(42.3)	(44.2)	(79.7)	(82.4)	(84.7)	(88.4)
	8-7/8	11,250	11,630	11,955	12,480	22,495	23,260	23,905	24,960
	(226)	(50.0)	(51.7)	(53.2)	(55.5)	(100.1)	(103.5)	(106.3)	(111.0)
15M[10]	5-11/16	7,985	8,930	9,780	11,295	15,975	17,860	19,565	22,590
	(145)	(35.5)	(39.7)	(43.5)	(50.2)	(71.1)	(79.4)	(87.0)	(100.5)
	9-13/16	18,005	18,620	19,135	19,980	36,010	37,235	38,270	39,955
	(250)	(80.1)	(82.8)	(85.1)	(88.9)	(160.2)	(165.6)	(170.2)	(177.7)
	12-5/8	23,045	23,830	24,495	25,575	46,095	47,665	48,985	51,145
	(320)	(102.5)	(106.0)	(108.9)	(113.8)	(205.0)	(212.0)	(217.9)	(227.5)
20M[10]	7-7/8	12,940	14,465	15,845	18,300	25,875	28,930	31,695	36,595
	(200)	(57.6)	(64.3)	(70.5)	(81.4)	(115.1)	(128.7)	(141.0)	(162.8)
	14	30,595	32,685	33,590	35,075	61,195	65,370	67,185	70,145
	(355)	(136.1)	(145.4)	(149.4)	(156.0)	(272.2)	(290.8)	(298.8)	(312.0)
	15-3/8	34,725	35,910	36,905	38,530	69,450	71,815	73,805	77,060
	(390)	(154.5)	(159.7)	(164.2)	(171.4)	(308.9)	(319.5)	(328.3)	(342.8)
25M	9-1/16	15,955	17,840	19,540	22,565	31,915	35,680	39,085	45,130
	(230)	(71.0)	(79.4)	(86.9)	(100.4)	(142.0)	(158.7)	(173.9)	(200.8)
	15-15/16	37,285	41,685	45,665	52,075	74,570	83,370	91,325	104,150
	(405)	(165.8)	(185.4)	(203.1)	(231.6)	(331.7)	(370.8)	(406.2)	(463.3)
	19-13/16	51,760	57,870	62,070	64,805	103,520	115,735	124,135	129,610
	(504)	(230.2)	(257.4)	(276.1)	(288.3)	(460.5)	(514.8)	(552.2)	(576.5)
30M	10-1/4	19,180	21,440	23,490	27,120	38,355	42,885	46,975	54,245
	(260)	(85.3)	(95.4)	(104.5)	(120.6)	(170.6)	(190.8)	(209.0)	(241.3)
	17-15/16	44,400	49,640	54,375	62,790	88,795	99,275	108,750	125,575
	(455)	(197.5)	(220.8)	(241.9)	(279.3)	(395.0)	(441.6)	(483.7)	(558.6)
	23-9/16	66,895	74,790	81,930	88,665	133,790	149,580	163,860	177,325
	(598)	(297.6)	(332.7)	(364.4)	(394.4)	(595.1)	(665.4)	(728.9)	(788.8)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 61-70 as necessary to the above values. Compare to the steel values in table 53. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete and water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.45.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete conditions except as indicated in note 10.

10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 15M and 20M diameter anchors for dry and water-saturated concrete conditions. See Table 60.

11 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by α_{seis} = 0.68. See section 3.1.8 for additional information on seismic applications.

Table 58 — Hilti HIT-RE 500 V3 adhesive design information with CA rebar in core drilled holes roughened with the TE-YRT Roughening Tool in accordance with CSA A23.3 Annex D[1]

Design parameter		Symbol	Units	Rebar size		Ref
				15M	20M	A23.3-14
Anchor O.D.		d_a	–	16.0	19.5	
Effective minimum embedment[2]		h_{ef}	–	80	90	
Effective maximum embedment[2]		h_{ef}	–	320	390	
Min. concrete thickness[2]		h_{min}	–	$2h_{ef}$		
Critical edge distance		c_{ac}	–	$h_{ef} + 2d_0$		
Minimum edge distance[3]		c_{min}	–	80	98	
Minimum anchor spacing		s_{min}	–	80	98	
Coeff. for factored conc. breakout resistance, uncracked concrete[4]		$k_{c,uncr}$	–	10		D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete[4]		$k_{c,cr}$	–	7		D.6.2.2
Concrete material resistance factor		ϕc	–	0.65		8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]		R_{conc}	–	1.00		D.5.3 (c)
Dry concrete and water saturated concrete						
Temp. range A[6]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	970 (6.7)	985 (6.8)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,720 (11.9)	1,690 (11.7)	D.6.5.2
Temp. range B[6]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	670 (4.6)	680 (4.7)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,190 (8.2)	1,170 (8.1)	D.6.5.2
Anchor category, dry concrete		-	-	1	1	D.5.3(c)
Resistance modification factor		R_{dry}	-	1.00	1.00	
Reduction for Seismic Tension		$\alpha_{N,seis}$	-	0.90	0.90	

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, table 23 and 25A, and converted for use with CSA A23.3 Annex D.

2 See figure 2 of section 3.2.4.3.4.

3 Minimum edge distance may be reduced to 45mm provided rebar remains untorqued. See ESR-3814 section 4.1.9.

4 For all design cases, ψc,N = 1.0. The appropriate coefficient for breakout resistance for cracked concrete (kc,cr) or uncracked concrete (kc,uncr) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C). Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond stress values correspond to concrete compressive strength in the range 2,500 psi ≤ f′c ≤ 8,000 psi.

8 For structures assigned to Seismic Design Categories C, D, E, or F, bond stress values must be multiplied by $\alpha_{N,seis}$.

Table 59 — Hilti HIT-RE 500 V3 adhesive factored resistance for core drilled holes roughened with Hilti TE-YRT roughening tool with concrete / bond failure for CA rebar in uncracked concrete[1,2,3,4,5,6,7,8,9]

		Tension - N_r				Shear - V_r			
Rebar size	Effective embedment in. (mm)	f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
15M	5-11/16	11,410	12,635	12,635	12,635	22,820	25,265	25,265	25,265
	(145)	(50.8)	(56.2)	(56.2)	(56.2)	(101.5)	(112.4)	(112.4)	(112.4)
	9-13/16	21,780	21,780	21,780	21,780	43,565	43,565	43,565	43,565
	(250)	(96.9)	(96.9)	(96.9)	(96.9)	(193.8)	(193.8)	(193.8)	(193.8)
	12-5/8	27,880	27,880	27,880	27,880	55,760	55,760	55,760	55,760
	(320)	(124.0)	(124.0)	(124.0)	(124.0)	(248.0)	(248.0)	(248.0)	(248.0)
20M	7-7/8	18,485	20,665	20,865	20,865	36,965	41,330	41,735	41,735
	(200)	(82.2)	(91.9)	(92.8)	(92.8)	(164.4)	(183.8)	(185.6)	(185.6)
	14	37,040	37,040	37,040	37,040	74,080	74,080	74,080	74,080
	(355)	(164.8)	(164.8)	(164.8)	(164.8)	(329.5)	(329.5)	(329.5)	(329.5)
	15-3/8	40,690	40,690	40,690	40,690	81,380	81,380	81,380	81,380
	(390)	(181.0)	(181.0)	(181.0)	(181.0)	(362.0)	(362.0)	(362.0)	(362.0)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 61-70 as necessary to the above values. Compare to the steel values in table 53. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete or water-saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all lightweight, λ_a = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 60 — Hilti HIT-RE 500 V3 adhesive factored resistance for core drilled holes roughened with Hilti TE-YRT roughening tool with concrete / bond failure for CA rebar in cracked concrete[1,2,3,4,5,6,7,8,9]

		Tension - N_r				Shear - V_r			
Rebar size	Effective embedment in. (mm)	f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
15M	5-11/16	7,125	7,125	7,125	7,125	14,250	14,250	14,250	14,250
	(145)	(31.7)	(31.7)	(31.7)	(31.7)	(63.4)	(63.4)	(63.4)	(63.4)
	9-13/16	12,285	12,285	12,285	12,285	24,570	24,570	24,570	24,570
	(250)	(54.6)	(54.6)	(54.6)	(54.6)	(109.3)	(109.3)	(109.3)	(109.3)
	12-5/8	15,725	15,725	15,725	15,725	31,445	31,445	31,445	31,445
	(320)	(69.9)	(69.9)	(69.9)	(69.9)	(139.9)	(139.9)	(139.9)	(139.9)
20M	7-7/8	12,160	12,160	12,160	12,160	24,325	24,325	24,325	24,325
	(200)	(54.1)	(54.1)	(54.1)	(54.1)	(108.2)	(108.2)	(108.2)	(108.2)
	14	21,590	21,590	21,590	21,590	43,175	43,175	43,175	43,175
	(355)	(96.0)	(96.0)	(96.0)	(96.0)	(192.1)	(192.1)	(192.1)	(192.1)
	15-3/8	23,715	23,715	23,715	23,715	47,435	47,435	47,435	47,435
	(390)	(105.5)	(105.5)	(105.5)	(105.5)	(211.0)	(211.0)	(211.0)	(211.0)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 61-70 as necessary to the above values. Compare to the steel values in table 53. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete or water-saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.
Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by α_{seis} = 0.675. See section 3.1.8 for additional information on seismic applications.

Table 61 — Load adjustment factors for 10M rebar in uncracked concrete[1,2,3]

10M Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-8/9 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.24	0.15	0.12	n/a	n/a	n/a	0.06	0.04	0.03	0.11	0.07	0.06	n/a	n/a	n/a
	2-3/16	(55)	0.58	0.55	0.54	0.26	0.16	0.13	0.53	0.52	0.52	0.08	0.05	0.04	0.15	0.10	0.08	n/a	n/a	n/a
	3	(76)	0.61	0.57	0.56	0.30	0.19	0.15	0.54	0.53	0.53	0.12	0.08	0.06	0.25	0.16	0.13	n/a	n/a	n/a
	4	(102)	0.65	0.59	0.57	0.35	0.22	0.17	0.56	0.54	0.54	0.19	0.12	0.10	0.35	0.22	0.17	n/a	n/a	n/a
	5	(127)	0.68	0.62	0.59	0.41	0.25	0.20	0.57	0.55	0.54	0.27	0.17	0.14	0.41	0.25	0.20	n/a	n/a	n/a
	5-11/16	(145)	0.71	0.63	0.61	0.45	0.28	0.22	0.58	0.56	0.55	0.33	0.21	0.17	0.45	0.28	0.22	0.56	n/a	n/a
	6	(152)	0.72	0.64	0.61	0.47	0.29	0.23	0.58	0.56	0.55	0.35	0.22	0.18	0.47	0.29	0.23	0.58	n/a	n/a
	7	(178)	0.76	0.66	0.63	0.54	0.34	0.27	0.60	0.57	0.56	0.44	0.28	0.23	0.54	0.34	0.27	0.62	n/a	n/a
	8	(203)	0.79	0.69	0.65	0.62	0.38	0.30	0.61	0.58	0.57	0.54	0.35	0.28	0.62	0.38	0.30	0.67	n/a	n/a
	8-1/4	(210)	0.80	0.69	0.65	0.64	0.40	0.31	0.61	0.58	0.57	0.57	0.36	0.29	0.64	0.40	0.31	0.68	0.58	n/a
	9	(229)	0.83	0.71	0.67	0.70	0.43	0.34	0.62	0.59	0.58	0.65	0.41	0.33	0.70	0.43	0.34	0.71	0.61	n/a
	10-1/16	(256)	0.87	0.74	0.69	0.78	0.48	0.38	0.64	0.60	0.59	0.76	0.49	0.39	0.78	0.48	0.38	0.75	0.64	0.60
	11	(279)	0.90	0.76	0.71	0.85	0.53	0.42	0.65	0.61	0.60	0.87	0.56	0.44	0.85	0.53	0.42	0.78	0.67	0.62
	12	(305)	0.94	0.78	0.72	0.93	0.58	0.45	0.67	0.62	0.61	0.99	0.63	0.51	0.93	0.58	0.45	0.81	0.70	0.65
	14	(356)	1.00	0.83	0.76	1.00	0.67	0.53	0.69	0.64	0.62	1.00	0.80	0.64	1.00	0.67	0.53	0.88	0.76	0.70
	16	(406)		0.88	0.80		0.77	0.61	0.72	0.66	0.64		0.98	0.78		0.77	0.61	0.94	0.81	0.75
	18	(457)		0.92	0.84		0.87	0.68	0.75	0.68	0.66		1.00	0.93		0.87	0.68	1.00	0.86	0.80
	24	(610)		1.00	0.95		1.00	0.91	0.83	0.75	0.71			1.00		1.00	0.91		0.99	0.92
	30	(762)			1.00			1.00	0.91	0.81	0.76						1.00		1.00	1.00
	36	(914)							1.00	0.87	0.82									
	> 48	(1219)								0.99	0.92									

Table 62 — Load adjustment factors for 10M rebar in cracked concrete[1,2,3]

10M Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
Embedment h_{ef}	in.	(mm)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-8/9 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.49	0.44	0.42	n/a	n/a	n/a	0.05	0.03	0.03	0.10	0.07	0.05	n/a	n/a	n/a
	2-3/16	(55)	0.58	0.55	0.54	0.52	0.46	0.43	0.53	0.52	0.52	0.07	0.04	0.04	0.14	0.09	0.07	n/a	n/a	n/a
	3	(76)	0.61	0.57	0.56	0.60	0.50	0.47	0.54	0.53	0.53	0.11	0.07	0.06	0.23	0.15	0.12	n/a	n/a	n/a
	4	(102)	0.65	0.59	0.57	0.70	0.56	0.51	0.55	0.54	0.53	0.18	0.11	0.09	0.35	0.23	0.18	n/a	n/a	n/a
	5	(127)	0.68	0.62	0.59	0.80	0.62	0.56	0.57	0.55	0.54	0.25	0.16	0.13	0.49	0.32	0.25	n/a	n/a	n/a
	5-11/16	(145)	0.71	0.63	0.61	0.88	0.66	0.59	0.57	0.56	0.55	0.30	0.19	0.15	0.60	0.39	0.31	0.55	n/a	n/a
	6	(152)	0.72	0.64	0.61	0.91	0.68	0.61	0.58	0.56	0.55	0.32	0.21	0.17	0.65	0.41	0.33	0.56	n/a	n/a
	7	(178)	0.76	0.66	0.63	1.00	0.74	0.65	0.59	0.57	0.56	0.41	0.26	0.21	0.82	0.52	0.42	0.61	n/a	n/a
	8	(203)	0.79	0.69	0.65		0.81	0.70	0.60	0.58	0.57	0.50	0.32	0.25	1.00	0.64	0.51	0.65	n/a	n/a
	8-1/4	(210)	0.80	0.69	0.65		0.83	0.72	0.61	0.58	0.57	0.53	0.34	0.27		0.67	0.53	0.66	0.57	n/a
	9	(229)	0.83	0.71	0.67		0.88	0.76	0.62	0.59	0.58	0.60	0.38	0.30		0.76	0.61	0.69	0.59	n/a
	10-1/16	(256)	0.87	0.74	0.69		0.96	0.81	0.63	0.60	0.58	0.71	0.45	0.36		0.90	0.72	0.73	0.63	0.58
	11	(279)	0.90	0.76	0.71		1.00	0.86	0.64	0.61	0.59	0.81	0.51	0.41		1.00	0.82	0.76	0.65	0.61
	12	(305)	0.94	0.78	0.72			0.92	0.66	0.62	0.60	0.92	0.59	0.47			0.92	0.79	0.68	0.63
	14	(356)	1.00	0.83	0.76			1.00	0.68	0.64	0.62	1.00	0.74	0.59			1.00	0.86	0.74	0.68
	16	(406)		0.88	0.80				0.71	0.66	0.63		0.90	0.72				0.92	0.79	0.73
	18	(457)		0.92	0.84				0.74	0.68	0.65		1.00	0.86				0.97	0.84	0.78
	24	(610)		1.00	0.95				0.81	0.73	0.70			1.00				1.00	0.97	0.90
	30	(762)			1.00				0.89	0.79	0.75								1.00	1.00
	36	(914)							0.97	0.85	0.80									
	> 48	(1219)							1.00	0.97	0.90									

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.

4 Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \ge 3^*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \ge 3^*h_{ef}$, then $f_{HV} = 1.0$.

Table 63 — Load adjustment factors for 15M rebar in uncracked concrete[1,2,3]

15M Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}			5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8
	in.	(mm)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.24	0.14	0.11	n/a	n/a	n/a	0.04	0.02	0.02	0.08	0.04	0.03	n/a	n/a	n/a
	3-1/8	(80)	0.59	0.55	0.54	0.29	0.17	0.13	0.54	0.52	0.52	0.10	0.05	0.04	0.20	0.11	0.08	n/a	n/a	n/a
	4	(102)	0.61	0.57	0.55	0.33	0.19	0.14	0.55	0.53	0.53	0.14	0.08	0.06	0.29	0.15	0.12	n/a	n/a	n/a
	5	(127)	0.64	0.58	0.57	0.37	0.21	0.16	0.56	0.54	0.53	0.20	0.11	0.08	0.37	0.21	0.16	n/a	n/a	n/a
	6	(152)	0.67	0.60	0.58	0.41	0.23	0.18	0.57	0.54	0.54	0.27	0.14	0.11	0.41	0.23	0.18	n/a	n/a	n/a
	7	(178)	0.70	0.62	0.59	0.46	0.26	0.20	0.58	0.55	0.54	0.33	0.18	0.14	0.46	0.26	0.20	n/a	n/a	n/a
	7-1/4	(184)	0.71	0.62	0.60	0.47	0.26	0.20	0.58	0.55	0.55	0.35	0.18	0.14	0.47	0.26	0.20	0.58	n/a	n/a
	8	(203)	0.73	0.64	0.61	0.50	0.28	0.22	0.59	0.56	0.55	0.41	0.21	0.17	0.50	0.28	0.22	0.61	n/a	n/a
	9	(229)	0.76	0.65	0.62	0.56	0.31	0.24	0.60	0.57	0.56	0.49	0.26	0.20	0.56	0.31	0.24	0.64	n/a	n/a
	10	(254)	0.78	0.67	0.63	0.62	0.35	0.27	0.61	0.57	0.56	0.57	0.30	0.23	0.62	0.35	0.27	0.68	n/a	n/a
	11-3/8	(289)	0.82	0.69	0.65	0.71	0.40	0.31	0.63	0.58	0.57	0.69	0.36	0.28	0.71	0.40	0.31	0.72	0.58	n/a
	12	(305)	0.84	0.70	0.66	0.74	0.42	0.32	0.64	0.59	0.58	0.75	0.39	0.31	0.74	0.42	0.32	0.74	0.60	n/a
	14-1/8	(359)	0.90	0.74	0.69	0.88	0.49	0.38	0.66	0.61	0.59	0.96	0.50	0.39	0.88	0.49	0.38	0.81	0.65	0.60
	16	(406)	0.96	0.77	0.71	0.99	0.56	0.43	0.68	0.62	0.60	1.00	0.61	0.47	0.99	0.56	0.43	0.86	0.69	0.64
	18	(457)	1.00	0.80	0.74	1.00	0.63	0.48	0.71	0.63	0.61		0.72	0.56	1.00	0.63	0.48	0.91	0.73	0.67
	20	(508)		0.84	0.76		0.70	0.54	0.73	0.65	0.63		0.85	0.66		0.70	0.54	0.96	0.77	0.71
	22	(559)		0.87	0.79		0.77	0.59	0.75	0.66	0.64		0.98	0.76		0.77	0.59	1.00	0.81	0.75
	24	(610)		0.91	0.82		0.83	0.65	0.78	0.68	0.65		1.00	0.87		0.83	0.65		0.85	0.78
	30	(762)		1.00	0.90		1.00	0.81	0.84	0.72	0.69			1.00		1.00	0.81		0.95	0.87
	36	(914)			0.98			0.97	0.91	0.77	0.73						0.97		1.00	0.95
	> 48	(1219)			1.00			1.00	1.00	0.86	0.80						1.00			1.00

Table 64 — Load adjustment factors for 15M rebar in cracked concrete[1,2,3]

15M Rebar cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To and away from edge f_{RV}					
Embedment h_{ef}			5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8	5-11/16	9-13/16	12-5/8
	in.	(mm)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)	(145)	(250)	(320)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.46	0.41	0.40	n/a	n/a	n/a	0.04	0.02	0.02	0.09	0.04	0.03	n/a	n/a	n/a
	3-1/8	(80)	0.59	0.55	0.54	0.55	0.46	0.44	0.54	0.52	0.52	0.10	0.05	0.04	0.21	0.09	0.07	n/a	n/a	n/a
	4	(102)	0.61	0.57	0.55	0.61	0.50	0.46	0.55	0.53	0.52	0.15	0.07	0.05	0.29	0.13	0.10	n/a	n/a	n/a
	5	(127)	0.64	0.58	0.57	0.68	0.54	0.49	0.56	0.53	0.53	0.21	0.09	0.07	0.41	0.19	0.15	n/a	n/a	n/a
	6	(152)	0.67	0.60	0.58	0.76	0.58	0.52	0.57	0.54	0.53	0.27	0.12	0.10	0.54	0.25	0.19	n/a	n/a	n/a
	7	(178)	0.70	0.62	0.59	0.84	0.62	0.56	0.58	0.55	0.54	0.34	0.15	0.12	0.68	0.31	0.24	n/a	n/a	n/a
	7-1/4	(184)	0.71	0.62	0.60	0.86	0.63	0.56	0.58	0.55	0.54	0.36	0.16	0.13	0.72	0.33	0.25	0.58	n/a	n/a
	8	(203)	0.73	0.64	0.61	0.93	0.66	0.59	0.59	0.55	0.55	0.42	0.19	0.15	0.83	0.38	0.30	0.61	n/a	n/a
	9	(229)	0.76	0.65	0.62	1.00	0.71	0.62	0.60	0.56	0.55	0.50	0.23	0.18	0.99	0.45	0.35	0.65	n/a	n/a
	10	(254)	0.78	0.67	0.63		0.76	0.66	0.62	0.57	0.56	0.58	0.26	0.21	1.00	0.53	0.41	0.68	n/a	n/a
	11-3/8	(289)	0.82	0.69	0.65		0.82	0.71	0.63	0.58	0.57	0.71	0.32	0.25		0.64	0.50	0.73	0.56	n/a
	12	(305)	0.84	0.70	0.66		0.86	0.73	0.64	0.58	0.57	0.77	0.35	0.27		0.69	0.54	0.75	0.57	n/a
	14-1/8	(359)	0.90	0.74	0.69		0.97	0.81	0.66	0.60	0.58	0.98	0.44	0.35		0.89	0.69	0.81	0.62	0.57
	16	(406)	0.96	0.77	0.71		1.00	0.88	0.69	0.61	0.59	1.00	0.53	0.42		1.00	0.84	0.86	0.66	0.61
	18	(457)	1.00	0.80	0.74			0.96	0.71	0.62	0.60		0.64	0.50			0.96	0.91	0.70	0.65
	20	(508)		0.84	0.76			1.00	0.73	0.64	0.62		0.75	0.58			1.00	0.96	0.74	0.68
	22	(559)		0.87	0.79				0.76	0.65	0.63		0.86	0.67				1.00	0.78	0.72
	24	(610)		0.91	0.82				0.78	0.66	0.64		0.98	0.77					0.81	0.75
	30	(762)		1.00	0.90				0.85	0.71	0.67		1.00	1.00					0.91	0.84
	36	(914)			0.98				0.92	0.75	0.71								0.99	0.92
	> 48	(1219)			1.00				1.00	0.83	0.78								1.00	1.00

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.

4 Spacing factor reduction in shear applicable when $c < 3{*}h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{HV} = 1.0$.

Table 65 — Load adjustment factors for 20M rebar in uncracked concrete[1,2,3]

	20M Rebar uncracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
	Embedment h_{ef}		7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8
	in.	(mm)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.21	0.11	0.10	n/a	n/a	n/a	0.03	0.01	0.01	0.06	0.03	0.02	n/a	n/a	n/a
	3-7/8	(98)	0.58	0.55	0.54	0.26	0.14	0.13	0.53	0.52	0.52	0.09	0.04	0.04	0.18	0.09	0.08	n/a	n/a	n/a
	4	(102)	0.58	0.55	0.54	0.27	0.15	0.13	0.53	0.52	0.52	0.10	0.05	0.04	0.19	0.09	0.09	n/a	n/a	n/a
	5	(127)	0.61	0.56	0.55	0.30	0.16	0.15	0.54	0.53	0.53	0.13	0.07	0.06	0.27	0.13	0.12	n/a	n/a	n/a
	6	(152)	0.63	0.57	0.57	0.33	0.18	0.16	0.55	0.53	0.53	0.17	0.09	0.08	0.33	0.17	0.16	n/a	n/a	n/a
	7	(178)	0.65	0.58	0.58	0.36	0.19	0.18	0.56	0.54	0.54	0.22	0.11	0.10	0.36	0.19	0.18	n/a	n/a	n/a
	8	(203)	0.67	0.60	0.59	0.39	0.21	0.19	0.57	0.54	0.54	0.27	0.13	0.12	0.39	0.21	0.19	n/a	n/a	n/a
	9	(229)	0.69	0.61	0.60	0.42	0.23	0.21	0.58	0.55	0.55	0.32	0.16	0.15	0.42	0.23	0.21	n/a	n/a	n/a
	10	(254)	0.71	0.62	0.61	0.46	0.25	0.23	0.59	0.55	0.55	0.38	0.19	0.17	0.46	0.25	0.23	0.59	n/a	n/a
	11	(279)	0.73	0.63	0.62	0.50	0.27	0.25	0.60	0.56	0.56	0.43	0.22	0.20	0.50	0.27	0.25	0.62	n/a	n/a
	12	(305)	0.75	0.64	0.63	0.54	0.30	0.27	0.60	0.57	0.56	0.49	0.25	0.22	0.54	0.30	0.27	0.65	n/a	n/a
	14	(356)	0.80	0.67	0.65	0.63	0.34	0.31	0.62	0.58	0.57	0.62	0.31	0.28	0.63	0.34	0.31	0.70	n/a	n/a
	16	(406)	0.84	0.69	0.67	0.72	0.39	0.36	0.64	0.59	0.58	0.76	0.38	0.34	0.72	0.39	0.36	0.74	0.59	n/a
	18	(457)	0.88	0.71	0.70	0.81	0.44	0.40	0.66	0.60	0.59	0.91	0.45	0.41	0.81	0.44	0.40	0.79	0.63	0.61
	20	(508)	0.92	0.74	0.72	0.90	0.49	0.45	0.67	0.61	0.60	1.00	0.53	0.48	0.90	0.49	0.45	0.83	0.66	0.64
	22	(559)	0.97	0.76	0.74	0.99	0.54	0.49	0.69	0.62	0.61		0.61	0.56	0.99	0.54	0.49	0.87	0.69	0.67
	24	(610)	1.00	0.79	0.76	1.00	0.59	0.54	0.71	0.63	0.62		0.70	0.63	1.00	0.59	0.54	0.91	0.72	0.70
	26	(660)		0.81	0.78		0.64	0.58	0.73	0.64	0.63		0.79	0.72		0.64	0.58	0.95	0.75	0.73
	28	(711)		0.83	0.80		0.69	0.62	0.74	0.65	0.64		0.88	0.80		0.69	0.62	0.99	0.78	0.76
	30	(762)		0.86	0.83		0.74	0.67	0.76	0.66	0.65		0.97	0.89		0.74	0.67	1.00	0.81	0.78
	36	(914)		0.93	0.89		0.89	0.80	0.81	0.70	0.68		1.00	1.00		0.89	0.80		0.89	0.86
	> 48	(1219)		1.00	1.00		1.00	1.00	0.92	0.76	0.75					1.00	1.00		1.00	0.99

Table 66 — Load adjustment factors for 20M rebar in cracked concrete[1,2,3]

	20M Rebar cracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
	Embedment h_{ef}		7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8	7-7/8	14	15-3/8
	in.	(mm)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)	(200)	(355)	(390)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.43	0.39	0.39	n/a	n/a	n/a	0.03	0.01	0.01	0.06	0.02	0.02	n/a	n/a	n/a
	3-7/8	(98)	0.58	0.55	0.54	0.53	0.45	0.44	0.53	0.52	0.52	0.09	0.04	0.04	0.18	0.08	0.07	n/a	n/a	n/a
	4	(102)	0.58	0.55	0.54	0.54	0.45	0.44	0.54	0.52	0.52	0.10	0.04	0.04	0.19	0.08	0.07	n/a	n/a	n/a
	5	(127)	0.61	0.56	0.55	0.59	0.48	0.47	0.54	0.52	0.52	0.14	0.06	0.05	0.27	0.11	0.10	n/a	n/a	n/a
	6	(152)	0.63	0.57	0.57	0.64	0.51	0.49	0.55	0.53	0.53	0.18	0.08	0.07	0.36	0.15	0.14	n/a	n/a	n/a
	7	(178)	0.65	0.58	0.58	0.70	0.53	0.52	0.56	0.53	0.53	0.22	0.09	0.09	0.45	0.19	0.17	n/a	n/a	n/a
	8	(203)	0.67	0.60	0.59	0.76	0.56	0.54	0.57	0.54	0.54	0.27	0.12	0.10	0.55	0.23	0.21	n/a	n/a	n/a
	9	(229)	0.69	0.61	0.60	0.82	0.59	0.57	0.58	0.54	0.54	0.33	0.14	0.12	0.65	0.28	0.25	n/a	n/a	n/a
	10	(254)	0.71	0.62	0.61	0.88	0.62	0.60	0.59	0.55	0.55	0.38	0.16	0.15	0.77	0.32	0.29	0.59	n/a	n/a
	11	(279)	0.73	0.63	0.62	0.95	0.65	0.62	0.60	0.55	0.55	0.44	0.19	0.17	0.88	0.37	0.34	0.62	n/a	n/a
	12	(305)	0.75	0.64	0.63	1.00	0.69	0.65	0.61	0.56	0.56	0.50	0.21	0.19	1.00	0.43	0.38	0.65	n/a	n/a
	14	(356)	0.80	0.67	0.65		0.75	0.71	0.62	0.57	0.56	0.64	0.27	0.24		0.54	0.48	0.70	n/a	n/a
	16	(406)	0.84	0.69	0.67		0.82	0.77	0.64	0.58	0.57	0.77	0.33	0.30		0.66	0.59	0.75	0.56	n/a
	18	(457)	0.88	0.71	0.70		0.89	0.83	0.66	0.59	0.58	0.93	0.39	0.35		0.78	0.71	0.80	0.60	0.58
	20	(508)	0.92	0.74	0.72		0.96	0.90	0.68	0.60	0.59	1.00	0.46	0.41		0.92	0.83	0.84	0.63	0.61
	22	(559)	0.97	0.76	0.74		1.00	0.96	0.69	0.61	0.60		0.53	0.48		1.00	0.95	0.88	0.66	0.64
	24	(610)	1.00	0.79	0.76			1.00	0.71	0.62	0.61		0.60	0.54			1.00	0.92	0.69	0.67
	26	(660)		0.81	0.78				0.73	0.63	0.62		0.68	0.61				0.96	0.72	0.69
	28	(711)		0.83	0.80				0.75	0.64	0.63		0.76	0.68				0.99	0.74	0.72
	30	(762)		0.86	0.83				0.76	0.65	0.64		0.84	0.76				1.00	0.77	0.74
	36	(914)		0.93	0.89				0.82	0.68	0.67		1.00	1.00					0.84	0.82
	> 48	(1219)		1.00	1.00				0.92	0.74	0.72								0.98	0.94

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when $c < 3 * h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{HV} = 1.0$.

Table 67 — Load adjustment factors for 25M rebar in uncracked concrete[1,2,3]

	25M Rebar uncracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To and away from edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
	Embedment h_{ef}		9-1/16	15-15/16	19-13/16	9-1/16	15-15/16	19-13/16	9-1/16	15-15/16	19-13/16	9-1/16	15-15/16	19-13/16	9-1/16	15-15/16	19-13/16	9-1/16	15-15/16	19-13/16
	in.	(mm)	(230)	(405)	(504)	(230)	(405)	(504)	(230)	(405)	(504)	(230)	(405)	(504)	(230)	(405)	(504)	(230)	(405)	(504)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.24	0.12	0.10	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.02	0.02	n/a	n/a	n/a
	5	(127)	0.59	0.55	0.54	0.32	0.16	0.13	0.54	0.52	0.52	0.11	0.05	0.04	0.22	0.09	0.07	n/a	n/a	n/a
	6	(152)	0.61	0.56	0.55	0.34	0.18	0.14	0.55	0.53	0.52	0.14	0.06	0.05	0.28	0.12	0.10	n/a	n/a	n/a
	7	(178)	0.63	0.57	0.56	0.37	0.19	0.15	0.55	0.53	0.53	0.18	0.08	0.06	0.36	0.15	0.12	n/a	n/a	n/a
	8	(203)	0.65	0.58	0.57	0.40	0.21	0.16	0.56	0.53	0.53	0.22	0.09	0.07	0.40	0.19	0.15	n/a	n/a	n/a
	9	(229)	0.67	0.59	0.58	0.43	0.22	0.18	0.57	0.54	0.53	0.26	0.11	0.09	0.43	0.22	0.18	n/a	n/a	n/a
	10	(254)	0.68	0.60	0.58	0.46	0.24	0.19	0.58	0.54	0.54	0.30	0.13	0.10	0.46	0.24	0.19	n/a	n/a	n/a
	11-9/16	(294)	0.71	0.62	0.60	0.51	0.26	0.21	0.59	0.55	0.54	0.38	0.16	0.13	0.51	0.26	0.21	0.59	n/a	n/a
	12	(305)	0.72	0.63	0.60	0.52	0.27	0.21	0.59	0.55	0.54	0.40	0.17	0.14	0.52	0.27	0.21	0.60	n/a	n/a
	14	(356)	0.76	0.65	0.62	0.59	0.31	0.24	0.61	0.56	0.55	0.50	0.22	0.17	0.59	0.31	0.24	0.65	n/a	n/a
	16	(406)	0.79	0.67	0.63	0.68	0.35	0.28	0.62	0.57	0.56	0.62	0.26	0.21	0.68	0.35	0.28	0.69	n/a	n/a
	18	(457)	0.83	0.69	0.65	0.76	0.39	0.31	0.64	0.58	0.57	0.74	0.31	0.25	0.76	0.39	0.31	0.74	n/a	n/a
	18-7/16	(469)	0.84	0.69	0.66	0.78	0.40	0.32	0.64	0.58	0.57	0.76	0.33	0.26	0.78	0.40	0.32	0.75	0.56	n/a
	20	(508)	0.87	0.71	0.67	0.85	0.44	0.35	0.65	0.59	0.57	0.86	0.37	0.30	0.85	0.44	0.35	0.78	0.59	n/a
	22-3/8	(568)	0.91	0.73	0.69	0.95	0.49	0.39	0.67	0.60	0.58	1.00	0.44	0.35	0.95	0.49	0.39	0.82	0.62	0.58
	24	(610)	0.94	0.75	0.70	1.00	0.52	0.42	0.68	0.60	0.59		0.48	0.39	1.00	0.52	0.42	0.85	0.64	0.60
	26	(660)	0.98	0.77	0.72		0.57	0.45	0.70	0.61	0.60		0.55	0.44		0.57	0.45	0.89	0.67	0.62
	28	(711)	1.00	0.79	0.74		0.61	0.49	0.71	0.62	0.60		0.61	0.49		0.61	0.49	0.92	0.69	0.64
	30	(762)		0.81	0.75		0.66	0.52	0.73	0.63	0.61		0.68	0.54		0.66	0.52	0.95	0.72	0.67
	36	(914)		0.88	0.80		0.79	0.63	0.77	0.65	0.63		0.89	0.71		0.79	0.63	1.00	0.79	0.73
	> 48	(1219)		1.00	0.90		1.00	0.84	0.86	0.71	0.68		1.00	1.00		1.00	0.84		0.91	0.84

Table 68 — Load adjustment factors for 25M rebar in cracked concrete[1,2,3]

	25M Rebar cracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To and away from edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
	Embedment h_{ef}		9-1/16	15-15/16	19-13/16	9-1/16	15-15/16	19-13/16	9-1/16	15-15/16	19-13/16	9-1/16	15-15/16	19-13/16	9-1/16	15-15/16	19-13/16	9-1/16	15-15/16	19-13/16
	in.	(mm)	(230)	(405)	(504)	(230)	(405)	(504)	(230)	(405)	(504)	(230)	(405)	(504)	(230)	(405)	(504)	(230)	(405)	(504)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.42	0.39	0.38	n/a	n/a	n/a	0.02	0.01	0.01	0.05	0.02	0.01	n/a	n/a	n/a
	5	(127)	0.59	0.55	0.54	0.55	0.46	0.44	0.54	0.52	0.52	0.11	0.05	0.03	0.22	0.09	0.07	n/a	n/a	n/a
	6	(152)	0.61	0.56	0.55	0.60	0.48	0.46	0.55	0.53	0.52	0.14	0.06	0.04	0.29	0.12	0.09	n/a	n/a	n/a
	7	(178)	0.63	0.57	0.56	0.65	0.51	0.48	0.55	0.53	0.52	0.18	0.08	0.06	0.36	0.16	0.11	n/a	n/a	n/a
	8	(203)	0.65	0.58	0.57	0.70	0.53	0.50	0.56	0.53	0.53	0.22	0.10	0.07	0.44	0.19	0.14	n/a	n/a	n/a
	9	(229)	0.67	0.59	0.58	0.75	0.56	0.51	0.57	0.54	0.53	0.27	0.11	0.08	0.53	0.23	0.16	n/a	n/a	n/a
	10	(254)	0.68	0.60	0.58	0.80	0.59	0.53	0.58	0.54	0.53	0.31	0.13	0.10	0.62	0.27	0.19	n/a	n/a	n/a
	11-9/16	(294)	0.71	0.62	0.60	0.89	0.63	0.57	0.59	0.55	0.54	0.39	0.17	0.12	0.77	0.33	0.24	0.60	n/a	n/a
	12	(305)	0.72	0.63	0.60	0.91	0.64	0.58	0.59	0.55	0.54	0.41	0.17	0.13	0.82	0.35	0.25	0.61	n/a	n/a
	14	(356)	0.76	0.65	0.62	1.00	0.69	0.62	0.61	0.56	0.55	0.51	0.22	0.16	1.00	0.44	0.32	0.65	n/a	n/a
	16	(406)	0.79	0.67	0.63		0.75	0.66	0.62	0.57	0.56	0.63	0.27	0.19		0.54	0.39	0.70	n/a	n/a
	18	(457)	0.83	0.69	0.65		0.81	0.71	0.64	0.58	0.56	0.75	0.32	0.23		0.64	0.46	0.74	n/a	n/a
	18-7/16	(469)	0.84	0.69	0.66		0.83	0.72	0.64	0.58	0.56	0.78	0.33	0.24		0.67	0.48	0.75	0.57	n/a
	20	(508)	0.87	0.71	0.67		0.87	0.75	0.65	0.59	0.57	0.88	0.38	0.27		0.75	0.54	0.78	0.59	n/a
	22-3/8	(568)	0.91	0.73	0.69		0.95	0.81	0.67	0.60	0.58	1.00	0.44	0.32		0.89	0.64	0.83	0.62	0.56
	24	(610)	0.94	0.75	0.70		1.00	0.85	0.68	0.60	0.58		0.49	0.36		0.99	0.71	0.86	0.65	0.58
	26	(660)	0.98	0.77	0.72			0.90	0.70	0.61	0.59		0.56	0.40		1.00	0.80	0.89	0.67	0.60
	28	(711)	1.00	0.79	0.74			0.95	0.71	0.62	0.60		0.62	0.45			0.90	0.93	0.70	0.63
	30	(762)		0.81	0.75			1.00	0.73	0.63	0.60		0.69	0.50			1.00	0.96	0.72	0.65
	36	(914)		0.88	0.80				0.78	0.66	0.63		0.91	0.65				1.00	0.79	0.71
	> 48	(1219)		1.00	0.90				0.87	0.71	0.67		1.00	1.00					0.91	0.82

[1] Linear interpolation not permitted.

[2] Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.

[4] Spacing factor reduction in shear applicable when c < 3*h_{ef}. f_{AV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then $f_{HV} = 1.0$.

Table 69 — Load adjustment factors for 30M rebar in uncracked concrete[1,2,3]

	30M Rebar uncracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
	Embedment h_{ef}		10-1/4	17-15/16	23-9/16	10-1/4	17-15/16	23-9/16	10-1/4	17-15/16	23-9/16	10-1/4	17-15/16	23-9/16	10-1/4	17-15/16	23-9/16	10-1/4	17-15/16	23-9/16
	in.	(mm)	(260)	(455)	(598)	(260)	(455)	(598)	(260)	(455)	(598)	(260)	(455)	(598)	(260)	(455)	(598)	(260)	(455)	(598)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.25	0.13	0.10	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.02	0.01	n/a	n/a	n/a
	5-7/8	(150)	0.59	0.55	0.54	0.34	0.17	0.13	0.54	0.52	0.52	0.12	0.05	0.03	0.23	0.10	0.07	n/a	n/a	n/a
	6	(152)	0.59	0.56	0.54	0.34	0.18	0.13	0.54	0.52	0.52	0.12	0.05	0.04	0.24	0.10	0.07	n/a	n/a	n/a
	7	(178)	0.61	0.57	0.55	0.37	0.19	0.14	0.55	0.53	0.52	0.15	0.06	0.04	0.30	0.13	0.09	n/a	n/a	n/a
	8	(203)	0.63	0.57	0.56	0.39	0.20	0.15	0.55	0.53	0.52	0.18	0.08	0.05	0.36	0.16	0.11	n/a	n/a	n/a
	9	(229)	0.64	0.58	0.56	0.42	0.21	0.16	0.56	0.53	0.53	0.22	0.09	0.07	0.42	0.19	0.13	n/a	n/a	n/a
	10	(254)	0.66	0.59	0.57	0.45	0.23	0.17	0.57	0.54	0.53	0.25	0.11	0.08	0.45	0.22	0.15	n/a	n/a	n/a
	11	(279)	0.67	0.60	0.58	0.47	0.24	0.18	0.57	0.54	0.53	0.29	0.13	0.09	0.47	0.24	0.18	n/a	n/a	n/a
	12	(305)	0.69	0.61	0.58	0.50	0.25	0.19	0.58	0.55	0.54	0.33	0.14	0.10	0.50	0.25	0.19	n/a	n/a	n/a
	13-1/4	(337)	0.71	0.62	0.59	0.54	0.27	0.21	0.59	0.55	0.54	0.39	0.17	0.12	0.54	0.27	0.21	0.60	n/a	n/a
	14	(356)	0.72	0.63	0.60	0.56	0.28	0.21	0.59	0.55	0.54	0.42	0.18	0.13	0.56	0.28	0.21	0.61	n/a	n/a
	16	(406)	0.75	0.65	0.61	0.63	0.32	0.24	0.61	0.56	0.55	0.51	0.22	0.15	0.63	0.32	0.24	0.65	n/a	n/a
	18	(457)	0.78	0.67	0.63	0.71	0.35	0.27	0.62	0.57	0.55	0.61	0.26	0.18	0.71	0.35	0.27	0.69	n/a	n/a
	20	(508)	0.81	0.69	0.64	0.79	0.39	0.30	0.63	0.58	0.56	0.72	0.31	0.22	0.79	0.39	0.30	0.73	n/a	n/a
	20-7/8	(531)	0.83	0.69	0.65	0.82	0.41	0.31	0.64	0.58	0.56	0.77	0.33	0.23	0.82	0.41	0.31	0.75	n/a	n/a
	22	(559)	0.85	0.70	0.66	0.87	0.43	0.33	0.65	0.58	0.57	0.83	0.36	0.25	0.87	0.43	0.33	0.77	0.58	n/a
	24	(610)	0.88	0.72	0.67	0.94	0.47	0.36	0.66	0.59	0.57	0.94	0.41	0.28	0.94	0.47	0.36	0.80	0.61	n/a
	26-9/16	(675)	0.92	0.75	0.69	1.00	0.52	0.39	0.68	0.60	0.58	1.00	0.47	0.33	1.00	0.52	0.39	0.84	0.64	0.56
	28	(711)	0.94	0.76	0.70		0.55	0.42	0.69	0.61	0.58		0.51	0.36		0.55	0.42	0.86	0.65	0.58
	30	(762)	0.97	0.78	0.71		0.59	0.44	0.70	0.61	0.59		0.57	0.40		0.59	0.44	0.89	0.68	0.60
	36	(914)	1.00	0.83	0.75		0.71	0.53	0.74	0.64	0.61		0.75	0.52		0.71	0.53	0.98	0.74	0.66
	> 48	(1219)		0.95	0.84		0.95	0.71	0.82	0.68	0.64		1.00	0.80		0.95	0.71	1.00	0.86	0.76

Table 70 — Load adjustment factors for 30M rebar in cracked concrete[1,2,3]

	30M Rebar cracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To and away from edge f_{RV}					
	Embedment h_{ef}		10-1/4	17-15/16	23-9/16	10-1/4	17-15/16	23-9/16	10-1/4	17-15/16	23-9/16	10-1/4	17-15/16	23-9/16	10-1/4	17-15/16	23-9/16	10-1/4	17-15/16	23-9/16
	in.	(mm)	(260)	(455)	(598)	(260)	(455)	(598)	(260)	(455)	(598)	(260)	(455)	(598)	(260)	(455)	(598)	(260)	(455)	(598)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.41	0.38	0.38	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.02	0.01	n/a	n/a	n/a
	5-7/8	(150)	0.59	0.55	0.54	0.56	0.47	0.44	0.54	0.52	0.52	0.12	0.05	0.03	0.23	0.10	0.07	n/a	n/a	n/a
	6	(152)	0.59	0.56	0.54	0.56	0.47	0.44	0.54	0.52	0.52	0.12	0.05	0.03	0.24	0.10	0.07	n/a	n/a	n/a
	7	(178)	0.61	0.57	0.55	0.60	0.49	0.46	0.55	0.53	0.52	0.15	0.07	0.04	0.30	0.13	0.09	n/a	n/a	n/a
	8	(203)	0.63	0.57	0.56	0.64	0.51	0.47	0.55	0.53	0.52	0.19	0.08	0.05	0.37	0.16	0.11	n/a	n/a	n/a
	9	(229)	0.64	0.58	0.56	0.68	0.53	0.49	0.56	0.53	0.53	0.22	0.10	0.06	0.44	0.19	0.13	n/a	n/a	n/a
	10	(254)	0.66	0.59	0.57	0.72	0.56	0.50	0.57	0.54	0.53	0.26	0.11	0.07	0.52	0.22	0.15	n/a	n/a	n/a
	11	(279)	0.67	0.60	0.58	0.77	0.58	0.52	0.57	0.54	0.53	0.30	0.13	0.09	0.60	0.26	0.17	n/a	n/a	n/a
	12	(305)	0.69	0.61	0.58	0.81	0.60	0.54	0.58	0.55	0.54	0.34	0.15	0.10	0.68	0.29	0.19	n/a	n/a	n/a
	13-1/4	(337)	0.71	0.62	0.59	0.87	0.63	0.56	0.59	0.55	0.54	0.40	0.17	0.11	0.79	0.34	0.23	0.60	n/a	n/a
	14	(356)	0.72	0.63	0.60	0.91	0.65	0.57	0.59	0.55	0.54	0.43	0.19	0.12	0.86	0.37	0.25	0.62	n/a	n/a
	16	(406)	0.75	0.65	0.61	1.00	0.70	0.61	0.61	0.56	0.55	0.52	0.23	0.15	1.00	0.45	0.30	0.66	n/a	n/a
	18	(457)	0.78	0.67	0.63		0.75	0.64	0.62	0.57	0.55	0.62	0.27	0.18		0.54	0.36	0.70	n/a	n/a
	20	(508)	0.81	0.69	0.64		0.81	0.68	0.64	0.58	0.56	0.73	0.32	0.21		0.63	0.42	0.74	n/a	n/a
	20-7/8	(531)	0.83	0.69	0.65		0.83	0.70	0.64	0.58	0.56	0.78	0.34	0.22		0.68	0.45	0.75	n/a	n/a
	22	(559)	0.85	0.70	0.66		0.86	0.72	0.65	0.59	0.56	0.84	0.36	0.24		0.73	0.48	0.77	0.58	n/a
	24	(610)	0.88	0.72	0.67		0.92	0.76	0.66	0.59	0.57	0.96	0.42	0.28		0.83	0.55	0.81	0.61	n/a
	26-9/16	(675)	0.92	0.75	0.69		0.99	0.81	0.68	0.60	0.58	1.00	0.48	0.32		0.97	0.64	0.85	0.64	0.56
	28	(711)	0.94	0.76	0.70		1.00	0.84	0.69	0.61	0.58		0.52	0.35		1.00	0.69	0.87	0.66	0.57
	30	(762)	0.97	0.78	0.71			0.88	0.70	0.62	0.59		0.58	0.39			0.77	0.90	0.68	0.59
	36	(914)	1.00	0.83	0.75			1.00	0.74	0.64	0.61		0.76	0.51			1.00	0.99	0.75	0.65
	> 48	(1219)		0.95	0.84				0.82	0.69	0.64		1.00	0.78				1.00	0.86	0.75

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when c < 3*h_{ef}. f_{AV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{HV} = 1.0.

HIT-RE 500 V3 adhesive with HAS Threaded Rod

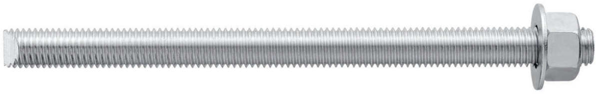


Table 71 — Hilti HIT-RE 500 V3 design information with Hilti HAS threaded rods in hammer drilled holes in accordance with CSA A23.3 Annex D[1,8]

Design parameter		Symbol	Units	Nominal rod diameter (in.)							Ref
				3/8	1/2	5/8	3/4	7/8	1	1-1/4	A23.3-14
Nominal anchor diameter		d_a	mm	9.5	12.7	15.9	19.1	22.2	25.4	31.8	
Effective minimum embedment[2]		$h_{ef,min}$	mm	60	70	79	89	89	102	127	
Effective maximum embedment[2]		$h_{ef,max}$	mm	191	254	318	381	445	508	635	
Min. concrete thickness[2]		h_{min}	mm	h_{ef} + 30	$h_{ef} + 2d_0$						
Critical edge distance		c_{ac}	–	$2h_{ef}$							
Minimum edge distance[3]		c_{min}	mm	48	64	79	95	111	127	159	
Minimum anchor spacing		s_{min}	mm	48	64	79	95	111	127	159	
Coeff. for factored conc. breakout resistance, uncracked concrete[4]		$k_{c,uncr}$	–	10							D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete[4]		$k_{c,cr}$	–	7							D.6.2.2
Concrete material resistance factor		ϕ_c	–	0.65							8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]		R_{conc}	–	1.00							D.5.3(c)
Dry and water saturated concrete											
Temp. range A[6]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	1,280 (8.8)	1,270 (8.8)	1,260 (8.7)	1,250 (8.6)	1,240 (8.6)	1,240 (8.6)	1,180 (8.1)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	2,380 (16.4)	2,300 (15.9)	2,210 (15.2)	2,130 (14.7)	2,040 (14.1)	1,960 (13.5)	1,790 (12.3)	D.6.5.2
Temp. range B[6]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	880 (6.1)	870 (6.0)	870 (6.0)	860 (5.9)	860 (5.9)	850 (5.9)	810 (5.6)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,640 (11.3)	1,590 (11.0)	1,530 (10.6)	1,470 (10.1)	1,410 (9.7)	1,350 (9.3)	1,240 (8.6)	D.6.5.2
Anchor category, dry concrete		–	–	1	1	1	1	1	1	1	
Resistance modification factor		R_{dry}	–	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Water-filled hole											
Temp. range A[6]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	940 (6.5)	940 (6.5)	940 (6.5)	940 (6.5)	940 (6.5)	950 (6.6)	920 (6.3)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,760 (12.1)	1,700 (11.7)	1,660 (11.4)	1,600 (11.0)	1,550 (10.7)	1,500 (10.3)	1,400 (9.7)	D.6.5.2
Temp. range B[6]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	650 (4.5)	650 (4.5)	650 (4.5)	650 (4.5)	650 (4.5)	650 (4.5)	640 (4.4)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,210 (8.3)	1,170 (8.1)	1,140 (7.9)	1,110 (7.7)	1,070 (7.4)	1,040 (7.2)	970 (6.7)	D.6.5.2
Anchor category, water-filled hole		–	–	3	3	3	3	3	3	3	
Resistance modification factor		R_{wf}	–	0.75	0.75	0.75	0.75	0.75	0.75	0.75	
Submerged concrete											
Temp. range A[6]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	820 (5.7)	830 (5.7)	830 (5.7)	840 (5.8)	850 (5.9)	860 (5.9)	860 (5.9)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,530 (10.6)	1,500 (10.3)	1,470 (10.1)	1,430 (9.9)	1,400 (9.7)	1,370 (9.4)	1,300 (9.0)	D.6.5.2
Temp. range B[6]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	570 (3.9)	570 (3.9)	580 (4.0)	580 (4.0)	590 (4.1)	590 (4.1)	590 (4.1)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,060 (7.3)	1,030 (7.1)	1,010 (7.0)	990 (6.8)	960 (6.6)	940 (6.5)	900 (6.2)	D.6.5.2
Anchor category, underwater		–	–	3	3	3	3	3	3	3	
Resistance modification factor		R_{uw}		0.75	0.75	0.75	0.75	0.75	0.75	0.75	
Reduction for seismic tension		$\alpha_{N,seis}$	–	0.92	0.93	0.95	1.00	1.00	1.00	1.00	

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, tables 8 and 9, and converted for use with CSA A23.3 Annex D.

2 See figure 4 of section 3.2.4.3.4.

3 Minimum edge distance may be reduced to 45mm ≤ c_{ai} < 5d provided T_{inst} is reduced. See ESR-3814 section 4.1.9.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond stress values corresponding to concrete compressive stress f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of $(f'_c/2{,}500)^{0.25}$ [for SI: $(f'_c/17.2)^{0.25}$] for uncracked concrete and $(f'c/2{,}500)^{0.15}$ [for SI: $(f'c/17.2)^{0.15}$] for cracked concrete.

8 For structures assigned to Seismic Design Categories C, D, E, or F, bond strength values must be multiplied by $\alpha_{N,seis}$.

Table 72 — Hilti HIT-RE 500 V3 design information with Hilti HAS threaded rods in diamond core drilled holes in accordance with CSA A23.3 Annex D[1]

Design parameter	Symbol	Units	Nominal rod diameter (in.)							Ref
			3/8	1/2	5/8	3/4	7/8	1	1-1/4	A23.3-14
Nominal anchor diameter	d_a	mm	9.5	12.7	15.9	19.1	22.2	25.4	31.8	
Effective minimum embedment[2]	h_{ef}	mm	60	70	79	89	89	102	127	
Effective maximum embedment[2]	h_{ef}	mm	191	254	318	381	445	508	635	
Minimum concrete thickness[2]	h_{min}	mm	h_{ef} + 30		h_{ef} + $2d_o$					
Critical edge distance	c_{ac}	–	$2h_{ef}$							
Minimum edge distance	c_{min}[3]	mm	48	64	79	95	111	127	159	
Minimum anchor spacing	s_{min}	mm	48	64	79	95	111	127	159	
Coeff. for factored concrete breakout resistance, uncracked concrete	$k_{c,uncr}$[4]	–	10							D.6.2.2
Coeff. for factored concrete breakout resistance, cracked concrete	$k_{c,cr}$[4]	–	7							D.6.2.2
Concrete material resistance factor	ϕ_s	–	0.65							8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]	R_{conc}	–	1.00							D.5.3(c)
Dry and water saturated concrete										
Temp. range A[6] Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi	1,550	1,550	1,550	1,550	1,550	1,550	1,550	D.6.5.2
		(MPa)	(10.7)	(10.7)	(10.7)	(10.7)	(10.7)	(10.7)	(10.7)	
Temp. range B[6] Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi	1,070	1,070	1,070	1,070	1,070	1,070	1,070	D.6.5.2
		psi	(7.4)	(7.4)	(7.4)	(7.4)	(7.4)	(7.4)	(7.4)	
Anchor category, dry concrete	–	–	2	2	3	3	3	3	3	
Resistance modification factor	R_{dry}	–	0.85	0.85	0.75	0.75	0.75	0.75	0.75	

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, tables 8 and 10, and converted for use with CSA A23.3 Annex D.

2 See figure 4 of section 3.2.4.3.4.

3 Minimum edge distance may be reduced to 45mm ≤ c_{ai} < 5d provided T_{inst} is reduced. See ESR-3814 section 4.1.9.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond stress values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of $(f'_c/2{,}500)^{0.25}$ [for SI: $(f'_c/17.2)^{0.25}$] for uncracked concrete.

Table 73 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete/bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8,9,11]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	2-3/8 (60)	3,060 (13.6)	3,425 (15.2)	3,750 (16.7)	4,330 (19.3)	3,060 (13.6)	3,425 (15.2)	3,750 (16.7)	4,330 (19.3)
	3-3/8 (86)	5,185 (23.1)	5,800 (25.8)	6,355 (28.3)	7,335 (32.6)	10,375 (46.1)	11,600 (51.6)	12,705 (56.5)	14,670 (65.3)
	4-1/2 (114)	7,985 (35.5)	8,930 (39.7)	9,430 (41.9)	10,130 (45.1)	15,970 (71.0)	17,855 (79.4)	18,855 (83.9)	20,260 (90.1)
	7-1/2 (191)	14,200 (63.2)	15,010 (66.8)	15,715 (69.9)	16,885 (75.1)	28,395 (126.3)	30,025 (133.6)	31,425 (139.8)	33,770 (150.2)
1/2	2-3/4 (70)	3,815 (17.0)	4,265 (19.0)	4,670 (20.8)	5,395 (24.0)	7,630 (33.9)	8,530 (37.9)	9,345 (41.6)	10,790 (48.0)
	4-1/2 (114)	7,985 (35.5)	8,930 (39.7)	9,780 (43.5)	11,295 (50.2)	15,970 (71.0)	17,855 (79.4)	19,560 (87.0)	22,585 (100.5)
	6 (152)	12,295 (54.7)	13,745 (61.1)	15,060 (67.0)	17,385 (77.3)	24,590 (109.4)	27,490 (122.3)	30,115 (134.0)	34,775 (154.7)
	10 (254)	24,390 (108.5)	25,790 (114.7)	26,995 (120.1)	29,005 (129.0)	48,785 (217.0)	51,585 (229.5)	53,990 (240.2)	58,015 (258.1)
5/8[10]	3-1/8 (79)	4,620 (20.6)	5,165 (23.0)	5,660 (25.2)	6,535 (29.1)	9,245 (41.1)	10,335 (46.0)	11,320 (50.4)	13,070 (58.1)
	5-5/8 (143)	11,160 (49.6)	12,480 (55.5)	13,670 (60.8)	15,785 (70.2)	22,320 (99.3)	24,955 (111.0)	27,335 (121.6)	31,565 (140.4)
	7-1/2 (191)	17,185 (76.4)	19,210 (85.5)	21,045 (93.6)	24,300 (108.1)	34,365 (152.9)	38,420 (170.9)	42,090 (187.2)	48,600 (216.2)
	12-1/2 (318)	36,620 (162.9)	38,725 (172.2)	40,530 (180.3)	43,550 (193.7)	73,245 (325.8)	77,445 (344.5)	81,055 (360.6)	87,100 (387.4)
3/4[10]	3-1/2 (89)	5,480 (24.4)	6,125 (27.2)	6,710 (29.8)	7,745 (34.5)	10,955 (48.7)	12,250 (54.5)	13,420 (59.7)	15,495 (68.9)
	6-3/4 (171)	14,670 (65.3)	16,400 (73.0)	17,970 (79.9)	20,745 (92.3)	29,340 (130.5)	32,805 (145.9)	35,935 (159.8)	41,495 (184.6)
	9 (229)	22,585 (100.5)	25,255 (112.3)	27,665 (123.1)	31,945 (142.1)	45,175 (200.9)	50,505 (224.7)	55,325 (246.1)	63,885 (284.2)
	15 (381)	48,600 (216.2)	53,740 (239.1)	56,250 (250.2)	60,445 (268.9)	97,200 (432.4)	107,485 (478.1)	112,495 (500.4)	120,885 (537.7)
7/8[10]	3-1/2 (89)	5,480 (24.4)	6,125 (27.2)	6,710 (29.8)	7,745 (34.5)	10,955 (48.7)	12,250 (54.5)	13,420 (59.7)	15,495 (68.9)
	7-7/8 (200)	18,485 (82.2)	20,670 (91.9)	22,640 (100.7)	26,145 (116.3)	36,975 (164.5)	41,340 (183.9)	45,285 (201.4)	52,290 (232.6)
	10-1/2 (267)	28,465 (126.6)	31,820 (141.6)	34,860 (155.1)	40,255 (179.1)	56,925 (253.2)	63,645 (283.1)	69,720 (310.1)	80,505 (358.1)
	17-1/2 (445)	61,240 (272.4)	68,470 (304.6)	73,325 (326.2)	78,795 (350.5)	122,485 (544.8)	136,940 (609.1)	146,650 (652.3)	157,585 (701.0)
1[10]	4 (102)	6,690 (29.8)	7,480 (33.3)	8,195 (36.5)	9,465 (42.1)	13,385 (59.5)	14,965 (66.6)	16,395 (72.9)	18,930 (84.2)
	9 (229)	22,585 (100.5)	25,255 (112.3)	27,665 (123.1)	31,945 (142.1)	45,175 (200.9)	50,505 (224.7)	55,325 (246.1)	63,885 (284.2)
	12 (305)	34,775 (154.7)	38,880 (172.9)	42,590 (189.5)	49,180 (218.8)	69,550 (309.4)	77,760 (345.9)	85,180 (378.9)	98,360 (437.5)
	20 (508)	74,825 (332.8)	83,655 (372.1)	91,640 (407.6)	98,875 (439.8)	149,650 (665.7)	167,310 (744.2)	183,280 (815.3)	197,755 (879.7)
1-1/4[10]	5 (127)	9,355 (41.6)	10,455 (46.5)	11,455 (51.0)	13,225 (58.8)	18,705 (83.2)	20,915 (93.0)	22,910 (101.9)	26,455 (117.7)
	11-1/4 (286)	31,565 (140.4)	35,290 (157.0)	38,660 (172.0)	44,640 (198.6)	63,135 (280.8)	70,585 (314.0)	77,320 (343.9)	89,285 (397.1)
	15 (381)	48,600 (216.2)	54,335 (241.7)	59,520 (264.8)	68,730 (305.7)	97,200 (432.4)	108,670 (483.4)	119,045 (529.5)	137,460 (611.4)
	25 (635)	104,570 (465.1)	116,910 (520.0)	128,070 (569.7)	141,095 (627.6)	209,140 (930.3)	233,825 (1040.1)	256,140 (1139.4)	282,190 (1255.2)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 30 - 41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete or water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.44.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. For diamond core drilling, except as indicated in note 10, multiply above values by 0.55.
Diamond core drilling is not permitted for the water-filled or under-water (submerged) applications.

10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 5/8", 3/4", 7/8", 1", and 1-1/4". See Table 76.

11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 74 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete/bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8,9,11]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	2-3/8 (60)	2,145 (9.5)	2,395 (10.7)	2,530 (11.3)	2,645 (11.8)	2,145 (9.5)	2,395 (10.7)	2,530 (11.3)	2,645 (11.8)
	3-3/8 (86)	3,385 (15.1)	3,500 (15.6)	3,595 (16.0)	3,755 (16.7)	6,770 (30.1)	7,000 (31.1)	7,195 (32.0)	7,510 (33.4)
	4-1/2 (114)	4,515 (20.1)	4,665 (20.8)	4,795 (21.3)	5,005 (22.3)	9,025 (40.1)	9,335 (41.5)	9,590 (42.7)	10,015 (44.5)
	7-1/2 (191)	7,520 (33.5)	7,780 (34.6)	7,995 (35.6)	8,345 (37.1)	15,045 (66.9)	15,555 (69.2)	15,985 (71.1)	16,690 (74.2)
1/2	2-3/4 (70)	2,670 (11.9)	2,985 (13.3)	3,270 (14.5)	3,775 (16.8)	5,340 (23.8)	5,970 (26.6)	6,540 (29.1)	7,555 (33.6)
	4-1/2 (114)	5,590 (24.9)	6,175 (27.5)	6,345 (28.2)	6,625 (29.5)	11,180 (49.7)	12,345 (54.9)	12,690 (56.4)	13,250 (58.9)
	6 (152)	7,960 (35.4)	8,230 (36.6)	8,460 (37.6)	8,830 (39.3)	15,920 (70.8)	16,460 (73.2)	16,920 (75.3)	17,665 (78.6)
	10 (254)	13,265 (59.0)	13,720 (61.0)	14,100 (62.7)	14,720 (65.5)	26,535 (118.0)	27,435 (122.0)	28,200 (125.4)	29,440 (131.0)
5/8[10]	3-1/8 (79)	3,235 (14.4)	3,615 (16.1)	3,960 (17.6)	4,575 (20.4)	6,470 (28.8)	7,235 (32.2)	7,925 (35.2)	9,150 (40.7)
	5-5/8 (143)	7,810 (34.8)	8,735 (38.9)	9,570 (42.6)	10,270 (45.7)	15,625 (69.5)	17,470 (77.7)	19,135 (85.1)	20,540 (91.4)
	7-1/2 (191)	12,030 (53.5)	12,760 (56.8)	13,115 (58.3)	13,690 (60.9)	24,055 (107.0)	25,520 (113.5)	26,230 (116.7)	27,385 (121.8)
	12-1/2 (318)	20,565 (91.5)	21,265 (94.6)	21,855 (97.2)	22,820 (101.5)	41,135 (183.0)	42,535 (189.2)	43,715 (194.4)	45,640 (203.0)
3/4[10]	3-1/2 (89)	3,835 (17.1)	4,285 (19.1)	4,695 (20.9)	5,425 (24.1)	7,670 (34.1)	8,575 (38.1)	9,390 (41.8)	10,845 (48.2)
	6-3/4 (171)	10,270 (45.7)	11,480 (51.1)	12,575 (55.9)	14,525 (64.6)	20,540 (91.4)	22,965 (102.1)	25,155 (111.9)	29,045 (129.2)
	9 (229)	15,810 (70.3)	17,675 (78.6)	18,735 (83.3)	19,560 (87.0)	31,620 (140.7)	35,355 (157.3)	37,470 (166.7)	39,120 (174.0)
	15 (381)	29,380 (130.7)	30,380 (135.1)	31,225 (138.9)	32,600 (145.0)	58,760 (261.4)	60,760 (270.3)	62,445 (277.8)	65,200 (290.0)
7/8[10]	3-1/2 (89)	3,835 (17.1)	4,285 (19.1)	4,695 (20.9)	5,425 (24.1)	7,670 (34.1)	8,575 (38.1)	9,390 (41.8)	10,845 (48.2)
	7-7/8 (200)	12,940 (57.6)	14,470 (64.4)	15,850 (70.5)	18,300 (81.4)	25,880 (115.1)	28,935 (128.7)	31,700 (141.0)	36,605 (162.8)
	10-1/2 (267)	19,925 (88.6)	22,275 (99.1)	24,400 (108.5)	26,410 (117.5)	39,850 (177.3)	44,550 (198.2)	48,805 (217.1)	52,820 (235.0)
	17-1/2 (445)	39,670 (176.5)	41,020 (182.5)	42,160 (187.5)	44,020 (195.8)	79,340 (352.9)	82,040 (364.9)	84,315 (375.1)	88,035 (391.6)
1[10]	4 (102)	4,685 (20.8)	5,240 (23.3)	5,740 (25.5)	6,625 (29.5)	9,370 (41.7)	10,475 (46.6)	11,475 (51.0)	13,250 (58.9)
	9 (229)	15,810 (70.3)	17,675 (78.6)	19,365 (86.1)	22,360 (99.5)	31,620 (140.7)	35,355 (157.3)	38,730 (172.3)	44,720 (198.9)
	12 (305)	24,340 (108.3)	27,215 (121.1)	29,815 (132.6)	34,425 (153.1)	48,685 (216.6)	54,430 (242.1)	59,625 (265.2)	68,850 (306.3)
	20 (508)	51,815 (230.5)	53,580 (238.3)	55,065 (244.9)	57,490 (255.7)	103,630 (461.0)	107,155 (476.7)	110,130 (489.9)	114,985 (511.5)
1-1/4[10]	5 (127)	6,545 (29.1)	7,320 (32.6)	8,020 (35.7)	9,260 (41.2)	13,095 (58.2)	14,640 (65.1)	16,035 (71.3)	18,520 (82.4)
	11-1/4 (286)	22,095 (98.3)	24,705 (109.9)	27,060 (120.4)	31,250 (139.0)	44,195 (196.6)	49,410 (219.8)	54,125 (240.8)	62,500 (278.0)
	15 (381)	34,020 (151.3)	38,035 (169.2)	41,665 (185.3)	48,110 (214.0)	68,040 (302.7)	76,070 (338.4)	83,330 (370.7)	96,220 (428.0)
	25 (635)	73,200 (325.6)	79,665 (354.4)	81,875 (364.2)	85,485 (380.3)	146,395 (651.2)	159,330 (708.7)	163,750 (728.4)	170,970 (760.5)

[1] See Section 3.1.8 for explanation on development of load values.

[2] See Section 3.1.8 to convert design strength value to ASD value.

[3] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[4] Apply spacing, edge distance, and concrete thickness factors in tables 30-41 as necessary to the above values. Compare to the steel values in table 29 to the above values. The lesser of the values is to be used for the design.

[5] Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176 °F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

[6] Tabular values are for dry or water saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.44.

[7] Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

[8] Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

[9] Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete except as indicated in note 10.

[10] Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 5/8", 3/4", 7/8", 1", and 1-1/4". See Table 77.

[11] Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by α_{seis} indicated below. See section 3.1.8 for additional information on seismic applications.
3/8-in. diameter - α_{seis} = 0.69
1/2-in. diameter - α_{seis} = 0.70
5/8-in. diameter - α_{seis} = 0.71
3/4-in. diameter and larger - α_{seis} = 0.75

Table 75 — Steel factored resistance for Hilti HAS threaded rods for use with CSA A23.3 Annex D

Nominal anchor diameter in.	HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr.36[4,6]			HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6]			HAS-B-105 / HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6]			HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4]		
	Tensile[1] ΦN_{sar} lb (kN)	Shear[2] ΦV_{sar} lb (kN)	Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN)	Tensile[1] ΦN_{sar} lb (kN)	Shear[2] ΦV_{sar} lb (kN)	Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN)	Tensile[1] ΦN_{sar} lb (kN)	Shear[2] ΦV_{sar} lb (kN)	Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN)	Tensile[1] ΦN_{sar} lb (kN)	Shear[2] ΦV_{sar} lb (kN)	Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN)
3/8	3,055 (13.6)	1,720 (7.7)	1,030 (4.6)	3,955 (17.6)	2,225 (9.9)	2,225 (9.9)	6,570 (29.2)	3,695 (16.4)	3,695 (16.4)	4,610 (20.5)	2,570 (11.4)	2,055 (9.1)
1/2	5,595 (24.9)	3,150 (14.0)	1,890 (8.4)	7,240 (32.2)	4,070 (18.1)	4,070 (18.1)	12,035 (53.5)	6,765 (30.1)	6,765 (30.1)	8,445 (37.6)	4,705 (20.9)	3,765 (16.7)
5/8	8,915 (39.7)	5,015 (22.3)	3,010 (13.4)	11,525 (51.3)	6,485 (28.8)	6,485 (28.8)	19,160 (85.2)	10,780 (48.0)	10,780 (48.0)	13,445 (59.8)	7,490 (33.3)	5,990 (26.6)
3/4	13,190 (58.7)	7,420 (33.0)	4,450 (19.8)	17,060 (75.9)	9,600 (42.7)	9,600 (42.7)	28,365 (126.2)	15,955 (71.0)	15,955 (71.0)	16,920 (75.3)	9,425 (41.9)	7,540 (33.5)
7/8	18,210 (81.0)	10,245 (45.6)	6,145 (27.3)	23,550 (104.8)	13,245 (58.9)	13,245 (58.9)	39,150 (174.1)	22,020 (97.9)	22,020 (97.9)	23,350 (103.9)	13,010 (57.9)	10,410 (46.3)
1	23,890 (106.3)	13,440 (59.8)	8,065 (35.9)	30,890 (137.4)	17,380 (77.3)	17,380 (77.3)	51,360 (228.5)	28,890 (128.5)	28,890 (128.5)	30,635 (136.3)	17,065 (75.9)	13,650 (60.7)
1-1/4	38,225 (170.0)	21,500 (95.6)	12,900 (57.4)	49,425 (219.9)	27,800 (123.7)	27,800 (123.7)	82,175 (365.5)	46,220 (205.6)	46,220 (205.6)	37,565 (167.1)	21,130 (94.0)	16,905 (75.2)

1 Tensile = $\phi A_{se,N} f_{uta} R$ as noted in CSA A23.3 Eq. D.2.

2 Shear = $\phi\ 0.60 A_{se,V} f_{uta} R$ as noted in CSA A23.3 Eq. D.31.

3 Seismic Shear = $\alpha_{V,seis} V_{sar}$: Reduction factor for seismic shear only. See CSA A23.3 Annex D for additional information on seismic applications. Seismic shear for HIT-RE 500 V3

4 HAS-V, HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).

5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.

6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

Table 75 — Hilti HIT-RE 500-V3 design information with HAS threaded rods in core drilled holes roughened with the TE-YRT Roughening Tool in accordance with CSA A23.3 Annex D[1,8]

Design parameter		Symbol	Units	Nominal rod diameter (in.)					Ref A23.3-14
				5/8	3/4	7/8	1	1-1/4	
Nominal anchor diameter		d_a	mm	15.9	19.1	22.2	25.4	31.8	
Effective minimum embedment[2]		h_{ef}	mm	79	89	89	102	127	
Effective maximum embedment[2]		h_{ef}	ƒmm	318	286	445	508	635	
Minimum concrete thickness[2]		h_{min}	mm	$h_{ef} + 2d_o$					
Critical edge distance		c_{ac}	–	$2h_{ef}$					
Minimum edge distance[3]		c_{min}	mm	79	95	111	127	159	
Minimum anchor spacing		s_{min}	mm	79	95	111	127	159	
Coeff. for factored concrete breakout resistance, uncracked concrete[4]		$k_{c,uncr}$	–	10					D.6.2.2
Coeff. for factored concrete breakout resistance, cracked concrete[4]		$k_{c,cr}$	–	7					D.6.2.2
Concrete material resistance factor		ϕ_s	–	0.65					8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]		R_{conc}	–	1.00					D.5.3(c)
Dry and water saturated concrete									
Temp. range A[6]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	880 (6.1)	875 (6.0)	870 (6.0)	870 (6.0)	825 (5.7)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	2,210 (15.2)	2,130 (14.7)	2,040 (14.1)	1,960 (13.5)	1,790 (12.3)	D.6.5.2
Temp. range B[6]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	610 (4.2)	605 (4.2)	605 (4.2)	600 (4.1)	570 (3.9)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,530 (10.6)	1,470 (10.1)	1,410 (9.7)	1,350 (9.3)	1,240 (8.6)	D.6.5.2
Anchor category, dry concrete		-	-	1	1	1	1	1	
Resistance modification factor		R_{dry}	-	1.00	1.00	1.00	1.00	1.00	
Reduction for seismic tension		$\alpha_{N,seis}$	-	0.95	1.00	1.00	1.00	1.00	

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, table 11 and 12, and converted for use with CSA A23.3 Annex D.

2 See figure 8 of section 3.2.4.3.4.

3 Minimum edge distance may be reduced to 45mm ≤ c_{ai} < 5d provided Tinst is reduced. See ESR-3814 section 4.1.9.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond stress values correspond to concrete compressive strength in the range 2,500 psi ≤ f'_c ≤ 8,000 psi.

8 For structures assigned to Seismic Design Categories C, D, E, or F, bond stress values must be multiplied by $\alpha_{N,seis}$.

Table 76 — Hilti HIT-RE 500 V3 Core Drilled and roughened with TE-YRT Roughening Tool adhesive factored resistance with concrete / bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8,9]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
5/8	3-1/8 (79)	4,620 (20.6)	5,165 (23.0)	5,660 (25.2)	6,535 (29.1)	9,245 (41.1)	10,335 (46.0)	11,320 (50.4)	13,070 (58.1)
	5-5/8 (143)	11,160 (49.6)	12,480 (55.5)	13,670 (60.8)	15,785 (70.2)	22,320 (99.3)	24,955 (111.0)	27,335 (121.6)	31,565 (140.4)
	7-1/2 (191)	17,185 (76.4)	19,210 (85.5)	21,045 (93.6)	21,160 (94.1)	34,365 (152.9)	38,420 (170.9)	42,090 (187.2)	42,320 (188.2)
	12-1/2 (318)	35,265 (156.9)	35,265 (156.9)	35,265 (156.9)	35,265 (156.9)	70,535 (313.7)	70,535 (313.7)	70,535 (313.7)	70,535 (313.7)
3/4	3-1/2 (89)	5,480 (24.4)	6,125 (27.2)	6,710 (29.8)	7,745 (34.5)	10,955 (48.7)	12,250 (54.5)	13,420 (59.7)	15,495 (68.9)
	6-3/4 (171)	14,670 (65.3)	16,400 (73.0)	17,970 (79.9)	20,745 (92.3)	29,340 (130.5)	32,805 (145.9)	35,935 (159.8)	41,495 (184.6)
	9 (229)	22,585 (100.5)	25,255 (112.3)	27,665 (123.1)	29,365 (130.6)	45,175 (200.9)	50,505 (224.7)	55,325 (246.1)	58,735 (261.3)
	11-1/4 (286)	31,565 (140.4)	35,290 (157.0)	36,710 (163.3)	36,710 (163.3)	63,135 (280.8)	70,585 (314.0)	73,420 (326.6)	73,420 (326.6)
7/8	3-1/2 (89)	5,480 (24.4)	6,125 (27.2)	6,710 (29.8)	7,745 (34.5)	10,955 (48.7)	12,250 (54.5)	13,420 (59.7)	15,495 (68.9)
	7-7/8 (200)	18,485 (82.2)	20,670 (91.9)	22,640 (100.7)	26,145 (116.3)	36,975 (164.5)	41,340 (183.9)	45,285 (201.4)	52,290 (232.6)
	10-1/2 (267)	28,465 (126.6)	31,820 (141.6)	34,860 (155.1)	38,285 (170.3)	56,925 (253.2)	63,645 (283.1)	69,720 (310.1)	76,565 (340.6)
	17-1/2 (445)	61,240 (272.4)	63,805 (283.8)	63,805 (283.8)	63,805 (283.8)	122,485 (544.8)	127,610 (567.6)	127,610 (567.6)	127,610 (567.6)
1	4 (102)	6,690 (29.8)	7,480 (33.3)	8,195 (36.5)	9,465 (42.1)	13,385 (59.5)	14,965 (66.6)	16,395 (72.9)	18,930 (84.2)
	9 (229)	22,585 (100.5)	25,255 (112.3)	27,665 (123.1)	31,945 (142.1)	45,175 (200.9)	50,505 (224.7)	55,325 (246.1)	63,885 (284.2)
	12 (305)	34,775 (154.7)	38,880 (172.9)	42,590 (189.5)	48,040 (213.7)	69,550 (309.4)	77,760 (345.9)	85,180 (378.9)	96,085 (427.4)
	20 (508)	74,825 (332.8)	80,070 (356.2)	80,070 (356.2)	80,070 (356.2)	149,650 (665.7)	160,140 (712.3)	160,140 (712.3)	160,140 (712.3)
1-1/4	5 (127)	9,355 (41.6)	10,455 (46.5)	11,455 (51.0)	13,225 (58.8)	18,705 (83.2)	20,915 (93.0)	22,910 (101.9)	26,455 (117.7)
	11-1/4 (286)	31,565 (140.4)	35,290 (157.0)	38,660 (172.0)	44,640 (198.6)	63,135 (280.8)	70,585 (314.0)	77,320 (343.9)	89,285 (397.1)
	15 (381)	48,600 (216.2)	54,335 (241.7)	59,520 (264.8)	68,555 (304.9)	97,200 (432.4)	108,670 (483.4)	119,045 (529.5)	137,110 (609.9)
	25 (635)	104,570 (465.1)	114,255 (508.2)	114,255 (508.2)	114,255 (508.2)	209,140 (930.3)	228,515 (1016.5)	228,515 (1016.5)	228,515 (1016.5)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 30 - 41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete or water-saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 77 — Hilti HIT-RE 500 V3 Core Drilled and roughened with TE-YRT Roughening Tool adhesive factored resistance with concrete / bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8,9]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
5/8	3-1/8 (79)	3,235 (14.4)	3,510 (15.6)	3,510 (15.6)	3,510 (15.6)	6,470 (28.8)	7,020 (31.2)	7,020 (31.2)	7,020 (31.2)
	5-5/8 (143)	6,320 (28.1)	6,320 (28.1)	6,320 (28.1)	6,320 (28.1)	12,640 (56.2)	12,640 (56.2)	12,640 (56.2)	12,640 (56.2)
	7-1/2 (191)	8,425 (37.5)	8,425 (37.5)	8,425 (37.5)	8,425 (37.5)	16,850 (75.0)	16,850 (75.0)	16,850 (75.0)	16,850 (75.0)
	12-1/2 (318)	14,045 (62.5)	14,045 (62.5)	14,045 (62.5)	14,045 (62.5)	28,085 (124.9)	28,085 (124.9)	28,085 (124.9)	28,085 (124.9)
3/4	3-1/2 (89)	3,835 (17.1)	4,285 (19.1)	4,690 (20.9)	4,690 (20.9)	7,670 (34.1)	8,575 (38.1)	9,385 (41.7)	9,385 (41.7)
	6-3/4 (171)	9,050 (40.2)	9,050 (40.2)	9,050 (40.2)	9,050 (40.2)	18,095 (80.5)	18,095 (80.5)	18,095 (80.5)	18,095 (80.5)
	9 (229)	12,065 (53.7)	12,065 (53.7)	12,065 (53.7)	12,065 (53.7)	24,130 (107.3)	24,130 (107.3)	24,130 (107.3)	24,130 (107.3)
	11-1/4 (286)	15,080 (67.1)	15,080 (67.1)	15,080 (67.1)	15,080 (67.1)	30,160 (134.2)	30,160 (134.2)	30,160 (134.2)	30,160 (134.2)
7/8	3-1/2 (89)	3,835 (17.1)	4,285 (19.1)	4,695 (20.9)	5,425 (24.1)	7,670 (34.1)	8,575 (38.1)	9,390 (41.8)	10,845 (48.2)
	7-7/8 (200)	12,245 (54.5)	12,245 (54.5)	12,245 (54.5)	12,245 (54.5)	24,490 (108.9)	24,490 (108.9)	24,490 (108.9)	24,490 (108.9)
	10-1/2 (267)	16,325 (72.6)	16,325 (72.6)	16,325 (72.6)	16,325 (72.6)	32,655 (145.2)	32,655 (145.2)	32,655 (145.2)	32,655 (145.2)
	17-1/2 (445)	27,210 (121.0)	27,210 (121.0)	27,210 (121.0)	27,210 (121.0)	54,420 (242.1)	54,420 (242.1)	54,420 (242.1)	54,420 (242.1)
1	4 (102)	4,685 (20.8)	5,240 (23.3)	5,740 (25.5)	6,625 (29.5)	9,370 (41.7)	10,475 (46.6)	11,475 (51.0)	13,250 (58.9)
	9 (229)	15,810 (70.3)	15,995 (71.1)	15,995 (71.1)	15,995 (71.1)	31,620 (140.7)	31,985 (142.3)	31,985 (142.3)	31,985 (142.3)
	12 (305)	21,325 (94.9)	21,325 (94.9)	21,325 (94.9)	21,325 (94.9)	42,650 (189.7)	42,650 (189.7)	42,650 (189.7)	42,650 (189.7)
	20 (508)	35,540 (158.1)	35,540 (158.1)	35,540 (158.1)	35,540 (158.1)	71,080 (316.2)	71,080 (316.2)	71,080 (316.2)	71,080 (316.2)
1-1/4	5 (127)	6,545 (29.1)	7,320 (32.6)	8,020 (35.7)	9,260 (41.2)	13,095 (58.2)	14,640 (65.1)	16,035 (71.3)	18,520 (82.4)
	11-1/4 (286)	22,095 (98.3)	23,695 (105.4)	23,695 (105.4)	23,695 (105.4)	44,195 (196.6)	47,395 (210.8)	47,395 (210.8)	47,395 (210.8)
	15 (381)	31,595 (140.5)	31,595 (140.5)	31,595 (140.5)	31,595 (140.5)	63,190 (281.1)	63,190 (281.1)	63,190 (281.1)	63,190 (281.1)
	25 (635)	52,660 (234.2)	52,660 (234.2)	52,660 (234.2)	52,660 (234.2)	105,320 (468.5)	105,320 (468.5)	105,320 (468.5)	105,320 (468.5)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 30 - 41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete or water-saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.
Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λa as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by α_{seis} indicated below. See section 3.1.8 for additional information on seismic applications.
5/8-in. diameter α_{seis}=0.71
3/4-in. diameter and larger - α_{seis} = 0.75

HIT-RE 500 V3 adhesive with HIS-(R)N Inserts

Table 78 — Hilti HIT-RE 500 V3 design information with Hilti HIS-N and HIS-RN internally threaded inserts in hammer drilled holes in accordance with CSA A23.3 Annex D[1,7]

Design parameter		Symbol	Units	Nominal bolt/cap screw diameter (in.)				Ref
				3/8	1/2	5/8	3/4	A23.3-14
HIS insert outside diameter		D	mm	16.5	20.5	25.4	27.6	
Effective embedment[2]		h_{ef}	mm	110	125	170	205	
Min. concrete thickness[2]		h_{min}	mm	150	170	230	270	
Critical edge distance		c_{ac}	–	$2h_{ef}$				
Minimum edge distance		c_{min}	mm	83	102	127	140	
Minimum anchor spacing		s_{min}	mm	83	102	127	140	
Coeff. for factored conc. breakout resistance, uncracked concrete[3]		$k_{c,uncr}$	–	10				D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete[3]		$k_{c,cr}$	–	7				D.6.2.2
Concrete material resistance factor		ϕ_c	–	0.65				8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]		R_{conc}	–	1.00				D.5.3(c)
Dry and water saturated concrete								
Temp. range A[5]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	1,070 (7.4)	1,070 (7.4)	1,070 (7.4)	1,070 (7.4)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,790 (12.3)	1,790 (12.3)	1,790 (12.3)	1,790 (12.3)	D.6.5.2
Temp. range B[5]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	740 (5.1)	740 (5.1)	740 (5.1)	740 (5.1)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,240 (8.6)	1,240 (8.6)	1,240 (8.6)	1,240 (8.6)	D.6.5.2
Anchor category, dry concrete		–	–	1	1	1	1	
Resistance modification factor		R_{dry}	–	1.00	1.00	1.00	1.00	
Water-filled hole								
Temp. range A[5]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	800 (5.5)	810 (5.6)	820 (5.7)	820 (5.7)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,340 (9.2)	1,350 (9.3)	1,370 (9.4)	1,380 (9.5)	D.6.5.2
Temp. range B[5]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	550 (3.8)	560 (3.9)	570 (3.9)	570 (3.9)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	920 (6.3)	930 (6.4)	950 (6.6)	950 (6.6)	D.6.5.2
Anchor category, water-filled hole		–	–	3	3	3	3	
Resistance modification factor		R_{wf}	–	0.75	0.75	0.75	0.75	
Underwater applications								
Temp. range A[5]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	710 (4.9)	720 (5.0)	750 (5.2)	750 (5.2)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,190 (8.2)	1,210 (8.3)	1,250 (8.6)	1,260 (8.7)	D.6.5.2
Temp. range B[5]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	490 (3.4)	500 (3.4)	510 (3.5)	520 (3.6)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	820 (5.7)	840 (5.8)	860 (5.9)	870 (6.0)	D.6.5.2
Anchor category, underwater		–	–	3	3	3	3	
Resistance modification factor		R_{uw}		0.75	0.75	0.75	0.75	
Reduction for seismic tension		$\alpha_{N,seis}$	–	1.00	1.00	1.00	1.00	

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, tables 16 and 17, and converted for use with CSA A23.3 Annex D.

2 See figure 3 of this section.

3 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Bond stress values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of $(f'_c/2,500)^{0.25}$ [for SI: $(f'_c/17.2)^{0.25}$]. for uncracked concrete and $(f'c/2,500)^{0.15}$ [for SI: $(f'c/17.2)^{0.15}$] for cracked concrete

7 For structures assigned to Seismic Design Categories C, D, E, or F, bond stress values must be multiplied by $\alpha_{N,seis}$.

Table 79 — Hilti HIT-RE 500 V3 design information with Hilti HIS-N and HIS-RN internally threaded inserts in diamond core drilled holes in accordance with CSA A23.3 Annex D[1]

Design parameter	Symbol	Units	Nominal bolt/cap screw diameter (in.)				Ref
			3/8	1/2	5/8	3/4	A23.3-14
HIS insert outside diameter	D	mm	16.5	20.5	25.4	27.6	
Effective embedment[2]	h_{ef}	mm	110	125	170	205	
Min. concrete thickness[2]	h_{min}	mm	150	170	230	270	
Critical edge distance	c_{ac}	–	$2h_{ef}$				
Minimum edge distance	c_{min}	mm	83	102	127	140	
Minimum anchor spacing	s_{min}	mm	83	102	127	140	
Coeff. for factored conc. breakout resistance, uncracked concrete[3]	$k_{c,uncr}$	–	10				D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete[3]	$k_{c,cr}$	–	7				D.6.2.2
Concrete material resistance factor	ϕ_c	–	0.65				8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]	R_{conc}	–	1.00				D.5.3(c)
Dry concrete							
Temp. range A[5] Characteristic bond stress in uncracked concrete[6,7]	τ_{cr}	psi (MPa)	1,200 (8.3)	1,200 (8.3)	1,200 (8.3)	1,200 (8.3)	D.6.5.2
Temp. range B[5] Characteristic bond stress in uncracked concrete[6,7]	τ_{cr}	psi (MPa)	830 (5.7)	830 (5.7)	830 (5.7)	830 (5.7)	D.6.5.2
Anchor category, dry concrete	–	–	3	3	3	3	
Resistance modification factor	R_{dry}	–	0.75	0.75	0.75	0.75	
Water saturated hole							
Temp. range A[5] Characteristic bond stress in uncracked concrete[6,7]	τ_{cr}	psi (MPa)	1,200 (8.3)	1,200 (8.3)	1,200 (8.3)	1,200 (8.3)	D.6.5.2
Temp. range B[5] Characteristic bond stress in uncracked concrete[6,7]	τ_{cr}	psi (MPa)	830 (5.7)	830 (5.7)	830 (5.7)	830 (5.7)	D.6.5.2
Anchor category, water-saturated conc.	–	–	3	3	3	3	
Resistance modification factor	R_{wf}	–	0.75	0.75	0.75	0.75	

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, tables 16 and 17, and converted for use with CSA A23.3 Annex D.

2 See figure 8 of section 3.2.4.3.6.

3 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Bond stress values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of $(f'_c/2{,}500)^{0.25}$ [for SI: $(f'_c/17.2)^{0.25}$] for uncracked concrete.

Table 80 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8,9,11]

Thread size	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8-16 UNC	4-3/8 (110)	7,540 (33.5)	8,430 (37.5)	9,235 (41.1)	10,660 (47.4)	15,080 (67.1)	16,860 (75.0)	18,470 (82.1)	21,325 (94.9)
1/2-13 UNC[10]	5 (125)	9,135 (40.6)	10,210 (45.4)	11,185 (49.8)	12,915 (57.5)	18,265 (81.3)	20,420 (90.8)	22,370 (99.5)	25,830 (114.9)
5/8-11 UNC[10]	6-3/4 (170)	14,485 (64.4)	16,195 (72.0)	17,740 (78.9)	20,485 (91.1)	28,970 (128.9)	32,390 (144.1)	35,480 (157.8)	40,970 (182.2)
3/4-10 UNC[10]	8-1/8 (205)	19,180 (85.3)	21,445 (95.4)	23,490 (104.5)	27,125 (120.7)	38,360 (170.6)	42,890 (190.8)	46,985 (209.0)	54,255 (241.3)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 50 - 51 as necessary to the above values. Compare to the steel values in table 49. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.

6 Tabular values are for dry concrete or water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.52.
For submerged (under water) applications multiply design strength by 0.46.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. For diamond core drilling, except as indicated in note 10, multiply uncracked concrete tabular values by 0.57.
Diamond core drilling is not permitted for the water-filled or under-water (submerged) applications.

10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 1/2-13 UNC, 5/8-11 UNC, and 3/4-10 UNC anchors in dry and water-saturated concrete. See Table 83.

11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 81 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9,11]

Thread size	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8-16 UNC	4-3/8 (110)	5,280 (23.5)	5,900 (26.2)	6,465 (28.8)	6,985 (31.1)	10,555 (47.0)	11,800 (52.5)	12,925 (57.5)	13,965 (62.1)
1/2-13 UNC[10]	5 (125)	6,395 (28.4)	7,150 (31.8)	7,830 (34.8)	9,040 (40.2)	12,785 (56.9)	14,295 (63.6)	15,660 (69.7)	18,080 (80.4)
5/8-11 UNC[10]	6-3/4 (170)	10,140 (45.1)	11,335 (50.4)	12,420 (55.2)	14,340 (63.8)	20,280 (90.2)	22,675 (100.9)	24,835 (110.5)	28,680 (127.6)
3/4-10 UNC[10]	8-1/8 (205)	13,425 (59.7)	15,010 (66.8)	16,445 (73.1)	18,990 (84.5)	26,855 (119.5)	30,025 (133.5)	32,890 (146.3)	37,975 (168.9)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 50-51 as necessary to the above values. Compare to the steel values in table 49. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130 (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete or water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.52.
For submerged (under water) applications multiply design strength by 0.46.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete except as indicated in note 10.

10 Diamond core drilling is permitted in cracked concrete with use of the Hilti TE-YRT roughening tool for 1/2-13 UNC, 5/8-11 UNC, and 3/4-10 UNC anchors in dry and water-saturated concrete. See Table 84.

11 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by α_{seis} = 0.75. See section 3.1.8 for additional information on seismic applications.

Table 82 — Hilti HIT-RE 500 V3 design information with Hilti HIS-N and HIS-RN internally threaded inserts in core drilled holes roughened with the TE-YRT Roughening Tool in accordance with CSA A23.3 Annex D[1]

Design parameter		Symbol	Units	Nominal bolt/cap screw diameter (in.)			Ref
				1/2	5/8	3/4	A23.3-14
HIS insert outside diameter		D	mm	20.5	25.4	27.6	
Effective embedment[2]		h_{ef}	mm	125	170	205	
Min. concrete thickness[2]		h_{min}	mm	170	230	270	
Critical edge distance		c_{ac}	–	$2h_{ef}$			
Minimum edge distance		c_{min}	mm	102	127	140	
Minimum anchor spacing		s_{min}	mm	102	127	140	
Coeff. for factored conc. breakout resistance, uncracked concrete[3]		$k_{c,uncr}$	–	10			D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete[3]		$k_{c,cr}$	–	7			D.6.2.2
Concrete material resistance factor		ϕ_c	–	0.65			8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]		R_{conc}	–	1.00			D.5.3(c)
Dry and water saturated concrete							
Temp. range A[5]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	750 (5.2)	750 (5.2)	750 (5.2)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,790 (12.3)	1,790 (12.3)	1,790 (12.3)	D.6.5.2
Temp. range B[5]	Characteristic bond stress in cracked concrete[6,7]	τ_{cr}	psi (MPa)	515 (3.6)	515 (3.6)	515 (3.6)	D.6.5.2
	Characteristic bond stress in uncracked concrete[6,7]	τ_{uncr}	psi (MPa)	1,240 (8.6)	1,240 (8.6)	1,240 (8.6)	D.6.5.2
Anchor category, dry concrete		-	-	1	1	1	
Resistance modification factor		R_{dry}	-	1.00	1.00	1.00	
Reduction for seismic tension		$\alpha_{N,seis}$	-	1.00	1.00	1.00	

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018,, table 29, and converted for use with CSA A23.3 Annex D.

2 See figure 8 of section 3.2.4.3.6.

3 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Bond stress values correspond to concrete compressive strength in the range 2,500 psi ≤ f'_c ≤ 8,000 psi.

7 For structures assigned to Seismic Design Categories C, D, E, or F, bond stress values must be multiplied by $\alpha_{N,seis}$.

Table 83 — Hilti HIT-RE 500-V3 adhesive core drilled and roughened with TE-YRT Roughening Tool factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8]

Thread size	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/2-13 UNC	5 (125)	9,135 (40.6)	10,210 (45.4)	11,185 (49.8)	12,915 (57.5)	18,265 (81.3)	20,420 (90.8)	22,370 (99.5)	25,830 (114.9)
5/8-11 UNC	6-3/4 (170)	14,485 (64.4)	16,195 (72.0)	17,740 (78.9)	20,485 (91.1)	28,970 (128.9)	32,390 (144.1)	35,480 (157.8)	40,970 (182.2)
3/4-10 UNC	8-1/8 (205)	19,180 (85.3)	21,445 (95.4)	23,490 (104.5)	27,125 (120.7)	38,360 (170.6)	42,890 (190.8)	46,985 (209.0)	54,255 (241.3)

Table 84 — Hilti HIT-RE 500 V3 adhesive core drilled and roughened with TE-YRT Roughening Tool factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9]

Thread size	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/2-13 UNC	5 (125)	6,105 (27.2)	6,105 (27.2)	6,105 (27.2)	6,105 (27.2)	12,215 (54.3)	12,215 (54.3)	12,215 (54.3)	12,215 (54.3)
5/8-11 UNC	6-3/4 (170)	10,140 (45.1)	10,255 (45.6)	10,255 (45.6)	10,255 (45.6)	20,280 (90.2)	20,505 (91.2)	20,505 (91.2)	20,505 (91.2)
3/4-10 UNC	8-1/8 (205)	13,425 (59.7)	13,475 (59.9)	13,475 (59.9)	13,475 (59.9)	26,855 (119.5)	26,955 (119.9)	26,955 (119.9)	26,955 (119.9)

[1] See Section 3.1.8 for explanation on development of load values.

[2] See Section 3.1.8 to convert design strength value to ASD value.

[3] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[4] Apply spacing, edge distance, and concrete thickness factors in tables 50 - 51 as necessary to the above values. Compare to the steel values in table 49. The lesser of the values is to be used for the design.

[5] Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

[6] Tabular values are for dry concrete or water-saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.

[7] Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

[8] Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

[9] Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by α_{seis} = 0.75. See section 3.1.8 for additional information on seismic applications.

Table 85 — Steel factored resistance for steel bolt/cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

Thread size	ASTM A193 B7			ASTM A193 Grade B8M Stainless Steel		
	Tensile[4] N_{sar} lb (kN)	Shear[5] V_{sar} lb (kN)	Seismic Shear[6] $V_{sar,eq}$ lb (kN)	Tensile[4] N_{sar} lb (kN)	Shear[5] V_{sar} lb (kN)	Seismic Shear[6] $V_{sar,eq}$ lb (kN)
3/8-16 UNC	5,765 (25.6)	3,215 (14.3)	2,250 (10.0)	5,070 (22.6)	2,825 (12.6)	1,975 (8.8)
1/2-13 UNC	9,635 (42.9)	5,880 (26.2)	4,115 (18.3)	9,290 (41.3)	5,175 (23.0)	3,620 (16.1)
5/8-11 UNC	16,020 (71.3)	9,365 (41.7)	6,555 (29.2)	14,790 (65.8)	8,240 (36.7)	5,770 (25.7)
3/4-10 UNC	16,280 (72.4)	13,860 (61.7)	9,700 (43.1)	21,895 (97.4)	12,195 (54.2)	8,535 (38.0)

[1] See Section 3.1.8 to convert design strength value to ASD value.

[2] Hilti HIS-N and HIS-RN inserts with steel bolts are considered brittle steel elements.

[3] Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.

[4] Tensile = $A_{se,N}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D

[5] Shear = $A_{se,V}\ \phi_s$ 0.60 f_{uta} R as noted in CSA A23.3 Annex D. For 3/8-in diameter insert, shear = $A_{se,V}\ \phi_s$ 0.50 f_{uta} R.

[6] Seismic Shear = $\alpha_{V,seis}\ V_{sar}$: Reduction factor for seismic shear only. See section 3.1.8 for additional information on seismic applications.

POST-INSTALLED REBAR DESIGN IN CONCRETE PER ACI 318

3.2.4.3.8 Development and splicing of post-installed reinforcement

Calculations for post-installed rebar for typical development lengths may be done according to ACI 318 Chapter 25 (formerly ACI 318-11 Chapter 12) and CSA A23.3 Chapter 12 for adhesive anchors tested and approved in accordance with AC 308. This section contains tables for the data provided in ICC Evaluation Services ESR-3814. Refer to section 3.1.14 and the Hilti North America Post-Installed Reinforcing Bar Guide for the design method.

Table 86 — Calculated tension development and Class B Splice lengths for Grade 60 bars in walls, slabs, columns, and footings per ACI 318 Chapter 25 for Hilti HIT-RE 500 V3

Rebar size	$\frac{c_b + K_{tr}}{d_b}$	min. edge dist. in.[1]	min. spacing in.[2]	f'_c = 2,500 psi		f'_c = 3,000 psi		f'_c = 4,000 psi		f'_c = 6,000 psi	
				ℓ_d in.	Class B splice in.	ℓ_d in.	Class B splice in.	ℓ_d in.	Class B splice in.	ℓ_d in.	Class B splice in.
#3	2.5	2-1/4	2	12	14	12	13	12	12	12	12
#4		2-3/4	2-1/2	14	19	13	17	12	15	12	12
#5		3	3-1/4	18	23	16	21	14	18	12	15
#6		3-3/4	3-3/4	22	28	20	26	17	22	14	18
#7		4-1/2	4-1/2	32	41	29	37	25	32	20	26
#8		5	5	36	47	33	43	28	37	23	30
#9		5-1/4	5-3/4	41	53	37	48	32	42	26	34
#10		5-3/4	6-1/2	46	59	42	54	36	47	30	38

1 Edge distances are determined using the minimum cover specified by ESR-3814 with an additional 6% of the development length per suggestions for drilling without an aid per Hilti Post-Installed Reinforcing Bar Guide Section 3.3. Smaller edge distances may be possible, for which development and splice lengths may need to be recalculated. For further information on required cover see ACI 318, Sec. 20.6.1.3.1; see Sec. 2.2 for determination of c_b.

2 Spacing values represent those producing c_b =5 d_b rounded up to the nearest 1/4 in. Smaller spacing values may be possible, for which development and splice lengths may need to be recalculated. For further information on required spacing see ACI 318 Sec. 25.2; see Sec. 2.2 for determination of c_b.

3 ψ_t = 1.0 See ACI 318, Sec. 25.4.2.4.

4 ψ_e = 1.0 for non-epoxy coated bars. See ACI 318, Sec. 25.4.2.4.

5 ψ_s = 0.8 for #6 bars and smaller bars, 1.0 for #7 and larger bars. See ACI 318, Sec. 25.4.2.4.

6 Values are for normal weight concrete. For sand-lightweight concrete, multiply development and splice lengths by 1.18, for all-lightweight concrete multiply development and splice lengths by 1.33. See ACI 318 Sec. 19.2.4.

7 Development and splice length values are for static design. Seismic design development and splice lengths can be found in ACI 318 18.8.5 for special moment frames and ACI 318 18.10.2.3 for special structural walls. For further information about reinforcement in seismic design, see ACI 318 Ch. 18.

8 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples.

Table 87 — Suggested embedment, edge distance, and spacing (see figure below) to develop 125% of f_y in Grade 60 bars based on ACI 318 Chapter 17 - SDC A and B only[1,2,3,4,5,6,7]

Rebar size	f'_c = 2,500 psi				f'_c = 3,000 psi				f'_c = 4,000 psi				f'_c = 6,000 psi			
	Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} in.	Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} in.	Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} in.	Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} in.
		Cond. I	Cond. II			Cond. I	Cond. II			Cond. I	Cond. II			Cond. I	Cond. II	
#3	7	17	8	15	6	16	7	14	6	16	7	13	5	15	6	11
#4	9	23	11	22	9	23	11	21	8	22	10	19	7	20	9	17
#5	11	29	15	29	11	28	14	28	10	27	13	25	9	25	11	22
#6	13	35	19	37	13	34	18	35	12	32	16	32	11	30	14	28
#7	16	41	23	45	15	40	22	43	14	38	20	39	13	36	17	34
#8	18	48	27	54	17	46	26	51	16	44	24	47	15	42	21	41
#9	21	56	32	63	20	54	30	60	18	50	27	54	17	47	24	48
#10	25	65	37	74	24	63	35	70	22	58	32	64	19	54	28	56

1 For additional information see May-June 2013 issue of the ACI Structural Journal, "Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures" by Charney, Pal and Silva.

2 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Bond stresses apply for sustained and non-sustained load conditions. Additional reductions per ACI 318, 17.3.1.2 are not included, however, and as such these embedments are not intended for sustained tension load applications. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the unbolded and bolded tabulated hef values by 0.80 and 0.86, respectively. Reduction factors for non-sustained loading and no bar overstrength may be combined.

3 c_a and s are the minimum edge distance and bar spacing (from bar centerline) associated with the tabulated embedments. Refer to sec. 3.1.14 for applicability of edge distance "Condition I" and "Condition II."

4 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

5 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814 Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

6 Values are for normal weight concrete. For lightweight concrete contact Hilti.

7 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

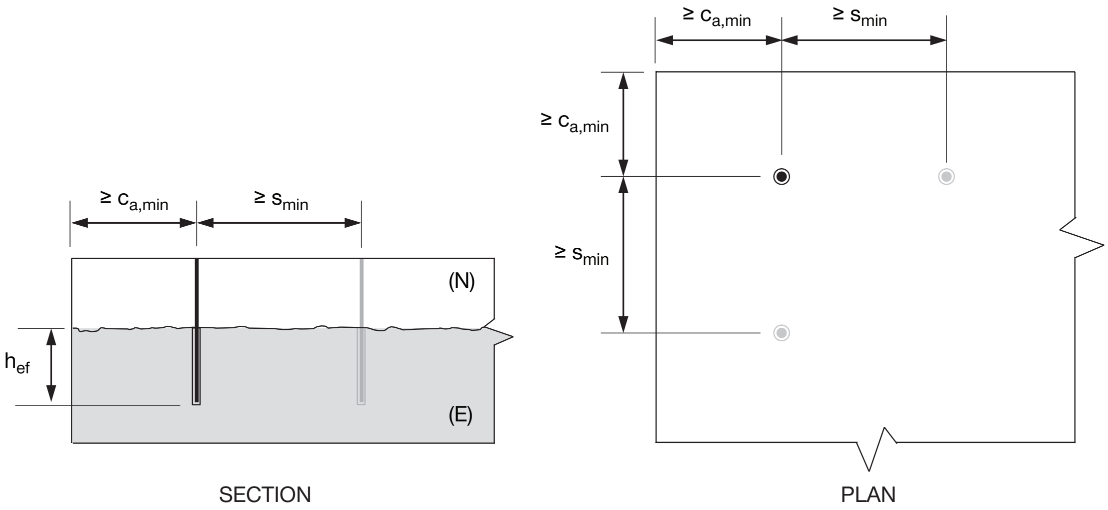


Illustration of Table 87 dimensions

Table 88 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of f_y in Grade 60 wall/column starter bars in a linear array with bar spacing = 24 inches - SDC A and B only[1,2,3,4,5,6]

		f'_c = 2,500 psi			f'_c = 3,000 psi			f'_c = 4,000 psi			f'_c = 6,000 psi		
		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.	
Rebar size	Linear spacing s in.		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II
#3	24	7	17	8	6	16	7	6	16	7	5	15	6
#4		9	23	11	9	23	11	8	22	10	7	20	9
#5		13	34	19	11	30	17	10	27	13	9	25	11
#6		21	57	32	19	51	28	15	43	23	11	32	17
#7		-	-	-	-	-	-	24	66	35	18	52	27

1 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

2 c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 24 in. Refer to sec. 3.1.14.3 for applicability of edge distance "Condition I" and "Condition II."

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814 Tables 12 and 13 assuming dry concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for detailed explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

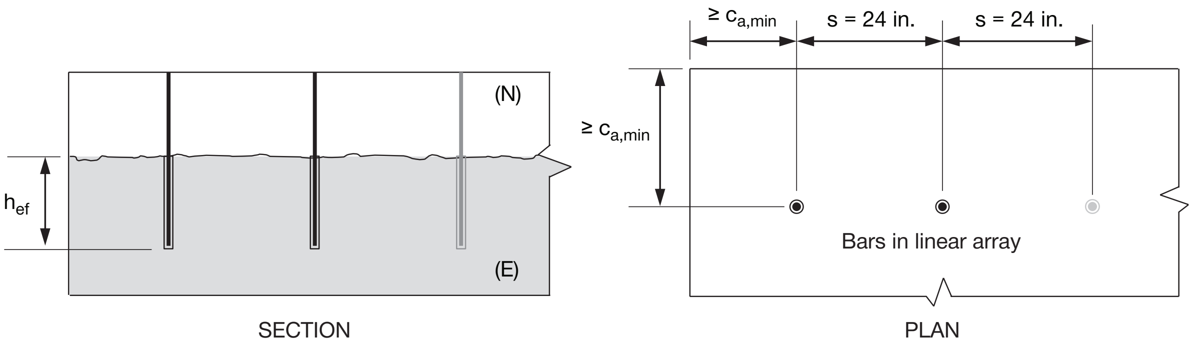


Illustration of Table 88 dimensions

Table 89 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of fy in Grade 60 wall/column starter bars in a linear array with bar spacing = 18 inches - SDC A and B only[1,2,3,4,5,6]

		f'_c = 2,500 psi			f'_c = 3,000 psi			f'_c = 4,000 psi			f'_c = 6,000 psi		
		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.	
Rebar size	Linear spacing s in.		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II
#3	18	7	17	8	6	16	7	6	16	7	5	15	6
#4		10	26	14	9	23	13	8	22	10	7	20	9
#5		–	–	–	–	–	–	13	36	19	10	28	14

1 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

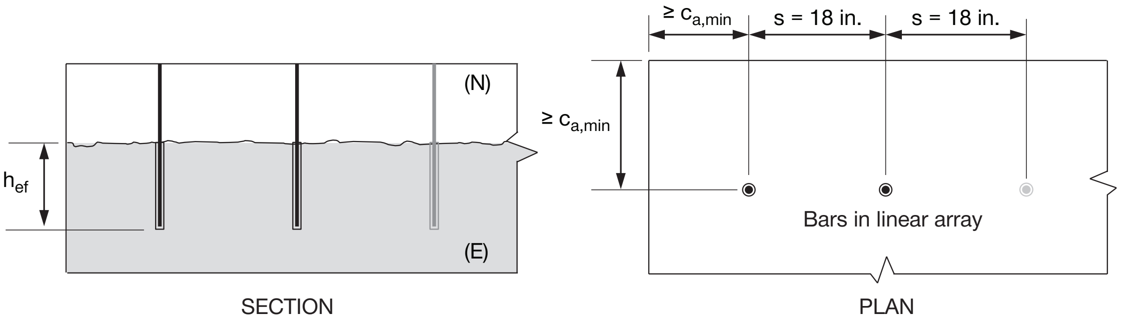
2 c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 18 in. Refer to sec. 3.1.14.3 for applicability of edge distance "Condition I" and "Condition II."

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814 Tables 12 and 13 assuming dry concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for detailed explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.



SECTION

PLAN

Illustration of Table 89 dimensions

Table 90 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of f_y in Grade 60 wall/column starter bars in a linear array with bar spacing = 12 inches - SDC A and B only[1,2,3,4,5,6]

Rebar size	Linear spacing s in.	f'_c = 2,500 psi			f'_c = 3,000 psi			f'_c = 4,000 psi			f'_c = 6,000 psi		
		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.		Effective embed. h_{ef} in.	Minimum edge dist $c_{a,min}$ in.	
			Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II
#3	12	7	17	10	6	16	9	6	16	7	5	15	6
#4		–	–	–	–	–	–	11	31	16	8	24	12

[1] h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

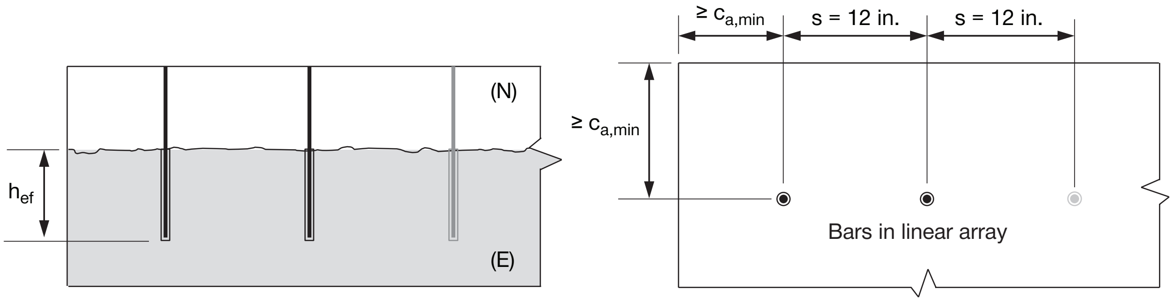
[2] c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 12 in. Refer to sec. 3.1.14.3 for applicability of edge distance "Condition I" and "Condition II."

[3] Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

[4] Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814 Tables 12 and 13 assuming dry concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

[5] Values are for normal weight concrete. For lightweight concrete contact Hilti.

[6] Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for detailed explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.



SECTION

PLAN

Illustration of Table 90 dimensions

Table 91 — Calculated tension development and Class B Splice lengths for Canadian 400 MPa bars in walls, slabs, columns, and footings per CSA 23.3-14 for Hilti HIT-RE 500 V3 - non-seismic design only[3,4,5,6,7,8]

Rebar size	$d_{cs} + K_{tr}$	min. edge dist. mm[1]	min. spacing mm[2]	f'_c = 20 MPa		f'_c = 25 MPa		f'_c = 30 MPa		f'_c = 40 MPa	
				ℓ_d mm	Class B splice mm	ℓ_d mm	Class B splice mm	ℓ_d mm	Class B splice mm	ℓ_d mm	Class B splice mm
10M	$2.5\ d_b$	60	50	300	380	300	340	300	310	300	300
15M		70	75	410	540	370	480	340	440	300	380
20M		80	100	510	660	450	490	410	540	360	460
25M		120	125	820	1,060	730	950	670	870	580	750
30M		130	150	960	1,250	860	1,120	790	1,020	680	890

1 Edge distances are determined using the minimum cover specified by ESR-3184 with an additional 6% of the development length per suggestions for drilling without an aid per Hilti Post-Installed Reinforcing Bar Guide Section 3.3. Smaller edge distances may be possible, for which development and splice lengths may need to be recalculated. For further information on required cover see CSA A23.1-14 Table 17; see Sec. 3.2 for determination of d_{cs}.

2 Spacing values represent those producing $d_{cs} = 5d_b$. Smaller spacing values may be possible, for which development and splice lengths may need to be recalculated. For further information on required spacing see CSA A23.1 Sec. 6.6.5.2; see Sec. 3.2 for determination of d_{cs}.

3 k_1 and k_2 as defined by CSA A23.3 12.2.4 (a) and (b), are taken as 1.0 for post-installed reinforcing bars. For additional information see May-June 2013 issue of the ACI Structural Journal, “Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures” by Charney, Pal and Silva.

4 k_4 = 0.8 for 20M bars and smaller bars, 1.0 for 25M and larger bars. See CSA A23.3 12.2.4 (d).

5 K_{tr} is assumed to equal zero.

6 Values are for normal weight concrete. For lightweight concrete, multiply development and splice lengths by 1.3.

7 Development and splice length values are for static design. For tension development and splice lengths of bars in joints, see CSA A23.3 21.3.3.5. For further information about reinforcement in seismic design, see CSA A23.3 Ch. 21.

8 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples.

Table 92 — Suggested embedment, edge distance, and spacing (see figure below) to develop 125% of f_y in Canadian 400 MPa bars based on CSA 23.3-14 Annex D - non-seismic design only[1,2,3,4,5,6,7]

Rebar size	f'_c = 20 MPa				f'_c = 25 MPa				f'_c = 30 MPa				f'_c = 40 MPa			
	Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} mm	Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} mm	Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} mm	Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ in.		Min. spacing s_{min} mm
		Cond. I	Cond. II			Cond. I	Cond. II			Cond. I	Cond. II			Cond. I	Cond. II	
10M	180	480	220	440	170	470	200	400	160	450	190	380	150	430	180	350
15M	260	690	350	690	240	670	320	640	230	650	300	600	220	620	280	550
20M	310	850	450	900	300	820	420	840	280	800	400	790	270	760	360	720
25M	420	1,140	630	1,260	400	1,080	590	1,170	380	1,050	560	1,110	350	1,000	500	1,000
30M	530	1,420	790	1,580	490	1,340	740	1,470	460	1,280	690	1,380	420	1,200	630	1,260

1 For additional information see May-June 2013 issue of the ACI Structural Journal, “Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures” by Charney, Pal and Silva.

2 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.3 to develop 125% of nominal bar yield. Bond stresses apply for sustained and non-sustained load conditions. Additional reductions per ACI 318, 17.3.1.2 are not included, however, and as such these embedments are not intended for sustained tension load applications. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the unbolded and bolded tabulated hef values by 0.80 and 0.86, respectively. Reduction factors for non-sustained loading and no bar overstrength may be combined.

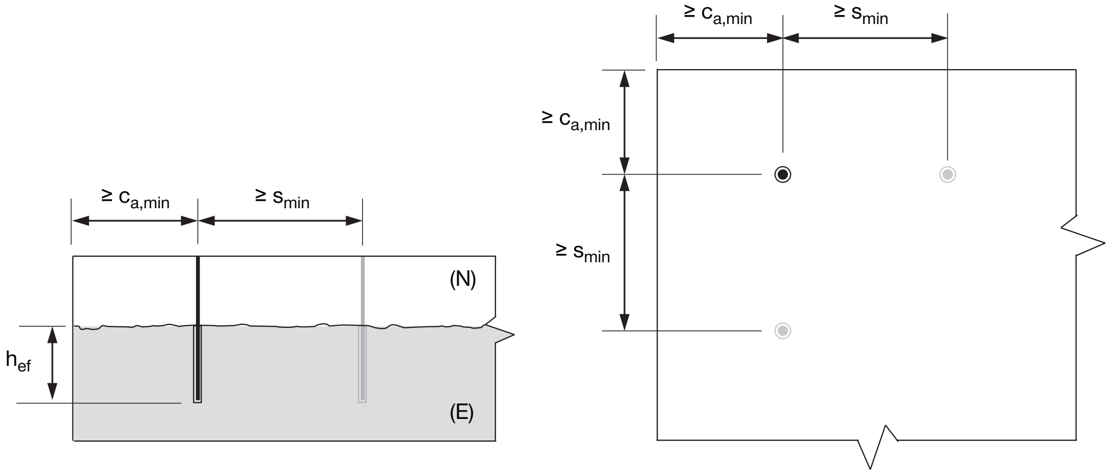
3 c_a and s are the minimum edge distance and bar spacing (from bar centerline) associated with the tabulated embedments. Refer to sec. 3.1.14.3 for applicability of edge distance “Condition I” and “Condition II.”

4 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

5 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814 Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

6 Values are for normal weight concrete. For lightweight concrete contact Hilti.

7 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.



SECTION

PLAN

Illustration of Table 91 dimensions

Table 93 — Suggested embedment and edge distance (see figure below) based on CSA 23.3 Annex D to develop 125% of f_y in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 600 mm - non-seismic only[1,2,3,4,5]

Rebar size	Linear spacing s mm	f'_c = 20 MPa			f'_c = 25 MPa			f'_c = 30 MPa			f'_c = 40 MPa		
		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm	
			Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II
10M	600	180	480	220	170	470	200	160	450	190	150	430	180
15M		280	760	420	240	670	350	230	650	300	220	620	280
20M		-	-	-	430	1,220	650	380	1,080	570	310	890	460

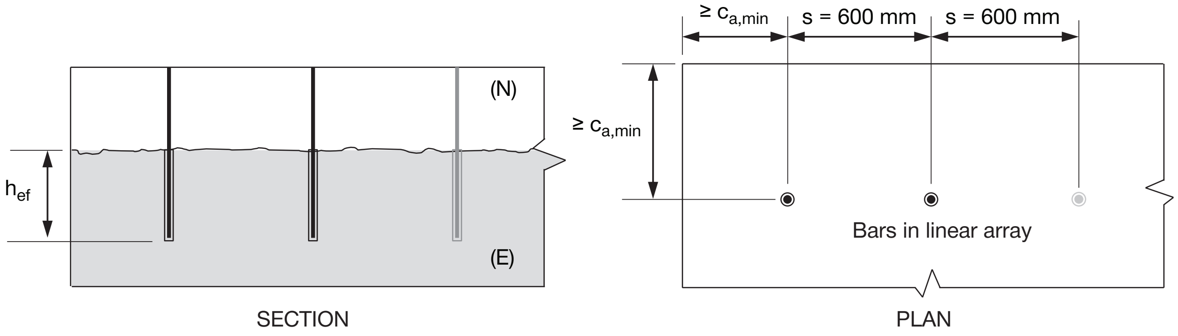
1 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

2 c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 600 mm. Refer to sec. 3.1.14.3 for applicability of edge distance “Condition I” and “Condition II.”

3 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

4 Values are for normal weight concrete. For lightweight concrete contact Hilti.

5 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.



SECTION PLAN

Illustration of Table 93 dimensions

Table 94 — Suggested embedment and edge distance (see figure below) based on CSA 23.3 Annex D to develop 125% of f_y in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 450 mm - non-seismic only[1,2,3,4,5]

Rebar size	Linear spacing s mm	f'_c = 20 MPa			f'_c = 25 MPa			f'_c = 30 MPa			f'_c = 40 MPa		
		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm		Effective embed. h_{ef} mm	Minimum edge dist $c_{a,min}$ mm	
			Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II		Cond. I	Cond. II
10M	450	180	480	220	170	470	200	160	450	190	150	430	180
15M		400	1,090	590	340	950	510	300	840	440	240	690	360

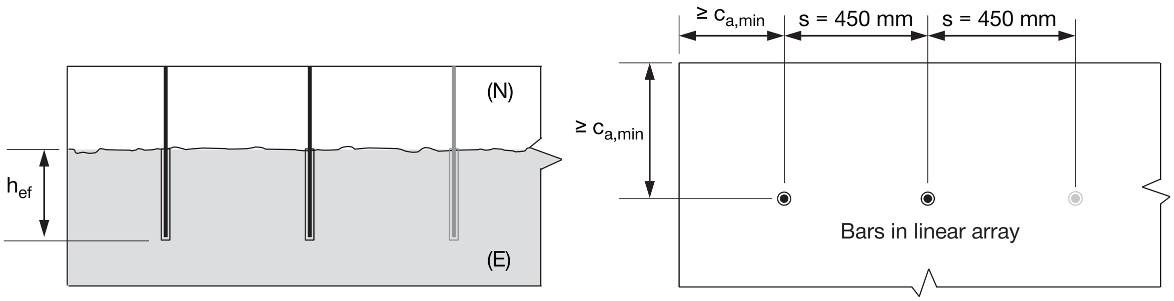
[1] h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

[2] c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 450 mm. Refer to sec. 3.1.14.3 for applicability of edge distance “Condition I” and “Condition II.”

[3] Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

[4] Values are for normal weight concrete. For lightweight concrete contact Hilti.

[5] Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.



SECTION

PLAN

Illustration of Table 94 dimensions

Table 95 — Suggested embedment and edge distance (see figure below) based on CSA 23.3 Annex D to develop 125% of f_y in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 300 mm - non-seismic only[1,2,3,4,5]

		f'_c = 20 MPa			f'_c = 25 MPa			f'_c = 30 MPa			f'_c = 40 MPa		
			Minimum edge dist $c_{a,min}$ mm			Minimum edge dist $c_{a,min}$ mm			Minimum edge dist $c_{a,min}$ mm			Minimum edge dist $c_{a,min}$ mm	
Rebar size	Linear spacing s mm	Effective embed. h_{ef} mm	Cond. I	Cond. II	Effective embed. h_{ef} mm	Cond. I	Cond. II	Effective embed. h_{ef} mm	Cond. I	Cond. II	Effective embed. h_{ef} mm	Cond. I	Cond. II
10M	300	240	650	350	200	560	300	180	500	260	160	450	210

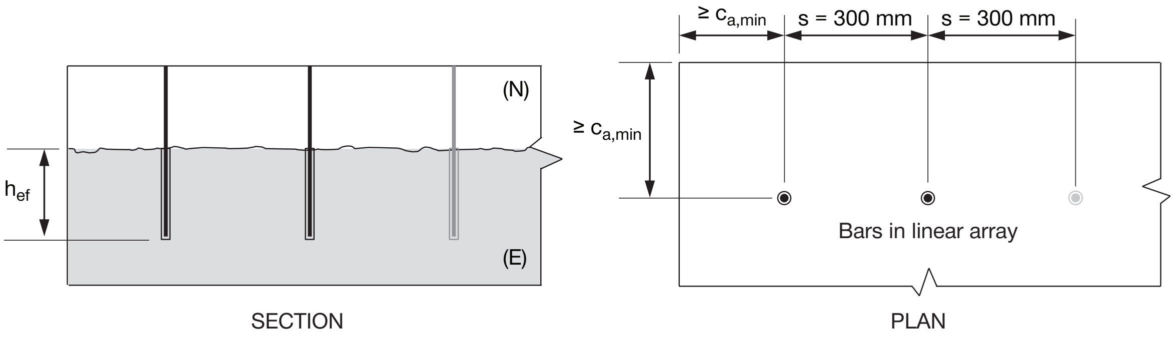
1 h_{ef} is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

2 c_a is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 300 mm. Refer to sec. 3.1.14.3 for applicability of edge distance “Condition I” and “Condition II.”

3 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

4 Values are for normal weight concrete. For lightweight concrete contact Hilti.

5 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.



SECTION PLAN

Illustration of Table 95 dimensions

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

MATERIAL SPECIFICATIONS

Figure 9 — Hilti HIT-RE 500 V3 adhesive cure and working time (approx.)

[°F]	[°C]	t_{work}	$t_{cure, ini}$	$t_{cure, full}$
23	-5	2 h	48 h	168 h
32	0	2 h	24 h	36 h
40	4	2 h	16 h	24 h
50	10	1.5 h	12 h	16 h
60	16	1 h	8 h	16 h
72	22	25 min	4 h	6.5 h
85	29	15 min	2.5 h	5 h
95	35	12 min	2 h	4.5 h
105	41	10 min	2 h	4 h

≥ +5 °C / 41 °F

= 2x t_{cure}

Table 96 — Resistance of cured Hilti HIT-RE 500 V3 to chemicals

Chemicals tested	Content (%)	Resistance
toluene	47.5	+
iso-octane	30.4	
heptane	17.1	
methanol	3	
butanol	2	
toluene	60	+
xylene	30	
methylnaphthalene	10	
diesel	100	+
petrol	100	+
methanol	100	–
dichloromethane	100	–
mono-chlorobenzene	100	●
ethylacetat	50	+
methylisobutylketone	50	
salicylic acid-methylester	50	+
mcetophenon	50	
acetic acid	50	–
propionic acid	50	
sulfuric acid	100	–
nitric acid	100	–
hyrdocholoric acid	36	–
potassium hydroxide	100	–
sodium hydroxide 20%	100	–
triethanolamine	50	–
butylamine	50	
benzyl alcohol	100	–
ethanol	100	
ethyl acetate	100	
methyl ethly ketone (MEK)	100	
trichlorethylene	100	
lutensit TC KLC 50	3	+
marlophen NP 9,5	2	
water	95	
tetrahydrofurane	100	–
demineralized water	100	+
salt water	saturated	+
salt spray testing	–	+
SO_2	–	+
environment/weather	–	+
oil for formwork (forming oil)	100	+
concrete plasticizer	–	+
concrete drilling mud	–	+
concrete potash solution	–	+
saturated suspension of bore-hole cuttings	–	+

Key:
– non-resistant
+ resistant
● limited resistance

Samples of the HIT-HY 200 A/R V3 adhesive were immersed in the various chemical compounds for up to one year. At the end of the test period, the samples were analyzed. Any samples showing no visible damage and having less than a 25% reduction in bending (flexural) strength were classified as "Resistant." Samples that had slight damage, such as small cracks, chips, etc. or reduction in bending strength of 25% or more were classified as "Limited Resistance" (i.e. exposed for 48 hours or less until chemical is cleaned up). Samples that were heavily damaged or destroyed were classified as "Non-Resistant."

Note: In actual use, the majority of the adhesive is encased in the base material, leaving very little surface area exposed.

ORDERING INFORMATION

HIT-RE 500 V3

Description	Package contents	Qty
HIT-RE 500 V3 (11.1 fl oz/330 ml)	Includes (1) foil pack with (1) mixer and 3/8 filler tube per pack	1
HIT-RE 500 V3 Master Carton (11.1 fl oz/330 ml)	Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack	25
HIT-RE 500 V3 Combo (11.1 fl oz/330 ml)	Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 Manual Dispenser	25
HIT-RE 500 V3 Master Carton (16.9 fl oz/500 ml)	Includes (1) master carton containing (20) foil packs with (1) mixer and 3/8 filler tube per pack	20
HIT-RE 500 V3 Combo (16.9 fl oz/500 ml)	Includes (2) master cartons containing (20) foil packs each with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 Manual Dispenser	40
HIT-RE 500 V3 (47.3 fl oz/1400 ml)	Includes (4) foil packs with (1) mixer and 3/8 filler tube per pack	4
HIT-RE 500 V3 Pallet (47.3 fl oz/1400 ml)	Includes (64) foil packs with (1) mixer and 3/8 filler tube per pack and (1) P800 Pneumatic Dispenser	64
HIT-RE 500 V3 TE-CD Starter Package	Includes foil packs, dispensers, vacuum, hammer drill and various drill bit sizes. Contact Hilti for exact package contents.	40
HIT-RE 500 V3 TE-YD Starter Package	Includes foil packs, dispensers, vacuum, hammer drill and various drill bit sizes. Contact Hilti for exact package contents.	40
HIT-RE-M Static Mixer For use with HIT-RE 500 V3 cartridges		1

TE-YRT Roughening Tool

Order description	Description	Length
TE-YRT 7/8" x 15"	Roughening tool for use with 3/4" diameter threaded rod in core drilled holes	15"
TE-YRT 1-1/8" x 20	Roughening tool for use with 1" diameter threaded rod in core drilled holes	20"
TE-YRT 1-3/8" x 25"	Roughening tool for use with 1-1/4" diameter threaded rod in core drilled holes	25"
RTG 7/8"	Roughening tool gauge for TE-YRT 7/8"	
RTG 1-1/8"	Roughening tool gauge for TE-YRT 1-1/8"	
RTG 1-3/8"	Roughening tool gauge for TE-YRT 1-3/8"	

TE-CD Hollow Drill Bits

Order description	Working length
Hollow Drill Bit TE-CD 1/2" x 13"	8"
Hollow Drill Bit TE-CD 9/16" x 14"	9-1/2"
Hollow Drill Bit TE-CD 5/8" x 14"	9-1/2"
Hollow Drill Bit TE-CD 3/4" x 14"	9-1/2"

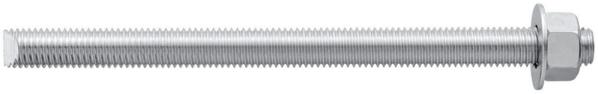
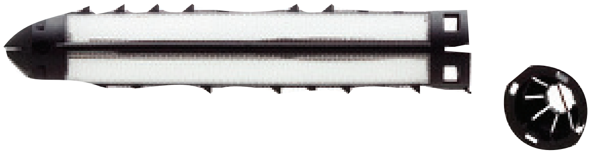
TE-YD Hollow Drill Bits

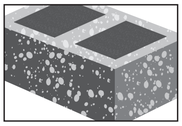
Order description	Working length
Hollow drill bit TE-YD 5/8" x 24"	15-3/4"
Hollow drill bit TE-YD 3/4" x 24"	15-3/4"
Hollow drill bit TE-YD 7/8" x 24"	15-3/4"
Hollow drill bit TE-YD 1" x 24"	15-3/4"
Hollow drill bit TE-YD 1-1/8" x 24"	15-3/4"
Hollow drill bit TE-YD 5/8" x 35"	26"
Hollow drill bit TE-YD 3/4" x 35"	26"
Hollow drill bit TE-YD 7/8" x 35"	26"
Hollow drill bit TE-YD 1" x 35"	26"
Hollow drill bit TE-YD 1-1/8" x 47"	39"

3.2.4 HIT-HY 270 HYBRID FOR MASONRY CONSTRUCTION

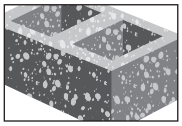
PRODUCT DESCRIPTION

HIT-HY 270 with Threaded Rod, Rebar, and HIS-N/RN Inserts

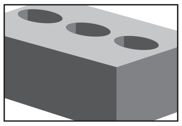
Anchor System		Features and Benefits
	Hilti HIT-HY 270 Cartridge	- Injectable two-component hybrid adhesive mortar - For use in grouted and ungrouted concrete masonry block walls, solid and hollow brick walls and unreinforced multi-wythe brick walls referred to as unreinforced masonry or URM. - ICC-ES approved for grout-filled and ungrouted concrete masonry and hollow brick - ICC-ES approved for unreinforced masonry (URM) - No hole cleaning requirement when installed with SafeSet™ hollow drill bit technology
	Hilti HAS Threaded Rods	
	Rebar	
	Mesh sleeve HIT-SC	
	Hilti HIS-N/RN	



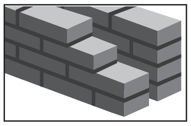
Grout-filled concrete masonry



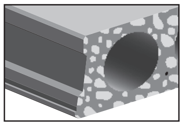
Ungrouted concrete masonry



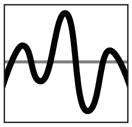
Hollow brick



Unreinforced masonry



Hollowcore concrete



Seismic Design categories A-F

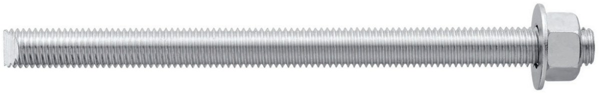
SAFESET

Hollow drill bit

Approvals/Listings	
ICC-ES (International Code Council)	ESR-4143 in hollow and grout-filled CMU and hollow brick per ICC-ES AC58 ESR-4144 in unreinforced masonry per ICC-ES AC60
European Technical Approval	ETA-13/1036
City of Los Angeles	2017 LABC Supplement (within ESR-4143 and ESR-4144)
Florida Building Code	2017 FBC Supplement (within ESR-4143) w/ HVHZ
U.S. Green Building Council	LEED® Credit 4.1-Low Emitting Materials

DESIGN DATA IN MASONRY

HIT-HY 270 adhesive with Hilti HAS threaded rods and deformed reinforcing bars (Rebar)



Hilti HAS Threaded Rods

Deformed Reinforcing Bars (Rebar)

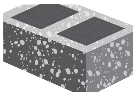
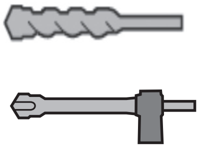
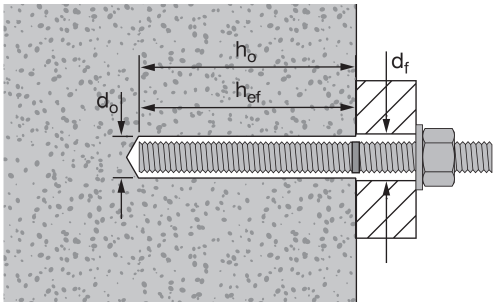
Permissible Base Materials			Permissible drilling method		
Permissible Base Materials		Grout-filled concrete masonry	Permissible drilling method		Hammer drilling with carbide tipped drill bit Hilti TE-CD or TE-YD hollow drill bit (for diameters 1/2" - 3/4")

Figure 1 — Hilti HIT-HY 270 specifications for HAS threaded rod and reinforcing bars in grout-filled concrete masonry walls



Hilti installation specifications for HAS threaded rod in grout-filled concrete masonry walls

Setting information	Symbol	Units	Nominal rod diameter (in.)			
			3/8	1/2	5/8	3/4
Nominal bit diameter	d_o	in.	7/16	9/16	3/4	7/8
Nominal / effective embedment	h_o / h_{ef}	in. (mm)	3-3/8 (86)	4-1/2 (114)	5-5/8 (143)	6-3/4 (171)
Maximum installation torque	T_{inst}	ft-lb (Nm)	6 (8)	7.5 (10)	7.5 (10)	10 (13.5)
Diameter of fixture hole	d_f	in.	7/16	9/16	11/16	13/16

Hilti installation specifications for reinforcing bars in grout-filled concrete masonry walls

Setting information	Symbol	Units	Rebar size			
			#3	#4	#5	#6
Nominal bit diameter	d_o	in.	1/2	5/8	3/4	7/8
Nominal / effective embedment	h_o / h_{ef}	in. (mm)	3-3/8 (86)	4-1/2 (114)	5-5/8 (143)	6-3/4 (171)

MATERIAL SPECIFICATIONS

Table 1 — Properties of fully-cured HIT-HY 270 adhesive

Compressive strength	ASTM D695/DIN 53454	7,252-10,153 psi	50-70 MPa
Modulus of elasticity (Compression test)	ASTM D790/DIN 53452	246,568 psi	1,700 MPa
Water absorption	ASTM D570/DIN 53495	3 - 8%	
Electrical resistance	VDE/DIN 0303T3	4.2 x 10^{11} ohm/in.	1.065 x 10^{12} ohm/cm

Material specifications for Hilti HAS threaded rods and Hilti HIS-N inserts are listed in section 3.2.8.

Table 2 — Hilti HIT-HY 270 allowable adhesive bond tension loads for threaded rods and reinforcing bars in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]

				Spacing[9]			Edge distance[10]		
Nominal anchor diameter	Rebar size	Effective embedment in. (mm)[11]	Tension lb (kN)	Critical s_{cr} in. (mm)	Minimum s_{min} in. (mm)	Load reduction factor @ s_{min}[12]	Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load reduction factor @ c_{min}[12]
3/8	#3	3-3/8 (86)	1,240 (5.5)	13.5 (343)	4 (102)	0.70	12 (305)	4 (102)	0.80
1/2	#4	4-1/2 (114)	2,035 (9.1)	18 (457)		0.70	20 (508)		0.76
5/8	#5	5-5/8 (143)	2,840 (12.6)	22.5 (572)		0.50	20 (508)		0.71
3/4	#6	6-3/4 (171)	3,810 (16.9)	27 (686)		0.50	20 (508)		0.66

Table 3 — Hilti HIT-HY 270 allowable adhesive bond shear loads for threaded rods and reinforcing bars in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]

				Spacing[9]			Edge distance[10]			
									Load reduction factor @ c_{min}[12]	
Nominal anchor diameter	Rebar size	Effective embedment in. (mm)[11]	Shear lb (kN)	Critical s_{cr} in. (mm)	Minimum s_{min} in. (mm)	Load reduction factor @ s_{min}[12]	Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load perpendicular to edge	Load parallel to edge
3/8	#3	3-3/8 (86)	850 (3.8)	13.5 (343)	4 (102)	1.00	12 (305)	4 (102)	0.88	1.00
1/2	#4	4-1/2 (114)	1,495 (6.7)	18 (457)		1.00	12 (305)		0.49	1.00
5/8	#5	5-5/8 (143)	2,615 (11.6)	22.5 (572)		0.50	20 (508)		0.40	0.78
3/4	#6	6-3/4 (171)	4,090 (18.2)	27 (686)		0.50	20 (508)		0.26	0.60

The following footnotes apply to both Tables 1 and 2:

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

2 Anchors may be installed in any location in the face of the masonry wall including cell, web, and mortar joints. Anchors are limited to one per masonry cell. See Figure 2

3 Linear interpolation of load values between minimum spacing (s_{min}) and critical spacing (s_{cr}) and between minimum edge distance (c_{min}) and critical edge distance (c_{cr}) is permitted.

4 Concrete masonry thickness must be equal to or greater than 1.5 times the anchor embedment depth. EXCEPTION: the 5/8-inch- and the 3/4-inch diameter anchors (No. 5 and No. 6 bars) may be installed in minimum nominally 8-inch thick concrete masonry.

5 When using the basic load combinations in accordance with IBC Section 1605.3.1, tabulated allowable loads must not be increased for seismic or wind loading. When using the alternative basic load combinations in IBC Section 1605.3.2 that include seismic or wind loads, tabulated allowable loads may be increased by 33-1/3 percent, or the alternative basic load combinations may be reduced by a factor of 0.75.

6 Allowable loads must be the lesser of the adjusted masonry or bond tabulated values and the steel values given in tables 3 and 4.

7 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 13.

8 For combined loading: $(T_{applied} / T_{allowable})^n + (V_{applied} / V_{allowable})^n \leq 1$ where n = 5/3 for 3/8- and 1/2-inch diameters (#3 and #4 rebar) and n = 1 for 5/8- and 3/4-inch diameters (#5 and #6 rebar).

9 The critical spacing, s_{cr}, is the anchor spacing where full load values may be used. The minimum spacing, s_{min}, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

10 The critical edge distance, c_{cr}, is the edge distance where full load values may be used. The minimum edge distance, c_{min}, is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to the closest edge.

11 Embedment depth is measured from the outside face of the concrete masonry unit.

12 Load reduction factors are multiplicative: both spacing and edge distance load reduction factors, and spacing and edge distances for all adjacent anchors/ edges less than s_{cr}/c_{cr},must be considered. Load values for anchors installed at less than scr and c_{cr} must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

Table 4 — Allowable steel strength for Hilti HAS threaded rods [1]

Nominal anchor diameter in.	ASTM A307 Grade A		HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr. 36 [2]		HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55 [2]		HAS-B-105 and HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr. 105 [2]		HAS-R Stainless Steel ASTM F593 (3/8-in to 1-in) ASTM A193 (1/4 and 1-1/8-in to 2-in)	
	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
1/4	970	500	-	-	-	-	-	-	925	475
	(4.3)	(2.2)	-	-	-	-	-	-	(4.1)	(2.1)
5/16	1,520	780	-	-	-	-	-	-	1,445	745
	(6.8)	(3.5)	-	-	-	-	-	-	(6.4)	(3.3)
3/8	-	-	2,115	1,090	2,730	1,410	4,555	2,345	3,645	1,875
	-	-	(9.4)	(4.8)	(12.1)	(6.3)	(20.3)	(10.4)	(16.2)	(8.3)
1/2	-	-	3,755	1,935	4,860	2,505	8,095	4,170	6,480	3,335
	-	-	(16.7)	(8.6)	(21.6)	(11.1)	(36.0)	(18.5)	(28.8)	(14.8)
5/8	-	-	5,870	3,025	7,595	3,910	12,655	6,520	10,125	5,215
	-	-	(26.1)	(13.5)	(33.8)	(17.4)	(56.3)	(29.0)	(45.0)	(23.2)
3/4	-	-	8,455	4,355	10,935	5,635	18,225	9,390	12,390	6,385
	-	-	(37.6)	(19.4)	(48.6)	(25.1)	(81.1)	(41.8)	(55.1)	(28.4)

1 Steel strength as defined in AISC Manual of Steel Construction (ASD):
Tensile = 0.33 x F_u x Nominal Area
Shear = 0.17 x F_u x Nominal Area

2 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

Table 5 — Hilti HIT-HY 270 allowable tension and shear values for reinforcing bars based on steel strength[1,2,3]

Rebar size	Tension lb (kN)	Shear lb (kN)
	ASTM A615, GRADE 60	ASTM A615, GRADE 60
#3	2,905	1,495
	(12.9)	(6.7)
#4	5,280	2,720
	(23.5)	(12.1)
#5	8,185	4,215
	(36.4)	(18.7)
#6	11,615	5,985
	(51.7)	(26.6)

The following footnotes apply to both Tables 3 and 4:
1 Allowable load used in the design must be the lesser of bond values and tabulated steel values.
2 The allowable tension and shear values for threaded rods to resist short term loads, such as wind or seismic, must be calculated in accordance with the appropriate IBC Sections.
3 Allowable steel loads are based on tension and shear stresses equal to 0.33 x F_u and 0.17 x F_u , respectively.

Figure 2 — Allowable anchor installation locations in the face of grout-filled concrete block

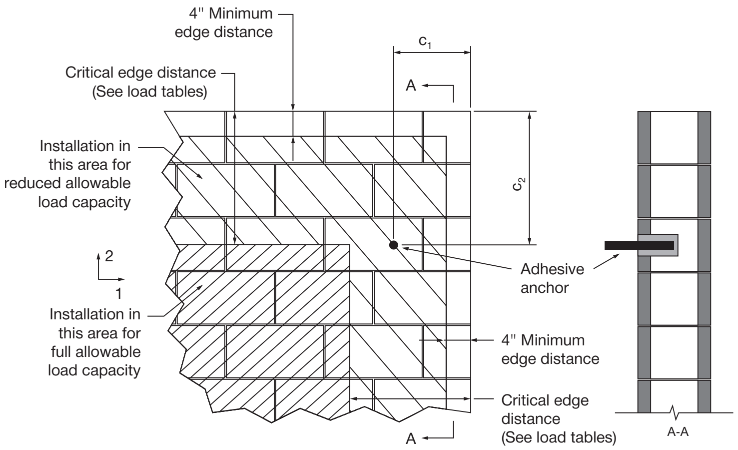


Table 6 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods and reinforcing bars in the top of grout-filled concrete masonry walls[1,2,4,5,6,7,8]

Nominal anchor diameter or rebar size	Effective embedment in. (mm)	Edge distance in. (mm)	End distance in. (mm)	Spacing		Tension load[9]		Shear load[9]		
				Critical s_{cr} in. (mm)	Minimum s_{min} in. (mm)	@ s_{cr} lb (kN)	Reduction factor @ s_{min}	Parallel to edge of masonry wall @ s_{cr} lb (kN)	Perpendicular to edge of masonry wall @ s_{cr} lb (kN)	Reduction Factor @ s_{min}
1/2[3]	4-1/2 (114)	1-3/4 (44)	8 (203)	16 (406)	3 (76)	1,165 (5.2)	0.57	815 (3.6)	345 (1.5)	0.50
		4 (102)				1,625 (7.2)	0.50	1,445 (6.4)	505 (2.2)	0.50
5/8[3]	5-5/8 (143)	1-3/4 (44)				1,165 (5.2)	0.58	1,190 (5.3)	385 (1.7)	0.50
		4 (102)				1,590 (7.1)	0.50	1,825 (8.1)	655 (2.9)	0.50
3/4[3]	6-3/4 (171)	2-3/4 (70)				1,020 (4.5)	0.74	1,405 (6.3)	425 (1.9)	0.59
#4[10]	4-1/2 (114)	1-3/4 (44)		16 (406)	16 (406)	865 (3.8)	1.00	635 (2.8)	245 (1.1)	1.00
#5[10]	5-5/8 (143)					980 (4.4)		755 (3.4)	295 (1.3)	

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

2 When using the basic load combinations in accordance with IBC Section 1605.3.1, or the alternative basic load combinations in IBC Section 1605.3.2, tabulated allowable loads must not be increased for seismic or wind loading.

3 One anchor shall be permitted to be installed in each cell.

4 Anchors are not permitted to be installed in a head joint, flange or web of the concrete masonry unit.

5 Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in tables 3 and 4.

6 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 13.

7 For combined loading: $(T_{applied} / T_{allowable})^n + (V_{applied} / V_{allowable})^n \leq 1$ where n = 5/3 for 1/2-inch diameters (#4 rebar) and n = 1 for 5/8-inch diameters (#5 rebar).

8 The tabulated edge distance is measured from the anchor centerline to the edge of the concrete block. See figure 3.

9 Linear interpolation of load values between the two tabulated edge distances is permitted.

10 One anchor shall be permitted to be installed in each concrete block.

Figure 3 — Edge and end distances for threaded rods and reinforcing bars installed in the top of grout-filled CMU

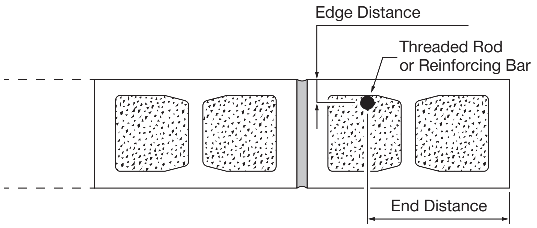


Table 7 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods and reinforcing bars in the side of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]

Nominal anchor diameter or rebar size	Effective embedment in. (mm)	Minimum edge distance in. (mm)	Minimum end distance in. (mm)	Tension lb (kN)	Shear load, lb (kN)	
					Load parallel to edge of masonry wall	Load perpendicular to edge of masonry wall
1/2	4-1/2 (114)	1-3/4 (44)	8 (203)	990 (4.4)	885 (3.9)	255 (1.1)
5/8	5-5/8 (143)			1,200 (5.3)	1,220 (5.4)	330 (1.5)
3/4	5-5/8 (143)	2-3/4 (70)		1,200 (5.3)	1,770 (7.9)	530 (2.4)
#4	4-1/2 (114)	1-3/4 (44.5)		1,055 (4.7)	835 (3.7)	255 (1.1)
#5	5-5/8 (143)			1,160 (5.2)	990 (4.4)	275 (1.2)

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

2 When using the basic load combinations in accordance with IBC Section 1605.3.1 or the alternative basic load combinations in IBC Section 1605.3.2. Tabulated allowable loads must not be increased for seismic or wind loading.

3 One anchor shall be permitted to be installed in each concrete block.

4 Anchors are not permitted to be installed in mortar joint of the concrete masonry unit.

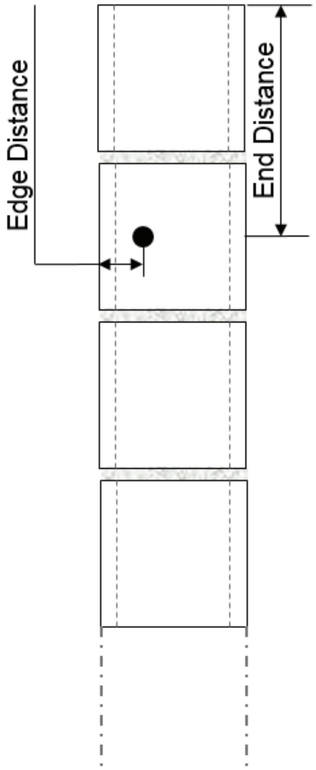
5 Allowable loads must be the lesser of bond tabulated values and the steel values given in tables 3 and 4.

6 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 13.

7 Anchors installed on the side of the wall, shall have minimum of 16" vertical spacing.

8 For combined loading: $(T_{applied}/T_{allowable}) + (V_{applied}/V_{allowable}) \le 1$, where n = 5/3 for 1/2-inch diameters (#4 rebar) and n=1 for 5/8-inch diameter or #5 and #6 rebar.

Figure 4 — Edge and end distances for threaded rods and reinforcing bars installed in the side of grout-filled CMU



HIT-HY 270 adhesive with Hilti HIS-N and HIS-RN internally threaded insert

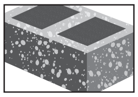
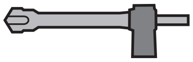
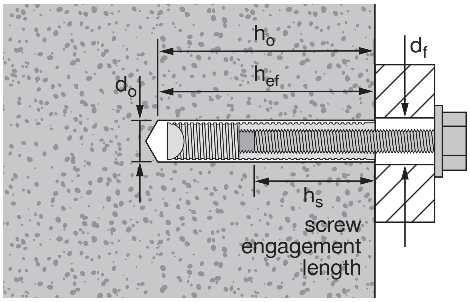
Permissible Base Materials			Permissible drilling method		
		Grout-filled concrete masonry		 	Hammer drilling with carbide tipped drill bit Hilti TE-CD or TE-YD hollow drill bit

Figure 5 — Hilti HIT-HY 270 specifications for HIS-N and HIS-RN inserts in grout-filled concrete masonry walls



Hilti installation specifications for HIS-N and HIS-RN inserts in grout-filled concrete masonry walls

Setting information	Symbol	Units	Thread size	
			3/8-16 UNC	1/2-13 UNC
Nominal bit diameter	d_o	in.	11/16	7/8
Nominal / effective embedment	h_o / h_{ef}	in. (mm)	4-3/8 (110)	5 (125)
Maximum installation torque	T_{inst}	ft-lb (Nm)	6 (8)	7.5 (10)
Diameter of fixture hole	d_f	in.	7/16	9/16
Thread engagement length	h_s	in. (mm)	3/8 to 15/16 (10 to 25)	1/2 to 1-1/4 (13 – 32)

Table 8 — Hilti HIT-HY 270 allowable adhesive bond tension loads for HIS-N and HIS-RN inserts in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]

Thread size	Effective embedment in. (mm)[11]	Tension lb (kN)	Spacing[9]			Edge distance[10]		
			Critical s_{cr} in. (mm)	Minimum s_{min} in. (mm)	Load reduction factor @ s_{min}[12]	Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load reduction factor @ c_{min}[12]
3/8-16 UNC	4-3/8 (110)	2,075 (9.2)	17 (432)	4 (102)	0.55	12 (305)	4 (102)	0.82
1/2-13 UNC	5 (125)	2,710 (12.1)	20 (508)		0.55	20 (508)		0.63

Table 9 — Hilti HIT-HY 270 allowable adhesive bond shear loads for HIS-N and HIS-RN inserts in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]

Thread size	Effective embedment in. (mm)[11]	Shear lb (kN)	Spacing[9]			Edge distance[10]			
								Load reduction factor	
			Critical s_{cr} in. (mm)	Minimum s_{min} in. (mm)	Load reduction factor @ s_{min}[12]	Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load perpendicular to edge	Load parallel to edge
3/8-16 UNC	4-3/8 (110)	1,100 (4.9)	17.0 (432)	4 (102)	0.74	12 (305)	4 (102)	0.72	1.00
1/2-13 UNC	5 (125)	2,065 (9.2)	20 (508)		0.71	20 (508)		0.40	0.87

The following footnotes apply to both Tables 7 and 8:

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

2 Anchors may be installed in any location in the face of the masonry wall including cell, web, and mortar joints. Anchors are limited to one per masonry cell. See Figure 2.

3 Linear interpolation of load values between minimum spacing (s_{min}) and critical spacing (s_{cr}) and between minimum edge distance (c_{min}) and critical edge distance (c_{cr}) is permitted.

4 Concrete masonry thickness must be equal to or greater than 1.5 times the anchor embedment depth.

5 When using the basic load combinations in accordance with IBC Section 1605.3.1, tabulated allowable loads must not be increased for seismic or wind loading. When using the alternative basic load combinations in IBC Section 1605.3.2 that include seismic or wind loads, tabulated allowable loads may be increased by 33-1/3 percent, or the alternative basic load combinations may be reduced by a factor of 0.75.

6 Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in tables 3 and 4.

7 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 13.

8 For combined loading: $(T_{applied} / T_{allowable})^n + (V_{applied} / V_{allowable})^n \le 1$ where n = 5/3

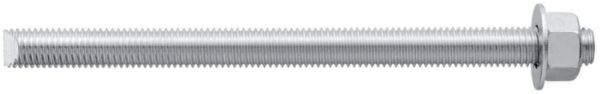
9 The critical spacing, s_{cr}, is the anchor spacing where full load values may be used. The minimum spacing, s_{min}, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

10 The critical edge distance, c_{cr}, is the edge distance where full load values may be used. The minimum edge distance, c_{min}, is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to each edge.

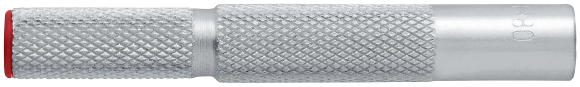
11 Embedment depth is measured from the outside face of the concrete masonry unit.

12 Load reduction factors are multiplicative: both spacing and edge distance load reduction factors, and spacing and edge distances for all adjacent anchors/edges less than s_{cr}/c_{cr}, must be considered. Load values for anchors installed at less than s_{cr} and c_{cr} must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

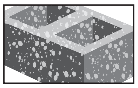
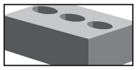
HIT-HY 270 adhesive with Hilti HAS threaded rods and Hilti HIT-IC Inserts



Hilti HAS Threaded Rods



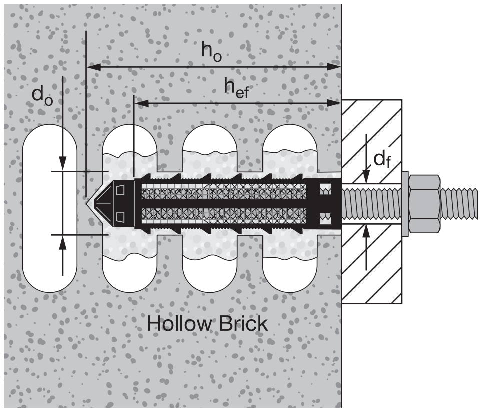
Hilti HIT-IC Inserts

Permissible Base Materials		Ungrouted Concrete Masonry	Permissible drilling method		Rotary only drilling with carbide tipped drill bit
		Brick with Holes			Hilti TE-CD or TE-YD Hollow Drill Bit (for rod diameters 1/4"-3/8")

Hilti installation specifications for HAS threaded rod in hollow masonry and brick with holes

Setting information	Symbol	Units	Nominal rod diameter (in.)			
			1/4	5/16	3/8	1/2
Nominal bit diameter	d_o	in.	1/2	5/8	5/8	11/16
Screen size, CMU	HIT-SC	-	12x50	16x50	16x50	18x50
Depth drilled, CMU	h_o	in. (mm)	Through face shell			
Effective embedment, CMU	h_{ef}	in. (mm)	2 (50)	2 (50)	2 (50)	2 (50)
Screen size, Brick	HIT-SC	-	12x85	16x85	16x85	18x85
Depth drilled, Brick	h_o	in. (mm)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)
Effective embedment, Brick	h_{ef}	in. (mm)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)
Maximum installation torque	T_{inst}	ft-lb (Nm)	2.2 (3)	2.2 (3)	3 (4)	4.5 (6)
Diameter of fixture hole	d_f	in.	9/32	3/8	7/16	9/16

Figure 6 — Hilti HIT-HY 270 specifications for Hilti HAS threaded rod in hollow masonry and brick with holes



Hilti installation specifications for #14 screw in hollow masonry and brick with holes

Setting information	Symbol	Units	CMU	Brick
Nominal bit diameter	d_o	in.	1/2	1/2
Screen size	HIT-S	-	12/l	12/l
Depth drilled	h_o	in. (mm)	Through face shell	2 (50)
Effective embedment	h_{ef}	in. (mm)	2 (50)	2 (50)
Diameter of fixture hole	d_f	in.	9/32	9/32

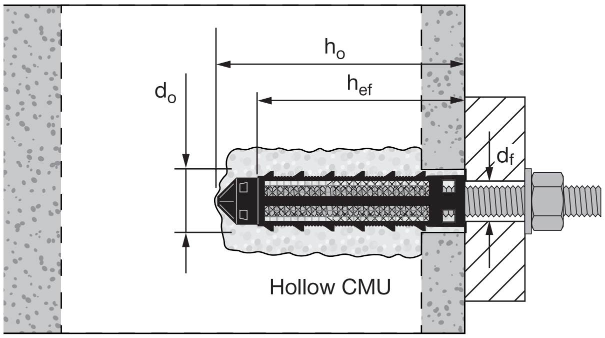


Table 10 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods in the face of hollow concrete masonry units[1,3,7,9,10]

Nominal anchor diameter in.	Embedment in. (mm)[2]	Tension load lb (kN)		Critical and minimum edge distance for tension, c_{cr} and c_{min} in (mm)	Shear load at c_{cr} lb (kN)		Edge distances for shear[6]		
		Installation in the cell lb (kN)[4,5,8]	Installation in the bed joint lb (kN)[5,8]		Installation in the cell lb (kN)[4,5,8]	Installation in the bed joint lb (kN)[5,8]	Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load reduction factor @ c_{min}
1/4	2 (51)	220 (1.0)	300 (1.3)	4 (102)	355 (1.6)	385 (1.7)	4 (102)	4 (102)	1.00
5/16		390 (1.7)	300 (1.3)		630 (2.8)	435 (1.9)	12 (305)		0.73
3/8		390 (1.7)	300 (1.3)		645 (2.9)	550 (2.4)	12 (305)		0.73
1/2		390 (1.7)	330 (1.5)		670 (3.0)	755 (3.4)	12 (305)		0.73

Table 11 — Hilti HIT-HY 270 allowable adhesive bond loads for Hilti HIT-IC inserts in the face of hollow concrete masonry units[1,3,7,9,10]

Nominal anchor diameter in.	Embedment in. (mm)[2]	Tension load, installation in the cell lb (kN)[4,5,8]	Critical and minimum edge distance for tension, c_{cr} and c_{min} in (mm)	Shear load, installation in the cell lb (kN)[4,5,8]	Edge distances for shear[6]		
					Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load reduction factor @ c_{min}
#14 Screw	2 (51)	190 (0.8)	4 (102)	235 (1.0)	4 (102)	4 (102)	1.00
5/16-18 UNC		415 (1.8)		605 (2.7)	12 (305)		0.80
3/8-16 UNC		480 (2.1)		620 (2.8)	12 (305)		0.78
1/2-13 UNC		495 (2.2)		620 (2.8)	12 (305)		0.75

The following footnotes apply to both Tables 9 and 10:

1 All values are for anchors installed in hollow concrete masonry with minimum masonry strength of 1500 psi. Concrete masonry units must be light-, medium, normal-weight conforming to ASTM C90. Allowable loads have been calculated using a safety factor of 5.

2 Tabulated embedment depth is limited by the length of the plastic HIT-SC screens.

3 Anchors must be installed in the face of the hollow CMU masonry wall. A maximum of two anchors may be installed in a single cell of the hollow CMU block.

4 Tabulated values are for anchors installed in the cell of the hollow CMU. Installation in other locations of the hollow CMU (mortar joints, flange, or cell web) is not permitted.

5 Two anchors may be spaced as close as 4 inches apart with no reduction in tension or shear capacity. EXCEPTION: Two 3/8-inch diameter HIT-IC inserts and two ½-inch diameter HIT-IC inserts installed in the same cell spaced as close as 4 inches require a 20% reduction in the tension capacity.

6 The critical edge distance, c_{cr}, is the edge distance where full load values in the table may be used. The minimum edge distance, c_{min}, is the minimum edge distance for which values are available and installation is permitted. Edge distance is measured from the center of the anchor to any edge.

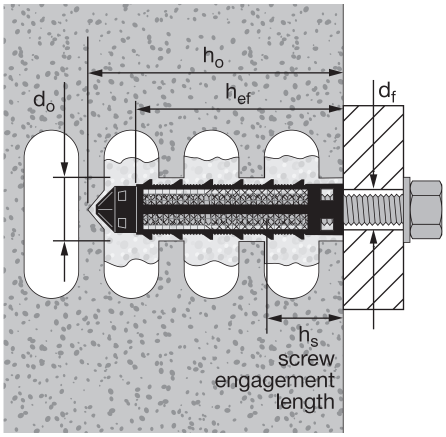
7 Anchors are not recognized for resisting earthquake forces. When using the basic load combinations in accordance with IBC Section 1605.3.1, or the alternative basic load combinations in IBC Section 1605.3.2, tabulated allowable loads must not be increased for wind loading.

8 Allowable loads must be the lesser of the adjusted bond values tabulated above and the steel values given in Table 3.

9 Tabulated allowable bond loads must be adjusted for increased base material temperatures in accordance with Figure 13, as applicable.

10 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

Figure 7 — Hilti HIT-HY 270 specifications for Hilti HIT-IC in hollow masonry and brick with holes



Hilti installation specifications for Hilti HIT-IC in hollow masonry and brick with holes

Setting information	Symbol	Units	Nominal rod diameter (in.)		
			5/16	3/8	1/2
Nominal bit diameter	d_o	in.	5/8	7/8	7/8
HIT-IC size, CMU	HIT-IC	-	5/16x2	3/8x2	1/2x2
Screen size, CMU	HIT-SC	-	16x50	22x50	22x50
Nominal embedment, CMU	h_o	in. (mm)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)
Effective embedment, CMU	h_{ef}	in. (mm)	2 (50)	2 (50)	2 (50)
Screw engagement length, CMU	h_s	in. (mm)	3/8 - 1 1/2 (9.5 - 38)	3/8 - 1 1/2 (9.5 - 38)	1/2 - 1 1/2 (12.5 - 38)
HIT-IC size, Brick	HIT-IC	-	5/16x3-3/16	3/8x3-3/16	1/2x3-3/16
Screen size, Brick	HIT-SC	-	16x85	22x85	22x85
Nominal embedment, Brick	h_o	in. (mm)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)
Effective embedment, Brick	h_{ef}	in. (mm)	3-1/8 (79)	3-1/8 (79)	3-1/8 (79)
Screw engagement length, Brick	h_s	in. (mm)	3/8 - 3 (9.5 - 76)	3/8 - 3 (9.5 - 76)	1/2 - 3 (12.5 - 76)
Maximum installation torque	T_{inst}	ft-lb (Nm)	2.2 (3)	3 (4)	4.5 (6)
Diameter of fixture hole	d_f	in.	3/8	7/16	9/16

Table 12 — Hilti HIT-HY 270 allowable adhesive bond tension loads for threaded rods in the face of hollow brick[1,3,4,8,9,10,11]

Nominal anchor diameter in.	Effective embedment in. (mm)[2]	Tension lb (kN)	Spacing[5]			Edge distance[6]		
			Critical s_{cr} in. (mm)	Minimum s_{min} in. (mm)	Load reduction factor @ s_{min}[7]	Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load reduction factor @ c_{min}[7]
1/4	3-1/8 (79)	530 (2.4)	8 (203)	4 (102)	0.88	6 3/8 (162)	4 (102)	0.93
5/16		735 (3.3)			0.82			0.80
3/8		905 (4.0)			0.54			0.83
1/2		905 (4.0)			0.50			1.00

Table 13 — Hilti HIT-HY 270 allowable adhesive bond shear loads for threaded rods in the face of hollow brick[1,3,4,8,9,10,11]

Nominal anchor diameter in.	Effective embedment in. (mm)[2]	Shear lb (kN)	Spacing[5]			Edge distance[6]		
			Critical s_{cr} in. (mm)	Minimum s_{min} in. (mm)	Load reduction factor @ s_{min}[7]	Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load reduction factor @ c_{min}[7]
1/4	3-1/8 (79)	370 (1.6)	8 (203)	4 (102)	0.84	8 (203)	4 (102)	0.86
5/16		595 (2.6)			0.81	8 (203)		0.93
3/8		1,045 (4.6)			0.59	12 (305)		0.54
1/2		1,685 (7.5)			0.50	12 (305)		0.36

The following footnotes apply to both Tables 11 and 12:

1 All values are for anchors installed in hollow brick masonry with minimum masonry strength of 3000 psi. Hollow brick units must be in conformance with ASTM C652. Allowable loads have been calculated using a safety factor of 5.

2 Tabulated embedment depth is limited by the length of the plastic HIT-SC screens.

3 Anchors must be installed in the face of the hollow brick masonry wall.

4 Tabulated values are for the anchor installed in the center of the hollow brick, mortar joints, flanges, or cell web (all wall face locations permitted).

5 The critical spacing, s_{cr}, is the anchor spacing where full load values in the table may be used. The minimum spacing, s_{min}, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

6 The critical edge distance, c_{cr}, is the edge distance where full load values in the table may be used. The minimum edge distance, c_{min}, is the minimum edge distance for which values are available and installation is permitted. Edge distance is measured from the center of the anchor to each edge.

7 Load reduction factors are multiplicative: both spacing and edge distance load reduction factors, and spacing and edge distances for all adjacent anchors/ edges less than s_{cr}/c_{cr},must be considered. Load values for anchors installed at less than s_{cr} and c_{cr} must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

8 Anchors are not recognized for resisting earthquake forces. When using the basic load combinations in accordance with IBC Section 1605.3.1, or the alternative basic load combinations in IBC Section 1605.3.2, tabulated allowable loads must not be increased for wind loading.

9 Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in table 3.

10 Tabulated allowable bond loads must be adjusted for increased base material temperatures in accordance with Figure 13, as applicable.

11 For combined loading: $(T_{applied}/T_{allowable}) + (V_{applied}/V_{allowable}) \le 1$

Table 14 — Hilti HIT-HY 270 allowable adhesive bond loads for HIT-IC inserts in the face of hollow brick[1,3,4,5,7,8,9,10]

Thread size	Effective embedment in. (mm)[2]	Tension lb (kN)	Critical and minimum edge distance for tension, c_{cr} and c_{min} in. (mm)	Shear lb (kN)	Edge distance for shear[6]		
					Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load reduction factor @ c_{min}
#14 Screw	2 (51)	170 (0.8)	6 3/8 (162)	222 (1.0)	8 (203)	8 (203)	1.00
5/16-18 UNC	3-1/8 (79)	880 (3.9)		655 (2.9)	8 (203)		1.00
3/8-16 UNC		880 (3.9)		1,235 (5.5)	12 (305)		0.66
1/2-13 UNC		990 (4.4)		1,895 (8.4)	12 (305)		0.44

1 All values are for anchors installed in hollow brick masonry with minimum masonry strength of 3000 psi. Hollow brick units must be in conformance with ASTM C652. Allowable loads have been calculated using a safety factor of 5.

2 Tabulated embedment depth is limited by the length of the plastic HIT-SC screens.

3 Anchors must be installed in the face of the hollow brick masonry wall.

4 Tabulated values are for one anchor installed in the hollow brick, mortar joints, flanges, or cell web (all wall face locations permitted).

5 One anchor is permitted to be installed in each brick. Two anchors installed in adjacent bricks may be spaced as close as 8 inches apart with no load reduction.

6 The critical edge distance, c_{cr}, is the edge distance where full load values in the table may be used. The minimum edge distance, c_{min}, is the minimum edge distance for which values are available and installation is permitted. Edge distance is measured from the center of the anchor to each edge.

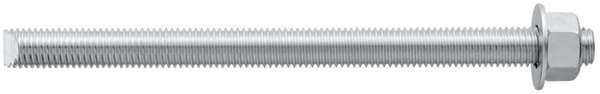
7 Anchors are not recognized for resisting earthquake forces. When using the basic load combinations in accordance with IBC Section 1605.3.1, or the alternative basic load combinations in IBC Section 1605.3.2, tabulated allowable loads must not be increased for wind loading.

8 Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in table 3.

9 Tabulated allowable bond loads must be adjusted for increased base material temperatures in accordance with Figure 13, as applicable.

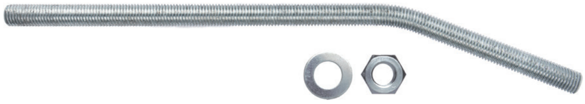
10 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \le 1$

HIT-HY 270 adhesive with Hilti HAS threaded rods and deformed reinforcing bars (Rebar)



Hilti HAS Threaded Rods

Deformed Reinforcing Bars (Rebar)



Bent threaded rod 22.5 degrees

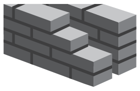
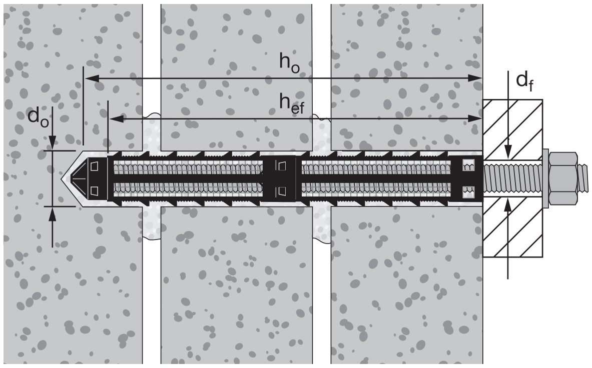
Permissible Base Materials		Unreinforced Multi-wythe Brick (URM)	Permissible drilling method		Rotary only drilling with carbide tipped drill bit

Figure 8 — Hilti HIT-HY 270 specifications for HAS rods in multi-wythe brick wall



Hilti installation specifications for HAS rods in multi-wythe brick wall

Setting information	Symbol	Units	Nominal rod diameter (in.)							
			3/8		1/2		5/8		3/4	
Nominal bit diameter	d_o	in.	5/8		11/16		7/8		1	
Screen size	HIT-SC	-	2x 16x85	3x 16x85	2x 18x85	3x 18x85	2x 22x85	3x 22x85	26x200	26x125 + 26x200
Nominal embedment	h_o	in. (mm)	7-1/8 (181)	10-3/4 (273)	7-1/8 (181)	10-3/4 (273)	7-1/8 (181)	10-3/4 (273)	8-1/4 (210)	13-1/4 (337)
Effective embedment	h_{ef}	in. (mm)	6 (152)	10 (254)	6 (152)	10 (254)	6 (152)	10 (254)	8 (203)	13 (330)
Maximum installation torque	T_{inst}	ft-lb (Nm)	10 (14)		30 (41)		45 (61)		60 (81)	
Diameter of fixture hole	d_f	in.	7/16		9/16		11/16		13/16	

Hilti installation specifications for rebar in multi-wythe brick wall

Setting information	Symbol	Units	Nominal rod diameter (in.)		
			#4	#5	#6
Nominal bit diameter	d_o	in.	1	1	1
Screen size	HIT-SC	-	26x200	26x200	26x200
Nominal embedment	h_o	in. (mm)	8-1/4 (210)	8-1/4 (210)	8-1/4 (210)
Effective embedment	h_{ef}	in. (mm)	8 (203)	8 (203)	8 (203)

Figure 9 — Hilti HIT-HY 270 specifications for rebar in multi-wythe brick wall

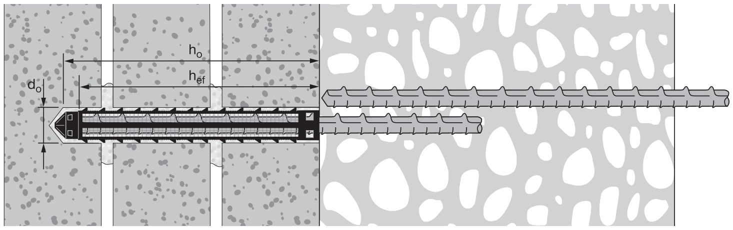


Table 15 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods in multi-wythe solid brick wall[1,2,3,4,5,6,8,9]

Nominal anchor diameter in.	Effective embedment[7] in. (mm)	Tension lb (kN)	Shear lb (kN)	Spacing			Edge distance		
				Critical s_{cr} in. (mm)	Minimum s_{min} in. (mm)	Load reduction factor@ s_{min}	Critical c_{cr} in. (mm)	Minimum c_{min} in. (mm)	Load reduction factor@ c_{min}
3/8	6 (152)	895 (4.0)	680 (3.0)	16 (406)	8 (203)	0.50	16 (406)	8 (203)	0.50
	10 (254)	1,325 (5.9)	795 (3.5)						
1/2	6 (152)	895 (4.0)	1,075 (4.8)						
	10 (254)	1,455 (6.5)	1,115 (5.0)						
5/8	6 (152)	1,025 (4.6)	1,405 (6.3)						
	10 (254)	1,955 (8.7)	1,445 (6.4)						
3/4	8 (203)	1,575 (7.0)	1,985 (8.8)						
	13 (330)	2,135 (9.5)	1,985 (8.8)						

[1] All values are based on mortar shear strength of 45 psi or greater. Allowable loads are calculated using a safety factor of 5.

[2] Anchors must be installed in the face of the multi-wythe URM wall. The wall must have a minimum thickness of 13 inches made up of 3 wythes of brick.

[3] Tabulated values are for maximum one anchor installed in the center of the brick of the multi-wythe URM wall.

[4] Edge distance, c_{min}, and spacing, s_{min}, are the minimum distances for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to each edge. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

[5] Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in table 3.

[6] Allowable loads shall be adjusted for increased base material temperature in accordance with Figure 13.

[7] Tabulated embedment depth is limited by the length of the plastic HIT-SC screens.

[8] For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \le 1$

[9] Load reduction factors are multiplicative: both spacing and edge distance load reduction factors, and spacing and edge distances for all adjacent anchors/ edges less than s_{cr}/c_{cr}, must be considered. Load values for anchors installed at less than s_{cr} and c_{cr} must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

Table 16 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods in multi-wythe hollow brick wall [1,3,4,5,7,8]

Nominal anchor diameter in.	Effective embedment in. (mm)[6]	Tension lb (kN)	Shear lb (kN)	Minimum edge distance c_{min} in. (mm)	Spacing: Critical s_{cr} in. (mm)	Spacing: Minimum s_{min} in. (mm)	Spacing: Load reduction factor in tension @ s_{min}	Spacing: Load reduction factor in shear @ s_{min}
Anchor installed into the face of brick masonry wall[2]								
3/8	6-1/4 (160)	880 (3.9)	560 (2.5)	4 (102)	16 (406)	8 (203)	0.89	1.00
	9-3/4 (248)	1,540 (6.9)	895 (4.0)				0.96	0.75
1/2	6-1/4 (160)	1,430 (6.4)	655 (2.9)				0.59	0.75
	9-3/4 (248)	2,020 (9.0)	895 (4.0)				0.89	0.78
5/8	6-1/4 (160)	1,695 (7.5)	655 (2.9)				0.50	0.71
	9-3/4 (248)	2,165 (9.6)	895 (4.0)				0.71	0.58
3/4	8 (203)	1,380 (6.1)	855 (3.8)				1.00	0.67
	10 (250)	2,075 (9.2)	1,070 (4.8)				0.79	0.54
Anchor installed into the top of brick masonry wall								
3/8	3-1/8 (79)	315 (1.4)	220 (1.0)	2.5 (64)	8 (203)	8 (203)	1	1
Anchor installed into the side of brick masonry wall								
3/8	3-1/8– (79)	570 (2.5)	290 (1.3)	2.5 (64)	8 (203)	8 (203)	1	1

1 All values are for anchors installed in brick masonry with minimum masonry strength of 3000 psi. Brick units must be in conformance with ASTM C652. Allowable loads have been calculated using a safety factor of 5.

2 Anchors must be installed in the face of the multi-wythe URM wall. 2-wythe brick walls must have minimum of 6 inches thickness. Anchors with the effective embedment larger than 6-1/4" inches must be installed in the wall with minimum thickness of 13 inches made up of 3-wythe brick walls.

3 Edge distance, c_{min}, and spacing, s_{min}, are the minimum distances for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to each edge. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

4 Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in table 3.

5 Allowable loads shall be adjusted for increased base material temperature in accordance with Figure 13.

6 Tabulated embedment depth is limited by the length of the plastic HIT-SC screens.

7 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

8 Load reduction factors are multiplicative: both spacing and edge distance load reduction factors, and spacing and edge distances for all adjacent anchors/ edges less than s_{cr} / $c_{cr,}$ must be considered. Load values for anchors installed at less than s_{cr} and c_{cr} must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

Figure 10 — Hilti HIT-HY 270 shear anchor or dowel in configuration A

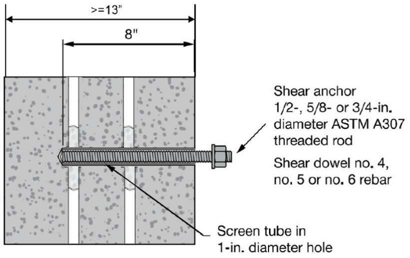


Figure 11 — Hilti HIT-HY 270 with 22-1/2° combination anchor in configuration B

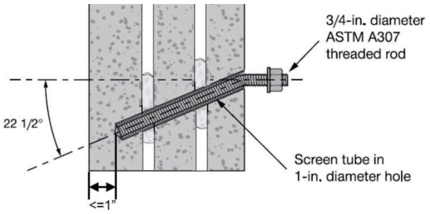


Table 17 — Hilti HIT-HY 270 allowable adhesive bond seismic loads for threaded rods and reinforcing bars in unreinforced brick masonry[1,2,3]

Configuration A – Shear anchor or rebar dowel				
Nominal anchor diameter (in.) or rebar size	Embedment in. (mm)	Minimum wall thickness in. (mm)	Tension lb (kN)	Shear lb (kN)[4]
1/2 or # 4	8 (203)	13 (330)	-	500 (2.2)
5/8 or # 5			-	750 (3.3
3/4 or # 6			-	1,000 (4.4)
Configuration B – 22-1/2° combination anchor				
Nominal anchor diameter (in.)	Embedment in. (mm)	Minimum wall thickness in. (mm)	Tension lb (kN)	Shear lb (kN)[4]
3/4	Within 1 inch of opposite wall surface	13 (330)	1200 (5.3)	1,000 (4.4)

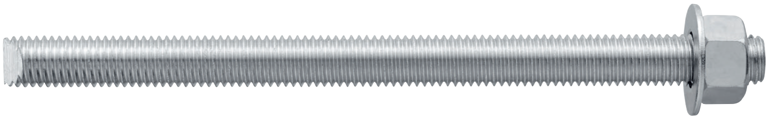
1 Allowable load values are applicable only to anchors where in-place shear tests indicate minimum mortar strength of 50 psi.

2 Allowable loads are computed in accordance with ICC-ES AC60 (2010) and IBC (2009).

3 No increase for short-term loading is permitted, such as loading induced by wind or earthquake.

4 Anchors must be tested in accordance with the requirements of IEBC and UCBC

HIT-HY 270 adhesive with Hilti HAS threaded rods



Hilti HAS threaded rod

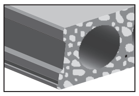
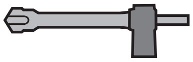
Permissible Base Materials			Permissible drilling method		
		Hollow core concrete		 	Rotary only drilling with carbide tipped drill bit Hilti TE-CD or TE-YD Hollow Drill Bit

Table 18 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods in hollow core concrete panels[1,4,5,6]

Nominal anchor diameter in.	Effective embedment in. (mm)[2]	Minimum concrete thickness in. (mm)[3]	Tension lb (kN)	Shear lb (kN)
3/8	2 (50.8)	1-3/8 (34.9)	450 (2.0)	560 (2.5)

1 All values are for anchor installed in hollow core concrete with minimum compressive strength of 7,000 psi. Due to variations in materials and dimensional configurations, on-site testing is required to determine the actual performance of the anchor. Allowable loads are calculated using a safety factor of 5.

2 Tabulated embedment depth is limited by the plastic HIT-SC 16x50 mm screens. See Figure 12.

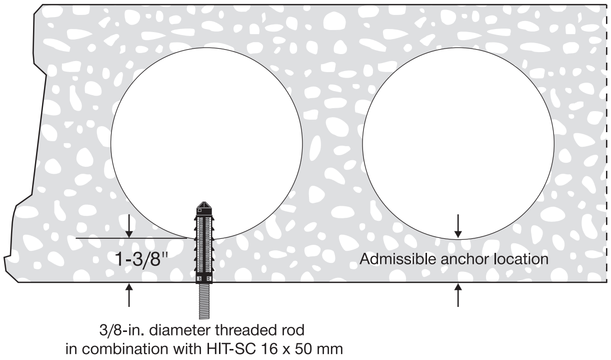
3 The required concrete thickness is the thickness for which values are available and installation is recommended. Anchors shall be installed along the centerline of the hollow core or along the line of minimum thickness. Verify these requirements with the hollow core plank supplier before installation. The required thickness is measured from the inner to the outer side of hollow core panel. See Figure 12.

4 Tabulated allowable loads must be the lesser of the adjusted bond values tabulated and the steel values in table 3.

5 Allowable loads shall be adjusted for increased base material temperature in accordance with Figure 13.

6 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

Figure 12 — Hilti HIT-HY 270 adhesive installed in hollow core concrete[1,2]



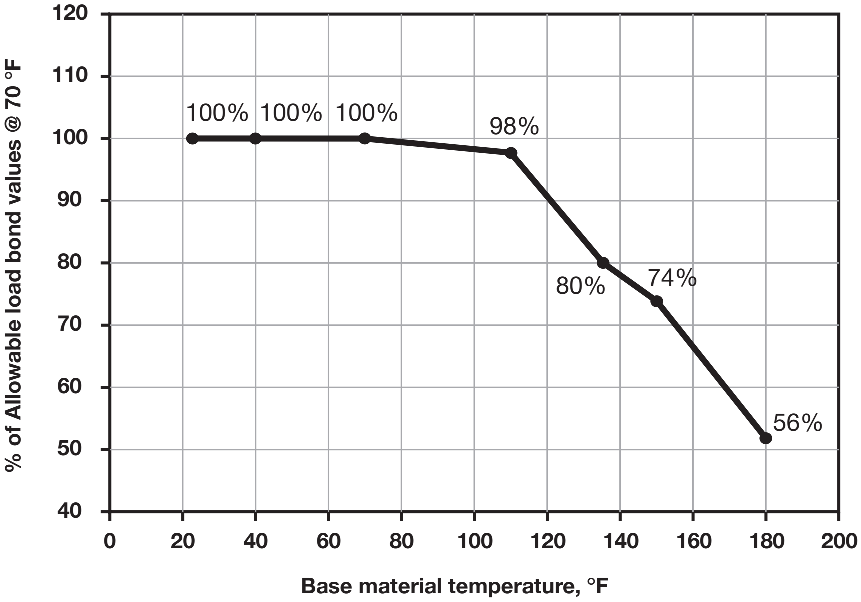
1 Representation of the tested conditions for which allowable adhesive bond loads are applicable. Refer to footnote 3 of corresponding load table above for more information on requirements and restrictions on the admissible anchor installation.

2 Minimum edge distance is 6-inches.
Minimum spacing is:
- 8-inches along the length of each hollow core section.
- One anchor per hollow core section (left and right on page), 6-inches minimum between adjacent hollow core sections.

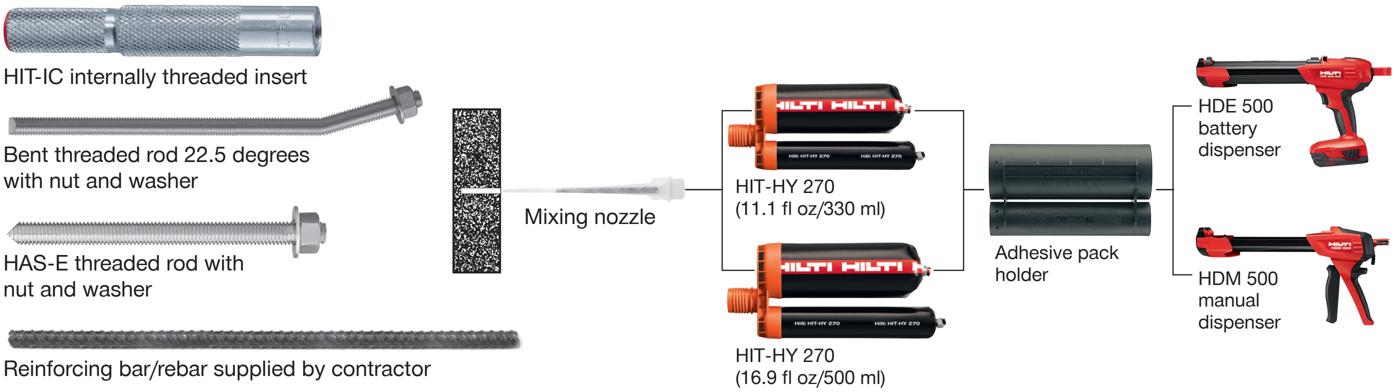
INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

Figure 13 — Influence of in-service temperature on bond loads

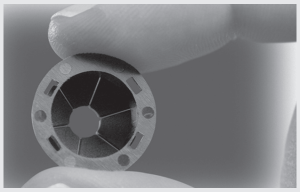


ORDERING INFORMATION

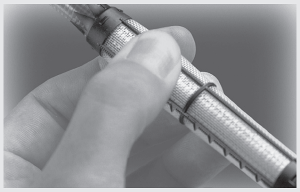


Description	Package Contents	Qty of Foil Packs
HIT-HY 270 (11.1OZ/330ML)	Includes (1) foil pack with (1) mixer and 3/8-in. filler tuber per pack	1
HIT-HY 270 (11.1OZ/330ML) 1 MC	Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8-in. filler tuber per pack	25
HIT-HY 270 (16.9OZ/500ML) 1 MC	Includes (1) master carton containing (20) foil packs with (1) mixer and 3/8-in. filler tuber per pack	20
HIT-HY 270/500ML (2MC)+ HDM 500	Includes (2) master cartons containing (20) foil packs each with (1) mixer and 3/8-in. filler tuber per pack and (1) HDM 500 manual dispenser	40
HIT-HY 270/500ML (2MC)+ HDE 500 KIT	Includes (2) master cartons containing (20) foil packs each with (1) mixer and 3/8-in. filler tuber per pack and (1) HDM 500 manual dispenser	40
HY 270 TE 30-C AVR SAFESET PACK	Includes TE 30-C AVR, VC 150 6-X, (40) HIT-HY 270 500/1, HDE 500-A22, C 4/36 LI-ION, (1) B 22/2.6 LI-ION, HIT-CB 500, TE-CD BITS: (1) 1/2"-13", (1) 9/16"-14", (1) 5/8"-14", (1) 3/4"-14", & BAG SMALL	40
HY 270 TE 6-A22 SAFESET PACK	Includes TE 6-A22, VC 150 6-X, (40) HIT-HY 270 500/1, HDE 500-A22, C 4/36 LI-ION, (2) B 22/5.2 LI-ION, HIT-CB 500, TE-CD BITS: (1) 1/2"-13", (1) 9/16"-14", (1) 5/8"-14", (1) 3/4"-14", & BAG SMALL	40
HY 270 TE 30-A36 SAFESET PACK	Includes TE 30-A36, VC 150 6-X, (40) HIT-HY 270 500/1, HDE 500-A22, C 4/36-350 LI-ION, (2) B 36/6.0 LI-ION, HIT-CB 500, TE-CD BITS: (1) 1/2"-13", (1) 9/16"-14", (1) 5/8"-14", (1) 3/4"-14", & BAG SMALL	40
HIT-RE-M Static Mixer	For use with HIT-HY 270 cartridges	1

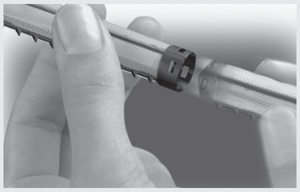
Customize the sleeve to the length of your application. Different embedment depths are created with minimal effort.



Step 1: Remove the centering ring of any screen tube within the cell.



Step 2: Pierce the tip of the screen tube with the rod intended to be used to check embedment depth.



Step 3: Combine screen tubes to desired length.

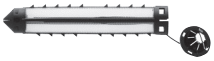
Brick with holes and hollow concrete block

Threaded Rod			Mesh Sleeve		Approximate fastenings per foil pack[1]	
Rod Size 5.8 Grade	Embedment, in.	Qty	Nominal Bit Dia., in.	Mesh Sleeve per Fastening	11.1 fl oz (330 ml)	16.9 fl oz (500 ml)
Plastic Sleeve (for #14 screw)	2	20	1/2	(1) HIT S-12/I	25	40
HAS B 1/4 x 3	2	20	1/2	(1) SC 12x50	25	40
HAS B 1/4 x 4-1/2	3-1/8	20	1/2	(1) SC 12x85	16	26
HAS B 5/16 x 3	2	20	5/8	(1) SC 16x50	16	26
HAS B 5/16 x 4-1/2	3-1/8	20	5/8	(1) SC 16x85	7	12
HAS-E 3/8 x 3	2	10	5/8	(1) SC 16x50	16	26
HAS-E 3/8 x 4-3/8	3-1/8	10	5/8	(1) SC 16x85	7	12
HAS-E 1/2 x 3-1/8	2	10	11/16	(1) SC 18x50	9	15
HAS-E 1/2 x 4-1/2	3-1/8	10	11/16	(1) SC 18x85	4	7

Composite mesh sleeves for hollow masonry and brick material

Description	For use with:	Qty	Actual Dia., in.	Length, in.	Bit Dia.
Mesh sleeve HIT-SC 12x50 ①	1/4 dia. rods	20	0.47	1.97	1/2
Mesh sleeve HIT-SC 12x85 ①	1/4 dia. rods	20	0.47	3.35	1/2
Mesh sleeve HIT-SC 16x50 ①	5/16, 3/8 dia. rods and 5/16 HIT-IC rods	20	0.63	1.97	5/8
Mesh sleeve HIT-SC 16x85 ①	5/16, 3/8 dia. rods and 5/16 HIT-IC rods	20	0.63	3.35	5/8
Mesh sleeve HIT-SC 18x50 ①	1/2 dia. rods	20	0.71	1.97	11/16
Mesh sleeve HIT-SC 18x85 ①	1/2 dia. rods	20	0.71	3.35	11/16
Mesh sleeve HIT-SC 22x50 ①	5/8 dia. rods, 3/8 and 1/2 HIT-IC rods	20	0.87	1.97	7/8
Mesh sleeve HIT-SC 22x85 ①	5/8 dia. rods, 3/8 and 1/2 HIT-IC rods	10	0.87	3.35	7/8
Mesh sleeve HIT-SC 26x125 ②	3/4 dia. rods	20	1.02	4.92	1
Mesh sleeve HIT-SC 26x200 ②	3/4 dia. rods	20	1.02	7.87	1

①



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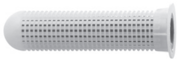
Internally threaded inserts for hollow masonry and brick material

Description	For use with:	Qty	Bit Dia., in.	Threads per inch
Internally Threaded HIT-IC 5/16 x 2	In hollow material use with HIT-SC 16 x 50	10	5/8	18
Internally Threaded HIT-IC 5/16 x 3-3/16 ③	In hollow material use with HIT-SC 16 x 85	10	5/8	18
Internally Threaded HIT-IC 3/8 x 2	In hollow material use with HIT-SC 22 x 50	10	7/8	16
Internally Threaded HIT-IC 3/8 x 3-3/16 ③	In hollow material use with HIT-SC 22 x 85	10	7/8	16
Internally Threaded HIT-IC 1/2 x 2	In hollow material use with HIT-SC 22 x 50	10	7/8	13
Internally Threaded HIT-IC 1/2 3 x 3/16 ③	In hollow material use with HIT-SC 22 x 85	10	7/8	13
HIT Combi-Insert HIT-S - 12/I ④	Plastic sleeve for #14 screw	20	1/2	-

③

④



Multi-wythe brick walls

Threaded Rod			Mesh Sleeve		Approximate fastenings per foil pack[1]	
Rod Size 5.8 Grade	**Embedment, in.**	**Qty**	**Bit Diameter, in.**	**Mesh Sleeve per Fastening**	**11.1 fl oz (330 ml)**	**16.9 fl oz (500 ml)**
HAS-E 3/8 x 5-1/8	4	20	5/8	(2) SC 16x50	15	24
HAS-E 3/8 x 8	6-3/4	10	5/8	(2) SC 16x85	9	14
HAS-E 3/8 x 12	10	10	5/8	(3) SC 16x85	5	9
HAS-E 1/2 x 8	6-3/4	10	11/16	(2) SC 18x85	7	11
HAS-E 1/2 x 12	10	10	11/16	(3) SC 18x85	4	7
HAS-E 5/8 x 8	6-3/4	20	7/8	(2) SC 22x85	4	7
HAS-E 5/8 x 12	10	10	7/8	(3) SC 22x85	2	4
HAS-E 3/4 x 10	8	10	1	(1) SC 26x200	2	4
HAS-E 3/4 x 14	13	10	1	(1) SC 26x200, (1) SC 26x125	1	2
HAS-E 3/4 x 17	15-3/4	10	1	(2) SC 26x200	1	2
HAS-E 3/4 x 19	18	10	1	(2) SC 26x125, (1) SC 26 x 200	1	2
HAS-E 3/4 x 25	23-1/2	10	1	(3) SC 26x200	0	1

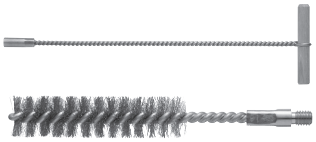
Internally threaded inserts

Threaded Rod			Mesh Sleeve		Approximate fastenings per foil pack[1]	
Rod Size 5.8 Grade	**Embedment, in.**	**Qty**	**Bit Diameter, in.**	**Mesh Sleeve per Fastening**	**11.1 fl oz (330 ml)**	**16.9 fl oz (500 ml)**
Internally Threaded HIT-IC 5/16 x 2	2	10	5/8	(1) SC 16x50	16	26
Internally Threaded HIT-IC 5/16 x 3-3/16	3-1/4	10	5/8	(1) SC 16x85	7	12
Internally Threaded HIT-IC 3/8 x 2	2	10	7/8	(1) SC 22x50	9	15
Internally Threaded HIT-IC 3/8 x 3-3/16	3-1/4	10	7/8	(1) SC 22x85	4	7
Internally Threaded HIT-IC 1/2 x 2	2	10	7/8	(1) SC 22x50	9	15
Internally Threaded HIT-IC 1/2 3-3/16	3-1/4	10	7/8	(1) SC 22x85	4	7

[1] Assumes use with HDM 500 Manual Dispenser

Cleaning accessories

Hole Diameter	Round Brush Size use with HIT-RBH handle	Qty
1/2	HIT-RB 1/2	1
5/8	HIT-RB 5/8	1
11/16	HIT-RB 11/16	1
7/8	HIT-RB 7/8	1
1	HIT-RB 1	1



3.2.5 HIT-ICE ADHESIVE ANCHORING SYSTEM

PRODUCT DESCRIPTION

HIT-ICE with Threaded Rod, Rebar, and HIS-N Inserts

<table>
<tr><th colspan="2">Mortar Systems</th><th>Features and Benefits</th></tr>
<tr><td></td><td>Hilti HIT-ICE Cartridge</td><td rowspan="4">

Winter formulation for base material temperatures down to -10°F (-23°C)
Two hole cleaning options including the Hilti SafeSet™ System using the TE-CD or TE-YD Hollow Drill Bit in conjunction with a Hilti Vacuum to remove the dust as you drill.
Small edge distance and anchor spacing allowance
Mixing tube provides proper mixing and accurate dispensing of mixed resin
Contains no styrene and virtually odorless
Cures quickly over a large range of base material temperatures
Excellent weathering resistance and resistance to high temperatures
High load capacities

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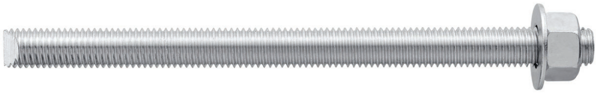
<tr><td></td><td>Rebar</td></tr>
<tr><td></td><td>Hilti HAS Threaded Rod</td></tr>
<tr><td></td><td>Hilti HIS-N</td></tr>
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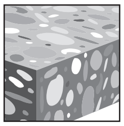
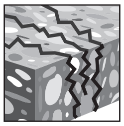
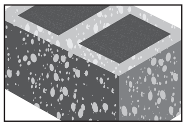


Uncracked concrete



Cracked concrete



Grout-filled concrete masonry

SAFESET

SafeSet™ System with Hollow Drill Bit

Profis Anchor design software

Approvals/Listings	
U.S. Green Building Council	LEED® Credit 4.1-Low Emitting Materials

MATERIAL SPECIFICATIONS

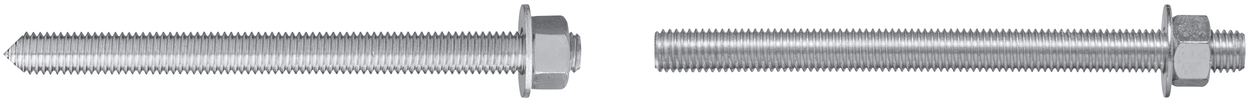
Table 1 - Material properties of cured HIT-ICE adhesive

Compressive strength	72 MPa	10,440 psi
Tensile strength	12 MPa	1,740 psi
Water absorption DIN 53495	2.4%	
Electrical resistance DIN/VDE 0303T3	$2x10^{11}$ OHM/cm	$5.1x10^{11}$ OHM/in.

For material specifications for anchor rods and inserts, please refer to section 3.2.8 of the Hilti North American Tech Guide volume 2: Anchor Fastening Technical Guide, Edition 17.

TECHNICAL DATA

Hilti HIT-ICE with HAS Threaded Rod



Hilti HAS threaded rod

Figure 1 — Hilti HAS threaded rod installation conditions

Permissible concrete conditions	Uncracked concrete	Dry concrete	Permissible drilling method	Hammer drilling with carbide tipped drill bit
	Cracked concrete	Water saturated concrete		Hilti TE-CD or TE-YD Hollow Drill Bit

Table 2 — Hilti HAS Rod installation specifications installed with Hilti HIT-ICE adhesive system

Setting information		Symbol	Units	Nominal rod diameter						
				3/8	1/2	5/8	3/4	7/8	1	1-1/4
Nominal bit diameter		d_o	in.	7/16	9/16	3/4	7/8	1	1-1/8	1-3/8
Effective embedment	minimum	$h_{ef,min}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (79)	3-1/2 (89)	3-1/2 (89)	4 (102)	5 (127)
	maximum	$h_{ef,max}$	in. (mm)	7-1/2 (191)	10 (254)	12-1/2 (318)	15 (381)	17-1/2 (445)	20 (508)	25 (635)
Minimum diameter of fixture hole	through-set		in.	1/2	5/8	13/16[1]	15/16[1]	1-1/8[1]	1-1/4[1]	1-1/2[1]
	preset		in.	7/16	9/16	11/16	13/16	15/16	1-1/8	1-3/8
Installation torque		T_{inst}	ft-lb (Nm)	15 (20)	30 (40)	60 (80)	100 (136)	125 (169)	150 (203)	200 (271)
Minimum concrete thickness		h_{min}	in. (mm)	h_{ef}+1-1/4 (h_{ef}+30)		$h_{ef}+2*d_o$				
Minimum edge distance[2]		c_{min}	in. (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	5-5/8 (143)
Minimum anchor spacing		s_{min}	in. (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	5-5/8 (143)

[1] Install using (2) washers. See Figure 3.

[2] Edge distance of 1-3/4-inch (44mm) is permitted provided the installation torque is reduced to 0.30 T_{inst} for 5d < s < 16-in. and to 0.5T_{inst} for s >16-in.

Figure 2 —
HAS threaded rods

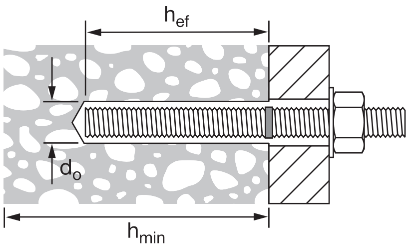
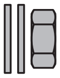


Figure 3 —
Installation with (2) washers



DESIGN DATA IN CONCRETE PER ACI 318

ACI 318 Chapter 17 design

Load Resistance Factored Design of anchors is described in the provisions of ACI 318 Chapter 17 for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Load Resistance Factored Design tables with unfactored characteristic loads that are based on testing in accordance with ACI 355.4. These tables are followed by Hilti Simplified Design Tables. The load values in these tables were developed using the Strength Design parameters developed through testing per ACI 355.4 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to the of the Hilti North American Product Technical Guide, Volume 2: Anchor Fastening Technical Guide.

For additional information or technical assistance, contact Hilti at 800-879-5000 (US) or 800-363-4459 (CA)

Table 3 — Hilti HIT-ICE design information with HAS threaded rods in holes drilled with a hammer drill and carbide bit (or hollow drill bit) in accordance with ACI 318 Ch. 17[1]

	Design parameter	Symbol	Units	Nominal rod diameter (in.)							Ref ACI 318
				3/8	1/2	5/8	3/4	7/8	1	1-1/4	
	Nominal anchor diameter	d_a	in (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	7/8 (22.2)	1 (25.4)	1-1/4 (31.8)	
	Effective minimum embedment[2]	$h_{ef,min}$	in (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (79)	3-1/2 (89)	3-1/2 (89)	4 (102)	5 (127)	
	Effective maximum embedment[2]	$h_{ef,max}$	in (mm)	7-1/2 (191)	10 (254)	12-1/2 (318)	15 (381)	17-1/2 (445)	20 (508)	25 (635)	
	Minimum concrete thickness[2]	h_{min}	in (mm)	h_{ef} + 1-1/4 (h_{ef} + 30)		hef + $2d_0$[(8)]					
	Critical edge distance	c_{ac}	in (mm)	$c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{1160}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4 $\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$ $\left(c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right) \right.$ need not be larger than 2.4 $\tau_{k,uncr}$ need not be taken as greater than: $\left. \tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a} \right)$							
	Minimum edge distance[3]	c_{min}	in (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	6-1/4 (159)	
	Minimum anchor spacing	s_{min}	in (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	6-1/4 (159)	
	Effectiveness factor for uncracked concrete[4]	$k_{c,uncr}$	-	24 (10)							17.4.2.2
	Effectiveness factor for cracked concrete[4]	$k_{c,cr}$	-	17 (7.1)							17.4.2.2
	Strength reduction factor for tension, concrete failure modes[5]	$\Phi_{c,N}$	-	0.65							17.3.3
	Strength reduction factor for shear, concrete failure modes[5]	$\Phi_{c,V}$	-	0.70							17.3.3
Temperature range A[6]	Characteristic bond stress in cracked concrete[7]	$\tau_{k,cr}$	psi (MPa)	715 (4.9)	615 (4.2)	520 (3.6)	420 (2.9)	325 (2.2)	n/a	n/a	17.4.5
	Characteristic bond stress in uncracked concrete[7]	$\tau_{k,uncr}$	psi (MPa)	1,215 (8.4)	1,200 (8.3)	1,185 (8.2)	1,075 (7.4)	1,060 (7.3)	1,050 (7.2)	1,020 (7.0)	17.4.5
Permissible installation conditions	Strength reduction factor for tension, bond failure modes, dry concrete	-	-	2	1	2	1	1	1	1	
		-	-	0.55	0.65	0.55	0.65	0.65	0.65	0.65	
	Strength reduction factor for tension, bond failure modes, water saturated concrete	-	-	2	1	2	1	1	1	1	
		-	-	0.55	0.65	0.55	0.65	0.65	0.65	0.65	

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See figure 2 and 3 of this section.

3 Minimum edge distance may be reduced to 1-3/4" (44mm) ≤ c_{min} < 5d provided T_{inst} is reduced to 0.30 T_{inst} for 5d < s < 16-in. and to $0.5T_{inst}$ for s >16-in.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (54°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength f'_c = 2500 psi (17.2 Mpa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 Mpa) and 8,000 psi (55.2 Mpa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$]

8 d_0 = drilled hole diameter

Table 4 — Hilti HIT-ICE adhesive design strength with concrete / bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8	2-3/8 (60)	1,870 (8.3)	1,905 (8.5)	1,960 (8.7)	2,040 (9.1)	2,380 (10.6)	2,425 (10.8)	2,495 (11.1)	2,595 (11.5)
	3-3/8 (86)	2,655 (11.8)	2,705 (12.0)	2,785 (12.4)	2,900 (12.9)	6,765 (30.1)	6,890 (30.6)	7,090 (31.5)	7,380 (32.8)
	4-1/2 (114)	3,545 (15.8)	3,610 (16.1)	3,715 (16.5)	3,865 (17.2)	9,020 (40.1)	9,185 (40.9)	9,450 (42.0)	9,845 (43.8)
	7-1/2 (191)	5,905 (26.3)	6,015 (26.8)	6,190 (27.5)	6,445 (28.7)	15,030 (66.9)	15,305 (68.1)	15,755 (70.1)	16,405 (73.0)
1/2	2-3/4 (70)	3,370 (15.0)	3,430 (15.3)	3,530 (15.7)	3,680 (16.4)	7,255 (32.3)	7,390 (32.9)	7,605 (33.8)	7,920 (35.2)
	4-1/2 (114)	5,515 (24.5)	5,615 (25.0)	5,780 (25.7)	6,020 (26.8)	11,875 (52.8)	12,095 (53.8)	12,445 (55.4)	12,960 (57.6)
	6 (152)	7,350 (32.7)	7,485 (33.3)	7,705 (34.3)	8,025 (35.7)	15,835 (70.4)	16,125 (71.7)	16,595 (73.8)	17,280 (76.9)
	10 (254)	12,250 (54.5)	12,480 (55.5)	12,840 (57.1)	13,375 (59.5)	26,390 (117.4)	26,875 (119.5)	27,660 (123.0)	28,805 (128.1)
5/8	3-1/8 (79)	4,000 (17.8)	4,075 (18.1)	4,190 (18.6)	4,365 (19.4)	9,280 (41.3)	10,165 (45.2)	10,670 (47.5)	11,110 (49.4)
	5-5/8 (143)	7,200 (32.0)	7,330 (32.6)	7,545 (33.6)	7,855 (34.9)	18,325 (81.5)	18,660 (83.0)	19,205 (85.4)	20,000 (89.0)
	7-1/2 (191)	9,600 (42.7)	9,775 (43.5)	10,060 (44.7)	10,475 (46.6)	24,430 (108.7)	24,880 (110.7)	25,605 (113.9)	26,665 (118.6)
	12-1/2 (318)	15,995 (71.1)	16,290 (72.5)	16,765 (74.6)	17,460 (77.7)	40,720 (181.1)	41,465 (184.4)	42,675 (189.8)	44,445 (197.7)
3/4	3-1/2 (89)	5,105 (22.7)	5,595 (24.9)	6,040 (26.9)	6,290 (28.0)	11,000 (48.9)	12,050 (53.6)	13,010 (57.9)	13,545 (60.3)
	6-3/4 (171)	11,115 (49.4)	11,320 (50.4)	11,650 (51.8)	12,130 (54.0)	23,935 (106.5)	24,375 (108.4)	25,090 (111.6)	26,125 (116.2)
	9 (229)	14,820 (65.9)	15,090 (67.1)	15,530 (69.1)	16,175 (71.9)	31,915 (142.0)	32,500 (144.6)	33,450 (148.8)	34,835 (155.0)
	15 (381)	24,695 (109.8)	25,150 (111.9)	25,885 (115.1)	26,955 (119.9)	53,190 (236.6)	54,170 (241.0)	55,750 (248.0)	58,060 (258.3)
7/8	3-1/2 (89)	5,105 (22.7)	5,595 (24.9)	6,460 (28.7)	7,235 (32.2)	11,000 (48.9)	12,050 (53.6)	13,915 (61.9)	15,585 (69.3)
	7-7/8 (200)	14,915 (66.3)	15,190 (67.6)	15,635 (69.5)	16,280 (72.4)	32,125 (142.9)	32,715 (145.5)	33,670 (149.8)	35,065 (156.0)
	10-1/2 (267)	19,885 (88.5)	20,255 (90.1)	20,845 (92.7)	21,705 (96.5)	42,835 (190.5)	43,620 (194.0)	44,895 (199.7)	46,750 (208.0)
	17-1/2 (445)	33,145 (147.4)	33,755 (150.1)	34,740 (154.5)	36,175 (160.9)	71,390 (317.6)	72,700 (323.4)	74,825 (332.8)	77,920 (346.6)
1	4 (102)	6,240 (27.8)	6,835 (30.4)	7,895 (35.1)	9,360 (41.6)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,165 (89.7)
	9 (229)	19,295 (85.8)	19,650 (87.4)	20,225 (90.0)	21,065 (93.7)	41,565 (184.9)	42,330 (188.3)	43,565 (193.8)	45,365 (201.8)
	12 (305)	25,730 (114.5)	26,205 (116.6)	26,970 (120.0)	28,085 (124.9)	55,420 (246.5)	56,435 (251.0)	58,085 (258.4)	60,490 (269.1)
	20 (508)	42,885 (190.8)	43,670 (194.3)	44,945 (199.9)	46,805 (208.2)	92,365 (410.9)	94,060 (418.4)	96,810 (430.6)	100,815 (448.4)
1-1/4	5 (127)	8,720 (38.8)	9,555 (42.5)	11,030 (49.1)	13,510 (60.1)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)
	11-1/4 (286)	29,290 (130.3)	29,830 (132.7)	30,700 (136.6)	31,970 (142.2)	63,085 (280.6)	64,250 (285.8)	66,125 (294.1)	68,860 (306.3)
	15 (381)	39,055 (173.7)	39,770 (176.9)	40,935 (182.1)	42,625 (189.6)	84,115 (374.2)	85,665 (381.1)	88,165 (392.2)	91,810 (408.4)
	25 (635)	65,090 (289.5)	66,285 (294.8)	68,220 (303.5)	71,045 (316.0)	140,195 (623.6)	142,775 (635.1)	146,940 (653.6)	153,020 (680.7)

1 See section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7 - 18 as necessary to the above values. Compare to the steel values in table 6. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (54°C), max. long term temperature = 110°F (43°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength value by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

Table 5 — Hilti HIT-ICE adhesive design strength with concrete / bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8	2-3/8 (60)	1,100 (4.9)	1,120 (5.0)	1,155 (5.1)	1,200 (5.3)	1,400 (6.2)	1,425 (6.3)	1,470 (6.5)	1,530 (6.8)
	3-3/8 (86)	1,565 (7.0)	1,590 (7.1)	1,640 (7.3)	1,705 (7.6)	3,980 (17.7)	4,055 (18.0)	4,170 (18.5)	4,345 (19.3)
	4-1/2 (114)	2,085 (9.3)	2,125 (9.5)	2,185 (9.7)	2,275 (10.1)	5,305 (23.6)	5,405 (24.0)	5,560 (24.7)	5,790 (25.8)
	7-1/2 (191)	3,475 (15.5)	3,540 (15.7)	3,640 (16.2)	3,795 (16.9)	8,845 (39.3)	9,005 (40.1)	9,270 (41.2)	9,655 (42.9)
1/2	2-3/4 (70)	1,725 (7.7)	1,760 (7.8)	1,810 (8.1)	1,885 (8.4)	3,720 (16.5)	3,790 (16.9)	3,900 (17.3)	4,060 (18.1)
	4-1/2 (114)	2,825 (12.6)	2,880 (12.8)	2,960 (13.2)	3,085 (13.7)	6,085 (27.1)	6,200 (27.6)	6,380 (28.4)	6,645 (29.6)
	6 (152)	3,770 (16.8)	3,835 (17.1)	3,950 (17.6)	4,110 (18.3)	8,115 (36.1)	8,265 (36.8)	8,505 (37.8)	8,855 (39.4)
	10 (254)	6,280 (27.9)	6,395 (28.4)	6,580 (29.3)	6,855 (30.5)	13,525 (60.2)	13,775 (61.3)	14,175 (63.1)	14,760 (65.7)
5/8	3-1/8 (79)	1,755 (7.8)	1,785 (7.9)	1,840 (8.2)	1,915 (8.5)	4,465 (19.9)	4,550 (20.2)	4,680 (20.8)	4,875 (21.7)
	5-5/8 (143)	3,160 (14.1)	3,215 (14.3)	3,310 (14.7)	3,450 (15.3)	8,040 (35.8)	8,190 (36.4)	8,425 (37.5)	8,775 (39.0)
	7-1/2 (191)	4,210 (18.7)	4,290 (19.1)	4,415 (19.6)	4,595 (20.4)	10,720 (47.7)	10,920 (48.6)	11,235 (50.0)	11,700 (52.0)
	12-1/2 (318)	7,020 (31.2)	7,150 (31.8)	7,355 (32.7)	7,660 (34.1)	17,870 (79.5)	18,195 (80.9)	18,730 (83.3)	19,505 (86.8)
3/4	3-1/2 (89)	2,250 (10.0)	2,295 (10.2)	2,360 (10.5)	2,455 (10.9)	4,850 (21.6)	4,940 (22.0)	5,080 (22.6)	5,295 (23.6)
	6-3/4 (171)	4,340 (19.3)	4,420 (19.7)	4,550 (20.2)	4,740 (21.1)	9,350 (41.6)	9,525 (42.4)	9,800 (43.6)	10,205 (45.4)
	9 (229)	5,790 (25.8)	5,895 (26.2)	6,070 (27.0)	6,320 (28.1)	12,470 (55.5)	12,700 (56.5)	13,070 (58.1)	13,610 (60.5)
	15 (381)	9,650 (42.9)	9,825 (43.7)	10,115 (45.0)	10,530 (46.8)	20,780 (92.4)	21,165 (94.1)	21,780 (96.9)	22,685 (100.9)
7/8	3-1/2 (89)	2,030 (9.0)	2,070 (9.2)	2,130 (9.5)	2,220 (9.9)	4,380 (19.5)	4,460 (19.8)	4,590 (20.4)	4,780 (21.3)
	7-7/8 (200)	4,575 (20.4)	4,655 (20.7)	4,795 (21.3)	4,990 (22.2)	9,850 (43.8)	10,030 (44.6)	10,325 (45.9)	10,750 (47.8)
	10-1/2 (267)	6,095 (27.1)	6,210 (27.6)	6,390 (28.4)	6,655 (29.6)	13,135 (58.4)	13,375 (59.5)	13,765 (61.2)	14,335 (63.8)
	17-1/2 (445)	10,160 (45.2)	10,350 (46.0)	10,650 (47.4)	11,090 (49.3)	21,890 (97.4)	22,290 (99.2)	22,940 (102.0)	23,890 (106.3)

1 See section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7-18 as necessary to the above values. Compare to the steel values in table 6. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (54°C), max. long term temperature = 110°F (43°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength value by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for static loads only. Seismic applications are not permitted.

Table 6 — Steel design strength for Hilti HAS threaded rods for use with ACI 318 Chapter 17

Nominal anchor diameter in.	HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr. 36[4,5]			HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6]			HAS-B-105 and HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4]			HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4]		
	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)
3/8	3,370 (15.0)	1,750 (7.8)	1,050 (4.7)	4,360 (19.4)	2,270 (10.1)	1,590 (7.1)	7,270 (32.3)	3,780 (16.8)	2,645 (11.8)	5,040 (22.4)	2,790 (12.4)	1,955 (8.7)
1/2	6,175 (27.5)	3,210 (14.3)	1,925 (8.6)	7,985 (35.5)	4,150 (18.5)	2,905 (12.9)	13,305 (59.2)	6,920 (30.8)	4,845 (21.6)	9,225 (41.0)	5,110 (22.7)	3,575 (15.9)
5/8	9,835 (43.7)	5,110 (22.7)	3,065 (13.6)	12,715 (56.6)	6,610 (29.4)	4,625 (20.6)	21,190 (94.3)	11,020 (49.0)	7,715 (34.3)	14,690 (65.3)	8,135 (36.2)	5,695 (25.3)
3/4	14,550 (64.7)	7,565 (33.7)	4,540 (20.2)	18,820 (83.7)	9,785 (43.5)	6,850 (30.5)	31,360 (139.5)	16,310 (72.6)	11,415 (50.8)	18,485 (82.2)	10,235 (45.5)	7,165 (31.9)
7/8	20,085 (89.3)	10,445 (46.5)	6,265 (27.9)	25,975 (115.5)	13,505 (60.1)	9,455 (42.1)	43,285 (192.5)	22,510 (100.1)	15,755 (70.1)	25,510 (113.5)	14,125 (62.8)	9,890 (44.0)
1	26,350 (117.2)	13,700 (60.9)	8,220 (36.6)	34,075 (151.6)	17,720 (78.8)	12,405 (55.2)	56,785 (252.6)	29,530 (131.4)	20,670 (91.9)	33,465 (148.9)	18,535 (82.4)	12,975 (57.7)
1-1/4	42,160 (187.5)	21,920 (97.5)	13,150 (58.5)	54,515 (242.5)	28,345 (126.1)	19,840 (88.3)	90,855 (404.1)	47,245 (210.2)	33,070 (147.1)	41,430 (184.3)	21,545 (95.8)	12,925 (57.5)

1 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 17.4.1.2

2 Shear = $\phi\ 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 17.5.1.2b.

3 Seismic Shear = $\alpha_{V,seis} \phi V_{sa}$: Reduction factor for seismic shear only. See ACI 318 for additional information on seismic applications.

4 HAS-V, HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).

5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.

6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

Table 7 — Load adjustment factors for 3/8-in. diameter threaded rods in uncracked concrete[1,2,3]

3/8-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To edge f_{RV}							
Embedment h_{ef}	in.	(mm)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.44	0.32	0.23	0.13	n/a	n/a	n/a	n/a	0.30	0.11	0.08	0.05	0.44	0.22	0.16	0.10	n/a	n/a	n/a	n/a
	1-7/8	(48)	0.61	0.59	0.57	0.54	0.46	0.33	0.24	0.14	0.58	0.54	0.53	0.52	0.33	0.12	0.09	0.05	0.46	0.24	0.18	0.10	n/a	n/a	n/a	n/a
	2	(51)	0.62	0.60	0.57	0.54	0.48	0.34	0.25	0.14	0.59	0.54	0.54	0.53	0.36	0.13	0.10	0.06	0.48	0.27	0.20	0.12	n/a	n/a	n/a	n/a
	3	(76)	0.69	0.65	0.61	0.57	0.61	0.43	0.31	0.18	0.63	0.57	0.55	0.54	0.66	0.25	0.18	0.11	0.61	0.43	0.31	0.18	n/a	n/a	n/a	n/a
	3-5/8	(92)	0.72	0.68	0.63	0.58	0.71	0.50	0.36	0.21	0.65	0.58	0.56	0.55	0.88	0.33	0.24	0.15	0.71	0.49	0.36	0.21	0.78	n/a	n/a	n/a
	4	(102)	0.74	0.70	0.65	0.59	0.79	0.53	0.38	0.22	0.67	0.59	0.57	0.55	1.00	0.38	0.28	0.17	0.79	0.53	0.38	0.23	0.82	n/a	n/a	n/a
	4-5/8	(117)	0.78	0.73	0.671	0.60	0.91	0.61	0.44	0.26	0.70	0.60	0.58	0.56		0.47	0.35	0.21	0.91	0.61	0.44	0.26	0.89	0.63	n/a	n/a
	5	(127)	0.80	0.75	0.69	0.61	0.98	0.66	0.48	0.28	0.71	0.61	0.60	0.56		0.53	0.40	0.24	0.98	0.66	0.48	0.28	0.92	0.66	n/a	n/a
	5-3/4	(146)	0.85	0.78	0.71	0.68	1.00	0.75	0.55	0.32	0.74	0.63	0.60	0.57		0.65	0.49	0.30	1.00	0.75	0.55	0.32	0.99	0.71	0.64	n/a
	6	(152)	0.86	0.80	0.72	0.63		0.79	0.57	0.332	0.75	0.63	0.61	0.58		0.69	0.52	0.31		0.79	0.57	0.33	1.00	0.72	0.66	n/a
	7	(178)	0.93	0.85	0.76	0.66		0.92	0.67	0.39	0.80	0.65	0.63	0.59		0.87	0.65	0.40		0.92	0.67	0.39		0.78	0.71	n/a
	8	(203)	0.99	0.90	0.80	0.68		1.00	0.76	0.44	0.84	0.67	0.64	0.60		1.00	0.80	0.48		1.00	0.76	0.44		0.83	0.76	n/a
	8-3/4	(222)	1.00	0.93	0.82	0.69			0.84	0.48	0.87	0.69	0.66	0.61			0.91	0.55			0.84	0.48		0.87	0.80	0.67
	9	(229)		0.94	0.83	0.70			0.86	0.50	0.88	0.70	0.66	0.62			0.95	0.57			0.86	0.50		0.88	0.80	0.68
	10	(254)		0.99	0.87	0.72			0.96	0.55	0.92	0.72	0.68	0.63			1.00	0.67			0.96	0.55		0.93	0.85	0.71
	11	(279)		1.00	0.91	0.74			1.00	0.61	0.97	0.74	0.70	0.64				0.77			1.00	0.61		0.98	0.89	0.75
	12	(305)			0.94	0.77				0.66	1.00	0.76	0.72	0.65				0.88				0.66		1.00	0.93	0.78
	14	(356)			1.00	0.81				0.78		0.80	0.75	0.68				1.00				0.78			1.00	0.85
	16	(406)				0.86				0.88		0.85	0.79	0.70								0.89				0.91
	18	(457)				0.90				1.00		0.89	0.82	0.73								0.10				0.96
	24	(610)				1.00						1.00	0.93	0.81								1.00				1.00
	30	(762)											1.00	0.88												
	36	(914)												0.96												
	>48	(1219)												1.00												

Table 8 — Load adjustment factors for 3/8-in. diameter threaded rods in cracked concrete[1,2,3]

3/8-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To edge f_{RV}							
Embedment h_{ef}	in.	(mm)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	2-3/8 (60)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.59	0.54	0.49	0.43	n/a	n/a	n/a	n/a	0.36	0.13	0.10	0.06	0.59	0.27	0.20	0.12	n/a	n/a	n/a	n/a
	1-7/8	(48)	0.61	0.59	0.57	0.54	0.61	0.56	0.50	0.44	0.59	0.55	0.54	0.53	0.40	0.15	0.11	0.07	0.61	0.30	0.22	0.13	n/a	n/a	n/a	n/a
	2	(51)	0.62	0.60	0.57	0.54	0.63	0.57	0.51	0.44	0.60	0.55	0.54	0.53	0.44	0.16	0.12	0.07	0.63	0.32	0.24	0.15	n/a	n/a	n/a	n/a
	3	(76)	0.68	0.65	0.61	0.57	0.79	0.70	0.60	0.49	0.64	0.57	0.56	0.54	0.81	0.30	0.22	0.13	0.79	0.59	0.45	0.27	n/a	n/a	n/a	n/a
	3-5/8	(92)	0.72	0.68	0.63	0.58	0.91	0.79	0.66	0.53	0.67	0.59	0.57	0.55	1.00	0.40	0.30	0.18	0.91	0.79	0.59	0.36	0.84	n/a	n/a	n/a
	4	(102)	0.74	0.70	0.65	0.59	0.98	0.84	0.70	0.55	0.69	0.60	0.58	0.56		0.46	0.34	0.21	0.98	0.84	0.69	0.41	0.88	n/a	n/a	n/a
	4-5/8	(117)	0.78	0.73	0.67	0.60	1.00	0.93	0.76	0.58	0.72	0.61	0.59	0.57		0.57	0.43	0.26	1.00	0.93	0.76	0.51	0.94	0.68	n/a	n/a
	5	(127)	0.804	0.75	0.69	0.61		0.99	0.80	0.60	0.74	0.62	0.61	0.57		0.64	0.48	0.29		0.99	0.80	0.58	0.98	0.70	n/a	n/a
	5-3/4	(146)	0.85	0.78	0.71	0.63		1.00	0.89	0.65	0.78	0.64	0.62	0.58		0.79	0.59	0.36		1.00	0.89	0.65	1.00	0.75	0.69	n/a
	6	(152)	0.86	0.80	0.72	0.63			0.91	0.66	0.79	0.65	0.62	0.59		0.84	0.63	0.38			0.91	0.66		0.77	0.70	n/a
	7	(178)	0.93	0.85	0.76	0.66			1.00	0.72	0.84	0.67	0.64	0.60		1.00	0.79	0.48			1.00	0.72		0.83	0.76	n/a
	8	(203)	0.99	0.90	0.80	0.68				0.78	0.89	0.70	0.66	0.62			0.97	0.58				0.78		0.89	0.81	n/a
	8-3/4	(222)	1.00	0.93	0.82	0.69				0.83	0.92	0.72	0.68	0.63			1.00	0.67				0.83		0.93	0.85	0.71
	9	(229)		0.94	0.83	0.70				0.85	0.93	0.72	0.68	0.63				0.70				0.85		0.94	0.86	0.72
	10	(254)		0.99	0.87	0.72				0.91	0.98	0.75	0.70	0.65				0.81				0.91		0.99	0.90	0.76
	11	(279)		1.00	0.91	0.74				0.98	1.00	0.77	0.73	0.66				0.92				0.98		1.00	0.95	0.80
	12	(305)			0.94	0.76				1.00		0.80	0.75	0.67				1.00				1.00			0.99	0.84
	14	(356)			1.00	0.81						0.85	0.79	0.70											1.000	0.90
	16	(406)				0.86						0.90	0.83	0.73												0.96
	18	(457)				0.90						0.95	0.87	0.76												1.00
	24	(610)				1.00						1.00	0.99	0.85												
	30	(762)											1.00	0.94												
	36	(914)												1.00												
	>48	(1219)																								

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for $5d \le s \le 16$-in. and to 0.5 T_{max} for $s > 16$-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3{*}h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \ge 3{*}h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \ge 3{*}h_{ef}$, then $f_{HV} = 1.0$.

Table 9 — Load adjustment factors for 1/2-in. diameter threaded rods in uncracked concrete[1,2,3]

1/2-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To edge f_{RV}							
Embedment h_{ef}		in. (mm)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.404	0.275	0.20	0.12	n/a	n/a	n/a	n/a	0.11	0.07	0.05	0.03	0.22	0.14	0.11	0.06	n/a	n/a	n/a	n/a
	2-1/2	(64)	0.62	0.59	0.57	0.54	0.49	0.32	0.24	0.14	0.55	0.54	0.53	0.52	0.19	0.12	0.09	0.06	0.37	0.25	0.18	0.11	n/a	n/a	n/a	n/a
	3	(76)	0.64	0.61	0.58	0.55	0.54	0.35	0.26	0.15	0.57	0.55	0.54	0.53	0.24	0.16	0.12	0.07	0.49	0.32	0.24	0.15	n/a	n/a	n/a	n/a
	4	(102)	0.68	0.65	0.61	0.57	0.67	0.42	0.31	0.18	0.59	0.57	0.55	0.54	0.38	0.25	0.19	0.11	0.67	0.42	0.31	0.18	0.59	n/a	n/a	n/a
	5	(127)	0.73	0.69	0.64	0.58	0.83	0.49	0.36	0.21	0.61	0.58	0.57	0.55	0.53	0.35	0.26	0.16	0.83	0.49	0.36	0.21	0.66	n/a	n/a	n/a
	5-3/4	(146)	0.76	0.71	0.66	0.60	0.96	0.55	0.41	0.24	0.63	0.59	0.58	0.56	0.65	0.43	0.32	0.19	0.96	0.55	0.41	0.24	0.71	0.62	n/a	n/a
	6	(152)	0.78	0.72	0.67	0.60	1.00	0.58	0.42	0.25	0.63	0.60	0.58	0.56	0.69	0.46	0.34	0.21	1.00	0.58	0.42	0.25	0.72	0.63	n/a	n/a
	7	(178)	0.82	0.76	0.69	0.62		0.67	0.49	0.29	0.65	0.62	0.60	0.57	0.87	0.57	0.43	0.26		0.67	0.49	0.29	0.78	0.68	n/a	n/a
	7-1/4	(184)	0.83	0.77	0.70	0.62		0.70	0.5	0.30	0.66	0.62	0.60	0.57	0.92	0.60	0.45	0.27		0.69	0.51	0.30	0.79	0.69	0.63	n/a
	8	(203)	0.87	0.80	0.72	0.63		0.77	0.56	0.33	0.67	0.63	0.61	0.58	1.00	0.70	0.53	0.32		0.77	0.56	0.33	0.83	0.73	0.66	n/a
	9	(229)	0.91	0.83	0.75	0.65		0.86	0.63	0.37	0.70	0.65	0.62	0.59		0.84	0.63	0.38		0.86	0.63	0.37	0.88	0.77	0.70	n/a
	10	(254)	0.96	0.87	0.78	0.67		0.96	0.70	0.41	0.72	0.66	0.64	0.60		0.98	0.73	0.44		0.96	0.70	0.41	0.93	0.81	0.74	n/a
	11-1/4	(286)	1.00	0.92	0.81	0.69		1.00	0.79	0.46	0.74	0.69	0.65	0.61		1.00	0.88	0.53		1.00	0.79	0.46	0.99	0.86	0.78	0.66
	12	(305)		0.94	0.83	0.70			0.85	0.49	0.76	0.70	0.66	0.62			0.97	0.58			0.85	0.49	1.00	0.89	0.81	0.69
	14	(356)		1.00	0.89	0.73			0.99	0.58	0.80	0.73	0.69	0.64			1.00	0.73			0.99	0.58		0.96	0.87	0.74
	16	(406)			0.94	0.77			1.00	0.66	0.85	0.76	0.72	0.65				0.89			1.00	0.66		1.00	0.93	0.79
	18	(457)			1.00	0.80				0.74	0.89	0.80	0.74	0.67				1.00				0.74			0.99	0.83
	20	(508)				0.83				0.82	0.93	0.83	0.77	0.69								0.82			1.00	0.88
	22	(559)				0.87				0.91	0.98	0.86	0.80	0.71								0.91				0.92
	24	(610)				0.90				0.99	1.00	0.89	0.83	0.73								0.99				0.96
	30	(762)				1.00				1.00		0.99	0.91	0.79								1.00				1.00
	36	(914)										1.00	0.99	0.85												
	>48	(1219)											1.00	0.96												

Table 10 — Load adjustment factors for 1/2-in. diameter threaded rods in cracked concrete[1,2,3]

1/2-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				‖ To edge f_{RV}							
Embedment h_{ef}		in. (mm)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.526	0.49	0.45	0.41	n/a	n/a	n/a	n/a	0.15	0.10	0.08	0.05	0.30	0.20	0.15	0.09	n/a	n/a	n/a	n/a
	2-1/2	(64)	0.62	0.59	0.57	0.54	0.61	0.56	0.50	0.44	0.57	0.55	0.54	0.53	0.26	0.17	0.13	0.08	0.52	0.34	0.26	0.15	n/a	n/a	n/a	n/a
	3	(76)	0.64	0.61	0.58	0.55	0.67	0.60	0.53	0.46	0.58	0.56	0.55	0.54	0.34	0.22	0.17	0.10	0.67	0.45	0.34	0.20	n/a	n/a	n/a	n/a
	4	(102)	0.68	0.65	0.61	0.57	0.80	0.70	0.60	0.49	0.61	0.58	0.57	0.549	0.52	0.35	0.26	0.16	0.80	0.69	0.52	0.31	0.66	n/a	n/a	n/a
	5	(127)	0.73	0.69	0.64	0.58	0.93	0.80	0.67	0.53	0.64	0.60	0.59	0.56	0.73	0.48	0.36	0.22	0.93	0.80	0.67	0.43	0.736	n/a	n/a	n/a
	5-3/4	(146)	0.76	0.71	0.66	0.60	1.00	0.89	0.73	0.56	0.66	0.62	0.60	0.57	0.90	0.60	0.45	0.27	1.00	0.89	0.73	0.54	0.79	0.69	n/a	n/a
	6	(152)	0.78	0.72	0.67	0.60		0.91	0.75	0.57	0.66	0.62	0.60	0.57	0.96	0.63	0.48	0.29		0.91	0.75	0.57	0.81	0.70	n/a	n/a
	7	(178)	0.82	0.76	0.69	0.62		1.00	0.83	0.62	0.69	0.64	0.62	0.58	1.00	0.80	0.60	0.36		1.00	0.83	0.62	0.87	0.76	n/a	n/a
	7-1/4	(184)	0.83	0.77	0.70	0.62			0.85	0.63	0.70	0.65	0.62	0.59		0.84	0.63	0.38			0.85	0.63	0.89	0.77	0.70	n/a
	8	(203)	0.87	0.80	0.72	0.63			0.91	0.66	0.72	0.66	0.64	0.60		0.98	0.73	0.44			0.91	0.66	0.93	0.81	0.74	n/a
	9	(229)	0.91	0.83	0.75	0.65			1.00	0.70	0.74	0.69	0.65	0.61		1.00	0.87	0.52			1.00	0.70	0.99	0.86	0.78	n/a
	10	(254)	0.96	0.87	0.78	0.67				0.75	0.77	0.71	0.67	0.62			1.00	0.61				0.75	1.00	0.91	0.82	n/a
	11-1/4	(286)	1.00	0.92	0.81	0.69				0.81	0.81	0.73	0.69	0.64				0.73				0.81		0.96	0.87	0.74
	12	(305)		0.94	0.83	0.70				0.85	0.83	0.75	0.70	0.64				0.81				0.85		0.99	0.90	0.76
	14	(356)		1.00	0.89	0.73				0.95	0.88	0.79	0.74	0.67				1.00				0.95		1.00	0.97	0.82
	16	(406)			0.94	0.77				1.00	0.93	0.83	0.77	0.69								1.00			1.00	0.88
	18	(457)			1.00	0.80					0.99	0.87	0.81	0.72												0.93
	20	(508)				0.83					1.00	0.91	0.84	0.74												0.98
	22	(559)				0.87						0.95	0.87	0.77												1.00
	24	(610)				0.90						0.99	0.91	0.79												
	30	(762)				1.00						1.00	1.00	0.86												
	36	(914)												0.93												
	>48	(1219)												1.00												

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when c < 3*h_{ef}. f_{AV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{AV} = f_{AN}.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{HV} = 1.0.

Table 11 — Load adjustment factors for 5/8-in. diameter threaded rods in uncracked concrete[1,2,3]

5/8-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To edge f_{RV}							
Embedment h_{ef}	in.	(mm)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.39	0.26	0.19	0.11	n/a	n/a	n/a	n/a	0.09	0.05	0.04	0.02	0.187	0.10	0.08	0.05	n/a	n/a	n/a	n/a
	3-1/8	(79)	0.62	0.60	0.57	0.54	0.52	0.32	0.23	0.14	0.56	0.54	0.53	0.52	0.22	0.12	0.09	0.06	0.45	0.25	0.19	0.11	n/a	n/a	n/a	n/a
	4	(102)	0.65	0.62	0.59	0.55	0.62	0.36	0.27	0.16	0.58	0.55	0.54	0.53	0.32	0.18	0.14	0.08	0.62	0.36	0.27	0.16	n/a	n/a	n/a	n/a
	4-5/8	(117)	0.67	0.64	0.60	0.56	0.69	0.40	0.29	0.17	0.59	0.56	0.55	0.54	0.40	0.22	0.17	0.10	0.69	0.40	0.29	0.17	0.60	n/a	n/a	n/a
	5	(127)	0.68	0.648	0.61	0.57	0.74	0.42	0.31	0.18	0.60	0.57	0.56	0.54	0.45	0.25	0.19	0.11	0.74	0.42	0.31	0.18	0.63	n/a	n/a	n/a
	6	(152)	0.72	0.68	0.63	0.58	0.891	0.47	0.35	0.20	0.62	0.58	0.57	0.55	0.59	0.33	0.25	0.15	0.89	0.47	0.35	0.20	0.69	n/a	n/a	n/a
	7	(178)	0.76	0.71	0.66	0.59	1.00	0.54	0.40	0.23	0.64	0.59	0.58	0.55	0.75	0.42	0.31	0.19	1.00	0.54	0.40	0.23	0.74	n/a	n/a	n/a
	7-1/8	(181)	0.76	0.71	0.66	0.60		0.55	0.40	0.24	0.64	0.59	0.58	0.56	0.77	0.43	0.32	0.19		0.55	0.40	0.24	0.75	0.62	n/a	n/a
	8	(203)	0.80	0.74	0.68	0.61		0.62	0.45	0.27	0.66	0.61	0.59	0.56	0.91	0.51	0.38	0.23		0.62	0.45	0.27	0.79	0.65	n/a	n/a
	9	(229)	0.83	0.77	0.70	0.62		0.69	0.51	0.30	0.68	0.62	0.60	0.57	1.00	0.61	0.45	0.27		0.69	0.51	0.30	0.84	0.69	0.63	n/a
	10	(254)	0.87	0.80	0.72	0.63		0.77	0.57	0.33	0.70	0.63	0.61	0.58		0.71	0.53	0.32		0.77	0.57	0.33	0.89	0.73	0.6	n/a
	11	(279)	0.91	0.83	0.74	0.65		0.85	0.62	0.36	0.72	0.65	0.62	0.59		0.82	0.61	0.37		0.85	0.62	0.36	0.93	0.76	0.694	n/a
	12	(305)	0.94	0.86	0.77	0.66		0.92	0.68	0.40	0.74	0.66	0.63	0.59		0.93	0.70	0.42		0.92	0.68	0.40	0.97	0.80	0.73	n/a
	14	(356)	1.00	0.92	0.81	0.69		1.00	0.79	0.46	0.77	0.69	0.65	0.61		1.00	0.88	0.53		1.00	0.79	0.46	1.00	0.86	0.78	0.66
	16	(406)		0.97	0.86	0.71			0.90	0.53	0.81	0.71	0.68	0.63			1.00	0.65			0.90	0.53		0.92	0.84	0.71
	18	(457)		1.00	0.90	0.74			1.00	0.60	0.85	0.74	0.70	0.64				0.77			1.00	0.60		0.98	0.89	0.75
	20	(508)			0.94	0.77				0.66	0.89	0.77	0.72	0.66				0.90				0.66		1.00	0.94	0.79
	22	(559)			0.99	0.79				0.73	0.93	0.80	0.74	0.67				1.00				0.73			0.98	0.83
	24	(610)			1.00	0.82				0.79	0.97	0.82	0.76	0.69								0.79			1.00	0.86
	26	(660)				0.85				0.86	1.00	0.85	0.79	0.70								0.86				0.90
	28	(711)				0.87				0.93		0.87	0.81	0.72								0.93				0.93
	30	(762)				0.90				0.99		0.90	0.83	0.73								0.99				0.97
	36	(914)				0.98				1.00		0.98	0.89	0.78								1.00				1.00
	> 48	(1219)				1.00						1.00	1.00	0.87												

Table 12 — Load adjustment factors for 5/8-in. diameter threaded rods in cracked concrete[1,2,3]

5/8-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To edge f_{RV}							
Embedment h_{ef}	in.	(mm)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)	3-1/8 (79)	5-5/8 (143)	7-1/2 (191)	12-1/2 (318)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.49	0.46	0.43	0.40	n/a	n/a	n/a	n/a	0.14	0.09	0.06	0.04	0.28	0.17	0.13	0.08	n/a	n/a	n/a	n/a
	3-1/8	(79)	0.62	0.59	0.57	0.54	0.61	0.56	0.50	0.44	0.58	0.56	0.55	0.53	0.33	0.20	0.15	0.09	0.61	0.40	0.30	0.18	n/a	n/a	n/a	n/a
	4	(102)	0.65	0.62	0.59	0.55	0.70	0.62	0.55	0.46	0.602	0.57	0.56	0.54	0.48	0.29	0.22	0.13	0.70	0.58	0.44	0.26	n/a	n/a	n/a	n/a
	4-5/8	(117)	0.67	0.64	0.60	0.56	0.76	0.67	0.58	0.48	0.62	0.59	0.57	0.55	0.60	0.36	0.27	0.16	0.76	0.67	0.55	0.33	0.69	n/a	n/a	n/a
	5	(127)	0.68	0.65	0.61	0.57	0.80	0.70	0.60	0.49	0.63	0.59	0.58	0.55	0.67	0.41	0.31	0.18	0.80	0.70	0.60	0.37	0.71	n/a	n/a	n/a
	6	(152)	0.72	0.68	0.63	0.58	0.91	0.78	0.66	0.53	0.65	0.61	0.59	0.57	0.88	0.54	0.40	0.24	0.91	0.78	0.66	0.48	0.78	n/a	n/a	n/a
	7	(178)	0.76	0.71	0.66	0.59	1.00	0.87	0.72	0.56	0.68	0.63	0.61	0.58	1.00	0.68	0.51	0.30	1.00	0.87	0.72	0.56	0.85	n/a	n/a	n/a
	7-1/8	(181)	0.76	0.71	0.66	0.60		0.88	0.73	0.56	0.68	0.63	0.61	0.58		0.69	0.52	0.31		0.88	0.73	0.56	0.85	0.72	n/a	n/a
	8	(203)	0.80	0.74	0.68	0.61		0.96	0.78	0.60	0.70	0.65	0.62	0.59		0.83	0.62	0.37		0.96	0.78	0.59	0.90	0.77	n/a	n/a
	9	(229)	0.83	0.77	0.70	0.62		1.00	0.85	0.63	0.73	0.67	0.64	0.60		0.99	0.74	0.44		1.00	0.85	0.63	0.96	0.81	0.74	n/a
	10	(254)	0.87	0.80	0.72	0.63			0.91	0.66	0.76	0.68	0.65	0.61		1.00	0.87	0.52			0.91	0.66	1.00	0.86	0.78	n/a
	11	(279)	0.91	0.83	0.74	0.65			0.98	0.70	0.78	0.70	0.67	0.62			1.00	0.60			0.98	0.70		0.90	0.82	n/a
	12	(305)	0.94	0.86	0.77	0.66			1.00	0.73	0.81	0.72	0.68	0.63				0.68			1.00	0.73		0.94	0.85	n/a
	14	(356)	1.00	0.92	0.81	0.69				0.81	0.86	0.76	0.71	0.65				0.86				0.81		1.00	0.92	0.78
	16	(406)		0.97	0.86	0.71				0.89	0.91	0.79	0.74	0.67				1.00				0.89			0.98	0.83
	18	(457)		1.00	0.90	0.74				0.97	0.96	0.83	0.77	0.69								0.97			1.00	0.88
	20	(508)			0.94	0.77				1.00	1.00	0.87	0.80	0.72								1.00				0.93
	22	(559)			0.99	0.79						0.90	0.83	0.74												0.97
	24	(610)			1.00	0.82						0.94	0.86	0.76												1.00
	26	(660)				0.85						0.98	0.89	0.78												
	28	(711)				0.87						1.00	0.92	0.80												
	30	(762)				0.90							0.95	0.82												
	36	(914)				0.98							1.00	0.89												
	> 48	(1219)				1.00								1.00												

[1] Linear interpolation not permitted

[2] Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{HV} = 1.0$.

Table 13 — Load adjustment factors for 3/4-in. diameter threaded rods in uncracked concrete[1,2,3]

3/4-in. threaded rods uncracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
														⊥ Toward edge f_{RV}				‖ To edge f_{RV}							
Embedment h_{ef}	in.	3-1/2	6-3/4	9	15	3-1/2	6-3/4	9	15	3-1/2	6-3/4	9	15	3-1/2	6-3/4	9	15	3-1/2	6-3/4	9	15	3-1/2	6-3/4	9	15
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	(mm)	(89)	(171)	(229)	(381)	(89)	(171)	(229)	(381)	(89)	(171)	(229)	(381)	(89)	(171)	(229)	(381)	(89)	(171)	(229)	(381)	(89)	(171)	(229)	(381)
1-3/4	(44)	n/a	n/a	n/a	n/a	0.39	0.24	0.18	0.10	n/a	n/a	n/a	n/a	0.09	0.04	0.03	0.02	0.17	0.09	0.06	0.04	n/a	n/a	n/a	n/a
3-3/4	(95)	0.62	0.59	0.57	0.54	0.57	0.32	0.24	0.14	0.57	0.54	0.54	0.53	0.27	0.13	0.10	0.06	0.53	0.27	0.20	0.12	n/a	n/a	n/a	n/a
4	(102)	0.63	0.60	0.57	0.54	0.60	0.33	0.25	0.14	0.57	0.55	0.54	0.53	0.29	0.15	0.11	0.07	0.59	0.30	0.22	0.13	n/a	n/a	n/a	n/a
5	(127)	0.66	0.62	0.59	0.56	0.70	0.38	0.28	0.16	0.59	0.56	0.55	0.53	0.41	0.21	0.15	0.09	0.70	0.38	0.28	0.16	n/a	n/a	n/a	n/a
5-1/4	(133)	0.67	0.63	0.60	0.56	0.73	0.39	0.29	0.17	0.60	0.56	0.55	0.54	0.44	0.22	0.17	0.10	0.73	0.39	0.29	0.17	0.62	n/a	n/a	n/a
6	(152)	0.69	0.65	0.61	0.57	0.83	0.43	0.31	0.18	0.61	0.57	0.56	0.54	0.54	0.27	0.20	0.12	0.83	0.41	0.31	0.18	0.67	n/a	n/a	n/a
7	(178)	0.73	0.67	0.63	0.58	0.92	0.48	0.35	0.21	0.63	0.58	0.57	0.55	0.68	0.34	0.26	0.15	0.92	0.48	0.35	0.21	0.72	n/a	n/a	n/a
8	(203)	0.76	0.70	0.65	0.59	1.00	0.53	0.39	0.23	0.65	0.59	0.58	0.56	0.83	0.42	0.31	0.19	1.00	0.53	0.39	0.23	0.77	n/a	n/a	n/a
8-1/2	(216)	0.77	0.71	0.66	0.59		0.57	0.42	0.24	0.66	0.60	0.58	0.56	0.91	0.46	0.34	0.21		0.57	0.42	0.24	0.79	0.63	n/a	n/a
9	(229)	0.79	0.72	0.67	0.60		0.60	0.44	0.26	0.67	0.61	0.59	0.56	0.99	0.50	0.37	0.22		0.60	0.44	0.26	0.81	0.65	n/a	n/a
10	(254)	0.82	0.75	0.69	0.61		0.67	0.49	0.27	0.68	0.62	0.60	0.57	1.00	0.58	0.44	0.26		0.67	0.49	0.29	0.86	0.68	n/a	n/a
10-3/4	(273)	0.85	0.77	0.70	0.62		0.72	0.53	0.31	0.70	0.63	0.60	0.57		0.65	0.49	0.29		0.72	0.53	0.31	0.89	0.71	0.64	n/a
12	(305)	0.89	0.80	0.72	0.63		0.80	0.59	0.34	0.72	0.64	0.62	0.58		0.77	0.57	0.35		0.80	0.59	0.34	0.94	0.75	0.68	n/a
14	(356)	0.95	0.85	0.76	0.66		0.93	0.69	0.40	0.76	0.66	0.63	0.60		0.97	0.72	0.43		0.931	0.68	0.40	1.00	0.81	0.73	n/a
16	(406)	1.00	0.90	0.80	0.68		1.00	0.79	0.46	0.80	0.69	0.65	0.61		1.00	0.89	0.53		1.00	0.78	0.46		0.86	0.78	n/a
16-3/4	(425)		0.91	0.81	0.69			0.82	0.48	0.81	0.70	0.66	0.61			0.95	0.57			0.82	0.48		0.88	0.80	0.68
18	(457)		0.94	0.83	0.70			0.88	0.52	0.83	0.71	0.67	0.62			1.00	0.63			0.88	0.52		0.92	0.83	0.70
20	(508)		0.99	0.87	0.72			0.98	0.57	0.87	0.73	0.69	0.64				0.74			0.98	0.57		0.96	0.88	0.74
22	(559)		1.00	0.91	0.74			1.00	0.63	0.91	0.76	0.71	0.65				0.86			1.00	0.63		1.00	0.92	0.78
24	(610)			0.94	0.77				0.69	0.94	0.78	0.73	0.66				0.98				0.69			0.96	0.81
26	(660)			0.98	0.79				0.74	0.98	0.80	0.75	0.68				1.00				0.74			1.00	0.84
28	(711)			1.00	0.81				0.80	1.00	0.83	0.77	0.69								0.80				0.87
30	(762)				0.83				0.86		0.85	0.79	0.71								0.86				0.91
36	(914)				0.90				1.00		0.92	0.85	0.75								1.00				0.99
> 48	(1219)				1.00						1.00	0.96	0.83												1.00

Table 14 — Load adjustment factors for 3/4-in. diameter threaded rods in cracked concrete[1,2,3]

3/4-in. threaded rods cracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
														⊥ Toward edge f_{RV}				‖ To edge f_{RV}							
Embedment h_{ef}	in.	3-1/2	6-3/4	9	15	3-1/2	6-3/4	9	15	3-1/2	6-3/4	9	15	3-1/2	6-3/4	9	15	3-1/2	6-3/4	9	15	3-1/2	6-3/4	9	15
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	(mm)	(89)	(171)	(229)	(381)	(89)	(171)	(229)	(381)	(89)	(171)	(229)	(381)	(89)	(171)	(229)	(381)	(89)	(171)	(229)	(381)	(89)	(171)	(229)	(381)
1-3/4	(44)	n/a	n/a	n/a	n/a	0.47	0.44	0.42	0.39	n/a	n/a	n/a	n/a	0.14	0.08	0.06	0.04	0.28	0.16	0.12	0.07	n/a	n/a	n/a	n/a
3-3/4	(95)	0.62	0.59	0.57	0.54	0.63	0.56	0.50	0.44	0.60	0.57	0.55	0.54	0.43	0.25	0.18	0.11	0.63	0.49	0.37	0.22	n/a	n/a	n/a	n/a
4	(102)	0.63	0.60	0.57	0.54	0.65	0.57	0.51	0.44	0.60	0.57	0.56	0.54	0.48	0.27	0.20	0.12	0.65	0.56	0.40	0.24	n/a	n/a	n/a	n/a
5	(127)	0.66	0.62	0.59	0.56	0.74	0.63	0.56	0.47	0.63	0.59	0.57	0.55	0.67	0.38	0.28	0.17	0.74	0.63	0.56	0.34	n/a	n/a	n/a	n/a
5-1/4	(133)	0.67	0.63	0.60	0.56	0.76	0.65	0.57	0.48	0.63	0.59	0.58	0.55	0.72	0.41	0.30	0.18	0.76	0.65	0.57	0.37	0.73	n/a	n/a	n/a
6	(152)	0.70	0.65	0.61	0.57	0.83	0.70	0.60	0.49	0.65	0.60	0.59	0.56	0.88	0.50	0.37	0.22	0.83	0.70	0.61	0.45	0.78	n/a	n/a	n/a
7	(178)	0.73	0.67	0.63	0.58	0.92	0.77	0.65	0.52	0.68	0.62	0.60	0.57	1.00	0.62	0.47	0.28	0.92	0.77	0.65	0.52	0.84	n/a	n/a	n/a
8	(203)	0.76	0.70	0.65	0.59	1.00	0.84	0.70	0.55	0.70	0.64	0.62	0.58		0.76	0.57	0.34	1.00	0.84	0.70	0.55	0.90	n/a	n/a	n/a
8-1/2	(216)	0.78	0.71	0.66	0.59		0.88	0.72	0.56	0.72	0.65	0.62	0.59		0.84	0.63	0.38		0.88	0.72	0.56	0.93	0.77	n/a	n/a
9	(229)	0.80	0.72	0.67	0.60		0.91	0.75	0.57	0.73	0.66	0.63	0.59		0.91	0.68	0.41		0.91	0.75	0.57	0.96	0.79	n/a	n/a
10	(254)	0.82	0.75	0.69	0.61		0.99	0.80	0.60	0.75	0.67	0.64	0.60		1.00	0.80	0.48		0.99	0.80	0.60	1.00	0.83	n/a	n/a
10-3/4	(273)	0.85	0.77	0.70	0.62		1.00	0.84	0.62	0.77	0.69	0.65	0.61			0.90	0.53		1.00	0.84	0.62		0.87	0.79	n/a
12	(305)	0.89	0.80	0.72	0.63			0.91	0.66	0.81	0.71	0.67	0.62			1.00	0.63			0.91	0.66		0.91	0.83	n/a
14	(356)	0.95	0.85	0.76	0.66			1.00	0.72	0.86	0.74	0.70	0.64				0.79			1.00	0.72		0.99	0.90	n/a
16	(406)	1.00	0.90	0.80	0.68				0.78	0.91	0.78	0.73	0.66				0.97				0.78		1.00	0.96	n/a
16-3/4	(425)		0.91	0.81	0.69				0.81	0.93	0.79	0.74	0.67				1.00				0.81			0.98	0.83
18	(457)		0.94	0.83	0.70				0.85	0.96	0.81	0.76	0.68								0.85			1.00	0.86
20	(508)		0.99	0.87	0.72				0.91	1.00	0.85	0.79	0.70								0.91				0.90
22	(559)		1.00	0.91	0.74				0.98		0.88	0.82	0.73								0.98				0.95
24	(610)			0.94	0.77				1.00		0.92	0.84	0.75								1.00				0.99
26	(660)			0.98	0.79						0.95	0.87	0.77												1.00
28	(711)			1.00	0.81						0.99	0.90	0.79												
30	(762)				0.83						1.00	0.93	0.81												
36	(914)				0.90							1.00	0.87												
> 48	(1219)				1.00								0.99												

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3{*}h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{HV} = 1.0$.

Table 15 — Load adjustment factors for 7/8-in. diameter threaded rods in uncracked concrete[1,2,3]

7/8-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To edge f_{RV}							
Embedment h_{ef}		in.	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2
		(mm)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.40	0.23	0.17	0.10	n/a	n/a	n/a	n/a	0.09	0.03	0.02	0.01	0.18	0.06	0.05	0.03	n/a	n/a	n/a	n/a
	4-3/8	(111)	0.62	0.59	0.57	0.54	0.63	0.33	0.24	0.14	0.58	0.54	0.54	0.53	0.35	0.13	0.09	0.06	0.63	0.25	0.19	0.11	n/a	n/a	n/a	n/a
	5	(127)	0.64	0.61	0.58	0.55	0.68	0.35	0.26	0.15	0.60	0.55	0.54	0.53	0.43	0.15	0.12	0.07	0.68	0.31	0.23	0.14	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.65	0.62	0.59	0.55	0.71	0.37	0.27	0.16	0.60	0.55	0.54	0.53	0.50	0.18	0.13	0.08	0.71	0.35	0.27	0.16	0.65	n/a	n/a	n/a
	6	(152)	0.67	0.63	0.60	0.56	0.75	0.39	0.28	0.17	0.61	0.56	0.55	0.54	0.57	0.20	0.15	0.09	0.75	0.39	0.28	0.17	0.68	n/a	n/a	n/a
	7	(178)	0.70	0.65	0.61	0.57	0.83	0.43	0.31	0.18	0.63	0.57	0.56	0.54	0.71	0.25	0.19	0.11	0.83	0.43	0.31	0.18	0.73	n/a	n/a	n/a
	8	(203)	0.72	0.67	0.63	0.58	0.92	0.47	0.35	0.20	0.65	0.58	0.56	0.55	0.87	0.31	0.23	0.14	0.92	0.47	0.35	0.20	0.78	n/a	n/a	n/a
	9	(229)	0.75	0.69	0.64	0.59	1.00	0.52	0.38	0.22	0.67	0.59	0.57	0.55	1.00	0.37	0.28	0.17	1.00	0.52	0.38	0.22	0.83	n/a	n/a	n/a
	9-7/8	(251)	0.78	0.71	0.66	0.59		0.57	0.42	0.24	0.69	0.59	0.58	0.56		0.43	0.32	0.19		0.57	0.42	0.24	0.87	0.61	n/a	n/a
	10	(254)	0.78	0.71	0.66	0.60		0.57	0.42	0.25	0.69	0.60	0.58	0.56		0.43	0.33	0.20		0.57	0.42	0.25	0.87	0.62	n/a	n/a
	11	(279)	0.81	0.73	0.68	0.61		0.63	0.46	0.27	0.71	0.61	0.59	0.56		0.50	0.38	0.23		0.63	0.46	0.27	0.91	0.65	n/a	n/a
	12	(305)	0.84	0.75	0.69	0.62		0.69	0.51	0.30	0.73	0.62	0.60	0.57		0.57	0.43	0.26		0.69	0.51	0.30	0.96	0.68	n/a	n/a
	12-1/2	(318)	0.85	0.77	0.70	0.62		0.72	0.53	0.31	0.74	0.62	0.60	0.57		0.61	0.46	0.27		0.72	0.53	0.31	0.98	0.69	0.63	n/a
	14	(356)	0.89	0.80	0.72	0.63		0.80	0.59	0.35	0.77	0.63	0.61	0.58		0.72	0.54	0.32		0.80	0.59	0.35	1.00	0.73	0.67	n/a
	16	(406)	0.95	0.84	0.75	0.65		0.92	0.67	0.40	0.80	0.65	0.63	0.59		0.88	0.66	0.40		0.92	0.67	0.40		0.78	0.71	n/a
	18	(457)	1.00	0.88	0.79	0.67		1.00	0.76	0.44	0.84	0.67	0.64	0.60		1.00	0.79	0.47		1.00	0.76	0.44		0.83	0.75	n/a
	19-1/2	(495)		0.91	0.81	0.69			0.82	0.48	0.87	0.69	0.65	0.61			0.89	0.53			0.82	0.48		0.86	0.78	0.66
	20	(508)		0.92	0.82	0.69			0.84	0.49	0.88	0.69	0.66	0.61			0.92	0.55			0.84	0.49		0.87	0.79	0.67
	22	(559)		0.97	0.85	0.71			0.93	0.54	0.92	0.71	0.67	0.63			1.00	0.64			0.93	0.54		0.92	0.83	0.70
	24	(610)		1.00	0.88	0.73			1.00	0.59	0.96	0.73	0.69	0.64				0.73			1.00	0.59		0.96	0.87	0.73
	26	(660)			0.91	0.75				0.64	0.99	0.75	0.71	0.65				0.82				0.64		1.00	0.91	0.76
	28	(711)			0.94	0.77				0.69	1.00	0.77	0.72	0.66				0.92				0.69			0.94	0.79
	30	(762)			0.98	0.79				0.74		0.79	0.74	0.67				1.00				0.74			0.97	0.82
	36	(914)			1.00	0.84				0.89		0.84	0.78	0.70								0.89			1.00	0.90
	> 48	(1219)				0.96				1.00		0.96	0.88	0.77								1.00				1.00

Table 16 — Load adjustment factors for 7/8-in. diameter threaded rods in cracked concrete[1,2,3]

7/8-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To edge f_{RV}							
Embedment h_{ef}		in.	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2	3-1/2	7-7/8	10-1/2	17-1/2
		(mm)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)	(89)	(200)	(267)	(445)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.46	0.43	0.41	0.38	n/a	n/a	n/a	n/a	0.16	0.07	0.06	0.03	0.32	0.15	0.11	0.07	n/a	n/a	n/a	n/a
	4-3/8	(111)	0.62	0.59	0.57	0.54	0.63	0.56	0.50	0.44	0.62	0.57	0.56	0.54	0.63	0.29	0.22	0.13	0.63	0.56	0.44	0.26	n/a	n/a	n/a	n/a
	5	(127)	0.64	0.61	0.58	0.55	0.68	0.59	0.52	0.45	0.64	0.58	0.57	0.55	0.77	0.36	0.27	0.16	0.68	0.59	0.52	0.32	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.65	0.62	0.59	0.55	0.71	0.62	0.54	0.46	0.65	0.59	0.58	0.55	0.89	0.41	0.31	0.19	0.71	0.62	0.54	0.37	0.79	n/a	n/a	n/a
	6	(152)	0.67	0.63	0.60	0.56	0.75	0.64	0.56	0.47	0.67	0.60	0.58	0.56	1.00	0.47	0.35	0.21	0.75	0.64	0.56	0.42	0.82	n/a	n/a	n/a
	7	(178)	0.70	0.648	0.61	0.57	0.83	0.70	0.60	0.49	0.70	0.62	0.60	0.57		0.59	0.44	0.27	0.83	0.70	0.60	0.49	0.89	n/a	n/a	n/a
	8	(203)	0.72	0.67	0.63	0.58	0.92	0.76	0.64	0.52	0.72	0.63	0.61	0.58		0.72	0.54	0.33	0.92	0.76	0.64	0.52	0.95	n/a	n/a	n/a
	9	(229)	0.75	0.69	0.64	0.59	1.00	0.82	0.69	0.54	0.75	0.65	0.63	0.59		0.86	0.65	0.39	1.00	0.82	0.69	0.54	1.00	n/a	n/a	n/a
	9-7/8	(251)	0.78	0.71	0.66	0.59		0.88	0.72	0.56	0.78	0.67	0.64	0.60		0.99	0.74	0.45		0.87	0.72	0.56		0.81	n/a	n/a
	10	(254)	0.78	0.71	0.66	0.60		0.88	0.73	0.56	0.78	0.67	0.64	0.60		1.00	0.76	0.46		0.88	0.73	0.56		0.82	n/a	n/a
	11	(279)	0.81	0.73	0.68	0.61		0.95	0.77	0.59	0.81	0.69	0.65	0.61			0.88	0.53		0.95	0.77	0.59		0.86	n/a	n/a
	12	(305)	0.84	0.75	0.69	0.61		1.00	0.82	0.61	0.84	0.70	0.67	0.62			1.00	0.60		1.00	0.82	0.61		0.90	n/a	n/a
	12-1/2	(318)	0.85	0.77	0.70	0.62			0.84	0.62	0.85	0.71	0.67	0.62				0.64			0.84	0.62		0.92	0.83	n/a
	14	(356)	0.90	0.80	0.72	0.63			0.92	0.66	0.89	0.74	0.69	0.64				0.75			0.91	0.66		0.97	0.88	n/a
	16	(406)	0.95	0.84	0.75	0.65			1.00	0.71	0.95	0.77	0.72	0.66				0.92			1.00	0.71		1.00	0.94	n/a
	18	(457)	1.00	0.88	0.79	0.67				0.76	1.00	0.80	0.75	0.68				1.00				0.76			1.00	n/a
	19-1/2	(495)		0.91	0.81	0.69				0.80		0.83	0.77	0.69								0.80				0.88
	20	(508)		0.92	0.82	0.69				0.82		0.84	0.78	0.70								0.82				0.89
	22	(559)		0.97	0.85	0.71				0.87		0.87	0.81	0.72								0.87				0.93
	24	(610)		1.00	0.88	0.73				0.93		0.90	0.83	0.74								0.93				0.97
	26	(660)			0.91	0.75				0.99		0.94	0.86	0.76								0.99				1.00
	28	(711)			0.94	0.77				1.00		0.97	0.89	0.78								1.00				
	30	(762)			0.98	0.79						1.00	0.92	0.80												
	36	(914)			1.00	0.85							1.00	0.86												
	> 48	(1219)				0.96								0.97												

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{HV} = 1.0$.

Table 17 — Load adjustment factors for 1-in. diameter threaded rods in uncracked concrete[1,2,3]

1-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To edge f_{RV}							
Embedment h_{ef}		in. (mm)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)	4 (102)	9 (229)	12 (305)	20 (508)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.38	0.23	0.17	0.10	n/a	n/a	n/a	n/a	0.08	0.03	0.02	0.01	0.15	0.05	0.04	0.02	n/a	n/a	n/a	n/a
	5	(127)	0.62	0.59	0.57	0.542	0.63	0.32	0.24	0.14	0.59	0.54	0.53	0.52	0.37	0.12	0.09	0.05	0.63	0.24	0.18	0.12	n/a	n/a	n/a	n/a
	6	(152)	0.65	0.61	0.58	0.550	0.70	0.36	0.26	0.15	0.60	0.55	0.54	0.53	0.48	0.16	0.12	0.07	0.70	0.31	0.23	0.14	n/a	n/a	n/a	n/a
	6-1/4	(159)	0.65	0.62	0.59	0.552	0.71	0.37	0.27	0.16	0.61	0.55	0.54	0.53	0.51	0.17	0.12	0.08	0.71	0.33	0.25	0.15	0.65	n/a	n/a	n/a
	7	(178)	0.67	0.63	0.60	0.558	0.76	0.39	0.29	0.17	0.62	0.56	0.55	0.53	0.61	0.20	0.15	0.09	0.76	0.39	0.29	0.17	0.69	n/a	n/a	n/a
	8	(203)	0.70	0.65	0.61	0.567	0.83	0.43	0.31	0.18	0.64	0.56	0.55	0.54	0.74	0.24	0.18	0.11	0.84	0.43	0.31	0.19	0.74	n/a	n/a	n/a
	9	(229)	0.72	0.67	0.63	0.575	0.91	0.47	0.34	0.20	0.65	0.57	0.56	0.54	0.89	0.29	0.22	0.13	0.91	0.47	0.34	0.20	0.78	n/a	n/a	n/a
	10	(254)	0.75	0.69	0.64	0.583	0.98	0.50	0.37	0.22	0.67	0.58	0.57	0.55	1.00	0.34	0.25	0.15	0.98	0.50	0.37	0.22	0.83	n/a	n/a	n/a
	11	(279)	0.77	0.70	0.65	0.592	1.00	0.55	0.41	0.24	0.69	0.59	0.57	0.55		0.39	0.29	0.17	1.00	0.55	0.41	0.24	0.87	n/a	n/a	n/a
	11-1/4	(286)	0.78	0.71	0.66	0.594		0.57	0.42	0.24	0.70	0.59	0.58	0.55		0.40	0.30	0.18		0.57	0.42	0.24	0.88	0.60	n/a	n/a
	12	(305)	0.80	0.72	0.67	0.600		0.60	0.44	0.26	0.71	0.60	0.58	0.56		0.44	0.33	0.20		0.60	0.44	0.26	0.91	0.62	n/a	n/a
	13	(330)	0.82	0.74	0.68	0.608		0.65	0.48	0.28	0.72	0.61	0.59	0.56		0.50	0.37	0.22		0.65	0.48	0.28	0.94	0.65	n/a	n/a
	14	(356)	0.84	0.76	0.69	0.617		0.70	0.52	0.30	0.74	0.61	0.59	0.57		0.56	0.42	0.25		0.70	0.52	0.30	0.98	0.67	n/a	n/a
	14-1/4	(362)	0.85	0.76	0.70	0.619		0.72	0.53	0.31	0.74	0.62	0.60	0.57		0.57	0.43	0.26		0.72	0.53	0.31	0.99	0.68	0.62	n/a
	16	(406)	0.90	0.80	0.72	0.633		0.80	0.59	0.35	0.77	0.63	0.61	0.58		0.68	0.51	0.31		0.80	0.59	0.35	1.00	0.72	0.65	n/a
	18	(457)	0.94	0.83	0.75	0.650		0.90	0.66	0.39	0.81	0.65	0.62	0.59		0.81	0.61	0.35		0.90	0.664	0.40		0.76	0.70	n/a
	20	(508)	0.99	0.87	0.78	0.667		1.00	0.74	0.43	0.84	0.66	0.63	0.60		0.95	0.71	0.43		1.00	0.74	0.43		0.80	0.73	n/a
	22	(559)	1.00	0.91	0.81	0.683			0.81	0.48	0.88	0.68	0.65	0.60		1.00	0.82	0.49			0.81	0.48		0.84	0.77	n/a
	22-1/4	(565)		0.91	0.81	0.685			0.82	0.48	0.88	0.68	0.65	0.61			0.84	0.50			0.82	0.48		0.85	0.77	0.65
	24	(610)		0.94	0.83	0.700			0.89	0.52	0.91	0.69	0.66	0.61			0.94	0.56			0.89	0.52		0.88	0.80	0.67
	26	(660)		0.98	0.86	0.717			0.96	0.56	0.94	0.71	0.67	0.62			1.00	0.63			0.96	0.56		0.92	0.83	0.70
	28	(711)		1.00	0.89	0.733			1.00	0.61	0.98	0.73	0.69	0.63				0.71			1.00	0.61		0.95	0.86	0.73
	30	(762)			0.92	0.750				0.65	1.00	0.74	0.70	0.64				0.79				0.65		0.98	0.89	0.75
	36	(914)			1.00	0.800				0.78		0.79	0.74	0.67				1.00				0.78		1.00	0.98	0.83
	> 48	(1219)				0.900				1.00		0.87	0.82	0.73								1.00			1.00	0.95

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for $5d \le s \le 16$-in. and to 0.5 T_{max} for $s > 16$-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \ge 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \ge 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 18 — Load adjustment factors for 1-1/4-in. diameter threaded rods in uncracked concrete[1,2,3]

1-1/4-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To and away from edge f_{RV}							
Embedment h_{ef}		in. (mm)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	15 (381)	25 (635)	5 (127)	11-1/4 (286)	11-1/4 (286)	25 (635)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	n/a	0.37	0.22	0.16	0.09	n/a	n/a	n/a	n/a	0.05	0.02	0.01	0.01	0.11	0.03	0.02	0.02	n/a	n/a	n/a	n/a
	6-1/4	(159)	0.62	0.59	0.57	0.542	0.64	0.32	0.24	0.14	0.59	0.54	0.53	0.52	0.37	0.11	0.08	0.05	0.64	0.22	0.16	0.10	n/a	n/a	n/a	n/a
	7	(178)	0.64	0.60	0.58	0.547	0.68	0.34	0.25	0.15	0.60	0.54	0.54	0.53	0.44	0.13	0.10	0.06	0.68	0.26	0.19	0.12	n/a	n/a	n/a	n/a
	8	(203)	0.66	0.62	0.59	0.553	0.73	0.37	0.27	0.16	0.61	0.55	0.54	0.53	0.53	0.16	0.12	0.07	0.73	0.32	0.24	0.15	0.66	n/a	n/a	n/a
	9	(229)	0.68	0.63	0.60	0.560	0.79	0.40	0.29	0.17	0.62	0.56	0.55	0.53	0.63	0.19	0.14	0.09	0.79	0.38	0.28	0.17	0.70	n/a	n/a	n/a
	10	(254)	0.70	0.65	0.61	0.567	0.84	0.43	0.32	0.19	0.64	0.561	0.55	0.54	0.74	0.22	0.17	0.10	0.84	0.43	0.32	0.19	0.74	n/a	n/a	n/a
	11	(279)	0.72	0.66	0.62	0.573	0.90	0.46	0.34	0.20	0.65	0.57	0.56	0.54	0.86	0.26	0.19	0.12	0.90	0.46	0.34	0.20	0.78	n/a	n/a	n/a
	12	(305)	0.74	0.68	0.63	0.580	0.96	0.49	0.36	0.21	0.66	0.57	0.56	0.54	0.98	0.29	0.22	0.13	0.96	0.49	0.36	0.21	0.81	n/a	n/a	n/a
	13	(330)	0.76	0.69	0.64	0.587	1.00	0.53	0.39	0.23	0.68	0.58	0.57	0.55	1.00	0.33	0.25	0.15	1.00	0.53	0.39	0.23	0.84	n/a	n/a	n/a
	14	(356)	0.78	0.71	0.66	0.593		0.57	0.42	0.25	0.70	0.59	0.57	0.55		0.37	0.28	0.17		0.57	0.42	0.25	0.88	0.58	n/a	n/a
	14-1/4	(362)	0.78	0.71	0.66	0.595		0.58	0.43	0.25	0.70	0.59	0.57	0.55		0.38	0.28	0.17		0.58	0.43	0.25	0.88	0.58	n/a	n/a
	15	(381)	0.80	0.72	0.67	0.600		0.61	0.45	0.26	0.71	0.59	0.58	0.55		0.41	0.31	0.18		0.61	0.45	0.26	0.91	0.61	n/a	n/a
	16	(406)	0.82	0.74	0.68	0.607		0.65	0.48	0.28	0.72	0.60	0.58	0.56		0.45	0.34	0.20		0.65	0.48	0.28	0.94	0.62	n/a	n/a
	17	(432)	0.84	0.75	0.69	0.613		0.69	0.51	0.30	0.73	0.60	0.59	0.56		0.49	0.37	0.22		0.69	0.51	0.30	0.96	0.64	n/a	n/a
	18	(457)	0.86	0.77	0.70	0.620		0.73	0.54	0.32	0.75	0.61	0.59	0.56		0.53	0.40	0.24		0.73	0.54	0.32	0.99	0.66	0.60	n/a
	20	(508)	0.90	0.80	0.72	0.633		0.81	0.60	0.35	0.77	0.62	0.60	0.57		0.63	0.47	0.28		0.81	0.60	0.35	1.00	0.70	0.63	n/a
	22	(559)	0.94	0.83	0.74	0.647		0.89	0.66	0.39	0.80	0.63	0.61	0.58		0.72	0.54	0.33		0.89	0.66	0.39		0.73	0.67	n/a
	24	(610)	0.98	0.86	0.77	0.660		0.97	0.72	0.42	0.83	0.65	0.62	0.58		0.82	0.62	0.37		0.97	0.72	0.42		0.77	0.70	n/a
	26	(660)	1.00	0.89	0.79	0.673		1.00	0.78	0.46	0.86	0.66	0.63	0.59		0.93	0.70	0.42		1.00	0.78	0.46		0.80	0.72	n/a
	28	(711)		0.92	0.81	0.687			0.84	0.49	0.88	0.67	0.64	0.60		1.00	0.78	0.47			0.84	0.49		0.81	0.75	0.63
	30	(762)		0.94	0.83	0.700			0.90	0.53	0.91	0.68	0.65	0.61			0.86	0.52			0.90	0.53		0.86	0.78	0.66
	36	(914)		1.00	0.90	0.740			1.00	0.63	0.99	0.72	0.68	0.63			1.00	0.68			1.00	0.63		0.94	0.85	0.72
	> 48	(1219)			1.00	0.820				0.84	1.00	0.79	0.74	0.67				1.00				0.84		1.00	0.98	0.83

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for $5d \le s \le 16$-in. and to 0.5 T_{max} for $s > 16$-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \ge 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \ge 3*h_{ef}$, then $f_{HV} = 1.0$.

Hilti HIT-ICE adhesive with deformed reinforcing bars (rebar)

Figure 4 — Rebar installation conditions

Permissible concrete conditions	Uncracked concrete	Dry concrete	Permissible drilling method	Hammer drilling with carbide tipped drill bit
		Water-saturated concrete		Hilti TE-CD or TE-YD Hollow Drill Bit

Table 19 — Rebar installation specifications with Hilti HIT-ICE adhesive system

Setting information		Symbol	Units	Rebar size								
				#3	#4	#5	#6	#7	#8	#9	#10	#11
Nominal bit diameter		d_o	in.	1/2	5/8	3/4	7/8	1	1-1/8	1-3/8	1-1/2	1-3/4
Effective embedment	minimum	$h_{ef,min}$	in. (mm)	2-3/8 (60)	2-3/8 (60)	3 (76)	3 (76)	3-3/8 (85)	4 (102)	4-1/2 (114)	5 (127)	5-1/2 (140)
	maximum	$h_{ef,max}$	in. (mm)	7-1/2 (191)	10 (254)	12-1/2 (318)	15 (381)	17-1/2 (445)	20 (508)	22-1/2 (572)	25 (635)	27-1/2 (699)
Minimum concrete thickness		h_{min}	in. (mm)	h_{ef} + 1-1/4 (h_{ef} + 30)		(h_{ef} + 2d_o)						
Minimum edge distance[1]		c_{min}	in. (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	5-5/8 (143)	6-1/4 (159)	7 (178)
Minimum anchor spacing		s_{min}	in. (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	5-5/8 (143)	6-1/4 (159)	7 (178)

[1] Edge distance of 1-3/4-inch (44mm) is permitted provided the rebar remains un-torqued.

Figure 5 — Rebar installed with HIT-ICE adhesive

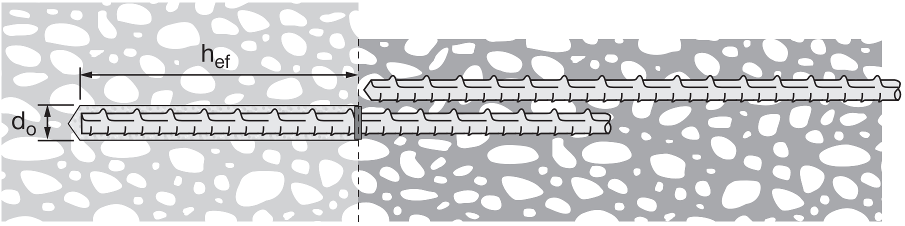


Table 20 — Hilti HIT-ICE design information with Rebar holes drilled with a hammer drill and carbide bit (or hollow drill bit) in accordance with ACI 318 Ch. 17[1]

	Design parameter	Symbol	Units	Nominal rod diameter (in.)									Ref
				#3	#4	#5	#6	#7	#8	#9	#10	#11	ACI 318
	Nominal anchor diameter	d_a	in (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	7/8 (22.2)	1.00 (25.4)	1-1/8 (28.6)	1-1/4 (31.8)	1-3/8 (34.9)	
	Effective minimum embedment[2]	$h_{ef,min}$	in (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (79)	3-1/2 (89)	3-1/2 (89)	4 (102)	4-1/2 (114)	5 (127)	5-1/2 (114)	
	Effective maximum embedment[2]	$h_{ef,max}$	in (mm)	7-1/2 (191)	10 (254)	12-1/2 (318)	15 (381)	17-1/2 (445)	20 (508)	22-1/2 (572)	25 (635)	27-1/2 (699)	
	Minimum concrete thickness[2]	h_{min}	in (mm)	h_{ef} + 1-1/4 (h_{ef} + 30)	hef + $2d_0$(8)								
	Critical edge distance	in (mm)	-	$c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{1160}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4 $\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$ $\left(c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)\right.$ need not be larger than 2.4 $\tau_{k,uncr}$ need not be taken as greater than: $\left. \tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a} \right)$									
	Minimum edge distance	c_{min}	in (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	5-5/8 (143)	6-1/4 (159)	7 (178)	
	Minimum anchor spacing	s_{min}	in (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-3/4 (95)	4-3/8 (111)	5 (127)	5-5/8 (143)	6-1/4 (159)	7 (178)	
	Effectiveness factor for uncracked concrete[4]	$k_{c,uncr}$	-	24 (10)									17.4.2.2
	Effectiveness factor for cracked concrete[4]	$k_{c,cr}$	-	17 (7.1)									17.4.2.2
	Strength reduction factor for tension, concrete failure modes[5]	$\Phi_{c,N}$	-	0.65									17.3.3
	Strength reduction factor for shear, concrete failure modes[5]	$\Phi_{c,V}$	-	0.70									17.3.3
Temperature range A[6]	Characteristic bond stress in cracked concrete[7]	$\tau_{k,cr}$	psi MPa	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	17.4.5
	Characteristic bond stress in uncracked concrete[7]	$\tau_{k,uncr}$	psi (MPa)	1,015 (7.0)	1,005 (6.9)	990 (6.8)	975 (6.7)	965 (6.7)	950 (6.6)	935 (6.4)	920 (6.3)	905 (6.2)	17.4.5
Permissible installation conditions	Strength reduction factor for tension, bond failure modes, dry concrete	Anchor category	-	1	1	1	2	2	2	2	2	2	
		$\Phi_{b,dry}$	-	0.65	0.65	0.65	0.55	0.55	0.55	0.55	0.55	0.55	
	Strength reduction factor for tension, bond failure modes, water saturated concrete	Anchor category	-	1	1	1	2	2	2	2	2	2	
		$\Phi_{b,ws}$	-	0.65	0.65	0.65	0.55	0.55	0.55	0.55	0.55	0.55	

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See figure 4 of this section.

3 Minimum edge distance may be reduced to 1-3/4" (44mm) provided the rebar remains untorqued.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (54°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength f'_c = 2500 psi (17.2 Mpa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 Mpa) and 8,000 psi (55.2 Mpa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

8 d_0 = drilled hole diameter

Table 21 — Hilti HIT-ICE adhesive design strength with concrete / bond failure for US rebar in uncracked concrete[1,2,3,4,5,6,7,8]

		Tension — ϕN_n				Shear — ϕV_n			
Rebar size	Effective embedment in. (mm)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
#3	3-3/8 (86)	2,625 (11.7)	2,670 (11.9)	2,750 (12.2)	2,865 (12.7)	5,650 (25.1)	5,755 (25.6)	5,920 (26.3)	6,165 (27.4)
	4-1/2 (114)	3,500 (15.6)	3,560 (15.8)	3,665 (16.3)	3,820 (17.0)	7,535 (33.5)	7,670 (34.1)	7,895 (35.1)	8,225 (36.6)
	7-1/2 (191)	5,830 (25.9)	5,935 (26.4)	6,110 (27.2)	6,365 (28.3)	12,555 (55.8)	12,785 (56.9)	13,160 (58.5)	13,705 (61.0)
#4	4-1/2 (114)	4,620 (20.6)	4,705 (20.9)	4,840 (21.5)	5,040 (22.4)	9,945 (44.2)	10,130 (45.1)	10,425 (46.4)	10,855 (48.3)
	6 (152)	6,155 (27.4)	6,270 (27.9)	6,455 (28.7)	6,720 (29.9)	13,260 (59.0)	13,505 (60.1)	13,900 (61.8)	14,475 (64.4)
	10 (254)	10,260 (45.6)	10,450 (46.5)	10,755 (47.8)	11,200 (49.8)	22,100 (98.3)	22,510 (100.1)	23,165 (103.0)	24,125 (107.3)
#5	5-5/8 (143)	7,105 (31.6)	7,240 (32.2)	7,450 (33.1)	7,760 (34.5)	15,310 (68.1)	15,590 (69.3)	16,045 (71.4)	16,710 (74.3)
	7-1/2 (191)	9,475 (42.1)	9,650 (42.9)	9,930 (44.2)	10,345 (46.0)	20,410 (90.8)	20,785 (92.5)	21,395 (95.2)	22,280 (99.1)
	12-1/2 (318)	15,795 (70.3)	16,085 (71.5)	16,555 (73.6)	17,240 (76.7)	34,020 (151.3)	34,645 (154.1)	35,655 (158.6)	37,130 (165.2)
#6	6-3/4 (171)	8,530 (37.9)	8,685 (38.6)	8,940 (39.8)	9,310 (41.4)	21,710 (96.6)	22,110 (98.3)	22,755 (101.2)	23,695 (105.4)
	9 (229)	11,370 (50.6)	11,580 (51.5)	11,920 (53.0)	12,410 (55.2)	28,945 (128.8)	29,480 (131.1)	30,340 (135.0)	31,595 (140.5)
	15 (381)	18,955 (84.3)	19,300 (85.9)	19,865 (88.4)	20,685 (92.0)	48,245 (214.6)	49,130 (218.5)	50,565 (224.9)	52,655 (234.2)
#7	7-7/8 (200)	11,490 (51.1)	11,700 (52.0)	12,040 (53.6)	12,540 (55.8)	29,245 (130.1)	29,785 (132.5)	30,655 (136.4)	31,920 (142.0)
	10-1/2 (267)	15,320 (68.1)	15,600 (69.4)	16,055 (71.4)	16,720 (74.4)	38,995 (173.5)	39,710 (176.6)	40,870 (181.8)	42,560 (189.3)
	17-1/2 (445)	25,530 (113.6)	26,000 (115.7)	26,760 (119.0)	27,870 (124.0)	64,990 (289.1)	66,185 (294.4)	68,120 (303.0)	70,935 (315.5)
#8	9 (229)	14,775 (65.7)	15,045 (66.9)	15,485 (68.9)	16,125 (71.7)	37,605 (167.3)	38,295 (170.3)	39,415 (175.3)	41,045 (182.6)
	12 (305)	19,700 (87.6)	20,060 (89.2)	20,645 (91.8)	21,500 (95.6)	50,140 (223.0)	51,060 (227.1)	52,555 (233.8)	54,725 (243.4)
	20 (508)	32,830 (146.0)	33,435 (148.7)	34,410 (153.1)	35,835 (159.4)	83,565 (371.7)	85,105 (378.6)	87,590 (389.6)	91,210 (405.7)
#9	10-1/8 (257)	18,400 (81.8)	18,740 (83.4)	19,290 (85.8)	20,085 (89.3)	46,840 (208.4)	47,705 (212.2)	49,095 (218.4)	51,130 (227.4)
	13-1/2 (343)	24,535 (109.1)	24,990 (111.2)	25,715 (114.4)	26,780 (119.1)	62,455 (277.8)	63,605 (282.9)	65,460 (291.2)	68,170 (303.2)
	22-1/2 (572)	40,895 (181.9)	41,645 (185.2)	42,860 (190.6)	44,635 (198.5)	104,095 (463.0)	106,010 (471.6)	109,105 (485.3)	113,620 (505.4)
#10	11-1/4 (286)	22,355 (99.4)	22,765 (101.3)	23,430 (104.2)	24,400 (108.5)	56,900 (253.1)	57,950 (257.8)	59,640 (265.3)	62,110 (276.3)
	15 (381)	29,805 (132.6)	30,355 (135.0)	31,240 (139.0)	32,535 (144.7)	75,870 (337.5)	77,265 (343.7)	79,520 (353.7)	82,810 (368.4)
	25 (635)	49,675 (221.0)	50,590 (225.0)	52,065 (231.6)	54,220 (241.2)	126,450 (562.5)	128,775 (572.8)	132,535 (589.5)	138,020 (613.9)

1 See section 3.1.8 for explanation on development of load values.

2 See section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 23-30 as necessary to the above values. Compare to the steel values in table 22. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength by 0.85.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete, multiply design strength (factored resistance) by λ_a as follows: For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

Table 22 — Steel design strength for US rebar[1,2]

Rebar size	ASTM A615 Grade 40 [4]		ASTM A615 Grade 60 [4]		ASTM A706 Grade 60 [4]	
	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)
#3	4,290 (19.1)	2,375 (10.6)	5,720 (25.4)	3,170 (14.1)	6,600 (29.4)	3,430 (15.3)
#4	7,800 (34.7)	4,320 (19.2)	10,400 (46.3)	5,760 (25.6)	12,000 (53.4)	6,240 (27.8)
#5	12,090 (53.8)	6,695 (29.8)	16,120 (71.7)	8,930 (39.7)	18,600 (82.7)	9,670 (43.0)
#6	17,160 (76.3)	9,505 (42.3)	22,880 (101.8)	12,670 (56.4)	26,400 (117.4)	13,730 (61.1)
#7	23,400 (104.1)	12,960 (57.6)	31,200 (138.8)	17,280 (76.9)	36,000 (160.1)	18,720 (83.3)
#8	30,810 (137.0)	17,065 (75.9)	41,080 (182.7)	22,750 (101.2)	47,400 (210.8)	24,650 (109.6)
#9	39,000 (173.5)	21,600 (96.1)	52,000 (231.3)	28,800 (128.1)	60,000 (266.9)	31,200 (138.8)
#10	49,530 (220.3)	27,430 (122.0)	66,040 (293.8)	36,575 (162.7)	76,200 (339.0)	39,625 (176.3)

[1] See Section 3.1.8 to convert design strength value to ASD value.

[2] ASTM A706 Grade 60 rebar are considered ductile steel elements. ASTM A615 Grade 40 and 60 rebar are considered brittle steel elements.

[3] Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

[4] Shear = $\phi\ 0.60\ A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

Table 23 — Load adjustment factors for #3 rebar in uncracked concrete[1,2,3]

#3 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To edge f_{RV}					
Embedment h_{ef}	in.	(mm)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)	3-3/8 (86)	4-1/2 (114)	7-1/2 (191)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.33	0.24	0.14	n/a	n/a	n/a	0.13	0.10	0.06	0.26	0.20	0.12	n/a	n/a	n/a
	1-7/8	(48)	0.59	0.57	0.54	0.34	0.25	0.14	0.55	0.54	0.53	0.14	0.11	0.07	0.29	0.22	0.13	n/a	n/a	n/a
	2	(51)	0.60	0.57	0.54	0.35	0.25	0.15	0.55	0.54	0.53	0.16	0.12	0.07	0.32	0.24	0.14	n/a	n/a	n/a
	3	(76)	0.65	0.61	0.57	0.45	0.33	0.19	0.57	0.56	0.54	0.29	0.22	0.13	0.45	0.33	0.19	n/a	n/a	n/a
	4	(102)	0.70	0.65	0.59	0.56	0.41	0.24	0.60	0.58	0.56	0.45	0.34	0.20	0.56	0.41	0.24	n/a	n/a	n/a
	4-5/8	(117)	0.73	0.67	0.60	0.65	0.47	0.28	0.61	0.59	0.57	0.56	0.42	0.25	0.65	0.47	0.28	0.67	n/a	n/a
	5	(127)	0.75	0.69	0.61	0.71	0.51	0.30	0.62	0.60	0.57	0.63	0.47	0.28	0.71	0.51	0.30	0.70	n/a	n/a
	5-3/4	(146)	0.78	0.71	0.63	0.81	0.59	0.34	0.64	0.62	0.58	0.78	0.58	0.35	0.81	0.59	0.34	0.75	0.68	n/a
	6	(152)	0.80	0.72	0.63	0.85	0.62	0.36	0.65	0.62	0.59	0.83	0.62	0.37	0.85	0.62	0.36	0.77	0.70	n/a
	7	(178)	0.85	0.76	0.66	0.99	0.72	0.42	0.67	0.64	0.60	1.00	0.78	0.47	0.99	0.72	0.42	0.83	0.75	n/a
	8	(203)	0.90	0.80	0.68	1.00	0.82	0.48	0.70	0.66	0.62		0.96	0.57	1.00	0.82	0.48	0.89	0.80	n/a
	8-3/4	(222)	0.93	0.82	0.69		0.90	0.52	0.71	0.68	0.63		1.00	0.66		0.90	0.52	0.93	0.84	0.71
	9	(229)	0.94	0.83	0.70		0.92	0.54	0.72	0.68	0.63			0.68		0.92	0.54	0.94	0.85	0.72
	10	(254)	0.99	0.87	0.72		1.00	0.59	0.74	0.70	0.64			0.80		1.00	0.59	0.99	0.90	0.76
	11	(279)	1.00	0.91	0.74			0.65	0.77	0.72	0.66			0.93			0.65	1.00	0.94	0.80
	12	(305)		0.94	0.77			0.71	0.79	0.74	0.67			1.00			0.71		0.99	0.83
	14	(356)		1.00	0.81			0.83	0.84	0.78	0.70						0.83		1.00	0.90
	16	(406)			0.86			0.95	0.89	0.82	0.73						0.95			0.96
	18	(457)			0.90			1.00	0.94	0.86	0.76						1.00			1.00
	24	(610)			1.00				1.00	0.99	0.85									
	30	(762)								1.00	0.93									
	36	(914)									1.00									
	> 48	(1219)																		

Table 24 — Load adjustment factors for #4 rebar in uncracked concrete[1,2,3]

#4 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To edge f_{RV}					
Embedment h_{ef}	in.	(mm)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.28	0.21	0.12	n/a	n/a	n/a	0.09	0.06	0.04	0.17	0.13	0.08	n/a	n/a	n/a
	2-1/2	(64)	0.59	0.57	0.54	0.33	0.24	0.14	0.55	0.54	0.53	0.15	0.11	0.07	0.29	0.22	0.13	n/a	n/a	n/a
	3	(76)	0.61	0.58	0.55	0.36	0.27	0.16	0.56	0.55	0.53	0.19	0.14	0.09	0.36	0.27	0.16	n/a	n/a	n/a
	4	(102)	0.65	0.61	0.57	0.44	0.32	0.19	0.57	0.56	0.54	0.30	0.22	0.13	0.44	0.32	0.19	n/a	n/a	n/a
	5	(127)	0.69	0.64	0.58	0.52	0.38	0.22	0.59	0.58	0.55	0.41	0.31	0.19	0.52	0.38	0.22	n/a	n/a	n/a
	5-3/4	(146)	0.71	0.66	0.60	0.59	0.43	0.25	0.61	0.59	0.56	0.51	0.38	0.23	0.59	0.43	0.25	0.65	n/a	n/a
	6	(152)	0.72	0.67	0.60	0.62	0.45	0.27	0.61	0.59	0.57	0.54	0.41	0.24	0.62	0.45	0.27	0.67	n/a	n/a
	7	(178)	0.76	0.69	0.62	0.72	0.53	0.31	0.63	0.61	0.58	0.68	0.51	0.31	0.72	0.53	0.31	0.72	n/a	n/a
	7-1/4	(184)	0.77	0.70	0.62	0.75	0.55	0.32	0.63	0.61	0.58	0.72	0.54	0.32	0.75	0.55	0.32	0.73	0.67	n/a
	8	(203)	0.80	0.72	0.63	0.82	0.60	0.35	0.65	0.62	0.59	0.84	0.63	0.38	0.82	0.60	0.35	0.77	0.70	n/a
	9	(229)	0.83	0.75	0.65	0.93	0.68	0.40	0.67	0.64	0.60	1.00	0.75	0.45	0.93	0.68	0.40	0.82	0.74	n/a
	10	(254)	0.87	0.78	0.67	1.00	0.76	0.44	0.68	0.65	0.61		0.88	0.53	1.00	0.76	0.44	0.86	0.78	n/a
	11-1/4	(286)	0.92	0.81	0.69		0.85	0.50	0.71	0.67	0.62		1.00	0.63		0.85	0.50	0.91	0.83	0.70
	12	(305)	0.94	0.83	0.70		0.91	0.53	0.72	0.68	0.63			0.69		0.91	0.53	0.94	0.86	0.72
	14	(356)	1.00	0.89	0.73		1.00	0.62	0.76	0.71	0.65			0.87		1.00	0.62	1.00	0.92	0.78
	16	(406)		0.94	0.77			0.71	0.80	0.74	0.67			1.00			0.71		0.99	0.83
	18	(457)		1.00	0.80			0.80	0.83	0.77	0.70						0.80		1.00	0.88
	20	(508)			0.83			0.88	0.87	0.81	0.72						0.88			0.93
	22	(559)			0.87			0.97	0.91	0.84	0.74						0.97			0.98
	24	(610)			0.90			1.00	0.94	0.87	0.76						1.00			1.00
	30	(762)			1.00				1.00	0.96	0.83									
	36	(914)								1.00	0.89									
	> 48	(1219)									1.00									

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3 * h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3 * h_{ef}$. If $c \geq 3 * h_{ef}$, then $f_{HV} = 1.0$.

Table 25 — Load adjustment factors for #5 rebar in uncracked concrete[1,2,3]

#5 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To edge f_{RV}					
Embedment h_{ef}	in.	(mm)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)	4-1/2 (114)	6 (152)	10 (254)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.26	0.19	0.11	n/a	n/a	n/a	0.06	0.05	0.03	0.12	0.09	0.06	n/a	n/a	n/a
	3-1/8	(79)	0.59	0.57	0.54	0.33	0.24	0.14	0.55	0.54	0.53	0.15	0.11	0.07	0.30	0.22	0.13	n/a	n/a	n/a
	4	(102)	0.62	0.59	0.55	0.38	0.28	0.16	0.56	0.55	0.54	0.21	0.16	0.10	0.38	0.28	0.16	n/a	n/a	n/a
	5	(127)	0.65	0.61	0.57	0.44	0.32	0.19	0.57	0.56	0.54	0.30	0.23	0.14	0.44	0.32	0.19	n/a	n/a	n/a
	6	(152)	0.68	0.63	0.58	0.50	0.37	0.21	0.59	0.57	0.55	0.39	0.30	0.18	0.50	0.37	0.21	n/a	n/a	n/a
	7	(178)	0.71	0.66	0.59	0.58	0.42	0.25	0.60	0.59	0.56	0.50	0.37	0.22	0.58	0.42	0.25	n/a	n/a	n/a
	7-1/8	(181)	0.71	0.66	0.60	0.59	0.43	0.25	0.61	0.59	0.56	0.51	0.38	0.23	0.59	0.43	0.25	0.65	n/a	n/a
	8	(203)	0.74	0.68	0.61	0.66	0.49	0.28	0.62	0.60	0.57	0.61	0.46	0.27	0.66	0.49	0.28	0.69	n/a	n/a
	9	(229)	0.77	0.70	0.62	0.74	0.55	0.32	0.63	0.61	0.58	0.72	0.54	0.33	0.74	0.55	0.32	0.73	0.67	n/a
	10	(254)	0.80	0.72	0.63	0.83	0.61	0.36	0.65	0.62	0.59	0.85	0.64	0.38	0.83	0.61	0.36	0.77	0.70	n/a
	11	(279)	0.83	0.74	0.65	0.91	0.67	0.39	0.66	0.64	0.60	0.98	0.73	0.44	0.91	0.67	0.39	0.81	0.74	n/a
	12	(305)	0.86	0.77	0.66	0.99	0.73	0.43	0.68	0.65	0.61	1.00	0.84	0.50	0.99	0.73	0.43	0.85	0.77	n/a
	14	(356)	0.91	0.81	0.69	1.00	0.85	0.50	0.71	0.67	0.62		1.00	0.63	1.00	0.85	0.50	0.91	0.83	0.70
	16	(406)	0.97	0.86	0.71		0.97	0.57	0.74	0.70	0.64			0.77		0.97	0.57	0.98	0.89	0.75
	18	(457)	1.00	0.90	0.74		1.00	0.64	0.77	0.72	0.66			0.92		1.00	0.64	1.00	0.94	0.79
	20	(508)		0.94	0.77			0.71	0.80	0.75	0.68			1.00			0.71		0.99	0.84
	22	(559)		0.99	0.79			0.78	0.83	0.77	0.69						0.78		1.00	0.88
	24	(610)		1.00	0.82			0.85	0.86	0.80	0.71						0.85			0.92
	26	(660)			0.85			0.92	0.89	0.82	0.73						0.92			0.96
	28	(711)			0.87			1.00	0.92	0.85	0.75						1.00			0.99
	30	(762)			0.90				0.95	0.87	0.76									1.00
	36	(914)			0.98				1.00	0.94	0.82									
	> 48	(1219)			1.00					1.00	0.92									

Table 26 — Load adjustment factors for #6 rebar in uncracked concrete[1,2,3]

#6 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To edge f_{RV}					
Embedment h_{ef}	in.	(mm)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)	6-3/4 (171)	9 (229)	15 (381)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.24	0.18	0.10	n/a	n/a	n/a	0.05	0.04	0.02	0.09	0.07	0.04	n/a	n/a	n/a
	3-3/4	(95)	0.59	0.57	0.54	0.33	0.24	0.14	0.55	0.54	0.53	0.15	0.11	0.07	0.30	0.22	0.13	n/a	n/a	n/a
	4	(102)	0.60	0.57	0.54	0.34	0.25	0.15	0.55	0.54	0.53	0.16	0.12	0.07	0.33	0.24	0.15	n/a	n/a	n/a
	5	(127)	0.62	0.59	0.56	0.39	0.28	0.17	0.56	0.55	0.54	0.23	0.17	0.10	0.39	0.28	0.17	n/a	n/a	n/a
	6	(152)	0.65	0.61	0.57	0.44	0.32	0.19	0.57	0.56	0.54	0.30	0.22	0.13	0.44	0.32	0.19	n/a	n/a	n/a
	7	(178)	0.67	0.63	0.58	0.49	0.36	0.21	0.59	0.57	0.55	0.38	0.28	0.17	0.49	0.36	0.21	n/a	n/a	n/a
	8	(203)	0.70	0.65	0.59	0.55	0.41	0.24	0.60	0.58	0.56	0.46	0.34	0.21	0.55	0.41	0.24	n/a	n/a	n/a
	8-1/2	(216)	0.71	0.66	0.59	0.59	0.43	0.25	0.61	0.59	0.56	0.50	0.38	0.23	0.59	0.43	0.25	0.65	n/a	n/a
	9	(229)	0.72	0.67	0.60	0.62	0.46	0.27	0.61	0.59	0.57	0.55	0.41	0.25	0.62	0.46	0.27	0.67	n/a	n/a
	10	(254)	0.75	0.69	0.61	0.69	0.51	0.30	0.62	0.60	0.57	0.64	0.48	0.29	0.69	0.51	0.30	0.70	n/a	n/a
	10-3/4	(273)	0.77	0.70	0.62	0.74	0.55	0.32	0.63	0.61	0.58	0.72	0.54	0.32	0.74	0.55	0.32	0.73	0.66	n/a
	12	(305)	0.80	0.72	0.63	0.83	0.61	0.36	0.65	0.62	0.59	0.84	0.63	0.38	0.83	0.61	0.36	0.77	0.70	n/a
	14	(356)	0.85	0.76	0.66	0.97	0.71	0.42	0.67	0.64	0.60	1.00	0.80	0.48	0.97	0.71	0.42	0.83	0.76	n/a
	16	(406)	0.90	0.80	0.68	1.00	0.81	0.48	0.70	0.66	0.62		0.98	0.59	1.00	0.81	0.48	0.89	0.81	n/a
	16-3/4	(425)	0.91	0.81	0.69		0.85	0.50	0.71	0.67	0.62		1.00	0.63		0.85	0.50	0.91	0.83	0.70
	18	(457)	0.94	0.83	0.70		0.91	0.54	0.72	0.68	0.63			0.70		0.91	0.54	0.95	0.86	0.72
	20	(508)	0.99	0.87	0.72		1.00	0.60	0.75	0.70	0.65			0.82		1.00	0.60	1.00	0.91	0.76
	22	(559)	1.00	0.91	0.74			0.65	0.77	0.73	0.66			0.94			0.65		0.95	0.80
	24	(610)		0.94	0.77			0.71	0.80	0.75	0.67			1.00			0.71		0.99	0.84
	26	(660)		0.98	0.79			0.77	0.82	0.77	0.69						0.77		1.00	0.87
	28	(711)		1.00	0.81			0.83	0.85	0.79	0.70						0.83			0.90
	30	(762)			0.83			0.89	0.87	0.81	0.72						0.89			0.94
	36	(914)			0.90			1.00	0.95	0.87	0.76						1.00			1.00
	> 48	(1219)			1.00				1.00	0.99	0.85									

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 27 — Load adjustment factors for #7 rebar in uncracked concrete[1,2,3]

#7 Rebar uncracked Concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ‖ To edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
Embedment h_{ef}	in. (mm)		7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)	7-7/8 (200)	10-1/2 (267)	17-1/2 (445)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.23	0.17	0.10	n/a	n/a	n/a	0.03	0.03	0.02	0.07	0.05	0.03	n/a	n/a	n/a
	4-3/8	(111)	0.59	0.57	0.54	0.33	0.24	0.14	0.54	0.54	0.53	0.14	0.10	0.06	0.28	0.21	0.12	n/a	n/a	n/a
	5	(127)	0.61	0.58	0.55	0.35	0.26	0.15	0.55	0.54	0.53	0.17	0.13	0.08	0.34	0.25	0.15	n/a	n/a	n/a
	6	(152)	0.63	0.60	0.56	0.39	0.29	0.17	0.56	0.55	0.54	0.22	0.17	0.10	0.39	0.29	0.17	n/a	n/a	n/a
	7	(178)	0.65	0.61	0.57	0.44	0.32	0.19	0.57	0.56	0.54	0.28	0.21	0.13	0.44	0.32	0.19	n/a	n/a	n/a
	8	(203)	0.67	0.63	0.58	0.48	0.35	0.21	0.58	0.57	0.55	0.34	0.26	0.15	0.48	0.35	0.21	n/a	n/a	n/a
	9	(229)	0.69	0.64	0.59	0.53	0.39	0.23	0.59	0.58	0.55	0.41	0.31	0.18	0.53	0.39	0.23	n/a	n/a	n/a
	9-7/8	(251)	0.71	0.66	0.59	0.59	0.43	0.25	0.60	0.58	0.56	0.47	0.35	0.21	0.59	0.43	0.25	0.63	n/a	n/a
	10	(254)	0.71	0.66	0.60	0.59	0.44	0.26	0.60	0.58	0.56	0.48	0.36	0.21	0.59	0.44	0.26	0.64	n/a	n/a
	11	(279)	0.73	0.67	0.60	0.65	0.48	0.28	0.61	0.59	0.57	0.55	0.41	0.25	0.65	0.48	0.28	0.67	n/a	n/a
	12	(305)	0.75	0.69	0.61	0.71	0.52	0.31	0.62	0.60	0.57	0.63	0.47	0.28	0.71	0.52	0.31	0.70	n/a	n/a
	12-1/2	(318)	0.76	0.70	0.62	0.74	0.55	0.32	0.63	0.60	0.57	0.67	0.50	0.30	0.74	0.55	0.32	0.71	0.65	n/a
	14	(356)	0.80	0.72	0.63	0.83	0.61	0.36	0.64	0.62	0.58	0.79	0.59	0.36	0.83	0.61	0.36	0.75	0.69	n/a
	16	(406)	0.84	0.75	0.65	0.95	0.70	0.41	0.66	0.63	0.60	0.97	0.72	0.43	0.95	0.70	0.41	0.81	0.73	n/a
	18	(457)	0.88	0.79	0.67	1.00	0.79	0.46	0.68	0.65	0.61	1.00	0.86	0.52	1.00	0.79	0.46	0.86	0.78	n/a
	19-1/2	(495)	0.91	0.81	0.69		0.85	0.50	0.70	0.66	0.62		0.97	0.58		0.85	0.50	0.89	0.81	0.68
	20	(508)	0.92	0.82	0.69		0.87	0.51	0.70	0.67	0.62		1.00	0.61		0.87	0.51	0.90	0.82	0.69
	22	(559)	0.97	0.85	0.71		0.96	0.56	0.72	0.68	0.63			0.70		0.96	0.56	0.95	0.86	0.73
	24	(610)	1.00	0.88	0.73		1.00	0.61	0.74	0.70	0.64			0.80		1.00	0.61	0.99	0.90	0.76
	26	(660)		0.91	0.75			0.67	0.76	0.72	0.66			0.90			0.67	1.00	0.93	0.79
	28	(711)		0.94	0.77			0.72	0.78	0.74	0.67			1.00			0.72		0.97	0.82
	30	(762)		0.98	0.79			0.77	0.81	0.75	0.68						0.77		1.00	0.85
	36	(914)		1.00	0.84			0.92	0.87	0.80	0.72						0.92			0.93
	> 48	(1219)			0.96			1.00	0.99	0.90	0.79						1.00			1.00

Table 28 — Load adjustment factors for #8 rebar in uncracked concrete[1,2,3]

#8 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ‖ To edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
Embedment h_{ef}	in. (mm)		9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)	9 (229)	12 (305)	20 (508)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.23	0.17	0.10	n/a	n/a	n/a	0.03	0.02	0.01	0.05	0.04	0.02	n/a	n/a	n/a
	5	(127)	0.59	0.57	0.54	0.33	0.24	0.14	0.54	0.54	0.53	0.13	0.10	0.06	0.26	0.20	0.12	n/a	n/a	n/a
	6	(152)	0.61	0.58	0.55	0.36	0.27	0.16	0.55	0.54	0.53	0.17	0.13	0.08	0.34	0.26	0.16	n/a	n/a	n/a
	7	(178)	0.63	0.60	0.56	0.40	0.29	0.17	0.56	0.55	0.54	0.22	0.16	0.10	0.40	0.29	0.17	n/a	n/a	n/a
	8	(203)	0.65	0.61	0.57	0.44	0.32	0.19	0.57	0.56	0.54	0.27	0.20	0.12	0.44	0.32	0.19	n/a	n/a	n/a
	9	(229)	0.67	0.63	0.58	0.48	0.35	0.21	0.58	0.56	0.55	0.32	0.24	0.14	0.48	0.35	0.21	n/a	n/a	n/a
	10	(254)	0.69	0.64	0.58	0.52	0.38	0.23	0.59	0.57	0.55	0.37	0.28	0.17	0.52	0.38	0.23	n/a	n/a	n/a
	11	(279)	0.70	0.65	0.59	0.57	0.42	0.25	0.59	0.58	0.56	0.43	0.32	0.19	0.57	0.42	0.25	n/a	n/a	n/a
	11-1/4	(286)	0.71	0.66	0.59	0.59	0.43	0.25	0.60	0.58	0.56	0.44	0.33	0.20	0.59	0.43	0.25	0.62	n/a	n/a
	12	(305)	0.72	0.67	0.60	0.63	0.46	0.27	0.60	0.59	0.56	0.49	0.37	0.22	0.63	0.46	0.27	0.64	n/a	n/a
	13	(330)	0.74	0.68	0.61	0.68	0.50	0.29	0.61	0.59	0.57	0.55	0.41	0.25	0.68	0.50	0.29	0.67	n/a	n/a
	14	(356)	0.76	0.69	0.62	0.73	0.54	0.32	0.62	0.60	0.57	0.61	0.46	0.28	0.73	0.54	0.32	0.69	n/a	n/a
	14-1/4	(362)	0.76	0.70	0.62	0.74	0.55	0.32	0.62	0.60	0.57	0.63	0.47	0.28	0.74	0.55	0.32	0.70	0.64	n/a
	16	(406)	0.80	0.72	0.63	0.84	0.61	0.36	0.64	0.61	0.58	0.75	0.56	0.34	0.84	0.61	0.36	0.74	0.67	n/a
	18	(457)	0.83	0.75	0.65	0.94	0.69	0.41	0.65	0.63	0.59	0.90	0.67	0.40	0.94	0.69	0.41	0.79	0.72	n/a
	20	(508)	0.87	0.78	0.67	1.00	0.77	0.45	0.67	0.64	0.60	1.00	0.79	0.47	1.00	0.77	0.45	0.83	0.75	n/a
	22	(559)	0.91	0.81	0.68		0.85	0.50	0.69	0.66	0.61		0.91	0.54		0.85	0.50	0.87	0.79	n/a
	22-1/4	(565)	0.91	0.81	0.69		0.85	0.50	0.69	0.66	0.61		0.92	0.55		0.85	0.50	0.88	0.80	0.67
	24	(610)	0.94	0.83	0.70		0.92	0.54	0.71	0.67	0.62		1.00	0.62		0.92	0.54	0.91	0.83	0.70
	26	(660)	0.98	0.86	0.72		1.00	0.59	0.72	0.68	0.63			0.70		1.00	0.59	0.95	0.86	0.72
	28	(711)	1.00	0.89	0.73			0.63	0.74	0.70	0.64			0.78			0.63	0.98	0.89	0.75
	30	(762)		0.92	0.75			0.68	0.76	0.71	0.65			0.87			0.68	1.00	0.92	0.78
	36	(914)		1.00	0.80			0.81	0.81	0.76	0.68			1.00			0.81		1.00	0.85
	> 48	(1219)			0.90			1.00	0.91	0.84	0.74						1.00			0.98

[1] Linear interpolation not permitted

[2] Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

[3] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[4] Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

[5] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 29 — Load adjustment factors for #9 rebar in uncracked concrete[1,2,3]

#9 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To edge f_{RV}					
Embedment h_{ef}	in.	(mm)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)	10-1/8 (257)	13-1/2 (343)	22-1/2 (572)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.22	0.16	0.10	n/a	n/a	n/a	0.02	0.02	0.01	0.04	0.03	0.02	n/a	n/a	n/a
	5-5/8	(143)	0.59	0.57	0.54	0.33	0.24	0.14	0.54	0.53	0.52	0.13	0.09	0.06	0.25	0.19	0.11	n/a	n/a	n/a
	6	(152)	0.60	0.57	0.54	0.34	0.25	0.15	0.54	0.54	0.53	0.14	0.10	0.06	0.28	0.21	0.12	n/a	n/a	n/a
	7	(178)	0.62	0.59	0.55	0.38	0.28	0.16	0.55	0.54	0.53	0.17	0.13	0.08	0.35	0.26	0.16	n/a	n/a	n/a
	8	(203)	0.63	0.60	0.56	0.41	0.30	0.18	0.56	0.55	0.53	0.21	0.16	0.10	0.41	0.30	0.18	n/a	n/a	n/a
	9	(229)	0.65	0.61	0.57	0.44	0.33	0.19	0.57	0.56	0.54	0.25	0.19	0.11	0.44	0.33	0.19	n/a	n/a	n/a
	10	(254)	0.66	0.62	0.57	0.48	0.35	0.21	0.57	0.56	0.54	0.30	0.22	0.13	0.48	0.35	0.21	n/a	n/a	n/a
	11	(279)	0.68	0.64	0.58	0.52	0.38	0.22	0.58	0.57	0.55	0.34	0.26	0.15	0.52	0.38	0.22	n/a	n/a	n/a
	12	(305)	0.70	0.65	0.59	0.56	0.41	0.24	0.59	0.57	0.55	0.39	0.29	0.18	0.56	0.41	0.24	n/a	n/a	n/a
	12-7/8	(327)	0.71	0.66	0.60	0.61	0.44	0.26	0.60	0.58	0.56	0.43	0.33	0.20	0.61	0.44	0.26	0.62	n/a	n/a
	13	(330)	0.71	0.66	0.60	0.61	0.45	0.26	0.60	0.58	0.56	0.44	0.33	0.20	0.61	0.45	0.26	0.62	n/a	n/a
	14	(356)	0.73	0.67	0.60	0.66	0.48	0.28	0.60	0.59	0.56	0.49	0.37	0.22	0.66	0.48	0.28	0.65	n/a	n/a
	16	(406)	0.76	0.70	0.62	0.75	0.55	0.32	0.62	0.60	0.57	0.60	0.45	0.27	0.75	0.55	0.32	0.69	n/a	n/a
	16-1/4	(413)	0.77	0.70	0.62	0.76	0.56	0.33	0.62	0.60	0.57	0.62	0.46	0.28	0.76	0.56	0.33	0.69	0.63	n/a
	18	(457)	0.80	0.72	0.63	0.85	0.62	0.36	0.63	0.61	0.58	0.72	0.54	0.32	0.85	0.62	0.36	0.73	0.66	n/a
	20	(508)	0.83	0.75	0.65	0.94	0.69	0.40	0.65	0.62	0.59	0.84	0.63	0.38	0.94	0.69	0.40	0.77	0.70	n/a
	22	(559)	0.86	0.77	0.66	1.00	0.76	0.44	0.66	0.63	0.60	0.97	0.73	0.44	1.00	0.76	0.44	0.81	0.73	n/a
	24	(610)	0.90	0.80	0.68		0.83	0.49	0.68	0.65	0.60	1.00	0.83	0.50		0.83	0.49	0.84	0.77	n/a
	25-1/4	(641)	0.92	0.81	0.69		0.87	0.51	0.69	0.65	0.61		0.90	0.54		0.87	0.51	0.87	0.79	0.66
	26	(660)	0.93	0.82	0.69		0.90	0.53	0.69	0.66	0.61		0.94	0.56		0.90	0.53	0.88	0.80	0.67
	28	(711)	0.96	0.85	0.71		0.97	0.57	0.71	0.67	0.62		1.00	0.63		0.97	0.57	0.91	0.83	0.70
	30	(762)	0.99	0.87	0.72		1.00	0.61	0.72	0.68	0.63			0.70		1.00	0.61	0.94	0.86	0.72
	36	(914)	1.00	0.94	0.77			0.73	0.77	0.72	0.66			0.92			0.73	1.00	0.94	0.79
	> 48	(1219)		1.00	0.86			0.97	0.86	0.79	0.71			1.00			0.97		1.00	0.92

Table 30 — Load adjustment factors for #10 rebar in uncracked concrete[1,2,3]

#10 Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			‖ To edge f_{RV}					
Embedment h_{ef}	in.	(mm)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)	11-1/4 (286)	15 (381)	25 (635)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.22	0.16	0.09	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.03	0.02	n/a	n/a	n/a
	6-1/4	(159)	0.59	0.57	0.54	0.33	0.24	0.14	0.54	0.53	0.52	0.12	0.09	0.05	0.24	0.18	0.11	n/a	n/a	n/a
	7	(178)	0.60	0.58	0.55	0.35	0.26	0.15	0.55	0.54	0.53	0.14	0.11	0.06	0.29	0.22	0.13	n/a	n/a	n/a
	8	(203)	0.62	0.59	0.55	0.38	0.28	0.16	0.55	0.54	0.53	0.18	0.13	0.08	0.35	0.26	0.16	n/a	n/a	n/a
	9	(229)	0.63	0.60	0.56	0.41	0.30	0.18	0.56	0.55	0.53	0.21	0.16	0.09	0.41	0.30	0.18	n/a	n/a	n/a
	10	(254)	0.65	0.61	0.57	0.44	0.33	0.19	0.57	0.55	0.54	0.25	0.18	0.11	0.44	0.33	0.19	n/a	n/a	n/a
	11	(279)	0.66	0.62	0.57	0.48	0.35	0.20	0.57	0.56	0.54	0.28	0.21	0.13	0.48	0.35	0.20	n/a	n/a	n/a
	12	(305)	0.68	0.63	0.58	0.51	0.38	0.22	0.58	0.56	0.55	0.32	0.24	0.14	0.51	0.38	0.22	n/a	n/a	n/a
	13	(330)	0.69	0.64	0.59	0.55	0.41	0.24	0.58	0.57	0.55	0.36	0.27	0.16	0.55	0.41	0.24	n/a	n/a	n/a
	14	(356)	0.71	0.66	0.59	0.60	0.44	0.26	0.59	0.58	0.55	0.41	0.30	0.18	0.60	0.44	0.26	n/a	n/a	n/a
	14-1/4	(362)	0.71	0.66	0.60	0.61	0.45	0.26	0.59	0.58	0.55	0.42	0.31	0.19	0.61	0.45	0.26	0.61	n/a	n/a
	15	(381)	0.72	0.67	0.60	0.64	0.47	0.27	0.60	0.58	0.56	0.45	0.34	0.20	0.64	0.47	0.27	0.63	n/a	n/a
	16	(406)	0.74	0.68	0.61	0.68	0.50	0.29	0.60	0.59	0.56	0.50	0.37	0.22	0.68	0.50	0.29	0.65	n/a	n/a
	17	(432)	0.75	0.69	0.61	0.72	0.53	0.31	0.61	0.59	0.57	0.54	0.41	0.24	0.72	0.53	0.31	0.67	n/a	n/a
	18	(457)	0.77	0.70	0.62	0.77	0.56	0.33	0.62	0.60	0.57	0.59	0.44	0.27	0.77	0.56	0.33	0.69	0.62	n/a
	20	(508)	0.80	0.72	0.63	0.85	0.63	0.37	0.63	0.61	0.58	0.69	0.52	0.31	0.85	0.63	0.37	0.72	0.66	n/a
	22	(559)	0.83	0.74	0.65	0.94	0.69	0.40	0.64	0.62	0.58	0.80	0.60	0.36	0.94	0.69	0.40	0.76	0.69	n/a
	24	(610)	0.86	0.77	0.66	1.00	0.75	0.44	0.66	0.63	0.59	0.91	0.68	0.41	1.00	0.75	0.44	0.79	0.72	n/a
	26	(660)	0.89	0.79	0.67		0.81	0.48	0.67	0.64	0.60	1.00	0.77	0.46		0.81	0.48	0.82	0.75	n/a
	28	(711)	0.91	0.81	0.69		0.88	0.51	0.68	0.65	0.61		0.86	0.52		0.88	0.51	0.86	0.78	0.66
	30	(762)	0.94	0.83	0.70		0.94	0.55	0.70	0.66	0.61		0.96	0.57		0.94	0.55	0.89	0.80	0.68
	36	(914)	1.00	0.90	0.74		1.00	0.66	0.73	0.69	0.64		1.00	0.75		1.00	0.66	0.97	0.88	0.74
	> 48	(1219)		1.00	0.82			0.88	0.81	0.76	0.68			1.00			0.88	1.00	1.00	0.86

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

HIT-ICE with HIS-N Inserts

Figure 6 - Hilti HIS-N and HIS-RN internally threaded insert installation conditions

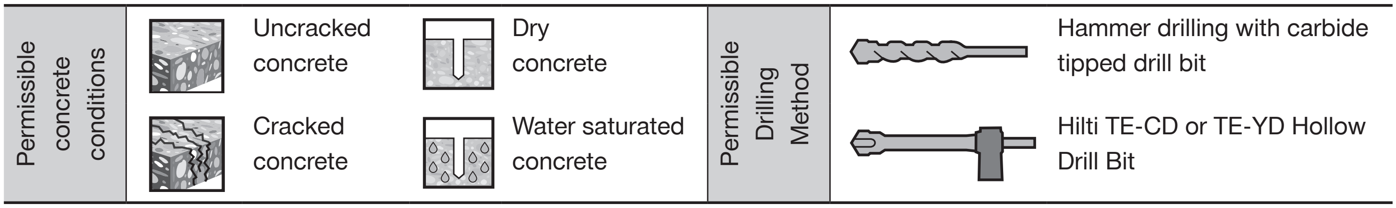


Table 31 — Hilti HIS-N and HIS-RN installation specifications

Setting information		Symbol	Units	Thread size			
				3/8-16 UNC	1/2-13 UNC	5/8-11 UNC	3/4-10 UNC
Outside diameter of insert			in.	0.65	0.81	1.00	1.09
Nominal bit diameter		d_o	in.	11/16	7/8	1-1/8	1-1/4
Effective embedment		h_{ef}	in. (mm)	4-3/8 (110)	5 (125)	6-3/8 (170)	8-1/8 (205)
Thread engagement	minimum	h_s	in.	3/8	1/2	5/8	3/4
	maximum		in.	15/16	1-3/16	1-1/2	1-7/8
Installation torque		T_{inst}	ft-lb (Nm)	15 (20)	30 (40)	60 (81)	100 (136)
Minimum concrete thickness		h_{min}	in. (mm)	5.9 (150)	6.7 (170)	9.1 (230)	10.6 (270)

Figure 7 — HIS-N and HIS-RN specifications

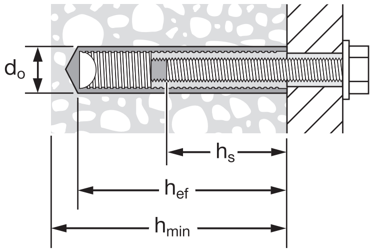


Table 32 — Hilti HIT-ICE design information with Hilti HIS-R and HIS-RN holes drilled with a hammer drill and carbide bit (or hollow drill bit) accordance with ACI 318 Ch. 17[1]

	Design parameter	Symbol	Units	Nominal rod diameter (in.)				Ref
				3/8	1/2	5/8	3/4	ACI 318
	Nominal anchor diameter	d_a	in (mm)	0.65 (16.5)	0.81 (20.5)	1.00 (25.4)	1.09 (27.6)	
	Effective embedment[2]	h_{ef}	in (mm)	4 3/8 (110)	5 (125)	6 3/4 (170)	8 1/8 (205)	
	Minimum concrete thickness[2]	h_{min}	in (mm)	5.9 (150)	6.7 (170)	9.1 (230)	10.6 (270)	
	Critical edge distance	c_{ac}	in (mm)	$c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{1160}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4 $\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr} \sqrt{h_{ef} * f'_c}}{\pi * d_a}$ $\left(c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right) \right.$ need not be larger than 2.4 $\tau_{k,uncr}$ need not be taken as greater than: $\left. \tau_{k,uncr} = \frac{k_{uncr} \sqrt{h_{ef} * f'_c}}{\pi * d_a} \right)$				
	Minimum edge distance	c_{min}	in (mm)	3 1/4 (83)	4 (102)	5 (127)	5 1/2 (140)	
	Minimum anchor spacing	s_{min}	in (mm)	3 1/4 (83)	4 (102)	5 (127)	5 1/2 (140)	
	Effectiveness factor for uncracked concrete[4]	$k_{c,uncr}$	-	24 (10)				17.4.2.2
	Effectiveness factor for cracked concrete[4]	$k_{c,cr}$	-	17 (7.1)				17.4.2.2
	Strength reduction factor for tension, concrete failure modes[5]	$\Phi_{c,N}$	-	0.65				17.3.3
	Strength reduction factor for shear, concrete failure modes[5]	$\Phi_{c,V}$	-	0.70				17.3.3
Temperature range A[6]	Characteristic bond stress in cracked concrete[7]	$\tau_{k,cr}$	psi MPa	350 (2.4)	300 (2.1)	n/a	n/a	17.4.5
	Characteristic bond stress in uncracked concrete[7]	$\tau_{k,uncr}$	psi (MPa)	830 (5.7)	855 (5.9)	840 (5.8)	830 (5.7)	17.4.5
	Reduction for seismic tension	$\alpha_{N,seis}$	-	n/a				
Permissible installation conditions	Strength reduction factor for tension, bond failure modes, dry concrete	Anchor category	-	2	1	1	1	
		$\Phi_{b,dry}$	-	0.55	0.65	0.65	0.65	
	Strength reduction factor for tension, bond failure modes, water saturated concrete	Anchor category	-	2	1	1	1	
		$\Phi_{b,ws}$	-	0.55	0.65	0.65	0.65	

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See figure 7 of this section.

3 Minimum edge distance may be reduced to 1-3/4" (44mm) < c_{min} < 5d provided T_{inst} is reduced to 0.30 T_{inst} for 5d < s < 16-in. and to $0.5T_{ins}$t for s >16-in.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (54°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength f'_c = 2500 psi (17.2 Mpa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 Mpa) and 8,000 psi (55.2 Mpa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

8 d_0 = drilled hole diameter.

Table 33 — Hilti HIT-ICE adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8]

Thread size	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8-16 UNC	4-3/8 (111)	4,080 (18.1)	4,155 (18.5)	4,275 (19.0)	4,450 (19.8)	10,380 (46.2)	10,570 (47.0)	10,880 (48.4)	11,330 (50.4)
1/2-13 UNC	5 (127)	7,070 (31.4)	7,200 (32.0)	7,410 (33.0)	7,720 (34.3)	15,230 (67.7)	15,510 (69.0)	15,965 (71.0)	16,625 (74.0)
5/8-11 UNC	6-3/4 (171)	11,580 (51.5)	11,790 (52.4)	12,135 (54.0)	12,640 (56.2)	24,940 (110.9)	25,395 (113.0)	26,140 (116.3)	27,220 (121.1)
3/4-10 UNC	8-1/8 (206)	15,010 (66.8)	15,285 (68.0)	15,735 (70.0)	16,385 (72.9)	32,330 (143.8)	32,925 (146.5)	33,885 (150.7)	35,290 (157.0)

Table 34 — Hilti HIT-ICE adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9]

Thread size	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8-16 UNC	4-3/8 (111)	1,720 (7.7)	1,750 (7.8)	1,805 (8.0)	1,875 (8.3)	4,380 (19.5)	4,460 (19.8)	4,590 (20.4)	4,780 (21.3)
1/2-13 UNC	5 (127)	2,480 (11.0)	2,525 (11.2)	2,600 (11.6)	2,710 (12.1)	5,345 (23.8)	5,440 (24.2)	5,600 (24.9)	5,835 (26.0)

1 See section 3.1.8 for explanation on development of load values.
2 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 36-37 as necessary to the above values. Compare to the steel values in table 35. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C). Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength (factored resistance) by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by λ_a as follows: For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for static loads only. Seismic applications are not permitted.

Table 35 — Steel design strength for steel bolt / cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

Thread size	ACI 318 Chapter 17 Based Design			
	ASTM A193 B7		ASTM A193 Grade B8M stainless steel	
	Tensile[4] ϕN_{sa} lb (kN)	Shear[5] ϕV_{sa} lb (kN)	Tensile[4] ϕN_{sa} lb (kN)	Shear[5] ϕV_{sa} lb (kN)
3/8-16 UNC	6,300 (28.0)	3,490 (15.5)	5,540 (24.6)	3,070 (13.7)
1/2-13 UNC	10,525 (46.8)	6,385 (28.4)	10,145 (45.1)	5,620 (25.0)
5/8-11 UNC	17,500 (77.8)	10,170 (45.2)	16,160 (71.9)	8,950 (39.8)
3/4-10 UNC	17,785 (79.1)	15,055 (67.0)	23,915 (106.4)	13,245 (58.9)

1 See section 3.1.8 to convert design strength value to ASD value.
2 Hilti HIS-N and HIS-RN inserts with steel bolts are to be considered brittle steel elements.
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.
4 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
5 Shear = ϕ 0.60 $A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17. For 3/8-in diameter insert shear = ϕ 0.50 $A_{se,V} f_{uta}$

Table 36 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2]

HIS-N and HIS-RN all diameters uncracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[5] f_{HV}			
														⊥ Toward edge f_{RV}				‖ To edge f_{RV}							
Internal diameter	in. (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)
Embedment h_{ef}	in. (mm)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)	4-3/8 (111)	5 (127)	6-3/4 (171)	8-1/8 (206)
Spacing (s) / Edge distanc (c_a) / Concrete thickness (h), - in. (mm)	3-1/4 (83)	0.62	n/a	n/a	n/a	0.46	n/a	n/a	n/a	0.56	n/a	n/a	n/a	0.23	n/a	n/a	n/a	0.46	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4 (102)	0.65	0.63	n/a	n/a	0.52	0.50	n/a	n/a	0.58	0.56	n/a	n/a	0.31	0.23	n/a	n/a	0.52	0.46	n/a	n/a	n/a	n/a	n/a	n/a
	5 (127)	0.69	0.67	0.62	n/a	0.61	0.57	0.46	n/a	0.60	0.58	0.56	n/a	0.44	0.32	0.20	n/a	0.61	0.57	0.40	n/a	n/a	n/a	n/a	n/a
	5-1/2 (140)	0.71	0.68	0.64	0.61	0.65	0.60	0.49	0.41	0.61	0.59	0.56	0.55	0.50	0.37	0.23	0.18	0.65	0.60	0.46	0.35	n/a	n/a	n/a	n/a
	6 (152)	0.73	0.70	0.65	0.62	0.70	0.64	0.51	0.44	0.62	0.59	0.57	0.56	0.57	0.43	0.26	0.20	0.70	0.64	0.51	0.40	0.68	n/a	n/a	n/a
	7 (178)	0.77	0.73	0.67	0.64	0.82	0.72	0.57	0.48	0.63	0.61	0.58	0.57	0.72	0.54	0.33	0.25	0.82	0.72	0.57	0.48	0.73	0.66	n/a	n/a
	8 (203)	0.80	0.77	0.70	0.66	0.94	0.81	0.62	0.52	0.65	0.63	0.59	0.58	0.88	0.66	0.40	0.31	0.94	0.81	0.62	0.52	0.78	0.71	n/a	n/a
	9 (229)	0.84	0.80	0.72	0.68	1.00	0.91	0.68	0.57	0.67	0.64	0.60	0.59	1.00	0.78	0.48	0.37	1.00	0.91	0.68	0.57	0.83	0.75	n/a	n/a
	10 (254)	0.88	0.83	0.75	0.71		1.00	0.75	0.62	0.69	0.66	0.61	0.60		0.92	0.56	0.43		1.00	0.75	0.62	0.88	0.79	0.67	n/a
	11 (279)	0.92	0.87	0.77	0.73			0.83	0.68	0.71	0.67	0.62	0.60		1.00	0.65	0.50			0.83	0.68	0.92	0.83	0.71	0.65
	12 (305)	0.96	0.90	0.80	0.75			0.91	0.75	0.73	0.69	0.64	0.61			0.74	0.57			0.91	0.75	0.96	0.87	0.74	0.68
	14 (356)	1.00	0.97	0.85	0.79			1.00	0.87	0.77	0.72	0.66	0.63			0.93	0.71			1.00	0.87	1.00	0.94	0.80	0.73
	16 (406)		1.00	0.90	0.83				0.99	0.81	0.75	0.68	0.65			1.00	0.87				0.99		1.00	0.85	0.78
	18 (457)			0.94	0.87				1.00	0.85	0.78	0.70	0.67				1.00				1.00			0.90	0.83
	24 (610)			1.00	0.99					0.96	0.88	0.77	0.73											1.00	0.96
	30 (762)				1.00					1.00	0.97	0.84	0.79												1.00
	36 (914)										1.00	0.91	0.84												
	> 48 (1219)											1.00	0.96												

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when c < 3*h_{ef}. f_{AV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{AV} = f_{AN}.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{HV} = 1.0.

Table 37 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2]

HIS-N and HIS-RN all diameters uncracked concrete		Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[4] f_{AV}		Edge distance in shear				Concrete thickness factor in shear[5] f_{HV}	
								⊥ Toward edge f_{RV}		‖ To edge f_{RV}			
Internal diameter	in. (mm)	3/8 (9.5)	1/2 (12.7)	3/8 (9.5)	1/2 (12.7)	3/8 (9.5)	1/2 (12.7)	3/8 (9.5)	1/2 (12.7)	3/8 (9.5)	1/2 (12.7)	3/8 (9.5)	1/2 (12.7)
Embedment h_{ef}	in. (mm)	4-3/8 (111)	5 (127)	4-3/8 (111)	5 (127)	4-3/8 (111)	5 (127)	4-3/8 (111)	5 (127)	4-3/8 (111)	5 (127)	4-3/8 (111)	5 (127)
Spacing (s) / Edge distanc (c_a) / Concrete thickness (h), - in. (mm)	3-1/4 (83)	0.62	n/a	0.63	n/a	0.59	n/a	0.39	n/a	0.63	n/a	n/a	n/a
	4 (102)	0.65	0.63	0.71	0.66	0.61	0.60	0.53	0.47	0.71	0.66	n/a	n/a
	5 (127)	0.69	0.67	0.82	0.75	0.64	0.63	0.74	0.66	0.82	0.75	n/a	n/a
	5-1/2 (140)	0.71	0.68	0.87	0.80	0.65	0.64	0.85	0.76	0.87	0.80	n/a	n/a
	6 (152)	0.73	0.70	0.93	0.85	0.66	0.65	0.97	0.87	0.93	0.85	0.81	n/a
	7 (178)	0.77	0.73	1.00	0.95	0.69	0.68	1.00	1.00	1.00	0.95	0.87	0.84
	8 (203)	0.80	0.77		1.00	0.72	0.70				1.00	0.93	0.90
	9 (229)	0.84	0.80			0.75	0.73					0.99	0.95
	10 (254)	0.88	0.83			0.77	0.75					1.00	1.00
	11 (279)	0.92	0.87			0.80	0.78						
	12 (305)	0.96	0.90			0.83	0.80						
	14 (356)	1.00	0.97			0.88	0.85						
	16 (406)		1.00			0.94	0.90						
	18 (457)					0.99	0.95						
	24 (610)					1.00	1.00						
	30 (762)												
	36 (914)												
	> 48 (1219)												

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when c < 3*h_{ef}. f_{AV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{AV} = f_{AN}.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{HV} = 1.0.

DESIGN DATA IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on testing in accordance with ACI 355.4. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8 Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

Table 38 — Hilti HIT-ICE design information with HAS threaded rods in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

Design parameter		Symbol	Units	Nominal rod diameter (in.)							Ref
				3/8	1/2	5/8	3/4	7/8	1	1-1/4	A23.3-14
Nominal anchor O.D.		d_a	mm	9.5	12.7	15.9	19.1	22.2	25.4	31.8	
Effective minimum embedment[2]		$h_{ef,min}$	mm	60	70	79	89	89	102	127	
Effective maximum embedment[2]		$h_{ef,max}$	mm	191	254	318	381	445	508	635	
Minimum concrete thickness[2]		h_{min}	mm	$h_{ef} + 30$		$h_{ef} + 2d_o$					
Critical edge distance		c_{ac}	mm	$c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4 $\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$							
Minimum edge distance[3]		c_{min}	mm	48	64	79	95	111	127	159	
Minimum anchor spacing		s_{min}	mm	48	64	79	95	111	127	159	
Coeff. for factored concrete breakout resistance, uncracked concrete[4]		$k_{c,uncr}$	–	10							D.6.2.2
Coeff. for factored concrete breakout resistance, cracked concrete[4]		$k_{c,cr}$	–	7							D.6.2.2
Concrete material resistance factor		ϕ_c	–	0.65							8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]		R_{conc}	–	1.00							D.5.3(c)
Temp. range A[6]	Characteristic bond stress in cracked concrete[7]	τ_{cr}	psi (MPa)	715 (4.9)	615 (4.2)	520 (3.6)	420 (2.9)	325 (2.2)	n/a	n/a	D.6.5.2
	Characteristic bond stress in uncracked concrete[7]	τ_{uncr}	psi (MPa)	1,215 (8.4)	1,200 (8.3)	1,185 (8.2)	1,075 (7.4)	1,060 (7.3)	1,050 (7.2)	1,020 (7.0)	D.6.5.2
Reduction for seismic tension		$\alpha_{N,seis}$	–	n/a							
Permissible installation conditions	Resistance modification factor tension & shear, bond failure dry concrete	Anchor category	–	2	1	2	1	1	1	1	D.5.3(c)
		R_{dry}	–	0.85	1.00	0.85	1.00	1.00	1.00	1.00	
	Resistance modification factor tension & shear, bond failure water-saturated concrete	Anchor category	–	2	1	2	1	1	1	1	D.5.3(c)
		R_{ws}	–	0.85	1.00	0.85	1.00	1.00	1.00	1.00	

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See figure 2 and 3 of this section.

3 Minimum edge distance may be reduced to 44mm < c_{min} < 5d provided T_{inst} is reduced to 0.30 T_{inst} for 5d < s < 16-in. and to 0.5T_{inst} for s >16-in.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength f'_c = 2500 psi (17.2 Mpa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 Mpa) and 8,000 psi (55.2 Mpa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

Table 39 — Hilti HIT-ICE adhesive factored resistance with concrete / bond failure for threaded rod in uncracked concrete [1,2,3,4,5,6,7,8]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	2-3/8 (60)	1,905 (8.5)	1,950 (8.7)	1,985 (8.8)	2,045 (9.1)	1,905 (8.5)	1,950 (8.7)	1,985 (8.8)	2,045 (9.1)
	3-3/8 (86)	2,710 (12.1)	2,770 (12.3)	2,825 (12.6)	2,905 (12.9)	5,420 (24.1)	5,545 (24.7)	5,645 (25.1)	5,810 (25.8)
	4-1/2 (114)	3,615 (16.1)	3,695 (16.4)	3,765 (16.7)	3,875 (17.2)	7,230 (32.2)	7,390 (32.9)	7,525 (33.5)	7,745 (34.5)
	7-1/2 (191)	6,025 (26.8)	6,160 (27.4)	6,270 (27.9)	6,455 (28.7)	12,045 (53.6)	12,320 (54.8)	12,545 (55.8)	12,910 (57.4)
1/2	2-3/4 (70)	3,420 (15.2)	3,500 (15.6)	3,565 (15.8)	3,665 (16.3)	6,845 (30.4)	6,995 (31.1)	7,125 (31.7)	7,335 (32.6)
	4-1/2 (114)	5,600 (24.9)	5,725 (25.5)	5,830 (25.9)	6,000 (26.7)	11,200 (49.8)	11,450 (50.9)	11,660 (51.9)	12,000 (53.4)
	6 (152)	7,465 (33.2)	7,635 (34.0)	7,775 (34.6)	8,000 (35.6)	14,930 (66.4)	15,265 (67.9)	15,550 (69.2)	16,000 (71.2)
	10 (254)	12,440 (55.3)	12,720 (56.6)	12,955 (57.6)	13,335 (59.3)	24,885 (110.7)	25,445 (113.2)	25,915 (115.3)	26,670 (118.6)
5/8	3-1/8 (79)	4,080 (18.1)	4,170 (18.6)	4,250 (18.9)	4,370 (19.4)	8,160 (36.3)	8,345 (37.1)	8,495 (37.8)	8,745 (38.9)
	5-5/8 (143)	7,345 (32.7)	7,510 (33.4)	7,645 (34.0)	7,870 (35.0)	14,685 (65.3)	15,015 (66.8)	15,295 (68.0)	15,740 (70.0)
	7-1/2 (191)	9,790 (43.6)	10,010 (44.5)	10,195 (45.4)	10,495 (46.7)	19,580 (87.1)	20,025 (89.1)	20,390 (90.7)	20,985 (93.4)
	12-1/2 (318)	16,320 (72.6)	16,685 (74.2)	16,995 (75.6)	17,490 (77.8)	32,635 (145.2)	33,370 (148.4)	33,985 (151.2)	34,975 (155.6)
3/4	3-1/2 (89)	5,480 (24.4)	5,985 (26.6)	6,095 (27.1)	6,270 (27.9)	10,955 (48.7)	11,965 (53.2)	12,185 (54.2)	12,545 (55.8)
	6-3/4 (171)	11,285 (50.2)	11,540 (51.3)	11,750 (52.3)	12,095 (53.8)	22,570 (100.4)	23,080 (102.7)	23,505 (104.6)	24,190 (107.6)
	9 (229)	15,045 (66.9)	15,385 (68.4)	15,670 (69.7)	16,125 (71.7)	30,095 (133.9)	30,770 (136.9)	31,340 (139.4)	32,255 (143.5)
	15 (381)	25,080 (111.6)	25,645 (114.1)	26,115 (116.2)	26,880 (119.6)	50,155 (223.1)	51,285 (228.1)	52,230 (232.3)	53,755 (239.1)
7/8	3-1/2 (89)	5,480 (24.4)	6,125 (27.2)	6,710 (29.8)	7,215 (32.1)	10,955 (48.7)	12,250 (54.5)	13,420 (59.7)	14,430 (64.2)
	7-7/8 (200)	15,145 (67.4)	15,490 (68.9)	15,775 (70.2)	16,235 (72.2)	30,290 (134.7)	30,975 (137.8)	31,545 (140.3)	32,465 (144.4)
	10-1/2 (267)	20,195 (89.8)	20,650 (91.9)	21,030 (93.5)	21,645 (96.3)	40,390 (179.7)	41,300 (183.7)	42,060 (187.1)	43,290 (192.6)
	17-1/2 (445)	33,655 (149.7)	34,415 (153.1)	35,050 (155.9)	36,075 (160.5)	67,315 (299.4)	68,835 (306.2)	70,100 (311.8)	72,145 (320.9)
1	4 (102)	6,690 (29.8)	7,480 (33.3)	8,195 (36.5)	9,335 (41.5)	13,385 (59.5)	14,965 (66.6)	16,395 (72.9)	18,670 (83.0)
	9 (229)	19,595 (87.2)	20,040 (89.1)	20,405 (90.8)	21,000 (93.4)	39,190 (174.3)	40,075 (178.3)	40,815 (181.5)	42,005 (186.8)
	12 (305)	26,130 (116.2)	26,715 (118.8)	27,210 (121.0)	28,005 (124.6)	52,255 (232.4)	53,435 (237.7)	54,415 (242.1)	56,005 (249.1)
	20 (508)	43,545 (193.7)	44,530 (198.1)	45,350 (201.7)	46,670 (207.6)	87,090 (387.4)	89,055 (396.1)	90,695 (403.4)	93,345 (415.2)
1-1/4	5 (127)	9,355 (41.6)	10,455 (46.5)	11,455 (51.0)	13,225 (58.8)	18,705 (83.2)	20,915 (93.0)	22,910 (101.9)	26,455 (117.7)
	11-1/4 (286)	29,745 (132.3)	30,415 (135.3)	30,975 (137.8)	31,880 (141.8)	59,485 (264.6)	60,830 (270.6)	61,950 (275.6)	63,755 (283.6)
	15 (381)	39,660 (176.4)	40,555 (180.4)	41,300 (183.7)	42,505 (189.1)	79,315 (352.8)	81,105 (360.8)	82,600 (367.4)	85,010 (378.1)
	25 (635)	66,095 (294.0)	67,590 (300.6)	68,830 (306.2)	70,840 (315.1)	132,195 (588.0)	135,175 (601.3)	137,665 (612.4)	141,680 (630.2)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 10-21 as necessary to the above values. Compare to the steel values in table 43. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength (factored resistance) by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45

Table 40 — Hilti HIT-ICE adhesive factored resistance with concrete / bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	2-3/8 (60)	1,120 (5.0)	1,150 (5.1)	1,170 (5.2)	1,205 (5.4)	1,120 (5.0)	1,150 (5.1)	1,170 (5.2)	1,205 (5.4)
	3-3/8 (86)	1,595 (7.1)	1,630 (7.3)	1,660 (7.4)	1,710 (7.6)	3,190 (14.2)	3,260 (14.5)	3,320 (14.8)	3,420 (15.2)
	4-1/2 (114)	2,125 (9.5)	2,175 (9.7)	2,215 (9.9)	2,280 (10.1)	4,255 (18.9)	4,350 (19.3)	4,430 (19.7)	4,560 (20.3)
	7-1/2 (191)	3,545 (15.8)	3,625 (16.1)	3,690 (16.4)	3,800 (16.9)	7,090 (31.5)	7,250 (32.2)	7,380 (32.8)	7,600 (33.8)
1/2	2-3/4 (70)	1,755 (7.8)	1,795 (8.0)	1,825 (8.1)	1,880 (8.4)	3,505 (15.6)	3,585 (16.0)	3,650 (16.2)	3,760 (16.7)
	4-1/2 (114)	2,870 (12.8)	2,935 (13.1)	2,990 (13.3)	3,075 (13.7)	5,740 (25.5)	5,870 (26.1)	5,975 (26.6)	6,150 (27.4)
	6 (152)	3,825 (17.0)	3,910 (17.4)	3,985 (17.7)	4,100 (18.2)	7,650 (34.0)	7,825 (34.8)	7,970 (35.4)	8,200 (36.5)
	10 (254)	6,375 (28.4)	6,520 (29.0)	6,640 (29.5)	6,835 (30.4)	12,755 (56.7)	13,040 (58.0)	13,280 (59.1)	13,670 (60.8)
5/8	3-1/8 (79)	1,790 (8.0)	1,830 (8.1)	1,865 (8.3)	1,920 (8.5)	3,580 (15.9)	3,660 (16.3)	3,730 (16.6)	3,835 (17.1)
	5-5/8 (143)	3,220 (14.3)	3,295 (14.7)	3,355 (14.9)	3,455 (15.4)	6,445 (28.7)	6,590 (29.3)	6,710 (29.9)	6,905 (30.7)
	7-1/2 (191)	4,295 (19.1)	4,395 (19.5)	4,475 (19.9)	4,605 (20.5)	8,595 (38.2)	8,785 (39.1)	8,950 (39.8)	9,210 (41.0)
	12-1/2 (318)	7,160 (31.9)	7,320 (32.6)	7,455 (33.2)	7,675 (34.1)	14,320 (63.7)	14,645 (65.1)	14,915 (66.3)	15,350 (68.3)
3/4	3-1/2 (89)	2,285 (10.2)	2,340 (10.4)	2,380 (10.6)	2,450 (10.9)	4,570 (20.3)	4,675 (20.8)	4,760 (21.2)	4,900 (21.8)
	6-3/4 (171)	4,410 (19.6)	4,510 (20.1)	4,590 (20.4)	4,725 (21.0)	8,820 (39.2)	9,015 (40.1)	9,185 (40.8)	9,450 (42.0)
	9 (229)	5,880 (26.1)	6,010 (26.7)	6,120 (27.2)	6,300 (28.0)	11,755 (52.3)	12,025 (53.5)	12,245 (54.5)	12,600 (56.1)
	15 (381)	9,800 (43.6)	10,020 (44.6)	10,205 (45.4)	10,500 (46.7)	19,595 (87.2)	20,040 (89.1)	20,405 (90.8)	21,000 (93.4)
7/8	3-1/2 (89)	2,065 (9.2)	2,110 (9.4)	2,150 (9.6)	2,210 (9.8)	4,130 (18.4)	4,220 (18.8)	4,300 (19.1)	4,425 (19.7)
	7-7/8 (200)	4,645 (20.7)	4,750 (21.1)	4,835 (21.5)	4,975 (22.1)	9,290 (41.3)	9,495 (42.2)	9,670 (43.0)	9,955 (44.3)
	10-1/2 (267)	6,190 (27.5)	6,330 (28.2)	6,450 (28.7)	6,635 (29.5)	12,385 (55.1)	12,665 (56.3)	12,895 (57.4)	13,270 (59.0)
	17-1/2 (445)	10,320 (45.9)	10,550 (46.9)	10,745 (47.8)	11,060 (49.2)	20,640 (91.8)	21,105 (93.9)	21,495 (95.6)	22,120 (98.4)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 7-18 as necessary to the above values. Compare to the steel values in table 41. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Seismic applicaitons are not permitted.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength (factored resistance) by 0.85.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, $\lambda_a = 0.51$. For all-lightweight, $\lambda_a = 0.45$

9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors:
Seismic applicaitons are not permitted.

Table 41 — Steel factored resistance for Hilti HIT-V and HAS threaded rods

Nominal anchor diameter in.	HAS-V / HAS-V HDG ASTM F1554 Gr. 36[3,5]		HAS-E / HAS-E HDG ASTM F1554 Gr. 55[3,5]		HAS-B and HAS-B HDG[3,5] ASTM A193 B7 and ASTM F 1554 Gr. 105		HAS-R Stainless Steel[4] ASTM F593 (3/8-in to 1-in) ASTM A193 (1-1/8-in to 1-1/4-in)		HAS-R stainless steel ASTM F 593 - AISI 304/316 SS[4]	
	Tensile[1] N_{sar} lb (kN)	Shear[2] V_{sar} lb (kN)	Tensile[1] N_{sar} lb (kN)	Shear[2] V_{sar} lb (kN)	Tensile[1] N_{sar} lb (kN)	Shear[2] V_{sar} lb (kN)	Tensile[1] N_{sar} lb (kN)	Shear[2] V_{sar} lb (kN)	Tensile[1] N_{sar} lb (kN)	Shear[2] V_{sar} lb (kN)
3/8	3,055 (13.6)	1,720 (7.7)	3,955 (17.6)	2,225 (9.9)	6,590 (29.3)	3,705 (16.5)	4,610 (20.5)	2,570 (11.4)	4,610 (20.5)	2,140 (9.5)
1/2	5,595 (24.9)	3,150 (14.0)	7,240 (32.2)	4,070 (18.1)	12,065 (53.7)	6,785 (30.2)	8,445 (37.6)	4,705 (20.9)	8,445 (37.6)	4,705 (20.9)
5/8	8,915 (39.7)	5,015 (22.3)	11,525 (51.3)	6,485 (28.8)	19,210 (85.4)	10,805 (48.1)	13,445 (59.8)	7,490 (33.3)	13,445 (59.8)	7,490 (33.3)
3/4	13,190 (58.7)	7,420 (33.0)	17,060 (75.9)	9,600 (42.7)	28,435 (126.5)	15,995 (71.1)	16,920 (75.3)	9,425 (41.9)	16,915 (75.2)	9,425 (41.9)
7/8	18,210 (81.0)	10,245 (45.6)	23,550 (104.8)	13,245 (58.9)	39,245 (174.6)	22,075 (98.2)	23,350 (103.9)	13,010 (57.9)	23,350 (103.9)	13,010 (57.9)
1	23,890 (106.3)	13,440 (59.8)	30,890 (137.4)	17,380 (77.3)	51,485 (229.0)	28,960 (128.8)	30,635 (136.3)	17,065 (75.9)	30,635 (136.3)	17,065 (75.9)
1-1/4	38,225 (170.0)	21,500 (95.6)	49,425 (219.9)	27,800 (123.7)	82,375 (366.4)	46,335 (206.1)	37,565 (167.1)	21,130 (94.0)	49,010 (218.0)	27,305 (121.5)

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Table 42 — Hilti HIT-ICE adhesive design information with CA rebar in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

Design parameter		Symbol	Units	Rebar size					Ref
				10M	15M	20M	25M	30M	A23.3-14
Anchor O.D.		d_a	mm	11.3	16.0	19.5	25.2	29.9	
Effective minimum embedment[2]		$h_{ef,min}$	mm	70	80	90	101	120	
Effective maximum embedment[2]		$h_{ef,max}$	mm	226	320	390	504	598	
Minimum concrete thickness[2]		h_{min}	mm	h_{ef} + 30	h_{ef} + $2d_o$				
Critical edge distance		c_{ac}	mm	$c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4 $\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$					
Minimum edge distance[3]		c_{min}	mm	57	80	98	126	150	
Minimum anchor spacing		s_{min}	mm	57	80	98	126	150	
Coeff. for factored concrete breakout resistance, uncracked concrete[4]		$k_{c,uncr}$	–	10					D.6.2.2
Coeff. for factored concrete breakout resistance, cracked concrete[4]		$k_{c,cr}$	–	7					D.6.2.2
Concrete material resistance factor		ϕ_c	–	0.65					8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]		R_{conc}	–	1.00					D.5.3(c)
Temp. range A[6]	Characteristic bond stress in cracked concrete[7]	τ_{cr}	psi (MPa)	n/a	n/a	n/a	n/a	n/a	D.6.5.2
	Characteristic bond stress in uncracked concrete[7]	τ_{uncr}	psi (MPa)	1,010 (7.0)	990 (6.8)	975 (6.7)	950 (6.6)	930 (6.4)	D.6.5.2
Reduction for seismic tension		$\alpha_{N,seis}$	–	n/a					
Permissible installation conditions	Resistance modification factor tension & shear, bond failure dry concrete	Anchor category	–	1	1	2	2	1	D.5.3(c)
		R_{dry}	–	1.00	1.00	0.85	0.85	1.00	
	Resistance modification factor tension & shear, bond failure water-saturated concrete	Anchor category	–	1	1	2	2	1	D.5.3(c)
		R_{ws}	–	1.00	1.00	0.85	0.85	1.00	

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See figure 5 of this section.

3 Minimum edge distance may be reduced to 45mm provided rebar remains untorqued.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

Table 43 — CA rebar installation specifications with Hilti HIT-ICE adhesive anchor system[1]

Setting information		Symbol	Units	Rebar size				
				10M	15M	20M	25M	30M
Nominal bit diameter		d_o	in.	9/16	3/4	1	1-1/4	1-3/8
Effective embedment	minimum	$h_{ef,min}$	mm	60	80	90	100	120
	maximum	$h_{ef,max}$	mm	226	320	390	504	598
Minimum concrete thickness		h_{min}	mm	h_{ef} + 30	h_{ef} + $2d_o$			

1 See figure 5 of this section.

Table 44 — Hilti HIT-ICE adhesive factored resistance with concrete / bond failure for CA rebar in uncracked concrete [1,2,3,4,5,6,7,8]

		Tension N_r				Shear V_r			
Rebar size	Effective embedment in. (mm)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
10M	4-1/2 (115)	4,220 (18.8)	4,315 (19.2)	4,395 (19.5)	4,520 (20.1)	8,435 (37.5)	8,625 (38.4)	8,785 (39.1)	9,045 (40.2)
	7-1/16 (180)	6,605 (29.4)	6,750 (30.0)	6,875 (30.6)	7,075 (31.5)	13,205 (58.7)	13,505 (60.1)	13,750 (61.2)	14,155 (63.0)
	8-7/8 (226)	8,290 (36.9)	8,475 (37.7)	8,635 (38.4)	8,885 (39.5)	16,580 (73.8)	16,955 (75.4)	17,265 (76.8)	17,770 (79.0)
15M	5-11/16 (145)	7,380 (32.8)	7,550 (33.6)	7,690 (34.2)	7,910 (35.2)	14,765 (65.7)	15,100 (67.2)	15,375 (68.4)	15,825 (70.4)
	9-13/16 (250)	12,730 (56.6)	13,015 (57.9)	13,255 (59.0)	13,640 (60.7)	25,455 (113.2)	26,030 (115.8)	26,510 (117.9)	27,285 (121.4)
	12-5/8 (320)	16,290 (72.5)	16,660 (74.1)	16,965 (75.5)	17,460 (77.7)	32,585 (144.9)	33,320 (148.2)	33,930 (150.9)	34,920 (155.3)
20M	7-7/8 (200)	10,390 (46.2)	10,625 (47.3)	10,820 (48.1)	11,135 (49.5)	20,775 (92.4)	21,245 (94.5)	21,635 (96.2)	22,270 (99.1)
	14 (355)	18,440 (82.0)	18,855 (83.9)	19,200 (85.4)	19,765 (87.9)	36,880 (164.0)	37,710 (167.7)	38,405 (170.8)	39,525 (175.8)
	15-3/8 (390)	20,255 (90.1)	20,715 (92.1)	21,095 (93.8)	21,710 (96.6)	40,515 (180.2)	41,430 (184.3)	42,190 (187.7)	43,425 (193.2)
25M	9-1/16 (230)	15,045 (66.9)	15,380 (68.4)	15,665 (69.7)	16,125 (71.7)	30,085 (133.8)	30,765 (136.8)	31,330 (139.4)	32,245 (143.4)
	15-15/16 (405)	26,490 (117.8)	27,085 (120.5)	27,585 (122.7)	28,390 (126.3)	52,975 (235.7)	54,175 (241.0)	55,170 (245.4)	56,780 (252.6)
	19-13/16 (504)	32,965 (146.6)	33,705 (149.9)	34,330 (152.7)	35,330 (157.2)	65,925 (293.3)	67,415 (299.9)	68,655 (305.4)	70,660 (314.3)
30M	10-1/4 (260)	23,235 (103.4)	23,760 (105.7)	24,200 (107.6)	24,905 (110.8)	46,475 (206.7)	47,525 (211.4)	48,400 (215.3)	49,810 (221.6)
	17-15/16 (455)	40,665 (180.9)	41,585 (185.0)	42,350 (188.4)	43,585 (193.9)	81,330 (361.8)	83,165 (369.9)	84,695 (376.7)	87,170 (387.7)
	23-9/16 (598)	53,445 (237.7)	54,650 (243.1)	55,660 (247.6)	57,280 (254.8)	106,890 (475.5)	109,305 (486.2)	111,315 (495.2)	114,565 (509.6)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 46-50 as necessary. Compare to the steel values in table 45. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength (factored resistance) by 0.85.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

Table 45 — Steel factored resistance for CA rebar[1]

Rebar size	CSA-G30.18 Grade 400 [2]	
	Tensile[3] N_{sa} lb (kN)	Shear[4] V_{sa} lb (kN)
10M	7,245 (32.2)	4,035 (17.9)
15M	14,525 (64.6)	8,090 (36.0)
20M	21,570 (95.9)	12,020 (53.5)
25M	36,025 (160.2)	20,070 (89.3)
30M	50,715 (225.6)	28,255 (125.7)

1 See Section 3.1.8 to convert design strength value to ASD value.
2 CSA-G30.18 Grade 400 rebar are considered ductile steel elements.
3 Tensile = $A_{se,N}\ \Phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D
4 Shear = $A_{se,V}\ \Phi_s$ 0.60 f_{uta} R as noted in CSA A23.3 Annex D.

Table 46 — Load adjustment factors for 10M rebar in uncracked concrete[1,2,3]

10M Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Embedment h_{ef}	in.	(mm)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-8/9 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)	4-1/2 (115)	7-1/16 (180)	8-7/8 (226)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.26	0.16	0.13	n/a	n/a	n/a	0.10	0.06	0.05	0.19	0.12	0.10	n/a	n/a	n/a
	2-3/16	(55)	0.58	0.55	0.54	0.28	0.18	0.14	0.54	0.53	0.53	0.13	0.08	0.07	0.26	0.17	0.13	n/a	n/a	n/a
	3	(76)	0.61	0.57	0.56	0.34	0.21	0.17	0.56	0.54	0.54	0.22	0.14	0.11	0.34	0.21	0.17	n/a	n/a	n/a
	4	(102)	0.65	0.59	0.57	0.42	0.26	0.20	0.58	0.56	0.55	0.33	0.21	0.17	0.42	0.26	0.20	n/a	n/a	n/a
	5	(127)	0.68	0.62	0.59	0.51	0.32	0.25	0.60	0.57	0.56	0.47	0.30	0.24	0.51	0.32	0.25	n/a	n/a	n/a
	5-11/16	(145)	0.71	0.63	0.61	0.58	0.36	0.28	0.61	0.58	0.57	0.57	0.36	0.29	0.58	0.36	0.28	0.68	n/a	n/a
	6	(152)	0.72	0.64	0.61	0.61	0.38	0.30	0.62	0.59	0.58	0.61	0.39	0.31	0.61	0.38	0.30	0.69	n/a	n/a
	7	(178)	0.76	0.66	0.63	0.71	0.44	0.35	0.64	0.60	0.59	0.77	0.49	0.39	0.71	0.44	0.35	0.75	n/a	n/a
	8	(203)	0.79	0.69	0.65	0.81	0.51	0.40	0.66	0.62	0.60	0.94	0.60	0.48	0.81	0.51	0.40	0.80	n/a	n/a
	8-1/4	(210)	0.80	0.69	0.65	0.84	0.52	0.41	0.67	0.62	0.61	0.99	0.63	0.50	0.84	0.52	0.41	0.81	0.70	n/a
	9	(229)	0.83	0.71	0.67	0.92	0.57	0.45	0.68	0.63	0.61	1.00	0.72	0.57	0.92	0.57	0.45	0.85	0.73	n/a
	10-1/16	(256)	0.87	0.74	0.69	1.00	0.64	0.50	0.70	0.65	0.63		0.85	0.68	1.00	0.64	0.50	0.90	0.77	0.72
	11	(279)	0.90	0.76	0.71		0.69	0.55	0.72	0.66	0.64		0.97	0.77		0.69	0.55	0.94	0.81	0.75
	12	(305)	0.94	0.78	0.72		0.76	0.60	0.74	0.68	0.65		1.00	0.88		0.76	0.60	0.98	0.84	0.78
	14	(356)	1.00	0.83	0.76		0.88	0.70	0.78	0.71	0.68			1.00		0.88	0.70	1.00	0.91	0.85
	16	(406)		0.88	0.80		1.00	0.80	0.82	0.74	0.70					1.00	0.80		0.98	0.90
	18	(457)		0.92	0.84			0.90	0.86	0.77	0.73						0.90		1.00	0.96
	24	(610)		1.00	0.95			1.00	0.98	0.86	0.81						1.00			1.00
	30	(762)			1.00				1.00	0.95	0.88									
	36	(914)								1.00	0.96									
	> 48	(1219)									1.00									

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3^*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3^*h_{ef}$. If $c \geq 3^*h_{ef}$, then $f_{HV} = 1.0$.

Table 47 — Load adjustment factors for 15M rebar in uncracked concrete[1,2,3]

15M Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Embedment h_{ef}	in.	(mm)	5-11/16 (145)	9-13/16 (250)	12-5/8 (320)	5-11/16 (145)	9-13/16 (250)	12-5/8 (320)	5-11/16 (145)	9-13/16 (250)	12-5/8 (320)	5-11/16 (145)	9-13/16 (250)	12-5/8 (320)	5-11/16 (145)	9-13/16 (250)	12-5/8 (320)	5-11/16 (145)	9-13/16 (250)	12-5/8 (320)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.25	0.14	0.11	n/a	n/a	n/a	0.07	0.04	0.03	0.13	0.08	0.06	n/a	n/a	n/a
	3-1/8	(80)	0.59	0.55	0.54	0.33	0.18	0.14	0.55	0.53	0.53	0.16	0.09	0.07	0.32	0.18	0.14	n/a	n/a	n/a
	4	(102)	0.62	0.57	0.55	0.37	0.21	0.16	0.56	0.54	0.54	0.23	0.13	0.10	0.37	0.21	0.16	n/a	n/a	n/a
	5	(127)	0.65	0.58	0.57	0.43	0.24	0.19	0.58	0.55	0.55	0.32	0.18	0.14	0.43	0.24	0.19	n/a	n/a	n/a
	6	(152)	0.68	0.60	0.58	0.49	0.28	0.21	0.59	0.56	0.55	0.42	0.24	0.19	0.49	0.28	0.21	n/a	n/a	n/a
	7	(178)	0.70	0.62	0.59	0.57	0.32	0.25	0.61	0.58	0.56	0.52	0.30	0.24	0.57	0.32	0.25	n/a	n/a	n/a
	7-1/4	(184)	0.71	0.62	0.60	0.59	0.33	0.26	0.61	0.58	0.57	0.55	0.32	0.25	0.59	0.33	0.26	0.67	n/a	n/a
	8	(203)	0.73	0.64	0.61	0.65	0.37	0.28	0.62	0.59	0.57	0.64	0.37	0.29	0.65	0.37	0.28	0.70	n/a	n/a
	9	(229)	0.76	0.65	0.62	0.73	0.41	0.32	0.64	0.60	0.58	0.76	0.44	0.35	0.73	0.41	0.32	0.75	n/a	n/a
	10	(254)	0.79	0.67	0.63	0.81	0.46	0.35	0.65	0.61	0.59	0.90	0.52	0.41	0.81	0.46	0.35	0.79	n/a	n/a
	11-3/8	(289)	0.83	0.69	0.65	0.93	0.52	0.40	0.68	0.62	0.60	1.00	0.63	0.49	0.93	0.52	0.40	0.84	0.70	n/a
	12	(305)	0.85	0.70	0.66	0.98	0.55	0.42	0.69	0.63	0.61		0.68	0.53	0.98	0.55	0.42	0.86	0.72	n/a
	14-1/8	(359)	0.91	0.74	0.69	1.00	0.65	0.50	0.72	0.65	0.63		0.87	0.68	1.00	0.65	0.50	0.94	0.78	0.72
	16	(406)	0.97	0.77	0.71		0.73	0.56	0.75	0.67	0.65		1.00	0.82		0.73	0.56	1.00	0.83	0.76
	18	(457)	1.00	0.80	0.74		0.82	0.64	0.78	0.69	0.66			0.98		0.82	0.64		0.88	0.81
	20	(508)		0.84	0.76		0.91	0.71	0.81	0.72	0.68			1.00		0.91	0.71		0.93	0.85
	22	(559)		0.87	0.79		1.00	0.78	0.84	0.74	0.70					1.00	0.78		0.97	0.90
	24	(610)		0.91	0.82			0.85	0.87	0.76	0.72						0.85		1.00	0.94
	30	(762)		1.00	0.90			1.00	0.96	0.82	0.77						1.00			1.00
	36	(914)			0.98				1.00	0.89	0.83									
	> 48	(1219)			1.00					1.00	0.94									

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 48 — Load adjustment factors for 20M rebar in uncracked concrete[1,2,3]

20M Rebar uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Embedment h_{ef}	in.	(mm)	7-7/8 (200)	14 (355)	15-3/8 (390)	7-7/8 (200)	14 (355)	15-3/8 (390)	7-7/8 (200)	14 (355)	15-3/8 (390)	7-7/8 (200)	14 (355)	15-3/8 (390)	7-7/8 (200)	14 (355)	15-3/8 (390)	7-7/8 (200)	14 (355)	15-3/8 (390)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.21	0.12	0.10	n/a	n/a	n/a	0.05	0.03	0.03	0.10	0.06	0.05	n/a	n/a	n/a
	3-7/8	(98)	0.58	0.55	0.54	0.29	0.16	0.14	0.55	0.53	0.53	0.16	0.09	0.08	0.29	0.16	0.14	n/a	n/a	n/a
	4	(102)	0.58	0.55	0.54	0.29	0.16	0.14	0.55	0.54	0.53	0.17	0.10	0.09	0.29	0.16	0.14	n/a	n/a	n/a
	5	(127)	0.61	0.56	0.55	0.33	0.18	0.16	0.56	0.54	0.54	0.24	0.14	0.12	0.33	0.18	0.16	n/a	n/a	n/a
	6	(152)	0.63	0.57	0.57	0.38	0.20	0.19	0.58	0.55	0.55	0.32	0.18	0.16	0.38	0.20	0.19	n/a	n/a	n/a
	7	(178)	0.65	0.58	0.58	0.42	0.23	0.21	0.59	0.56	0.56	0.40	0.22	0.20	0.42	0.23	0.21	n/a	n/a	n/a
	8	(203)	0.67	0.60	0.59	0.47	0.26	0.23	0.60	0.57	0.57	0.49	0.27	0.25	0.47	0.26	0.23	n/a	n/a	n/a
	9	(229)	0.69	0.61	0.60	0.53	0.29	0.26	0.62	0.58	0.57	0.58	0.33	0.30	0.53	0.29	0.26	n/a	n/a	n/a
	10	(254)	0.71	0.62	0.61	0.59	0.32	0.29	0.63	0.59	0.58	0.68	0.38	0.35	0.59	0.32	0.29	0.72	n/a	n/a
	11	(279)	0.73	0.63	0.62	0.65	0.35	0.32	0.64	0.60	0.59	0.78	0.44	0.40	0.65	0.35	0.32	0.75	n/a	n/a
	12	(305)	0.75	0.64	0.63	0.71	0.39	0.35	0.65	0.61	0.60	0.89	0.50	0.46	0.71	0.39	0.35	0.79	n/a	n/a
	14	(356)	0.80	0.67	0.65	0.83	0.45	0.41	0.68	0.62	0.62	1.00	0.63	0.58	0.83	0.45	0.41	0.85	n/a	n/a
	16	(406)	0.84	0.69	0.67	0.95	0.52	0.47	0.71	0.64	0.63		0.77	0.70	0.95	0.52	0.47	0.91	0.75	n/a
	18	(457)	0.88	0.71	0.70	1.00	0.58	0.53	0.73	0.66	0.65		0.92	0.84	1.00	0.58	0.53	0.96	0.80	0.77
	20	(508)	0.92	0.74	0.72		0.64	0.58	0.76	0.68	0.66		1.00	0.98		0.64	0.58	1.00	0.84	0.81
	22	(559)	0.97	0.76	0.74		0.71	0.64	0.78	0.69	0.68			1.00		0.71	0.64		0.88	0.85
	24	(610)	1.00	0.79	0.76		0.77	0.70	0.81	0.71	0.70					0.77	0.70		0.92	0.89
	26	(660)		0.81	0.78		0.84	0.76	0.83	0.73	0.71					0.84	0.76		0.96	0.93
	28	(711)		0.83	0.80		0.90	0.82	0.86	0.75	0.73					0.90	0.82		0.99	0.96
	30	(762)		0.86	0.83		0.97	0.88	0.89	0.76	0.75					0.97	0.88		1.00	0.99
	36	(914)		0.93	0.89		1.00	1.00	0.96	0.82	0.80					1.00	1.00			1.00
	> 48	(1219)		1.00	1.00				1.00	0.92	0.90									

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 49 — Load adjustment factors for 25M rebar in uncracked concrete[1,2,3]

25M Rebar uncracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
Embedment h_{ef}	in. (mm)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)	9-1/16 (230)	15-15/16 (405)	19-13/16 (504)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4 (44)	n/a	n/a	n/a	0.22	0.12	0.10	n/a	n/a	n/a	0.03	0.02	0.02	0.07	0.04	0.03	n/a	n/a	n/a
	5 (127)	0.59	0.55	0.54	0.33	0.18	0.14	0.55	0.53	0.53	0.17	0.09	0.08	0.33	0.18	0.14	n/a	n/a	n/a
	6 (152)	0.61	0.56	0.55	0.36	0.20	0.16	0.56	0.54	0.54	0.22	0.12	0.10	0.36	0.20	0.16	n/a	n/a	n/a
	7 (178)	0.63	0.57	0.56	0.40	0.22	0.17	0.57	0.55	0.54	0.27	0.16	0.13	0.40	0.22	0.17	n/a	n/a	n/a
	8 (203)	0.65	0.58	0.57	0.44	0.24	0.19	0.58	0.56	0.55	0.34	0.19	0.15	0.44	0.24	0.19	n/a	n/a	n/a
	9 (229)	0.67	0.59	0.58	0.48	0.26	0.21	0.59	0.56	0.55	0.40	0.23	0.18	0.48	0.26	0.21	n/a	n/a	n/a
	10 (254)	0.68	0.60	0.58	0.52	0.29	0.23	0.60	0.57	0.56	0.47	0.27	0.21	0.52	0.29	0.23	n/a	n/a	n/a
	11-9/16 (294)	0.71	0.62	0.60	0.61	0.33	0.26	0.62	0.58	0.57	0.58	0.33	0.27	0.61	0.33	0.26	0.68	n/a	n/a
	12 (305)	0.72	0.63	0.60	0.63	0.34	0.27	0.62	0.58	0.57	0.62	0.35	0.28	0.63	0.34	0.27	0.69	n/a	n/a
	14 (356)	0.76	0.65	0.62	0.73	0.40	0.32	0.64	0.60	0.58	0.78	0.44	0.35	0.73	0.40	0.32	0.75	n/a	n/a
	16 (406)	0.79	0.67	0.63	0.84	0.46	0.37	0.66	0.61	0.60	0.95	0.54	0.43	0.84	0.46	0.37	0.80	n/a	n/a
	18 (457)	0.83	0.69	0.65	0.94	0.52	0.41	0.68	0.62	0.61	1.00	0.64	0.52	0.94	0.52	0.41	0.85	n/a	n/a
	18-7/16 (469)	0.84	0.69	0.66	0.97	0.53	0.42	0.69	0.63	0.61		0.67	0.54	0.97	0.53	0.42	0.86	0.71	n/a
	20 (508)	0.87	0.71	0.67	1.00	0.57	0.46	0.70	0.64	0.62		0.75	0.60	1.00	0.57	0.46	0.90	0.74	n/a
	22-3/8 (568)	0.91	0.73	0.69		0.64	0.51	0.72	0.65	0.63		0.89	0.72		0.64	0.51	0.95	0.79	0.73
	24 (610)	0.94	0.75	0.70		0.69	0.55	0.74	0.67	0.64		0.99	0.80		0.69	0.55	0.98	0.81	0.76
	26 (660)	0.98	0.77	0.72		0.75	0.59	0.76	0.68	0.65		1.00	0.90		0.75	0.59	1.00	0.85	0.79
	28 (711)	1.00	0.79	0.74		0.80	0.64	0.78	0.69	0.67			1.00		0.80	0.64		0.88	0.82
	30 (762)		0.81	0.75		0.86	0.68	0.80	0.71	0.68					0.86	0.68		0.91	0.85
	36 (914)		0.88	0.80		1.00	0.82	0.86	0.75	0.71					1.00	0.82		1.00	0.93
	> 48 (1219)		1.00	0.90			1.00	0.98	0.83	0.79						1.00			1.00

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3{*}h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{HV} = 1.0$.

Table 50 — Load adjustment factors for 30M rebar in uncracked concrete[1,2,3]

30M Rebar uncracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[4] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear[5] f_{HV}		
Embedment h_{ef}	in. (mm)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	10-1/4 (260)	17-15/16 (455)	23-9/16 (598)	23-9/16 (598)
Spacing (s) / Edge distance (c_a) / Concrete thickness (h), - in. (mm)	1-3/4 (44)	n/a	n/a	n/a	0.23	0.13	0.09	n/a	n/a	n/a	0.02	0.01	0.01	0.04	0.03	0.02	n/a	n/a	n/a
	5-7/8 (150)	0.60	0.55	0.54	0.35	0.19	0.14	0.54	0.53	0.53	0.14	0.08	0.06	0.28	0.16	0.12	n/a	n/a	n/a
	6 (152)	0.60	0.56	0.54	0.35	0.19	0.14	0.55	0.53	0.53	0.14	0.08	0.06	0.28	0.16	0.12	n/a	n/a	n/a
	7 (178)	0.61	0.57	0.55	0.38	0.21	0.16	0.55	0.54	0.53	0.18	0.10	0.08	0.36	0.20	0.15	n/a	n/a	n/a
	8 (203)	0.63	0.57	0.56	0.41	0.23	0.17	0.56	0.54	0.53	0.22	0.12	0.09	0.41	0.23	0.17	n/a	n/a	n/a
	9 (229)	0.65	0.58	0.56	0.45	0.25	0.18	0.57	0.55	0.54	0.26	0.15	0.11	0.45	0.25	0.18	n/a	n/a	n/a
	10 (254)	0.66	0.59	0.57	0.48	0.27	0.20	0.58	0.55	0.54	0.30	0.17	0.13	0.48	0.27	0.20	n/a	n/a	n/a
	11 (279)	0.68	0.60	0.58	0.52	0.29	0.21	0.58	0.56	0.55	0.35	0.20	0.15	0.52	0.29	0.21	n/a	n/a	n/a
	12 (305)	0.70	0.61	0.58	0.56	0.31	0.23	0.59	0.56	0.55	0.40	0.23	0.17	0.56	0.31	0.23	n/a	n/a	n/a
	13-1/4 (337)	0.72	0.62	0.59	0.62	0.34	0.26	0.60	0.57	0.56	0.46	0.26	0.20	0.62	0.34	0.26	0.63	n/a	n/a
	14 (356)	0.73	0.63	0.60	0.66	0.36	0.27	0.61	0.57	0.56	0.50	0.29	0.22	0.66	0.36	0.27	0.65	n/a	n/a
	16 (406)	0.76	0.65	0.61	0.75	0.41	0.31	0.62	0.58	0.57	0.61	0.35	0.27	0.75	0.41	0.31	0.69	n/a	n/a
	18 (457)	0.79	0.67	0.63	0.85	0.46	0.35	0.64	0.59	0.58	0.73	0.42	0.32	0.85	0.46	0.35	0.74	n/a	n/a
	20 (508)	0.83	0.69	0.64	0.94	0.52	0.39	0.65	0.60	0.59	0.86	0.49	0.37	0.94	0.52	0.39	0.78	n/a	n/a
	20-7/8 (531)	0.84	0.69	0.65	0.98	0.54	0.41	0.66	0.61	0.59	0.92	0.52	0.40	0.98	0.54	0.41	0.79	n/a	n/a
	22 (559)	0.86	0.70	0.66	1.00	0.57	0.43	0.67	0.61	0.60	0.99	0.57	0.43	1.00	0.57	0.43	0.81	0.68	n/a
	24 (610)	0.89	0.72	0.67		0.62	0.47	0.68	0.62	0.60	1.00	0.64	0.49		0.62	0.47	0.85	0.71	n/a
	26-9/16 (675)	0.93	0.75	0.69		0.69	0.52	0.70	0.64	0.61		0.75	0.57		0.69	0.52	0.89	0.74	0.68
	28 (711)	0.96	0.76	0.70		0.72	0.54	0.71	0.65	0.62		0.81	0.62		0.72	0.54	0.92	0.76	0.70
	30 (762)	0.99	0.78	0.71		0.77	0.58	0.73	0.66	0.63		0.90	0.69		0.77	0.58	0.95	0.79	0.72
	36 (914)	1.00	0.83	0.75		0.93	0.70	0.77	0.69	0.66		1.00	0.90		0.93	0.70	1.00	0.86	0.79
	> 48 (1219)		0.95	0.84		1.00	0.93	0.86	0.75	0.71			1.00		1.00	0.93		1.00	0.91

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 T_{max} for 5d ≤ s ≤ 16-in. and to 0.5 T_{max} for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3{*}h_{ef}$. f_{AV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance, $c < 3{*}h_{ef}$. If $c \geq 3{*}h_{ef}$, then $f_{HV} = 1.0$.

Table 51 — Hilti HIT-ICE design information with Hilti HIS-N and HIS-RN internally threaded inserts in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

Design parameter		Symbol	Units	Nominal bolt/cap screw diameter (in.)				Ref
				3/8	1/2	5/8	3/4	A23.3-14
HIS insert outside diameter		D	mm	16.5	20.5	25.4	27.6	
Effective embedment[2]		h_{ef}	mm	110	125	170	205	
Minimum concrete thickness[2]		h_{min}	mm	150	170	230	270	
Critical edge distance		c_{min}	mm	$c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4 $\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$				
Minimum edge distance		s_{min}	mm	83	102	127	140	
Minimum anchor spacing		s_{min}	mm	83	102	127	140	
Coeff. for factored concrete breakout resistance, uncracked concrete[3]		$k_{c,uncr}$	–	10				D.6.2.2
Coeff. for factored concrete breakout resistance, cracked concrete[3]		$k_{c,cr}$	–	7				D.6.2.2
Concrete material resistance factor		ϕ_c	–	0.65				8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[4]		R_{conc}	–	1.00				D.5.3(c)
Temp. range A[5]	Characteristic bond stress in cracked concrete[6]	τ_{cr}	psi (MPa)	350 (2.4)	30 (0.2)	n/a	n/a	D.6.5.2
	Characteristic bond stress in uncracked concrete[6]	τ_{uncr}	psi (MPa)	830 (5.7)	855 (5.9)	840 (5.8)	830 (5.7)	D.6.5.2
Reduction for seismic tension		$\alpha_{N,seis}$	–	n/a				
Permissible installation conditions	Resistance modification factor tension & shear, bond failure dry concrete	Anchor category	–	2	1	1	1	D.5.3(c)
		R_{dry}	–	0.85	1.00	1.00	1.00	
	Resistance modification factor tension & shear, bond failure water-saturated concrete	Anchor category	–	2	1	1	1	D.5.3(c)
		R_{ws}	–	0.85	1.00	1.00	1.00	

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See figure 7 of this section.

3 Minimum edge distance may be reduced to 44mm < c_{min} < 5d provided T_{inst} is reduced.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3. For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).

Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2,500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

Table 52 — Hilti HIT-ICE adhesive factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8]

Thread size	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8-16 UNC	4-3/8	4,120	4,210	4,290	4,415	8,235	8,420	8,575	8,825
	(110)	(18.3)	(18.7)	(19.1)	(19.6)	(36.6)	(37.5)	(38.2)	(39.3)
1/2-13 UNC	5	7,065	7,225	7,360	7,575	14,135	14,455	14,720	15,150
	(125)	(31.4)	(32.1)	(32.7)	(33.7)	(62.9)	(64.3)	(65.5)	(67.4)
5/8-11 UNC	6-3/4	11,660	11,920	12,140	12,495	23,315	23,840	24,280	24,990
	(170)	(51.9)	(53.0)	(54.0)	(55.6)	(103.7)	(106.1)	(108.0)	(111.2)
3/4-10 UNC	8-1/8	15,140	15,485	15,765	16,230	30,280	30,965	31,535	32,455
	(205)	(67.3)	(68.9)	(70.1)	(72.2)	(134.7)	(137.7)	(140.3)	(144.4)

Table 53 — Hilti HIT-ICE adhesive factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9]

Thread size	Effective embedment in. (mm)	Tension N_r				Shear V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8-16 UNC	4-3/8	1,735	1,775	1,810	1,860	3,475	3,550	3,615	3,720
	(110)	(7.7)	(7.9)	(8.0)	(8.3)	(15.4)	(15.8)	(16.1)	(16.6)
1/2-13 UNC	5	2,480	2,535	2,580	2,660	4,960	5,070	5,165	5,315
	(125)	(11.0)	(11.3)	(11.5)	(11.8)	(22.1)	(22.6)	(23.0)	(23.6)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 36-37 as necessary. Compare to the steel values in table 54.
The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength value by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by l_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for static loads only. Seismic applications are not permitted.

Table 54 — Steel factored resistance for steel bolt / cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

Thread size	ASTM A193 B7		ASTM A193 Grade B8M stainless steel	
	Tensile[4] N_{sar} lb (kN)	Shear[5] V_{sar} lb (kN)	Tensile[4] N_{sar} lb (kN)	Shear[5] V_{sar} lb (kN)
3/8-16 UNC	5,765	3,215	5,070	2,825
	(25.6)	(14.3)	(22.6)	(12.6)
1/2-13 UNC	9,635	5,880	9,290	5,175
	(42.9)	(26.2)	(41.3)	(23.0)
5/8-11 UNC	16,020	9,365	14,790	8,240
	(71.3)	(41.7)	(65.8)	(36.7)
3/4-10 UNC	16,280	13,860	21,895	12,195
	(72.4)	(61.7)	(97.4)	(54.2)

1 See section 3.1.8 to convert design strength value to ASD value.
2 Hilti HIS-N and HIS-RN inserts with steel bolts are considered brittle steel elements.
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.
4 Tensile = $A_{se,N}$ Φ_s f_{uta} R as noted in CSA A23.3 Annex D
5 Shear = $A_{se,V}$ Φ_s 0.60 f_{uta} R as noted in CSA A23.3 Annex D. For 3/8-in diameter insert, shear = $A_{se,V}$ Φ_s 0.50 f_{uta} R.

Figure 8 — HIT-ICE installation conditions for masonry construction

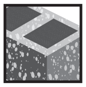
Permissible masonty conditions	 Grout-filed concrete masonry	Permissible drilling method	 Hammer drilling with carbide tip

Table 55 — Hilti HIT-ICE allowable loads for threaded rods in grout-filled concrete masonry units[1, 2, 3, 4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Distance from edge		Tension^{5,6}		Shear lb (kN)^{5,6}					
		in.	(mm)	lb	(kN)	HAS-E ISO 898 Class 5.5		HAS-E B7 ASTM A193 Grade B7		HAS-R AISI 304 / 316	
3/8	3-1/2 (89)	4	(102)	1,550	(6.9)	1360	(6.0)	2020	(9.0)	1875	(8.3)
		≥12	(305)								
1/2	4-1/4 (108)	4	(102)	1,785	(7.9)	2,020	(9.0)	2,020	(9.0)	2,020	(9.0)
		≥12	(305)			2,420	(10.8)	4,170	(18.5)	3,335	(14.8)
5/8	5 (127)	4	(102)	2,265	(10.1)	2,020	(9.0)	2,020	(9.0)	2,020	(9.0)
		≥12	(305)			3,780	(16.8)	5,625	(25.0)	5,215	(23.2)
3/4	6-5/8 (168)	4	(102)	3,740	(16.6)	2,020	(9.0)	2,020	(9.0)	2,020	(9.0)
		≥12	(305)			5,445	(24.2)	5,625	(25.0)	5,625	(25.0)

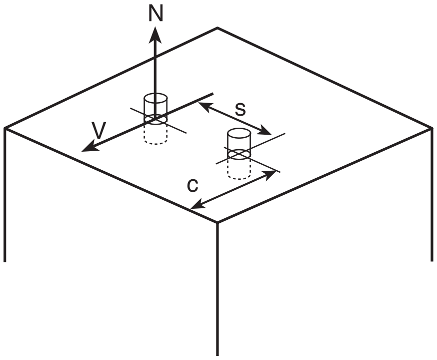
Table 56 — Hilti HIT-ICE ultimate loads for threaded rods in grout-filled concrete masonry units[1, 2, 3, 4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Distance from edge		Tension lb (kN)^{5,6}		Shear lb (kN)^{5,6}					
		in.	(mm)	lb	(kN)	HAS-E ISO 898 Class 5.5		HAS-E B7 ASTM A193 Grade B7		HAS-R AISI 304 / 316	
3/8	3-1/2 (90)	4	(102)	6,005	(26.7)	3,605	(16.0)	6,210	(27.6)	4,970	(22.1)
		≥12	(305)								
1/2	4-1/4 (108)	4	(102)	7,140	(31.8)	6,405	(28.5)	8,075	(35.9)	8,075	(35.9)
		≥12	(305)					11,040	(49.1)	8,835	(39.3)
5/8	5 (127)	4	(102)	9,060	(40.3)	8,075	(35.9)	8,075	(35.9)	8,075	(35.9)
		≥12	(305)			10,010	(44.2)	17,260	(76.8)	13,805	(61.4)
3/4	6-5/8 (168)	4	(102)	14,970	(66.6)	8,075	(35.9)	8,075	(35.9)	8,075	(35.9)
		≥12	(305)			14,415	(64.1)	22,500	(100.1)	16,800	(75.2)

1 Values are for lightweight, medium-weight or normal-weight concrete masonry units conforming to ASTM C90 with 2,000 psi grout conforming to ASTM C476.
2 Embedment depth is measured from the outside face of the concrete masonry unit.
3 Values are for anchors located in the grouted cell, head joint, bed joint, T-joint, cross web or any combination of the above.
4 Values for edge distances between 4 inches and 12 inches can be calculated by linear interpolation.
5 Loads are based on the lesser of bond strength, steel strength or base material strength.
6 Steel values in accordance with AISC

Allowable load values	**Ultimate load values**
Tension = 0.33 x F_u x A_{nom}	Tension = 0.75 x F_u x A_{nom}
Shear = 0.17 x F_u x A_{nom}	Shear = 0.45 x F_u x A_{nom}

Figure 9 — Anchor spacing and edge distance



Edge distance for shear and tension:
Grout-filled, normal-weight and lightweight block

c_{cr} = 12 in. minimum from free edge
c_{min} = 4 in. minimum from free edge

Anchor spacing for shear and tension:
Grout-filled, normal-weight and lightweight block

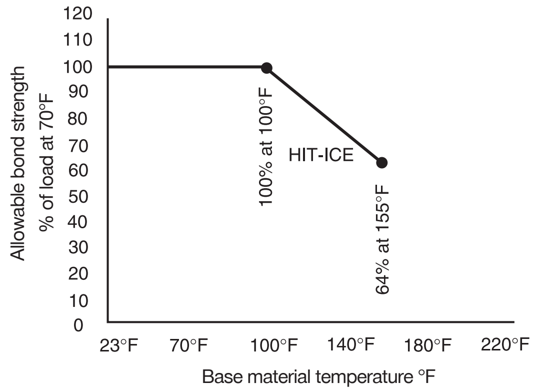
s_{cr} = s_{min} = maximum (1) anchor per cell and minimum 8 inches center-to-center spacing between anchors

Table 57 — Allowable loads for anchorage to the top of grout-filled block walls with Hilti HIT-ICE[1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Edge distance		Tension		Shear lb (kN)			
		in.	(mm)	lb	(kN)	Load II to edge		Load ⊥ to edge	
1/2	4-1/4 (108)	1-3/4	(45)	1,120	(5.0)	1,425	(6.3)	560	(2.5)
		2-3/4	(70)	1,440	(6.4)	2,085	(9.3)	1,110	(4.9)
5/8	5 (127)	1-3/4	(45)	1,475	(6.5)	1,800	(8.0)	680	(3.0)
		2-3/4	(70)	1,630	(7.2)	3,070	(13.7)	1,110	(4.9)

1 Allowable loads calculated using a factor of safety of 4.
2 Allowable loads are based on masonry capacity. The steel strength must be checked.
3 Minimum edge distance is 1-3/4 inches.
4 Minimum masonry prism strength is 1,500 psi.

Figure 10 — Influence of temperature on masonry bond strength[1,2]



1 Test procedure involves the concrete being held at the elevated temperature for 24 hours them removing it from the controlled environment and testing to failure.

2 Long term creep test in accordance with ICC-ES Acceptance Criteria AC58.

Table 58 -Gel time[1,2]

Base material temperature		HIT-ICE
°F	°C	
–10	–23	1.5 h
0	–18	1.5 h
20	–7	1 h
40	4	15
60	16	5 min
70	21	2.5 min
90	32	1 min

Table 59 - Full cure time[1,2]

Base material temperature		HIT-ICE
°F	°C	
–10	–23	36 h
0	–18	24 h
20	–7	6 h
40	4	1.5 h
60	16	1 h
70	21	45 min
90	32	35 min

1 Product temperatures must be maintained above 0°F (–18°C) prior to installation.

2 Gel times and full cure times are approximate.

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com (US), or www.hilti.ca (Canada). Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION

Description	Contents
HIT-ICE Cartridge 10 oz (297 ml)	24 Cartridges, 24 Mixers

Description	Notes	Qty/Pkg
MD 1000 Dispenser	For use with HIT-ICE cartridges	1

Description	Notes	Qty/Pkg
HIT-M2 Mixer for HIT-ICE only	For use with HIT-ICE cartridges	1

HIT-ICE Cartridge

MD 1000 Dispenser

HIT-ICE Mixer

HIT Filler Tube

For ordering information on anchor rods and inserts, dispensers, hole cleaning equipment and other accessories, see section 3.2.9.

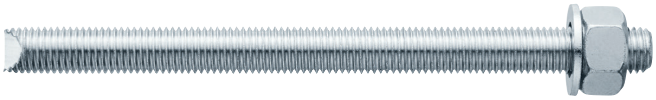
HIT-ICE Mixer

HIT-ICE Cartridge

HIT-ICE Dispenser

3.2.6 HVU2 CAPSULE ADHESIVE ANCHORING SYSTEM

PRODUCT DESCRIPTION

Mortar system	Features and Benefits
 Hilti HVU2 adhesive capsule  Hilti HAS threaded rod with setting tip  Hilti HIS-N and HIS-RN internally threaded inserts	- Combines high performance, versatility, and convenience of nearly instant loading - Rapid cure time — as soon as 5 minutes at room temperature - Diamond core drilling applicable, even in cracked concrete and seismic applications - Tough, resilient soft foil capsule — little risk of breakage - Suitable for tough jobsite conditions including water-saturated concrete and low installation temperature - SafeSet™ automatic hole cleaning with Hilti hollow drill bit and Hilti vacuum for virtually dust free use and OSHA 1926.1153 Table 1 compliance - Faster and more convenient installation with drill driver, impact driver, or hammer drill

Uncracked concrete

Cracked concrete

Seismic Desing Categories A-F

Diamond core drilling permitted

Hollow Drill Bit

PROFIS Anchor design software

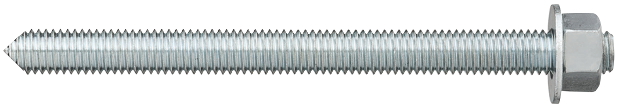
Listings/Approvals	
ICC-ES (International Code Council) **- 2021 International Building Code / International Residential Code**	ESR-4372 in concrete per ACI 318 Ch. 17 / ACI 355.4 / ICC-ES AC308
NSF/ANSI Std 61	Certification for use in potable water
European Technical Approval	ETA-18/0184, ETA-18/0185
City of Los Angeles	2020 LABC Supplement (within ESR-4372)
Florida Building Code	2020 FBC Supplement (within ESR-4372) w/ High Velocity Hurricane Zone
U.S. Green Building Council	LEED® Credit 4.1-Low Emitting Materials

DESIGN DATA IN CONCRETE PER ACI 318

ACI 318 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-4372 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-4372 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Hilti HVU2 Adhesive Capsule with Hilti HAS Threaded Rod



Hilti HAS threaded rod with setting tip

Figure 1 — Hilti HAS threaded rod installation conditions

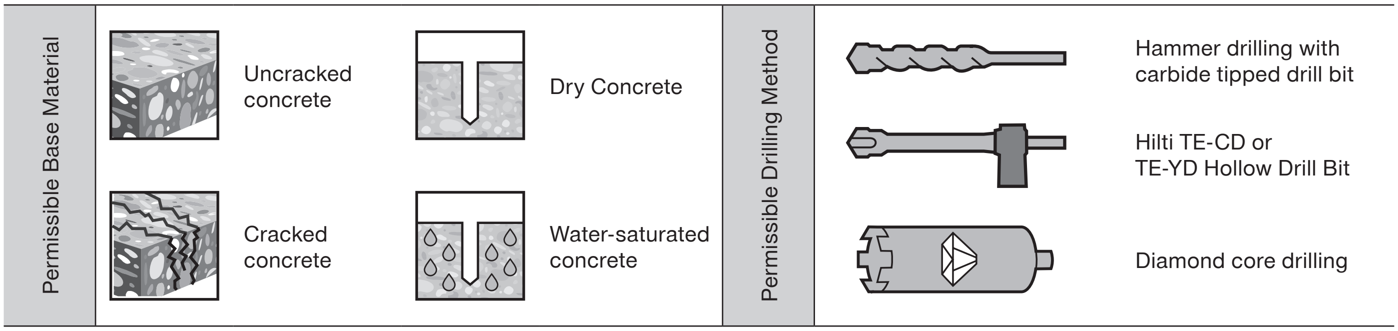


Table 1 — Hilti HAS threaded rod installation specifications [1]

Setting information		Symbol	Units	Nominal rod diameter (in.)						
				3/8	1/2	5/8	3/4	7/8	1	1-1/4 [2]
Nominal bit diameter		d_o	-	7/16”	9/16”	11/16”	7/8”	1”	1-1/8”	1-3/8”
		d_o	-	12mm	9/16”	11/16”	7/8”	1”	1-1/8”	1-3/8”
		d_o	-	-	9/16”	11/16”	7/8”	1”	1-1/8”	1-3/8”
Effective embedment		h_{ef}	in. (mm)	3-1/2 (89)	4-1/4 (108)	5 (127)	6-5/8 (168)	6-5/8 (168)	8-1/4 (210)	11 (279)
Diameter of fixture hole		d_f	in.	7/16	9/16	11/16	13/16	15/16	1-1/8	1-3/8
Installation torque		T_{inst}	ft-lb (Nm)	15 (20)	30 (41)	60 (81)	100 (136)	125 (169)	150 (203)	200 (271)
Minimum concrete thickness		h_{min}	in. (mm)	4-3/4 (121)	5-1/2 (140)	6-3/8 (162)	8-3/8 (213)	8-5/8 (219)	10-1/2 (267)	13-3/4 (349)
Minimum edge distance		c_{min}	in. (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-1/4 (95)	4-3/8 (111)	5 (127)	6-1/4 (159)
Minimum anchor spacing		s_{min}	in. (mm)	1-7/8 (48)	2-1/2 (64)	3-1/8 (79)	3-1/4 (95)	4-3/8 (111)	5 (127)	6-1/4 (159)

1 Material specifications for Hilti HAS threaded rods are listed in section 3.2.7.
2 1-1/4-in. diameter threaded rods to be installed in generally vertical down direction only.

Figure 2 — Hilti HAS threaded rods installed with Hilti HVU2 adhesive capsule

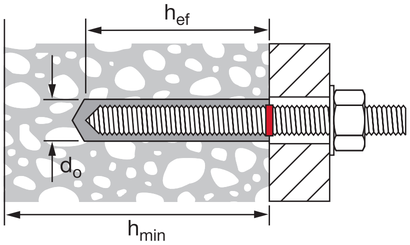


Table 2 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for threaded rod in uncracked concrete ^{1,2,3,4,5,6,7,8,9}

Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)	f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)
3/8	3-1/2	3,955	4,145	4,465	4,965	8,515	8,930	9,620	10,690
	(89)	(17.6)	(18.4)	(19.9)	(22.1)	(37.9)	(39.7)	(42.8)	(47.6)
1/2	4-1/4	6,835	7,485	8,645	10,585	14,720	16,125	18,620	22,805
	(108)	(30.4)	(33.3)	(38.5)	(47.1)	(65.5)	(71.7)	(82.8)	(101.4)
5/8	5	8,720	9,555	11,030	13,510	18,785	20,575	23,760	29,100
	(127)	(38.8)	(42.5)	(49.1)	(60.1)	(83.6)	(91.5)	(105.7)	(129.4)
3/4	6-5/8	13,300	14,570	16,825	20,605	28,650	31,380	36,235	44,380
	(168)	(59.2)	(64.8)	(74.8)	(91.7)	(127.4)	(139.6)	(161.2)	(197.4)
7/8	6-5/8	13,300	14,570	16,825	20,605	28,650	31,380	36,235	44,380
	(168)	(59.2)	(64.8)	(74.8)	(91.7)	(127.4)	(139.6)	(161.2)	(197.4)
1	8-1/4	18,485	20,245	23,380	28,635	39,810	43,610	50,355	61,675
	(210)	(82.2)	(90.1)	(104.0)	(127.4)	(177.1)	(194.0)	(224.0)	(274.3)
1-1/4 (10)	11	28,455	31,175	35,995	44,085	61,290	67,140	77,530	94,950
	(279)	(126.6)	(138.7)	(160.1)	(196.1)	(272.6)	(298.7)	(344.9)	(422.4)

Table 3 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for threaded rod in cracked concrete ^{1,2,3,4,5,6,7,8,9,11}

Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)	f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)
1/2	4-1/4	4,580	4,695	4,890	5,175	9,860	10,115	10,530	11,145
	(108)	(20.4)	(20.9)	(21.8)	(23.0)	(43.9)	(45.0)	(46.8)	(49.6)
5/8	5	6,175	6,765	7,190	7,610	13,305	14,575	15,485	16,390
	(127)	(27.5)	(30.1)	(32.0)	(33.9)	(59.2)	(64.8)	(68.9)	(72.9)
3/4	6-5/8	9,420	10,320	11,430	12,100	20,290	22,230	24,625	26,060
	(168)	(41.9)	(45.9)	(50.8)	(53.8)	(90.3)	(98.9)	(109.5)	(115.9)
7/8	6-5/8	9,420	10,320	11,915	14,115	20,290	22,230	25,670	30,405
	(168)	(41.9)	(45.9)	(53.0)	(62.8)	(90.3)	(98.9)	(114.2)	(135.2)
1	8-1/4	13,090	14,340	16,560	20,090	28,200	30,890	35,670	43,275
	(210)	(58.2)	(63.8)	(73.7)	(89.4)	(125.4)	(137.4)	(158.7)	(192.5)
1-1/4 (10)	11	20,155	22,080	25,495	31,225	43,415	47,560	54,915	67,260
	(279)	(89.7)	(98.2)	(113.4)	(138.9)	(193.1)	(211.6)	(244.3)	(299.2)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7 – 10 as necessary to the above values. Compare to the steel values in table 6. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 For 3/8-in to 1-in dia. threaded rods, tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 1-1/4-in diameter rods to be installed in generally vertically downward direction only.
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.75.
See section 3.1.8 for additional information on seismic applications.

Table 4 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for threaded rod in uncracked concrete [1,2,3,4,5,6,7,8,9]

Diamond core drilling

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)	f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)
1/2	4-1/4	6,835	7,485	8,645	9,970	14,720	16,125	18,620	21,475
	(108)	(30.4)	(33.3)	(38.5)	(44.3)	(65.5)	(71.7)	(82.8)	(95.5)
5/8	5	8,720	9,555	11,030	13,510	18,785	20,575	23,760	29,100
	(127)	(38.8)	(42.5)	(49.1)	(60.1)	(83.6)	(91.5)	(105.7)	(129.4)
3/4	6-5/8	13,300	14,570	16,825	20,605	28,650	31,380	36,235	44,380
	(168)	(59.2)	(64.8)	(74.8)	(91.7)	(127.4)	(139.6)	(161.2)	(197.4)
7/8	6-5/8	13,300	14,570	16,825	20,605	28,650	31,380	36,235	44,380
	(168)	(59.2)	(64.8)	(74.8)	(91.7)	(127.4)	(139.6)	(161.2)	(197.4)
1	8-1/4	18,485	20,245	23,380	28,635	39,810	43,610	50,355	61,675
	(210)	(82.2)	(90.1)	(104.0)	(127.4)	(177.1)	(194.0)	(224.0)	(274.3)
1-1/4 (10)	11	28,455	31,175	35,995	44,085	61,290	67,140	77,530	94,950
	(279)	(126.6)	(138.7)	(160.1)	(196.1)	(272.6)	(298.7)	(344.9)	(422.4)

Table 5 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9,11]

Diamond core drilling

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)	f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)
1/2	4-1/4	4,665	4,665	4,665	4,665	10,045	10,045	10,045	10,045
	(108)	(20.8)	(20.8)	(20.8)	(20.8)	(44.7)	(44.7)	(44.7)	(44.7)
5/8	5	6,175	6,765	6,860	6,860	13,305	14,575	14,775	14,775
	(127)	(27.5)	(30.1)	(30.5)	(30.5)	(59.2)	(64.8)	(65.7)	(65.7)
3/4	6-5/8	9,420	10,320	10,905	10,905	20,290	22,230	23,495	23,495
	(168)	(41.9)	(45.9)	(48.5)	(48.5)	(90.3)	(98.9)	(104.5)	(104.5)
7/8	6-5/8	9,420	10,320	11,915	12,725	20,290	22,230	25,670	27,410
	(168)	(41.9)	(45.9)	(53.0)	(56.6)	(90.3)	(98.9)	(114.2)	(121.9)
1	8-1/4	13,090	14,340	16,560	18,110	28,200	30,890	35,670	39,005
	(210)	(58.2)	(63.8)	(73.7)	(80.6)	(125.4)	(137.4)	(158.7)	(173.5)
1-1/4 (10)	11	20,155	22,080	25,495	30,185	43,415	47,560	54,915	65,010
	(279)	(89.7)	(98.2)	(113.4)	(134.3)	(193.1)	(211.6)	(244.3)	(289.2)

1 See Section 3.1.8 of for explanation on development of load values.
2 See Section 3.1.8 of to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7 – 10 as necessary to the above values. Compare to the steel values in table 6. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 For 1/2-in to 1-in dia. threaded rods, tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 1-1/4-in diameter rods to be installed in generally vertically downward direction only.
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.75.
See section 3.1.8 for additional information on seismic applications.

Table 6 — Steel design strength for Hilti HAS threaded rods for use with ACI 318 Chapter 17

Nominal anchor diameter in.	HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6]			HAS-B-105 and HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6]			HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4]		
	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)
3/8	4,360 (19.4)	2,270 (10.1)	1,590 (7.1)	7,270 (32.3)	3,780 (16.8)	2,645 (11.8)	5,040 (22.4)	2,790 (12.4)	1,955 (8.7)
1/2	7,985 (35.5)	4,150 (18.5)	2,905 (12.9)	13,305 (59.2)	6,920 (30.8)	4,845 (21.6)	9,225 (41.0)	5,110 (22.7)	3,575 (15.9)
5/8	12,715 (56.6)	6,610 (29.4)	4,625 (20.6)	21,190 (94.3)	11,020 (49.0)	7,715 (34.3)	14,690 (65.3)	8,135 (36.2)	5,695 (25.3)
3/4	18,820 (83.7)	9,785 (43.5)	6,850 (30.5)	31,360 (139.5)	16,310 (72.6)	11,415 (50.8)	18,485 (82.2)	10,235 (45.5)	7,165 (31.9)
7/8	25,975 (115.5)	13,505 (60.1)	9,455 (42.1)	43,285 (192.5)	22,510 (100.1)	15,755 (70.1)	25,510 (113.5)	14,125 (62.8)	9,890 (44.0)
1	34,075 (151.6)	17,720 (78.8)	12,405 (55.2)	56,785 (252.6)	29,530 (131.4)	20,670 (91.9)	33,465 (148.9)	18,535 (82.4)	12,975 (57.7)
1-1/4	54,515 (242.5)	28,345 (126.1)	19,840 (88.3)	90,855 (404.1)	47,245 (210.2)	33,070 (147.1)	41,430 (184.3)	21,545 (95.8)	12,925 (57.5)

1 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 17.4.1.2

2 Shear = $\phi\ 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 17.5.1.2b.

3 Seismic Shear = $\alpha_{V,seis}\ \phi\ V_{sa}$: Reduction factor for seismic shear only. See ACI 318 for additional information on seismic applications.

4 HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).

5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.

6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-E-55, and HAS-B-105 (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

Table 7 — Load adjustment factors for 3/8, 1/2, 5/8, and 3/4-in. diameter threaded rods in uncracked concrete [1,2]

3/8, 1/2, 5/8 & 3/4-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[3] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[4] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To edge f_{RV}							
Thread size, in.			3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4
Embedment h_{ef}		in.	3-1/2	4-1/4	5	6-5/8	3-1/2	4-1/4	5	6-5/8	3-1/2	4-1/4	5	6-5/8	3-1/2	4-1/4	5	6-5/8	3-1/2	4-1/4	5	6-5/8	3-1/2	4-1/4	5	6-5/8
		(mm)	(89)	(108)	(127)	(168)	(89)	(108)	(127)	(168)	(89)	(108)	(127)	(168)	(89)	(108)	(127)	(168)	(89)	(108)	(127)	(168)	(89)	(108)	(127)	(168)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in (mm)	1-7/8	(48)	0.59	n/a	n/a	n/a	0.30	n/a	n/a	n/a	0.53	n/a	n/a	n/a	0.10	n/a	n/a	n/a	0.19	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2	(51)	0.60	n/a	n/a	n/a	0.31	n/a	n/a	n/a	0.54	n/a	n/a	n/a	0.11	n/a	n/a	n/a	0.21	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	0.62	0.58	n/a	n/a	0.35	0.29	n/a	n/a	0.55	0.54	n/a	n/a	0.15	0.10	n/a	n/a	0.30	0.20	n/a	0.54	n/a	n/a	n/a	n/a
	3	(76)	0.64	0.60	n/a	n/a	0.38	0.31	n/a	n/a	0.56	0.54	n/a	n/a	0.19	0.13	n/a	n/a	0.38	0.26	n/a	0.54	n/a	n/a	n/a	n/a
	3-1/8	(79)	0.65	0.60	0.58	n/a	0.39	0.32	0.31	n/a	0.56	0.54	0.54	n/a	0.21	0.14	0.12	n/a	0.39	0.28	0.24	0.54	n/a	n/a	n/a	n/a
	3-1/4	(83)	0.65	0.61	0.59	0.57	0.40	0.33	0.32	0.29	0.56	0.55	0.54	0.53	0.22	0.15	0.13	0.09	0.40	0.29	0.26	0.18	n/a	n/a	n/a	n/a
	4	(102)	0.69	0.63	0.61	0.59	0.46	0.37	0.35	0.31	0.57	0.56	0.55	0.54	0.30	0.20	0.18	0.12	0.46	0.37	0.35	0.25	n/a	n/a	n/a	n/a
	4-3/4	(121)	0.73	0.66	0.63	0.61	0.53	0.41	0.39	0.34	0.59	0.57	0.56	0.55	0.39	0.26	0.23	0.16	0.53	0.41	0.39	0.32	0.60	n/a	n/a	n/a
	5	(127)	0.74	0.67	0.63	0.61	0.55	0.42	0.40	0.35	0.59	0.57	0.57	0.55	0.42	0.28	0.24	0.17	0.55	0.42	0.40	0.34	0.61	n/a	n/a	n/a
	5-1/2	(140)	0.76	0.68	0.65	0.62	0.61	0.45	0.43	0.36	0.60	0.58	0.57	0.56	0.48	0.32	0.28	0.20	0.61	0.45	0.43	0.36	0.64	0.56	n/a	n/a
	6	(152)	0.79	0.70	0.66	0.63	0.66	0.48	0.45	0.38	0.61	0.59	0.58	0.56	0.55	0.37	0.32	0.23	0.66	0.48	0.45	0.38	0.67	0.58	n/a	n/a
	6-3/8	(162)	0.80	0.71	0.67	0.64	0.70	0.51	0.47	0.40	0.62	0.59	0.58	0.57	0.60	0.40	0.35	0.25	0.70	0.51	0.47	0.40	0.69	0.60	0.58	n/a
	7	(178)	0.83	0.73	0.69	0.66	0.77	0.56	0.51	0.42	0.63	0.60	0.59	0.57	0.69	0.46	0.41	0.29	0.77	0.56	0.51	0.42	0.72	0.63	0.60	n/a
	8	(203)	0.88	0.77	0.71	0.68	0.88	0.64	0.57	0.46	0.65	0.61	0.60	0.58	0.85	0.57	0.50	0.35	0.88	0.64	0.57	0.46	0.77	0.68	0.65	n/a
	8-3/8	(213)	0.90	0.78	0.72	0.69	0.92	0.67	0.60	0.48	0.66	0.62	0.61	0.59	0.91	0.61	0.53	0.37	0.92	0.67	0.60	0.48	0.79	0.69	0.66	0.59
	10	(254)	0.98	0.84	0.77	0.72	1.00	0.80	0.71	0.54	0.69	0.64	0.63	0.60	1.00	0.79	0.69	0.49	1.00	0.80	0.71	0.54	0.86	0.75	0.72	0.64
	12	(305)	1.00	0.90	0.82	0.77		0.96	0.85	0.65	0.72	0.67	0.66	0.62		1.00	0.91	0.64		0.96	0.85	0.65	0.95	0.83	0.79	0.70
	14	(356)		0.97	0.88	0.81		1.00	1.00	0.76	0.76	0.70	0.68	0.64			1.00	0.81		1.00	1.00	0.76	1.00	0.89	0.85	0.76
	16	(406)		1.00	0.93	0.86				0.87	0.80	0.73	0.71	0.67				0.99				0.87		0.95	0.91	0.81
	18	(457)			0.98	0.90				0.98	0.84	0.76	0.73	0.69				1.00				0.98		1.00	0.97	0.86
	24	(610)			1.00	1.00				1.00	0.95	0.84	0.81	0.75								1.00			1.00	1.00
	30	(762)									1.00	0.93	0.89	0.81												
	36	(914)										1.00	0.97	0.87												
	> 48	(1219)											1.00	1.00												

Table 8 — Load adjustment factors for 1/2, 5/8, and 3/4-in. diameter threaded rods in cracked concrete[1,2]

1/2, 5/8 & 3/4-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear[4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Thread size, in.			1/2	5/8	3/4	1/2	5/8	3/4	1/2	5/8	3/4	1/2	5/8	3/4	1/2	5/8	3/4	1/2	5/8	3/4
Embedment h_{ef}		in.	4-1/4	5	6-5/8	4-1/4	5	6-5/8	4-1/4	5	6-5/8	4-1/4	5	6-5/8	4-1/4	5	6-5/8	4-1/4	5	6-5/8
		(mm)	(108)	(127)	(168)	(108)	(127)	(168)	(108)	(127)	(168)	(108)	(127)	(168)	(108)	(127)	(168)	(108)	(127)	(168)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in (mm)	2-1/2	(64)	0.58	n/a	n/a	0.53	n/a	n/a	0.54	n/a	n/a	0.11	n/a	n/a	0.21	n/a	n/a	n/a	n/a	n/a
	3	(76)	0.60	n/a	n/a	0.58	n/a	n/a	0.54	n/a	n/a	0.14	n/a	n/a	0.28	n/a	n/a	n/a	n/a	n/a
	3-1/8	(79)	0.60	0.58	n/a	0.59	0.53	n/a	0.55	0.54	n/a	0.15	0.12	n/a	0.29	0.24	n/a	n/a	n/a	n/a
	3-1/4	(83)	0.61	0.59	0.57	0.60	0.54	0.51	0.55	0.54	0.53	0.16	0.13	0.09	0.31	0.26	0.18	n/a	n/a	n/a
	4	(102)	0.63	0.61	0.59	0.66	0.59	0.55	0.56	0.55	0.54	0.21	0.18	0.12	0.43	0.35	0.25	n/a	n/a	n/a
	4-3/4	(121)	0.66	0.63	0.61	0.73	0.64	0.59	0.57	0.56	0.55	0.28	0.23	0.16	0.55	0.46	0.32	n/a	n/a	n/a
	5	(127)	0.67	0.63	0.61	0.75	0.66	0.60	0.57	0.57	0.55	0.30	0.25	0.17	0.60	0.49	0.35	n/a	n/a	n/a
	5-1/2	(140)	0.68	0.65	0.62	0.80	0.70	0.63	0.58	0.57	0.56	0.34	0.28	0.20	0.69	0.57	0.40	0.57	n/a	n/a
	6	(152)	0.70	0.66	0.63	0.85	0.73	0.66	0.59	0.58	0.56	0.39	0.32	0.23	0.78	0.65	0.46	0.60	n/a	n/a
	6-3/8	(162)	0.71	0.67	0.64	0.89	0.76	0.68	0.59	0.58	0.57	0.43	0.36	0.25	0.86	0.71	0.50	0.62	0.58	n/a
	7	(178)	0.73	0.69	0.66	0.95	0.81	0.72	0.60	0.59	0.57	0.49	0.41	0.29	0.95	0.81	0.57	0.65	0.61	n/a
	8	(203)	0.77	0.71	0.68	1.00	0.89	0.78	0.62	0.60	0.58	0.60	0.50	0.35	1.00	0.89	0.70	0.69	0.65	n/a
	8-3/8	(213)	0.78	0.72	0.69		0.92	0.81	0.62	0.61	0.59	0.65	0.53	0.38		0.92	0.75	0.71	0.66	0.59
	10	(254)	0.84	0.77	0.72		1.00	0.92	0.65	0.63	0.60	0.84	0.70	0.49		1.00	0.92	0.77	0.72	0.64
	12	(305)	0.90	0.82	0.77			1.00	0.68	0.66	0.62	1.00	0.92	0.65			1.00	0.84	0.79	0.71
	14	(356)	0.97	0.88	0.81				0.71	0.68	0.65		1.00	0.81				0.91	0.86	0.76
	16	(406)	1.00	0.93	0.86				0.74	0.71	0.67			0.99				0.98	0.92	0.81
	18	(457)		0.98	0.90				0.77	0.74	0.69			1.00				1.00	0.97	0.86
	24	(610)		1.00	1.00				0.86	0.81	0.75								1.00	1.00
	30	(762)							0.95	0.89	0.81									
	36	(914)							1.00	0.97	0.87									
	> 48	(1219)								1.00	1.00									

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

Table 9 — Load adjustment factors for 7/8, 1, and 1-1/4-in. diameter threaded rods in uncracked concrete[1,2]

7/8, 1 & 1-1/4-in. threaded rods uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Thread size, in.			7/8	1	1 1/4	7/8	1	1 1/4	7/8	1	1 1/4	7/8	1	1 1/4	7/8	1	1 1/4	7/8	1	1 1/4
Embedment h_{ef}		in.	6-5/8	8-1/4	11	6-5/8	8-1/4	11	6-5/8	8-1/4	11	6-5/8	8-1/4	11	6-5/8	8-1/4	11	6-5/8	8-1/4	11
		(mm)	(168)	(210)	(279)	(168)	(210)	(279)	(168)	(210)	(279)	(168)	(210)	(279)	(168)	(210)	(279)	(168)	(210)	(279)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in (mm)	4-3/8	(111)	0.58	n/a	n/a	0.35	n/a	n/a	0.55	n/a	n/a	0.14	n/a	n/a	0.28	n/a	n/a	n/a	n/a	n/a
	5	(127)	0.60	0.58	n/a	0.37	0.34	n/a	0.55	0.54	n/a	0.17	0.12	n/a	0.34	0.25	n/a	n/a	n/a	n/a
	6	(152)	0.61	0.60	n/a	0.41	0.37	n/a	0.56	0.55	n/a	0.23	0.16	n/a	0.41	0.33	n/a	n/a	n/a	n/a
	6-1/4	(159)	0.62	0.60	0.58	0.42	0.37	0.34	0.56	0.55	0.54	0.24	0.17	0.11	0.42	0.35	0.22	n/a	n/a	n/a
	7	(178)	0.63	0.62	0.59	0.45	0.40	0.35	0.57	0.56	0.54	0.29	0.21	0.13	0.45	0.40	0.27	n/a	n/a	n/a
	8	(203)	0.65	0.63	0.61	0.50	0.43	0.37	0.58	0.57	0.55	0.35	0.25	0.16	0.50	0.43	0.33	n/a	n/a	n/a
	8-5/8	(219)	0.67	0.64	0.61	0.52	0.45	0.39	0.59	0.57	0.55	0.39	0.28	0.18	0.52	0.45	0.36	0.60	n/a	n/a
	9	(229)	0.67	0.65	0.62	0.54	0.46	0.40	0.59	0.57	0.56	0.42	0.30	0.19	0.54	0.46	0.39	0.61	n/a	n/a
	10	(254)	0.69	0.67	0.63	0.59	0.50	0.42	0.60	0.58	0.56	0.49	0.35	0.23	0.59	0.50	0.42	0.64	n/a	n/a
	10-1/2	(267)	0.70	0.68	0.64	0.62	0.51	0.44	0.61	0.59	0.57	0.52	0.38	0.24	0.62	0.51	0.44	0.66	0.59	n/a
	11	(279)	0.71	0.68	0.65	0.64	0.53	0.45	0.61	0.59	0.57	0.56	0.40	0.26	0.64	0.53	0.45	0.67	0.60	n/a
	12	(305)	0.73	0.70	0.66	0.70	0.57	0.47	0.62	0.60	0.57	0.64	0.46	0.30	0.70	0.57	0.47	0.70	0.63	n/a
	13	(330)	0.75	0.72	0.67	0.76	0.61	0.50	0.63	0.61	0.58	0.72	0.52	0.34	0.76	0.61	0.50	0.73	0.66	n/a
	13-3/4	(349)	0.76	0.73	0.68	0.81	0.65	0.52	0.64	0.61	0.59	0.78	0.56	0.37	0.81	0.65	0.52	0.75	0.67	0.58
	14	(356)	0.77	0.73	0.68	0.82	0.66	0.53	0.64	0.62	0.59	0.81	0.58	0.38	0.82	0.66	0.53	0.76	0.68	0.59
	15	(381)	0.79	0.75	0.70	0.88	0.71	0.55	0.65	0.62	0.59	0.89	0.64	0.42	0.88	0.71	0.55	0.79	0.70	0.61
	16	(406)	0.81	0.77	0.71	0.94	0.75	0.58	0.67	0.63	0.60	0.99	0.71	0.46	0.94	0.75	0.58	0.81	0.73	0.63
	17	(432)	0.83	0.78	0.72	1.00	0.80	0.62	0.68	0.64	0.61	1.00	0.78	0.50	1.00	0.80	0.62	0.84	0.75	0.65
	18	(457)	0.84	0.80	0.74		0.85	0.65	0.69	0.65	0.61		0.85	0.55		0.85	0.65	0.86	0.77	0.67
	20	(508)	0.88	0.84	0.76		0.94	0.72	0.71	0.67	0.62		0.99	0.64		0.94	0.72	0.91	0.81	0.70
	24	(610)	0.96	0.90	0.82		1.00	0.87	0.75	0.70	0.65		1.00	0.85		1.00	0.87	1.00	0.89	0.77
	30	(762)	1.00	1.00	0.90			1.00	0.81	0.75	0.69			1.00			1.00		1.00	0.86
	36	(914)			0.97				0.87	0.80	0.72									0.95
	> 48	(1219)			1.00				1.00	0.90	0.80									1.00

Table 10 — Load adjustment factors for 7/8, 1, and 1-1/4-in. diameter threaded rods in cracked concrete[1,2]

7/8, 1 & 1-1/4-in. threaded rods cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [4] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [5] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Thread size, in.			7/8	1	1 1/4	7/8	1	1 1/4	7/8	1	1 1/4	7/8	1	1 1/4	7/8	1	1 1/4	7/8	1	1 1/4
Embedment h_{ef}		in.	6-5/8	8-1/4	11	6-5/8	8-1/4	11	6-5/8	8-1/4	11	6-5/8	8-1/4	11	6-5/8	8-1/4	11	6-5/8	8-1/4	11
		(mm)	(168)	(210)	(279)	(168)	(210)	(279)	(168)	(210)	(279)	(168)	(210)	(279)	(168)	(210)	(279)	(168)	(210)	(279)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in (mm)	4-3/8	(111)	0.58	n/a	n/a	0.53	n/a	n/a	0.55	n/a	n/a	0.14	n/a	n/a	0.28	n/a	n/a	n/a	n/a	n/a
	5	(127)	0.60	0.58	n/a	0.56	0.53	n/a	0.55	0.54	n/a	0.17	0.12	n/a	0.35	0.25	n/a	n/a	n/a	n/a
	6	(152)	0.61	0.60	n/a	0.61	0.58	n/a	0.56	0.55	n/a	0.23	0.16	n/a	0.46	0.33	n/a	n/a	n/a	n/a
	6-1/4	(159)	0.62	0.60	0.58	0.62	0.59	0.53	0.56	0.55	0.54	0.24	0.17	0.11	0.49	0.35	0.23	n/a	n/a	n/a
	7	(178)	0.63	0.62	0.59	0.66	0.62	0.56	0.57	0.56	0.54	0.29	0.21	0.13	0.57	0.41	0.27	n/a	n/a	n/a
	8	(203)	0.65	0.63	0.61	0.71	0.66	0.59	0.58	0.57	0.55	0.35	0.25	0.16	0.70	0.51	0.33	n/a	n/a	n/a
	8-5/8	(219)	0.67	0.64	0.61	0.75	0.69	0.61	0.59	0.57	0.55	0.39	0.28	0.18	0.75	0.57	0.37	0.60	n/a	n/a
	9	(229)	0.67	0.65	0.62	0.77	0.71	0.62	0.59	0.57	0.56	0.42	0.30	0.20	0.77	0.60	0.39	0.61	n/a	n/a
	10	(254)	0.69	0.67	0.63	0.82	0.75	0.66	0.60	0.58	0.56	0.49	0.35	0.23	0.82	0.71	0.46	0.64	n/a	n/a
	10-1/2	(267)	0.70	0.68	0.64	0.85	0.78	0.67	0.61	0.59	0.57	0.53	0.38	0.25	0.85	0.76	0.49	0.66	0.59	n/a
	11	(279)	0.71	0.68	0.65	0.88	0.80	0.69	0.61	0.59	0.57	0.57	0.41	0.26	0.88	0.80	0.53	0.68	0.61	n/a
	12	(305)	0.73	0.70	0.66	0.94	0.85	0.73	0.62	0.60	0.57	0.65	0.46	0.30	0.94	0.85	0.60	0.71	0.63	n/a
	13	(330)	0.75	0.72	0.67	1.00	0.90	0.76	0.63	0.61	0.58	0.73	0.52	0.34	1.00	0.90	0.68	0.73	0.66	n/a
	13-3/4	(349)	0.76	0.73	0.68		0.94	0.79	0.64	0.61	0.59	0.79	0.57	0.37		0.94	0.74	0.76	0.68	0.59
	14	(356)	0.77	0.73	0.68		0.95	0.80	0.65	0.62	0.59	0.81	0.59	0.38		0.95	0.76	0.76	0.68	0.59
	15	(381)	0.79	0.75	0.70		1.00	0.84	0.66	0.62	0.59	0.90	0.65	0.42		1.00	0.84	0.79	0.71	0.61
	16	(406)	0.81	0.77	0.71			0.88	0.67	0.63	0.60	0.99	0.71	0.46			0.88	0.81	0.73	0.63
	17	(432)	0.83	0.78	0.72			0.92	0.68	0.64	0.61	1.00	0.78	0.51			0.92	0.84	0.75	0.65
	18	(457)	0.84	0.80	0.74			0.96	0.69	0.65	0.61		0.85	0.55			0.96	0.86	0.77	0.67
	20	(508)	0.88	0.84	0.76			1.00	0.71	0.67	0.62		1.00	0.65			1.00	0.91	0.82	0.71
	24	(610)	0.96	0.90	0.82				0.75	0.70	0.65			0.85				1.00	0.89	0.77
	30	(762)	1.00	1.00	0.90				0.81	0.75	0.69			1.00					1.00	0.87
	36	(914)			0.97				0.87	0.80	0.72									0.95
	> 48	(1219)			1.00				1.00	0.90	0.80									1.00

[1] Linear interpolation not permitted

[2] When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, is applicable when edge distance c < 3*h_{ef}. If c ≥ 3*h_{ef}, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance c < 3*h_{ef}. If c ≥ 3*h_{ef}, then f_{HV} = 1.0.

Hilti HVU2 with Hilti HIS-N Inserts

Figure 3 — Hilti HIS-N and HIS-RN internally threaded insert installation conditions

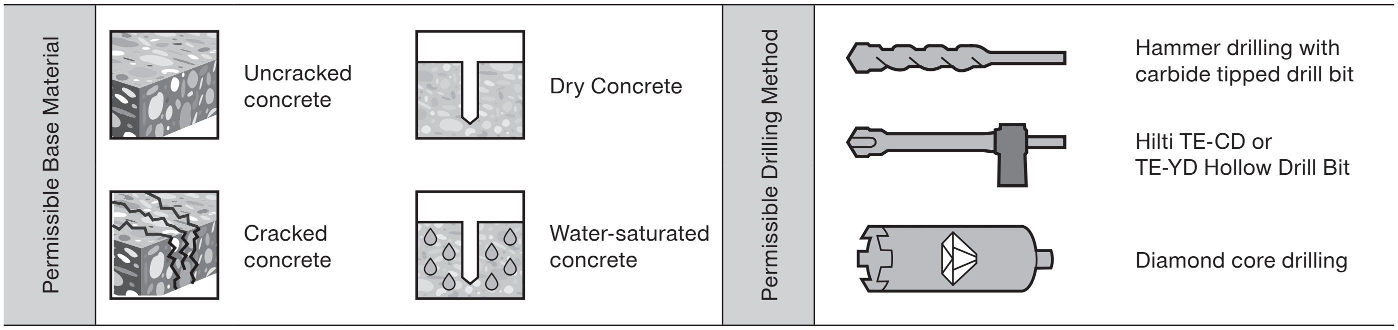
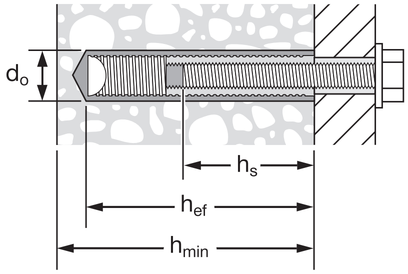


Table 11 — Hilti HIS-N and HIS-RN internally threaded insert installation specifications

Setting information		Symbol	Units	Thread Size			
				3/8-16 UNC	1/2-13 UNC	5/8-11 UNC	3/4-10 UNC
Outside diameter of insert			in.	0.65	0.81	1.00	1.09
Nominal bit diameter (all drilling methods)		d_o	in.	11/16	7/8	1-1/8	1-1/4
Effective embedment		h_{ef}	in.	4-3/8	5	6-3/4	8-1/8
			(mm)	(110)	(125)	(170)	(205)
Thread engagement	minimum	h_s	in.	3/8	1/2	5/8	3/4
	maximum		in.	15/16	1-3/16	1-1/2	1-7/8
Installation torque		T_{inst}	ft-lb	15	30	60	100
			(Nm)	(20)	(41)	(81)	(136)
Minimum Concrete Thickness		h_{min}	in.	5-7/8	6-3/4	9	10-5/8
			(mm)	(150)	(170)	(230)	(270)
Minimum edge distance		c_{min}	in.	3-1/4	4	5	5-1/2
			(mm)	(83)	(102)	(127)	(140)
Minimum spacing		s_{min}	in.	3-1/4	4	5	5-1/2
			(mm)	(83)	(102)	(127)	(140)

Figure 4 — Hilti HIS-N and HIS-RN internally threaded inserts installed with Hilti HVU2 adhesive capsules

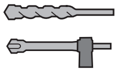


DESIGN OF HILTI HVU2 ADHESIVE CAPSULES WITH HIS-N AND HIS-RN INSERTS PER ACI 318 CHAPTER 17

Hilti HVU2 adhesive capsule testing for ICC-ES ESR-4372 did not include the Hilti HIS-N and HIS-RN inserts. Additional testing was performed with the HIS-N and HIS-RN inserts and the results evaluated per ACI 355.4 and ICC-ES AC308 and published in the following tables. The tables include the design parameters per ACI 318 Ch. 17 and the parameters are calculated using

ACI 318 Ch. 17 to develop the Hilti Simplified Design Tables. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8.

Table 12 — HVU2 adhesive capsule design information with Hilti HIS-N and HIS-RN internally threaded inserts per ACI 318 Chapter 17 [1]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

Setting information		Symbol	Units	Nominal bolt/cap screw diameter (in)			
				3/8	1/2	5/8	3/4
HIS insert outside diameter		d_a	in. (mm)	0.65 (16.5)	0.81 (20.5)	1.00 (25.4)	1.09 (27.6)
Effective embedment [2]		h_{ef}	in. (mm)	4-1/4 (110)	5 (125)	6-3/4 (170)	8-1/8 (205)
Minimum concrete thickness [2]		h_{min}	in. (mm)	5-7/8 (150)	6-3/4 (170)	9 (230)	10-5/8 (270)
Critical edge distance		c_{ac}	-	See footnote 8 below			
Minimum edge distance		c_{min}	in. (mm)	3-1/4 (83)	4 (102)	5 (127)	5-1/2 (140)
Minimum anchor spacing		s_{min}	in. (mm)	3-1/4 (83)	4 (102)	5 (127)	5-1/2 (140)
Effectiveness factor for uncracked concrete [3]		$k_{c,uncr}$	in-lb (SI)	24 (10.0)			
Effectiveness factor for cracked concrete [3]		$k_{c,cr}$	in-lb (SI)	17 (7.1)			
Strength reduction factor for concrete failure in tension [4]		$\Phi_{c,N}$	-	0.65			
Strength reduction factor for concrete failure in shear [4]		$\Phi_{c,V}$	-	0.70			
Temp. range A [5]	Characteristic bond stress in cracked concrete [6,7]	τ_{cr}	psi (MPa)	725 (4.99)	725 (4.99)	725 (4.99)	725 (4.99)
	Characteristic bond stress in uncracked concrete [6,7]	τ_{uncr}	psi (MPa)	1,490 (10.26)	1,490 (10.26)	1,490 (10.26)	1,490 (10.26)
Temp. range B [5]	Characteristic bond stress in cracked concrete [6,7]	τ_{cr}	psi (MPa)	670 (4.63)	670 (4.63)	670 (4.63)	670 (4.63)
	Characteristic bond stress in uncracked concrete [6,7]	τ_{uncr}	psi (MPa)	1,380 (9.53)	1,380 (9.53)	1,380 (9.53)	1,380 (9.53)
Temp. range C [5]	Characteristic bond stress in cracked concrete [6,7]	τ_{cr}	psi (MPa)	420 (2.90)	420 (2.90)	420 (2.90)	420 (2.90)
	Characteristic bond stress in uncracked concrete [6,7]	τ_{uncr}	psi (MPa)	865 (5.97)	865 (5.97)	865 (5.97)	865 (5.97)
Reduction for seismic tension		$\alpha_{N,seis}$	-	1.0			
Permissible installation conditions	Strength reduction factor for bond failure, dry concrete	Anchor category	-	1			
		Φ_d	-	0.65			
	Strength reduction factor for bond failure, water-saturated concrete	Anchor category	-	1			
		Φ_{ws}	-	0.65			

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See Figure 4.

3 For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

4 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.

5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Bond strength values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between
2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^n$ [for SI: $(f'_c / 17.2)^n$],
where n is as follows:
n = 0 for uncracked concrete, all drilling methods
n = 0.26 for cracked concrete, carbide bit or Hilti hollow drill bit

7 Characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.

8 $c_{ac} = h_{ef} \cdot \left(\frac{\tau_{k,uncr}}{1{,}160}\right)^{0.4} \cdot \left[3.1 - 0.7 \cdot \frac{h}{h_{ef}}\right]$, where

$\frac{h}{h_{ef}}$ need not be greater than 2.4, and

$\tau_{k,uncr}$ need not be greater than $\tau_{k,uncr} = \frac{\tau_{k,uncr}\sqrt{h_{ef} \cdot f'_c}}{\pi \cdot d_a}$ (use imperial units in all equations)

Table 13 — HVU2 adhesive capsule design information with Hilti HIS-N and HIS-RN internally threaded inserts per ACI 318 Chapter 17 [1,2]

Diamond core drilling

Setting information		Symbol	Units	Nominal bolt/cap screw diameter (in)			
				3/8	1/2	5/8	3/4
Temp. range A [3]	Characteristic bond stress in cracked concrete [4,5]	τ_{cr}	psi (MPa)	505 (3.49)	505 (3.49)	505 (3.49)	505 (3.49)
	Characteristic bond stress in uncracked concrete [4,5]	τ_{uncr}	psi (MPa)	1,415 (9.77)	1,415 (9.77)	1,415 (9.77)	1,415 (9.77)
Temp. range B [3]	Characteristic bond stress in cracked concrete [4,5]	τ_{cr}	psi (MPa)	475 (3.28)	475 (3.28)	475 (3.28)	475 (3.28)
	Characteristic bond stress in uncracked concrete [4,5]	τ_{uncr}	psi (MPa)	1,330 (9.17)	1,330 (9.17)	1,330 (9.17)	1,330 (9.17)
Temp. range C [3]	Characteristic bond stress in cracked concrete [4,5]	τ_{cr}	psi (MPa)	305 (2.11)	305 (2.11)	305 (2.11)	305 (2.11)
	Characteristic bond stress in uncracked concrete [4,5]	τ_{uncr}	psi (MPa)	855 (5.89)	855 (5.89)	855 (5.89)	855 (5.89)
Reduction for seismic tension		$\alpha_{N,seis}$	-	1.0			

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 Items from Table 12 (d_a, h_{ef}, h_{min}, c_{ac}, c_{min}, s_{min}, $k_{c,uncr}$, $k_{c,cr}$, and Φ factors) are applicable to this table for diamond core drilling.

3 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

4 Bond strength values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi
(55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^n$ [for SI: $(f'_c / 17.2)^n$], where n is as follows:
n = 0 for uncracked concrete, all drilling methods
n = 0.18 for cracked concrete, diamond core drill bit

5 Characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.

Table 14 — Steel design strength for steel bolt and cap screw for Hilti HIS-N and HIS-RN internally threaded inserts [1,2,3]

Thread size	ASTM A193 B7			ASTM A193 Grade B8M stainless steel		
	Tensile[4] ϕN_{sa} lb (kN)	Shear[5] ϕV_{sa} lb (kN)	Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN)	Tensile[4] ϕN_{sa} lb (kN)	Shear[5] ϕV_{sa} lb (kN)	Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN)
3/8-16 UNC	6,300 (28.0)	3,490 (15.5)	2,445 (10.9)	5,540 (24.6)	3,070 (13.7)	2,150 (9.6)
1/2-13 UNC	11,530 (51.3)	6,385 (28.4)	4,470 (19.9)	10,145 (45.1)	5,620 (25.0)	3,935 (17.5)
5/8-11 UNC	18,365 (81.7)	10,170 (45.2)	7,120 (31.6)	16,160 (71.9)	8,950 (39.8)	6,265 (27.9)
3/4-10 UNC	27,180 (120.9)	15,055 (67.0)	10,540 (46.9)	23,915 (106.4)	13,245 (58.9)	9,270 (41.2)

1 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.

2 Hilti HIS-N and HIS-RN inserts with steel bolts are to be considered brittle steel elements.

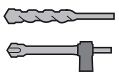
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.

4 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

5 Shear values determined by static shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17.

6 Seismic Shear = $\alpha_{V,seis}\ \phi_{Vsa}$: Reduction for seismic shear only. See section 3.1.8 for additional information on seismic applications.

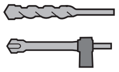
Table 15 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2,3,4,5,6,7,8,9]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

Thread size	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)	f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)
3/8-16 UNC	4-3/8 (110)	7,140 (31.8)	7,820 (34.8)	8,650 (38.5)	8,650 (38.5)	15,375 (68.4)	16,840 (74.9)	18,635 (82.9)	18,635 (82.9)
1/2-13 UNC	5 (125)	8,720 (38.8)	9,555 (42.5)	11,030 (49.1)	12,325 (54.8)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	26,540 (118.1)
5/8-11 UNC	6-3/4 (170)	13,680 (60.9)	14,985 (66.7)	17,305 (77.0)	20,540 (91.4)	29,460 (131.0)	32,275 (143.6)	37,265 (165.8)	44,235 (196.8)
3/4-10 UNC	8-1/8 (205)	18,065 (80.4)	19,790 (88.0)	22,850 (101.6)	26,945 (119.9)	38,910 (173.1)	42,620 (189.6)	49,215 (218.9)	58,040 (258.2)

Table 16 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2,3,4,5,6,7,8,9,10]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

Thread size	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)	f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)
3/8-16 UNC	4-3/8 (110)	4,210 (18.7)	4,415 (19.6)	4,755 (21.2)	5,285 (23.5)	9,070 (40.3)	9,510 (42.3)	10,245 (45.6)	11,385 (50.6)
1/2-13 UNC	5 (125)	5,995 (26.7)	6,285 (28.0)	6,775 (30.1)	7,530 (33.5)	12,915 (57.4)	13,540 (60.2)	14,595 (64.9)	16,215 (72.1)
5/8-11 UNC	6-3/4 (170)	9,690 (43.1)	10,480 (46.6)	11,290 (50.2)	12,550 (55.8)	20,870 (92.8)	22,570 (100.4)	24,320 (108.2)	27,025 (120.2)
3/4-10 UNC	8-1/8 (205)	12,795 (56.9)	13,750 (61.2)	14,815 (65.9)	16,465 (73.2)	27,560 (122.6)	29,610 (131.7)	31,910 (141.9)	35,460 (157.7)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 19 – 20 as necessary to the above values. Compare to the steel values in table 14. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry or water saturated concrete conditions.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.

10 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.75.
See section 3.1.8 for additional information on seismic applications.

Table 17 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2,3,4,5,6,7,8,9]

Diamond core drilling

Thread size	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)	f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)
3/8-16 UNC	4-3/8	7,140	7,820	8,215	8,215	15,375	16,840	17,700	17,700
	(111)	(31.8)	(34.8)	(36.5)	(36.5)	(68.4)	(74.9)	(78.7)	(78.7)
1/2-13 UNC	5	8,720	9,555	11,030	11,700	18,785	20,575	23,760	25,205
	(127)	(38.8)	(42.5)	(49.1)	(52.0)	(83.6)	(91.5)	(105.7)	(112.1)
5/8-11 UNC	6-3/4	13,680	14,985	17,305	19,505	29,460	32,275	37,265	42,010
	(171)	(60.9)	(66.7)	(77.0)	(86.8)	(131.0)	(143.6)	(165.8)	(186.9)
3/4-10 UNC	8-1/8	18,065	19,790	22,850	25,590	38,910	42,620	49,215	55,115
	(206)	(80.4)	(88.0)	(101.6)	(113.8)	(173.1)	(189.6)	(218.9)	(245.2)

Table 18 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2,3,4,5,6,7,8,9,10]

Diamond core drilling

Thread size	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)	f'_c = 2500 psi (17.2 Mpa) lb (kN)	f'_c = 3000 psi (20.7 Mpa) lb (kN)	f'_c = 4000 psi (27.6 Mpa) lb (kN)	f'_c = 6000 psi (41.4 Mpa) lb (kN)
3/8-16 UNC	4-3/8	2,935	3,030	3,190	3,435	6,315	6,525	6,875	7,395
	(111)	(13.1)	(13.5)	(14.2)	(15.3)	(28.1)	(29.0)	(30.6)	(32.9)
1/2-13 UNC	5	4,175	4,315	4,545	4,890	8,995	9,295	9,790	10,530
	(127)	(18.6)	(19.2)	(20.2)	(21.8)	(40.0)	(41.3)	(43.5)	(46.8)
5/8-11 UNC	6-3/4	6,960	7,195	7,575	8,150	14,990	15,495	16,315	17,550
	(171)	(31.0)	(32.0)	(33.7)	(36.3)	(66.7)	(68.9)	(72.6)	(78.1)
3/4-10 UNC	8-1/8	9,135	9,440	9,940	10,690	19,670	20,325	21,405	23,030
	(206)	(40.6)	(42.0)	(44.2)	(47.6)	(87.5)	(90.4)	(95.2)	(102.4)

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 19 – 20 as necessary to the above values. Compare to the steel values in table 14.
The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.94.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.60.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry or water saturated concrete conditions.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

9 Tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.

10 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.75.
See section 3.1.8 for additional information on seismic applications.

Table 19 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2]

HIS-N and HIS-RN all diameters cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[3] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[4] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To edge f_{RV}							
Thread size, in.			3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4
Embedment h_{ef}		in.	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8
		(mm)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in (mm)	3-1/4	(83)	0.61	n/a	n/a	n/a	0.40	n/a	n/a	n/a	0.55	n/a	n/a	n/a	0.15	n/a	n/a	n/a	0.31	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4	(102)	0.63	0.61	n/a	n/a	0.45	0.42	n/a	n/a	0.56	0.55	n/a	n/a	0.21	0.19	n/a	n/a	0.42	0.38	n/a	n/a	n/a	n/a	n/a	n/a
	5	(127)	0.67	0.63	0.61	n/a	0.51	0.47	0.40	n/a	0.57	0.57	0.55	n/a	0.29	0.26	0.17	n/a	0.51	0.47	0.33	n/a	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.68	0.65	0.62	0.61	0.55	0.50	0.42	0.38	0.58	0.58	0.56	0.55	0.34	0.30	0.19	0.15	0.55	0.50	0.39	0.29	n/a	n/a	n/a	n/a
	6	(152)	0.70	0.66	0.63	0.62	0.59	0.53	0.44	0.39	0.59	0.58	0.56	0.55	0.39	0.35	0.22	0.17	0.59	0.53	0.44	0.33	0.60	n/a	n/a	n/a
	7	(178)	0.73	0.69	0.65	0.64	0.67	0.60	0.48	0.43	0.60	0.60	0.57	0.56	0.49	0.43	0.28	0.21	0.67	0.60	0.48	0.42	0.64	0.62	n/a	n/a
	8	(203)	0.76	0.71	0.67	0.66	0.77	0.67	0.53	0.46	0.62	0.61	0.58	0.57	0.60	0.53	0.34	0.26	0.77	0.67	0.53	0.46	0.69	0.66	n/a	n/a
	9	(229)	0.80	0.74	0.69	0.68	0.86	0.76	0.57	0.50	0.63	0.62	0.59	0.58	0.71	0.63	0.40	0.31	0.86	0.76	0.57	0.50	0.73	0.70	0.60	n/a
	10	(254)	0.83	0.77	0.71	0.70	0.96	0.84	0.62	0.53	0.65	0.64	0.60	0.58	0.83	0.74	0.47	0.36	0.96	0.84	0.62	0.53	0.77	0.74	0.64	n/a
	11	(279)	0.86	0.79	0.74	0.72	1.00	0.92	0.68	0.57	0.66	0.65	0.61	0.59	0.96	0.86	0.55	0.41	1.00	0.92	0.68	0.57	0.81	0.78	0.67	0.61
	12	(305)	0.90	0.82	0.76	0.74		1.00	0.74	0.61	0.68	0.66	0.62	0.60	1.00	0.98	0.62	0.47		1.00	0.74	0.61	0.84	0.81	0.70	0.64
	14	(356)	0.96	0.87	0.80	0.78			0.87	0.71	0.71	0.69	0.64	0.62		1.00	0.78	0.59			0.87	0.71	0.91	0.87	0.75	0.69
	16	(406)	1.00	0.92	0.84	0.82			0.99	0.82	0.74	0.72	0.66	0.63			0.96	0.73			0.99	0.82	0.97	0.94	0.80	0.73
	18	(457)		0.98	0.89	0.85			1.00	0.92	0.77	0.75	0.68	0.65			1.00	0.87			1.00	0.92	1.00	0.99	0.85	0.78
	24	(610)		1.00	1.00	0.97				1.00	0.85	0.83	0.74	0.70				1.00				1.00		1.00	0.99	0.90
	30	(762)				1.00					0.94	0.91	0.80	0.75											1.00	1.00
	36	(914)									1.00	0.99	0.86	0.80												
	> 48	(1219)										1.00	0.99	0.90												

Table 20 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2]

HIS-N and HIS-RN all diameters cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[3] f_{AV}				Edge distance in shear								Concrete thickness factor in shear[4] f_{HV}			
															⊥ Toward edge f_{RV}				∥ To edge f_{RV}							
Thread size, in.			3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4	3/8	1/2	5/8	3/4
Embedment h_{ef}		in.	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8	4-3/8	5	6-3/4	8-1/8
		(mm)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)	(111)	(127)	(171)	(206)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in (mm)	3-1/4	(83)	0.61	n/a	n/a	n/a	0.59	n/a	n/a	n/a	0.55	n/a	n/a	n/a	0.19	n/a	n/a	n/a	0.37	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4	(102)	0.63	0.61	n/a	n/a	0.66	0.59	n/a	n/a	0.57	0.56	n/a	n/a	0.26	0.20	n/a	n/a	0.51	0.39	n/a	n/a	n/a	n/a	n/a	n/a
	5	(127)	0.67	0.63	0.61	n/a	0.75	0.66	0.59	n/a	0.58	0.57	0.55	n/a	0.36	0.27	0.17	n/a	0.71	0.55	0.34	n/a	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.68	0.65	0.62	0.61	0.79	0.69	0.62	0.59	0.59	0.58	0.56	0.55	0.41	0.31	0.19	0.15	0.79	0.63	0.39	0.29	n/a	n/a	n/a	n/a
	6	(152)	0.70	0.66	0.63	0.62	0.84	0.73	0.65	0.62	0.60	0.58	0.56	0.55	0.47	0.36	0.22	0.17	0.84	0.72	0.44	0.34	0.63	n/a	n/a	n/a
	7	(178)	0.73	0.69	0.65	0.64	0.94	0.80	0.70	0.67	0.62	0.60	0.57	0.56	0.59	0.45	0.28	0.21	0.94	0.80	0.56	0.42	0.69	0.63	n/a	n/a
	8	(203)	0.76	0.71	0.67	0.66	1.00	0.88	0.76	0.72	0.63	0.61	0.58	0.57	0.72	0.55	0.34	0.26	1.00	0.88	0.68	0.52	0.73	0.67	n/a	n/a
	9	(229)	0.80	0.74	0.69	0.68		0.96	0.83	0.78	0.65	0.63	0.59	0.58	0.86	0.66	0.41	0.31		0.96	0.82	0.62	0.78	0.71	0.61	n/a
	10	(254)	0.83	0.77	0.71	0.70		1.00	0.89	0.84	0.67	0.64	0.60	0.58	1.00	0.77	0.48	0.36		1.00	0.89	0.72	0.82	0.75	0.64	n/a
	11	(279)	0.86	0.79	0.74	0.72			0.96	0.90	0.68	0.65	0.61	0.59		0.89	0.55	0.42			0.96	0.83	0.86	0.79	0.67	0.61
	12	(305)	0.90	0.82	0.76	0.74			1.00	0.96	0.70	0.67	0.62	0.60		1.00	0.63	0.48			1.00	0.95	0.90	0.82	0.70	0.64
	14	(356)	0.96	0.87	0.80	0.78				1.00	0.73	0.70	0.64	0.62			0.79	0.60				1.00	0.97	0.89	0.76	0.69
	16	(406)	1.00	0.92	0.84	0.82					0.77	0.72	0.66	0.64			0.97	0.73					1.00	0.95	0.81	0.74
	18	(457)		0.98	0.89	0.85					0.80	0.75	0.68	0.65			1.00	0.87						1.00	0.86	0.78
	24	(610)		1.00	1.00	0.97					0.90	0.84	0.74	0.70				1.00							0.99	0.90
	30	(762)				1.00					1.00	0.92	0.81	0.75											1.00	1.00
	36	(914)										1.00	0.87	0.80												
	> 48	(1219)											0.99	0.91												

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

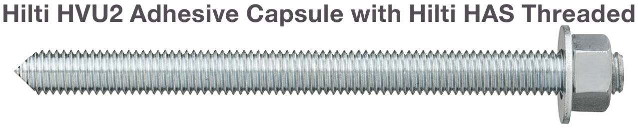
DESIGN DATA IN CONCRETE PER CSA A23.3

CSA A23.3 Annex D design

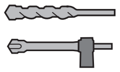
This section contains the Limit State Design tables with un-factored characteristic loads and pre-calculated factored resistance tables based on the published loads in ICC Evaluation Services ESR-4372 and testing per ACI 355.4.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

Hilti HVU2 Adhesive Capsule with Hilti HAS Threaded Rod



Hilti HAS threaded rod with setting tip — See Table 1 and Figures 1 and 2 of this document for installation parameters



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

Table 21 — Hilti HVU2 adhesive capsule design information with HAS threaded rods per CSA A23.3 Annex D [1]

Setting information		Symbol	Units	Nominal rod diameter (in.)							Ref A23.3-14
				3/8	1/2	5/8	3/4	7/8	1	1-1/4 [8]	
Nominal anchor diameter		d_a	mm	9.5	12.7	15.9	19.1	22.2	25.4	31.8	
Effective embedment [2]		h_{ef}	mm	89	108	127	168	168	210	279	
Min. concrete thickness [2]		h_{min}	mm	121	140	162	213	219	267	349	
Critical edge distance		c_{ac}	-	See footnote 9 below							
Minimum edge distance		c_{min}	mm	48	64	79	95	111	127	159	
Minimum anchor spacing		s_{min}	mm	48	64	79	95	111	127	159	
Coeff. for factored conc. breakout resistance, uncracked concrete[3]		$k_{c,uncr}$	-	10							D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete[3]		$k_{c,cr}$	-	7							D.6.2.2
Concrete material resistance factor		Φ_c	-	0.65							8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [4]		R_{conc}	-	1.00							D.5.3 (c)
Temp. range A [5]	Characteristic bond stress in cracked concrete [6,7]	τ_{cr}	psi (MPa)	- -	1,055 (7.3)	1,055 (7.3)	1,055 (7.3)	1,055 (7.3)	1,055 (7.3)	1,055 (7.3)	D.6.5.2
	Characteristic bond stress in uncracked concrete [6,7]	τ_{uncr}	psi (MPa)	1,475 (10.2)	1,950 (13.5)	1,950 (13.5)	1,950 (13.5)	1,950 (13.5)	1,950 (13.5)	2,015 (13.9)	D.6.5.2
Temp. range B [5]	Characteristic bond stress in cracked concrete [6,7]	τ_{cr}	psi (MPa)	- -	980 (6.8)	980 (6.8)	980 (6.8)	980 (6.8)	980 (6.8)	980 (6.8)	D.6.5.2
	Characteristic bond stress in uncracked concrete [6,7]	τ_{uncr}	psi (MPa)	1,370 (9.5)	1,815 (12.5)	1,815 (12.5)	1,815 (12.5)	1,815 (12.5)	1,815 (12.5)	1,870 (12.9)	D.6.5.2
Temp. range C [5]	Characteristic bond stress in cracked concrete [6,7]	τ_{cr}	psi (MPa)	- -	615 (4.2)	615 (4.2)	615 (4.2)	615 (4.2)	615 (4.2)	615 (4.2)	D.6.5.2
	Characteristic bond stress in uncracked concrete [6,7]	τ_{uncr}	psi (MPa)	860 (5.9)	1,135 (7.8)	1,135 (7.8)	1,135 (7.8)	1,135 (7.8)	1,135 (7.8)	1,170 (8.1)	D.6.5.2
Reduction for seismic tension		$\alpha_{N,seis}$	-	-	1.0						
Permissible installation conditions	Strength reduction factor for bond failure, dry concrete	Anchor category	-	1							D.5.3 (c)
		R_{dry}	-	1.00							
	Strength reduction factor for bond failure, water-saturated concrete	Anchor category	-	1							D.5.3 (c)
		R_{ws}	-	1.00							

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[1] Design information in this table is taken from ICC-ES ESR-4372, dated May, 2019, Tables 4 and 5, and converted for use with CSA A23.3 Annex D.

[2] See Figure 2.

[3] For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

[4] For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

[5] Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

[6] Bond strength values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2,500)^n$ [for SI: $(f'_c / 17.2)^n$].
where n is as follows:
n = 0.26 for uncracked concrete
n = 0.14 for cracked concrete

[7] For 3/8-in. to 1-in. rods, characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.

[8] 1-1/4-in. diameter rods to be installed in generally vertically downward direction only.

[9] $c_{ac} = h_{ef} \cdot \left(\frac{\tau_{k,uncr}}{1,160}\right)^{0.4} \cdot \left[3.1 - 0.7 \cdot \frac{h}{h_{ef}}\right]$, where

$\frac{h}{h_{ef}}$ need not be greater than 2.4, and

$\tau_{k,uncr}$ need not be greater than $\tau_{k,uncr} = \frac{\tau_{k,uncr}\sqrt{h_{ef} \cdot f'_c}}{\pi \cdot d_a}$ (use imperial units in all equations)

Table 22 — Hilti HVU2 design information with HAS threaded rods per CSA A23.3 Annex D [1,2]

Diamond core drilling

Design parameter		Symbol	Units	Nominal rod diameter (in.)						Ref A23.3-14
				1/2	5/8	3/4	7/8	1	1-1/4 [6]	
Temp. range A [3]	Characteristic bond stress in cracked concrete [4,5]	τ_{cr}	psi (MPa)	1,075 (7.4)	1,075 (7.4)	1,075 (7.4)	1,075 (7.4)	1,075 (7.4)	1,075 (7.4)	D.6.5.2
	Characteristic bond stress in uncracked concrete [4,5]	τ_{uncr}	psi (MPa)	1,830 (12.6)	1,830 (12.6)	1,830 (12.6)	1,830 (12.6)	1,830 (12.6)	1,885 (13.0)	D.6.5.2
Temp. range B [3]	Characteristic bond stress in cracked concrete [4,5]	τ_{cr}	psi (MPa)	1,010 (7.0)	1,010 (7.0)	1,010 (7.0)	1,010 (7.0)	1,010 (7.0)	1,010 (7.0)	D.6.5.2
	Characteristic bond stress in uncracked concrete [4,5]	τ_{uncr}	psi (MPa)	1,720 (11.9)	1,720 (11.9)	1,720 (11.9)	1,720 (11.9)	1,720 (11.9)	1,770 (12.2)	D.6.5.2
Temp. range C [3]	Characteristic bond stress in cracked concrete [4,5]	τ_{cr}	psi (MPa)	650 (4.5)	650 (4.5)	650 (4.5)	650 (4.5)	650 (4.5)	650 (4.5)	D.6.5.2
	Characteristic bond stress in uncracked concrete [4,5]	τ_{uncr}	psi (MPa)	1,105 (7.6)	1,105 (7.6)	1,105 (7.6)	1,105 (7.6)	1,105 (7.6)	1,135 (7.8)	D.6.5.2
Reduction for seismic tension		$\alpha_{N,seis}$	-	1.0						

1 Design information in this table is taken from ICC-ES ESR-4372, dated May, 2019, Tables 4 and 5, and converted for use with CSA A23.3Annex D.

2 Items from Table 21 (d_a, h_{ef}, h_{min}, c_{ac}, c_{min}, s_{min}, $k_{c,uncr}$, $k_{c,cr}$, and Φ factors) are applicable to this table for diamond core drilling.

3 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

4 Bond strength values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^n$ [for SI: $(f'_c / 17.2)^n$].
where n is as follows:
n = 0.26 for uncracked concrete
n = 0 for cracked concrete

5 For 1/2-in. to 1-in. rods, characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.

6 1-1/4-in. diameter rods to be installed in generally vertically downward direction only.

Table 23 — Steel factored resistance for Hilti HAS threaded rods for use with CSA A23.3 Annex D

Nominal anchor diameter in.	HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6]			HAS-B-105 / HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6]			HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4]		
	Tensile[1] ΦN_{sar} lb (kN)	Shear[2] ΦV_{sar} lb (kN)	Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN)	Tensile[1] ΦN_{sar} lb (kN)	Shear[2] ΦV_{sar} lb (kN)	Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN)	Tensile[1] ΦN_{sar} lb (kN)	Shear[2] ΦV_{sar} lb (kN)	Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN)
3/8	3,955 (17.6)	2,225 (9.9)	1,560 (6.9)	6,570 (29.2)	3,695 (16.4)	2,585 (11.5)	4,610 (20.5)	2,570 (11.4)	1,800 (8.0)
1/2	7,240 (32.2)	4,070 (18.1)	2,850 (12.7)	12,035 (53.5)	6,765 (30.1)	4,735 (21.1)	8,445 (37.6)	4,705 (20.9)	3,295 (14.7)
5/8	11,525 (51.3)	6,485 (28.8)	4,540 (20.2)	19,160 (85.2)	10,780 (48.0)	7,545 (33.6)	13,445 (59.8)	7,490 (33.3)	5,245 (23.3)
3/4	17,060 (75.9)	9,600 (42.7)	6,720 (29.9)	28,365 (126.2)	15,955 (71.0)	11,170 (49.7)	16,920 (75.3)	9,425 (41.9)	6,600 (29.4)
7/8	23,550 (104.8)	13,245 (58.9)	9,270 (41.2)	39,150 (174.1)	22,020 (97.9)	15,415 (68.6)	23,350 (103.9)	13,010 (57.9)	9,105 (40.5)
1	30,890 (137.4)	17,380 (77.3)	12,165 (54.1)	51,360 (228.5)	28,890 (128.5)	20,225 (90.0)	30,635 (136.3)	17,065 (75.9)	11,945 (53.1)
1-1/4	49,425 (219.9)	27,800 (123.7)	19,460 (86.6)	82,175 (365.5)	46,220 (205.6)	32,355 (143.9)	37,565 (167.1)	21,130 (94.0)	12,680 (56.4)

1 Tensile = $A_{se,N}$ ϕ f_{uta} R as noted in CSA A23.3Eq. D.2.

2 Shear = $A_{se,V}$ ϕ 0.60 f_{uta} R as noted in CSA A23.3 Eq. D.31.

3 Seismic Shear = $\alpha_{V,seis}$ V_{sar} : Reduction factor for seismic shear only. See CSA A23.3 Annex D for additional information on seismic applications. Seismic shear for HIT-RE 500 V3

4 HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).

5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.

6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-E-55, and HAS-B-105 (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

Table 24 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for threaded rod in uncracked concrete [1,2,3,4,5,6,7,8,9]

Hammer drilling with
carbide tipped drill bit, or
Hilti TE-CD or TE-YD
Hollow Drill Bit

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — N_r				Shear — V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	3-1/2	4,110	4,360	4,570	4,925	8,225	8,715	9,140	9,850
	(89)	(18.3)	(19.4)	(20.3)	(21.9)	(36.6)	(38.8)	(40.7)	(43.8)
1/2	4-1/4	7,330	8,195	8,975	10,365	14,660	16,390	17,955	20,730
	(108)	(32.6)	(36.5)	(39.9)	(46.1)	(65.2)	(72.9)	(79.9)	(92.2)
5/8	5	9,355	10,455	11,455	13,225	18,705	20,915	22,910	26,455
	(127)	(41.6)	(46.5)	(51.0)	(58.8)	(83.2)	(93.0)	(101.9)	(117.7)
3/4	6-5/8	14,265	15,950	17,470	20,175	28,530	31,900	34,940	40,350
	(168)	(63.5)	(70.9)	(77.7)	(89.7)	(126.9)	(141.9)	(155.4)	(179.5)
7/8	6-5/8	14,265	15,950	17,470	20,175	28,530	31,900	34,940	40,350
	(168)	(63.5)	(70.9)	(77.7)	(89.7)	(126.9)	(141.9)	(155.4)	(179.5)
1	8-1/4	19,825	22,165	24,280	28,035	39,645	44,325	48,555	56,070
	(210)	(88.2)	(98.6)	(108.0)	(124.7)	(176.4)	(197.2)	(216.0)	(249.4)
1-1/4 (10)	11	30,520	34,120	37,380	43,160	61,040	68,245	74,760	86,325
	(279)	(135.8)	(151.8)	(166.3)	(192.0)	(271.5)	(303.6)	(332.5)	(384.0)

Table 25 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9,11]

Hammer drilling with
carbide tipped drill bit, or
Hilti TE-CD or TE-YD
Hollow Drill Bit

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — N_r				Shear — V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/2	4-1/4	4,675	4,825	4,950	5,155	9,355	9,650	9,900	10,305
	(108)	(20.8)	(21.5)	(22.0)	(22.9)	(41.6)	(42.9)	(44.0)	(45.8)
5/8	5	6,545	7,095	7,280	7,580	13,095	14,190	14,560	15,155
	(127)	(29.1)	(31.6)	(32.4)	(33.7)	(58.2)	(63.1)	(64.8)	(67.4)
3/4	6-5/8	9,985	11,165	11,575	12,050	19,970	22,330	23,150	24,100
	(168)	(44.4)	(49.7)	(51.5)	(53.6)	(88.8)	(99.3)	(103.0)	(107.2)
7/8	6-5/8	9,985	11,165	12,230	14,060	19,970	22,330	24,460	28,115
	(168)	(44.4)	(49.7)	(54.4)	(62.5)	(88.8)	(99.3)	(108.8)	(125.1)
1	8-1/4	13,875	15,515	16,995	19,625	27,755	31,030	33,990	39,250
	(210)	(61.7)	(69.0)	(75.6)	(87.3)	(123.4)	(138.0)	(151.2)	(174.6)
1-1/4 (10)	11	21,365	23,885	26,165	30,215	42,730	47,770	52,330	60,425
	(279)	(95.0)	(106.2)	(116.4)	(134.4)	(190.1)	(212.5)	(232.8)	(268.8)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7 – 10 as necessary. Compare to the steel values in table 23.
The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 For 3/8-in to 1-in dia. threaded rods, tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 1-1/4-in diameter rods to be installed in generally vertically downward direction only.
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.75.
See section 3.1.8 for additional information on seismic applications.

Table 26 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for threaded rod in uncracked concrete [1,2,3,4,5,6,7,8]

Diamond core drilling

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — N_r				Shear — V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/2	4-1/4	7,330	8,195	8,975	9,890	14,660	16,390	17,955	19,785
	(108)	(32.6)	(36.5)	(39.9)	(44.0)	(65.2)	(72.9)	(79.9)	(88.0)
5/8	5	9,355	10,455	11,455	13,225	18,705	20,915	22,910	26,455
	(127)	(41.6)	(46.5)	(51.0)	(58.8)	(83.2)	(93.0)	(101.9)	(117.7)
3/4	6-5/8	14,265	15,950	17,470	20,175	28,530	31,900	34,940	40,350
	(168)	(63.5)	(70.9)	(77.7)	(89.7)	(126.9)	(141.9)	(155.4)	(179.5)
7/8	6-5/8	14,265	15,950	17,470	20,175	28,530	31,900	34,940	40,350
	(168)	(63.5)	(70.9)	(77.7)	(89.7)	(126.9)	(141.9)	(155.4)	(179.5)
1	8-1/4	19,825	22,165	24,280	28,035	39,645	44,325	48,555	56,070
	(210)	(88.2)	(98.6)	(108.0)	(124.7)	(176.4)	(197.2)	(216.0)	(249.4)
1-1/4 (10)	11	30,520	34,120	37,380	43,160	61,040	68,245	74,760	86,325
	(279)	(135.8)	(151.8)	(166.3)	(192.0)	(271.5)	(303.6)	(332.5)	(384.0)

Table 27 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9]

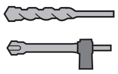
Diamond core drilling

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — N_r				Shear — V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/2	4-1/4	4,665	4,665	4,665	4,665	9,330	9,330	9,330	9,330
	(108)	(20.8)	(20.8)	(20.8)	(20.8)	(41.5)	(41.5)	(41.5)	(41.5)
5/8	5	6,545	6,860	6,860	6,860	13,095	13,725	13,725	13,725
	(127)	(29.1)	(30.5)	(30.5)	(30.5)	(58.2)	(61.0)	(61.0)	(61.0)
3/4	6-5/8	9,985	10,910	10,910	10,910	19,970	21,820	21,820	21,820
	(168)	(44.4)	(48.5)	(48.5)	(48.5)	(88.8)	(97.1)	(97.1)	(97.1)
7/8	6-5/8	9,985	11,165	12,230	12,730	19,970	22,330	24,460	25,455
	(168)	(44.4)	(49.7)	(54.4)	(56.6)	(88.8)	(99.3)	(108.8)	(113.2)
1	8-1/4	13,875	15,515	16,995	18,115	27,755	31,030	33,990	36,230
	(210)	(61.7)	(69.0)	(75.6)	(80.6)	(123.4)	(138.0)	(151.2)	(161.2)
1-1/4 (10)	11	21,365	23,885	26,165	30,190	42,730	47,770	52,330	60,385
	(279)	(95.0)	(106.2)	(116.4)	(134.3)	(190.1)	(212.5)	(232.8)	(268.6)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7 – 10 as necessary. Compare to the steel values in table 23. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 For 1/2-in to 1-in dia. threaded rods, tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 1-1/4-in diameter rods to be installed in generally vertically downward direction only.
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.75.
See section 3.1.8 for additional information on seismic applications.

Hilti HVU2 with Hilti HIS-N Inserts

Hilti HIS-N and HIS-RN internally threaded insert – See Table 11 and Figures 3 and 4 for installation parameters



Hammer drilling with carbide tipped drill bit, orHilti TE-CD or TE-YD Hollow Drill Bit

Table 28 — HVU2 adhesive capsule design information with Hilti HIS-N and HIS-RN internally threaded inserts per CSA A23.3 Annex D [1]

Design parameter		Symbol	Units	Nominal bolt/cap screw diameter (in.)				Ref A23.3-14
				3/8	1/2	5/8	3/4	
HIS insert outside diameter		d_a	mm	16.5	20.5	25.4	27.6	
Effective embedment [2]		h_{ef}	mm	110	125	170	205	
Min. concrete thickness [2]		h_{min}	mm	150	170	230	270	
Critical edge distance		c_{ac}	-	See footnote 8 below				
Minimum edge distance		c_{min}	mm	83	102	127	140	
Minimum anchor spacing		s_{min}	mm	83	102	127	140	
Coeff. for factored conc. breakout resistance, uncracked concrete[3]		$k_{c,uncr}$	-	10				D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete [3]		$k_{c,cr}$	-	7				D.6.2.2
Concrete material resistance factor		Φ_c	-	0.65				8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [4]		R_{conc}	-	1.00				D.5.3 (c)
Temp. range A [5]	Characteristic bond stress in cracked concrete [6,7]	τ_{cr}	psi (MPa)	725 (4.99)	725 (4.99)	725 (4.99)	725 (4.99)	D.6.5.2
	Characteristic bond stress in uncracked concrete [6,7]	τ_{uncr}	psi (MPa)	1,490 (10.26)	1,490 (10.26)	1,490 (10.26)	1,490 (10.26)	D.6.5.2
Temp. range B [5]	Characteristic bond stress in cracked concrete [6,7]	τ_{cr}	psi (MPa)	670 (4.63)	670 (4.63)	670 (4.63)	670 (4.63)	D.6.5.2
	Characteristic bond stress in uncracked concrete [6,7]	τ_{uncr}	psi (MPa)	1,380 (9.53)	1,380 (9.53)	1,380 (9.53)	1,380 (9.53)	D.6.5.2
Temp. range C [5]	Characteristic bond stress in cracked concrete [6,7]	τ_{cr}	psi (MPa)	420 (2.90)	420 (2.90)	420 (2.90)	420 (2.90)	D.6.5.2
	Characteristic bond stress in uncracked concrete [6,7]	τ_{uncr}	psi (MPa)	865 (5.97)	865 (5.97)	865 (5.97)	865 (5.97)	D.6.5.2
Reduction for seismic tension		$\alpha_{N,seis}$	-	1.0				
Permissible installation conditions	Strength reduction factor for bond failure, dry concrete	Anchor category	-	1				D.5.3 (c)
		R_{dry}	-	1.00				
	Strength reduction factor for bond failure, water-saturated concrete	Anchor category	-	1				D.5.3 (c)
		R_{ws}	-	1.00				

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See Figure 4.

3 For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

4 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in CSA A23.3 Section D.5.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.

5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., over significant periods of time.

6 Bond strength values corresponding to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between

7 Characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.

8 $c_{ac} = h_{ef} \cdot \left(\frac{\tau_{k,uncr}}{1,160}\right)^{0.4} \cdot \left[3.1 - 0.7 \cdot \frac{h}{h_{ef}}\right]$, where

$\frac{h}{h_{ef}}$ need not be greater than 2.4, and

$\tau_{k,uncr}$ need not be greater than $\tau_{k,uncr} = \frac{\tau_{k,uncr}\sqrt{h_{ef} \cdot f'_c}}{\pi \cdot d_a}$ (use metric units in all equations)

Table 29 — HVU2 adhesive capsule design information with Hilti HIS-N and HIS-RN internally threaded inserts per CSA A23.3 Annex D [1,2]

Diamond core drilling

Design parameter		Symbol	Units	Nominal rod diameter (in.)				Ref A23.3-14
				3/8	1/2	5/8	3/4	
Temp. range A [3]	Characteristic bond stress in cracked concrete [4,5]	τ_{cr}	psi (MPa)	505 (3.49)	505 (3.49)	505 (3.49)	505 (3.49)	D.6.5.2
	Characteristic bond stress in uncracked concrete [4,5]	τ_{uncr}	psi (MPa)	1,415 (9.77)	1,415 (9.77)	1,415 (9.77)	1,415 (9.77)	D.6.5.2
Temp. range B [3]	Characteristic bond stress in cracked concrete [4,5]	τ_{cr}	psi (MPa)	475 (3.28)	475 (3.28)	475 (3.28)	475 (3.28)	D.6.5.2
	Characteristic bond stress in uncracked concrete [4,5]	τ_{uncr}	psi (MPa)	1,330 (9.17)	1,330 (9.17)	1,330 (9.17)	1,330 (9.17)	D.6.5.2
Temp. range C [3]	Characteristic bond stress in cracked concrete [4,5]	τ_{cr}	psi (MPa)	305 (2.11)	305 (2.11)	305 (2.11)	305 (2.11)	D.6.5.2
	Characteristic bond stress in uncracked concrete [4,5]	τ_{uncr}	psi (MPa)	855 (5.89)	855 (5.89)	855 (5.89)	855 (5.89)	D.6.5.2
Reduction for seismic tension		$\alpha_{N,seis}$	-	1.0				

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 Items from Table 28 (d_a, h_{ef}, h_{min}, c_{ac}, c_{min}, s_{min}, $k_{c,uncr}$, $k_{c,cr}$, R and Φ factors) are applicable to this table for diamond core drilling.

3 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

4 Bond strength values corresponding to concrete compressive strength f'c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2,500)^n$ [for SI: $(f'_c / 17.2)^n$], where n is as follows:
n = 0 for uncracked concrete, all drilling methods
n = 0.18 for cracked concrete, diamond core drill bit

5 Characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.

Table 30 — Steel factored resistance for steel bolt/cap screw for Hilti HIS-N and HIS-RN internally threaded inserts [1,2,3]

Thread size	ASTM A193 B7			ASTM A193 Grade B8M Stainless Steel		
	Tensile [4] N_{sar} lb (kN)	Shear [5] V_{sar} lb (kN)	Seismic Shear [6] $V_{sar,eq}$ lb (kN)	Tensile [4] N_{sar} lb (kN)	Shear [5] V_{sar} lb (kN)	Seismic Shear [6] $V_{sar,eq}$ lb (kN)
3/8-16 UNC	5,765 (25.6)	3,215 (14.3)	2,250 (10.0)	5,070 (22.6)	2,825 (12.6)	1,975 (8.8)
1/2-13 UNC	9,635 (42.9)	5,880 (26.2)	4,115 (18.3)	9,290 (41.3)	5,175 (23.0)	3,620 (16.1)
5/8-11 UNC	16,020 (71.3)	9,365 (41.7)	6,555 (29.2)	14,790 (65.8)	8,240 (36.7)	5,770 (25.7)
3/4-10 UNC	16,280 (72.4)	13,860 (61.7)	9,700 (43.1)	21,895 (97.4)	12,195 (54.2)	8,535 (38.0)

1 See Section 3.1.8 to convert design strength value to ASD value.

2 Hilti HIS-N and HIS-RN inserts with steel bolts are considered brittle steel elements.

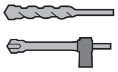
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.

4 Tensile = $A_{se,N}$ ϕ_s f_{uta} R as noted in CSA A23.3 Annex D.

5 Shear = $A_{se,V}$ ϕ_s 0.60 f_{uta} R as noted in CSA A23.3 Annex D. For 3/8-in diameter insert, shear = $A_{se,V}$ ϕ_s 0.50 f_{uta} R.

6 Seismic Shear = $\alpha_{V,seis}$ V_{sar} : Reduction factor for seismic shear only. See section 3.1.8 for additional information on seismic applications.

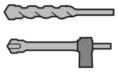
Table 31 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2,3,4,5,6,7,8,9]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

Thread size	Effective embedment in. (mm)	Tension — N_r				Shear — V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8-16 UNC	4-3/8	7,540	8,430	8,555	8,555	15,080	16,860	17,110	17,110
	(110)	(33.5)	(37.5)	(38.0)	(38.0)	(67.1)	(75.0)	(76.1)	(76.1)
1/2-13 UNC	5	9,135	10,210	11,185	12,115	18,265	20,420	22,370	24,225
	(125)	(40.6)	(45.4)	(49.8)	(53.9)	(81.3)	(90.8)	(99.5)	(107.8)
5/8-11 UNC	6-3/4	14,485	16,195	17,740	20,340	28,970	32,390	35,480	40,675
	(170)	(64.4)	(72.0)	(78.9)	(90.5)	(128.9)	(144.1)	(157.8)	(180.9)
3/4-10 UNC	8-1/8	19,180	21,445	23,490	26,735	38,360	42,890	46,985	53,465
	(205)	(85.3)	(95.4)	(104.5)	(118.9)	(170.6)	(190.8)	(209.0)	(237.8)

Table 32 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2,3,4,5,6,7,8,9,10]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

Thread size	Effective embedment in. (mm)	Tension — N_r				Shear — V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8-16 UNC	4-3/8	4,325	4,585	4,810	5,180	8,655	9,170	9,615	10,360
	(110)	(19.2)	(20.4)	(21.4)	(23.0)	(38.5)	(40.8)	(42.8)	(46.1)
1/2-13 UNC	5	6,125	6,495	6,810	7,335	12,255	12,985	13,615	14,675
	(125)	(27.3)	(28.9)	(30.3)	(32.6)	(54.5)	(57.8)	(60.6)	(65.3)
5/8-11 UNC	6-3/4	10,140	10,900	11,430	12,320	20,280	21,805	22,860	24,635
	(170)	(45.1)	(48.5)	(50.8)	(54.8)	(90.2)	(97.0)	(101.7)	(109.6)
3/4-10 UNC	8-1/8	13,425	14,330	15,025	16,190	26,855	28,660	30,050	32,385
	(205)	(59.7)	(63.7)	(66.8)	(72.0)	(119.5)	(127.5)	(133.7)	(144.0)

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 19 – 20 as necessary to the above values. Compare to the steel values in table 30. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.
9 Tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.75.
See section 3.1.8 for additional information on seismic applications.

Table 33 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2,3,4,5,6,7,8,9]

Diamond core drilling

Thread size	Effective embedment in. (mm)	Tension — N_r				Shear — V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8-16 UNC	4-3/8	7,540	8,145	8,145	8,145	15,080	16,290	16,290	16,290
	(110)	(33.5)	(36.2)	(36.2)	(36.2)	(67.1)	(72.5)	(72.5)	(72.5)
1/2-13 UNC	5	9,135	10,210	11,185	11,535	18,265	20,420	22,370	23,070
	(125)	(40.6)	(45.4)	(49.8)	(51.3)	(81.3)	(90.8)	(99.5)	(102.6)
5/8-11 UNC	6-3/4	14,485	16,195	17,740	19,365	28,970	32,390	35,480	38,735
	(170)	(64.4)	(72.0)	(78.9)	(86.1)	(128.9)	(144.1)	(157.8)	(172.3)
3/4-10 UNC	8-1/8	19,180	21,445	23,490	25,455	38,360	42,890	46,985	50,910
	(205)	(85.3)	(95.4)	(104.5)	(113.2)	(170.6)	(190.8)	(209.0)	(226.5)

Table 34 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2,3,4,5,6,7,8,9,10]

Diamond core drilling

Thread size	Effective embedment in. (mm)	Tension — N_r				Shear — V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8-16 UNC	4-3/8	2,990	3,110	3,215	3,385	5,980	6,225	6,430	6,775
	(110)	(13.3)	(13.8)	(14.3)	(15.1)	(26.6)	(27.7)	(28.6)	(30.1)
1/2-13 UNC	5	4,235	4,405	4,555	4,795	8,465	8,815	9,110	9,595
	(125)	(18.8)	(19.6)	(20.3)	(21.3)	(37.7)	(39.2)	(40.5)	(42.7)
5/8-11 UNC	6-3/4	7,110	7,400	7,645	8,055	14,215	14,800	15,295	16,105
	(170)	(31.6)	(32.9)	(34.0)	(35.8)	(63.2)	(65.8)	(68.0)	(71.6)
3/4-10 UNC	8-1/8	9,345	9,725	10,050	10,585	18,685	19,455	20,100	21,170
	(205)	(41.6)	(43.3)	(44.7)	(47.1)	(83.1)	(86.5)	(89.4)	(94.2)

[1] See Section 3.1.8 for explanation on development of load values.

[2] See Section 3.1.8 to convert design strength value to ASD value.

[3] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[4] Apply spacing, edge distance, and concrete thickness factors in tables 19 – 20 as necessary to the above values. Compare to the steel values in table 30. The lesser of the values is to be used for the design.

[5] Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.94.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.60.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

[6] Tabular values are for dry or water saturated concrete conditions.

[7] Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

[8] Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.51. For all-lightweight, λ_a = 0.45.

[9] Tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.

[10] Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by α_{seis} = 0.75.
See section 3.1.8 for additional information on seismic applications.

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com and www.hilti.ca. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

MATERIAL SPECIFICATIONS

Figure 5 — Hilti HVU2 adhesive cure time (approx.)

[°C]	[°F]	t_{cure}
-10...-6	14...22	5 h
-5...-1	23...31	3 h
0...4	32...40	40 min
5...9	41...49	20 min
10...19	50...67	10 min
20...40	68...104	5 min

Table 35 — Material properties of fully cured Hilti HVU2 adhesive

Compressive strength @ 73°F (23°C) / 50% humidity	11,200 psi	77.30 N/mm²
Tensile strength	1,241 psi	8.56 N/mm²
Water absorption after 24h	0.26%	

Key for Table 36 Behavior:

- \- non-resistant
- \+ resistant

Samples of cured HVU2 adhesive were immersed in the various chemical compounds at room temperature (77°F / 25°C) for 90 days. Samples that showed weight increase less than 4% were evaluated as Resistant” and samples that showed a weight increase greater than 6% were evaluated as Non-resistant”.

Note: In actual use, the majority of the adhesive is encased in the base material, leaving very little surface area exposed.

Table 36 — Resistance of fully cured Hilti HVU2 adhesive to chemicals

Chemical substance	Components	Content [Vol. %]	Behavior
Diesel-Fuel	Test mixture A 20/NP 2 Biodiesel	95.0 5.0	+
Alcohol	Methanol	100.0	-
Aliphatic halogenated hydrocarbons	Dichlormethane (Methylene chloride)	100.0	-
Aqueous organic surfactants/Tensides	Texapon N 28 Marlipal O 13/8 Water	3.0 2.0 95.0	+
Organic esters and ketones	Ethylacetate Methylisobutylketone	50.0 50.0	+
Aqueous organic acids	Acqueous acetic acid (10%)	100.0	+
Organic acids	Acetic acid Propionic acid	50.0 50.0	-
Inorganic acids	Sulfuric acid (20%)	100.0	+
Aliphatic Aldehydes	n-Butyraldehyde (Butanal) n-Heptaldehyde (Heptanal)	50.0 50.0	+
Cyclic and acyclic ether	Tetrahydrofuran (THF)	100.0	-
Hydrocarbons	Toluene Xylene Methylnaphthalene	60.0 30.0 10.0	+
Benzene and benzene mixtures	Benzene Toluene Xylene Methylnaphthalene	30.0 30.0 30.0 10.0	+
Inorganic bases	Sodium hydroxide (20%)	100.0	+
Amine	Triethanolamine n-Butylamine N,N-Dimethylaniline	35.0 30.0 35.0	-

ORDERING INFORMATION

Order information
Description
Adhesive capsule HVU2 3/8” x 3 1/2”
Adhesive capsule HVU2 1/2” x 4 1/4”
Adhesive capsule HVU2 5/8” x 5”
Adhesive capsule HVU2 3/4” x 6 5/8”
Adhesive capsule HVU2 7/8” x 6 5/8”
Adhesive capsule HVU2 1” x 8 1/4”
Adhesive capsule HVU2 1 1/4” x 11”

Accessories

① HAS anchor rods with setting tip

② HIS-N / HIS-RN internally threaded inserts

③ SF 6H-A22 cordless drill driver

④ SID 4-122 cordless impact driver

⑤ Hamer drill / combihammer

⑥ Tool shaft / sockets

①

②

③

④

⑤

⑥

3.2.7 HAS THREADED RODS AND HIT-Z ANCHOR RODS

Hilti has a full line of threaded rods available in 8 different material and coating types. Our new enhanced carbon steel rods now all meet the requirements of ASTM F1554, which allows engineers to design ductile fastening points with predictable steel failure for seismic applications in the three most common and relevant steel grades 36, 55 and 105.

Hilti still continues to provide the innovative HIT-Z anchor rods with HIT-HY 200 V3. This Hilti SafeSet system provides the ultimate in safety and load capacity combined with 60% faster installation due to zero-cleaning.

The following is the technical data and ordering information for diameters up to 1-1/4" and pre-cut lengths. Contact Hilti for additional information on HAS rod diameters up to 2-1/2" and custom lengths.

Specifications and physical properties of Hilti HAS threaded rods and Hilti HIT-Z anchor rods

	Threaded Rod Specification	Units	Specified Ultimate Strength, f_{uta}		Minimum Specified Yield Strength 0.2% Offset, f_{ya}	f_{uta} / f_{ya}	Elongation, Min. %	Reduction of Area, Min. %	Specification for Nuts and Washers
			Min.	Max[6]					
CARBON STEEL	**HAS-V-A307** 1/4-in. to 5/16-in. ASTM A307 Grade A[1,2]	psi	60,000	NA	37,500	1.60	10	-	**Nuts:** SAE J995 Grade 5 **Washers:** ASTM F884, HV and ANSI B18.22.1 Type A Plain
		(MPa)	(414)		(259)				
	HAS-V / HAS-V-36 / HAS-V-36 HDG ASTM F1554, Grade 36 [1,3,9] ASTM F1554 Compliant	psi	58,000	80,000	36,000	1.61	23	40	**Nuts:** ASTM A194/194M, Grade 2H, Heavy or ASTM A563-15 Grade A, Heavy **Washers:** ASTM F436 Type 1 and ANSI B18.22.1 Type A Plain
		(MPa)	(400)	(552)	(248)				
	HAS-E-55 / HAS-E-55 HDG ASTM F1554, Grade 55[1,3,9] ASTM F1554 Compliant	psi	75,000	95,000	55,000	1.36	21	30 (3/8" - 2")	
		(MPa)	(517)	(655)	(379)			22 (2-1/4" - 2-1/2")	
	HAS-B 105 / HAS-B-105 HDG ASTM A193, Grade B7[1,4] ASTM F1554, Grade 105[1,3,9] ASTM F1554 Compliant	psi	125,000(7)	150,000	105,000	1.19	16 (B7)	50 (B7)	**Nuts:** ASTM A194/194M, Grade 2H, Heavy or ASTM A563-15 Grade C **Washers:** ASTM F436 Type 1 and ANSI B18.22.1 Type A Plain
		(MPa)	(862)(7)	(1,034)	(724)		15 (Gr. 105)	45 (Gr. 105)	
	HIT-Z Anchor rod (HIT-HY 200 V3 only) Unalloyed carbon steel [1]	psi	94,200	NA	75,300	1.25	8	20	**Nuts:** ASTM A563 Gr. A **Washers:** ASTM F844, HV and ANSI B18.22.1 Type A Plain
		(MPa)	(650)		(519)				
STAINLESS STEEL	**HAS-R 304 / 316** 3/8-in. 5/8-in. AISI Type 304 / 316 ASTM F 593 CW1[5]	psi	100,000	150,000	65,000	1.54	20	-	**Nuts:** ASTM F594 **Washers:** ASTM A240 and ANSI B18.22.1 Type A Plain
		(MPa)	(690)	(1,034)	(448)				
	HAS-R 304 / 316 3/4-in. to 1-in. AISI Type 304 / 316 ASTM F 593 CW2[5]	psi	85,000	140,000	45,000	1.89	25	-	
		(MPa)	(586)	(966)	(310)				
	HAS-R 304 / 316 1/4-in. to 5/16-in. and 1-1/8" to 2-in. ASTM A193 Grade8(M), Class 1[4]	psi	75,000(8)	NA	30,000	2.50(7)	30	50	
		(MPa)	(517)(8)		(207)				
	HIT-Z Anchor rod (HIT-HY 200 V3 only) Grade 316	psi	94,200	NA	75,300	1.25	8	20	
		(MPa)	(650)		(519)				

1 All electroplated carbon steel threaded rods are zinc plated in accordance with ASTM F1941 Fe/Zn 5 AN, with nuts and washers zinc plated in accordance with ASTM B633 SC 1 Type III. All hot-dipped galvanized threaded rods, nuts, and washers are zinc plated in accordance with ASTM F2329.
2 Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
3 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
4 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
5 Standard Steel Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
6 Maximum specified steel strength according to ASTM standard. NA indicates that ASTM standard does not publish a maximum value.
7 For designs according to CSA A23.3 Annex D, the maximum value of f_{uta} is 860 MPa (124,700 psi) per clause D.6.1.2.
8 For calculating steel strength, ACI 318 section 17.4.1.2 and CSA A23.3 clause D.6.1.2 limit the ultimate strength to 1.9 f_{ya}.
Thus, f_{uta} = 57,000 psi (393 MPa) for calculation purposes when determining steel strength in tension (N_{sa}) and shear (V_{sa}).
9 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V-36, HAS-E-55, and HAS-B-105 (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

ORDERING INFORMATION

Hilti HIT-Z Anchor rods for Hilti HIT-HY 200 V3 Anchoring system

HIT-Z Carbon Steel		HIT-Z-R 316 Stainless Steel		HIT-Z (-R) Length Code
Description	Qty	Description	Qty	
3/8" x 3-3/8"	40	3/8" x 3-3/8"	40	D
3/8" x 4-3/8"	40	3/8" x 4-3/8"	40	F
3/8"x 5-1/8"	40	3/8"x 5-1/8"	40	H
3/8" x 6-3/8"	40	3/8" x 6-3/8"	40	J
1/2" x 4-1/2"	20	1/2" x 4-1/2"	20	F
1/2" x 6-1/2"	20	1/2" x 6-1/2"	20	J
1/2" x 7-3/4"	20	1/2" x 7-3/4"	20	M
5/8" x 6"	12	5/8" x 6"	12	I
5/8" x 8"	12	5/8" x 8"	12	M
5/8" x 9-1/2"	12	5/8" x 9-1/2"	12	P
3/4" x 6-1/2"	6	3/4" x 6-1/2"	6	K
3/4" x 8-1/2"	6	3/4" x 8-1/2"	6	N
3/4" x 9-3/4"	6	3/4" x 9-3/4"	6	Q

Hilti Rods are now stamped on the end to show grade of steel and overall anchor length!

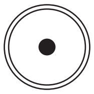
“/_\” = HIT-Z
“J” = Length Code

“HV” = HAS-V-36
“6 1/2” = Length

✕ = 1/4” & 5/16” HAS-V
Carbon steel
No length identification

“HE” = HAS-E-55
“6 1/2” = Length

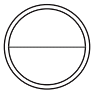
“HB” = HAS-B-105
“6 1/2” = Length



● = 1/4” & 5/16” HAS-R
Stainless steel 304
No length identification

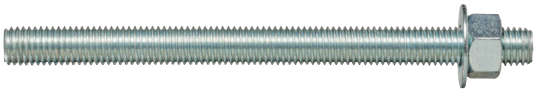
“R1” = 304 SS
“6 1/2” = Length

“R2” = 316 SS
“6 1/2” = Length

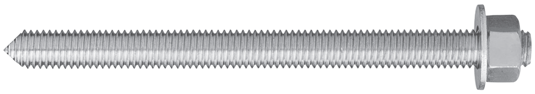


— = 1/4” & 5/16” HAS-R
Stainless steel 316
No length identification

Overview of the Hilti HAS standard off-the-shelf anchor rods for Hilti chemical anchoring systems[1]



HAS-V does not come with chisel point



HAS-E, HAS-B, and HAS-R all come with chisel point

HAS-V		HAS-V-36/ HAS-V-36 HDG		HAS-E-55		HAS-B-105		HAS-B-105 HDG Hot-dipped galvanized		HAS-R 304 Stainless Steel		HAS-R 316 Stainless Steel	
Description	Qty	Description	Qty	Description	Qty	Description	Qty	Description	Qty	Description	Qty	Description	Qty
1/4" x 3"	20	-	-	-	-	-	-	-	-	-	-	-	-
1/4" x 4-1/2"	20	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	3/8" x 3"	20	-	-	-	-	-	-	-	-
5/16" x 3"	20	-	-	-	-	-	-	-	-	-	-	-	-
5/16" x 4-1/2"	20	-	-	-	-	-	-	-	-	-	-	-	-
-	-	3/8" x 4-3/8"[2]	20	3/8" x 4-3/8"	20	-	-	-	-	-	-	-	-
-	-	3/8" x 5-1/8"[2]	20	3/8" x 5-1/8"	20	3/8" x 5-1/8"	20	-	-	3/8" x 5-1/8"	20	3/8" x 5-1/8"	20
-	-	3/8" x 8"[2]	10	3/8" x 8"	10	-	-	-	-	3/8" x 8"	10	3/8" x 8"	10
-	-	-	-	3/8" x 12"	10	-	-	-	-	-	-	-	-
-	-	-	-	1/2" x 3-1/8"	20	-	-	-	-	-	-	-	-
-	-	1/2" x 4-1/2"	20	1/2" x 4-1/2"	20	-	-	-	-	-	-	-	-
-	-	1/2" x 6-1/2"	20	1/2" x 6-1/2"	20	1/2" x 6-1/2"	20	-	-	1/2" x 6-1/2"	20	1/2" x 6-1/2"	20
-	-	1/2" x 8"[2]	10	1/2" x 8"	10	-	-	1/2" x 8"	10	1/2" x 8"	10	1/2" x 8"	10
-	-	-	-	1/2" x 10"	10	-	-	-	-	1/2" x 10"	10	1/2" x 11"	10
-	-	-	-	1/2" x 12"	10	-	-	-	-	-	-	1/2" x 12"	10
-	-	5/8" x 6"	10	5/8" x 6"	10	-	-	-	-	-	-	-	-
-	-	5/8" x 8"	10	5/8" x 8"	10	5/8" x 8"	10	5/8" x 8"	10	5/8" x 7-5/8"	20	5/8" x 7-5/8"	20
-	-	5/8" x 10"[2]	10	5/8" x 9"	10	-	-	-	-	5/8" x 10"	10	5/8" x 9"	10
-	-	5/8" x 12"[2]	10	5/8" x 12"	10	-	-	5/8" x 12"	10	-	-	5/8" x 12"	10
-	-	-	-	5/8" x 17"	10	-	-	-	-	-	-	-	-
-	-	3/4" x 6"[2]	10	3/4" x 6"	10	-	-	-	-	-	-	-	-
-	-	3/4" x 8"	10	3/4" x 8"	10	-	-	-	-	-	-	-	-
-	-	3/4" x 10"	10	3/4" x 10"	10	3/4" x 10"	10	3/4" x 10"	10	3/4" x 9-5/8"	10	3/4" x 9-5/8"	10
-	-	-	-	3/4" x 11"	10	-	-	-	-	-	-	3/4" x 10"	10
-	-	3/4" x 12"[2]	10	3/4" x 12"	10	-	-	-	-	3/4" x 12"	10	-	-
-	-	-	-	3/4" x 14"	10	3/4" x 14"	10	3/4" x 14"	10	3/4" x 14"	10	-	-
-	-	3/4" x 16"[2]	10	3/4" x 17"	10	-	-	-	-	3/4" x 16"	10	3/4" x 16"	10
-	-	-	-	3/4" x 19"	8	-	-	3/4"x20"	8	-	-	-	-
-	-	-	-	3/4" x 21"	8	-	-	-	-	-	-	-	-
-	-	-	-	3/4" x 25"	4	-	-	-	-	-	-	-	-
-	-	-	-	7/8" x 10"	10	-	-	7/8" x 10"	10	7/8" x 10"	10	7/8" x 10"	10
-	-	-	-	7/8" x 13"	8	-	-	7/8" x 12"	10	-	-	-	-
-	-	-	-	-	-	-	-	7/8" x 16"	10	-	-	7/8" x 16"	10
-	-	1" x 12"	4	1" x 12"	4	1" x 12"	4	-	-	1" x 12"	4	1" x 12"	4
-	-	-	-	1" x 14"	4	1" x 14"	4	-	-	-	-	-	-
-	-	-	-	1" x 16"	2	1" x 16"	2	1" x 16"	2	-	-	1" x 16"	2
-	-	-	-	1" x 20"	2	1" x 21"	2	1" x 21"	2	-	-	1" x 20"	2
-	-	-	-	1-1/4" x 16"	2	1-1/4" x 16"	2	1-1/4" x 16"	2	-	-	-	-
-	-	-	-	1-1/4" x 22"	2	1-1/4" x 23"	2	-	-	-	-	-	-

[1] Additional diameters (up to 2-1/2") and lengths are available upon request. Contact Hilti for the full portfolio.

[2] Not available in hot dipped galvanized.

3.2.8 ADHESIVE ANCHOR ACCESSORIES

Accessories — dispensers

Battery powered

Description	
HDE 500-A18/A22 compact battery dispenser kit[1] Includes dispenser, (2) compact B 18/22 1.6-Ah Li-Ion batteries, C 4/36 battery charger, black and red cartridge holders in a soft bag.	
HDE 500-A18/A22 industrial battery dispenser kit[1] Includes dispenser, (2) industrial B 18/22 3.3-Ah Li-Ion batteries, C 4/36 battery charger, black and red cartridge holders in a soft bag.	
HDE 500-A18/A22 battery dispenser tool body[1] Includes black and red cartridge holders	
Battery charger C 4/36 Li-Ion 115V Use with all B 14.4, B 18/22 batteries or B 36 batteries	
Battery compact 18/22 1.6-Ah Li-Ion	
Battery industrial B 18/22 3.3-Ah Li-Ion	
HDE 500-A18/22 hard case	

Manual

Description	
MD 1000 manual dispenser[1] For HIT ICE	
HDM 500 manual dispenser with black foil pack holder For use with 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil packs of HIT-RE 500-V3, HIT-HY 10 PLUS, HIT-HY 270	
HDM 500 manual dispenser with red foil pack holder For use with 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil pack adhesives HIT-HY 200-A V3 and HIT-HY 200-R V3	
HDM 500 manual dispenser with black and red foil pack holder For use with 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil pack adhesives HIT-HY 200-A V3, HIT-HY 200-R V3, HIT-RE 500-V3, HIT-HY 10 PLUS and HIT-HY 270	
HIT-CB 500 black cartridge (foil pack) holder replacement For use with 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil packs or HIT-RE 500V-3, HIT-HY 10 PLUS and HIT-HY 270	
HIT-CR 500 red cartridge (foil pack) holder replacement For use with 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil pack adhesives HIT-HY 200-A V3 and HIT-HY 200-R V3	
HDM 500 hard case only, no tool	

Pneumatic with 1/4 female compressed air coupling

Description	
P 3500 pneumatic dispenser[1] For use with HIT 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil pack	
HIT-P 8000D pneumatic dispenser[1] For use with HIT 47.3 fl oz/1400 ml jumbo foil pack	
P 3500 Cartridge (black foil pack) holder replacement For use with the P 3500 Pneumatic Dispenser and HIT-RE 500-V3, HIT-HY 270 and HIT-HY 10 PLUS	

1 Dispensers not compatible with HIT-HY 200 V3 Adhesive Anchor System.

Color coded cartridge holders with the same quality dispenser

With the introduction of HIT-HY 200 V3 and Safe Set™ Technology, Hilti has introduced a new chemistry with a 5:1 ratio. **All other Hilti adhesive anchor system have a 3:1 mix ratio.** The new technology allows for better performance and both the HDM 500 Manual Dispensers and HDE 500-A18/A22 Battery Dispenser can accept both cartridge ratios. Simply change out the cartridge holder and you can use the dispenser on any jobsite with any Hilti foil pack adhesive.

Red	Black
 	 

Hilti HIT Profi accessories for blowing out drilled holes

Description		Diameter in.	Length ft	Qty
Blow-Out Pump For use in holes up to 10 in. deep	①			1
Blow-Out Tool G 1/4 NPT Inlet For use in holes up to 11 in. deep. For holes deeper than 11 in., use Blow-Out Tool plus the following extensions	②			1
Extension hose for blow-out tool HIT-DL 10/0.8	③	0.39	2.6	1
Extension hose for blow-out tool HIT-DL 16/0.8	④	0.71	2.6	1
3/8 Claw-type Quick Connect HIT-DL A	⑤			1
Extension hose for HIT-DL A HIT-DL V10/1	⑥	0.39	3.3	1
Extension tube HIT-DL B (Rigid/bent)	⑦	0.63		5
Extension tube HIT-VL 16/0.7 (Rigid/straight)	⑧	0.63	2.3	10
Coupler for blowing extensions HIT-DL K Metal coupler for splicing 16 mm extension hose		0.63		10
Extension hose HIT-VL 16 (Flexible)	⑨	0.63	33	1
HIT-DRS Dust Removal System with one hole for vacuum attachment and another hole for the Blow-Out Tool. For use with compressed air				1

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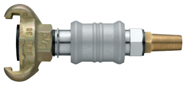

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Air nozzles

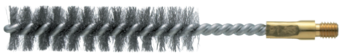
Attach to extension end for proper hole cleaning[1]

Description	Qty
HIT-DL 1/2 Use with 10 mm diameter hose	1
HIT-DL 9/16 Use with 10 mm diameter hose	1
HIT-DL 11/16 Use with 10 mm diameter hose	1
HIT-DL 3/4 Use with 16 mm diameter hose/tube	1
HIT-DL 7/8 Use with 16 mm diameter hose/tube	1
HIT-DL 1 Use with 16 mm diameter hose/tube	1
HIT-DL 1-3/8 Use with 16 mm diameter hose/tube	1

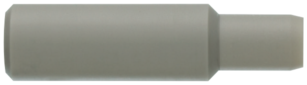
1 HIT-DL size determined by the diameter of drilled hole; see Accessory Selection Table below for proper sizing

Also avaliable in metric!

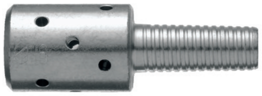
Round brush[2]



Piston plug (10 pack)[3]



Air nozzle



Hole diameter[1]	Description	Description	Use with hose dia.	Description
7/16	**HIT-RB 7/16**	**-**		**-**
1/2	**HIT-RB 1/2**	**HIT-IP 1/2**	9 mm	**HIT-DL 1/2**
9/16	**HIT-RB 9/16**	**HIT-IP 9/16**	9 mm	**HIT-DL 9/16**
5/8	**HIT-RB 5/8**	**HIT-IP 5/8**	9 mm	**-**
11/16	**HIT-RB 11/16**	**HIT-IP 11/16**	9 mm	**HIT-DL 11/16**
3/4	**HIT-RB 3/4**	**HIT-IP 3/4**	16 mm	**HIT-DL 3/4**
7/8	**HIT-RB 7/8**	**HIT-IP 7/8**	16 mm	**HIT-DL 7/8**
1	**HIT-RB 1**	**HIT-IP 1**	16 mm	**HIT-DL 1**
1-1/8	**HIT-RB 1 1/8**	**HIT-IP 1 1/8**	16 mm	**-**
1-1/4	**HIT-RB 1 1/4**	**HIT-IP 1 1/4**	16 mm	**-**
1- 3/8	**HIT-RB 1 3/8**	**HIT-IP 1 3/8**	16 mm	**HIT-DL 1 3/8**
1-1/2	**HIT-RB 1 1/2**	**HIT-IP 1 1/2**	16 mm	**-**
1-3/4	**HIT-RB 1 3/4**	**HIT-IP 1 3/4**	16 mm	**-**

1 Refer to adhesive anchor system installation instructions to determine the proper hole diameter for the fastening element to be used.
2 Attach brush to HIT-RBH T-handle, HIT-RBS or HIT-RBV extensions.
3 Use piston plugs to help prevent air voids during injection.

Hilti HIT Profi accessories for brushing drilled holes

Manual brush handle for round steel brush

Description		Qty
HIT-RBH (T-handle) Use to clean holes up to 11 in. deep	①	1

Manual brush extension for round steel brush

Description		Qty
HIT-RBV 11 in. extension for HIT-RBH (T-handle)	②	1

Holders for brush extension RBS

Connects RBS extension to your Hilti drill for use in cleaning holes

Description		Qty
TE-Y SDS Max connection	③	1
TE-C SDS + Connection	④	1

Extensions for round steel brushes

Description		Diameter in	Length ft	Qty
HIT-RBS 10/0.7	⑤	0.39	2.3	1
HIT-RBS-10/0.35	⑤	0.39	1.2	1

Hilti HIT Profi accessories for adhesive injection

Extension hoses

For use in holes deeper than 10 in.

Description		Diameter in.	Length ft	Qty
HIT-VL 9/1.0 flexible hose	⑥	0.35	3.3	10
HIT-VL 16/0.7 rigid tube	⑦	0.63	2.3	10
HIT-VL 16 flexible hose		0.63	33	1

Coupler for injection extensions

Description		Diameter in.	Qty
HIT-VL K Plastic coupler for connecting 16 mm (0.63 in.) hoses and tubes	⑧	0.63	5

Overhead injection accessories

Description		Hole Diameter in.	Qty
HIT-OHW overhead wedge	⑨	7/16 to 1-1/4	100
HIT-OHC1 overhead drip guard	⑩	7/16 to 5/8	10
HIT-OHC2 overhead drip guard		11/16 to 1-1/4	10

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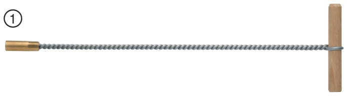

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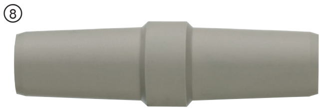

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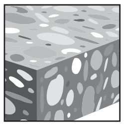
3.3.1 HDA UNDERCUT ANCHORS

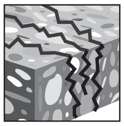
PRODUCT DESCRIPTION

HDA undercut anchors

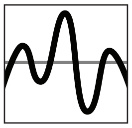
Anchor system		Features and benefits
HDA-P undercut anchor pre-set type 	HDA-T undercut anchor through-set type 	• Undercut segments provide cast-in-place like performance with limited expansion stresses • Self-undercutting wedges provide an easy, fast and reliable anchor installation • Excellent performance in cracked concrete • Suitable for dynamic loads including seismic, fatigue and shock. See Anchor Selector Guide • Undercut keying load transfer allows for reduced edge distances and anchor spacings • Through-set style provides increased shear capacity • Fully removable Type 316 stainless steel for corrosive environments • Sherardized zinc coating has equivalent corrosion resistance to hot-dip galvanization • ACI 349-01 Nuclear Design Guide is available. Call Hilti Technical Support



Uncracked concrete



Cracked concrete



Seismic design categories A-F

Profis anchor design software

Approvals/Listings	
ICC-ES (International Code Council)	ESR-1546 in concrete per ACI 318-Ch. 17 / ACI 355.2/ ICC-ES AC193
European Technical Approval	ETA-99/0009, ETA-99/0016
City of Los Angeles	Research Report No. 25939
Nuclear Quality Assurance	Qualified under NQA-1 Nuclear Quality Program

MATERIAL SPECIFICATIONS

HDA-P and HDA-T carbon steel with electroplated zinc

Cone bolts meet strength requirements of ISO 898, class 8.8. Minimum yield strength is 92.8 ksi (640 MPa) and minimum tensile strength is 116 ksi (800 MPa).

Sleeve for the M10 and M12 has a minimum tensile strength of 123 ksi (850 MPa).

Sleeve for the M16 has a minimum tensile strength of 101.5 ksi (700 MPa).

Sleeve for the M20 has a minimum tensile strength of 79.8 ksi (550 MPa).

The nut and washer are carbon steel.

All carbon steel components have a minimum 5 µm zinc plating thickness.

HDA-PR and HDA-TR stainless steel

Cone bolts have a minimum yield strength is 87 ksi (600 MPa) and minimum tensile strength is 116 ksi (800 MPa).

Sleeve for the M10 and M12 has a minimum tensile strength of 123 ksi (850 MPa).

Sleeve for the M16 has a minimum tensile strength of 101.5 ksi (700 MPa).

Nut conforms to DIN 934, grade A4-80.

HDA-PF and HDA-TF carbon steel with sherardized heavy zinc plating

Cone bolts meet strength requirements of ISO 898, class 8.8. Minimum yield strength is 92.8 ksi (640 MPa) and minimum tensile strength is 116 ksi (800 MPa).

Sleeve for the M10 and M12 has a minimum tensile strength of 123 ksi (850 MPa).

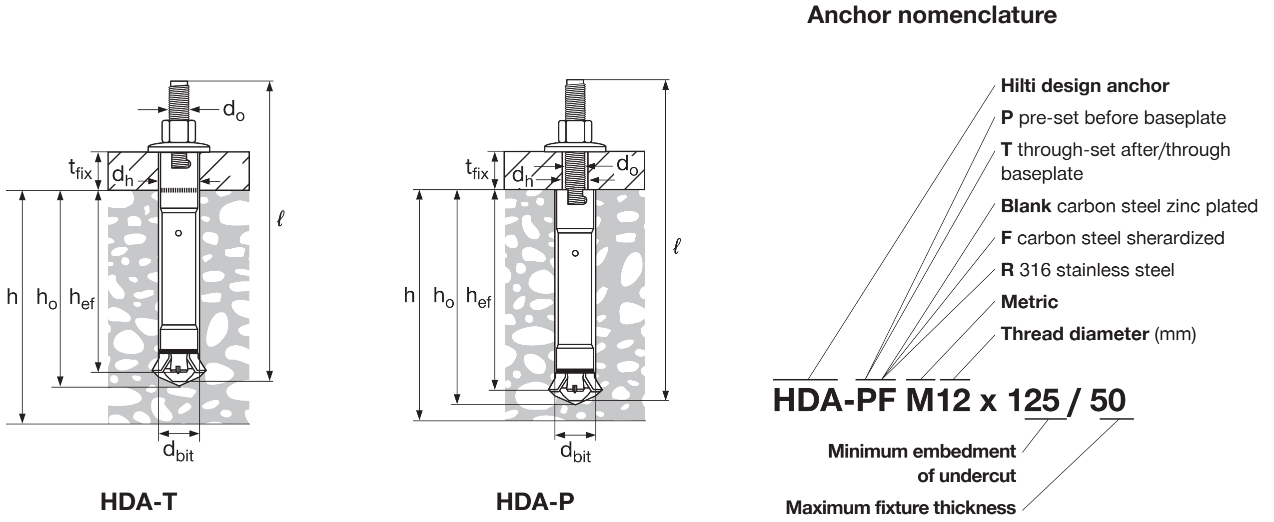
Sleeve for the M16 has a minimum tensile strength of 101.5 ksi (700 MPa).

Nuts and washers are carbon steel.

All carbon steel components have an average zinc plating thickness of 53 µm in accordance with ASTM A153.

INSTALLATION PARAMETERS

Figure 1 — Hilti HDA specifications



Anchor nomenclature

HDA-T

HDA-P

Table 1 — Hilti HDA specifications

			Nominal anchor diameter			
Setting information	Symbol	Units	M10	M12	M16	M20
Cone bolt thread diameter	d_o	mm	10	12	16	20
Nominal bit diameter[1]	d_{bit}	mm	20	22	30	37
Effective minimum embedment	h_{ef}	mm (in.)	100 (3.9)	125 (4.9)	190 (7.5)	250 (9.8)
Hole depth	h_o	mm (in.)	107 (4.2)	135 (5.3)	203 (8.0)	266 (10.5)
Max.fixture thickness, HDA-P	t_{fix}		See Section 3.3.1			
Fixture hole diameter, HDA-P	d_h	mm (in.)	12 (1/2)	14 (9/16)	18 (3/4)	22 (7/8)
Max.fixture thickness, HDA-T	t_{fix}		See Table 5			
Fixture hole diameter, HDA-T	d_h	mm (in.)	21 (7/8)	23 (15/16)	32 (1-1/4)	40 (1-9/16)
Length of anchor	ℓ		See Section 3.3.1			
Minimum concrete member thickness[2]	h_{min}	in. (mm)	7-1/8 (180)	7-1/2 (200)	10-5/8[3] (270)	13-3/4 (350)
Installation torque	T_{inst}	ft-lb (Nm)	37 (50)	59 (80)	89 (120)	221 (300)
Wrench size		mm	17	19	24	30

[1] HDA must be installed with the specified Hilti hammer drill and Hilti metric stop bit. See section 3.3.1.5.

[2] Minimum concrete thickness for HDA-P. For HDA-T, additional thickness needed to account for thin fixture which will increase effective embedment.

[3] When setting the anchor with TE 70, h_{min} ≥ 300mm (11.8 in) for HDA M16.

DESIGN INFORMATION IN CONCRETE PER ACI 318

ACI 318 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-1546 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-1546 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Table 2 — Hilti HDA-P and HDA-T carbon and stainless steel design strength with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter	Effective embed. mm (in.)	Tension - ϕN_n				Shear - ϕV_n			
		f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)"	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
M10	100	7,615	8,345	9,635	11,800	16,405	17,970	20,750	25,415
	(3.9)	(33.9)	(37.1)	(42.9)	(52.5)	(73.0)	(79.9)	(92.3)	(113.1)
M12	125	10,645	11,660	13,465	16,490	22,925	25,115	29,000	35,515
	(4.9)	(47.4)	(51.9)	(59.9)	(73.4)	(102.0)	(111.7)	(129.0)	(158.0)
M16	190	19,945	21,850	25,230	30,900	42,965	47,065	54,345	66,560
	(7.5)	(88.7)	(97.2)	(112.2)	(137.4)	(191.1)	(209.4)	(241.7)	(296.1)
M20	250	30,105	32,980	38,080	46,640	64,845	71,035	82,025	100,460
	(9.8)	(133.9)	(146.7)	(169.4)	(207.5)	(288.4)	(316.0)	(364.9)	(446.9)

Table 3 — Hilti HDA-P and HDA-T carbon and stainless steel design strength with concrete/pullout failure in cracked concrete[1,2,3,4,5]

Nominal anchor diameter	Effective embed. mm (in.)	Tension - ϕN_n				Shear - ϕV_n			
		f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)"	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
M10	100	5,845	6,405	7,395	9,055	13,125	14,375	16,600	20,330
	(3.9)	(26.0)	(28.5)	(32.9)	(40.3)	(58.4)	(63.9)	(73.8)	(90.4)
M12	125	7,305	8,005	9,240	11,320	18,340	20,090	23,200	28,415
	(4.9)	(32.5)	(35.6)	(41.1)	(50.4)	(81.6)	(89.4)	(103.2)	(126.4)
M16	190	14,615	16,005	18,485	22,640	34,370	37,650	43,475	53,245
	(7.5)	(65.0)	(71.2)	(82.2)	(100.7)	(152.9)	(167.5)	(193.4)	(236.8)
M20	250	21,920	24,010	27,725	33,955	51,875	56,830	65,620	80,365
	(9.8)	(97.5)	(106.8)	(123.3)	(151.0)	(230.8)	(252.8)	(291.9)	(357.5)

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 9 as necessary. Compare to the steel values in tables 4 and 5. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For sand-lightweight multiply the design loads by λ_a = 0.68.

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$= 0.75. No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

Table 4 — Steel strength for Hilti HDA-P carbon steel and stainless steel anchors[1,2]

Nominal anchor diameter	HDA-P carbon steel anchors			HDA-PR stainless steel anchors		
	Tensile ϕN_{sa}[3] lb (kN)	Shear ϕV_{sa}[4] lb (kN)	Seismic shear $\phi V_{sa,eq}$[5] lb (kN)	Tensile ϕN_{sa}[3] lb (kN)	Shear ϕV_{sa}[4] lb (kN)	Seismic shear $\phi V_{sa,eq}$[5] lb (kN)
M10	7,830 (34.8)	3,260 (14.5)	2,920 (13.0)	7,830 (34.8)	3,945 (17.5)	3,655 (16.3)
M12	11,395 (50.7)	4,735 (21.1)	4,235 (18.8)	11,395 (50.7)	5,845 (26.0)	5,260 (23.4)
M16	21,140 (94.0)	8,810 (39.2)	7,890 (35.1)	21,140 (94.0)	10,960 (48.8)	9,790 (43.5)
M20	33,060 (147.1)	13,500 (60.1)	12,130 (54.0)	n/a	n/a	n/a

1 See section 3.1.8 to convert design strength value to ASD value.

2 Hilti HDA-P Carbon and Stainless steel anchors are to be considered ductile steel elements.

3 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

4 Shear values determined by static shear tests with $\phi V_{sa} \le \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17.

5 Seismic shear values determined by seismic shear tests with $\phi V_{sa,eq} \le \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17.
See section 3.1.8 for additional information on seismic applications.

Table 5 — Steel strength for Hilti HDA-T carbon steel and stainless steel anchors[1,2]

Nominal anchor diameter	Thickness of fastened parts t_{fix} in. (mm)	HDA-T carbon steel anchors			HDA-TR stainless steel anchors		
		Tensile ϕN_{sa}[3] lb (kN)	Shear ϕV_{sa}[4] lb (kN)	Seismic shear $\phi V_{sa,eq}$[5] lb (kN)	Tensile ϕN_{sa}[3] lb (kN)	Shear ϕV_{sa}[4] lb (kN)	Seismic shear $\phi V_{sa,eq}$[5] lb (kN)
M10	$5/8 \le t_{fix} < 13/16$ $(15 \le t_{fix} \le 20)$	7,830 (34.8)	9,060 (40.3)	8,185 (36.4)	7,830 (34.8)	10,080 (44.8)	9,060 (40.3)
M12	$5/8 \le t_{fix} < 13/16$ $(15 \le t_{fix} < 20)$	11,395 (50.7)	10,815 (48.1)	9,790 (43.5)	11,395 (50.7)	13,155 (58.5)	11,690 (52.0)
	$13/16 \le t_{fix} < 2$ $(20 \le t_{fix} \le 50)$		12,130 (54.0)	10,815 (48.1)		14,465 (64.3)	13,005 (57.8)
M16	$13/16 \le t_{fix} < 1$ $(20 \le t_{fix} < 25)$	21,140 (94.0)	19,875 (88.4)	17,825 (79.3)	21,140 (94.0)	23,235 (103.4)	20,900 (93.0)
	$1 \le t_{fix} < 1\text{-}3/16$ $(25 \le t_{fix} < 30)$		22,505 (100.1)	20,315 (90.4)		24,550 (109.2)	22,065 (98.1)
	$1\text{-}3/16 \le t_{fix} \le 1\text{-}3/8$ $(30 \le t_{fix} < 35)$		24,845 (110.5)	22,355 (99.4)		25,715 (114.4)	23,090 (102.7)
	$1\text{-}3/8 < t_{fix} < 2\text{-}3/8$ $(35 \le t_{fix} \le 60)$		26,885 (119.6)	24,110 (107.2)		26,595 (118.3)	23,965 (106.6)
M20	$1 \le t_{fix} < 1\text{-}9/16$ $(25 \le t_{fix} < 40)$	33,060 (147.1)	29,370 (130.6)	26,450 (117.7)	n/a	n/a	n/a
	$1\text{-}9/16 \le t_{fix} < 2\text{-}1/8$ $(40 \le t_{fix} < 55)$		33,025 (146.9)	29,665 (132.0)			
	$2\text{-}1/8 \le t_{fix} < 4$ $(55 \le t_{fix} \le 100)$		35,510 (158.0)	32,005 (142.4)			

1 See section 3.1.8 to convert design strength value to ASD value.

2 Hilti HDA-T Carbon and Stainless steel anchors are to be considered ductile steel elements.

3 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17

4 Shear values determined by static shear tests with $\phi V_{sa} \le \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17

5 Seismic shear values determined by seismic shear tests with $\phi V_{sa,eq} \le \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17
See section 3.1.8 for additional information on seismic applications.

Table 6 — Load adjustment factors for M10 and M12 Hilti HDA-P and HDA-T carbon and stainless steel anchors in uncracked concrete[1,2]

M10 and M12 HDA-P and HDA-T uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Nominal diameter			M10	M12	M10	M12	M10	M12	M10	M12	M10	M12	M10	M12
Effective embedment h_{ef}		mm (in.)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	3-1/8	(79)	n/a	n/a	0.66	n/a	n/a	n/a	0.14	n/a	0.28	n/a	n/a	n/a
	3-1/2	(89)	n/a	n/a	0.70	n/a	n/a	n/a	0.17	n/a	0.33	n/a	n/a	n/a
	4	(102)	0.67	n/a	0.76	0.66	0.56	n/a	0.20	0.15	0.40	0.31	n/a	n/a
	4-1/2	(114)	0.69	n/a	0.82	0.71	0.56	n/a	0.24	0.18	0.48	0.37	n/a	n/a
	5	(127)	0.71	0.67	0.88	0.76	0.57	0.56	0.28	0.22	0.56	0.43	n/a	n/a
	6	(152)	0.75	0.70	1.00	0.86	0.59	0.57	0.37	0.28	0.74	0.57	n/a	n/a
	7	(178)	0.80	0.74		0.96	0.60	0.58	0.47	0.36	0.93	0.71	n/a	n/a
	7-1/8	(181)	0.80	0.74		0.97	0.60	0.59	0.48	0.37	0.96	0.73	0.64	n/a
	7-1/2	(191)	0.82	0.75		1.00	0.61	0.59	0.52	0.40	1.00	0.79	0.66	n/a
	8	(203)	0.84	0.77			0.61	0.60	0.57	0.44		0.87	0.68	0.62
	9	(229)	0.88	0.80			0.63	0.61	0.68	0.52		1.00	0.72	0.66
	10	(254)	0.92	0.84			0.64	0.62	0.80	0.61			0.76	0.69
	11	(279)	0.97	0.87			0.66	0.63	0.92	0.70			0.79	0.73
	12	(305)	1.00	0.91			0.67	0.64	1.00	0.80			0.83	0.76
	14	(356)		0.97			0.70	0.67		1.00			0.90	0.82
	16	(406)		1.00			0.73	0.69					0.96	0.88
	18	(457)					0.76	0.72					1.00	0.93
	20	(508)					0.79	0.74						0.98
	24	(610)					0.84	0.79						1.00
	30	(762)					0.93	0.86						
	36	(914)					1.00	0.93						
	42	(1067)						1.00						

Table 7 — Load adjustment factors for M10 and M12 Hilti HDA-P and HDA-T carbon and stainless steel anchors in cracked concrete[1,2]

M10 and M12 HDA-P and HDA-T cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Nominal diameter			M10	M12	M10	M12	M10	M12	M10	M12	M10	M12	M10	M12
Effective embedment h_{ef}		mm (in.)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	3-1/8	(79)	n/a	n/a	0.66	n/a	n/a	n/a	0.12	n/a	0.25	n/a	n/a	n/a
	3-1/2	(89)	n/a	n/a	0.70	n/a	n/a	n/a	0.15	n/a	0.29	n/a	n/a	n/a
	4	(102)	0.67	n/a	0.76	0.66	0.55	n/a	0.18	0.14	0.36	0.27	n/a	n/a
	4-1/2	(114)	0.69	n/a	0.82	0.71	0.56	n/a	0.21	0.16	0.43	0.33	n/a	n/a
	5	(127)	0.71	0.67	0.88	0.76	0.57	0.56	0.25	0.19	0.50	0.38	n/a	n/a
	6	(152)	0.75	0.70	1.00	0.86	0.58	0.57	0.33	0.25	0.66	0.50	n/a	n/a
	7	(178)	0.80	0.74		0.96	0.59	0.58	0.42	0.32	0.83	0.64	n/a	n/a
	7-1/8	(181)	0.80	0.74		0.97	0.59	0.58	0.43	0.33	0.86	0.65	0.62	n/a
	7-1/2	(191)	0.82	0.75		1.00	0.60	0.58	0.46	0.35	0.92	0.71	0.63	n/a
	8	(203)	0.84	0.77			0.61	0.59	0.51	0.39	1.00	0.78	0.65	0.60
	9	(229)	0.88	0.80			0.62	0.60	0.61	0.46		0.93	0.69	0.63
	10	(254)	0.92	0.84			0.63	0.61	0.71	0.54		1.00	0.73	0.67
	11	(279)	0.97	0.87			0.65	0.62	0.82	0.63			0.76	0.70
	12	(305)	1.00	0.91			0.66	0.63	0.94	0.71			0.80	0.73
	14	(356)		0.97			0.69	0.66	1.00	0.90			0.86	0.79
	16	(406)		1.00			0.71	0.68		1.00			0.92	0.84
	18	(457)					0.74	0.70					0.98	0.89
	20	(508)					0.77	0.72					1.00	0.94
	24	(610)					0.82	0.77						1.00
	30	(762)					0.90	0.83						
	36	(914)					0.98	0.90						
	42	(1067)					1.00	0.97						
	> 48	(1219)						1.00						

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[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

Table 8 — Load adjustment factors for M16 and M20 Hilti HDA-P and HDA-T carbon and stainless steel anchors in uncracked concrete[1,2]

M16 and M20 HDA-P and HDA-T uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Nominal diameter			M16	M20	M16	M20	M16	M20	M16	M20	M16	M20	M16	M20
Effective embedment h_{ef}		mm (in.)	190 (7.48)	250 (9.84)	190 (7.48)	250 (9.84)	190 (7.48)	250 (9.84)	190 (7.48)	250 (9.84)	190 (7.48)	250 (9.84)	190 (7.48)	250 (9.84)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	6	(152)	n/a	n/a	0.66	n/a	n/a	n/a	0.15	n/a	0.30	n/a	n/a	n/a
	7	(178)	n/a	n/a	0.72	n/a	n/a	n/a	0.19	n/a	0.38	n/a	n/a	n/a
	7-1/8	(181)	n/a	n/a	0.73	n/a	n/a	n/a	0.20	n/a	0.39	n/a	n/a	n/a
	7-1/2	(191)	0.67	n/a	0.75	n/a	0.56	n/a	0.21	n/a	0.42	n/a	n/a	n/a
	8	(203)	0.68	n/a	0.78	0.66	0.56	n/a	0.23	0.15	0.46	0.31	n/a	n/a
	9	(229)	0.70	n/a	0.85	0.71	0.57	n/a	0.28	0.18	0.55	0.37	n/a	n/a
	10	(254)	0.72	0.67	0.91	0.76	0.58	0.56	0.32	0.22	0.65	0.43	n/a	n/a
	11	(279)	0.75	0.69	0.98	0.81	0.59	0.57	0.37	0.25	0.75	0.50	0.59	n/a
	12	(305)	0.77	0.70	1.00	0.86	0.59	0.57	0.43	0.28	0.85	0.57	0.61	n/a
	14	(356)	0.81	0.74		0.96	0.61	0.58	0.54	0.36	1.00	0.71	0.66	0.58
	16	(406)	0.86	0.77		1.00	0.63	0.60	0.66	0.44		0.87	0.71	0.62
	18	(457)	0.90	0.80			0.64	0.61	0.78	0.52		1.00	0.75	0.66
	20	(508)	0.95	0.84			0.66	0.62	0.92	0.61			0.79	0.69
	24	(610)	1.00	0.91			0.69	0.64	1.00	0.80			0.87	0.76
	30	(762)		1.00			0.74	0.68		1.00			0.97	0.85
	36	(914)					0.78	0.72					1.00	0.93
	42	(1067)					0.83	0.75						1.00
	> 48	(1219)					0.88	0.79						

Table 9 — Load adjustment factors for M16 and M20 Hilti HDA-P and HDA-T carbon and stainless steel anchors in cracked concrete[1,2]

M16 and M20 HDA-P and HDA-T cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Nominal diameter			M16	M20	M16	M20	M16	M20	M16	M20	M16	M20	M16	M20
Effective embedment h_{ef}		mm (in.)	190 (7.48)	250 (9.84)	190 (7.48)	250 (9.84)	190 (7.48)	250 (9.84)	190 (7.48)	250 (9.84)	190 (7.48)	250 (9.84)	190 (7.48)	250 (9.84)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	6	(152)	n/a	n/a	0.66	n/a	n/a	n/a	0.13	n/a	0.27	n/a	n/a	n/a
	7	(178)	n/a	n/a	0.72	n/a	n/a	n/a	0.17	n/a	0.34	n/a	n/a	n/a
	7-1/8	(181)	n/a	n/a	0.73	n/a	n/a	n/a	0.17	n/a	0.35	n/a	n/a	n/a
	7-1/2	(191)	0.67	n/a	0.75	n/a	0.55	n/a	0.19	n/a	0.38	n/a	n/a	n/a
	8	(203)	0.68	n/a	0.78	0.66	0.56	n/a	0.21	0.14	0.41	0.27	n/a	n/a
	9	(229)	0.70	n/a	0.85	0.71	0.57	n/a	0.25	0.16	0.49	0.33	n/a	n/a
	10	(254)	0.72	0.67	0.91	0.76	0.57	0.56	0.29	0.19	0.58	0.38	n/a	n/a
	11	(279)	0.75	0.69	0.98	0.81	0.58	0.56	0.33	0.22	0.67	0.44	0.57	n/a
	12	(305)	0.77	0.70	1.00	0.86	0.59	0.57	0.38	0.25	0.76	0.50	0.59	n/a
	14	(356)	0.81	0.74		0.96	0.60	0.58	0.48	0.32	0.96	0.64	0.64	0.56
	16	(406)	0.86	0.77		1.00	0.62	0.59	0.59	0.39	1.00	0.78	0.68	0.60
	18	(457)	0.90	0.80			0.63	0.60	0.70	0.46		0.93	0.72	0.63
	20	(508)	0.95	0.84			0.65	0.61	0.82	0.54		1.00	0.76	0.67
	24	(610)	1.00	0.91			0.68	0.63	1.00	0.71			0.84	0.73
	30	(762)		1.00			0.72	0.67		1.00			0.94	0.82
	36	(914)					0.76	0.70					1.00	0.89
	42	(1067)					0.81	0.73						0.97
	> 48	(1219)					0.85	0.77						1.00

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

DESIGN INFORMATION IN CONCRETE PER ACI 318

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-1546. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

Table 10 — Steel resistance for Hilti HDA-P carbon steel and stainless steel anchors[1,2]

Nominal anchor diameter	HDA-P carbon steel anchors			HDA-PR stainless steel anchors		
	Tensile[3] N_{sar} lb (kN)	Shear[4] V_{sar} lb (kN)	Seismic shear[5] $V_{sar,eq}$ lb (kN)	Tensile[3] N_{sar} lb (kN)	Shear[4] V_{sar} lb (kN)	Seismic shear[5] $V_{sar,eq}$ lb (kN)
M10	7,100 (31.6)	3,195 (14.2)	2,865 (12.7)	7,100 (31.6)	3,870 (17.2)	3,585 (15.9)
M12	10,335 (46.0)	4,645 (20.7)	4,155 (18.5)	10,335 (46.0)	5,730 (25.5)	5,160 (23.0)
M16	19,170 (85.3)	8,640 (38.4)	7,740 (34.4)	19,170 (85.3)	10,750 (47.8)	9,600 (42.7)
M20	29,975 (133.3)	13,240 (58.9)	11,895 (52.9)	n/a	n/a	n/a

1 See section 3.1.8 to convert design strength value to ASD value.

2 Hilti HDA-P/-PR anchors are to be considered ductile steel elements.

3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.

4 Shear determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3, Annex D.

5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3, Annex D.
See Section 3.1.8 for additional information on seismic applications.

Table 11 — Steel resistance for Hilti HDA-T carbon steel and stainless steel anchors[1,2]

Nominal anchor diameter	Thickness of fastened parts t_{fix} in. (mm)	HDA-T carbon steel anchors			HDA-TR stainless steel anchors		
		Tensile[3] N_{sar} lb (kN)	Shear[4] V_{sar} lb (kN)	Seismic shear[5] $V_{sar,eq}$ lb (kN)	Tensile[3] N_{sar} lb (kN)	Shear[4] V_{sar} lb (kN)	Seismic shear[5] $V_{sar,eq}$ lb (kN)
M10	$5/8 \le t_{fix} < 13/16$ $(15 \le t_{fix} \le 20)$	7,100 (31.6)	8,885 (39.5)	8,025 (35.7)	7,100 (31.6)	9,890 (44.0)	8,885 (39.5)
M12	$5/8 \le t_{fix} < 13/16$ $(15 \le t_{fix} < 20)$	10,335 (46.0)	10,605 (47.2)	9,600 (42.7)	10,335 (46.0)	12,900 (57.4)	11,465 (51.0)
	$13/16 \le t_{fix} < 2$ $(20 \le t_{fix} \le 50)$		11,895 (52.9)	10,605 (47.2)		14,190 (63.1)	12,755 (56.7)
M16	13/16 ≤ tfix < 1 $(20 \le t_{fix} < 25)$	19,170 (85.3)	19,490 (86.7)	17,485 (77.8)	19,170 (85.3)	22,785 (101.4)	20,495 (91.2)
	$1 \le t_{fix} < 1\text{-}3/16$ $(25 \le t_{fix} < 30)$		22,070 (98.2)	19,920 (88.6)		24,080 (107.1)	21,640 (96.3)
	$1\text{-}3/16 \le t_{fix} \le 1\text{-}3/8$ $(30 \le t_{fix} < 35)$		24,365 (108.4)	21,925 (97.5)		25,225 (112.2)	22,645 (100.7)
	$1\text{-}3/8 < t_{fix} < 2\text{-}3/8$ $(35 \le t_{fix} \le 60)$		26,370 (117.3)	23,650 (105.2)		26,085 (116.0)	23,505 (104.6)
M20	$1 \le t_{fix} < 1\text{-}9/16$ $(25 \le t_{fix} < 40)$	29,975 (133.3)	28,805 (128.1)	25,940 (115.4)	N/A	N/A	N/A
	$1\text{-}9/16 \le t_{fix} < 2\text{-}1/8$ $(40 \le t_{fix} < 55)$		32,390 (144.1)	29,090 (129.4)			
	$2\text{-}1/8 \le t_{fix} < 4$ $(55 \le t_{fix-} \le 100)$		34,825 (154.9)	31,385 (139.6)			

1 See section 3.1.8 to convert design strength value to ASD value.

2 Hilti T/-TR anchors are to be considered ductile steel elements.

3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3, Annex D.

4 Shear determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3, Annex D.

5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3, Annex D.
See Section 3.1.8 for additional information on seismic applications.

Table 12 — Hilti HDA carbon and stainless steel design information in accordance with CSA A23.3[1]

Design parameter	Symbol	Units	Nominal anchor diameter							Ref A23.3
			M10		M12		M16		M20	
			HDA	HDA-R	HDA	HDA-R	HDA	HDA-R	HDA	
Anchor O.D.	d_a	mm	19		21		29		35	
		(in)	(0.75)		(0.83)		(1.14)		(1.38)	
Effective minimum embedment[2]	h_{ef}	mm	100		125		190		250	
		(in)	(3.94)		(4.92)		(7.48)		(9.84)	
Min. concrete thickness	h_{min}	-	See tables 1 of this section, or 3A and 3B of ESR-1546							
Critical edge distance	c_{ac}	-	1.5 x hef : See section 4.1.11 of ESR-1546							
Min. edge distance	c_{min}	mm	80		100		150		200	
		(in)	(3.15)		(3.94)		(5.91)		(7.87)	
Min. anchor spacing	s_{min}	mm	100		125		190		250	
		(in)	(3.94)		(4.92)		(7.48)		(9.84)	
Min. specified yield strength	f_{ya}	psi	92,800							
		(N/mm^2)	(640)							
Min. specified ult. strength	f_{uta}	psi	116,000							
		(N/mm^2)	(800)							
Effective tensile stress area	$A_{se,N}$	in^2	0.090		0.131		0.243		0.380	
		(mm^2)	(58.1)		(84.5)		(156.8)		(245.2)	
Steel embed. material resistance factor for reinforcement	ϕ_s	-	0.85							8.4.3
Resistance modification factor for tension, steel failure modes[3]	R	-	0.80							D.5.3
Resistance modification factor for shear, steel failure modes[3]	R	-	0.75							D.5.3
Factored steel resistance in tension	N_{sar}	-	See tables 10 and 11 of this section							D.6.1.2
Factored steel resistance in shear	V_{sar}	-	See tables 10 and 11 of this section							D.7.1.2
Factored steel resistance in shear, seismic	$V_{sar,eq}$	-	See tables 10 and 11 of this section							
Coeff. for factored concrete breakout resistance, uncracked concrete	$k_{c,uncr}$	-	12.5							D.6.2.2
Coeff. for factored concrete breakout resistance, cracked concrete	$k_{c,cr}$	-	10							D.6.2.2
Modification factor for anchor resistance, tension, uncracked concrete[4]	$\psi_{c,N}$	-	1.0							D.6.2.6
Anchor category	-	-	1							D.5.3 (c)
Concrete material resistance factor	ϕ_c	-	0.65							8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]	R	-	1.00							D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete[6]	$N_{pr,uncr}$	lb (kN)	N/A							D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete[6]	$N_{pr,cr}$	lb	6,295		7,870		15,745		23,615	D.6.3.2
		(kN)	(28.0)		(35.0)		(70.0)		(105.0)	

1 Design information in this table is taken from ICC-ES ESR-1546, dated March 2020 and converted for use with CSA A23.3 Annex D.

2 See figure 1 of this section.

3 The HDA is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 Chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-1546 for additional information.

Table 13 — Hilti HDA-P and HDA-T carbon and stainless steel factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter	Effective embed. mm (in.)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
M10	100	8,170	9,135	10,005	11,550	16,335	18,265	20,010	23,105
	(3.94)	(36.3)	(40.6)	(44.5)	(51.4)	(72.7)	(81.3)	(89.0)	(102.8)
M12	125	11,415	12,765	13,980	16,145	22,830	25,525	27,965	32,290
	(4.92)	(50.8)	(56.8)	(62.2)	(71.8)	(101.6)	(113.6)	(124.4)	(143.6)
M16	190	21,395	23,920	26,200	30,255	42,785	47,840	52,405	60,510
	(7.48)	(95.2)	(106.4)	(116.6)	(134.6)	(190.3)	(212.8)	(233.1)	(269.2)
M20	250	32,290	36,100	39,545	45,665	64,580	72,200	79,095	91,330
	(9.84)	(143.6)	(160.6)	(175.9)	(203.1)	(287.3)	(321.2)	(351.8)	(406.3)

Table 14 — Hilti HDA-P and HDA-T carbon and stainless steel factored resistance with concrete/pullout failure in cracked concrete[1,2,3,4,5]

Nominal anchor diameter	Effective embed. mm (in.)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
M10	100	6,295	7,040	7,710	8,905	13,070	14,615	16,005	18,485
	(3.94)	(28.0)	(31.3)	(34.3)	(39.6)	(58.1)	(65.0)	(71.2)	(82.2)
M12	125	7,870	8,800	9,640	11,130	18,265	20,420	22,370	25,830
	(4.92)	(35.0)	(39.1)	(42.9)	(49.5)	(81.3)	(90.8)	(99.5)	(114.9)
M16	190	15,745	17,600	19,280	22,265	34,230	38,270	41,925	48,410
	(7.48)	(70.0)	(78.3)	(85.8)	(99.0)	(152.3)	(170.2)	(186.5)	(215.3)
M20	250	23,615	26,400	28,920	33,395	51,665	57,760	63,275	73,065
	(9.84)	(105.0)	(117.4)	(128.6)	(148.5)	(229.8)	(256.9)	(281.5)	(325.0)

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 9 as necessary. Compare to the steel values in tables 10 and 11. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

INSTALLATION AND REMOVAL INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance.

HDA Undercut Anchors are fully removable. The removal process strips the anchor threads to prevent reuse of anchors for safety purposes.

Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in IFU.

ORDERING INFORMATION

HDA-T anchor

Description	HDA-T	HDA-TF	HDA-TR	HDA	Stop drill bit	Diamond core bit[1]	Setting tool
bolt dia. x h_{ef} / $t_{fix,max}$ overall length ℓ	Galvanized	Sherardised	316 Stainless	Box Qty	Description (mm) dia. x drill depth	Diameter (mm)	Description
M10x100/20 150 mm	●	●	●	12	TE-C-B20x120 TE-Y-B20x120	20	TE-C-ST 20 M10 TE-Y-ST 20 M10
M12x125/30 190 mm	●	●	●	8	TE-C-B22x155 TE-Y-B22x155	22	TE-C-ST 22 M12 TE-Y-ST 22 M12
M12x125/50 210 mm	●	●	●	8	TE-C-B22x175 TE-Y-B22x175	22	TE-C-ST 22 M12 TE-Y-ST 22 M12
M16x190/40 275 mm	●	●	●	4	TE-Y B30x230	30	TE-Y-ST 30 M16
M16x190/60 295 mm	●	●	●	4	TE-Y B30x250		
M20x250/50 360 mm	●			2	TE-Y B37x300	37	TE-Y-ST 37 M20
M20x250/100 410 mm	●			2	TE-Y B37x350		

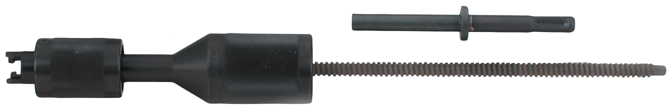
1 The drilling depth with the diamond core bit must not exceed 2/3 of the specified minimum drill hole depth. The last 1/3 of the drill hole depth must be completed with the specified hammer drill and stop drill bit. Always consult the engineer of record before cutting rebar.

HDA-P anchor

Description	HDA-P	HDA-PF	HDA-PR	HDA	Stop drill bit	Diamond core bit[1]	Setting tool
bolt dia. x h_{ef} / $t_{fix,max}$ overall length ℓ	Galvanized	Sherardised	316 Stainless	Box Qty	Description (mm) dia. x drill depth	Diameter (mm)	Description
M10x100/20 150 mm	●	●	●	12	TE-C B20x100 TE-Y B20x100	20	TE-C-ST 20 M10 TE-Y-ST 20 M10
M12x125/30 190 mm	●	●	●	8	TE-C B22x125 TE-Y B22x125	22	TE-C-ST 22 M12 TE-Y-ST 22 M12
M12x125/50 210 mm	●	●	●	8	TE-C-B22x125 TE-Y-B22x125	22	TE-C-ST 22 M12 TE-Y-ST 22 M12
M16x190/40 275 mm	●	●	●	4	TE-Y B30x190	30	TE-Y-ST 30 M16
M16x190/60 295 mm	●	●	●	4			
M20x250/50 360 mm	●			2	TE-Y B37x250	37	TE-Y-ST 37 M20
M20x250/100 410 mm	●			2			

1 The drilling depth with the diamond core bit must not exceed 2/3 of the specified minimum drill hole depth. The last 1/3 of the drill hole depth must be completed with the specified hammer drill and stop drill bit. Always consult the engineer of record before cutting rebar.

Removal tool with adapter



Description	Qty/pkg	Applicable anchor sizes
TE-C-HDA-RT 20-M10	1	HDA M10
TE-C-HDA-RT 22-M12	1	HDA M12
TE-C-HDA-RT 30-M16	1	HDA M16
TE-C-HDA-RT 37-M20	1	HDA M20

HAMMER DRILLS REQUIRED FOR SETTING HDA ANCHORS

HDA carbon steel — zinc plated

Anchor	Hilti hammer drill[1]								
	TE 25 (1st gear)	TE 36-A	TE 40/40-AVR	TE 56/56-ATC	TE 60-ATC	TE 70[2]/70-ATC	TE 75	TE-76/76-ATC	TE 80-ATC
	connection end								
	TE-C			TE-Y					
HDA-P M10x100/20	●	●	●	●	●				
HDA-T M10x100/20	●	●	●	●	●				
HDA-P M12x125/30	●	●	●	●	●				
HDA-T M12x125/30	●	●	●	●	●				
HDA-P M12x125/50	●	●	●	●	●				
HDA-T M12x125/50	●	●	●	●	●				
HDA-P M16x190/40						●	●	●	●
HDA-T M16x190/40						●	●	●	●
HDA-P M16x190/60						●	●	●	●
HDA-T M16x190/60						●	●	●	●
HDA-P M20x250/50						●		●	●
HDA-T M20x250/50						●		●	●
HDA-P M20x250/100						●		●	●
HDA-T M20x250/100						●		●	●

HDA-R stainless steel

Anchor	Hilti hammer drill[1]								
	TE 25 (1st gear)	TE 36-A	TE 40/40-AVR	TE 56/56-ATC	TE 60-ATC	TE 70[2]/70-ATC	TE 75	TE-76/76-ATC	TE 80-ATC
	connection end								
	TE-C			TE-Y					
HDA-PR M10x100/20	●	●	●						
HDA-TR M10x100/20	●	●	●	●	●				
HDA-PR M12x125/30	●	●	●	●	●				
HDA-TR M12x125/30	●	●	●	●	●				
HDA-PR M12x125/50	●	●	●	●	●				
HDA-TR M12x125/50	●	●	●	●	●				
HDA-PR M16x190/40						●	●	●	●
HDA-PR M16x190/60						●	●	●	●
HDA-PR M16x190/60						●	●	●	●
HDA-TR M16x190/60						●	●	●	●

HDA-F carbon steel — sherardized (heavy-duty galvanization)

Anchor	Hilti hammer drill[1]								
	TE 25 (1st gear)	TE 36-A	TE 40/40-AVR	TE 56/56-ATC	TE 60-ATC	TE 70[2]/70-ATC	TE 75	TE-76/76-ATC	TE 80-ATC
	connection end								
	TE-C			TE-Y					
HDA-PFM10x100/20		●	●		●				
HDA-TF M10x100/20		●	●		●				
HDA-PF M12x125/30		●	●		●				
HDA-TF M12x125/30		●	●		●				
HDA-PF M12x125/50		●	●		●				
HDA-TF M12x125/50		●	●		●				
HDA-PF M16x190/40						●	●	●	●
HDA-TF M16x190/40						●	●	●	●
HDA-PF M16x190/60						●	●	●	●
HDA-TF M16x190/60						●	●	●	●

1 To ensure IBC compliance, reference ESR-1546 or contact Hilti Technical Support.

2 Increase h_{min} when setting the HDA M16 with the TE 70. See Table 1 of this section, or ESR-1546 Table 3A and 3B.

3.3.2 HSL4 HEAVY-DUTY EXPANSION ANCHORS

PRODUCT DESCRIPTION

Anchor system

HSL4 Heavy-duty
Expansion Anchor

HSL4-B
Heavy-duty
Expansion Anchor
with Torque Cap

HSL4-G
Heavy-duty
Expansion Anchor
with Threaded Rod

HSL4-SK
Countersunk version
available as special

Features and benefits

- Approved for use in the concrete tension zone (cracked concrete)
- Approved for use with cored drilled holes using the Hilti diamond coring tool, DD-30 or DD-EC-1 with the SPX-T core bits or with the Hilti Diamond Coring Tool DD-110 to DD-250 with the SPPX-H, SPX-L or SPX-L Handheld core bits
- Data for use with the Strength Design provisions of ACI 318 Chapter 17 and ACI 349 Appendix B
- High load capacity
- Force-controlled expansion which allows for follow-up expansion
- Suitable for dynamic loading, including seismic[1], fatigue and shock
- No spinning of the anchor in hole when tightening bolt or nut
- Seismic qualification per ICC-ES AC193 and the requirements of ACI 318 Chapter 17

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[1] HSL4-G M24 is not approved for seismic design.

Uncracked concrete

Cracked concrete

Diamond cored holes
for cracked and
uncracked concrete

Seismic Design
Categories
A-F

Profis Anchor design
software

Hollow Drill Bit

Approvals/Listings	
ICC-ES (International Code Council)	ESR-4386 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193
European Technical Approval	ETA-19/0556
City of Los Angeles	2020 LABC Supplement (within ESR-4386)
Nuclear Quality Assurance	Qualified under NQA-1 Nuclear Quality Program

MATERIAL SPECIFICATIONS

Carbon steel bolt or threaded rod for HSL4, HSL4-G, HSL4-B and HSL4-SK conform to the steel strength requirements of ISO 898-1, grade 8 .8, f_{ya} > 93 ksi, f_{uta} > 116 ksi.

Nut, washer, expansion cone, expansion sleeve and spacing sleeve are all made of carbon steel.

Collapsible sleeve is made from acetal polyoxymethylene (POM) resin and thermoplastic elastomer (TPE).

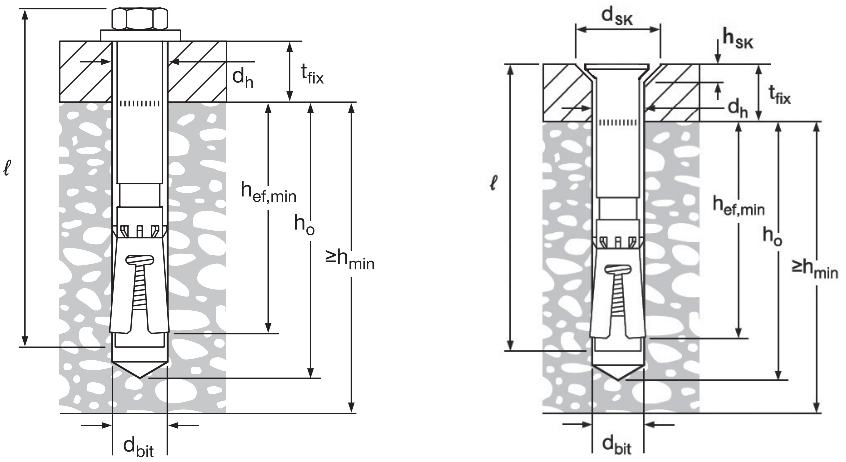
INSTALLATION PARAMETERS

Table 1 — HSL4 Specifications

Details			HSL4 anchor thread diameter													
			M8		M10		M12			M16			M20		M24	
Nominal drill bit diameter[1]	d_{bit}	mm	12		15		18			24			28		32	
Minimum concrete thickness	h_{min}	mm (in.)	See table 5													
Minimum hole depth	h_o	mm (in.)	80 (3-1/8)		90 (3-1/2)		105 (4-1/8)			125 (4-7/8)			155 (6-1/8)		180 (7-1/8)	
Effective minimum embedment	$h_{ef,min}$	mm (in.)	60 (2-3/8)		70 (2-3/4)		80 (3-1/8)			100 (3-7/8)			125 (4-7/8)		150 (5-7/8)	
Fixture hole diameter	d_h	mm (in.)	14 (9/16)		17 (11/16)		20 (13/16)			26 (1)			31 (1-1/4)		35 (1-3/8)	
Maximum thickness of part fastened HSL4, HSL4-B	t_{fix}	mm (in.)	20 (3/4)	40 (1-1/2)	20 (3/4)	40 (1-1/2)	5 (1/5)	25 (1)	50 (2)	10 (2/5)	25 (1)	50 (2)	30 (1-1/8)	60 (2-1/4)	30 (1-1/8)	60 (2-1/4)
Maximum thickness of part fastened HSL4-G	t_{fix}	mm (in.)	20 (3/4)		20 (3/4)	100 (4)	25 (1)	50 (2)		25 (1)	50 (2)		30 (1-1/8)	60 (2-1/4)	– –	– –
Washer diameter	d_w	mm (in.)	20 (3/4)		25 (1)		30 (1-1/8)			40 (1-9/16)			45 (1-3/4)		50 (2)	
Installation torque HSL4	T_{inst}	Nm (ft-lb)	15 (11)		25 (18)		60 (44)			75 (55)			145 (107)		210 (155)	
Installation torque HSL4-G	T_{inst}	Nm (ft-lb)	20 (15)		27 (20)		60 (44)			70 (52)			105 (77)		180 (132)	
Installation torque HSL4-SK	T_{inst}	Nm (ft-lb)	25 (18)		32 (24)		65 (48)			–			–		–	
Wrench size HSL4, HSL4-G	SW	mm	13		17		19			24			30		36	
Wrench size HSL4-B	SW	mm	–		–		24			30			36		41	
Wrench size HSL4-SK	SW	mm	5		6		8			–			–		–	
Diameter of countersunk hole HSL4-SK	d_{sk}	mm	22.5		25.5		32.9			–			–		–	

[1] Use metric bits only.

Figure 1



DESIGN DATA IN CONCRETE PER ACI 318

ACI 318 Chapter 17 Design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-4386 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8 of the North American Product Technical Guide, Volume 2: Anchor Fastening Technical Guide, Edition 22 (PTG Ed. 21). Data tables from ESR-4386 are not contained in this section but can be found at www.icc-es.org or at www.hilti.com.

Table 2 — Hilti HSL4 design strength with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter	Effective embed. mm (in.)	Tension - ϕN_n				Shear - ϕV_n			
		f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
M8	60 (2.4)	2,735 (12.2)	2,995 (13.3)	3,455 (15.4)	4,235 (18.8)	3,050 (13.6)	3,340 (14.9)	3,860 (17.2)	4,725 (21.0)
M10	70 (2.8)	3,570 (15.9)	3,910 (17.4)	4,515 (20.1)	5,530 (24.6)	7,685 (34.2)	8,420 (37.5)	9,720 (43.2)	11,905 (53.0)
M12	80 (3.2)	4,360 (19.4)	4,775 (21.2)	5,515 (24.5)	6,755 (30.0)	9,390 (41.8)	10,285 (45.7)	11,880 (52.8)	14,550 (64.7)
M16	100 (3.9)	6,095 (27.1)	6,675 (29.7)	7,705 (34.3)	9,440 (42.0)	13,125 (58.4)	14,375 (63.9)	16,600 (73.8)	20,330 (90.4)
M20	125 (4.9)	8,515 (37.9)	9,330 (41.5)	10,770 (47.9)	13,190 (58.7)	18,340 (81.6)	20,090 (89.4)	23,200 (103.2)	28,415 (126.4)
M24	150 (5.9)	11,195 (49.8)	12,260 (54.5)	14,160 (63.0)	17,340 (77.1)	24,110 (107.2)	26,410 (117.5)	30,495 (135.6)	37,350 (166.1)

Table 3 — Hilti HSL4 design strength with concrete / pullout failure in cracked concrete[1,2,3,4,5]

Nominal anchor diameter	Effective embed. mm (in.)	Tension - ϕN_n				Shear - ϕV_n			
		f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
M8	60 (2.4)	1,825 (8.1)	2,000 (8.9)	2,310 (10.3)	2,830 (12.6)	2,160 (9.6)	2,365 (10.5)	2,730 (12.1)	3,345 (14.9)
M10	70 (2.8)	2,920 (13.0)	3,200 (14.2)	3,695 (16.4)	4,525 (20.1)	7,685 (34.2)	8,420 (3 .5)	9,720 (43.2)	11,905 (53.0)
M12	80 (3.2)	4,360 (19.4)	4,775 (21.2)	5,515 (24.5)	6,755 (30.0)	9,390 (41.8)	10,285 (45.7)	11,880 (52.8)	14,550 (64.7)
M16	100 (3.9)	6,095 (27.1)	6,675 (29.7)	7,705 (34.3)	9,440 (42.0)	13,125 (58.4)	14,375 (63.9)	16,600 (73.8)	20,330 (90.4)
M20	125 (4.9)	8,515 (37.9)	9,330 (41.5)	10,770 (47.9)	13,190 (58.7)	18,340 (81.6)	20,090 (89.4)	23,200 (103.2)	28,415 (126.4)
M24[5]	150 (5 .9)	11,195 (49.8)	12,260 (54.5)	14,160 (63.0)	17,340 (77.1)	24,110 (107.2)	26,410 (117.5)	30,495 (135.6)	37,350 (166.1)

[1] See PTG Ed. 21 section 3.1.8 to convert design strength value to ASD value.

[2] Linear interpolation between concrete compressive strengths is not permitted.

[3] Apply spacing, edge distance, and concrete thickness factors in tables 5 to 8 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.

[4] Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0 .60.

[5] Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For all seismic tension loads for all other anchors, multiply cracked concrete tabular values in tension only by the following reduction factors:
M24 - $\alpha_{N,seis}$ = 0 .62. HSL4-G M24 is not approved for seismic design.
All other sizes - $\alpha_{N,seis}$ = 0.75
No reduction needed for seismic shear. See PTG Ed. 21 section 3.1.8 for additional information on seismic applications.

Table 4 — Steel strength for Hilti HSL4 anchors[1,2]

Nominal anchor diameter	HSL4, HSL4-B, HSL4-SK			HSL4-G		
	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic shear[5] $\phi V_{sa,eq}$ lb (kN)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic shear[5] $\phi V_{sa,eq}$ lb (kN)
M8	4,960 (22 .1)	4,705 (20 .9)	2,995 (13 .3)	4,960 (22 .1)	3,945 (17 .5)	2,455 (10 .9)
M10	7,830 (34 .8)	6,650 (29 .6)	5,495 (24 .4)	7,830 (34 .8)	5,450 (24 .2)	4,500 (20 .0)
M12	11,395 (50 .7)	9,570 (42 .6)	7,730 (34 .4)	11,395 (50 .7)	7,905 (35 .2)	6,385 (28 .4)
M16	21,140 (94 .0)	17,360 (77 .2)	16,115 (71 .7)	21,140 (94 .0)	14,745 (65 .6)	13,690 (60 .9)
M20	33,060 (147 .1)	25,690 (114 .3)	18,940 (84 .2)	33,060 (147 .1)	21,555 (95 .9)	15,900 (70 .7)
M24	47,590 (211 .7)	29,870 (132 .9)	24,810 (110 .4)	47,590 (211 .7)	28,060 (124 .8)	n/a

1 See PTG Ed. 21 section 3.1.8 to convert design strength value to ASD value.
2 Hilti HSL4 Carbon Steel anchors are to be considered ductile steel elements.
3 Tensile $\phi N_{sa} = \phi_{Ase,N} f_{uta}$ as noted in ACI 318 Chapter 17
4 Shear values determined by static shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa,\ eq} \leq \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17
See PTG Ed. 21 section 3.1.8 for additional information on seismic applications.

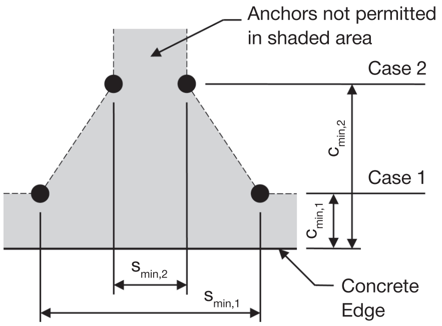
Table 5 — Edge distance, spacing and member thickness requirements[1]

Condition	Dimensional parameter		Symbol	Units	Nominal anchor diameter					
					M8	M10	M12	M16	M20	M24
A	Minimum concrete thickness		h_{min}	in. (mm)	4-3/4 (120)	5-1/2 (140)	6-1/4 (160)	7-7/8 (200)	9-7/8 (250)	11-7/8 (300)
	Critical edge distance		c_{ac}	in. (mm)	4-3/8 (110)	4-3/8 (110)	4-3/4 (120)	5-7/8 (150)	8-7/8 (225)	8-7/8 (225)
	Case 1	Minimum edge distance	$c_{min,1}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/2 (90)	4-3/4 (120)	5 (125)	5-7/8 (150)
		Minimum anchor spacing	$s_{min,1}$	in. (mm)	5-1/2 (140)	9-1/2 (240)	11 (280)	12-5/8 (320)	13-3/4 (350)	11-7/8 (300)
	Case 2	Minimum edge distance	$c_{min,2}$	in. (mm)	3-3/8 (85)	5 (125)	6-1/8 (155)	7-7/8 (200)	8-1/4 (210)	8-1/4 (210)
		Minimum anchor spacing	$s_{min,2}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (80)	4 (100)	5 (125)	5-7/8 (150)
B	Minimum concrete thickness		h_{min}	in. (mm)	4-3/8 (110)	4-3/4 (120)	5-3/8 (135)	6-1/4 (160)	7-1/2 (190)	8-7/8 (225)
	Critical edge distance		c_{ac}	in. (mm)	5-7/8 (150)	6-7/8 (175)	7-7/8 (200)	9-7/8 (250)	12-3/8 (312 .5)	14-3/4 (375)
	Case 1	Minimum edge distance	$c_{min,1}$	in. (mm)	2-3/8 (60)	3-1/2 (90)	4-3/8 (110)	6-1/4 (160)	7-7/8 (200)	8-7/8 (225)
		Minimum anchor spacing	$s_{min,1}$	in. (mm)	7 (180)	10-1/4 (260)	12-5/8 (320)	15 (380)	15-3/4 (400)	15 (380)
	Case 2	Minimum edge distance	$c_{min,2}$	in. (mm)	4 (100)	6-1/4 (160)	7-7/8 (200)	10-5/8 (270)	11-7/8 (300)	12-5/8 (320)
		Minimum anchor spacing	$s_{min,2}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (80)	4 (100)	5 (125)	5-7/8 (150)

[1] Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacing s as follows:

$$S \geq S_{min,2} + \frac{\left(S_{min,1} - S_{min,2}\right)}{\left(C_{min,1} - C_{min,2}\right)}\left(C - C_{min,2}\right)$$

Figure 2



For a specific edge distance, the permitted spacing is calculated as follows:

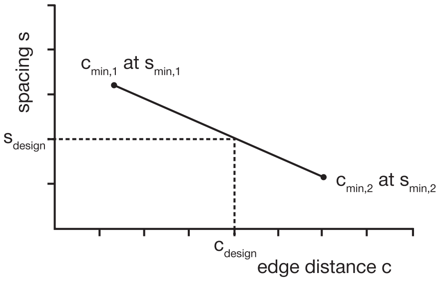


Table 6 — Load adjustment factors for M8, M10, and M12 Hilti HSL4 anchors in uncracked concrete[1,2]

M8, M10 and M12 HSL4 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			II to and away from edge f_{RV}					
Nominal dia.			M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12
Effective embedment h_{ef}		in. (mm)	2.38 (60)	2.76 (70)	3.15 (80)	2.36 (60)	2.76 (70)	3.15 (80)	2.38 (60)	2.76 (70)	3.15 (80)	2.38 (60)	2.76 (70)	3.15 (80)	2.38 (60)	2.76 (70)	3.15 (80)	2.38 (60)	2.76 (70)	3.15 (80)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in (mm)	2-3/8	(60)	0.67	n/a	n/a	0.45	n/a	n/a	0.58	n/a	n/a	0.32	n/a	n/a	0.45	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	0.68	n/a	n/a	0.47	n/a	n/a	0.58	n/a	n/a	0.35	n/a	n/a	0.47	n/a	n/a	n/a	n/a	n/a
	2-3/4	(70)	0.69	0.67	n/a	0.50	0.45	n/a	0.59	0.55	n/a	0.40	0.18	n/a	0.50	0.36	n/a	n/a	n/a	n/a
	3	(76)	0.71	0.68	n/a	0.53	0.48	n/a	0.60	0.56	n/a	0.46	0.20	n/a	0.53	0.41	n/a	n/a	n/a	n/a
	3-1/8	(79)	0.72	0.69	0.67	0.55	0.49	n/a	0.60	0.56	0.56	0.49	0.22	n/a	0.55	0.44	n/a	n/a	n/a	n/a
	3-1/2	(89)	0.75	0.71	0.69	0.60	0.53	0.48	0.62	0.57	0.56	0.58	0.26	0.23	0.60	0.52	0.46	n/a	n/a	n/a
	4	(102)	0.78	0.74	0.71	0.68	0.59	0.53	0.63	0.58	0.57	0.71	0.32	0.28	0.71	0.59	0.53	n/a	n/a	n/a
	4-3/8	(111)	0.81	0.76	0.73	0.74	0.64	0.56	0.65	0.58	0.58	0.81	0.36	0.32	0.81	0.64	0.56	0.76	n/a	n/a
	4-1/2	(114)	0.82	0.77	0.74	0.77	0.65	0.58	0.65	0.59	0.58	0.85	0.38	0.34	0.85	0.65	0.58	0.77	n/a	n/a
	4-3/4	(121)	0.84	0.79	0.75	0.81	0.69	0.60	0.66	0.59	0.59	0.92	0.41	0.37	0.92	0.69	0.60	0.79	0.61	n/a
	5	(127)	0.85	0.80	0.76	0.85	0.73	0.63	0.67	0.60	0.59	0.99	0.44	0.40	0.99	0.73	0.63	0.81	0.62	n/a
	5-3/8	(137)	0.88	0.83	0.78	0.91	0.78	0.68	0.68	0.60	0.60	1.00	0.49	0.44	1.00	0.78	0.68	0.84	0.64	0.62
	6	(152)	0.92	0.86	0.82	1.00	0.87	0.76	0.70	0.62	0.61		0.58	0.52		0.87	0.76	0.89	0.68	0.66
	7	(178)	0.99	0.92	0.87		1.00	0.89	0.73	0.64	0.63		0.73	0.65		1.00	0.89	0.96	0.73	0.71
	8	(203)	1.00	0.98	0.92			1.00	0.77	0.65	0.64		0.89	0.80			1.00	1.00	0.79	0.76
	9	(229)		1.00	0.98				0.80	0.67	0.66		1.00	0.95					0.83	0.80
	10	(254)		1.00	1.00				.083	0.69	0.68			1.00					0.88	0.85
	12	(305)		1.00	1.00				0.90	0.73	0.72								0.96	0.93
	14	(356)			1.00				0.96	0.77	0.75								1.00	1.00
	16	(406)							1.00	0.81	0.79									
	18	(457)								0.85	0.82									
	20	(508)								0.89	0.86									
	24	(610)								0.96	0.93									
	> 30	(762)								1.00	1.00									

Table 7 — Load adjustment factors for M8, M10, and M12 Hilti HSL4 anchors in cracked concrete[1,2]

M8, M10 and M12 HSL4 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			II to and away from edge f_{RV}					
Nominal dia.			M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12
Effective embedment h_{ef}		in. (mm)	2.38 (60)	2.76 (70)	3.15 (80)	2.36 (60)	2.76 (70)	3.15 (80)	2.38 (60)	2.76 (70)	3.15 (80)	2.38 (60)	2.76 (70)	3.15 (80)	2.38 (60)	2.76 (70)	3.15 (80)	2.38 (60)	2.76 (70)	3.15 (80)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in (mm)	2-3/8	(60)	0.67	n/a	n/a	0.75	n/a	n/a	0.58	n/a	n/a	0.33	n/a	n/a	0.65	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	0.68	n/a	n/a	0.78	n/a	n/a	0.58	n/a	n/a	0.35	n/a	n/a	0.71	n/a	n/a	n/a	n/a	n/a
	2-3/4	(70)	0.69	0.67	n/a	0.83	0.75	n/a	0.59	0.54	n/a	0.41	0.13	n/a	0.82	0.28	n/a	n/a	n/a	n/a
	3	(76)	0.71	0.68	n/a	0.88	0.79	n/a	0.60	0.55	n/a	0.46	0.15	n/a	0.88	0.29	n/a	n/a	n/a	n/a
	3-1/8	(79)	0.72	0.69	0.67	0.91	0.81	n/a	0.60	0.55	0.54	0.49	0.16	n/a	0.91	0.31	n/a	n/a	n/a	n/a
	3-1/2	(89)	0.75	0.71	0.69	0.99	0.88	0.80	0.62	0.55	0.55	0.59	0.18	0.17	0.99	0.37	0.33	n/a	n/a	n/a
	4	(102)	0.78	0.74	0.71	1.00	0.97	0.88	0.63	0.56	0.56	0.72	0.23	0.20	1.00	0.45	0.40	n/a	n/a	n/a
	4-3/8	(111)	0.81	0.76	0.73		1.00	0.94	0.65	0.57	0.56	0.82	0.26	0.23		0.51	0.46	0.76	n/a	n/a
	4-1/2	(114)	0.82	0.77	0.74		1.00	0.96	0.65	0.57	0.56	0.85	0.27	0.24		0.54	0.48	0.77	n/a	n/a
	4-3/4	(121)	0.84	0.79	0.75		1.00	1.00	0.66	0.57	0.57	0.93	0.29	0.26		0.58	0.52	0.80	0.54	n/a
	5	(127)	0.85	0.80	0.76		1.00	1.00	0.67	0.58	0.57	1.00	0.31	0.28		0.63	0.56	0.82	0.56	n/a
	5-3/8	(137)	0.88	0.83	0.78		1.00	1.00	0.68	0.58	0.58		0.35	0.31		0.70	0.63	0.85	0.58	0.56
	6	(152)	0.92	0.86	0.82		1.00	1.00	0.70	0.59	0.59		0.41	0.37		0.83	0.74	0.89	0.61	0.59
	7	(178)	0.99	0.92	0.87		1.00	1.00	0.73	0.61	0.60		0.52	0.47		1.00	0.93	0.97	0.66	0.63
	8	(203)	1.00	0.98	0.92			1.00	0.77	0.62	0.61		0.64	0.57			1.00	1.00	0.70	0.68
	9	(229)		1.00	0.98				0.80	0.67	0.63		1.00	0.68					0.74	0.72
	10	(254)		1.00	1.00				.083	0.65	0.64		0.89	0.80					0.79	0.76
	12	(305)		1.00	1.00				0.90	0.69	0.67		1.00	1.00					0.86	0.83
	14	(356)			1.00				0.96	0.72	0.70								1.93	0.90
	16	(406)							1.00	0.75	0.73								0.99	0.96
	18	(457)								0.78	0.76								1.00	1.00
	20	(508)								0.81	0.86									
	24	(610)								0.87	0.84									
	> 30	(762)								0.96	0.93									

1. Linear interpolation not permitted.
2. When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.
3. Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.
4. Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, it may not be permitted if both edge and spacing are less than “critical” distances. Check table 5 and figure 2 of this section to calculate permissible edge distance, spacing and concrete thickness combinations. For the HSL4-SH M8, M10 and M12 diameters, the minimum slab thickness must be increased by 5 mm (3/16-in.).

Table 8 — Load adjustment factors for M16, M20, and M24 Hilti HSL4 anchors in uncracked concrete [1,2]

M16, M20 and M24 HSL4 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			II to and away from edge f_{RV}					
Nominal dia.			M16	M20	M24	M16	M20	M24	M16	M20	M24	M16	M20	M24	M16	M20	M24	M16	M20	M24
Effective embedment h_{ef}	in. (mm)		3.948 (100)	4.92 (125)	5.91 (150)	3.948 (100)	4.92 (125)	5.91 (150)	3.948 (100)	4.92 (125)	5.91 (150)	3.948 (100)	4.92 (125)	5.91 (150)	3.948 (100)	4.92 (125)	5.91 (150)	3.948 (100)	4.92 (125)	5.91 (150)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in (mm)	4	(102)	0.67	n/a	n/a	n/a	n/a	n/a	0.56	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4-1/2	(114)	0.69	n/a	n/a	n/a	n/a	n/a	0.57	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4-3/4	(121)	0.70	n/a	n/a	0.51	n/a	n/a	0.58	n/a	n/a	0.30	n/a	n/a	0.51	n/a	n/a	n/a	n/a	n/a
	5	(127)	0.71	0.67	n/a	0.53	0.45	n/a	0.58	0.57	n/a	0.33	0.25	n/a	0.53	0.45	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.73	0.69	n/a	0.57	0.48	n/a	0.59	0.57	n/a	0.38	0.29	n/a	0.57	0.48	n/a	n/a	n/a	n/a
	5-7/8	(149)	0.75	0.70	0.67	0.60	0.50	0.45	0.59	0.58	0.57	0.42	0.32	0.26	0.60	0.50	0.45	n/a	n/a	n/a
	6	(152)	0.75	0.70	0.67	0.61	0.51	0.45	0.59	0.58	0.57	0.43	0.33	0.27	0.61	0.51	0.45	n/a	n/a	n/a
	6-1/4	(159)	0.76	0.71	0.68	0.63	0.53	0.47	0.60	0.58	0.57	0.46	0.35	0.29	0.63	0.53	0.47	0.63	n/a	n/a
	7	(178)	0.80	0.74	0.70	0.71	0.57	0.50	0.61	0.59	0.58	0.54	0.42	0.34	0.71	0.57	0.50	0.67	n/a	n/a
	7-1/2	(191)	0.82	0.75	0.71	0.76	0.61	0.53	0.62	0.60	0.59	0.60	0.46	0.38	0.76	0.61	0.53	0.69	0.63	n/a
	8	(203)	0.84	0.77	0.73	0.81	0.65	0.55	0.63	0.61	0.59	0.66	0.51	0.41	0.81	0.65	0.55	0.71	0.65	n/a
	8-7/8	(225)	0.88	0.80	0.75	0.90	0.72	0.60	0.64	0.62	0.60	077	0.60	0.48	0.90	0.72	0.60	0.75	0.69	0.64
	9	(229)	0.88	0.80	0.75	0.91	0.73	0.61	0.64	0.62	0.60	0.79	0.61	0.49	0.91	0.73	0.61	0.75	0.69	0.65
	10	(254)	0.92	0.84	0.78	1.00	0.81	0.68	0.66	0.63	0.62	0.92	0.71	0.58	1.00	0.81	0.68	0.79	0.73	0.68
	11	(279)	0.97	0.87	0.81	1.00	0.89	0.75	0.67	0.65	0.63	1.00	0.82	0.67	1.00	0.89	0.75	0.83	0.77	0.71
	12	(305)	1.00	0.91	0.84		0.97	0.81	0.69	0.66	0.64		0.94	0.76		0.97	0.81	0.87	0.80	0.75
	14	(356)	1.00	0.97	0.90		1.00	0.95	0.72	0.69	0.66		1.00	0.96		1.00	0.96	0.94	0.86	0.80
	16	(406)	1.00	1.00	0.95			1.00	0.75	0.71	0.69			1.00			1.00	1.00	0.92	0.86
	18	(457)			1.00				0.78	0.74	0.71								0.98	0.91
	20	(508)							0.82	0.77	0.73								1.00	0.96
	24	(610)							0.88	0.82	0.78									1.00
	30	(762)							0.97	0.90	0.85									
	36	(914)							1.00	0.98	0.92									
	> 48	(1219)								1.00	1.00									

Table 9 — Load adjustment factors for M8, M10, and M12 Hilti HSL4 anchors in cracked concrete[1,2]

M16, M20 and M24 HSL4 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			II to and away from edge f_{RV}					
Nominal dia.			M16	M20	M24	M16	M20	M24	M16	M20	M24	M16	M20	M24	M16	M20	M24	M16	M20	M24
Effective embedment h_{ef}	in. (mm)		3.948 (100)	4.92 (125)	5.91 (150)	3.948 (100)	4.92 (125)	5.91 (150)	3.948 (100)	4.92 (125)	5.91 (150)	3.948 (100)	4.92 (125)	5.91 (150)	3.948 (100)	4.92 (125)	5.91 (150)	3.948 (100)	4.92 (125)	5.91 (150)
Spacing (s) / edge distance (c_a) / concrete thickness (h), - in (mm)	4	(102)	0.67	n/a	n/a	n/a	n/a	n/a	0.55	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4-1/2	(114)	0.69	n/a	n/a	n/a	n/a	n/a	0.56	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4-3/4	(121)	0.70	n/a	n/a	0.85	n/a	n/a	0.56	n/a	n/a	0.22	n/a	n/a	0.43	n/a	n/a	n/a	n/a	n/a
	5	(127)	0.71	0.67	n/a	0.88	0.76	n/a	0.56	0.55	n/a	0.23	0.18	n/a	0.47	0.36	n/a	n/a	n/a	n/a
	5-1/2	(140)	0.73	0.69	n/a	0.95	0.81	n/a	0.57	0.56	n/a	0.27	0.21	n/a	0.54	0.42	n/a	n/a	n/a	n/a
	5-7/8	(149)	0.75	0.70	0.67	1.00	0.84	0.75	0.57	0.56	0.55	0.30	0.23	0.19	0.59	0.46	0.37	n/a	n/a	n/a
	6	(152)	0.75	0.70	0.67	1.00	0.86	0.76	0.58	0.56	0.56	0.31	0.24	0.19	0.61	0.47	0.38	n/a	n/a	n/a
	6-1/4	(159)	0.76	0.71	0.68	1.00	0.88	0.78	0.58	0.57	0.56	0.33	0.25	0.20	0.65	0.50	0.41	0.56	n/a	n/a
	7	(178)	0.80	0.74	0.70	1.00	0.96	0.84	0.59	0.57	0.56	0.39	0.30	0.24	0.77	0.60	0.48	0.59	n/a	n/a
	7-1/2	(191)	0.82	0.75	0.71	1.00	1.00	0.88	0.59	0.58	0.57	0.43	0.33	0.27	0.86	0.66	0.54	0.62	0.56	n/a
	8	(203)	0.84	0.77	0.73	1.00	1.00	0.92	0.60	0.59	0.57	0.47	0.36	0.30	0.94	0.73	0.59	0.64	0.58	n/a
	8-7/8	(225)	0.88	0.80	0.75	1.00	1.00	1.00	0.61	0.59	0.58	0.55	0.43	0.35	1.00	0.85	0.69	0.67	0.61	0.57
	9	(229)	0.88	0.80	0.75	1.00	1.00	1.00	0.61	0.60	0.58	0.56	0.43	0.35	1.00	0.87	0.71	0.67	0.62	0.58
	10	(254)	0.92	0.84	0.78	1.00	1.00	1.00	0.63	0.61	0.59	0.66	0.51	0.41	1.00	1.00	0.83	0.71	0.65	0.61
	11	(279)	0.97	0.87	0.81	1.00	1.00	1.00	0.64	0.62	0.60	0.76	0.59	0.48	1.00	1.00	0.95	0.75	0.68	0.64
	12	(305)	1.00	0.91	0.84		1.00	1.00	0.65	0.63	0.61	0.87	0.67	0.54		1.00	1.00	0.78	0.71	0.67
	14	(356)	1.00	0.97	0.90			1.00	0.68	0.65	0.63	1.00	0.84	0.68			1.00	0.84	0.77	0.72
	16	(406)	1.00	1.00	0.95				0.70	0.67	0.65		1.00	0.84				0.90	0.82	0.77
	18	(457)			1.00				0.73	0.69	0.67			1.00				0.95	0.87	0.82
	20	(508)							0.75	0.71	0.68			1.00				1.00	0.92	0.86
	24	(610)							0.80	0.76	0.72								1.00	0.94
	30	(762)							0.88	0.82	0.78									1.00
	36	(914)							0.95	0.88	0.83									
	> 48	(1219)							1.00	1.00	0.94									

1. Linear interpolation not permitted.
2. When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.
3. Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.
4. Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, it may not be permitted if both edge and spacing are less than "critical" distances. Check table 5 and figure 2 of this section to calculate permissible edge distance, spacing and concrete thickness combinations. For the HSL4-SH M8, M10 and M12 diameters, the minimum slab thickness must be increased by 5 mm (3/16-in.).

DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-4386. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to PTG Ed. 21 Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

Table 10 — Steel strength for Hilti HSL4 anchors[1,2]

Nominal anchor diameter	HSL4, HSL4-B, HSL4-SK			HSL4-G		
	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic shear[5] $\phi V_{sa,eq}$ lb (kN)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic shear[5] $\phi V_{sa,eq}$ lb (kN)
M8	4,495 (20.0)	4,615 (20.5)	2,940 (13.1)	4,495 (20.0)	3,870 (17.2)	2,410 (10.7)
M10	7,100 (31.6)	6,520 (29.0)	5,390 (24.0)	7,100 (31.6)	5,345 (23.8)	4,415 (19.6)
M12	10,335 (46.0)	9,385 (41.7)	7,580 (33.7)	10.335 (46.0)	7,755 (34.5)	6,265 (27.9)
M16	19,170 (94 .0)	17,025 (75.7)	15,805 (70.3)	19,170 (85.3)	14,460 (64.3)	13,430 (59.7)
M20	29,975 (133.3)	25,195 (112.1)	18,575 (82.6)	29,975 (133.3)	21,140 (94.0)	15,595 (69.4)
M24	43,145 (191.9)	29,295 (130.3)	24,335 (108.2)	43,145 (191.0)	27,520 (122.4)	n/a

1. See PTG Ed. 21 section 3.1.8 to convert design strength value to ASD value.
2. Hilti HSL4 anchors are to be considered ductile steel elements.
3. Tensile $N_{sar} = A_{se,}N\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D .
4. Shear determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0\ .6\ f_{uta}$ R as noted in CSA A23.3 Annex D .
5. Seismic shear values determined by seismic shear tests with $V_{sar,eq} <$ Ase,V ϕ_s 0 .6 f_{uta} R as noted in CSA A23.3 Annex D . See Section 3.1.8 for additional information on seismic applications.

Table 11 — Hilti HSL4 design information in accordance with CSA A23.3 Annex D[1]

Design parameter	Symbol	Units	Nominal anchor diameter						Ref A23.3
			M8	M10	M12	M16	M20	M24	
Anchor O.D.	d_a	mm (in.)	12 (0.47)	15 (0.59)	18 (0.71)	21 (0.94)	28 (1.10)	32 (1.26)	
Effective minimum embedment[2]	h_{ef}	mm (in.)	60 (2.4)	70 (2.8)	80 (3.1)	100 (3.9)	125 (4.9)	150 (5.9)	
Minimum concrete thickness	h_{min}	mm (in.)	See table 5						
Critical edge distance	c_{ac}	mm (in.)	See table 5						
Minimum edge distance	c_{min}	mm (in.)	See table 5						
	for s >	mm (in.)	See table 5						
Minimum anchor spacing	s_{min}	mm (in.)	See table 5						
	for c >	mm (in.)	See table 5						
Minimum hole depth in concrete	h_o	mm (in.)	80 (3.1)	90 (3.5)	105 (4.1)	125 (4.9)	155 (6.1)	190 (7.5)	
Minimum specified yield strength	f_{ya}	N/mm^2 (psi)	641 (93,000)						
Minimum specified ultimate strength	f_{uta}	N/mm^2 (psi)	800 (116,000)						
Effective tensile stress area	$A_{se,N}$	mm^2 (in^2)	36.8 (0.057)	58.1 (0.090)	84.5 (0.131)	156.8 (0.243)	245.2 (0.380)	352.9 (0.547)	
Steel embed. material resistance factor for reinforcement	ϕ_s	–	0.85						8.4.3
Resistance modification factor for tension, steel failure modes[3]	R	–	0.80						D.5.3
Resistance modification factor for shear, steel failure modes[3]	R	–	0.75						D.5.3
Factored steel resistance in tension	N_{sar}	lb (kN)	4,495 (20.0)	7,100 (31.6)	10,335 (46.0)	19,170 (85.3)	29,975 (133.3)	43,145 (191.9)	D.6.1.2
Factored steel resistance in shear HSL4, HSL-B, HSL4-SK	V_{sar}	lb (kN)	4,615 (20.5)	6,520 (29.0)	9,385 (41.7)	17,025 (75.7)	25,195 (112.1)	29,295 (130.3)	D.7.1.2
Factored steel resistance in shear HSL4-G		lb (kN)	3,870 (17.2)	5,345 (23.8)	7,755 (34.5)	14,460 (62.3)	21,140 (94.0)	27,520 (122.4)	D.7.1.2
Factored steel resistance in shear, seismic HSL4, HSL-B, HSL4-SK	$V_{sar,eq}$	lb (kN)	2,940 (13.1)	5,390 (24.0)	7,580 (33.7)	15,805 (70.3)	18,575 (82.6)	24,335 (108.3)	
Factored steel resistance in shear, seismic HSL4-G		lb (kN)	2,410 (10.7)	4,415 (19.6)	6,265 (27.9)	13,430 (59.7)	15,595 (69.4)	n/a[7]	
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	–	10						D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	–	7	10					D.6.2.2
Modification factor for anchor resistance, tension, uncracked concrete[4]	$\psi_{c,N}$	–	1.0						D.6.2.6
Anchor category	–	–	1.0						D.5.3(c)
Concrete material resistance factor	ϕ_c	–	0.65						8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]	R	–	1.0						D.5.3(c)
Factored pullout resistance in 20 MPa uncracked concrete[6]	$N_{pr,uncr}$	lb (kN)	2,945 (13.1)	n/a	n/a	n/a	n/a	n/a	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete[6]	$N_{pr,cr}$	lb (kN)	1,970 (8.8)	3,150 (14.0)	n/a	n/a	n/a	n/a	D.6.3.2
Factored seismic pullout resistance in 20 MPa cracked concrete[6]	$N_{pr,eq}$	lb (kN)	1,970 (8.8)	3,150 (14.0)	n/a	n/a	n/a	10,030[7] (44.6)	
Load bearing length of anchor in shear	ℓ_e	mm (in.)	24 (0.94)	30 (1.18)	36 (1.42)	48 (1.89)	56 (2.20)	64 (2.52)	D.7.2.2

[1] Design information in this table is taken from ICC-ES ESR-4386, table 3, and converted for use with CSA A23.3 Annex D.
[2] See Figure 1 of this document.
[3] The HSL4 is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
[4] For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used .
[5] For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
[6] For all design cases, $\psi_{c,P}$ = 1.0 . NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-4386 for additional information.
[7] HSL4-G M24 is not permitted for seismic applications.

Table 12 — Hilti HSL4 anchors factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter	Effective embed. mm (in.)	Tension - φN_n				Shear - φV_n			
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
M8	60 (2.4)	2,945 (13.1)	3,290 (14.6)	3,605 (16.0)	4,165 (18.5)	3,035 (13.5)	3,395 (15.1)	3,720 (16.5)	4,295 (19.1)
M10	70 (2.8)	3,825 (17.0)	4,280 (19.0)	4,685 (20.9)	5,415 (24.1)	7,655 (34.0)	8,560 (38.1)	9,375 (41.7)	10,825 (48.2)
M12	80 (3.1)	4,675 (20.8)	5,230 (23.3)	5,725 (25.5)	6,615 (29.4)	9,350 (41.6)	10,455 (46.5)	11,455 (50.9)	13,225 (58.8)
M16	100 (3.9)	6,535 (29.1)	7,305 (32.5)	8,005 (35.6)	9,240 (41.1)	13,070 (58.1)	14,615 (65.0)	16,005 (71.2)	18,485 (82.2)
M20	125 (4.9)	9,135 (40.6)	10,210 (45.4)	11,185 (49.8)	12,915 (57.5)	18,265 (81.3)	20,420 (90.8)	22,370 (99.5)	25,830 (114.9)
M24	150 (5.9)	12,005 (53.4)	13,425 (59.7)	14,705 (65.4)	16,980 (75.5)	24,010 (106.8)	26,845 (119.4)	29,405 (130.8)	33,955 (151.0)

Table 13 — Hilti HSL4 anchor factored resistance with concrete / pullout failure in cracked concrete[1,2,3,4,5]

Nominal anchor diameter	Effective embed. mm (in.)	Tension - φN_n				Shear - φV_n			
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
M8	60 (2.4)	1,970 (8.8)	2,200 (9.8)	2,410 (10.7)	2,785 (12.4)	2,125 (9.5)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)
M10	70 (2.8)	3,150 (17.0)	3,520 (19.0)	3,855 (20.9)	4,455 (24.1)	7,655 (34.0)	8,560 (38.1)	9,375 (41.7)	10,825 (48.2)
M12	80 (3.1)	4,675 (20.8)	5,230 (23.3)	5,725 (25.5)	6,615 (29.4)	9,350 (41.6)	10,455 (46.5)	11,455 (50.9)	13,225 (58.8)
M16	100 (3.9)	6,535 (29.1)	7,305 (32.5)	8,005 (35.6)	9,240 (41.1)	13,070 (58.1)	14,615 (65.0)	16,005 (71.2)	18,485 (82.2)
M20	125 (4.9)	9,135 (40.6)	10,210 (45.4)	11,185 (49.8)	12,915 (57.5)	18,265 (81.3)	20,420 (90.8)	22,370 (99.5)	25,830 (114.9)
M24[5]	150 (5.9)	12,005 (53.4)	13,425 (59.7)	14,705 (65.4)	16,980 (75.5)	24,010 (106.8)	26,845 (119.4)	29,405 (130.8)	33,955 (151.0)

1 See PTG Ed. 21 section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 9 as necessary. Compare to the steel values in table 10. The lesser of the values is to be used for the design.

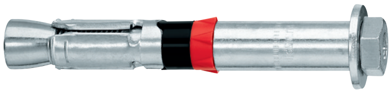
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0 .60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by the following reduction factors:
M24 - $\alpha_{N,seis}$ = 0 .62. HSL4-G M24 is not permitted for seismic applications.
All other sizes - $\alpha_{N,seis}$ = 0 .75
No reduction needed for seismic shear. See PTG Ed. 21 section 3.1.8 for additional information on seismic applications.

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION



HSL4 Bolt version

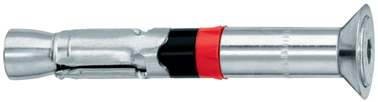
Description	Box qty
HSL4 M8 d12x97 20/-/-	40
HSL4 M8 d12x117 40/20/-	40
HSL4 M10 d15x109 20/-/-	20
HSL4 M10 d15x129 40/20/-	20
HSL4 M12 d18x131 25/-/-	20
HSL4 M12 d18x156 50/25/-	20
HSL4 M16 d24x138 10/-/-	10
HSL4 M16 d24x153 25/-/-	10
HSL4 M16 d24x178 50/25/-	10
HSL4 M20 d28x183 30/-/-	6
HSL4 M20 d28x213 60/30/-	6
HSL4 M24 d32x205 30/-/-	4
HSL4 M24 d32x235 60/30/-	4

HSL4-B Torque cap

Description	Box qty
HSL4-B M12 d18x121 5/-/-	20
HSL4-B M12 d18x141 25/-/-	20
HSL4-B M12 d18x166 50/25/-	10
HSL4-B M16 d24x151 10/-/-	10
HSL4-B M16 d24x166 25/-/-	10
HSL4-B M20 d28x198 30/-/-	6
HSL4-B M24 d32x223 30/-/-	4

HSL4-G Stud version

Description	Box qty
HSL4-G M8 d12x107 20/-/-	40
HSL4-G M10 d15x121 20/-/-	20
HSL4-G M10 d15x201 100/80/60	20
HSL4-G M12 d18x147 25/-/-	20
HSL4-G M12 d18x172 50/25/-	20
HSL4-G M16 d24x175 25/-/-	10
HSL4-G M16 d24x200 50/25/-	10
HSL4-G M20 d28x205 30/-/-	6
HSL4-G M20 d28x235 60/30/-	6



HSL4-SK Countersunk

Description	Box qty
HSL4-SK M8 d12x80 10/-/-	20
HSL4-SK M8 d12x90 20/-/-	20
HSL4-SK M10 d15x100 20/-/-	10
HSL4-SK M12 d18x120 25/-/-	10

Product nomenclature

$$\underbrace{\textbf{HSL4-G}}_{\text{A}}\ \underbrace{\textbf{M10}}_{\text{B}}\ \underbrace{\textbf{d15}}_{\text{C}}\underbrace{\textbf{x201}}_{\text{D}}\ \underbrace{\textbf{100/80/60}}_{\text{E}}$$

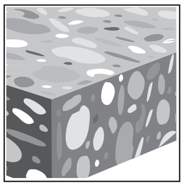
A: Anchor Name
B: Threaded rod diameter
C: Drill bit diameter
D: Total length of the anchor
E: Maximum fixture thickness at Min/Std/Max effective embedment

3.3.3 HSL-3-R HEAVY-DUTY STAINLESS STEEL EXPANSION ANCHORS

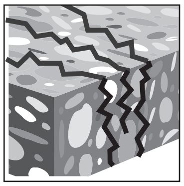
PRODUCT DESCRIPTION

HSL–3-R Heavy-duty Expansion Anchor

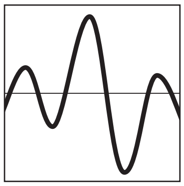
Anchor System	Features and Benefits
 HSL-3-R  HSL-3-GR  HSL-3-SKR	- Approved for use in cracked tension zone (cracked concrete) - Data for use with the Strength Design provisions of ACI 318 Chapter 17 and CSA A23.3 Annex D. - High load capacity - Force-controlled expansion which allows for follow-up expansion - Reliable clamping of part fastened to help overcome gap - No spinning of the anchor in hole when tightening bolt or nut - Seismic qualification per ICC-ES AC 193 and the requirements of ACI 318 Chapter 17 - Simplified tables for edge distance and spacing provided



Uncracked concrete



Cracked concrete



Seismic Desing Categories A-F

PROFIS Anchor design software

Listings/Approvals	
ICC-ES (International Code Council)	ESR-1545
European Technical Approval	ETA-02/0042
City of Los Angeles	LABD Supplement to ESR

MATERIAL SPECIFICATIONS

- Stainless steel bolt or threaded rod per DIN EN 10088-3.
- Stainless steel washer per DIN EN 10088-3.
- Stainless steel expansion sleeve per ASTM A 276/276A.
- Stainless steel spacing sleeve per ASTM A 511/A 511M.
- Stainless steel expansion cone per ASTM A 511/A 511M.
- Collapsible sleeve is made from acetal polyoxymethylene (POM) resin.

INSTALLATION PARAMETERS

Table 1 — HSL-3-R Specifications

Details	Symbol	Units	Nominal anchor diameter									
			M8		M10		M12		M16		M20	
Nominal drill bit diameter	d_{bit}	mm	12		15		18		24		28	
Minimum concrete thickness	h_{min}	mm (in)	120 (4-3/4)		140 (5-1/2)		150 (5-7/8)		200 (7-7/8)		250 (9-7/8)	
Minimum hole depth	h_o	mm (in)	80 (3-1/8)		90 (3-9/16)		105 (4-1/8)		125 (4-15/16)		155 (6-1/8)	
Effective minimum embedment	$h_{ef,min}$	mm (in)	60 (2.36)		70 (2.76)		80 (3.15)		100 (3.94)		125 (4.92)	
Minimum fixture hole diameter	d_h	mm (in)	14 (9/16)		17 (11/16)		20 (13/16)		26 (1)		31 (1-1/4)	
Diameter of countersunk hole in the fixture HSL-3-SKR	d_{SK}	mm (in)	22.5 (7/8)		25.5 (1)		32.9 (1-5/16)		N/A		N/A	
Height of countersunk head in the fixture HSL-3-SKR	h_{SK}	mm (in)	5.8 (1/4)		6 (1/4)		8 (5/16)		N/A		N/A	
Max. cumulative gap between part(s) being fastened and concrete surface	-	mm (in)	4 (1/8)		5 (3/16)		8 (5/16)		9 (3/8)		12 (1/2)	
Maximum thickness of part fastened HSL-3-R	$t_{fix,max}$	mm (in)	20 (3/4)	40 (1-1/2)	20 (3/4)	40 (1-1/2)	25 (1)	50 (2)	25 (1)	50 (2)	30 (1-1/8)	60 (2-1/4)
Overall length of anchor HSL-3-R	ℓ	mm (in)	98 (3-7/8)	118 (4-5/8)	110 (4-3/8)	130 (5-1/8)	131 (5-1/8)	156 (6-1/8)	153 (6)	178 (7)	183 (7-1/4)	213 (8-3/8)
Maximum thickness of part fastened HSL-3-GR	$t_{fix,max}$	mm (in)	20 (3/4)	100 (4)	20 (3/4)	100 (4)	25 (1)	100 (4)	25 (1)	100 (4)	30 (1-1/8)	100 (4)
Overall length of anchor HSL-3-GR	ℓ	mm (in)	102 (4)	182 (7-1/8)	115 (4-1/2)	197 (7-3/4)	139 (5-1/2)	214 (8-1/2)	163 (6-3/8)	238 (9-3/8)	190 (7-1/2)	260 (10-1/4)
Maximum thickness of part fastened HSL-3-SKR	$t_{fix,max}$	mm (in)	20 (3/4)		20 (3/4)		25 (1)		N/A		N/A	
Overall length of anchor HSL-3-SKR	ℓ	mm (in)	98 (3-7/8)		110 (4-3/8)		131 (5-1/8)		N/A		N/A	
Installation torque HSL-3-R	T_{inst}	Nm (ft-lb)	25 (18)		35 (26)		80 (59)		120 (89)		200 (148)	
Installation torque HSL-3-GR	T_{inst}	Nm (ft-lb)	30 (22)		50 (37)		80 (59)		120 (89)		200 (148)	
Installation torque HSL-3-SKR	T_{inst}	Nm (ft-lb)	18 (13)		50 (37)		80 (59)		N/A		N/A	
Wrench size, HSL-3-R, HSL-3-GR	SW	mm	13		17		19		24		30	
Allen wrench size, HSL-3-SKR	SW	mm	5		6		8		N/A		N/A	

Figure 1 — HSL-3-R and HSL-3-GR in the installed condition (HSL-3-R shown)

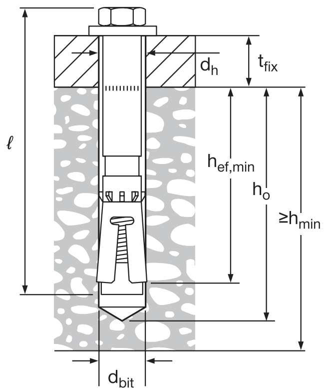
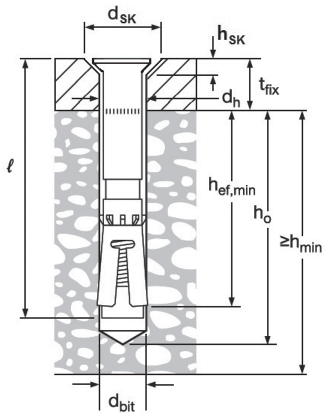


Figure 2 — HSL-3-SKR in the installed condition



DESIGN DATA IN CONCRETE PER ACI 318

ACI 318 Chapter 17 design

The load values in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR 1545 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8 of Hilti Product Technical Guide Volume 2-21. Data tables from ESR 1545 are not contained in this section, but can be found at **www.icc-es.org** or at **www.hilti.com**.

Table 2 — Hilti HSL-3-R design strength with concrete / pullout failure in uncracked concrete [1,2,3,4,5]

Nominal Anchor Diameter mm	Effective Embed. Depth mm (in.)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2500 psi (17.2 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 6000 psi (41.4 MPa) lb (kN)	f'_c = 2500 psi (17.2 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 6000 psi (41.4 MPa) lb (kN)
M8	60 (2.36)	1,700 (7.6)	1,730 (7.7)	1,780 (7.9)	1,855 (8.3)	3,050 (13.6)	3,340 (14.9)	3,860 (17.2)	4,725 (21.0)
M10	70 (2.76)	3,020 (13.4)	3,310 (14.7)	3,820 (17.0)	4,680 (20.8)	7,685 (34.2)	8,420 (37.5)	9,720 (43.2)	11,905 (53.0)
M12	80 (3.15)	3,690 (16.4)	4,040 (18.0)	4,665 (20.8)	5,715 (25.4)	9,390 (41.8)	10,285 (45.7)	11,880 (52.8)	14,550 (64.7)
M16	100 (3.94)	6,855 (30.5)	7,510 (33.4)	8,670 (38.6)	10,620 (47.2)	14,765 (65.7)	16,175 (71.9)	18,675 (83.1)	22,875 (101.8)
M20	125 (4.92)	10,645 (47.4)	11,660 (51.9)	13,465 (59.9)	16,490 (73.4)	22,925 (102.0)	25,115 (111.7)	29,000 (129.0)	35,515 (158.0)

Table 3 — Hilti HSL-3-R design strength with concrete / pullout failure in cracked concrete [1,2,3,4,5,6]

Nominal Anchor Diameter mm	Effective Embed. Depth mm (in.)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2500 psi (17.2 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 6000 psi (41.4 MPa) lb (kN)	f'_c = 2500 psi (17.2 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 6000 psi (41.4 MPa) lb (kN)
M8	60 (2.36)	1,390 (6.2)	1,520 (6.8)	1,755 (7.8)	2,150 (9.6)	2,160 (9.6)	2,365 (10.5)	2,730 (12.1)	3,345 (14.9)
M10	70 (2.76)	2,495 (11.1)	2,735 (12.2)	3,160 (14.1)	3,865 (17.2)	6,725 (29.9)	7,365 (32.8)	8,505 (37.8)	10,420 (46.4)
M12	80 (3.15)	3,690 (16.4)	4,040 (18.0)	4,665 (20.8)	5,715 (25.4)	9,390 (41.8)	10,285 (45.7)	11,880 (52.8)	14,550 (64.7)
M16	100 (3.94)	6,095 (27.1)	6,675 (29.7)	7,705 (34.3)	9,440 (42.0)	13,125 (58.4)	14,375 (63.9)	16,600 (73.8)	20,330 (90.4)
M20	125 (4.92)	7,715 (34.3)	8,450 (37.6)	9,760 (43.4)	11,950 (53.2)	18,340 (81.6)	20,090 (89.4)	23,200 (103.2)	28,415 (126.4)

1 See Section 3.1.6 for explanation on development of load values.
2 See Section 3.1.9 to convert design strength value to ASD value.
3 Linear interpolation between concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 9 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.
5 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.68. For all-lightweight, λ_a = 0.60.
6 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by
$\alpha_{N,seis}$ = 0.75. See Section 3.1.9 of Hilti Product Technical Guide Volume 2-19 for additional information on seismic applications.

Table 4 — Steel strength for Hilti HSL-3-R stainless steel anchors [1,2]

Nominal Anchor Diameter mm	HSL-3-R			HSL-3-GR			HSL-3-SKR		
	Tensile[3] ΦN_{sa} lb (kN)	Shear[4] ΦV_{sa} lb (kN)	Seismic Shear[5] ΦV_{sa} lb (kN)	Tensile[3] ΦN_{sa} lb (kN)	Shear[4] ΦV_{sa} lb (kN)	Seismic Shear[5] ΦV_{sa} lb (kN)	Tensile[3] ΦN_{sa} lb (kN)	Shear[4] ΦV_{sa} lb (kN)	Seismic Shear[5] ΦV_{sa} lb (kN)
M8	4,320 (19.2)	6,490 (28.9)	1,770 (7.9)	4,320 (19.2)	5,890 (26.2)	1,770 (7.9)	4,320 (19.2)	6,490 (28.9)	1,770 (7.9)
M10	6,845 (30.4)	9,160 (40.7)	4,310 (19.2)	6,845 (30.4)	8,620 (38.3)	4,310 (19.2)	6,845 (30.4)	9,160 (40.7)	4,310 (19.2)
M12	9,950 (44.3)	11,895 (52.9)	4,605 (20.5)	9,950 (44.3)	11,515 (51.2)	4,605 (20.5)	9,950 (44.3)	11,895 (52.9)	4,605 (20.5)
M16	18,530 (82.4)	18,735 (83.3)	9,350 (41.6)	18,530 (82.4)	18,940 (84.2)	9,350 (41.6)	-	-	-
M20	28,915 (128.6)	21,215 (94.4)	9,350 (41.6)	28,915 (128.6)	23,380 (104.0)	9,350 (41.6)	-	-	-

[1] See Section 3.1.9 to convert design strength value to ASD value.

[2] Hilti HSL-3 Stainless Steel anchors are to be considered ductile steel elements.

[3] Tensile = $\Phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17

[4] Shear values determined by static shear tests with $\Phi V_{sa} \leq \Phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.

[5] Seismic shear values determined by seismic shear tests with $\Phi V_{sa} < \Phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17. See Section 3.1.9 of Hilti Product Technical Guide Volume 2-21 for additional information on seismic applications.

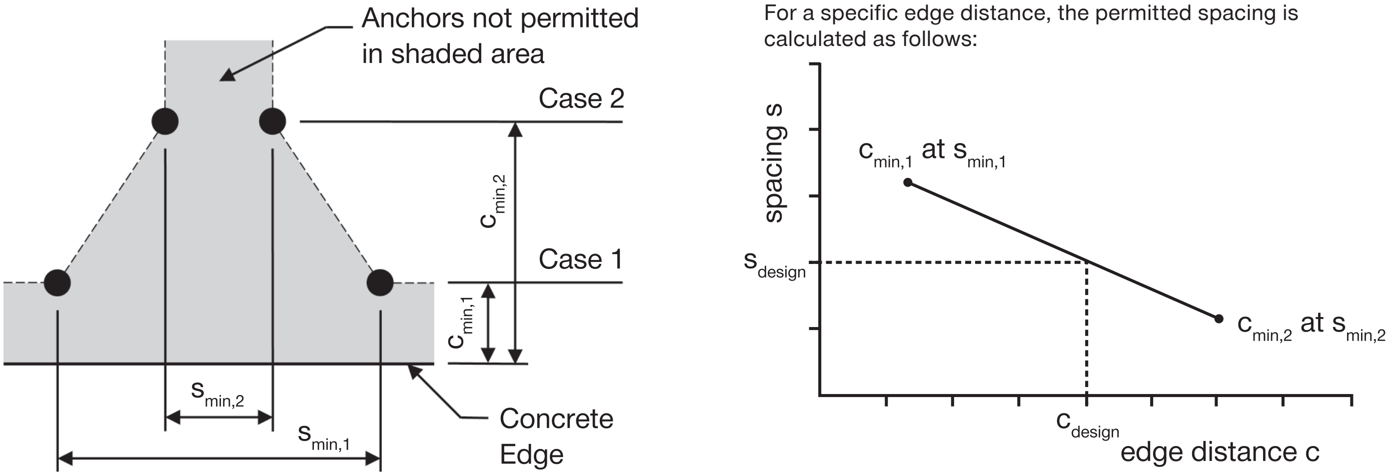
Table 5 — Edge distance, spacing and member thickness requirements [1]

Dimensional Parameter		Symbol	Units	Nominal anchor diameter				
				M8	M10	M12	M16	M20
Minimum concrete thickness		h_{min}	in. (mm)	4-3/4 (120)	5-1/2 (140)	5-7/8 (150)	7-7/8 (200)	9-7/8 (250)
Critical edge distance		c_{ac}	in. (mm)	7-7/8 (200)	11 (280)	8-5/8 (220)	9-1/2 (240)	15 (380)
Case 1	Minimum edge distance	$c_{min,1}$	in. (mm)	2-3/4 (70)	3-1/2 (90)	3-1/2 (90)	4 (100)	5-7/8 (150)
	Minimum anchor spacing	$s_{min,1}$	in. (mm)	5-1/2 (140)	6-1/4 160)	9-7/8 (250)	9-1/2 (240)	11-7/8 (300)
Case 2	Minimum edge distance	$c_{min,2}$	in. (mm)	4-3/4 (120)	5-1/8 (130)	6-1/4 (160)	9-1/2 (240)	11-7/8 (300)
	Minimum anchor spacing	$s_{min,2}$	in. (mm)	2-3/4 (70)	3-1/2 (90)	4 (100)	4 (100)	5 (125)

[1] Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissable spacing s as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}\ (c - c_{\ min,2})$$

Figure 3 — Interpolation of Minimum Edge Distance and Anchor Spacing



For a specific edge distance, the permitted spacing is calculated as follows:

Table 6 — Load adjustment factors for M8, M10, and M12 HSL-3-R anchors in uncracked concrete [1,4]

M8, M10 and M12 HSL-3-R Uncracked Concrete			Spacing Factor in Tension f_{AN}			Edge Distance Factor in Tension f_{RN}			Spacing Factor in Shear [2] f_{AV}			Edge Distance in Shear						Conc. Thickness Factor in Shear [3] f_{HV}		
												⊥ Toward Edge f_{RV}			‖ To Edge f_{RV}					
Nominal Diameter mm			M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12
Effective Embed. h_{ef} mm (in)			60 (2.36)	70 (2.76)	80 (3.15)	60 (2.36)	70 (2.76)	80 (3.15)	60 (2.36)	70 (2.76)	80 (3.15)	60 (2.36)	70 (2.76)	80 (3.15)	60 (2.36)	70 (2.76)	80 (3.15)	60 (2.36)	70 (2.76)	80 (3.15)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-3/4	(70)	0.69	n/a	n/a	0.37	n/a	n/a	0.56	n/a	n/a	0.21	n/a	n/a	0.37	n/a	n/a	n/a	n/a	n/a
	3	(76)	0.71	n/a	n/a	0.40	n/a	n/a	0.56	n/a	n/a	0.24	n/a	n/a	0.40	n/a	n/a	n/a	n/a	n/a
	3-1/2	(89)	0.75	0.71	n/a	0.45	0.33	0.44	0.57	0.55	n/a	0.30	0.18	0.23	0.45	0.33	0.44	n/a	n/a	n/a
	4	(102)	0.78	0.74	0.71	0.51	0.37	0.48	0.58	0.56	0.57	0.36	0.22	0.28	0.51	0.37	0.48	n/a	n/a	n/a
	4-3/4	(121)	0.84	0.79	0.75	0.60	0.43	0.55	0.60	0.57	0.59	0.47	0.28	0.37	0.60	0.43	0.55	0.63	n/a	n/a
	5	(127)	0.85	0.80	0.76	0.63	0.45	0.58	0.61	0.58	0.59	0.51	0.31	0.40	0.63	0.45	0.58	0.65	n/a	n/a
	5-1/8	(130)	0.86	0.81	0.77	0.65	0.47	0.59	0.61	0.58	0.59	0.53	0.32	0.41	0.65	0.47	0.59	0.66	n/a	n/a
	5-1/2	(140)	0.89	0.83	0.79	0.70	0.50	0.64	0.62	0.58	0.60	0.58	0.35	0.46	0.70	0.50	0.64	0.68	0.58	n/a
	6	(152)	0.92	0.86	0.82	0.76	0.55	0.70	0.63	0.59	0.61	0.67	0.40	0.52	0.76	0.55	0.70	0.71	0.60	n/a
	6-1/4	(159)	0.94	0.88	0.83	0.79	0.57	0.72	0.63	0.59	0.61	0.71	0.43	0.55	0.79	0.57	0.72	0.73	0.62	0.67
	6-1/2	(165)	0.96	0.89	0.84	0.83	0.59	0.75	0.64	0.60	0.62	0.75	0.45	0.59	0.83	0.59	0.75	0.74	0.63	0.68
	7	(178)	0.99	0.92	0.87	0.89	0.64	0.81	0.65	0.61	0.63	0.84	0.51	0.65	0.89	0.64	0.81	0.77	0.65	0.71
	8	(203)	1.00	0.98	0.92	1.00	0.73	0.93	0.67	0.62	0.64	1.00	0.62	0.80	1.00	0.73	0.93	0.82	0.70	0.76
	9	(229)		1.00	0.98		0.82	1.00	0.69	0.64	0.66		0.74	0.95		0.82	1.00	0.87	0.74	0.80
	9-7/8	(251)			1.00		0.90		0.71	0.65	0.68		0.85	1.00		0.90		0.91	0.77	0.84
	10	(254)					0.91		0.71	0.65	0.68		0.87			0.91		0.92	0.78	0.85
	11	(279)					1.00		0.73	0.67	0.70		1.00			1.00		0.96	0.82	0.89
	12	(305)							0.75	0.68	0.72							1.00	0.85	0.93
	14	(356)							0.80	0.71	0.75								0.92	1.00
	16	(406)							0.84	0.74	0.79								0.98	
	18	(457)							0.88	0.77	0.82								1.00	
	20	(508)							0.92	0.80	0.86									
	24	(610)							1.00	0.86	0.93									
	> 30	(762)								0.95	1.00									

Table 7 — Load adjustment factors for M8, M10, and M12 HSL-3-R anchors in cracked concrete [1,4]

M8, M10 and M12 HSL-3-R Cracked Concrete			Spacing Factor in Tension f_{AN}			Edge Distance Factor in Tension f_{RN}			Spacing Factor in Shear [2] f_{AV}			Edge Distance in Shear						Conc. Thickness Factor in Shear [3] f_{HV}		
												⊥ Toward Edge f_{RV}			‖ To Edge f_{RV}					
Nominal Diameter mm			M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12	M8	M10	M12
Effective Embed. h_{ef} mm (in)			60 (2.36)	70 (2.76)	80 (3.15)	60 (2.36)	70 (2.76)	80 (3.15)	60 (2.36)	70 (2.76)	80 (3.15)	60 (2.36)	70 (2.76)	80 (3.15)	60 (2.36)	70 (2.76)	80 (3.15)	60 (2.36)	70 (2.76)	80 (3.15)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-3/4	(70)	0.69	n/a	n/a	0.83	n/a	n/a	0.59	n/a	n/a	0.41	n/a	n/a	0.82	n/a	n/a	n/a	n/a	n/a
	3	(76)	0.71	n/a	n/a	0.88	n/a	n/a	0.60	n/a	n/a	0.46	n/a	n/a	0.88	n/a	n/a	n/a	n/a	n/a
	3-1/2	(89)	0.75	0.71	n/a	0.99	0.88	0.80	0.62	0.56	n/a	0.59	0.21	0.17	0.99	0.42	0.33	n/a	n/a	n/a
	4	(102)	0.78	0.74	0.71	1.00	0.97	0.88	0.63	0.57	0.56	0.72	0.26	0.20	1.00	0.51	0.40	n/a	n/a	n/a
	4-3/4	(121)	0.84	0.79	0.75		1.00	1.00	0.66	0.58	0.57	0.93	0.33	0.26		0.67	0.52	0.80	n/a	n/a
	5	(127)	0.85	0.80	0.76		1.00	1.00	0.67	0.58	0.57	1.00	0.36	0.28		0.72	0.56	0.82	n/a	n/a
	5-1/8	(130)	0.86	0.81	0.77		1.00	1.00	0.67	0.59	0.57		0.37	0.29		0.75	0.59	0.83	n/a	n/a
	5-1/2	(140)	0.89	0.83	0.79			1.00	0.68	0.59	0.58		0.41	0.33		0.83	0.65	0.86	0.61	n/a
	6	(152)	0.92	0.86	0.82			1.00	0.70	0.60	0.59		0.47	0.37		0.95	0.74	0.89	0.64	n/a
	6-1/4	(159)	0.94	0.88	0.83			1.00	0.71	0.61	0.59		0.50	0.39		1.00	0.79	0.91	0.65	0.60
	6-1/2	(165)	0.96	0.89	0.84				0.72	0.61	0.59		0.53	0.42			0.84	0.93	0.66	0.61
	7	(178)	0.99	0.92	0.87				0.73	0.62	0.60		0.60	0.47			0.93	0.97	0.69	0.63
	8	(203)	1.00	0.98	0.92				0.77	0.63	0.61		0.73	0.57			1.00	1.00	0.73	0.68
	9	(229)		1.00	0.98				0.80	0.65	0.63		0.87	0.68					0.78	0.72
	9-7/8	(251)			1.00				0.83	0.67	0.64		1.00	0.78					0.82	0.75
	10	(254)							0.83	0.67	0.64			0.80					0.82	0.76
	11	(279)							0.87	0.69	0.66			0.92					0.86	0.79
	12	(305)							0.90	0.70	0.67			1.00					0.90	0.83
	14	(356)							0.97	0.74	0.70								0.97	0.90
	16	(406)							1.00	0.77	0.73								1.00	0.96
	18	(457)								0.80	0.76									1.00
	20	(508)								0.84	0.79									
	24	(610)								0.90	0.84									
	> 30	(762)								1.00	0.93									

1 Linear interpolation not permitted.

2 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

3 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

4 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative.
To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

▨ — If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa).
Check with Figure 2 of this section to calculate permissable edge distance and spacing combinations.

Table 8 — Load adjustment factors for M16 and M20, HSL-3-R anchors in uncracked concrete [1,4]

M16 and M20 HSL-3-R Uncracked Concrete			Spacing Factor in Tension f_{AN}		Edge Distance Factor in Tension f_{RN}		Spacing Factor in Shear [2] f_{AV}		Edge Distance in Shear				Conc. Thickness Factor in Shear [3] f_{HV}	
									⊥ Toward Edge f_{RV}		‖ To Edge f_{RV}			
Nominal Diameter mm			M16	M20	M16	M20	M16	M20	M16	M20	M16	M20	M16	M20
Effective Embed. h_{ef} mm (in)			100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	4	(102)	0.67	n/a	0.47	n/a	0.56	n/a	0.21	n/a	0.42	n/a	n/a	n/a
	5	(127)	0.71	0.67	0.55	n/a	0.57	0.56	0.29	n/a	0.55	n/a	n/a	n/a
	5-7/8	(149)	0.75	0.70	0.62	0.41	0.59	0.57	0.37	0.26	0.62	0.41	n/a	n/a
	6	(152)	0.75	0.70	0.63	0.42	0.59	0.57	0.38	0.27	0.63	0.42	n/a	n/a
	7	(178)	0.80	0.74	0.74	0.47	0.60	0.58	0.48	0.33	0.74	0.47	n/a	n/a
	7-7/8	(200)	0.83	0.77	0.83	0.53	0.62	0.59	0.57	0.40	0.83	0.53	0.68	n/a
	8	(203)	0.84	0.77	0.84	0.53	0.62	0.59	0.59	0.41	0.84	0.53	0.68	n/a
	9	(229)	0.88	0.80	0.95	0.60	0.63	0.60	0.70	0.49	0.95	0.60	0.73	n/a
	9-1/2	(241)	0.90	0.82	1.00	0.63	0.64	0.61	0.76	0.53	1.00	0.63	0.74	n/a
	9-7/8	(251)	0.92	0.83		0.66	0.64	0.61	0.80	0.56		0.66	0.76	0.67
	10	(254)	0.92	0.84		0.67	0.65	0.61	0.82	0.57		0.67	0.76	0.68
	11	(279)	0.97	0.87		0.73	0.66	0.63	0.95	0.66		0.73	0.80	0.71
	11-7/8	(302)	1.00	0.90		0.79	0.67	0.64	1.00	0.74		0.79	0.83	0.74
	12	(305)		0.91		0.80	0.68	0.64		0.75		0.80	0.84	0.74
	13	(330)		0.94		0.87	0.69	0.65		0.85		0.87	0.87	0.77
	14	(356)		0.97		0.93	0.70	0.66		0.94		0.94	0.90	0.80
	15	(381)		1.00		1.00	0.72	0.67		1.00		1.00	0.94	0.83
	16	(406)					0.73	0.68					0.97	0.86
	18	(457)					0.76	0.71					1.00	0.91
	20	(508)					0.79	0.73						0.96
	24	(610)					0.85	0.78						1.00
	30	(762)					0.94	0.84						
	36	(914)					1.00	0.91						
	> 48	(1219)						1.00						

Table 9 — Load adjustment factors for M16, and M20, HSL-3-R anchors in cracked concrete [1,4]

M16 and M20 HSL-3-R Uncracked Concrete			Spacing Factor in Tension f_{AN}		Edge Distance Factor in Tension f_{RN}		Spacing Factor in Shear [2] f_{AV}		Edge Distance in Shear				Conc. Thickness Factor in Shear [3] f_{HV}	
									⊥ Toward Edge f_{RV}		‖ ‖ To Edge f_{RV}			
Nominal Diameter mm			M16	M20	M16	M20	M16	M20	M16	M20	M16	M20	M16	M20
Effective Embed. h_{ef} mm (in)			100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)	100 (3.94)	125 (4.92)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	4	(102)	0.67	n/a	0.76	n/a	0.55	n/a	0.17	n/a	0.33	n/a	n/a	n/a
	5	(127)	0.71	0.67	0.88	n/a	0.56	0.55	0.23	n/a	0.47	n/a	n/a	n/a
	5-7/8	(149)	0.75	0.70	1.00	0.84	0.57	0.56	0.30	0.23	0.59	0.46	n/a	n/a
	6	(152)	0.75	0.70	1.00	0.86	0.58	0.56	0.31	0.24	0.61	0.47	n/a	n/a
	7	(178)	0.80	0.74	1.00	0.96	0.59	0.57	0.39	0.30	0.77	0.60	n/a	n/a
	7-7/8	(200)	0.83	0.77	1.00	1.00	0.60	0.58	0.46	0.36	0.92	0.71	0.63	n/a
	8	(203)	0.84	0.77	1.00	1.00	0.60	0.59	0.47	0.36	0.94	0.73	0.64	n/a
	9	(229)	0.88	0.80	1.00	1.00	0.61	0.60	0.56	0.43	1.00	0.87	0.67	n/a
	9-1/2	(241)	0.90	0.82	1.00	1.00	0.62	0.60	0.61	0.47	1.00	0.94	0.69	n/a
	9-7/8	(251)	0.92	0.83		1.00	0.62	0.60	0.65	0.50		1.00	0.71	0.65
	10	(254)	0.92	0.84		1.00	0.63	0.61	0.66	0.51		1.00	0.71	0.65
	11	(279)	0.97	0.87		1.00	0.64	0.62	0.76	0.59		1.00	0.75	0.68
	11-7/8	(302)	1.00	0.90		1.00	0.65	0.63	0.85	0.66		1.00	0.77	0.71
	12	(305)		0.91			0.65	0.63	0.87	0.67			0.78	0.71
	13	(330)		0.94			0.66	0.64	0.98	0.75			0.81	0.74
	14	(356)		0.97			0.68	0.65	1.00	0.84			0.84	0.77
	15	(381)		1.00			0.69	0.66		0.94			0.87	0.80
	16	(406)					0.70	0.67		1.00			0.90	0.82
	18	(457)					0.73	0.69					0.95	0.87
	20	(508)					0.75	0.71					1.00	0.92
	24	(610)					0.80	0.76						1.00
	30	(762)					0.88	0.82						
	36	(914)					0.95	0.88						
	> 48	(1219)					1.00	1.00						

1 Linear interpolation not permitted.2 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

3 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

4 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

▨ — If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 of this section to calculate permissable edge distance and spacing combinations.

DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-1545. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures. For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

Table 10 — HSL-3-R stainless steel design information in accordance with CSA A23.3 Annex D [1]

Design parameter	Symbol	Units	Nominal anchor diameter					Ref A23.3
			M8	M10	M12	M16	M20	
Anchor O.D.	d_a	mm (in)	12 (0.47)	15 (0.59)	18 (0.71)	24 (0.94)	28 (1.10)	
Effective min. embedment [2]	h_{ef}	mm (in)	60 (2.36)	70 (2.76)	80 (3.15)	100 (3.94)	125 (4.92)	
Min. concrete thickness	h_{min}	-	See Table 5 of this document, or Table 5 of ESR-1545					
Critical edge distance	c_{ac}	-	See Table 5 of this document, or Table 5 of ESR-1545					
Minimum edge distance	c_{min}	-	See Table 5 of this document, or Table 5 of ESR-1545					
Minimum anchor spacing	s_{min}	-	See Table 5 of this document, or Table 5 of ESR-1545					
Min. specified yield strength HSL-3-R	f_{ya}	psi (N/mm^2)	81,200 (560)	65,300 (450)				
Min. specified yield strength HSL-3-GR		psi (N/mm^2)	81,200 (560)					
Min. specified yield strength HSL-3-SKR		psi (N/mm^2)	81,200 (560)	65,300 (450)		NA	NA	
Min. specified ult. strength	f_{ut}	psi (N/mm^2)	101,500 (700)					
Effective tensile stress area	$A_{se,N}$	in^2 (mm^2)	0.057 (36.6)	0.090 (58.0)	0.131 (84.3)	0.243 (157.0)	0.380 (245.0)	
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85					8.4.3
Resistance modification factor for tension, steel failure modes [3]	R	-	0.80					D.5.3
Resistance modification factor for shear, steel failure modes [3]	R	-	0.75					D.5.3
Factored steel resistance in tension	N_{sar}	lb (kN)	3,915 (17.4)	6,205 (27.6)	9,020 (40.1)	16,800 (74.7)	26,215 (116.6)	D.6.1.2
Factored steel resistance in shear HSL-3-R	V_{sar}	lb (kN)	6,365 (28.3)	8,985 (40.0)	11,665 (51.9)	18,375 (81.7)	20,810 (92.6)	D.7.1.2
Factored steel resistance in shear HSL-3-GR		lb (kN)	5,775 (25.7)	8,455 (37.6)	11,295 (50.2)	18,575 (82.6)	22,930 (102.0)	D.7.1.2
Factored steel resistance in shear HSL-3-SKR		lb (kN)	4,815 (21.4)	5,345 (23.8)	7,755 (34.5)	NA	NA	D.7.1.2
Factored steel resistance in shear, seismic — all versions	$V_{sar,eq}$	lb (kN)	1,735 (7.7)	4,230 (18.8)	4,515 (20.1)	9,170 (40.8)	9,170 (40.8)	
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10.0			11.3	12.6	D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	-	7.1	8.8	10.0			D.6.2.2
Modification factor for anchor resistance, tension, uncracked conc. [4]	$\psi_{c,N}$	-	1.0					D.6.2.6
Anchor category	-	-	3	2	2	1	1	D.5.3 (c)
Concrete material resistance factor	Φ_c	-	0.65					8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [5]	R	-	0.75	0.85	0.85	1.00	1.00	D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete [6]	$N_{pr,uncr}$	lb (kN)	1,870 (8.3)	NA				D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete [6]	$N_{pr,cr}$	lb (kN)	NA	2,700 (12.0)	NA	NA	8,310 (37.0)	D.6.3.2
Factored seismic pullout resistance in 20 MPa cracked concrete [6]	$N_{pr,eq}$	lb (kN)	1,620 (7.2)	2,700 (12.0)	3,985 (17.7)	6,565 (29.2)	8,310 (37.0)	
Load bearing length of anchor in shear	l_e	mm (in)	24 (0.94)	30 (1.18)	36 (1.42)	48 (1.89)	56 (2.20)	D.7.2.2

1 Design information in this table is taken from ICC-ES ESR-1545, table 4, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 and 2.
3 The HSL-3-R is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete (kc,cr) or uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-1545 for additional information.

Table 11 — Hilti HSL-3-R factored resistance with concrete / pullout failure in uncracked concrete [1,2,3,4]

Nominal anchor diameter	Effective embed. mm (in)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
M8	60	1,870	1,910	1,945	2,005	2,280	2,545	2,790	3,220
	(2.36)	(8.3)	(8.5)	(8.7)	(8.9)	(10.1)	(11.3)	(12.4)	(14.3)
M10	70	3,255	3,635	3,985	4,600	6,505	7,275	7,970	9,200
	(2.76)	(14.5)	(16.2)	(17.7)	(20.5)	(28.9)	(32.4)	(35.4)	(40.9)
M12	80	3,975	4,445	4,870	5,620	7,950	8,890	9,735	11,240
	(3.15)	(17.7)	(19.8)	(21.7)	(25.0)	(35.4)	(39.5)	(43.3)	(50.0)
M16	100	7,385	8,255	9,045	10,445	14,770	16,510	18,090	20,885
	(3.94)	(32.8)	(36.7)	(40.2)	(46.5)	(65.7)	(73.5)	(80.5)	(92.9)
M20	125	11,505	12,865	14,095	16,275	23,015	25,730	28,185	32,550
	(4.92)	(51.2)	(57.2)	(62.7)	(72.4)	(102.4)	(114.5)	(125.4)	(144.8)

Table 12 — Hilti HSL-3-R factored resistance with concrete / pullout failure in cracked concrete [1,2,3,4,5]

Nominal anchor diameter	Effective embed. mm (in)	Tension - N_r				Shear - V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
M8	60	1,615	1,810	1,980	2,285	1,615	1,810	1,980	2,285
	(2.36)	(7.2)	(8.0)	(8.8)	(10.2)	(7.2)	(8.0)	(8.8)	(10.2)
M10	70	2,705	3,020	3,310	3,825	5,725	6,400	7,010	8,095
	(2.76)	(12.0)	(13.4)	(14.7)	(17.0)	(25.5)	(28.5)	(31.2)	(36.0)
M12	80	3,975	4,445	4,870	5,620	7,950	8,890	9,735	11,240
	(3.15)	(17.7)	(19.8)	(21.7)	(25.0)	(35.4)	(39.5)	(43.3)	(50.0)
M16	100	6,535	7,305	8,005	9,240	13,070	14,615	16,005	18,485
	(3.94)	(29.1)	(32.5)	(35.6)	(41.1)	(58.1)	(65.0)	(71.2)	(82.2)
M20	125	8,310	9,295	10,180	11,755	18,265	20,420	22,370	25,830
	(4.92)	(37.0)	(41.3)	(45.3)	(52.3)	(81.3)	(90.8)	(99.5)	(114.9)

1 See Section 3.1.9 of Hilti Product Technical Guide Volume 2-21 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in Tables 6 through 9 as necessary. Compare to the steel values in Table 13. The lesser of the values is to be used for the design.
4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75. See Section 3.1.9 of Hilti Product Technical Guide Volume 2-21 for additional information on seismic applications.

Table 13 — Steel resistance for Hilti HSL-3-R anchors [1,2]

Nominal Anchor Diameter mm	HSL-3-R			HSL-3-GR			HSL-3-SKR		
	Tensile[3] N_{sar} lb (kN)	Shear[4] V_{sar} lb (kN)	Seismic Shear[5] $V_{sar,eq}$ lb (kN)	Tensile[3] Nsar lb (kN)	Shear[4] Vsar lb (kN)	Seismic Shear[5] Vsar,eq lb (kN)	Tensile[3] Nsar lb (kN)	Shear[4] Vsar lb (kN)	Seismic Shear[5] Vsar,eq lb (kN)
M8	3,915	6,365	1,735	3,915	5,775	1,735	3,915	6,365	1,735
	(17.4)	(28.3)	(7.7)	(17.4)	(25.7)	(7.7)	(17.4)	(28.3)	(7.7)
M10	6,205	8,985	4,230	6,205	8,455	4,230	6,205	8,985	4,230
	(27.6)	(40.0)	(18.8)	(27.6)	(37.6)	(18.8)	(27.6)	(40.0)	(18.8)
M12	9,020	11,665	4,515	9,020	11,295	4,515	9,020	11,665	4,515
	(40.1)	(51.9)	(20.1)	(40.1)	(50.2)	(20.1)	(40.1)	(51.9)	(20.1)
M16	16,800	18,375	9,170	16,800	18,575	9,170	-	-	-
	(74.7)	(81.7)	(40.8)	(74.7)	(82.6)	(40.8)			
M20	26,215	20,810	9,170	26,215	22,930	9,170	-	-	-
	(116.6)	(92.6)	(40.8)	(116.6)	(102.0)	(40.8)			

1 See Section 3.1.9 of Hilti Product Technical Guide Volume 2-21 to convert design strength value to ASD value.
2 Hilti HSL-3-R anchors are to be considered ductile steel elements.
2 Tensile = $A_{se,N}$ Φ_s f_{uta} R as noted in CSA A23.3 Annex D
4 Shear determined by static shear tests with $V_{sar} \leq 0.6$ $A_{se,V}$ Φ_s f_{uta} R as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \leq 0.60$ $A_{se,V}$ Φ_s f_{uta} R as noted in CSA A23.3 Annex D. See Section 3.1.9 of Hilti Product Technical Guide Volume 2-21 for additional information on seismic applications.

INSTALLATION INSTRUCTIONS

Installation Instructions for Use (IFU) are included with each product package. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION

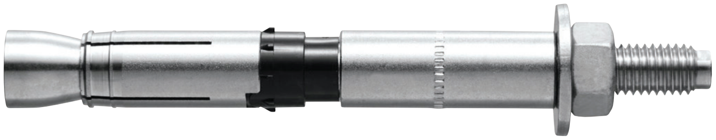
HSL-3-R bolt version

Description	Box qty
HSL-3-R M8 20/-/-	40
HSL-3-R M8 40/20/-	40
HSL-3-R M10 20/-/-	20
HSL-3-R M10 40/20/-	20
HSL-3-R M12 25/-/-	20
HSL-3-R M12 50/25/-	20
HSL-3-R M16 25/-/-	10
HSL-3-R M16 50/25/-	10
HSL-3-R M20 30/-/-	6
HSL-3-R M20 60/30/-	6

HSL-3-R

HSL-3-GR stud version

Description	Box qty
HSL-3-GR M8 20/-/-	40
HSL-3-GR M8 100/80/60	40
HSL-3-GR M10 20/-/-	20
HSL-3-GR M10 100/80/60	20
HSL-3-GR M12 25/-/-	20
HSL-3-GR M12 100/75/50	20
HSL-3-GR M16 25/-/-	10
HSL-3-GR M16 100/75/50	10
HSL-3-GR M20 30/-/-	6
HSL-3-GR M20 100/70/40	6



HSL-3-GR

HSL-3-SKR countersunk version

Description
HSL-3-SKR M8/10
HSL-3-SKR M8/20
HSL-3-SKR M10/20
HSL-3-SKR M12/25

HSL-3-SKR

HSL-3-SKR available by special order

3.3.4 HSL-GR STAINLESS STEEL HEAVY DUTY EXPANSION ANCHORS

PRODUCT DESCRIPTION

HSL-GR stainless steel heavy-duty expansion anchors

Anchor System	Features and Benefits
HSL-GR Heavy-duty Expansion Anchor 	• Type 316 stainless steel • High load capacity • Reliable clamping to help overcome gaps between fixture and concrete • Force-controlled expansion • HSL-GR will not spin during application of installation torque

Uncracked concrete

MATERIAL SPECIFICATIONS

Stainless steel threaded rod conforms to DIN 267, Type A4-70, f_{ya} = 65 ksi, $f_{uta} \geq$ 102 ksi.

Stainless steel expansion sleeve conforms to DIN 17440, $f_{uta} \geq$ 102 ksi.

Stainless steel cone conforms to DIN 17440, $f_{uta} \geq$ 102 ksi.

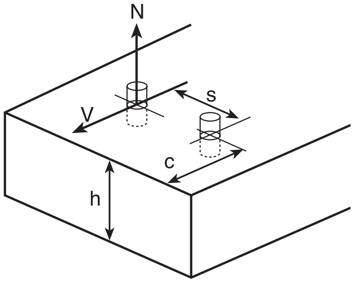
Stainless steel washer conforms to DIN 17441, 74 ksi $\leq f_{uta} \leq$ 103 ksi.

Stainless steel nut conforms to DIN 934.

Collapsible sleeve is made of Acetal resin plastic.

DESIGN DATA IN CONCRETE PER ALLOWABLE STRESS DESIGN

Anchor spacing and edge distance guidelines



Anchor spacing adjustment factors

s = Actual spacing

$s_{min} = 1.0\,h_{nom}$

$s_{cr} = 3.0\,h_{ef}$

Edge distance adjustment factors

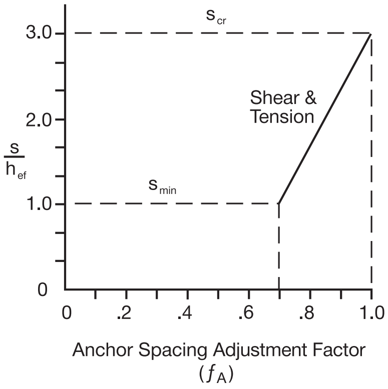
c = Actual edge distance

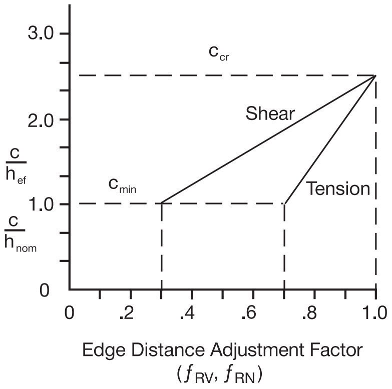
$c_{min} = 1.0\,h_{nom}$ $c_{cr} = 2.5\,h_{ef}$	Tension
$c_{min} = 1.0\,h_{nom}$ $c_{cr} = 2.5\,h_{nom}$	Shear

Anchor Size	h_{nom} mm	h_{nom} (in.)
M10	75	(3)
M12	80	(3-3/16)
M16	105	(4-1/8)
M20	130	(5-1/8)

h_{ef} - actual embedment depth

h_{nom} - standard embedment depth





Load adjustment factors (anchor spacing) f_A						Load adjustment factors (edge distance) f_R									
Tension/Shear						Tension f_{RN}						Shear f_{RV}			
Spacing s		Anchor diameter				Edge distance c		Anchor diameter				Anchor diameter			
mm	(in.)	M10	M12	M16	M20	mm	(in.)	M10	M12	M16	M20	M10	M12	M16	M20
65	(2-1/2)					65	(2-1/2)								
75	(3)	.70				75	(3)	.70				.30			
80	(3-1/8)	.71	.70			80	(3-1/8)	.71	.70			.33	.30		
105	(4-1/8)	.76	.74	.70		105	(4-1/8)	.78	.76	.70		.48	.44	.30	
130	(5-1/8)	.81	.79	.73	.70	130	(5-1/8)	.85	.83	.74	.70	.64	.59	.41	.30
155	(6-1/8)	.86	.84	.77	.72	155	(6-1/8)	.91	.88	.79	.73	.80	.74	.52	.39
175	(6-7/8)	.90	.87	.80	.75	162	(6-3/8)	.93	.90	.80	.75	.84	.78	.55	.41
195	(7-5/8)	.94	.91	.82	.77	187	(7-3/8)	1.0	.96	.85	.78	1.0	.92	.66	.50
225	(8-7/8)	1.0	.97	.87	.80	200	(7-7/8)		1.0	.88	.80		1.0	.72	.55
240	(9-3/8)		1.0	.89	.82	225	(8-7/8)			.92	.84			.83	.64
275	(10-3/4)			.94	.86	265	(10-3/8)			1.0	.91			1.0	.79
315	(12-3/8)			1.0	.91	275	(10-3/4)				.92			1.0	.82
350	(13-3/4)				.95	300	(11-3/4)				.96				.91
395	(15-1/2)				1.0	325	(12-3/4)				1.0				1.0
430	(17)					350	(13-3/4)								
470	(18-1/2)					390	(15-3/8)								

$s_{min} = 1.0\,h_{nom}$ $s_{cr} = 3.0\,h_{ef}$

$$f_A = 0.15\,\frac{s}{h_{ef}} + 0.55$$

for $s_{cr} > s > s_{min}$

$c_{min} = 1.0\,h_{nom}$ $c_{cr} = 2.5\,h_{ef}$

$$f_{RN} = (0.30)\left(\frac{c - 1.0\,h_{nom}}{2.5\,h_{ef} - 1.0\,h_{nom}}\right) + 0.70$$

for $c_{cr} > c > c_{min}$

$c_{min} = 1.0\,h_{nom}$ $c_{cr} = 2.5\,h_{nom}$

$$f_{RV} = 0.47\,\frac{c}{h_{nom}} - 0.17$$

for $c_{cr} > c > c_{min}$

Table 2 — Stainless steel Hilti HSL-GR allowable loads in normal-weight concrete[1]

Nominal anchor diameter	Nominal embedment mm (in.)	f'_c = 2,000 psi		f'_c = 3,000 psi		f'_c = 4,000 psi		f'_c = 6,000 psi	
		Tension kN (lb)	Shear kN (lb)	Tension kN (lb)	Shear kN (lb)	Tension kN (lb)	Shear kN (lb)	Tension kN (lb)	Shear kN (lb)
M10	75	6.8	13.7	9.1	14.8	11.5	15.8	11.5	16.4
	(3)	(1,535)	(3,090)	(2,055)	(3,325)	(2,575)	(3,560)	(2,595)	(3,690)
M12	80	8.7	20.2	11.3	21.8	13.8	23.3	17.5	25.0
	(3-3/16)	(1,960)	(4,540)	(2,530)	(4,890)	(3,105)	(5,245)	(3,925)	(5,615)
M16	105	17.6	34.7	20.9	39.9	24.2	45.0	30.7	46.9
	(4-1/8)	(3,965)	(7,805)	(4,705)	(8,965)	(5,450)	(10,125)	(6,900)	(10,550)
M20	130	25.1	52.9	30.7	58.7	36.4	64.5	44.5	64.5
	(5-1/8)	(5,650)	(11,900)	(6,910)	(13,195)	(8,175)	(14,490)	(10,005)	(14,490)

[1] Allowable loads calculated using a factor of safety of 3.5.

Table 3 — Stainless steel Hilti HSL-GR ultimate loads in normal-weight concrete

Nominal anchor diameter	Nominal embedment mm (in.)	f'_c = 2,000 psi		f'_c = 3,000 psi		f'_c = 4,000 psi		f'_c = 6,000 psi	
		Tension kN (lb)	Shear kN (lb)	Tension kN (lb)	Shear kN (lb)	Tension kN (lb)	Shear kN (lb)	Tension kN (lb)	Shear kN (lb)
M10	75	23.8	47.8	31.9	51.6	40.0	55.2	40.3	57.3
	(3)	(5,350)	(10,785)	(7,165)	(11,595)	(8,985)	(12,410)	(9,055)	(12,880)
M12	80	30.4	70.5	39.3	75.9	48.2	81.4	60.9	87.1
	(3-3/16)	(6,830)	(15,845)	(8,830)	(17,070)	(10,835)	(18,300)	(13,700)	(19,590)
M16	105	61.6	121.1	73.0	139.1	84.5	157.1	107.0	163.7
	(4-1/8)	(13,840)	(27,220)	(16,420)	(31,270)	(19,005)	(35,320)	(24,065)	(36,800)
M20	130	87.7	184.7	107.3	204.7	126.9	224.8	155.3	224.8
	(5-1/8)	(19,715)	(41,510)	(24,115)	(46,025)	(28,520)	(50,540)	(34,910)	(50,540)

Combined shear and tension loading

$$\left(\frac{N_d}{N_{rec}}\right)^{5/3} + \left(\frac{V_d}{V_{rec}}\right)^{5/3} \leq 1.0$$

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION

Stainless Steel Heavy-duty Expansion Anchor (31655)

Description	Box qty
M 10/20	20
M 12/25	20
M 16/25	10
M 20/30	6

ONE TOOL
MANY FEATURES
HILTI SIW 6AT
PLUS SI-AT MODULE

Installation. Documentation. Greater quality assurance.

Display provides information regarding selected anchor and settings

Scan bar codes on Hilti packaging to automatically adjust the setting

A quick glance lets you know if your installation was adequately pretensioned thanks to the SIW 6AT's brightly-lit LED displays

Simple navigation buttons

Lock button

WORKS ACCORDING TO PLAN

Hilti SIW 6AT plus SI-AT module for setting of Hilti expansion anchors.

Have more confidence that your design is installed properly on the jobsite with Hilti's new Adaptive Torque system! Hilti's next-generation intelligent impact wrench features adaptive torque technology, which allows for project documentation and greater quality assurance of installation. Hilti SIW 6AT Tool and SI-AT module quickly and definitively confirms that the anchor is adequately pretensioned without a calibrated torque wrench.

APPLICATIONS

Hilti KB-TZ2 and KB1 (3/8" diameter to 5/8 diameter sizes) expansion anchors used in:

- Specified structural applications
- Safety-relevant applications
- Less critical applications, e.g. securing lightweight ducts, lighting, and wiring in seismic risk areas
- Applications which require documentation and greater quality assurance

Lock and load

Hilti expansion anchors such as KB-TZ2 are secured by applying a specific torque to the nut. These anchor types derive tension resistance through the friction generated by expansion forces against the wall of the drilled hole. The torque generates the necessary expansion forces and pretension in the anchor to achieve its performance.

HIGHLIGHTS

- Automated project documentation and quality assurance
- Tested and approved in accordance with international standards (ETA and ICC-ES)
- Automatic update of new products, firmware, user-interface, functionality, etc.
- Verify the anchor was adequately pretensioned

HOW IT WORKS

The Hilti SIW 6AT plus SI-AT module is calibrated to install anchors with the appropriate pretension, similar to that provided by installing with a calibrated torque wrench.

DONE RIGHT EVERY TIME - ONLY WITH SAFESET

The best design method and your most accurate design are contingent on contractors following your specifications, in addition to proper installation.

The SIW 6AT is part of Hilti's Safeset solution and helps eliminate installation ambiguity almost entirely.

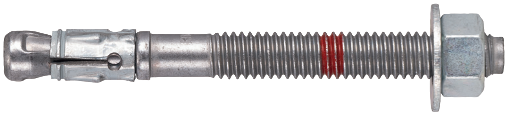
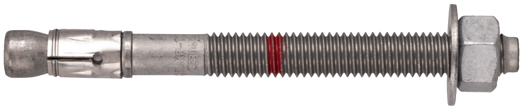
Developed as a total system, all SafeSet components feature intuitive elements that make installations simple, seamless, and faster than ever before.

SAFESET

3.3.5 KWIK BOLT TZ2 EXPANSION ANCHOR

PRODUCT DESCRIPTION

KWIK BOLT TZ2 Expansion anchor

Anchor System	Features and Benefits
 Carbon steel KB-TZ2  Stainless Steel 304/316 KB-TZ2	• IFU provides multiple installation methods including no hole cleaning with hammer drill, Hilti Dust Removal System (DRS) for virtually dustless installation (OSHA 1926.1153 Table 1 compliant) and core drilling installation. • More accurate SafeSet™ installation when using the Hilti SIW-6AT-A22 impact wrench and the SI-AT-A22 Adaptive Torque Module. • Product and length identification marks help facilitate quality control after installation. • Maximized thread lengths and multiple embedment depths to accommodate various base plate thicknesses. • Mechanical expansion allows immediate load application. • Raised impact section (dog point) helps protect threads from damage during installation. • Bolt meets ductility requirements of ACI 318 Section 2.3. • Functional coatings and profile on expansion wedges provide increased reliability.

Uncracked concrete	Cracked concrete	Grout-filled concrete masonry	Seismic Design Categories A-F	Fire sprinkler listings	Profis Engineering design software	Hollow Drill Bit and Adaptive Torque Tool (AT)

Approvals/ Listings

ICC-ES (International Code Council) • 2021 International Building Code / International Residential Code (IBC/IRC) • 2015 National Building Code of Canada (NBC-C)	ESR-4266 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193 ESR-4561 in grout-filled CMU per ICC-ES AC01 ELC-4266 in concrete per CSA A23.3 / ACI 355.2
City of Los Angeles	2020 LABC Supplement (within ESR-4266 & ESR-4561)
Florida Building Code	2020 FBC Supplement with HVHZ (within ESR-4266 & ESR-4561)
FM (Factory Mutual) — Carbon steel KB-TZ2 only	Pipe hanger components for automatic sprinkler systems 3/8 (up to 4-inch nominal pipe diameter) 1/2[1] (up to 8-inch nominal pipe diameter) 3/4 (up to 12-inch nominal pipe diameter)
UL and cUL (Underwriters Laboratory) — Carbon steel KB-TZ2 only	Pipe hanger equipment for fire protection services 3/8 (up to 4-inch nominal pipe diameter) 1/2[1] (up to 8-inch nominal pipe diameter) 5/8 & 3/4 (up to 12-inch nominal pipe diameter)
ANSI/MSS SP-58-2018	Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information.

APPROVED

LISTED

Pipe Hanger
757G

---

[1] 1/2-inch dia. with 1-1/2-inch effective embedment does not have FM or UL certification.

MATERIAL SPECIFICATIONS

Carbon steel with electroplated zinc-nickel plating

- Carbon steel anchor components plated in accordance with ASTM F1941 to a minimum thickness of 5 µm.
- Nuts conform to the requirements of ASTM A563, Grade A, Hex.
- Washers meet the requirements of ASTM F844.
- Expansion sleeves (wedges) are manufactured from carbon or stainless steel.
- Nuts and bolts are finished with a proprietary coating. Only Hilti KB-TZ2 nuts can be used with KB-TZ2 bolts.
- Carbon steel bolts are manufactured from carbon steel.

Stainless steel

- All nuts and washers for type 304 anchors are made from type 304 stainless.
- All nuts and washers for type 316 anchors are made from type 316 stainless.
- Nuts meet the dimensional requirements of ASTM F594.
- Washers meet the dimensional requirements of ANSI B18.22.1, Type A, plain.
- Expansion sleeve (wedges) are made from stainless steel.
- Nuts and bolts are finished with a proprietary coating. Only Hilti KB-TZ2 nuts can be used with KB-TZ2 bolts.
- Stainless steel 304 bolts are manufactured from AISI Type 304 stainless steel.
- Stainless steel 316 bolts are manufactured from AISI Type 316 stainless steel.

INSTALLATION PARAMETERS

Table 1 — Hilti KB-TZ2 setting information for installation in concrete and grout-filled concrete masonry units (CMU)[1]

	Setting information	Symbol	Units	Nominal anchor diameter (in)															
				1/4	3/8			1/2				5/8			3/4			1	
	Nominal bit diameter	d_o	in.	1/4	3/8			1/2				5/8			3/4			1	
	Effective minimum embedment	h_{ef}	in.	1-1/2	1-1/2	2	2-1/2	1-1/2 [2]	2	2-1/2	3-1/4	2-3/4	3-1/4	4	3-1/4	3-3/4	4-3/4	4	5-3/4
			(mm)	(38)	(38)	(51)	(64)	(38)	(51)	(64)	(83)	(70)	(83)	(102)	(83)	(95)	(121)	(102)	(146)
	Nominal minimum embedment	h_{nom}	in.	1-3/4	1-7/8	2-1/2	3	2 2)	2-1/2	3	3-3/4	3-1/4	3-3/4	4-1/2	4	4-1/2	5-1/2	4-5/8	6-3/8
			(mm)	(44)	(48)	(64)	(76)	(51)	(64)	(76)	(95)	(83)	(95)	(114)	(102)	(114)	(140)	(117)	(162)
	Min. hole depth	h_o	in.	2	2	2-3/4	3-1/4	2-1/4 [2]	2-3/4	3-1/4	4-1/4	3-3/4	4-1/4	4-3/4	4-1/4	4-3/4	5-3/4	5	6-3/4
			(mm)	(51)	(51)	(70)	(83)	(57)	(70)	(83)	(108)	(95)	(108)	(121)	(108)	(121)	(146)	(127)	(171)
	Fixture hole diameter	d_h	in.	5/16	7/16			9/16				11/16			13/16			1-1/8	
			(mm)	(7.9)	(11.1)			(14.3)				(17.5)			(20.6)			(28.6)	
Concrete	Installation torque Carbon steel	$T_{inst,conc}$	ft-lb	4	30			50				40			110			185	
			(Nm)	(5)	(41)			(68)				(54)			(149)			(251)	
	Installation torque Stainless steel	$T_{inst,conc}$	ft-lb	6	30			40				60			125			185	
			(Nm)	(8)	(41)			(54)				(81)			(169)			(251)	
Grout-filled CMU	Installation torque Carbon steel	$T_{inst,CMU}$	ft-lb	4	15			25				30			50			N/A	
			(Nm)	(5)	(20)			(34)				(41)			(68)			N/A	
	Installation torque Stainless steel	$T_{inst,CMU}$	ft-lb	6	15			25				35			50			N/A	
			(Nm)	(8)	(20)			(34)				(48)			(68)			N/A	

1 Shaded cells are not applicable for installations in grout-filled CMU.

2 Design information for h_{ef} = 1-1/2 is only applicable to carbon steel (CS) KB-TZ2 bolts.

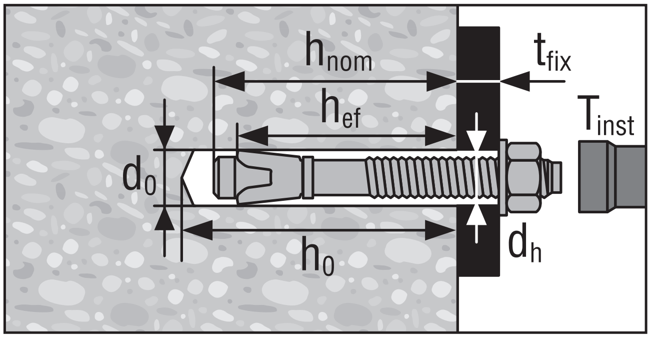
Hilti KWIK Bolt TZ2 Fracture Load (lb)[1]

Nominal Anchor Diameter (in)	Carbon Steel	Stainless Steel
1/4	2920	2920
3/8	6490	6180
1/2	11240	11870
5/8	17535	18835
3/4	25335	$f_{uta} \geq 105$, $f_y \geq 84$ [2]
1	$f_{uta} \geq 88$, $f_y \geq 75$ [2]	$f_{uta} \geq 99.9$, $f_y \geq 65$ [2]

1 Bolt fracture loads are determined by testing in a universal tensile machine for quality control at the manufacturing facility. These loads are not intended for design use.

2 All 3/4-in. stainless steel, all 1-in. carbon steel and all 1-in. stainless steel material strengths specified by the tensile and yield strengths expressed in (ksi). Bolt fracture loads not applicable for these models.

Figure 1 — Hilti KWIK Bolt TZ 2 specifications



DESIGN INFORMATION IN CONCRETE PER ACI 318

ACI 318 Chapter 17 Design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ICC-ES ESR-4266 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables refer to section 3.1.8. Data tables from ESR-4266 are not contained in this section but can be found at www.icc-es.org or at www.hilti.com

Table 2 — Hilti Carbon Steel KB-TZ2 design strength based on concrete failure modes in uncracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
1/4	1-1/2 (38)	1 3/4 (44)	945 (4.2)	980 (4.4)	1,040 (4.6)	1,125 (5.0)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
3/8	1-1/2 (38)	1 7/8 (48)	1,435 (6.4)	1,570 (7.0)	1,815 (8.1)	2,220 (9.9)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
	2 (51)	2 1/2 (64)	2,205 (9.8)	2,415 (10.7)	2,790 (12.4)	3,420 (15.2)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	2-1/2 (64)	3 (76)	2,715 (12.1)	2,895 (12.9)	3,205 (14.3)	3,690 (16.4)	6,640 (29.5)	7,275 (32.4)	8,400 (37.4)	10,290 (45.8)
1/2	1-1/2 (38)	2 (51)	1,610 (7.2)	1,765 (7.9)	2,040 (9.1)	2,495 (11.1)	1,735 (7.7)	1,900 (8.5)	2,195 (9.8)	2,690 (12.0)
	2 (51)	2 1/2 (64)	2,480 (11.0)	2,720 (12.1)	3,140 (14.0)	3,845 (17.1)	2,675 (11.9)	2,930 (13.0)	3,380 (15.0)	4,140 (18.4)
	2-1/2 (64)	3 (76)	3,085 (13.7)	3,375 (15.0)	3,900 (17.3)	4,775 (21.2)	6,640 (29.5)	7,275 (32.4)	8,400 (37.4)	10,290 (45.8)
	3-1/4 (83)	3 3/4 (95)	4,570 (20.3)	5,005 (22.3)	5,780 (25.7)	7,080 (31.5)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	2-3/4 (70)	3 1/4 (83)	3,495 (15.5)	3,830 (17.0)	4,425 (19.7)	5,420 (24.1)	7,660 (34.1)	8,395 (37.3)	9,690 (43.1)	11,870 (52.8)
	3-1/4 (83)	3 3/4 (95)	4,570 (20.3)	5,005 (22.3)	5,780 (25.7)	7,080 (31.5)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
	4 (102)	4 1/2 (114)	5,845 (26.0)	6,405 (28.5)	7,395 (32.9)	9,060 (40.3)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-1/4 (83)	4 (102)	5,140 (22.9)	5,630 (25.0)	6,505 (28.9)	7,965 (35.4)	11,075 (49.3)	12,130 (54.0)	14,005 (62.3)	17,155 (76.3)
	3-3/4[5] (95)	4 1/2 (114)	6,370 (28.3)	6,980 (31.0)	8,060 (35.9)	9,870 (43.9)	13,725 (61.1)	15,035 (66.9)	17,360 (77.2)	21,265 (94.6)
	4-3/4 (121)	5 1/2 (140)	8,075 (35.9)	8,845 (39.3)	10,215 (45.4)	12,510 (55.6)	17,390 (77.4)	19,050 (84.7)	22,000 (97.9)	26,945 (119.9)
1	4 (102)	4 5/8 (117)	7,020 (31.2)	7,690 (34.2)	8,880 (39.5)	10,875 (48.4)	15,120 (67.3)	16,565 (73.7)	19,125 (85.1)	23,425 (104.2)
	5-3/4 (146)	6 3/8 (162)	10,755 (47.8)	11,780 (52.4)	13,605 (60.5)	16,660 (74.1)	23,165 (103.0)	25,375 (112.9)	29,300 (130.3)	35,885 (159.6)

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 15 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60.
5 For core drilled installations of 3/4" anchors installed at 3-3/4" effective embedment, apply a reduction factor of 0.89 to the design tension strength.

Table 3 — Hilti Carbon Steel KB-TZ2 design strength based on concrete failure modes in cracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4,5]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
1/4	1-1/2 (38)	1 3/4 (44)	280 (1.2)	300 (1.3)	340 (1.5)	395 (1.8)	1,095 (4.9)	1,195 (5.3)	1,385 (6.2)	1,695 (7.5)
3/8	1-1/2 (38)	1 7/8 (48)	1,255 (5.6)	1,375 (6.1)	1,585 (7.1)	1,940 (8.6)	1,350 (6.0)	1,480 (6.6)	1,710 (7.6)	2,090 (9.3)
	2 (51)	2 1/2 (64)	1,930 (8.6)	2,115 (9.4)	2,440 (10.9)	2,990 (13.3)	2,080 (9.3)	2,275 (10.1)	2,630 (11.7)	3,220 (14.3)
	2-1/2 (64)	3 (76)	2,185 (9.7)	2,390 (10.6)	2,765 (12.3)	3,385 (15.1)	4,705 (20.9)	5,155 (22.9)	5,950 (26.5)	7,285 (32.4)
1/2	1-1/2 (38)	2 (51)	1,435 (6.4)	1,570 (7.0)	1,815 (8.1)	2,220 (9.9)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
	2 (51)	2 1/2 (64)	1,930 (8.6)	2,115 (9.4)	2,440 (10.9)	2,990 (13.3)	2,080 (9.3)	2,275 (10.1)	2,630 (11.7)	3,220 (14.3)
	2-1/2 (64)	3 (76)	2,700 (12.0)	2,955 (13.1)	3,415 (15.2)	4,180 (18.6)	5,810 (25.8)	6,365 (28.3)	7,350 (32.7)	9,000 (40.0)
	3-1/4 (83)	3 3/4 (95)	3,235 (14.4)	3,545 (15.8)	4,095 (18.2)	5,015 (22.3)	6,970 (31.0)	7,640 (34.0)	8,820 (39.2)	10,800 (48.0)
5/8	2-3/4 (70)	3 1/4 (83)	3,110 (13.8)	3,410 (15.2)	3,935 (17.5)	4,820 (21.4)	6,705 (29.8)	7,345 (32.7)	8,480 (37.7)	10,385 (46.2)
	3-1/4 (83)	3 3/4 (95)	4,000 (17.8)	4,380 (19.5)	5,060 (22.5)	6,195 (27.6)	8,615 (38.3)	9,435 (42.0)	10,895 (48.5)	13,345 (59.4)
	4 (102)	4 1/2 (114)	4,420 (19.7)	4,840 (21.5)	5,590 (24.9)	6,845 (30.4)	9,520 (42.3)	10,430 (46.4)	12,040 (53.6)	14,750 (65.6)
3/4	3-1/4 (83)	4 (102)	4,000 (17.8)	4,380 (19.5)	5,060 (22.5)	6,195 (27.6)	8,615 (38.3)	9,435 (42.0)	10,895 (48.5)	13,345 (59.4)
	3-3/4 (95)	4 1/2 (114)	4,955 (22.0)	5,430 (24.2)	6,270 (27.9)	7,680 (34.2)	10,675 (47.5)	11,695 (52.0)	13,505 (60.1)	16,540 (73.6)
	4-3/4 (121)	5 1/2 (140)	5,745 (25.6)	6,055 (26.9)	6,580 (29.3)	7,405 (32.9)	15,220 (67.7)	16,670 (74.2)	19,250 (85.6)	23,575 (104.9)
1	4 (102)	4 5/8 (117)	5,460 (24.3)	5,980 (26.6)	6,905 (30.7)	8,460 (37.6)	11,760 (52.3)	12,880 (57.3)	14,875 (66.2)	18,220 (81.0)
	5-3/4 (146)	6 3/8 (162)	7,675 (34.1)	8,410 (37.4)	9,710 (43.2)	11,890 (52.9)	20,270 (90.2)	22,205 (98.8)	25,640 (114.1)	31,400 (139.7)

1 See Section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 17 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.

4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60.

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.73. No reduction needed for seismic shear. See Section 3.1.8 for additional information on seismic applications.

Table 4 — Hilti Carbon Steel KB-TZ2 design strength based on steel failure per ACI 318 Ch. 17 [1,2]

Nominal anchor diameter in.	Effective embedment depth in. (mm)			Tensile [3] ϕN_{sa} lb (kN)	Shear [4] ϕV_{sa} lb (kN)	Seismic Shear [5] ϕV_{sa} lb (kN)
1/4	1-1/2 (38)			2,190 (9.7)	875 (3.9)	875 (3.9)
3/8	1-1/2 (38)			4,870 (21.7)	2,095 (9.3)	2,095 (9.3)
3/8	2 (51)		2-1/2 (64)	4,870 (21.7)	2,200 (9.8)	2,200 (9.8)
1/2	1-1/2 (38)		2 (51)	8,430 (37.5)	3,600 (16.0)	3,600 (16.0)
1/2	2-1/2 (64)		3-1/4 (83)	8,430 (37.5)	4,470 (19.9)	4,470 (19.9)
5/8	2-3/4 (70)	3-1/4 (83)	4 (102)	13,150 (58.5)	6,665 (29.6)	6,665 (29.6)
3/4	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	19,000 (84.5)	8,975 (39.9)	8,975 (39.9)
1 (25.4)	4 (102)			31,025 (138.0)	12,215 (54.3)	8,975 (39.9)
1 (25.4)	5-3/4 (146)			31,025 (138.0)	14,875 (66.2)	8,975 (39.9)

1 See Section 3.1.8 to convert design strength value to ASD value.

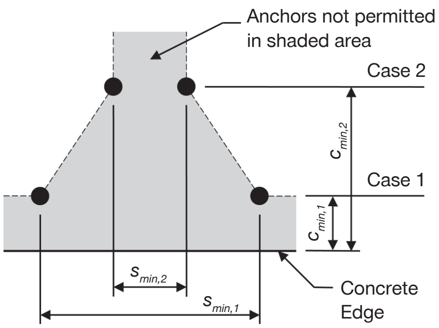
2 Hilti KB-TZ2 carbon steel anchors are to be considered ductile steel elements.

3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Ch. 17.

4 Shear values determined by static shear tests with $\phi V_{sa} < \phi$ 0.60 $A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.

5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi$ 0.60 $A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17. See Section 3.1.8 for additional information on seismic applications.

Figure 2



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}(c - c_{min,2})$$

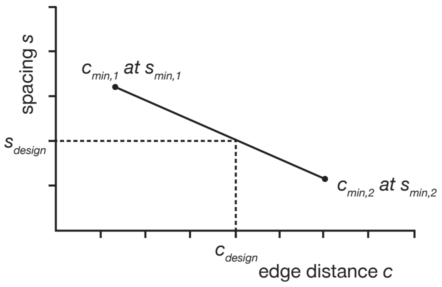


Table 5 — Hilti KB-TZ2 carbon steel installation parameters [1]

Setting information	Symbol	Units	Nominal Anchor diameter (in.)															
			1/4	3/8			1/2				5/8			3/4			1	
Effective embedment	h_{ef}	in.	1-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	3 1/4	2-3/4	3-1/4	4	3-1/4	3-3/4	4-3/4	4	5-3/4
		(mm)	(38)	(38)	(51)	(64)	(38)	(51)	(64)	(83)	(70)	(83)	(102)	(83)	(95)	(121)	(102)	(146)
Min. member thickness	h_{min}	in.	3-1/4	3-1/4	4	5	3-1/2	4	5	5-1/2	5	5-1/2	6	5-1/2	6	8	8	10
		(mm)	(83)	(83)	(102)	(127)	(89)	(102)	(127)	(140)	(127)	(140)	(152)	(140)	(152)	(203)	(203)	(254)
Case 1	$c_{min,1}$	in.	1-1/2	5	2-1/2	2-1/2	8	2-3/4	2-3/4	2-1/4	4-1/2	3-1/2	2-3/4	5	4	3-1/2	8	3
		(mm)	(38)	(127)	(64)	(64)	(203)	(70)	(70)	(57)	(114)	(89)	(70)	(127)	(102)	(89)	(203)	(76)
	for $s_{min,1} \geq$	in.	1-1/2	8	6	5	12	5-1/2	9-3/4	5-1/4	6-1/2	5-1/2	7-1/4	10	5-3/4	5-1/2	8	6-3/4
		(mm)	(38)	(203)	(152)	(127)	(305)	(140)	(248)	(133)	(165)	(140)	(184)	(254)	(146)	(140)	(203)	(171)
Case 2	$c_{min,2}$	in.	1-1/2	8	3-1/2	4	8	10	8	4-3/4	5-1/2	7	4-1/4	6	7-1/4	4-3/4	8	3-3/4
		(mm)	(38)	(203)	(89)	(102)	(203)	(254)	(203)	(121)	(140)	(178)	(108)	(152)	(184)	(121)	(203)	(95)
	for $s_{min,2} \geq$	in.	1-1/2	5	2-1/4	2	12	3-1/2	3	2	4-1/2	2-3/4	2-1/4	4-1/2	3-3/4	3-3/4	8	4-3/4
			(38)	(127)	(57)	(51)	(305)	(89)	(76)	(51)	(114)	(70)	(57)	(114)	(95)	(95)	(203)	(121)

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$, will determine the permissible spacings.

Table 6 — Load adjustment factors for Carbon Steel 1/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

1/4-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear [3] f_{AV}	⊥ Toward edge f_{RV}	∥ To edge f_{RV}	Concrete thickness factor in shear [4] f_{HV}
Effective Embedment h_{ef}		in.	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2
		(mm)	(38)	(38)	(38)	(38)	(38)	(38)
Nominal Embedment h_{nom}		in.	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4
		(mm)	(44)	(44)	(44)	(44)	(44)	(44)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2	(38)	0.67	0.42	0.56	0.23	0.42	n/a
	2	(51)	0.72	0.51	0.58	0.35	0.51	n/a
	2-1/2	(64)	0.78	0.63	0.60	0.49	0.63	n/a
	3	(76)	0.83	0.75	0.63	0.65	0.75	n/a
	3-1/4	(83)	0.86	0.81	0.64	0.73	0.81	0.74
	3-1/2	(89)	0.89	0.88	0.65	0.82	0.88	0.76
	4	(102)	0.94	1.00	0.67	1.00	1.00	0.82
	5	(127)	1.00		0.71			0.91
	6	(152)			0.75			1.00
	7	(178)			0.79			
	8	(203)			0.83			
	9	(229)			0.88			
	> 12	(305)			1.00			

Table 7 — Load adjustment factors for Carbon Steel 1/4-in. diameter KB-TZ2 in cracked concrete [1,2]

1/4-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear [3] f_{AV}	⊥ Toward edge f_{RV}	∥ To edge f_{RV}	Concrete thickness factor in shear [4] f_{HV}
Effective Embedment h_e		in.	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2
		(mm)	(38)	(38)	(38)	(38)	(38)	(38)
Nominal Embedment h_{nom}		in.	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4
		(mm)	(44)	(44)	(44)	(44)	(44)	(44)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2	(38)	0.67	0.75	0.57	0.29	0.59	n/a
	2	(51)	0.72	0.91	0.60	0.45	0.91	n/a
	2-1/2	(64)	0.78	1.00	0.62	0.63	1.00	n/a
	3	(76)	0.83		0.65	0.83		n/a
	3-1/4	(83)	0.86		0.66	0.94		0.80
	3-1/2	(89)	0.89		0.67	1.00		0.83
	4	(102)	0.94		0.70			0.89
	5	(127)	1.00		0.75			0.99
	6	(152)			0.80			1.00
	7	(178)			0.84			
	8	(203)			0.89			
	9	(229)			0.94			
	> 12	(305)			1.00			

[1] Linear interpolation not permitted

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

[3] Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

Table 8 — Load adjustment factors for Carbon Steel 3/8-in. diameter KB-TZ2 in uncracked concrete [1,2]

3/8-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}		in. (mm)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)
Nominal Embedment h_{nom}		in. (mm)	1-7/8 (48)	2-1/2 (64)	3 (76)	1-7/8 (48)	2-1/2 (64)	3 (76)	1-7/8 (48)	2-1/2 (64)	3 (76)	1-7/8 (48)	2-1/2 (64)	3 (76)	1-7/8 (48)	2-1/2 (64)	3 (76)	1-7/8 (48)	2-1/2 (64)	3 (76)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2	(51)	n/a	n/a	▨ 0.63	n/a	n/a	n/a	n/a	n/a	▨ 0.54	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	▨ 0.69	▨ 0.65	n/a	n/a	n/a	n/a	▨ 0.59	▨ 0.55	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	n/a	▨ 0.71	▨ 0.67	n/a	▨ 0.60	▨ 0.51	n/a	▨ 0.60	▨ 0.55	n/a	▨ 0.43	▨ 0.18	n/a	▨ 0.60	▨ 0.37	n/a	n/a	n/a
	3	(76)	n/a	▨ 0.75	▨ 0.70	n/a	▨ 0.69	▨ 0.58	n/a	▨ 0.61	▨ 0.56	n/a	▨ 0.57	▨ 0.24	n/a	▨ 0.69	▨ 0.48	n/a	n/a	n/a
	3-1/4	(83)	n/a	▨ 0.77	▨ 0.72	n/a	▨ 0.74	▨ 0.61	n/a	▨ 0.62	▨ 0.57	n/a	▨ 0.64	▨ 0.27	n/a	▨ 0.74	▨ 0.54	0.66	n/a	n/a
	3-1/2	(89)	n/a	▨ 0.79	▨ 0.73	n/a	0.80	▨ 0.65	n/a	▨ 0.63	▨ 0.58	n/a	0.72	▨ 0.30	n/a	0.80	▨ 0.61	0.68	n/a	n/a
	4	(102)	n/a	▨ 0.83	▨ 0.77	n/a	0.91	0.73	n/a	▨ 0.65	▨ 0.59	n/a	0.87	0.37	n/a	0.91	0.73	0.73	0.78	n/a
	5	(127)	▨ 1.00	▨ 0.92	0.83	▨ 1.00	1.00	0.91	▨ 0.67	▨ 0.69	0.61	▨ 1.00	1.00	0.52	▨ 1.00	1.00	0.91	0.82	0.87	0.66
	6	(152)	▨ 1.00	1.00	0.90	▨ 1.00		1.00	▨ 0.70	0.73	0.63	▨ 1.00		0.68	▨ 1.00		1.00	0.89	0.96	0.72
	8	(203)	1.00		1.00	1.00			0.77	0.80	0.67	1.00		1.00	1.00			1.00	1.00	0.83
	12	(305)							0.90	0.96	0.76									1.00
	18	(457)							1.00	1.00	0.89									
	> 24	(610)									1.00									

Table 9 — Load adjustment factors for Carbon Steel 3/8-in. diameter KB-TZ2 in cracked concrete [1,2]

3/8-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}		in. (mm)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)
Nominal Embedment h_{nom}		in. (mm)	1-7/8 (48)	2-1/2 (64)	3 (76)	1-7/8 (48)	2-1/2 (64)	3 (76)	1-7/8 (48)	2-1/2 (64)	3 (76)	1-7/8 (48)	2-1/2 (64)	3 (76)	1-7/8 (48)	2-1/2 (64)	3 (76)	1-7/8 (48)	2-1/2 (64)	3 (76)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2	(51)	n/a	n/a	▨ 0.63	n/a	n/a	n/a	n/a	n/a	▨ 0.54	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	▨ 0.69	▨ 0.65	n/a	n/a	n/a	n/a	▨ 0.58	▨ 0.55	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	n/a	▨ 0.71	▨ 0.67	n/a	▨ 0.87	▨ 0.75	n/a	▨ 0.59	▨ 0.55	n/a	▨ 0.40	▨ 0.18	n/a	▨ 0.80	▨ 0.37	n/a	n/a	n/a
	3	(76)	n/a	▨ 0.75	▨ 0.70	n/a	▨ 1.00	▨ 0.85	n/a	▨ 0.61	▨ 0.56	n/a	▨ 0.52	▨ 0.24	n/a	▨ 1.00	▨ 0.48	n/a	n/a	n/a
	3-1/4	(83)	n/a	▨ 0.77	▨ 0.72	n/a	▨ 1.00	▨ 0.90	n/a	▨ 0.62	▨ 0.57	n/a	▨ 0.59	▨ 0.27	n/a	▨ 1.00	▨ 0.55	0.78	n/a	n/a
	3-1/2	(89)	n/a	▨ 0.79	▨ 0.73	n/a	1.00	▨ 0.95	n/a	▨ 0.63	▨ 0.58	n/a	0.66	▨ 0.31	n/a	1.00	▨ 0.61	0.81	n/a	n/a
	4	(102)	n/a	▨ 0.83	▨ 0.77	n/a		1.00	n/a	▨ 0.64	▨ 0.59	n/a	0.81	0.37	n/a		0.75	0.86	0.76	n/a
	5	(127)	▨ 1.00	▨ 0.92	0.83	▨ 1.00			▨ 0.73	▨ 0.68	0.61	▨ 1.00	1.00	0.52	▨ 1.00		1.00	0.96	0.85	0.66
	6	(152)	▨ 1.00	1.00	0.90	▨ 1.00			▨ 0.78	0.72	0.63	▨ 1.00		0.69	▨ 1.00			1.00	0.93	0.72
	8	(203)	1.00		1.00	1.00			0.87	0.79	0.67	1.00		1.00	1.00				1.00	0.83
	12	(305)							1.00	0.93	0.76									1.00
	18	(457)								1.00	0.89									
	> 24	(610)									1.00									

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 10 — Load adjustment factors for Carbon Steel 1/2-in. diameter KB-TZ2 in uncracked concrete [1,2]

1/2-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear [3] f_{AV}				Edge distance in shear ⊥ Toward edge f_{RV}				Edge distance in shear ∥ To edge f_{RV}				Concrete thickness factor in shear [4] f_{HV}			
Effective Embedment h_{ef}	in.		1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4
	(mm)		(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)
Nominal Embedment h_{nom}	in.		2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4
	(mm)		(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2	(51)	n/a	n/a	n/a	0.60	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.53	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	n/a	n/a	0.62	n/a	n/a	n/a	0.30	n/a	n/a	n/a	0.54	n/a	n/a	n/a	0.11	n/a	n/a	n/a	0.21	n/a	n/a	n/a	n/a
	2-3/4	(70)	n/a	n/a	n/a	0.64	n/a	0.51	0.44	0.33	n/a	n/a	n/a	0.55	n/a	0.35	0.23	0.14	n/a	0.51	0.44	0.29	n/a	n/a	n/a	n/a
	3	(76)	n/a	n/a	0.70	0.65	n/a	0.55	0.47	0.35	n/a	n/a	0.57	0.55	n/a	0.40	0.26	0.16	n/a	0.55	0.47	0.33	n/a	n/a	n/a	n/a
	3-1/4	(83)	n/a	n/a	0.72	0.67	n/a	0.59	0.50	0.37	n/a	n/a	0.57	0.55	n/a	0.45	0.30	0.19	n/a	0.59	0.50	0.37	0.52	n/a	n/a	n/a
	3-1/2	(89)	n/a	0.79	0.73	0.68	n/a	0.64	0.53	0.38	n/a	0.61	0.58	0.56	n/a	0.51	0.33	0.21	n/a	0.64	0.53	0.38	0.54	n/a	n/a	n/a
	4	(102)	n/a	0.83	0.77	0.71	n/a	0.73	0.59	0.42	n/a	0.62	0.59	0.57	n/a	0.62	0.40	0.25	n/a	0.73	0.59	0.42	0.58	0.70	n/a	n/a
	4-3/4	(121)	n/a	0.90	0.82	0.74	n/a	0.86	0.70	0.48	n/a	0.64	0.61	0.58	n/a	0.80	0.52	0.33	n/a	0.86	0.70	0.48	0.63	0.76	n/a	n/a
	5	(127)	n/a	0.92	0.83	0.76	n/a	0.91	0.74	0.50	n/a	0.65	0.61	0.58	n/a	0.87	0.56	0.35	n/a	0.91	0.74	0.50	0.65	0.78	0.67	n/a
	5-1/4	(133)	n/a	0.94	0.85	0.77	n/a	0.95	0.78	0.53	n/a	0.66	0.62	0.59	n/a	0.93	0.61	0.38	n/a	0.95	0.78	0.53	0.66	0.80	0.69	n/a
	5-1/2	(140)	n/a	0.96	0.87	0.78	n/a	1.00	0.81	0.55	n/a	0.67	0.63	0.59	n/a	1.00	0.65	0.41	n/a	1.00	0.81	0.55	0.68	0.82	0.71	0.61
	6	(152)	n/a	1.00	0.90	0.81	n/a	1.00	0.89	0.60	n/a	0.68	0.64	0.60	n/a	1.00	0.74	0.46	n/a	1.00	0.89	0.60	0.71	0.85	0.74	0.63
	8	(203)	n/a		1.00	0.91	1.00	1.00	1.00	0.80	n/a	0.74	0.68	0.63	1.00	1.00	1.00	0.72	1.00	1.00	1.00	0.80	0.82	0.98	0.85	0.73
	9-3/4	(248)	n/a		1.00	1.00		1.00		0.98	n/a	0.80	0.72	0.66		1.00		0.96		1.00		0.98	0.90	1.00	0.94	0.81
	10	(254)	n/a					1.00		1.00	n/a	0.80	0.73	0.67		1.00		1.00		1.00		1.00	0.91		0.95	0.82
	12	(305)	1.00								0.75	0.86	0.77	0.70									1.00		1.00	0.89
	24	(610)									1.00	1.00	1.00	0.90												1.00
	> 30	(762)												1.00												

Table 11 — Load adjustment factors for Carbon Steel 1/2-in. diameter KB-TZ2 in cracked concrete [1,2]

1/2-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear [3] f_{AV}				Edge distance in shear ⊥ Toward edge f_{RV}				Edge distance in shear ∥ To edge f_{RV}				Concrete thickness factor in shear [4] f_{HV}			
Effective Embedment h_{ef}	in.		1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4
	(mm)		(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)
Nominal Embedment h_{nom}	in.		2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4
	(mm)		(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2	(51)	n/a	n/a	n/a	0.60	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.54	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	n/a	n/a	0.62	n/a	n/a	n/a	0.61	n/a	n/a	n/a	0.54	n/a	n/a	n/a	0.12	n/a	n/a	n/a	0.24	n/a	n/a	n/a	n/a
	2-3/4	(70)	n/a	n/a	n/a	0.64	n/a	0.93	0.80	0.68	n/a	n/a	n/a	0.55	n/a	0.50	0.19	0.16	n/a	0.93	0.38	0.33	n/a	n/a	n/a	n/a
	3	(76)	n/a	n/a	0.70	0.65	n/a	1.00	0.85	0.71	n/a	n/a	0.56	0.55	n/a	0.57	0.21	0.19	n/a	1.00	0.43	0.38	n/a	n/a	n/a	n/a
	3-1/4	(83)	n/a	n/a	0.72	0.67	n/a	1.00	0.90	0.75	n/a	n/a	0.56	0.56	n/a	0.64	0.24	0.21	n/a	1.00	0.48	0.42	0.76	n/a	n/a	n/a
	3-1/2	(89)	n/a	0.79	0.73	0.68	n/a	1.00	0.95	0.79	n/a	0.63	0.57	0.56	n/a	0.72	0.27	0.24	n/a	1.00	0.54	0.47	0.79	n/a	n/a	n/a
	4	(102)	n/a	0.83	0.77	0.71	n/a	1.00	1.00	0.86	n/a	0.65	0.58	0.57	n/a	0.88	0.33	0.29	n/a	1.00	0.66	0.58	0.85	0.78	n/a	n/a
	4-3/4	(121)	n/a	0.90	0.82	0.74	n/a	1.00	1.00	0.98	n/a	0.68	0.59	0.59	n/a	1.00	0.43	0.37	n/a	1.00	0.85	0.75	0.92	0.85	n/a	n/a
	5	(127)	n/a	0.92	0.83	0.76	n/a	1.00	1.00	1.00	n/a	0.69	0.60	0.59	n/a	1.00	0.46	0.40	n/a	1.00	0.92	0.81	0.95	0.87	0.63	n/a
	5-1/4	(133)	n/a	0.94	0.85	0.77	n/a	1.00	1.00		n/a	0.70	0.60	0.60	n/a	1.00	0.49	0.43	n/a	1.00	0.99	0.87	0.97	0.90	0.65	n/a
	5-1/2	(140)	n/a	0.96	0.87	0.78	n/a	1.00	1.00		n/a	0.71	0.61	0.60	n/a	1.00	0.53	0.47	n/a	1.00	1.00	0.93	0.99	0.92	0.66	0.63
	6	(152)	n/a	1.00	0.90	0.81	n/a	1.00	1.00		n/a	0.73	0.62	0.61	n/a	1.00	0.60	0.53	n/a	1.00	1.00	1.00	1.00	0.96	0.69	0.66
	8	(203)	n/a		1.00	0.91	1.00	1.00	1.00		n/a	0.81	0.66	0.65	1.00	1.00	0.93	0.82	1.00	1.00	1.00			1.00	0.80	0.76
	9-3/4	(248)	n/a		1.00	1.00		1.00			n/a	0.87	0.69	0.68		1.00	1.00	1.00		1.00					0.88	0.84
	10	(254)	n/a					1.00			n/a	0.88	0.70	0.68		1.00				1.00					0.89	0.85
	12	(305)	1.00								1.00	0.96	0.74	0.72											0.98	0.94
	24	(610)										1.00	0.98	0.94											1.00	1.00
	> 30	(762)											1.00	1.00												

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 12 — Load adjustment factors for Carbon Steel 5/8-in. diameter KB-TZ2 in uncracked concrete [1,2]

5/8-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}	in.		2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4
	(mm)		(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)
Nominal Embedment h_{nom}	in.		3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2
	(mm)		(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/4	(57)	n/a	0.62	n/a	n/a	n/a	0.38	n/a	0.53	n/a	n/a	n/a	0.10	n/a	n/a	0.20	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.64	0.61	n/a	n/a	0.42	n/a	0.54	0.54	n/a	n/a	0.13	n/a	n/a	0.27	n/a	n/a	n/a
	3	(76)	n/a	0.65	0.63	n/a	0.30	0.44	n/a	0.54	0.55	n/a	0.13	0.15	n/a	0.27	0.30	n/a	n/a	n/a
	3-1/2	(89)	n/a	0.68	0.65	n/a	0.33	0.48	n/a	0.55	0.56	n/a	0.17	0.19	n/a	0.33	0.38	n/a	n/a	n/a
	4	(102)	0.74	0.71	0.67	0.40	0.37	0.51	0.57	0.56	0.56	0.25	0.21	0.23	0.40	0.37	0.47	n/a	n/a	n/a
	4-1/2	(114)	0.77	0.73	0.69	0.45	0.40	0.56	0.58	0.57	0.57	0.30	0.24	0.28	0.45	0.40	0.56	n/a	n/a	n/a
	5	(127)	0.80	0.76	0.71	0.50	0.43	0.60	0.58	0.57	0.58	0.35	0.29	0.33	0.50	0.43	0.60	0.58	n/a	n/a
	5-1/2	(140)	0.83	0.78	0.73	0.55	0.48	0.64	0.59	0.58	0.59	0.41	0.33	0.38	0.55	0.48	0.64	0.61	0.56	n/a
	6	(152)	0.86	0.81	0.75	0.60	0.52	0.69	0.60	0.59	0.59	0.46	0.38	0.43	0.60	0.52	0.69	0.63	0.59	0.62
	6-1/2	(165)	0.89	0.83	0.77	0.65	0.57	0.74	0.61	0.59	0.60	0.52	0.42	0.48	0.65	0.57	0.74	0.66	0.61	0.64
	7	(178)	0.92	0.86	0.79	0.70	0.61	0.80	0.62	0.60	0.61	0.59	0.47	0.54	0.70	0.61	0.80	0.68	0.64	0.67
	7-1/4	(184)	0.94	0.87	0.80	0.73	0.63	0.83	0.62	0.61	0.61	0.62	0.50	0.57	0.73	0.63	0.83	0.70	0.65	0.68
	12	(305)	1.00	1.00	1.00	1.00	1.00	1.00	0.70	0.67	0.69	1.00	1.00	1.00	1.00	1.00	1.00	0.89	0.83	0.87
	24	(610)							0.90	0.85	0.88							1.00	1.00	1.00
	> 36	(914)							1.00	1.00	1.00									

Table 13 — Load adjustment factors for Carbon Steel 5/8-in. diameter KB-TZ2 in cracked concrete [1,2]

5/8-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}	in.		2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4
	(mm)		(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)
Nominal Embedment h_{nom}	in.		3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2
	(mm)		(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/4	(57)	n/a	0.62	n/a	n/a	n/a	0.56	n/a	0.54	n/a	n/a	n/a	0.10	n/a	n/a	0.20	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.64	0.61	n/a	n/a	0.61	n/a	0.55	0.54	n/a	n/a	0.13	n/a	n/a	0.27	n/a	n/a	n/a
	3	(76)	n/a	0.65	0.63	n/a	0.71	0.64	n/a	0.55	0.55	n/a	0.16	0.15	n/a	0.32	0.31	n/a	n/a	n/a
	3-1/2	(89)	n/a	0.68	0.65	n/a	0.79	0.69	n/a	0.56	0.56	n/a	0.20	0.19	n/a	0.41	0.39	n/a	n/a	n/a
	4	(102)	0.74	0.71	0.67	0.98	0.86	0.75	0.58	0.57	0.56	0.31	0.25	0.24	0.62	0.50	0.47	n/a	n/a	n/a
	4-1/2	(114)	0.77	0.73	0.69	1.00	0.94	0.81	0.59	0.57	0.57	0.37	0.30	0.28	0.74	0.60	0.56	n/a	n/a	n/a
	5	(127)	0.80	0.76	0.71	1.00	1.00	0.87	0.60	0.58	0.58	0.43	0.35	0.33	0.87	0.70	0.66	0.62	n/a	n/a
	5-1/2	(140)	0.83	0.78	0.73	1.00	1.00	0.93	0.61	0.59	0.59	0.50	0.40	0.38	1.00	0.81	0.76	0.65	0.60	n/a
	6	(152)	0.86	0.81	0.75		1.00	1.00	0.61	0.60	0.60	0.57	0.46	0.43		0.92	0.87	0.68	0.63	0.62
	6-1/2	(165)	0.89	0.83	0.77		1.00		0.62	0.61	0.60	0.64	0.52	0.49		1.00	0.98	0.71	0.66	0.64
	7	(178)	0.92	0.86	0.79		1.00		0.63	0.62	0.61	0.72	0.58	0.55		1.00	1.00	0.73	0.68	0.67
	7-1/4	(184)	0.94	0.87	0.80				0.64	0.62	0.62	0.76	0.61	0.58				0.74	0.69	0.68
	12	(305)	1.00	1.00	1.00				0.73	0.70	0.69	1.00	1.00	1.00				0.96	0.89	0.87
	24	(610)							0.96	0.90	0.88							1.00	1.00	1.00
	> 36	(914)							1.00	1.00	1.00									

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 14 — Load adjustment factors for Carbon Steel 3/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

3/4-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}		in. (mm)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)
Nominal Embedment h_{nom}		in. (mm)	4 (102)	4-1/2 (114)	5-1/2 (140)	4 (102)	4-1/2 (114)	5-1/2 (140)	4 (102)	4-1/2 (114)	5-1/2 (140)	4 (102)	4-1/2 (114)	5-1/2 (140)	4 (102)	4-1/2 (114)	5-1/2 (140)	4 (102)	4-1/2 (114)	5-1/2 (140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3-1/2	(89)	n/a	n/a	n/a	n/a	n/a	0.50	n/a	n/a	n/a	n/a	n/a	0.16	n/a	n/a	0.32	n/a	n/a	n/a
	3-3/4	(95)	n/a	0.67	0.63	n/a	n/a	0.52	n/a	0.56	0.55	n/a	n/a	0.18	n/a	n/a	0.36	n/a	n/a	n/a
	4	(102)	n/a	0.68	0.64	n/a	0.44	0.54	n/a	0.56	0.56	n/a	0.24	0.20	n/a	0.44	0.40	n/a	n/a	n/a
	4-1/2	(114)	0.73	0.70	0.66	n/a	0.48	0.57	0.56	0.57	0.56	n/a	0.29	0.24	n/a	0.48	0.47	n/a	n/a	n/a
	4-3/4	(121)	0.74	0.71	0.67	n/a	0.49	0.59	0.57	0.58	0.57	n/a	0.31	0.26	n/a	0.49	0.51	n/a	n/a	n/a
	5	(127)	0.76	0.72	0.68	0.42	0.51	0.61	0.57	0.58	0.57	0.27	0.33	0.28	0.42	0.51	0.55	n/a	n/a	n/a
	5-1/2	(140)	0.78	0.74	0.69	0.46	0.55	0.65	0.58	0.59	0.58	0.31	0.39	0.32	0.46	0.55	0.64	0.55	n/a	n/a
	5-3/4	(146)	0.79	0.76	0.70	0.48	0.58	0.67	0.58	0.59	0.58	0.33	0.41	0.34	0.48	0.58	0.67	0.57	n/a	n/a
	6	(152)	0.81	0.77	0.71	0.50	0.60	0.69	0.58	0.60	0.58	0.35	0.44	0.36	0.50	0.60	0.69	0.58	0.62	n/a
	7	(178)	0.86	0.81	0.75	0.58	0.70	0.78	0.60	0.61	0.60	0.45	0.55	0.46	0.58	0.70	0.78	0.62	0.67	n/a
	7-1/4	(184)	0.87	0.82	0.75	0.60	0.73	0.81	0.60	0.62	0.60	0.47	0.58	0.48	0.60	0.73	0.81	0.63	0.68	n/a
	8	(203)	0.91	0.86	0.78	0.67	0.80	0.89	0.61	0.63	0.61	0.54	0.68	0.56	0.67	0.80	0.89	0.67	0.72	0.67
	9	(229)	0.96	0.90	0.82	0.75	0.90	1.00	0.63	0.64	0.63	0.65	0.81	0.67	0.75	0.90	1.00	0.71	0.76	0.71
	10	(254)	1.00	0.94	0.85	0.83	1.00		0.64	0.66	0.64	0.76	0.94	0.78	0.83	1.00		0.75	0.80	0.75
	11	(279)		0.99	0.89	0.92			0.65	0.68	0.66	0.88	1.00	0.90	0.92			0.78	0.84	0.79
	12	(305)		1.00	0.92	1.00			0.67	0.69	0.67	1.00		1.00	1.00			0.82	0.88	0.82
	16	(406)			1.00				0.72	0.76	0.73							0.94	1.00	0.95
	18	(457)							0.75	0.79	0.75							1.00		1.00
	24	(610)							0.83	0.89	0.84									
	> 36	(914)							1.00	1.00	1.00									

Table 15 — Load adjustment factors for Carbon Steel 3/4-in. diameter KB-TZ2 in cracked concrete [1,2]

3/4-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}		in. (mm)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)
Nominal Embedment h_{nom}		in. (mm)	4 (102)	4-1/2 (114)	5-1/2 (140)	4 (102)	4-1/2 (114)	5-1/2 (140)	4 (102)	4-1/2 (114)	5-1/2 (140)	4 (102)	4-1/2 (114)	5-1/2 (140)	4 (102)	4-1/2 (114)	5-1/2 (140)	4 (102)	4-1/2 (114)	5-1/2 (140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3-1/2	(89)	n/a	n/a	n/a	n/a	n/a	0.63	n/a	n/a	n/a	n/a	n/a	0.13	n/a	n/a	0.26	n/a	n/a	n/a
	3-3/4	(95)	n/a	0.67	0.63	n/a	n/a	0.65	n/a	0.56	0.55	n/a	n/a	0.15	n/a	n/a	0.29	n/a	n/a	n/a
	4	(102)	n/a	0.68	0.64	n/a	0.78	0.68	n/a	0.56	0.55	n/a	0.22	0.16	n/a	0.44	0.32	n/a	n/a	n/a
	4-1/2	(114)	0.73	0.70	0.66	n/a	0.85	0.73	0.58	0.57	0.56	n/a	0.26	0.19	n/a	0.52	0.39	n/a	n/a	n/a
	4-3/4	(121)	0.74	0.71	0.67	n/a	0.88	0.75	0.58	0.57	0.56	n/a	0.28	0.21	n/a	0.57	0.42	n/a	n/a	n/a
	5	(127)	0.76	0.72	0.68	1.00	0.91	0.77	0.59	0.58	0.56	0.37	0.31	0.23	0.74	0.61	0.45	n/a	n/a	n/a
	5-1/2	(140)	0.78	0.74	0.69	1.00	0.98	0.83	0.59	0.58	0.57	0.43	0.35	0.26	0.85	0.71	0.52	0.61	n/a	n/a
	5-3/4	(146)	0.79	0.76	0.70	1.00	1.00	0.85	0.60	0.59	0.57	0.46	0.38	0.28	0.91	0.76	0.56	0.63	n/a	n/a
	6	(152)	0.81	0.77	0.71	1.00	1.00	0.88	0.60	0.59	0.57	0.49	0.40	0.30	0.97	0.81	0.59	0.64	0.60	n/a
	7	(178)	0.86	0.81	0.75		1.00	0.99	0.62	0.61	0.59	0.61	0.51	0.37	1.00	1.00	0.75	0.69	0.65	n/a
	7-1/4	(184)	0.87	0.82	0.75			1.00	0.62	0.61	0.59	0.64	0.54	0.39	1.00	1.00	0.79	0.71	0.66	n/a
	8	(203)	0.91	0.86	0.78				0.64	0.62	0.60	0.75	0.62	0.46			0.91	0.74	0.70	0.63
	9	(229)	0.96	0.90	0.82				0.65	0.64	0.61	0.89	0.74	0.54			1.00	0.79	0.74	0.67
	10	(254)	1.00	0.94	0.85				0.67	0.65	0.62	1.00	0.87	0.64				0.83	0.78	0.70
	11	(279)		0.99	0.89				0.69	0.67	0.64		1.00	0.74				0.87	0.82	0.74
	12	(305)		1.00	0.92				0.71	0.68	0.65			0.84				0.91	0.85	0.77
	16	(406)			1.00				0.77	0.74	0.70			1.00				1.00	0.98	0.89
	18	(457)							0.81	0.77	0.72								1.00	0.94
	24	(610)							0.91	0.86	0.80									1.00
	> 36	(914)							1.00	1.00	0.94									

[1] Linear interpolation not permitted

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

[3] Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 16 — Load adjustment factors for Carbon Steel 1-in. diameter KB-TZ2 in uncracked concrete [1,2]

1-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear [4] f_{HV}	
									⊥ Toward edge f_{RV}		∥ To edge f_{RV}			
Effective Embedment h_{ef}	in.		4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4
	(mm)		(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)
Nominal Embedment h_{nom}	in.		4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8
	(mm)		(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3	(76)	n/a	n/a	n/a	0.292	n/a	n/a	n/a	0.081	n/a	0.162	n/a	n/a
	3-3/4	(95)	n/a	n/a	n/a	0.321	n/a	n/a	n/a	0.113	n/a	0.227	n/a	n/a
	4	(102)	n/a	n/a	n/a	0.331	n/a	n/a	n/a	0.125	n/a	0.250	n/a	n/a
	4-1/4	(108)	n/a	n/a	n/a	0.341	n/a	n/a	n/a	0.137	n/a	0.274	n/a	n/a
	4-3/4	(121)	n/a	0.638	n/a	0.362	n/a	0.549	n/a	0.162	n/a	0.324	n/a	n/a
	5	(127)	n/a	0.645	n/a	0.372	n/a	0.552	n/a	0.175	n/a	0.349	n/a	n/a
	6	(152)	n/a	0.674	n/a	0.415	n/a	0.563	n/a	0.230	n/a	0.415	n/a	n/a
	6-3/4	(171)	n/a	0.696	n/a	0.449	n/a	0.570	n/a	0.274	n/a	0.449	n/a	n/a
	8	(203)	0.833	0.732	0.727	0.508	0.621	0.583	0.620	0.354	0.727	0.508	0.696	n/a
	10	(254)	0.917	0.790	0.909	0.625	0.652	0.604	0.867	0.494	0.909	0.625	0.778	0.645
	12	(305)	1.000	0.848	1.000	0.750	0.682	0.625	1.000	0.650	1.000	0.750	0.853	0.707
	18	(457)		1.000		1.000	0.773	0.688		1.000		1.000	1.000	0.866
	24	(610)					0.864	0.750						1.000
	36	(914)					1.000	0.875						
	> 48	(1219)						1.000						

Table 17 — Load adjustment factors for Carbon Steel 1-in. diameter KB-TZ2 in cracked concrete [1,2]

1-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear [4] f_{HV}	
									⊥ Toward edge f_{RV}		∥ To edge f_{RV}			
Effective Embedment h_{ef}	in.		4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4
	(mm)		(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)
Nominal Embedment h_{nom}	in.		4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8
	(mm)		(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3	(76)	n/a	n/a	n/a	0.542	n/a	n/a	n/a	0.081	n/a	0.162	n/a	n/a
	3-3/4	(95)	n/a	n/a	n/a	0.596	n/a	n/a	n/a	0.113	n/a	0.226	n/a	n/a
	4	(102)	n/a	n/a	n/a	0.614	n/a	n/a	n/a	0.124	n/a	0.249	n/a	n/a
	4-1/4	(108)	n/a	n/a	n/a	0.633	n/a	n/a	n/a	0.136	n/a	0.272	n/a	n/a
	4-3/4	(121)	n/a	0.638	n/a	0.671	n/a	0.549	n/a	0.161	n/a	0.322	n/a	n/a
	5	(127)	n/a	0.645	n/a	0.690	n/a	0.552	n/a	0.174	n/a	0.348	n/a	n/a
	6	(152)	n/a	0.674	n/a	0.770	n/a	0.562	n/a	0.228	n/a	0.457	n/a	n/a
	6-3/4	(171)	n/a	0.696	n/a	0.833	n/a	0.570	n/a	0.273	n/a	0.545	n/a	n/a
	8	(203)	0.833	0.732	1.000	0.943	0.619	0.583	0.606	0.352	1.000	0.703	0.691	n/a
	10	(254)	0.917	0.790		1.000	0.649	0.604	0.847	0.491		0.983	0.773	0.644
	12	(305)	1.000	0.848			0.679	0.625	1.000	0.646		1.000	0.846	0.706
	18	(457)		1.000			0.769	0.687		1.000			1.000	0.864
	24	(610)					0.858	0.749						0.998
	36	(914)					1.000	0.874						1.000
	> 48	(1219)						0.998						

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 18 — Hilti Stainless Steel KB-TZ2 design strength based on concrete failure modes in uncracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
1/4	1-1/2 (38)	1 3/4 (44)	705 (3.1)	760 (3.4)	850 (3.8)	995 (4.4)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
3/8	1-1/2 (38)	1 7/8 (48)	1,435 (6.4)	1,570 (7.0)	1,815 (8.1)	2,220 (9.9)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
	2 (51)	2 1/2 (64)	2,205 (9.8)	2,415 (10.7)	2,790 (12.4)	3,420 (15.2)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	2-1/2 (64)	3 (76)	2,720 (12.1)	2,910 (12.9)	3,235 (14.4)	3,760 (16.7)	6,640 (29.5)	7,275 (32.4)	8,400 (37.4)	10,290 (45.8)
1/2	2 (51)	2 1/2 (64)	2,195 (9.8)	2,390 (10.6)	2,725 (12.1)	3,285 (14.6)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	2-1/2 (64)	3 (76)	2,605 (11.6)	2,855 (12.7)	3,295 (14.7)	4,040 (18.0)	6,640 (29.5)	7,275 (32.4)	8,400 (37.4)	10,290 (45.8)
	3-1/4 (83)	3 3/4 (95)	3,575 (15.9)	3,915 (17.4)	4,520 (20.1)	5,540 (24.6)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	2-3/4 (70)	3 1/4 (83)	2,655 (11.8)	2,910 (12.9)	3,360 (14.9)	4,115 (18.3)	7,660 (34.1)	8,395 (37.3)	9,690 (43.1)	11,870 (52.8)
	3-1/4 (83)	3 3/4 (95)	3,910 (17.4)	4,220 (18.8)	4,765 (21.2)	5,645 (25.1)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
	4 (102)	4 1/2 (114)	5,235 (23.3)	5,700 (25.4)	6,525 (29.0)	7,895 (35.1)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-1/4 (83)	4 (102)	4,570 (20.3)	5,005 (22.3)	5,780 (25.7)	7,080 (31.5)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
	3-3/4[6] (95)	4 1/2 (114)	6,370 (28.3)	6,980 (31.0)	8,060 (35.9)	9,870 (43.9)	13,725 (61.1)	15,035 (66.9)	17,360 (77.2)	21,265 (94.6)
	4-3/4 (121)	5 1/2 (140)	8,075 (35.9)	8,845 (39.3)	10,215 (45.4)	12,510 (55.6)	17,390 (77.4)	19,050 (84.7)	22,000 (97.9)	26,945 (119.9)
1	4 (102)	4 5/8 (117)	7,020 (31.2)	7,690 (34.2)	8,880 (39.5)	10,875 (48.4)	15,120 (67.3)	16,565 (73.7)	19,125 (85.1)	23,425 (104.2)
	5-3/4 (146)	6 3/8 (162)	12,100 (53.8)	13,255 (59.0)	15,305 (68.1)	18,745 (83.4)	26,060 (115.9)	28,545 (127.0)	32,965 (146.6)	40,370 (179.6)

Table 19 — Hilti Stainless Steel KB-TZ2 design strength based on concrete failure modes in cracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4,5]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
1/4	1-1/2 (38)	1 3/4 (44)	300 (1.3)	330 (1.5)	380 (1.7)	465 (2.1)	1,095 (4.9)	1,195 (5.3)	1,385 (6.2)	1,695 (7.5)
3/8	1-1/2 (38)	1 7/8 (48)	1,255 (5.6)	1,375 (6.1)	1,585 (7.1)	1,940 (8.6)	1,350 (6.0)	1,480 (6.6)	1,710 (7.6)	2,090 (9.3)
	2 (51)	2 1/2 (64)	1,930 (8.6)	2,115 (9.4)	2,440 (10.9)	2,990 (13.3)	2,080 (9.3)	2,275 (10.1)	2,630 (11.7)	3,220 (14.3)
	2-1/2 (64)	3 (76)	2,185 (9.7)	2,390 (10.6)	2,765 (12.3)	3,385 (15.1)	4,705 (20.9)	5,155 (22.9)	5,950 (26.5)	7,285 (32.4)
1/2	2 (51)	2 1/2 (64)	1,565 (7.0)	1,710 (7.6)	1,975 (8.8)	2,420 (10.8)	1,685 (7.5)	1,845 (8.2)	2,130 (9.5)	2,605 (11.6)
	2-1/2 (64)	3 (76)	2,700 (12.0)	2,955 (13.1)	3,415 (15.2)	4,180 (18.6)	5,810 (25.8)	6,365 (28.3)	7,350 (32.7)	9,000 (40.0)
	3-1/4[8] (83)	3 3/4 (95)	3,235 (14.4)	3,545 (15.8)	4,095 (18.2)	5,015 (22.3)	6,970 (31.0)	7,640 (34.0)	8,820 (39.2)	10,800 (48.0)
5/8	2-3/4 (70)	3 1/4 (83)	3,110 (13.8)	3,410 (15.2)	3,935 (17.5)	4,820 (21.4)	6,705 (29.8)	7,345 (32.7)	8,480 (37.7)	10,385 (46.2)
	3-1/4 (83)	3 3/4 (95)	4,000 (17.8)	4,380 (19.5)	5,060 (22.5)	6,195 (27.6)	8,615 (38.3)	9,435 (42.0)	10,895 (48.5)	13,345 (59.4)
	4 (102)	4 1/2 (114)	4,420 (19.7)	4,840 (21.5)	5,590 (24.9)	6,845 (30.4)	9,520 (42.3)	10,430 (46.4)	12,040 (53.6)	14,750 (65.6)
3/4	3-1/4 (83)	4 (102)	4,000 (17.8)	4,380 (19.5)	5,060 (22.5)	6,195 (27.6)	8,615 (38.3)	9,435 (42.0)	10,895 (48.5)	13,345 (59.4)
	3-3/4[7] (95)	4 1/2 (114)	4,955 (22.0)	5,430 (24.2)	6,270 (27.9)	7,680 (34.2)	10,675 (47.5)	11,695 (52.0)	13,505 (60.1)	16,540 (73.6)
	4-3/4 (121)	5 1/2 (140)	5,715 (25.4)	6,260 (27.8)	7,230 (32.2)	8,855 (39.4)	15,220 (67.7)	16,670 (74.2)	19,250 (85.6)	23,575 (104.9)
1	4 (102)	4 5/8 (117)	6,240 (27.8)	6,835 (30.4)	7,895 (35.1)	9,665 (43.0)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
	5-3/4 (146)	6 3/8 (162)	9,410 (41.9)	10,310 (45.9)	11,905 (53.0)	14,580 (64.9)	20,270 (90.2)	22,205 (98.8)	25,640 (114.1)	31,400 (139.7)

[1] See Section 3.1.8 to convert design strength value to ASD value.

[2] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[3] Apply spacing, edge distance, and concrete thickness factors in tables 22 to 33 as necessary. Compare to the steel values in Table 20. The lesser of the values is to be used for the design.

[4] Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60.

[5] Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75.
No reduction needed for seismic shear, except for the 3/4 bolts where $\alpha_{V,seis}$ = 0.81. See Section 3.1.8 for additional information on seismic applications.

[6] For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.89 to the design tension strength.

[7] For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.81 to the design tension strength.

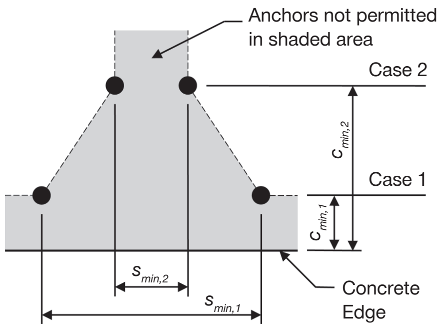
[8] For core drilled installations of 1/2" anchors installed at 3-1/4 effective embedment, apply a reduction factor of 0.85 to the design tension strength.

Table 20 — Hilti Stainless Steel KB-TZ2 design strength based on steel failure per ACI 318 Ch. 17 [1,2]

Nominal anchor diameter in.	Effective embedment depth in. (mm)			Tensile [3] ΦN_{sa} lb (kN)	Shear [4] ΦV_{sa} lb (kN)	Seismic Shear [5] ΦV_{sa} lb (kN)
1/4	1-1/2 (38)			2,190 (9.7)	950 (4.2)	720 (3.2)
3/8	1-1/2 (38)			4,635 (20.6)	3,000 (13.3)	3,000 (13.3)
3/8	2 (51)		2-1/2 (64)	4,635 (20.6)	3,175 (14.1)	3,175 (14.1)
1/2	2 (51)	2-1/2 (64)	3-1/4 (83)	8,905 (39.6)	5,425 (24.1)	5,425 (24.1)
5/8	2-3/4 (70)	3-1/4 (83)	4 (102)	14,125 (62.8)	8,030 (35.7)	8,030 (35.7)
3/4	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	18,035 (80.2)	10,765 (47.9)	8,755 (38.9)
1 (25.4)	4 (102)			35,215 (156.6)	14,920 (66.4)	8,755 (38.9)
1 (25.4)	5-3/4 (146)			35,215 (156.6)	20,410 (90.8)	8,755 (38.9)

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KB-TZ2 stainless steel anchors are to be considered ductile steel elements.
3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Ch. 17.
4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi\ 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
See Section 3.1.8 for additional information on seismic applications.

Figure 3



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}(c - c_{min,2})$$

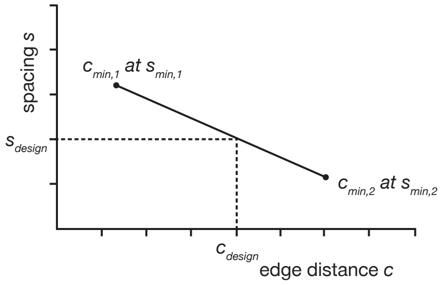


Table 21 — Hilti KB-TZ2 stainless steel installation parameters[1]

Setting information	Symbol	Units	Nominal Anchor diameter (in.)														
			1/4	3/8			1/2			5/8			3/4			1	
Effective embedment	h_{ef}	in.	1-1/2	1-1/2	2	2-1/2	2	2-1/2	3 1/4	2-3/4	3-1/4	4	3-1/4	3-3/4	4-3/4	4	5-3/4
		(mm)	(38)	(38)	(51)	(64)	(51)	(64)	(83)	(70)	(83)	(102)	(83)	(95)	(121)	(102)	(146)
Min. member thickness	h_{min}	in.	3-1/4	3-1/4	4	5	4	5	5-1/2	5	5-1/2	6	5-1/2	6	8	8	10
		(mm)	(83)	(83)	(102)	(127)	(102)	(127)	(140)	(127)	(140)	(152)	(140)	(152)	(203)	(203)	(254)
Case 1	$c_{min,1}$	in.	1-1/2	5	2-1/2	2-1/2	2-3/4	2-1/2	2-1/4	4	3-1/4	2-1/4	5	4	3 3/4	3-3/4	3
		(mm)	(38)	(127)	(64)	(64)	(70)	(64)	(57)	(102)	(83)	(57)	(127)	(102)	(95)	(95)	(76)
	for $s_{min,1} \geq$	in.	1-1/2	8	5	5	5-1/2	4-1/2	5-1/4	7	5-1/2	7	11	7-1/2	5 3/4	10	6-3/4
		(mm)	(38)	(203)	(127)	(127)	(140)	(114)	(133)	(178)	(140)	(178)	(279)	(191)	(146)	(254)	(171)
Case 2	$c_{min,2}$	in.	1-1/2	8	4	3-1/2	4-1/8	4-1/2	4-1/2	5-1/2	4	4-1/4	8	6	5-1/4	4-1/4	3-3/4
		(mm)	(38)	(203)	(102)	(89)	(105)	(114)	(114)	(140)	(102)	(108)	(203)	(152)	(133)	(108)	(95)
	for $s_{min,2} \geq$	in.	1-1/2	5	2-1/4	2-1/4	2-3/4	2-1/2	2	5-1/2	2-3/4	3	5	4	4	5	4-3/4
		(mm)	(38)	(127)	(57)	(57)	(70)	(64)	(51)	(140)	(70)	(76)	(127)	(102)	(102)	(127)	(121)

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$, will determine the permissible spacings.

Table 22 — Load adjustment factors for Stainless Steel 1/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

1/4-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear [3] f_{AV}	Edge distance in shear		Conc. thickness factor in shear [4] f_{HV}
						⊥ Toward edge f_{RV}	∥ To edge f_{RV}	
Effective Embedment h_{ef}		in. (mm)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)
Nominal Embedment h_{nom}		in. (mm)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2	(38)	0.67	0.42	0.56	0.23	0.42	n/a
	2	(51)	0.72	0.51	0.58	0.35	0.51	n/a
	2-1/2	(64)	0.78	0.63	0.60	0.49	0.63	n/a
	3	(76)	0.83	0.75	0.63	0.65	0.75	n/a
	3-1/4	(83)	0.86	0.81	0.64	0.73	0.81	0.74
	3-1/2	(89)	0.89	0.88	0.65	0.82	0.88	0.76
	4	(102)	0.94	1.00	0.67	1.00	1.00	0.82
	5	(127)	1.00		0.71			0.91
	6	(152)			0.75			1.00
	7	(178)			0.79			
	8	(203)			0.83			
	9	(229)			0.88			
	> 12	(305)			1.00			

Table 23 — Load adjustment factors for Stainless Steel 1/4-in. diameter KB-TZ2 in cracked concrete [1,2]

1/4-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear [3] f_{AV}	Edge distance in shear		Conc. thickness factor in shear [4] f_{HV}
						⊥ Toward edge f_{RV}	∥ To edge f_{RV}	
Effective Embedment h_{ef}		in. (mm)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)
Nominal Embedment h_{nom}		in. (mm)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2	(38)	0.67	0.75	0.57	0.29	0.59	n/a
	2	(51)	0.72	0.91	0.60	0.45	0.91	n/a
	2-1/2	(64)	0.78	1.00	0.62	0.63	1.00	n/a
	3	(76)	0.83		0.65	0.83		n/a
	3-1/4	(83)	0.86		0.66	0.94		0.80
	3-1/2	(89)	0.89		0.67	1.00		0.83
	4	(102)	0.94		0.70			0.89
	5	(127)	1.00		0.75			0.99
	6	(152)			0.80			1.00
	7	(178)			0.84			
	8	(203)			0.89			
	9	(229)			0.94			
	> 12	(305)			1.00			

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

Table 24 — Load adjustment factors for Stainless Steel 3/8-in. diameter KB-TZ2 in uncracked concrete [1,4]

3/8-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}		in.	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2
		(mm)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)
Nominal Embedment h_{nom}		in.	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3
		(mm)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/4	(57)	n/a	0.69	0.65	n/a	n/a	n/a	n/a	0.57	0.55	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	n/a	0.71	0.67	n/a	0.48	0.68	n/a	0.58	0.55	n/a	0.31	0.18	n/a	0.48	0.37	n/a	n/a	n/a
	3	(76)	n/a	0.75	0.70	n/a	0.55	0.77	n/a	0.59	0.56	n/a	0.40	0.24	n/a	0.55	0.48	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.77	0.72	n/a	0.59	0.81	n/a	0.60	0.57	n/a	0.45	0.27	n/a	0.59	0.54	0.69	n/a	n/a
	3-1/2	(89)	n/a	0.79	0.73	n/a	0.64	0.86	n/a	0.61	0.58	n/a	0.51	0.30	n/a	0.64	0.61	0.72	n/a	n/a
	4	(102)	n/a	0.83	0.77	n/a	0.73	0.97	n/a	0.62	0.59	n/a	0.62	0.37	n/a	0.73	0.74	0.77	0.70	n/a
	5	(127)	1.00	0.92	0.83	1.00	0.91	1.00	0.69	0.65	0.61	1.00	0.87	0.52	1.00	0.91	1.00	0.86	0.78	0.66
	6	(152)	1.00	1.00	0.90	1.00	1.00		0.72	0.68	0.63	1.00	1.00	0.68	1.00	1.00		0.94	0.85	0.72
	8	(203)	1.00		1.00	1.00			0.80	0.74	0.67	1.00		1.00	1.00			1.00	0.98	0.83
	10	(254)							0.87	0.80	0.71								1.00	0.93
	12	(305)							0.94	0.86	0.76									1.00
	18	(457)							1.00	1.00	0.89									
	> 24	(610)									1.00									

Table 25 — Load adjustment factors for Stainless Steel 3/8-in. diameter KB-TZ2 in cracked concrete [1,4]

3/8-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}		in.	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2
		(mm)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)
Nominal Embedment h_{nom}		in.	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3
		(mm)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/4	(57)	n/a	0.69	0.65	n/a	n/a	n/a	n/a	0.58	0.55	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	n/a	0.71	0.67	n/a	0.87	0.75	n/a	0.59	0.55	n/a	0.40	0.18	n/a	0.80	0.37	n/a	n/a	n/a
	3	(76)	n/a	0.75	0.70	n/a	1.00	0.85	n/a	0.61	0.56	n/a	0.52	0.24	n/a	1.00	0.48	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.77	0.72	n/a	1.00	0.90	n/a	0.62	0.57	n/a	0.59	0.27	n/a	1.00	0.55	0.78	n/a	n/a
	3-1/2	(89)	n/a	0.79	0.73	n/a	1.00	0.95	n/a	0.63	0.58	n/a	0.66	0.31	n/a	1.00	0.61	0.81	n/a	n/a
	4	(102)	n/a	0.83	0.77	n/a	1.00	1.00	n/a	0.64	0.59	n/a	0.81	0.37	n/a	1.00	0.75	0.86	0.76	n/a
	5	(127)	1.00	0.92	0.83	1.00			0.73	0.68	0.61	1.00	1.00	0.52	1.00		1.00	0.96	0.85	0.66
	6	(152)	1.00	1.00	0.90	1.00			0.78	0.72	0.63	1.00		0.69	1.00			1.00	0.93	0.72
	8	(203)	1.00		1.00	1.00			0.87	0.79	0.67	1.00		1.00	1.00				1.00	0.83
	10	(254)							0.96	0.86	0.72									0.93
	12	(305)							1.00	0.93	0.76									1.00
	18	(457)								1.00	0.89									
	> 24	(610)									1.00									

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 26 — Load adjustment factors for Stainless Steel 1/2-in. diameter KB-TZ2 in uncracked concrete [1,2]

1/2-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}		in. (mm)	2 (51)	2-1/2 (64)	3-1/4 (83)	2 (51)	2-1/2 (64)	3-1/4 (83)	2 (51)	2-1/2 (64)	3-1/4 (83)	2 (51)	2-1/2 (64)	3-1/4 (83)	2 (51)	2-1/2 (64)	3-1/4 (83)	2 (51)	2-1/2 (64)	3-1/4 (83)
Nominal Embedment h_{nom}		in. (mm)	2-1/2 (64)	3 (76)	3-3/4 (95)	2-1/2 (64)	3 (76)	3-3/4 (95)	2-1/2 (64)	3 (76)	3-3/4 (95)	2-1/2 (64)	3 (76)	3-3/4 (95)	2-1/2 (64)	3 (76)	3-3/4 (95)	2-1/2 (64)	3 (76)	3-3/4 (95)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2	(51)	n/a	n/a	0.60	n/a	n/a	n/a	n/a	n/a	0.54	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	n/a	0.62	n/a	n/a	0.40	n/a	n/a	0.54	n/a	n/a	0.12	n/a	n/a	0.24	n/a	n/a	n/a
	2-1/2	(64)	n/a	n/a	0.63	n/a	0.45	0.42	n/a	n/a	0.55	n/a	0.20	0.14	n/a	0.40	0.28	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.68	0.64	0.51	0.48	0.44	n/a	0.56	0.55	0.35	0.23	0.16	0.51	0.46	0.33	n/a	n/a	n/a
	3	(76)	0.75	0.70	0.65	0.55	0.51	0.46	0.59	0.57	0.55	0.40	0.26	0.19	0.55	0.51	0.37	n/a	n/a	n/a
	4	(102)	0.83	0.77	0.71	0.73	0.64	0.56	0.62	0.59	0.57	0.62	0.40	0.29	0.73	0.64	0.56	0.70	n/a	n/a
	4-1/8	(105)	0.84	0.78	0.71	0.75	0.66	0.57	0.63	0.59	0.57	0.65	0.42	0.30	0.75	0.66	0.57	0.71	n/a	n/a
	4-1/2	(114)	0.88	0.80	0.73	0.82	0.72	0.61	0.64	0.60	0.58	0.74	0.48	0.34	0.82	0.72	0.61	0.74	n/a	n/a
	4-3/4	(121)	0.90	0.82	0.74	0.86	0.76	0.64	0.64	0.61	0.59	0.80	0.52	0.37	0.86	0.76	0.64	0.76	n/a	n/a
	5	(127)	0.92	0.83	0.76	0.91	0.80	0.67	0.65	0.61	0.59	0.87	0.56	0.40	0.91	0.80	0.67	0.78	0.67	n/a
	5-1/4	(133)	0.94	0.85	0.77	0.95	0.84	0.70	0.66	0.62	0.60	0.93	0.61	0.43	0.95	0.84	0.70	0.80	0.69	n/a
	5-1/2	(140)	0.96	0.87	0.78	1.00	0.88	0.73	0.67	0.63	0.60	1.00	0.65	0.46	1.00	0.88	0.73	0.82	0.71	0.63
	6	(152)	1.00	0.90	0.81		0.96	0.80	0.68	0.64	0.61		0.74	0.53		0.96	0.80	0.85	0.74	0.66
	8	(203)		1.00	0.91		1.00	1.00	0.74	0.68	0.64		1.00	0.81		1.00	1.00	0.98	0.85	0.76
	12	(305)			1.00				0.86	0.77	0.72			1.00				1.00	1.00	0.93
	18	(457)							1.00	0.91	0.83									1.00
	24	(610)								1.00	0.93									
	> 30	(762)									1.00									

Table 27 — Load adjustment factors for Stainless Steel 1/2-in. diameter KB-TZ2 in cracked concrete [1,2]

1/2-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}		in. (mm)	2 (51)	2-1/2 (64)	3-1/4 (83)	2 (51)	2-1/2 (64)	3-1/4 (83)	2 (51)	2-1/2 (64)	3-1/4 (83)	2 (51)	2-1/2 (64)	3-1/4 (83)	2 (51)	2-1/2 (64)	3-1/4 (83)	2 (51)	2-1/2 (64)	3-1/4 (83)
Nominal Embedment h_{nom}		in. (mm)	2-1/2 (64)	3 (76)	3-3/4 (95)	2-1/2 (64)	3 (76)	3-3/4 (95)	2-1/2 (64)	3 (76)	3-3/4 (95)	2-1/2 (64)	3 (76)	3-3/4 (95)	2-1/2 (64)	3 (76)	3-3/4 (95)	2-1/2 (64)	3 (76)	3-3/4 (95)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2	(51)	n/a	n/a	0.60	n/a	n/a	n/a	n/a	n/a	0.54	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	n/a	0.62	n/a	n/a	0.61	n/a	n/a	0.54	n/a	n/a	0.12	n/a	n/a	0.24	n/a	n/a	n/a
	2-1/2	(64)	n/a	n/a	0.63	n/a	0.75	0.65	n/a	n/a	0.55	n/a	0.16	0.14	n/a	0.33	0.29	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.68	0.64	0.93	0.80	0.68	n/a	0.55	0.55	0.62	0.19	0.16	0.93	0.38	0.33	n/a	n/a	n/a
	3	(76)	0.75	0.70	0.65	1.00	0.85	0.71	0.63	0.56	0.55	0.71	0.21	0.19	1.00	0.43	0.38	n/a	n/a	n/a
	4	(102)	0.83	0.77	0.71	1.00	1.00	0.86	0.68	0.58	0.57	1.00	0.33	0.29	1.00	0.66	0.58	0.84	n/a	n/a
	4-1/8	(105)	0.84	0.78	0.71	1.00	1.00	0.88	0.68	0.58	0.58	1.00	0.34	0.30	1.00	0.69	0.61	0.85	n/a	n/a
	4-1/2	(114)	0.88	0.80	0.73		1.00	0.94	0.70	0.59	0.58		0.39	0.34		0.79	0.69	0.89	n/a	n/a
	4-3/4	(121)	0.90	0.82	0.74			0.98	0.71	0.59	0.59		0.43	0.37		0.85	0.75	0.91	n/a	n/a
	5	(127)	0.92	0.83	0.76			1.00	0.72	0.60	0.59		0.46	0.40		0.92	0.81	0.94	0.63	n/a
	5-1/4	(133)	0.94	0.85	0.77				0.73	0.60	0.60		0.49	0.43		0.99	0.87	0.96	0.65	n/a
	5-1/2	(140)	0.96	0.87	0.78				0.74	0.61	0.60		0.53	0.47		1.00	0.93	0.98	0.66	0.63
	6	(152)	1.00	0.90	0.81				0.76	0.62	0.61		0.60	0.53			1.00	1.00	0.69	0.66
	8	(203)		1.00	0.91				0.85	0.66	0.65		0.93	0.82					0.80	0.76
	12	(305)			1.00				1.00	0.74	0.72		1.00	1.00					0.98	0.94
	18	(457)								0.86	0.83								1.00	1.00
	24	(610)								0.98	0.94									
	> 30	(762)								1.00	1.00									

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 28 — Load adjustment factors for Stainless Steel 5/8-in. diameter KB-TZ2 in uncracked concrete [1,2]

5/8-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}		in.	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4
		(mm)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)
Nominal Embedment h_{nom}		in.	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2
		(mm)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/4	(57)	n/a	n/a	n/a	n/a	n/a	0.38	n/a	n/a	n/a	n/a	n/a	0.10	n/a	n/a	0.20	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.64	n/a	n/a	n/a	0.42	n/a	0.55	n/a	n/a	n/a	0.13	n/a	n/a	0.27	n/a	n/a	n/a
	3	(76)	n/a	0.65	0.63	n/a	n/a	0.44	n/a	0.56	0.55	n/a	n/a	0.15	n/a	n/a	0.30	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.67	0.64	n/a	0.56	0.46	n/a	0.56	0.55	n/a	0.22	0.17	n/a	0.45	0.34	n/a	n/a	n/a
	4	(102)	n/a	0.71	0.67	0.40	0.65	0.51	n/a	0.58	0.56	0.25	0.31	0.23	0.40	0.61	0.47	n/a	n/a	n/a
	4-1/4	(108)	n/a	0.72	0.68	0.43	0.67	0.53	n/a	0.58	0.57	0.28	0.34	0.26	0.43	0.67	0.51	n/a	n/a	n/a
	5	(127)	n/a	0.76	0.71	0.50	0.77	0.60	n/a	0.59	0.58	0.35	0.43	0.33	0.50	0.77	0.60	0.58	n/a	n/a
	5-1/2	(140)	0.83	0.78	0.73	0.55	0.85	0.64	0.59	0.60	0.59	0.41	0.49	0.38	0.55	0.85	0.64	0.61	0.65	n/a
	6	(152)	0.86	0.81	0.75	0.60	0.92	0.69	0.60	0.61	0.59	0.46	0.56	0.43	0.60	0.92	0.69	0.63	0.67	0.62
	7	(178)	0.92	0.86	0.79	0.70	1.00	0.80	0.62	0.63	0.61	0.59	0.71	0.54	0.70	1.00	0.80	0.68	0.73	0.67
	8	(203)	0.98	0.91	0.83	0.80		0.91	0.63	0.65	0.63	0.72	0.87	0.66	0.80		0.91	0.73	0.78	0.71
	10	(254)	1.00	1.00	0.92	1.00		1.00	0.67	0.69	0.66	1.00	1.00	0.92	1.00		1.00	0.82	0.87	0.80
	12	(305)			1.00				0.70	0.73	0.69			1.00				0.89	0.95	0.87
	24	(610)							0.90	0.95	0.88							1.00	1.00	1.00
	> 36	(914)							1.00	1.00	1.00									

Table 29 — Load adjustment factors for Stainless Steel 5/8-in. diameter KB-TZ2 in cracked concrete [1,2]

5/8-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Concrete thickness factor in shear [4] f_{HV}		
												⊥ Toward edge f_{RV}			∥ To edge f_{RV}					
Effective Embedment h_{ef}		in.	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4
		(mm)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)
Nominal Embedment h_{nom}		in.	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2
		(mm)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/4	(57)	n/a	n/a	n/a	n/a	n/a	0.56	n/a	n/a	n/a	n/a	n/a	0.10	n/a	n/a	0.20	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.64	n/a	n/a	n/a	0.61	n/a	0.55	n/a	n/a	n/a	0.13	n/a	n/a	0.27	n/a	n/a	n/a
	3	(76)	n/a	0.65	0.63	n/a	n/a	0.64	n/a	0.55	0.55	n/a	n/a	0.15	n/a	n/a	0.31	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.67	0.64	n/a	0.75	0.66	n/a	0.55	0.55	n/a	0.18	0.17	n/a	0.37	0.35	n/a	n/a	n/a
	4	(102)	n/a	0.71	0.67	0.98	0.86	0.75	n/a	0.57	0.56	0.31	0.25	0.24	0.62	0.50	0.47	n/a	n/a	n/a
	4-1/4	(108)	n/a	0.72	0.68	1.00	0.90	0.78	n/a	0.57	0.57	0.34	0.27	0.26	0.68	0.55	0.52	n/a	n/a	n/a
	5	(127)	n/a	0.76	0.71	1.00	1.00	0.87	n/a	0.58	0.58	0.43	0.35	0.33	0.87	0.70	0.66	0.62	n/a	n/a
	5-1/2	(140)	0.83	0.78	0.73	1.00		0.93	0.61	0.59	0.59	0.50	0.40	0.38	1.00	0.81	0.76	0.65	0.60	n/a
	6	(152)	0.86	0.81	0.75			1.00	0.61	0.60	0.60	0.57	0.46	0.43		0.92	0.87	0.68	0.63	0.62
	7	(178)	0.92	0.86	0.79				0.63	0.62	0.61	0.72	0.58	0.55		1.00	1.00	0.73	0.68	0.67
	8	(203)	0.98	0.91	0.83				0.65	0.63	0.63	0.88	0.71	0.67				0.78	0.73	0.71
	10	(254)	1.00	1.00	0.92				0.69	0.67	0.66	1.00	0.99	0.93				0.87	0.81	0.80
	12	(305)			1.00				0.73	0.70	0.69		1.00	1.00				0.96	0.89	0.87
	24	(610)							0.96	0.90	0.88							1.00	1.00	1.00
	> 36	(914)							1.00	1.00	1.00									

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 30 — Load adjustment factors for Stainless Steel 3/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

3/4-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4
		(mm)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)
Nominal Embedment h_{nom}		in.	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2
		(mm)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3-3/4	(95)	n/a	n/a	n/a	n/a	n/a	0.47	n/a	n/a	n/a	n/a	n/a	0.18	n/a	n/a	0.36	n/a	n/a	n/a
	4	(102)	n/a	0.68	0.64	n/a	0.44	0.48	n/a	0.56	0.56	n/a	0.24	0.20	n/a	0.44	0.40	n/a	n/a	n/a
	4-1/2	(114)	n/a	0.70	0.66	n/a	0.48	0.52	n/a	0.57	0.56	n/a	0.29	0.24	n/a	0.48	0.47	n/a	n/a	n/a
	5	(127)	0.76	0.72	0.68	0.42	0.51	0.55	0.57	0.58	0.57	0.27	0.33	0.28	0.42	0.51	0.55	n/a	n/a	n/a
	5-1/4	(133)	0.77	0.73	0.68	0.44	0.53	0.57	0.57	0.58	0.57	0.29	0.36	0.30	0.44	0.53	0.57	n/a	n/a	n/a
	5-1/2	(140)	0.78	0.74	0.69	0.46	0.55	0.59	0.58	0.59	0.58	0.31	0.39	0.32	0.46	0.55	0.59	0.55	n/a	n/a
	5-3/4	(146)	0.79	0.76	0.70	0.48	0.58	0.61	0.58	0.59	0.58	0.33	0.41	0.34	0.48	0.58	0.61	0.57	n/a	n/a
	6	(152)	0.81	0.77	0.71	0.50	0.60	0.63	0.58	0.60	0.58	0.35	0.44	0.36	0.50	0.60	0.63	0.58	0.62	n/a
	7	(178)	0.86	0.81	0.75	0.58	0.70	0.70	0.60	0.61	0.60	0.45	0.55	0.46	0.58	0.70	0.70	0.62	0.67	n/a
	7-1/2	(191)	0.88	0.83	0.76	0.63	0.75	0.75	0.60	0.62	0.61	0.49	0.61	0.51	0.63	0.75	0.75	0.65	0.69	n/a
	8	(203)	0.91	0.86	0.78	0.67	0.80	0.80	0.61	0.63	0.61	0.54	0.68	0.56	0.67	0.80	0.80	0.67	0.72	0.67
	9	(229)	0.96	0.90	0.82	0.75	0.90	0.90	0.63	0.64	0.63	0.65	0.81	0.67	0.75	0.90	0.90	0.71	0.76	0.71
	10	(254)	1.00	0.94	0.85	0.83	1.00	1.00	0.64	0.66	0.64	0.76	0.94	0.78	0.83	1.00	1.00	0.75	0.80	0.75
	11	(279)	1.00	0.99	0.89	0.92			0.65	0.68	0.66	0.88	1.00	0.90	0.92			0.78	0.84	0.79
	12	(305)		1.00	0.92	1.00			0.67	0.69	0.67	1.00		1.00	1.00			0.82	0.88	0.82
	16	(406)			1.00				0.72	0.76	0.73							0.94	1.00	0.95
	18	(457)							0.75	0.79	0.75							1.00		1.00
	24	(610)							0.83	0.89	0.84									
	> 36	(914)							1.00	1.00	1.00									

Table 31 — Load adjustment factors for Stainless Steel 3/4-in. diameter KB-TZ2 in cracked concrete [1,2]

3/4-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4
		(mm)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)
Nominal Embedment h_{nom}		in.	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2
		(mm)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3-3/4	(95)	n/a	n/a	n/a	n/a	n/a	0.65	n/a	n/a	n/a	n/a	n/a	0.15	n/a	n/a	0.29	n/a	n/a	n/a
	4	(102)	n/a	0.68	0.64	n/a	0.78	0.68	n/a	0.56	0.55	n/a	0.22	0.16	n/a	0.44	0.32	n/a	n/a	n/a
	4-1/2	(114)	n/a	0.70	0.66	n/a	0.85	0.73	n/a	0.57	0.56	n/a	0.26	0.19	n/a	0.52	0.39	n/a	n/a	n/a
	5	(127)	0.76	0.72	0.68	1.00	0.91	0.77	0.59	0.58	0.56	0.37	0.31	0.23	0.74	0.61	0.45	n/a	n/a	n/a
	5-1/4	(133)	0.77	0.73	0.68	1.00	0.95	0.80	0.59	0.58	0.56	0.40	0.33	0.24	0.79	0.66	0.49	n/a	n/a	n/a
	5-1/2	(140)	0.78	0.74	0.69	1.00	0.98	0.83	0.59	0.58	0.57	0.43	0.35	0.26	0.85	0.71	0.52	0.61	n/a	n/a
	5-3/4	(146)	0.79	0.76	0.70	1.00	1.00	0.85	0.60	0.59	0.57	0.46	0.38	0.28	0.91	0.76	0.56	0.63	n/a	n/a
	6	(152)	0.81	0.77	0.71	1.00	1.00	0.88	0.60	0.59	0.57	0.49	0.40	0.30	0.97	0.81	0.59	0.64	0.60	n/a
	7	(178)	0.86	0.81	0.75	1.00		0.99	0.62	0.61	0.59	0.61	0.51	0.37	1.00	1.00	0.75	0.69	0.65	n/a
	7-1/2	(191)	0.88	0.83	0.76	1.00		1.00	0.63	0.61	0.59	0.68	0.56	0.41	1.00		0.83	0.72	0.67	n/a
	8	(203)	0.91	0.86	0.78	1.00			0.64	0.62	0.60	0.75	0.62	0.46	1.00		0.91	0.74	0.70	0.63
	9	(229)	0.96	0.90	0.82				0.65	0.64	0.61	0.89	0.74	0.54			1.00	0.79	0.74	0.67
	10	(254)	1.00	0.94	0.85				0.67	0.65	0.62	1.00	0.87	0.64				0.83	0.78	0.70
	11	(279)	1.00	0.99	0.89				0.69	0.67	0.64		1.00	0.74				0.87	0.82	0.74
	12	(305)		1.00	0.92				0.71	0.68	0.65			0.84				0.91	0.85	0.77
	16	(406)			1.00				0.77	0.74	0.70			1.00				1.00	0.98	0.89
	18	(457)							0.81	0.77	0.72								1.00	0.94
	24	(610)							0.91	0.86	0.80									1.00
	> 36	(914)							1.00	1.00	0.94									

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[1] Linear interpolation not permitted

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

[3] Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 32 — Load adjustment factors for Stainless Steel 1-in. diameter KB-TZ2 in uncracked concrete [1,4]

1-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear [4] f_{HV}	
									⊥ Toward edge f_{RV}		∥ To edge f_{RV}			
Effective Embedment h_{ef}		in.	4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75
		(mm)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)
Nominal Embedment h_{nom}		in.	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8
		(mm)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3	(76)	n/a	n/a	n/a	0.302	n/a	n/a	n/a	0.085	n/a	0.170	n/a	n/a
	3-3/4	(95)	n/a	n/a	0.393	0.332	n/a	n/a	0.199	0.119	0.393	0.238	n/a	n/a
	4	(102)	n/a	n/a	0.409	0.342	n/a	n/a	0.219	0.131	0.409	0.262	n/a	n/a
	4-1/4	(108)	n/a	n/a	0.425	0.352	n/a	n/a	0.240	0.144	0.425	0.287	n/a	n/a
	4-3/4	(121)	n/a	0.638	0.458	0.373	n/a	0.551	0.284	0.170	0.458	0.339	n/a	n/a
	5	(127)	0.708	0.645	0.475	0.384	0.576	0.554	0.306	0.183	0.475	0.366	n/a	n/a
	6	(152)	0.750	0.674	0.545	0.429	0.591	0.565	0.403	0.241	0.545	0.429	n/a	n/a
	6-3/4	(171)	0.781	0.696	0.614	0.464	0.602	0.573	0.481	0.287	0.614	0.464	n/a	n/a
	8	(203)	0.833	0.732	0.727	0.525	0.621	0.586	0.620	0.371	0.727	0.525	0.696	n/a
	10	(254)	0.917	0.790	0.909	0.645	0.652	0.608	0.867	0.518	0.909	0.645	0.778	0.656
	12	(305)	1.000	0.848	1.000	0.774	0.682	0.629	1.000	0.681	1.000	0.774	0.853	0.718
	18	(457)		1.000		1.000	0.773	0.694		1.000		1.000	1.000	0.880
	24	(610)					0.864	0.758						1.000
	36	(914)					1.000	0.887						
	> 48	(1219)						1.000						

Table 33 — Load adjustment factors for Stainless Steel 1-in. diameter KB-TZ2 in cracked concrete [1,4]

1-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear [4] f_{HV}	
									⊥ Toward edge f_{RV}		∥ To edge f_{RV}			
Effective Embedment h_{ef}		in.	4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75
		(mm)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)
Nominal Embedment h_{nom}		in.	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8
		(mm)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3	(76)	n/a	n/a	n/a	0.542	n/a	n/a	n/a	0.081	n/a	0.162	n/a	n/a
	3-3/4	(95)	n/a	n/a	0.721	0.596	n/a	n/a	0.170	0.113	0.340	0.226	n/a	n/a
	4	(102)	n/a	n/a	0.750	0.614	n/a	n/a	0.188	0.124	0.375	0.249	n/a	n/a
	4-1/4	(108)	n/a	n/a	0.779	0.633	n/a	n/a	0.205	0.136	0.411	0.272	n/a	n/a
	4-3/4	(121)	n/a	0.638	0.840	0.671	n/a	0.549	0.243	0.161	0.485	0.322	n/a	n/a
	5	(127)	0.708	0.645	0.871	0.690	0.568	0.552	0.262	0.174	0.524	0.348	n/a	n/a
	6	(152)	0.750	0.674	1.000	0.770	0.582	0.562	0.344	0.228	0.689	0.457	n/a	n/a
	6-3/4	(171)	0.781	0.696		0.833	0.592	0.570	0.411	0.273	0.822	0.545	n/a	n/a
	8	(203)	0.833	0.732		0.943	0.609	0.583	0.530	0.352	1.000	0.703	0.661	n/a
	10	(254)	0.917	0.790		1.000	0.636	0.604	0.741	0.491		0.983	0.739	0.644
	12	(305)	1.000	0.848			0.664	0.625	0.974	0.646		1.000	0.809	0.706
	18	(457)		1.000			0.746	0.687	1.000	1.000			0.991	0.864
	24	(610)					0.828	0.749					1.000	0.998
	36	(914)					0.991	0.874						1.000
	> 48	(1219)					1.000	0.998						

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

■ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 34 — Hilti Carbon Steel KB-TZ2 in the soffit of uncracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations [1,2,3,4,5,6]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Installation per Figure 4				Installation per Figure 5			
			Min. conc. thickness [8] in. (mm)	Tension - ΦN_n		Shear - ΦV_n	Min. conc. thickness [8] in. (mm)	Tension - ΦN_n		Shear - ΦV_n
				f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)
1/4	1-1/2 (38)	1-3/4 (44)	2-1/2 (64)	775 (3.4)	820 (3.6)	1,060 (4.7)	2-1/4 (57)	620 (2.8)	655 (2.9)	730 (3.2)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	1,205 (5.4)	1,285 (5.7)	880 (3.9)	2-1/4 (57)	645 (2.9)	685 (3.0)	1,540 (6.9)
	2 (51)	2-1/2 (64)	2-1/2 (64)	1,705 (7.6)	1,830 (8.1)	1,380 (6.1)	2-1/4 (57)	1,615 (7.2)	1,730 (7.7)	1,630 (7.3)
	2-1/2 (64)	3 (76)	2-1/2 (64)	1,945 (8.7)	2,155 (9.6)	1,380 (6.1)	N/A	N/A	N/A	N/A
1/2	1-1/2 (38)	2 (51)	2-1/2 (64)	1,205 (5.4)	1,390 (6.2)	1,165 (5.2)	2-1/4 (57)	1,180 (5.2)	1,365 (6.1)	1,740 (7.7)
	2 (51)	2-1/2 (64)	2-1/2 (64)	1,790 (8.0)	2,015 (9.0)	1,470 (6.5)	2-1/4 (57)	1,235 (5.5)	1,395 (6.2)	2,065 (9.2)
	2-1/2 (64)	3 (76)	2-1/2 (64)	2,435 (10.8)	2,645 (11.8)	2,135 (9.5)	N/A	N/A	N/A	N/A
	3-1/4 (83)	3-3/4 (95)	2-1/2 (64)	3,065 (13.6)	3,390 (15.1)	2,755 (12.3)	3-1/4 (83)	1,730 (7.7)	1,915 (8.5)	2,250 (10.0)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	2,870 (12.8)	3,315 (14.7)	2,480 (11.0)	3-1/4 (83)	1,925 (8.6)	2,225 (9.9)	2,655 (11.8)
	4 (102)	4-1/2 (114)	2-1/2 (64)	3,780 (16.8)	4,365 (19.4)	3,025 (13.5)	N/A	N/A	N/A	N/A
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	2,470 (11.0)	2,730 (12.1)	2,655 (11.8)	N/A	N/A	N/A	N/A
	3-3/4[9] (95)	4-1/2 (114)	3-1/4 (83)	3,115 (13.9)	3,405 (15.1)	5,110 (22.7)	N/A	N/A	N/A	N/A

Table 35 — Hilti Carbon Steel KB-TZ2 in the soffit of cracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations [1,2,3,4,5,6,7]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Installation per Figure 4				Installation per Figure 5			
			Min. conc. thickness [8] in. (mm)	Tension - ΦN_n		Shear - ΦV_n	Min. conc. thickness [8] in. (mm)	Tension - ΦN_n		Shear - ΦV_n
				f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)
1/4	1-1/2 (38)	1-3/4 (44)	2-1/2 (64)	230 (1.0)	260 (1.2)	1,060 (4.7)	2-1/4 (57)	185 (0.8)	205 (0.9)	730 (3.2)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	1,055 (4.7)	1,220 (5.4)	880 (3.9)	2-1/4 (57)	565 (2.5)	650 (2.9)	1,540 (6.9)
	2 (51)	2-1/2 (64)	2-1/2 (64)	1,490 (6.6)	1.705 (7.6)	1,380 (6.1)	2-1/4 (57)	1,385 (6.2)	1,580 (7.0)	1,630 (7.3)
	2-1/2 (64)	3 (76)	2-1/2 (64)	1,565 (7.0)	1.695 (7.5)	1,380 (6.1)	N/A	N/A	N/A	N/A
1/2	1-1/2 (38)	2 (51)	2-1/2 (64)	1,075 (4.8)	1.230 (5.5)	1,165 (5.2)	2-1/4 (57)	960 (4.3)	1,100 (4.9)	1,740 (7.7)
	2 (51)	2-1/2 (64)	2-1/2 (64)	1,390 (6.2)	1.600 (7.1)	1,470 (6.5)	2-1/4 (57)	960 (4.3)	1,110 (4.9)	2,065 (9.2)
	2-1/2 (64)	3 (76)	2-1/2 (64)	2,130 (9.5)	2,435 (10.9)	2,135 (9.5)	N/A	N/A	N/A	N/A
	3-1/4 (83)	3-3/4 (95)	2-1/2 (64)	2,170 (9.7)	2,435 (10.8)	2,755 (12.3)	3-1/4 (83)	1,230 (5.5)	1,380 (6.1)	2,250 (10.0)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	2,555 (11.4)	2,950 (13.1)	2,480 (11.0)	3-1/4 (83)	1,715 (7.6)	1,980 (8.8)	2,655 (11.8)
	4 (102)	4-1/2 (114)	2-1/2 (64)	2,855 (12.7)	3,300 (14.7)	3,025 (13.5)	N/A	N/A	N/A	N/A
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	2,160 (9.6)	2,395 (10.7)	2,655 (11.8)	N/A	N/A	N/A	N/A
	3-3/4 (95)	4-1/2 (114)	3-1/4 (83)	2,425 (10.8)	2,735 (12.2)	5,110 (22.7)	N/A	N/A	N/A	N/A

1 See Section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).

4 Tabular values are lightweight concrete and no additional reduction factor is needed.

5 No additional reduction factors for spacing or edge distance need to be applied.

6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.

7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.73. See Section 3.1.8 for additional information on seismic applications.

8 Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 4 and 5.

9 For core drilled installations of 3/4" anchors installed at 3-3/4" effective embedment, apply a reduction factor of 0.89 to the design tension strength of anchors installed in uncracked concrete.

Figure 4 — Installation of Hilti KB-TZ2 carbon steel in the soffit of concrete over metal deck floor and roof assemblies – W deck[2]

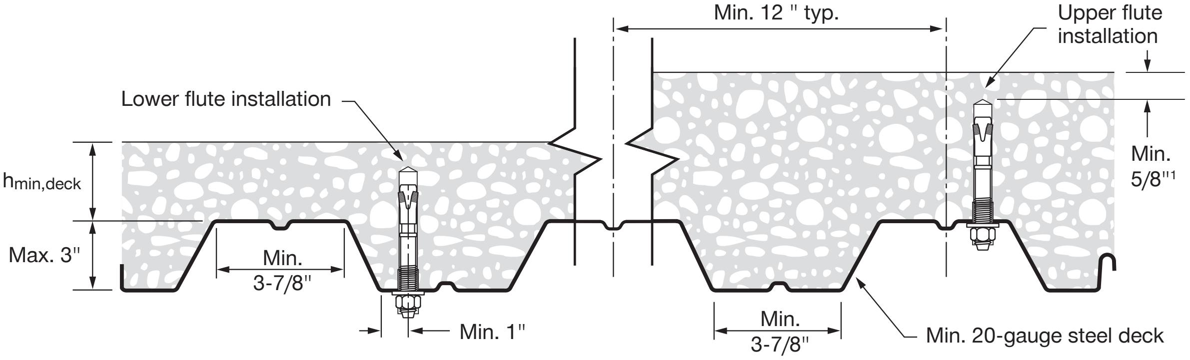
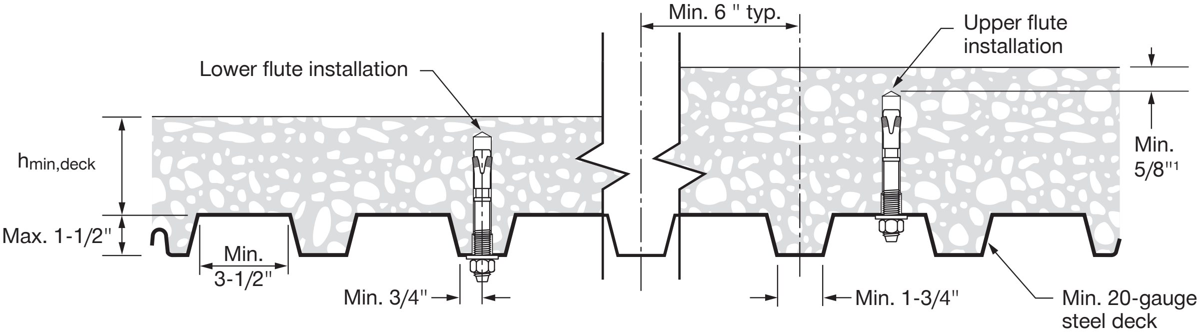


Figure 5 — Installation of Hilti KB-TZ2 carbon steel in the soffit of concrete over metal deck floor and roof assemblies – B deck



[1] 5/8" clearance between the bottom of the drilled hole and the concrete surface is only applicable for upper flute installations. Refer to Tables 34 and 35 for minimum concrete thicknesses for installations into the lower flute.

[2] For flute widths greater or equal to 4-1/2", the shear strength may be increased. Refer to ESR-4266 for more information.

Table 36 — Hilti KB-TZ2 carbon steel anchors setting information for installation on the top of concrete-filled profile steel deck asseblies according to figure 6 [1,2,3]

Design information	Symbol	Units	Nominal anchor diameter (in)			
			1/4	3/8		1/2
Effective minimum embedment	h_{ef}	in.	1-1/2	1-1/2	2	2
Nominal minimum embedment	h_{nom}	in.	1-3/4	1-7/8	2-1/2	2-1/2
Minimum hole depth	h_0	in.	2	2	2-1/2	2-3/4
Minimum concrete thickness [4]	$h_{min,deck}$	in.	2-1/2	2-1/2	2-1/2	3-2/4
Critical edge distance	$c_{ac,deck,top}$	in.	5	8	4-1/2	6
Minimum edge distance	$c_{min,deck,top}$	in.	3	16		7-1/2
Minimum spacing	$s_{min,deck,top}$	in.	3	8		9
Required installation torque	T_{inst}	ft-lb	4	30		50

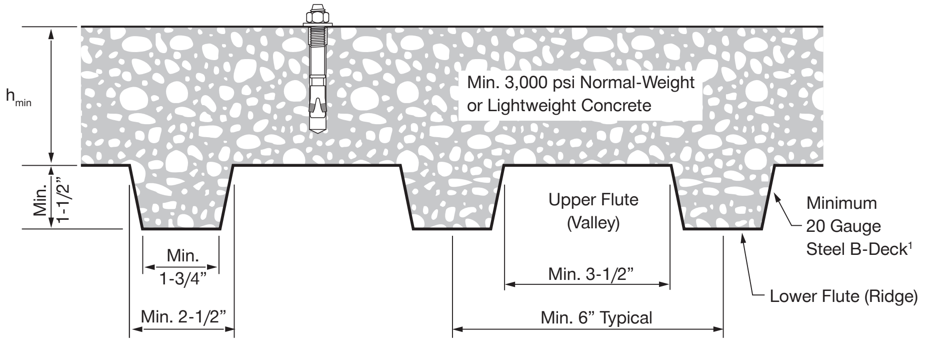
[1] Installation must comply with Figure 6 of this report.

[2] Design capacity shall be based on calculations according to values in Tables 2 and 3 of this report.

[3] Applicable for $h_{min,deck}$ < 4-in. For $h_{min,deck}$ ≥ 4-in, use setting information in Tables 1 and 5 of this section.

[4] Minimun concrete thickness refers to concrete thickness above the upper flute. See Figure 6.

Figure 6 — KB-TZ2 Installation in the top of concrete filled profile steel deck assemblies



[1] 1-1/2-in B-deck as a minimum profile size. Other deck profiles meeting the B-deck minimum dimensions are also permitted

DESIGN DATA IN CONCRETE PER CSA A23.3

CSA A23.3 Annex D Design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. Tables 37, 38, 42 and 43 in this section contains the Limit State Design tables that are based on the published loads in ICC-ES Evaluation Report ESR 4266 and converted for use with CSA A23.3 Annex D. Tables 40, 41, 45 and 46 are Hilti Simplified Design Tables which are pre-factored resistance tables based on the design parameters and variables in Tables 37, 38, 42 and 43. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363 4458 or at www.hilti.ca.

Table 37 — Hilti KB-TZ2 carbon steel tension design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations[1]

Design parameter	Symbol	Units	Nominal anchor diameter (in.)																Ref
			1/4	3/8			1/2				5/8			3/4			1		A23.3
Effective min. embedment [2]	h_{ef}	in. (mm)	1-1/2 (38)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	3-1/4 (83)	2-3/4 (70)	3-1/4 (83)	4 (102)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	4 (102)	5-3/4 (146)	
Min. concrete thickness	h_{min}	in. (mm)	See Table 5																
Minimum edge distance	c_{min}	in. (mm)	See Table 5																
Minimum anchor spacing	s_{min}	in. (mm)	See Table 5																
Tension, steel failure modes																			
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85	0.85			0.85				0.85			0.85			0.85		8.4.3
Resistance modification factor for tension, steel failure modes[3]	R	-	0.80	0.80			0.80				0.80			0.80			0.80		D.5.3
Min. specified yield strength	f_{ya}	psi (N/mm^2)	100,900 (696)	100,900 (696)			96,300 (664)				87,000 (600)			84,700 (584)			75,000 (517)		
Min. specified ult. strength	f_{ut}	psi (N/mm^2)	122,400 (844)	126,200 (870)			114,000 (786)				106,700 (736)			105,900 (730)			88,000 (607)		
Effective tensile stress area	$A_{se,N}$	in^2 (mm^2)	0.024 (15.4)	0.051 (33.2)			0.099 (63.6)				0.164 (106.0)			0.239 (154.4)			0.470 (303.2)		
Factored steel resistance in tension	N_{sar}	lb (kN)	1,985 (8.8)	4,420 (19.7)			7,645 (34.0)				11,925 (53.0)			17,230 (76.6)			28,145 (125.2)		D.6.1.2
Tension, concrete failure modes																			
Anchor category	-	-	3	1			1				1			1			1		D.5.3 (c)
Concrete material resistance factor	Φ_c	-	0.65	0.65			0.65				0.65			0.65			0.65		8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [5]	R	-	0.75	1.00			1.00				1.00			1.00			1.00		D.5.3 (c)
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10.0	10.0	10.0	10.0	11.3	11.3	10.0	10.0	10.0	10.0	10.0	11.3	11.3[7]	10.0	11.3	10.0	D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	-	7.1	8.8	8.8	7.1	10.0	8.8	8.8	7.1	8.8	8.8	7.1	8.8	8.8	8.8	8.8	8.8	D.6.2.2
Modification factor for anchor resistance, tension, uncracked conc. [4]	$\Psi_{c,N}$	-	1.0	1.0			1.0				1.0			1.0			1.0		
Critical edge distance	c_{ac}	in. (mm)	4 (102)	5 (127)	4-3/8 (111)	5-1/2 (140)	8 (203)	5-1/2 (140)	6-3/4 (171)	10 (254)	10 (254)	11-1/2 (292)	8-3/4 (222)	12 (305)	10 (254)	9 (229)	11 (279)	16 (406)	
Factored pullout resistance in 20 MPa uncracked concrete [6]	$N_{pr,uncr}$	lb (kN)	1,055 (4.7)	N/A	N/A	2,865 (12.7)	N/A	N/A	N/A	N/A	3,770 (16.8)	N/A	6,300 (28.0	N/A	N/A	N/A	N/A	N/A	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete [6]	$N_{pr,cr}$	lb (kN)	325 (1.4)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6,000 (26.7)	N/A	8,275 (36.8)	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete, seismic [6]	$N_{pr,eq}$	lb (kN)	325 (1.4)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5,880 (26.1)	N/A	8,275 (36.8)	D.6.3.2
Normalization factor, uncracked concrete	n_{uncr}	-	0.20	0.22	0.24	0.35	0.50	0.42	0.29	0.35	0.50	0.48	0.50	0.35	0.31	0.39	N/A	0.38	
Normalization factor, cracked concrete, seismic	n_{cr}	-	0.39	0.50	0.46	0.28	0.47	0.50	0.48	0.40	0.50	0.47	0.50	0.36	0.42	0.29	N/A	0.50	

[1] Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 4 and 6, and converted for use with CSA A23.3 Annex D.

[2] See Figure 1 of this document.

[3] The KB-TZ2 carbon steel anchor is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.

[4] For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

[5] For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

[6] For all design cases, $\Psi_{c,P}$ = 1.0. Tabular value for pullout strength is for a concrete compressive strength of 2,900 psi (20.0 M Pa). Pullout strength for concrete compressive strength greater than 2,900 psi (20.2 MPa) may be increased by multiplying the tabular pullout strength by $(f'_c / 2{,}900)^n$ for psi, or $(f'_c / 20.2)^n$ for MPa,

[7] For core drilled installation $k_{c,uncr}$ = 10.0 for 3/4" diameter installed at 3-3/4" effective embedment.

Table 38 — Hilti KB-TZ2 carbon steel shear design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations [1]

Design parameter	Symbol	Units	Nominal anchor diameter (in.)																Ref
			1/4	3/8			1/2				5/8			3/4			1		A23.3
Anchor O.D.	d_a	in. (mm)	0.25 (6.4)	0.375 (9.5)			0.5 (12.7)				0.625 (15.9)			0.75 (19.1)			1.00 (25.4)		
Effective min. embedment [2]	h_{ef}	in. (mm)	1-1/2 (38)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	3-1/4 (83)	2-3/4 (70)	3-1/4 (83)	4 (102)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	4 (102)	5-3/4 (146)	
Shear, steel failure modes																			
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85	0.85			0.85				0.85			0.85			0.85		8.4.3
Resistance modification factor for shear, steel failure modes [3]	R	-	0.75	0.75			0.75				0.75			0.75			0.75		D.5.3
Factored steel resistance in shear	V_{sar}	lb (kN)	855 (3.8)	2,055 (9.1)			3,530 (15.7)				6,540 (29.1)			8,800 (39.1)			11,980 (53.3)	14,550 (64.7)	D.7.1.2
Factored steel resistance in shear, seismic	$V_{sar,eq}$	lb (kN)	855 (3.8)	2,055 (9.1)			3,530 (15.7)				6,540 (29.1)			8,800 (39.1)			8,800 (39.1)		
Shear, concrete failure modes																			
Concrete material resistance factor	Φ_c	-	0.65	0.65			0.65				0.65			0.65			0.65		8.4.2
Resistance modification factor for shear, concrete failure modes [4]	R	-	1.00	1.00			1.00				1.00			1.00			1.00		D.5.3
Load bearing length of anchor in shear	ℓ_e	in. (mm)	1-1/2 (38)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	3-1/4 (83)	2-3/4 (70)	3-1/4 (83)	4 (102)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	4 (102)	5-3/4 (146)	
Effectiveness factor for pryout	k_{cp}	-	1.0	1.0	1.0	2.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	

1 Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 4 and 6, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB-TZ2 carbon steel anchor is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

Table 39 — Steel resistance for Hilti KB-TZ2 carbon steel anchors [1,2]

Nominal anchor diameter in.	Effective embedment depth in. (mm)			Tensile [3] ΦN_{sar} lb (kN)	Shear [4] ΦV_{sar} lb (kN)	Seismic Shear [5] $\Phi V_{sar,eq}$ lb (kN)
1/4	1-1/2 (38)			1,985 (8.8)	855 (3.8)	855 (3.8)
3/8	1-1/2 (38)			4,420 (19.7)	2,055 (9.1)	2,055 (9.1)
3/8	2 (51)	2-1/2 (64)		4,420 (19.7)	2,160 (9.6)	2,160 (9.6)
1/2	1-1/2 (38)	2 (51)		7,645 (34.0)	3,530 (15.7)	3,530 (15.7)
1/2	2-1/2 (64)	3-1/4 (83)		7,645 (34.0)	4,385 (19.5)	4,385 (19.5)
5/8	2-3/4 (70)	3-1/4 (83)	4 (102)	11,925 (53.0)	6,540 (29.1)	6,540 (29.1)
3/4	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	17,230 (76.6)	8,800 (39.1)	8,800 (39.1)
1	4 (102)			28,145 (125.2)	11,980 (53.3)	8,800 (39.1)
1	5-3/4 (146)			28,145 (125.2)	14,550 (64.7)	8,800 (39.1)

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Hilti KB-TZ2 carbon steel anchors are to be considered ductile steel elements.
3 Tensile $N_{sar} = A_{se,N}\, \Phi_s\, f_{uta}\, R$ as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with $V_{sar} < 0.6\, A_{se,V}\, \Phi_s\, f_{ut}a\, R$ as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \le 0.60\, A_{se,V}\, \Phi_s\, f_{uta}\, R$ as noted in CSA A23.3 Annex D. See Section 3.1.8 for additional information on seismic applications.

Table 40 — Hilti KB-TZ2 carbon steel factored resistance based on concrete failure modes in uncracked concrete, applicable for both hammer and core drilled installations [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1 1/2 (38)	1 3/4 (44)	1,055 (4.7)	1,105 (4.9)	1,145 (5.1)	1,210 (5.4)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
3/8	1 1/2 (38)	1 7/8 (48)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
	2 (51)	2 1/2 (64)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)
	2 1/2 (64)	3 (76)	2,865 (12.7)	3,095 (13.8)	3,300 (14.7)	3,650 (16.2)	3,305 (14.7)	3,695 (16.4)	4,050 (18.0)	4,675 (20.8)
1/2	1 1/2 (38)	2 (51)	1,735 (7.7)	1,940 (8.6)	2,125 (9.5)	2,455 (10.9)	1,735 (7.7)	1,940 (8.6)	2,125 (9.5)	2,455 (10.9)
	2 (51)	2 1/2 (64)	2,675 (11.9)	2,990 (13.3)	3,275 (14.6)	3,780 (16.8)	2,675 (11.9)	2,990 (13.3)	3,275 (14.6)	3,780 (16.8)
	2 1/2 (64)	3 (76)	3,305 (14.7)	3,695 (16.4)	4,050 (18.0)	4,675 (20.8)	3,305 (14.7)	3,695 (16.4)	4,050 (18.0)	4,675 (20.8)
	3 1/4 (83)	3 3/4 (95)	4,900 (21.8)	5,480 (24.4)	6,005 (26.7)	6,930 (30.8)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
5/8	2 3/4 (70)	3 1/4 (83)	3,770 (16.8)	4,215 (18.7)	4,615 (20.5)	5,330 (23.7)	7,630 (33.9)	8,530 (37.9)	9,345 (41.6)	10,790 (48.0)
	3 1/4 (83)	3 3/4 (95)	4,900 (21.8)	5,480 (24.4)	6,005 (26.7)	6,930 (30.8)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
	4 (102)	4 1/2 (114)	6,300 (28.0)	7,045 (31.3)	7,720 (34.3)	8,910 (39.6)	13,385 (59.5)	14,965 (66.6)	16,395 (72.9)	18,930 (84.2)
3/4	3 1/4 (83)	4 (102)	4,900 (21.8)	5,480 (24.4)	6,005 (26.7)	6,930 (30.8)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
	3 3/4[6] (95)	4 1/2 (114)	6,865 (30.5)	7,675 (34.1)	8,405 (37.4)	9,710 (43.2)	13,730 (61.1)	15,350 (68.3)	16,815 (74.8)	19,415 (86.4)
	4 3/4 (121)	5 1/2 (140)	8,660 (38.5)	9,685 (43.1)	10,605 (47.2)	12,250 (54.5)	17,320 (77.0)	19,365 (86.1)	21,215 (94.4)	24,495 (109.0)
1	4 (102)	4 5/8 (117)	7,560 (33.6)	8,455 (37.6)	9,260 (41.2)	10,695 (47.6)	15,125 (67.3)	16,910 (75.2)	18,525 (82.4)	21,390 (95.1)
	5 3/4 (146)	6 3/8 (162)	11,535 (51.3)	12,895 (57.4)	14,125 (62.8)	16,310 (72.6)	23,070 (102.6)	25,790 (114.7)	28,255 (125.7)	32,625 (145.1)

Table 41 — Hilti KB-TZ2 carbon steel factored resistance based on concrete failure modes in cracked concrete, applicable for both hammer and core drilled installations [1,2,3,4,5]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1 1/2 (38)	1 3/4 (44)	325 (1.4)	350 (1.6)	380 (1.7)	425 (1.9)	1,090 (4.9)	1,220 (5.4)	1,335 (5.9)	1,545 (6.9)
3/8	1 1/2 (38)	1 7/8 (48)	1,350 (6.0)	1,510 (6.7)	1,655 (7.4)	1,915 (8.5)	1,350 (6.0)	1,510 (6.7)	1,655 (7.4)	1,915 (8.5)
	2 (51)	2 1/2 (64)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)
	2 1/2 (64)	3 (76)	2,350 (10.4)	2,625 (11.7)	2,875 (12.8)	3,320 (14.8)	2,350 (10.4)	2,625 (11.7)	2,875 (12.8)	3,320 (14.8)
1/2	1 1/2 (38)	2 (51)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
	2 (51)	2 1/2 (64)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)
	2 1/2 (64)	3 (76)	2,910 (12.9)	3,255 (14.5)	3,565 (15.9)	4,115 (18.3)	2,910 (12.9)	3,255 (14.5)	3,565 (15.9)	4,115 (18.3)
	3 1/4 (83)	3 3/4 (95)	3,480 (15.5)	3,890 (17.3)	4,260 (19.0)	4,920 (21.9)	6,960 (31.0)	7,780 (34.6)	8,525 (37.9)	9,845 (43.8)
5/8	2 3/4 (70)	3 1/4 (83)	3,355 (14.9)	3,755 (16.7)	4,110 (18.3)	4,750 (21.1)	6,715 (29.9)	7,505 (33.4)	8,225 (36.6)	9,495 (42.2)
	3 1/4 (83)	3 3/4 (95)	4,315 (19.2)	4,820 (21.5)	5,285 (23.5)	6,100 (27.1)	8,625 (38.4)	9,645 (42.9)	10,565 (47.0)	12,200 (54.3)
	4 (102)	4 1/2 (114)	4,750 (21.1)	5,310 (23.6)	5,820 (25.9)	6,720 (29.9)	9,505 (42.3)	10,625 (47.3)	11,640 (51.8)	13,440 (59.8)
3/4	3 1/4 (83)	4 (102)	4,315 (19.2)	4,820 (21.5)	5,285 (23.5)	6,100 (27.1)	8,625 (38.4)	9,645 (42.9)	10,565 (47.0)	12,200 (54.3)
	3 3/4 (95)	4 1/2 (114)	5,345 (23.8)	5,975 (26.6)	6,545 (29.1)	7,335 (33.6)	10,690 (47.6)	11,955 (53.2)	13,095 (58.2)	15,120 (67.3)
	4 3/4 (121)	5 1/2 (140)	6,000 (26.7)	6,400 (28.5)	6,745 (30.0)	7,335 (32.6)	15,240 (67.8)	17,040 (75.8)	18,670 (83.0)	21,555 (95.9)
1	4 (102)	4 5/8 (117)	5,890 (26.2)	6,585 (29.3)	7,215 (32.1)	8,330 (37.0)	11,780 (52.4)	13,170 (58.6)	14,425 (64.2)	16,660 (74.1)
	5 3/4 (146)	6 3/8 (162)	8,275 (36.8)	9,250 (41.1)	10,135 (45.1)	11,700 (52.0)	20,300 (90.3)	22,695 (101.0)	24,865 (110.6)	28,710 (127.7)

1 See Section 3.1.8 to convert factored resistance value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 17 as necessary. Compare to the steel values in Table 39. The lesser of the values is to be used for the design.

4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, $\lambda_a = 0.68$; for all-lightweight, $\lambda_a = 0.60$.

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis} = 0.75$, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis} = 0.73$. No reduction needed for seismic shear. See Section 3.1.8 for additional information on seismic applications.

6 For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.89 to the design tension strength

Table 42 — Hilti KB-TZ2 stainless steel tension design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations [1]

Design parameter	Symbol	Units	Nominal anchor diameter (in.)															Ref
			1/4	3/8			1/2			5/8			3/4			1		A23.3
Effective min. embedment [2]	h_{ef}	in. (mm)	1-1/2 (38)	1-1/2 (38)	2 (51)	2-1/2 (64)	2 (51)	2-1/2 (64)	3-1/4 (83)	2-3/4 (70)	3-1/4 (83)	4 (102)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	4 (102)	5-3/4 (146)	
Min. concrete thickness	h_{min}	in. (mm)	See Table 19															
Minimum edge distance	c_{min}	in. (mm)	See Table 19															
Minimum anchor spacing	s_{min}	in. (mm)	See Table 19															
Tension, steel failure modes																		
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85	0.85			0.85			0.85			0.85			0.85		8.4.3
Resistance modification factor for tension, steel failure modes [3]	R	-	0.80	0.80			0.80			0.80			0.80			0.80		
Min. specified yield strength	f_{ya}	psi (N/mm²)	100,900 (696)	96,300 (664)			96,300 (664)			91,600 (632)			84,100 (580)			65,000 (448)		
Min. specified ult. strength	f_{ut}	psi (N/mm²)	122,400 (844)	120,100 (828)			120,400			114,600 (790)			100,500 (693)			99,900 (689)		
Effective tensile stress area	$A_{se,N}$	in² (mm²)	0.024 (15.4)	0.051 (33.2)			0.099 (63.6)			0.164 (106.0)			0.239 (154.4)			0.470 (303.2)		
Factored steel resistance in tension	N_{sar}	lb (kN)	2,050 (9.1)	4,210 (18.7)			8,070 (35.9)			12,810 (57.0)			16,350 (72.7)			31,930 (142.0)		D.6.1.2
Tension, concrete failure modes																		
Anchor category	-	-	3	1			1			1			1			1		D.5.3 (c)
Concrete material resistance factor	Φ_c	-	0.65	0.65			0.65			0.65			0.65			0.65		8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [5]	R	-	0.75	1.00			1.00			1.00			1.00			1.00		D.5.3 (c)
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	11.3[7]	10.0	11.3	11.3	D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	-	7.1	8.8	8.8	7.1	7.1	8.8	7.1	8.8	8.8	7.1	8.8	8.8[7]	8.8	10.0	8.8	D.6.2.2
Modification factor for anchor resistance, tension, uncracked conc. [4]	$\Psi_{c,N}$	-	1.0	1.0			1.0			1.0			1.0			1.0		
Critical edge distance	c_{ac}	in. (mm)	4 (102)	4-1/2 (114)	5-1/2 (140)	4-1/8 (105)	5-1/2 (140)	6-1/4 (159)	7-1/2 (191)	10 (254)	7 (178)	9 (229)	12 (305)	10 (254)	10 (254)	11 (279)	15-1/2 (394)	
Factored pullout resistance in 20 MPa uncracked concrete [6]	$N_{pr,uncr}$	lb (kN)	810 (3.6)	N/A	N/A	2,875 (12.8)	2,355 (10.5)	2,810 (12.5)	3,855 (17.1)	2,860 (12.7)	4,165 (18.5)	5,615 (25.0)	N/A	N/A	N/A	N/A	N/A	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete [6]	$N_{pr,cr}$	lb (kN)	360 (1.6)	N/A	N/A	N/A	N/A	N/A	N/A[8]	N/A	N/A	N/A	N/A	N/A	6,160 (27.4)	N/A	N/A	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete, seismic [6]	$N_{pr,eq}$	lb (kN)	360 (1.6)	N/A	N/A	N/A	N/A	N/A	N/A[8]	N/A	N/A	N/A	N/A	N/A	6,160 (27.4)	N/A	N/A	D.6.3.2
Normalization factor, uncracked concrete	n_{uncr}	-	0.39	N/A	N/A	0.37	0.46	0.50	0.50	0.50	0.42	0.47	N/A	N/A	0.30	N/A	N/A	
Normalization factor, cracked concrete, seismic	n_{cr}	-	0.50	N/A	N/A	N/A	N/A	N/A	0.50	N/A	N/A	N/A	N/A	N/A	0.50	N/A	N/A	

[1] Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 5 and 7, and converted for use with CSA A23.3 Annex D.

[2] See Figure 1 of this document.

[3] The KB-TZ2 stainless steel anchor is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.

[4] For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

[5] For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

[6] For all design cases, $\Psi_{c,P}$ = 1.0. Tabular value for pullout strength is for a concrete compressive strength of 2,900 psi (20.0 MPa). Pullout strength for concrete compressive strength greater than 2,900 psi (20.2 MPa) may be increased by multiplying the tabular pullout strength by (f'_c / 2,900)n for psi, or $(f'_c / 20.2)^n$ for MPa.

[7] For core drilled installation $k_{c,uncr}$ = 10.0 and $k_{c,cr}$ = 7.1 for 3/4" diameter installed at 3-3/4" effective embedment

[8] For core drilled installation, $N_{p,c}r$ = 4245 lb (18.9 kN) and $N_{p,eq}$ = 4245 lb (18.9 kN) for 1/2-inch diameter anchors installed at 3-3/4 inches (95 mm) effective embedment.

Table 43 — Hilti KB-TZ2 stainless steel shear design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations[1]

Design parameter	Symbol	Units	Nominal anchor diameter (in.)															Ref
			1/4	3/8			1/2			5/8			3/4			1		A23.3
Anchor O.D.	d_a	in. (mm)	0.25 (6.4)	0.375 (9.5)			0.5 (12.7)			0.625 (15.9)			0.75 (19.1)			1.00 (25.4)		
Effective min. embedment [2]	h_{ef}	in. (mm)	1-1/2 (38)	1-1/2 (38)	2 (51)	2-1/2 (64)	2 (51)	2-1/2 (64)	3-1/4 (83)	2-3/4 (70)	3-1/4 (83)	4 (102)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	4 (102)	5-3/4 (146)	
Shear, steel failure modes																		
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85	0.85			0.85			0.85			0.85			0.85		8.4.3
Resistance modification factor for shear, steel failure modes [3]	R	-	0.75	0.75			0.75			0.75			0.75			0.75		
Factored steel resistance in shear	V_{sar}	lb (kN)	930 (4.1)	2,940 (13.1)	3,115 (13.9)		5,320 (23.7)			7,875 (35.0)			10,555 (47.0)			14,635 (65.1)	20,020 (89.1)	D.7.1.2
Factored steel resistance in shear, seismic	$V_{sar,eq}$	lb (kN)	710 (3.2)	2,940 (13.1)	3,115 (13.9)		5,320 (23.7)			7,875 (35.0)			8,585 (38.2)			8,585 (38.2)		
Shear, concrete failure modes																		
Concrete material resistance factor	Φ_c	-	0.65	0.65			0.65			0.65			0.65			0.65		8.4.2
Resistance modification factor for shear, concrete failure modes [4]	R	-	0.75	1.00			1.00			1.00			1.00			1.00		D.5.3 (c)
Load bearing length of anchor in shear	ℓ_e	in. (mm)	1-1/2 (38)	1-1/2 (38)	2 (51)	2-1/2 (64)	2 (51)	2-1/2 (64)	3-1/4 (83)	2-3/4 (70)	3-1/4 (83)	4 (102)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	4 (102)	5-3/4 (146)	
Effectiveness factor for pryout	k_{cp}	-	1.0	1.0	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	

1 Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 5 and 7, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB-TZ2 stainless steel anchor is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

Table 44 — Steel resistance for Hilti KB-TZ2 stainless steel anchors [1,2]

Nominal anchor diameter in.	Effective embedment depth in. (mm)			Tensile [3] N_{sar} lb (kN)	Shear [4] V_{sar} lb (kN)	Seismic Shear [5] $V_{sar,eq}$ lb (kN)
1/4	1-1/2 (38)			2,050 (9.1)	930 (4.1)	710 (3.2)
3/8	1-1/2 (38)			4,210 (18.7)	2,940 (13.1)	2,940 (13.1)
3/8	2 (51)	2-1/2 (64)		4,210 (18.7)	3,115 (13.9)	3,115 (13.9)
1/2	2 (51)	2-1/2 (64)	3-1/4 (83)	8,070 (35.9)	5,320 (23.7)	5,320 (23.7)
5/8	2-3/4 (70)	3-1/4 (83)	4 (102)	12,810 (57.0)	7,875 (35.0)	7,875 (35.0)
3/4	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	16,350 (72.7)	10,555 (47.0)	8,585 (38.2)
1	4 (102)			31,930 (142.0)	14,635 (65.1)	8,585 (38.2)
1	5-3/4 (146)			31,930 (142.0)	20,020 (89.1)	8,585 (38.2)

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Hilti KB-TZ2 stainless steel anchors are to be considered ductile steel elements.
3 Tensile Nsar = Ase,N fs futa R as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with Vsar < 0.6 Ase,V fs futa R as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with Vsar,eq < 0.60 Ase,V fs futa R as noted in CSA A23.3 Annex D. See Section 3.1.8 for additional information on seismic applications.

Table 45 — Hilti KB-TZ2 stainless steel factored resistance based on concrete failure modes in uncracked concrete, applicable for both hammer and core drilled installations [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1 1/2 (38)	1 3/4 (44)	810 (3.6)	885 (3.9)	950 (4.2)	1,065 (4.7)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
3/8	1 1/2 (38)	1 7/8 (48)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
	2 (51)	2 1/2 (64)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)
	2 1/2 (64)	3 (76)	2,875 (12.8)	3,125 (13.9)	3,340 (14.9)	3,715 (16.5)	6,615 (29.4)	7,395 (32.9)	8,100 (36.0)	9,355 (41.6)
1/2	2 (51)	2 1/2 (64)	2,355 (10.5)	2,610 (11.6)	2,835 (12.6)	3,240 (14.4)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)
	2-1/2 (64)	3 (76)	2,810 (12.5)	3,140 (14.0)	3,440 (15.3)	3,975 (17.7)	6,615 (29.4)	7,395 (32.9)	8,100 (36.0)	9,355 (41.6)
	3 1/4 (83)	3 3/4 (95)	3,855 (17.1)	4,310 (19.2)	4,720 (21.0)	5,450 (24.2)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
5/8	2 3/4 (70)	3 1/4 (83)	2,860 (12.7)	3,200 (14.2)	3,505 (15.6)	4,045 (18.0)	7,630 (33.9)	8,530 (37.9)	9,345 (41.6)	10,790 (48.0)
	3 1/4 (83)	3 3/4 (95)	4,165 (18.5)	4,575 (20.3)	4,935 (22.0)	5,570 (24.8)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
	4 (102)	4 1/2 (114)	5,615 (25.0)	6,235 (27.7)	6,795 (30.2)	7,775 (34.6)	13,385 (59.5)	14,965 (66.6)	16,395 (72.9)	18,930 (84.2)
3/4	3 1/4 (83)	4 (102)	4,900 (21.8)	5,480 (24.4)	6,005 (26.7)	6,930 (30.8)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
	3 3/4[6] (95)	4 1/2 (114)	6,865 (30.5)	7,675 (34.1)	8,405 (37.4)	9,710 (43.2)	13,730 (61.1)	15,350 (68.3)	16,815 (74.8)	19,415 (86.4)
	4 3/4 (121)	5 1/2 (140)	8,660 (38.5)	9,685 (43.1)	10,605 (47.2)	12,250 (54.5)	17,320 (77.0)	19,365 (86.1)	21,215 (94.4)	24,495 (109.0)
1	4 (102)	4 5/8 (117)	7,560 (33.6)	8,455 (37.6)	9,260 (41.2)	10,695 (47.6)	15,125 (67.3)	16,910 (75.2)	18,525 (82.4)	21,390 (95.1)
	5 3/4 (146)	6 3/8 (162)	13,035 (58.0)	14,570 (64.8)	15,965 (71.0)	18,435 (82.0)	26,070 (116.0)	29,145 (129.6)	31,925 (142.0)	36,865 (164.0)

Table 46 — Hilti KB-TZ2 stainless steel factored resistance based on concrete failure modes in cracked concrete, applicable for both hammer and core drilled installations [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1 1/2 (38)	1 3/4 (44)	470 (2.1)	525 (2.3)	575 (2.6)	665 (3.0)	820 (3.6)	915 (4.1)	1,000 (4.5)	1,155 (5.1)
3/8	1 1/2 (38)	1 7/8 (48)	1,350 (6.0)	1,510 (6.7)	1,655 (7.4)	1,915 (8.5)	1,350 (6.0)	1,510 (6.7)	1,655 (7.4)	1,915 (8.5)
	2 (51)	2 1/2 (64)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)
	2 1/2 (64)	3 (76)	2,350 (10.4)	2,625 (11.7)	2,875 (12.8)	3,320 (14.8)	4,695 (20.9)	5,250 (23.4)	5,750 (25.6)	6,640 (29.5)
1/2	2 (51)	2 1/2 (64)	1,680 (7.5)	1,880 (8.4)	2,060 (9.2)	2,375 (10.6)	1,680 (7.5)	1,880 (8.4)	2,060 (9.2)	2,375 (10.6)
	2-1/2 (64)	3 (76)	2,910 (12.9)	3,255 (14.5)	3,565 (15.9)	4,115 (18.3)	5,820 (25.9)	6,505 (28.9)	7,130 (31.7)	8,230 (36.6)
	3 1/4[8] (83)	3 3/4 (95)	3,480 (15.5)	3,890 (17.3)	4,260 (19.0)	4,920 (21.9)	6,960 (31.0)	7,780 (34.6)	8,525 (37.9)	9,845 (43.8)
5/8	2 3/4 (70)	3 1/4 (83)	3,355 (14.9)	3,755 (16.7)	4,110 (18.3)	4,750 (21.1)	6,715 (29.9)	7,505 (33.4)	8,225 (36.6)	9,495 (42.2)
	3 1/4 (83)	3 3/4 (95)	4,315 (19.2)	4,820 (21.5)	5,285 (23.5)	6,100 (27.1)	8,625 (38.4)	9,645 (42.9)	10,565 (47.0)	12,200 (54.3)
	4 (102)	4 1/2 (114)	4,750 (21.1)	5,310 (23.6)	5,820 (25.9)	6,720 (29.9)	9,505 (42.3)	10,625 (47.3)	11,640 (51.8)	13,440 (59.8)
3/4	3 1/4 (83)	4 (102)	4,315 (19.2)	4,820 (21.5)	5,285 (23.5)	6,100 (27.1)	8,625 (38.4)	9,645 (42.9)	10,565 (47.0)	12,200 (54.3)
	3 3/4[7] (95)	4 1/2 (114)	5,345 (23.8)	5,975 (26.6)	6,545 (29.1)	7,560 (33.6)	10,690 (47.6)	11,955 (53.2)	13,095 (58.2)	15,120 (67.3)
	4 3/4 (121)	5 1/2 (140)	6,160 (27.4)	6,890 (30.6)	7,545 (33.6)	8,715 (38.8)	15,240 (67.8)	17,040 (75.8)	18,670 (83.0)	21,555 (95.9)
1	4 (102)	4 5/8 (117)	6,690 (29.8)	7,480 (33.3)	8,195 (36.5)	9,465 (42.1)	13,385 (59.5)	14,965 (66.6)	16,395 (72.9)	18,930 (84.2)
	5 3/4 (146)	6 3/8 (162)	10,150 (45.2)	11,350 (50.5)	12,430 (55.3)	14,355 (63.9)	20,300 (90.3)	22,695 (101.0)	24,865 (110.6)	28,710 (127.7)

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 22 to 33 as necessary. Compare to the steel values in Table 43. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear, except for the 3/4 bolts where $\alpha_{V,seis}$ = 0.81. See Section 3.1.8 for additional information on seismic applications.
6 For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.89 to the design tension strength.
7 For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.81 to the design tension strength.
8 Fore core drilled installations of 1/2" anchors installed at 3-1/4" effective embedment, apply a reduction factor of 0.85 to the design tension strength.

Table 47 — Hilti KB-TZ2 carbon steel factored resistance in the soffit of uncracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations[1,2,3,4,5,6]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Installation per Figure 4				Installation per Figure 5			
		Min. conc. thickness [8] in. (mm)	Tension - N_r		Shear - V_r	Min. conc. thickness [8] in. (mm)	Tension - N_r		Shear - V_r
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c ≥ 20 MPa (2,900 psi) lb (kN)		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c ≥ 20 MPa (2,900 psi) lb (kN)
1/4	1-3/4 (44)	2-1/2 (64)	835 (3.7)	905 (4.0)	1,040 (4.6)	2-1/4 (57)	670 (3.0)	725 (3.2)	715 (3.2)
3/8	1-7/8 (48)	2-1/2 (64)	1,195 (5.3)	1,310 (5.8)	865 (3.8)	2-1/4 (57)	640 (2.8)	700 (3.1)	1,510 (6.7)
	2-1/2 (64)	2-1/2 (64)	1,690 (7.5)	1,865 (8.3)	1,350 (6.0)	2-1/4 (57)	1600 (7.1)	1,765 (7.9)	1,595 (7.1)
	3 (76)	2-1/2 (64)	1,925 (8.6)	2,215 (9.9)	1,350 (6.0)	N/A	N/A	N/A	N/A
1/2	2 (51)	2-1/2 (64)	1,185 (5.3)	1,450 (6.4)	1,140 (5.1)	2-1/4 (57)	1,160 (5.2)	1,420 (6.3)	1,710 (7.6)
	2-1/2 (64)	2-1/2 (64)	1,760 (7.8)	2,090 (9.3)	1,440 (6.4)	2-1/4 (57)	1,220 (5.4)	1,445 (6.4)	2,025 (9.0)
	3-1/4 (83)	2-1/2 (64)	2,410 (10.7)	2,710 (12.1)	2,095 (9.3)	N/A	N/A	N/A	N/A
	3-3/4 (95)	2-1/2 (64)	3,030 (13.5)	3,490 (15.5)	2,700 (12.0)	3-1/4 (83)	1,710 (7.6)	1,975 (8.8)	2,210 (9.8)
5/8	3-1/4 (83)	2-1/2 (64)	2,820 (12.5)	3,455 (15.4)	2,430 (10.8)	3-1/4 (83)	1,890 (8.4)	2,315 (10.3)	2,605 (11.6)
	4-1/2 (114)	2-1/2 (64)	3,715 (16.5)	4,550 (20.2)	2,965 (13.2)	N/A	N/A	N/A	N/A
3/4	4 (102)	2-1/2 (64)	2,440 (10.9)	2,815 (12.5)	2,605 (11.6)	N/A	N/A	N/A	N/A
	4-1/2[9] (114)	3-1/4 (83)	3,085 (13.7)	3,495 (15.5)	5,015 (22.3)	N/A	N/A	N/A	N/A

Table 48 — Hilti KB-TZ2 carbon steel factored resistance in the soffit of cracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations [1,2,3,4,5,6,7]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Installation per Figure 4				Installation per Figure 5			
		Min. conc. thickness [8] in. (mm)	Tension - N_r		Shear - V_r	Min. conc. thickness [8] in. (mm)	Tension - N_r		Shear - V_r
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c ≥ 20 MPa (2,900 psi) lb (kN)		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c ≥ 20 MPa (2,900 psi) lb (kN)
1/4	1-3/4 (44)	2-1/2 (64)	250 (1.1)	290 (1.3)	1,040 (4.6)	2-1/4 (57)	195 (0.9)	230 (1.0)	715 (3.2)
3/8	1-7/8 (48)	2-1/2 (64)	1,040 (4.6)	1,270 (5.6)	865 (3.8)	2-1/4 (57)	555 (2.5)	680 (3.0)	1,510 (6.7)
	2-1/2 (64)	2-1/2 (64)	1,470 (6.5)	1,770 (7.9)	1,350 (6.0)	2-1/4 (57)	1,365 (6.1)	1,645 (7.3)	1,595 (7.1)
	3 (76)	2-1/2 (64)	1,550 (6.9)	1,735 (7.7)	1,350 (6.0)	N/A	N/A	N/A	N/A
1/2	2 (51)	2-1/2 (64)	1,055 (4.7)	1,275 (5.7)	1,140 (5.1)	2-1/4 (57)	945 (4.2)	1,160 (5.1)	1,710 (7.6)
	2-1/2 (64)	2-1/2 (64)	1,365 (6.1)	1,670 (7.4)	1,440 (6.4)	2-1/4 (57)	945 (4.2)	1,160 (5.2)	2,025 (9.0)
	3-1/4 (83)	2-1/2 (64)	2,095 (9.3)	2,545 (11.3)	2,095 (9.3)	N/A	N/A	N/A	N/A
	3-3/4 (95)	2-1/2 (64)	2,140 (9.5)	2,520 (11.2)	2,700 (12.0)	3-1/4 (83)	1,210 (5.4)	1,425 (6.3)	2,210 (9.8)
5/8	3-1/4 (83)	2-1/2 (64)	2,510 (11.2)	3,075 (13.7)	2,430 (10.8)	3-1/4 (83)	1,685 (7.5)	2,060 (9.2)	2,605 (11.6)
	4-1/2 (114)	2-1/2 (64)	2,810 (12.5)	3,440 (15.3)	2,965 (13.2)	N/A	N/A	N/A	N/A
3/4	4 (102)	2-1/2 (64)	2,135 (9.5)	2,470 (11.0)	2,605 (11.6)	N/A	N/A	N/A	N/A
	4-1/2 (114)	3-1/4 (83)	2,400 (10.7)	2,700 (12.0)	5,015 (22.3)	N/A	N/A	N/A	N/A

[1] See Section 3.1.8 to convert design strength value to ASD value.
[2] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
[3] Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
[4] Tabular values are lightweight concrete and no additional reduction factor is needed.
[5] No additional reduction factors for spacing or edge distance need to be applied.
[6] Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
[7] Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.73. See Section 3.1.8 for additional information on seismic applications.
[8] Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 4 and 5.
[9] For core drilled installations of 3/4“ anchors installed at 4-1/2“ nominal embedment, apply a reduction factor of 0.89 to the design tension strength of anchors installed in uncracked concrete.

Table 49 — Allowable tensile loads for Hilti KB-TZ2 carbon steel and stainless steel anchors in the face of grout-filled concrete masonry unit (CMU) walls [1,3,4,5,6]

					Spacing					Edge Distance				
Nominal anchor diameter	Nominal embedment		Allowable Tensile capacity at s_{cr} and c_{cr}		Critical spacing, s_{cr}		Minimum spacing[2], s_{min}		Load Multiplier at s_{min}	Critical edge distance, c_{cr}		Minimum edge distance, c_{min}		Load Multiplier at c_{min}
in.	in.	(mm)	lb	(kN)	in	(mm)	in	(mm)		in	(mm)	in	(mm)	
1/4	1-3/4	(44)	145	(0.6)	6	(152)	3	(76)	0.62	12	(305)	4	(102)	0.87
3/8	1-7/8	(48)	405	(1.8)	6	(152)			0.49					0.80
	3	(76)	590	(2.6)	10	(254)			0.58					0.93
1/2	2-1/2	(64)	500	(2.2)	8	(203)	4	(102)	0.59					0.94
	3-3/4	(95)	640	(2.8)	13	(330)			0.78					1.00
5/8	3-1/4	(83)	890	(4.0)	11	(279)	5	(127)	0.66	20	(508)			0.96
	4-1/2	(114)	940	(4.2)	16	(406)			0.61					0.96
3/4	4	(102)	1,245	(5.5)	13	(330)	6	(152)	0.49					0.75
	5-1/2	(140)	1,385	(6.2)	19	(483)			0.45					0.82

Table 50 — Allowable shear loads for Hilti KB-TZ2 carbon steel and stainless steel anchors in the face of grout-filled concrete masonry unit (CMU) walls [1,3,4,5,6]

					Spacing					Edge Distance					
Nominal anchor diameter	Nominal embedment		Allowable shear capacity at s_{cr} and c_{cr}		Critical spacing, s_{cr}		Minimum spacing, s_{min}^{2}		Load multiplier at s_{min}	Critical edge distance, c_{cr}		Minimum edge distance, c_{min}		Perpendicular load reduction factor at c_{min}	Parallel load reduction factor at c_{min}
in.	in.	(mm)	lb	(kN)	in	(mm)	in	(mm)		in	(mm)	in	(mm)		
1/4	1-3/4	(44)	320	(1.4)	6	(152)	3	(76)	0.73	12	(305)	4	(102)	1.00	1.00
3/8	1-7/8	(48)	585	(2.6)	6	(152)								0.76	0.99
	3	(76)	695	(3.1)	10	(254)									
1/2	2-1/2	(64)	1,045	(4.7)	8	(203)	4	(102)						0.50	0.83
	3-3/4	(95)			13	(330)									
5/8	3-1/4	(83)	1,735	(7.7)	11	(279)	5	(127)		20	(508)			0.36	0.75
	4-1/2	(114)	2,050	(9.1)	16	(406)								0.35	0.85
3/4	4	(102)	1,735	(7.7)	13	(330)	6	(152)						0.36	0.75
	5-1/2	(140)	2,050	(9.1)	19	(483)								0.35	0.85

1 Values valid for anchors installed in face shells of Type 1, Grade N, lightweight, medium-weight, or normal-weight concrete masonry units conforming to ASTM C90. The masonry units must be fully grouted with coarse grout conforming to 2018 and 2015 IBC Section 2103.3, 2012 IBC Section 2103.13, or 2009 IBC Section 2103.12. Mortar must comply with 2018 and 2015 IBC Section 2103.2.1, 2012 IBC Section 2103.9, or 2009 IBC Section 2103.8. Masonry compressive strength must be at least 1,500 psi at the time of anchor installation.

2 Loads tabulated are applicable to anchors spaced a critical distance of 4 times the effective embedment. The anchors may be placed at a minimum spacing, s_{min}, provided that reductions are applied to the tabulated values.

3 Anchors must be installed a minimum of 1-3/8-inches from any vertical mortar joint in accordance with Figure 6.

4 Embedment depth must be measured from the outside face of the concrete masonry unit.

5 For intermediate edge and spacing distances, allowable loads may be determined by linearly interpolating between the allowable loads at the two tabulated edge or spacing distances.

6 The tabulated allowable loads have been calculated based on a safety factor of 5.0.

Table 51 — Allowable tensile and shear loads for Hilti KB-TZ2 carbon and stainless steel anchors in the top of grout-filled concrete masonry walls [1,3,4,5,6]

Nominal anchor diameter	Nominal embedment		Minimum edge distance from edge of wall, C_{min}		Minimum spacing,[2] s_{min}		Minimum end distance C_{end}		Allowable tensile capacity		Allowable shear capacity			
											Parallel to edge of masonry wall		Perpendicular to edge of masonry wall	
in.	in.	(mm)	in	(mm)	in	(mm)	in	(mm)	lb	(kN)	lb	(kN)	lb	(kN)
3/8	1-7/8	(48)	1-3/4	(44)	6	(152)	12	(305)	300	(1.3)	325	(1.4)	175	(0.8)
	3	(76)			10	(254)	12	(305)	395	(1.8)	475	(2.1)	220	(1.0)
1/2	2-1/2	(64)			8	(203)	12	(305)	385	(1.7)	500	(2.2)	195	(0.9)
	3-3/4	(95)			13	(330)	12	(305)	485	(2.2)	610	(2.7)	240	(1.1)
5/8	3-1/4	(83)	2-3/4	(70)	11	(279)	12	(305)	620	(2.8)	930	(4.1)	410	(1.8)
	4-1/2	(114)			16	(406)	12	(305)	865	(3.8)	1240	(5.5)	465	(2.1)

1 Values valid for anchors installed in face shells of Type 1, Grade N, lightweight, medium-weight, or normal-weight concrete masonry units conforming to ASTM C90. The masonry units must be fully grouted with coarse grout conforming to 2018 and 2015 IBC Section 2103.3, 2012 IBC Section 2103.13, or 2009 IBC Section 2103.12. Mortar must comply with 2018 and 2015 IBC Section 2103.2.1, 2012 IBC Section 2103.9, or 2009 IBC Section 2103.8. Masonry compressive strength must be at least 1,500 psi at the time of anchor installation.

2 Loads tabulated are applicable to anchors spaced a critical distance of 4 times the effective embedment. The anchors may be placed at a minimum spacing, s_{min}, provided that reductions are applied to the tabulated values.

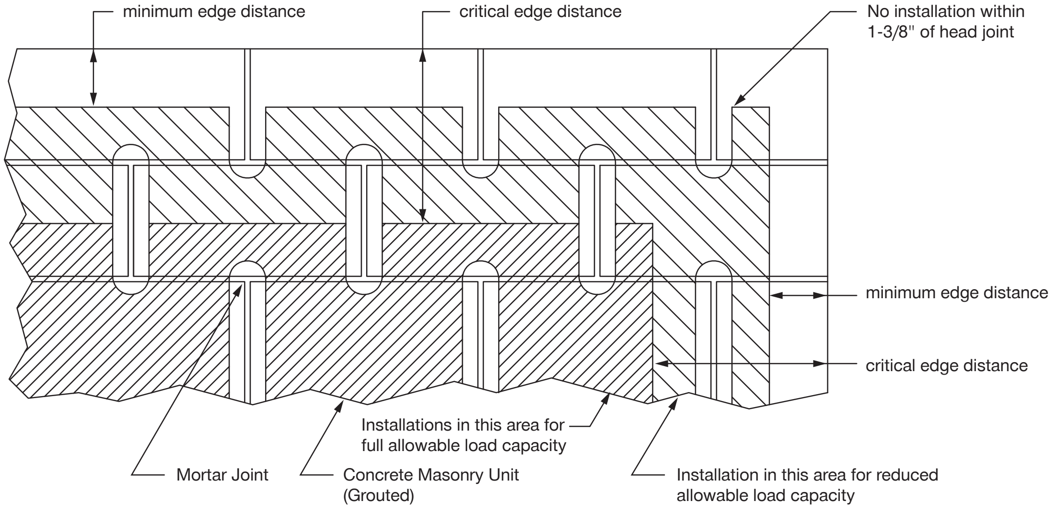
3 Anchors must be installed a minimum of 1-3/8 inches from any head joint in accordance with Figure 6.

4 Embedment depth must be measured from the outside face of the concrete masonry unit.

5 For intermediate edge and spacing distances, allowable loads may be determined by linearly interpolating between the allowable loads at the two tabulated edge or spacing distances.

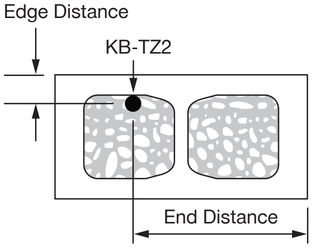
6 The tabulated allowable loads have been calculated based on a safety factor of 5.0.

Figure 7 — Acceptable locations (shaded areas) for Hilti KB-TZ2 anchors in the face of grout-filled CMU walls



Anchor installation is restricted to shaded areas

Figure 8 — Edge and end distances for the Hilti KB-TZ2 anchors installed in the top of grout-filled CMU walls



INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INSTRUCTIONS

Table 52 — Hilti KB-TZ2 carbon steel product portfolio

Description	Length (in)	Length ident. letter	Thread length (in)	Nominal embed. 1 (in)	Min. fixture thickness 1 (in)	Max. fixture thickness 1 (in)	Nominal embed. 2 (in)	Min. fixture thickness 2 (in)	Max. fixture thickness 2 (in)	Nominal embed. 3 (in)	Min. fixture thickness 3 (in)	Max. fixture thickness 3 (in)	Nominal embed. 4 (in)	Min. fixture thickness 4 (in)	Max. fixture thickness 4 (in)	Package quantity
KB-TZ2 1/4 x 2-1/8	2-1/8	B	7/8	1-3/4	0	1/8	-	-	-	-	-	-	-	-	-	100
KB-TZ2 1/4 x 2-1/2	2-1/2	C	1-1/4	1-3/4	0	1/2	-	-	-	-	-	-	-	-	-	100
KB-TZ2 1/4 x 3-1/4	3-1/4	D	2	1-3/4	0	1-1/4	-	-	-	-	-	-	-	-	-	100
KB-TZ2 1/4 x 4-1/2	4-1/2	G	3	1-3/4	1/8	2-1/2	-	-	-	-	-	-	-	-	-	100
KB-TZ2 3/8 x 2-1/2	2-1/2	C	1	1-7/8	0	1/4	-	-	-	-	-	-	-	-	-	50
KB-TZ2 3/8 x 3	3	D	1 1/2	1-7/8	0	3/4	2-1/2	0	1/4	-	-	-	-	-	-	50
KB-TZ2 3/8 x 3-1/2	3-1/2	Ω	2	1-7/8	0	1-1/4	2-1/2	0	3/4	3	0	1/4	-	-	-	50
KB-TZ2 3/8 x 3-3/4	3-3/4	E	2-1/4	1-7/8	0	1-1/2	2-1/2	0	1	3	0	1/2	-	-	-	50
KB-TZ2 3/8 x 5	5	H	3-1/2	1-7/8	0	2-3/4	2-1/2	0	2-1/4	3	0	1-3/4	-	-	-	50
KB-TZ2 3/8 x 7	7	L	4-7/8	1-7/8	1/2	4-3/4	2-1/2	0	4-1/4	3	0	3-3/4	-	-	-	50
KB-TZ2 1/2 x 3	3	D	1-1/8	2	1/4	1/2	2-1/2	0	0	-	-	-	-	-	-	20
KB-TZ2 1/2 x 3-3/4	3-3/4	E	1-5/8	2	1/2	1-1/4	2-1/2	0	3/4	3	0	1/4	-	-	-	20
KB-TZ2 1/2 x 4-1/2	4-1/2	G	2-3/8	2	1/2	2	2-1/2	0	1-1/2	3	0	1	3-3/4	0	1/4	20
KB-TZ2 1/2 x 5-1/2	5-1/2	I	3-3/8	2	1/2	3	2-1/2	0	2-1/2	3	0	2	3-3/4	0	1-1/4	20
KB-TZ2 1/2 x 7	7	L	4-3/4	2	5/8	4-1/2	2-1/2	1/8	4	3	0	3-1/2	3-3/4	0	2-3/4	20
KB-TZ2 1/2 x 8-1/2	8-1/2	O	4-7/8	2	2	6	2-1/2	1-1/2	5-1/2	3	1	5	3-3/4	1/4	4-1/4	20
KB-TZ2 1/2 x 10	10	R	4-7/8	2	3-1/2	7-1/2	2-1/2	3	7	3	2-1/2	6-1/2	3-3/4	1-3/4	5-3/4	20
KB-TZ2 5/8 x 4-1/4	4-1/4	F	2-1/4	3-1/4	0	3/8	-	-	-	-	-	-	-	-	-	15
KB-TZ2 5/8 x 4-3/4	4-3/4	G	2-3/4	3-1/4	0	7/8	3-3/4	0	3/8	-	-	-	-	-	-	15
KB-TZ2 5/8 x 5-1/2	5-1/2	I	3-1/2	3-1/4	0	1-5/8	3-3/4	0	1-1/8	4-1/2	0	3/8	-	-	-	15
KB-TZ2 5/8 x 6	6	J	4	3-1/4	0	2-1/8	3-3/4	0	1-5/8	4-1/2	0	7/8	-	-	-	15
KB-TZ2 5/8 x 7	7	L	4-7/8	3-1/4	0	3-1/8	3-3/4	0	2-5/8	4-1/2	0	1-7/8	-	-	-	15
KB-TZ2 5/8 x 8-1/2	8-1/2	O	6-1/2	3-1/4	0	4-5/8	3-3/4	0	4-1/8	4-1/2	0	3-3/8	-	-	-	15
KB-TZ2 5/8 x 10	10	R	7-1/8	3-1/4	1/8	6-1/8	3-3/4	0	5-5/8	4-1/2	0	4-7/8	-	-	-	15
KB-TZ2 3/4 x 4-3/4	4-3/4	G	2-1/2	4	0	1/8	-	-	-	-	-	-	-	-	-	10
KB-TZ2 3/4 x 5-1/2	5-1/2	I	3-1/4	4	0	7/8	4-1/2	0	3/8	-	-	-	-	-	-	10
KB-TZ2 3/4 x 6-1/4	6-1/4	J	3-1/4	4	0	1-5/8	4-1/2	0	1-1/8	5-1/2	0	1/8	-	-	-	10
KB-TZ2 3/4 x 7	7	L	4	4	0	2-3/8	4-1/2	0	1-7/8	5-1/2	0	7/8	-	-	-	10
KB-TZ2 3/4 x 8	8	N	5	4	0	3-3/8	4-1/2	0	2-7/8	5-1/2	0	1-7/8	-	-	-	10
KB-TZ2 3/4 x 9	9	P	6	4	0	4-3/8	4-1/2	0	3-7/8	5-1/2	0	2-7/8	-	-	-	10
KB-TZ2 3/4 x 10	10	R	7	4	0	5-3/8	4-1/2	0	4-7/8	5-1/2	0	3-7/8	-	-	-	10
KB-TZ2 1x6-1/2	6-1/2	K	2 1/2	4 5/8	0	1-1/8	6-3/8	-	-	-	-	-	-	-	-	10
KB-TZ2 1x8	8	N	3 7/8	4 5/8	0	2-5/8	6-3/8	0	7/8	-	-	-	-	-	-	10
KB-TZ2 1x9	9	P	3 7/8	4 5/8	7/8	3-5/8	6-3/8	0	1-7/8	-	-	-	-	-	-	10
KB-TZ2 1x10-1/2	10-1/2	R	6	4 5/8	3/8	5-1/8	6-3/8	0	3-3/8	-	-	-	-	-	-	10
KB-TZ2 1x12	12	T	6	4 5/8	1-7/8	6-5/8	6-3/8	1/8	4-7/8	-	-	-	-	-	-	10

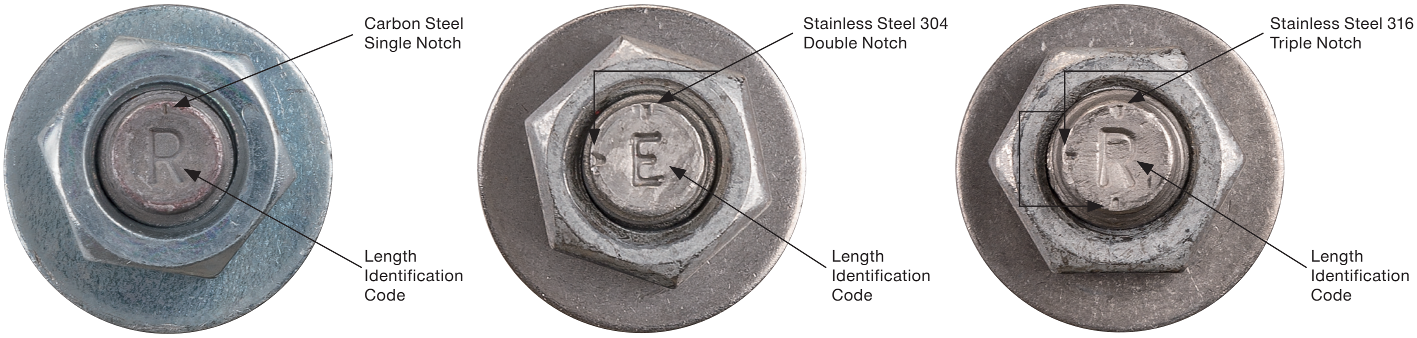
Table 53 — Hilti KB-TZ2 SS304 product portfolio

Description	Length (in)	Length ident. letter	Thread length (in)	Nominal embed. 1 (in)	Min. fixture thickness 1 (in)	Max. fixture thickness 1 (in)	Nominal embed. 2 (in)	Min. fixture thickness 2 (in)	Max. fixture thickness 2 (in)	Nominal embed. 3 (in)	Min. fixture thickness 3 (in)	Max. fixture thickness 3 (in)	Package quantity
KB-TZ2 1/4x2-1/8 SS304	2-1/8	B	7/8	1-3/4	0	1/8	-	-	-	-	-	-	100
KB-TZ2 1/4x2-1/2 SS304	2-1/2	C	1 1/4	1-3/4	0	1/2	-	-	-	-	-	-	100
KB-TZ2 1/4x3-1/4 SS304	3-1/4	D	2	1-3/4	0	1-1/4	-	-	-	-	-	-	100
KB-TZ2 1/4x4-1/2 SS304	4-1/2	G	3	1-3/4	1/8	2-1/2	-	-	-	-	-	-	100
KB-TZ2 3/8x2-1/2 SS304	2-1/2	C	1	1-7/8	0	1/4	-	-	-	-	-	-	50
KB-TZ2 3/8x3 SS304	3	D	1 1/2	1-7/8	0	3/4	2-1/2	0	1/4	-	-	-	50
KB-TZ2 3/8x3-1/2 SS304	3-1/2	Ω	2	1-7/8	0	1-1/4	2-1/2	0	3/4	3	0	1/4	50
KB-TZ2 3/8x3-3/4 SS304	3-3/4	E	2 1/4	1-7/8	0	1-1/2	2-1/2	0	1	3	0	1/2	50
KB-TZ2 3/8x5 SS304	5	H	3 1/2	1-7/8	0	2-3/4	2-1/2	0	2-1/4	3	0	1-3/4	50
KB-TZ2 3/8x7 SS304	7	L	4 7/8	1-7/8	1/2	4-3/4	2-1/2	0	4-1/4	3	0	3-3/4	50
KB-TZ2 1/2x3-3/4 SS304	3-3/4	E	1 5/8	2-1/2	0	3/4	3	0	1/4	-	-	-	20
KB-TZ2 1/2x4-1/2 SS304	4-1/2	G	2 3/8	2-1/2	0	1-1/2	3	0	1	3-3/4	0	1/4	20
KB-TZ2 1/2x5-1/2 SS304	5-1/2	I	3 3/8	2-1/2	0	2-1/2	3	0	2	3-3/4	0	1-1/4	20
KB-TZ2 1/2x7 SS304	7	L	4 3/4	2-1/2	1/8	4	3	0	3-1/2	3-3/4	0	2-3/4	20
KB-TZ2 5/8x4-1/4 SS304	4-1/4	F	2 1/4	3-1/4	0	3/8	-	-	-	-	-	-	15
KB-TZ2 5/8x4-3/4 SS304	4-3/4	G	2 3/4	3-1/4	0	7/8	3-3/4	0	3/8	-	-	-	15
KB-TZ2 5/8x6 SS304	6	J	4	3-1/4	0	2-1/8	3-3/4	0	1-5/8	4-1/2	0	7/8	15
KB-TZ2 5/8x7 SS304	7	L	4 7/8	3-1/4	0	3-1/8	3-3/4	0	2-5/8	4-1/2	0	1-7/8	15
KB-TZ2 5/8x8-1/2 SS304	8-1/2	O	6 1/2	3-1/4	0	4-5/8	3-3/4	0	4-1/8	4-1/2	0	3-3/8	15
KB-TZ2 5/8x10 SS304	10	R	7 1/8	3-1/4	1/8	6-1/8	3-3/4	0	5-5/8	4-1/2	0	4-7/8	15
KB-TZ2 3/4x4-3/4 SS304	4-3/4	G	1 3/4	4	0	1/8	-	-	-	-	-	-	10
KB-TZ2 3/4x5-1/2 SS304	5-1/2	I	2 1/2	4	0	7/8	4-1/2	0	3/8	-	-	-	10
KB-TZ2 3/4x6-1/4 SS304	6-1/4	J	3 1/4	4	0	1-5/8	4-1/2	0	1-1/8	5-1/2	0	1/8	10
KB-TZ2 3/4x7 SS304	7	L	4	4	0	2-3/8	4-1/2	0	1-7/8	5-1/2	0	7/8	10
KB-TZ2 3/4x8 SS304	8	N	5	4	0	3-3/8	4-1/2	0	2-7/8	5-1/2	0	1-7/8	10
KB-TZ2 3/4x9 SS304	9	P	6	4	0	4-3/8	4-1/2	0	3-7/8	5-1/2	0	2-7/8	10
KB-TZ2 3/4x10 SS304	10	R	7	4	0	5-3/8	4-1/2	0	4-7/8	5-1/2	0	3-7/8	10
KB-TZ2 3/4x12 SS304	12	T	7	4	1-5/8	7-3/8	4-1/2	1-1/8	6-7/8	5-1/2	1/8	5-7/8	10
KB-TZ2 1x6-1/2 SS304	6-1/2	K	2 1/2	4-5/8	0	7/8	6-3/8	-	-	-	-	-	10
KB-TZ2 1x8 SS304	8	N	3 7/8	4-5/8	0	2-3/8	6-3/8	0	7/8	-	-	-	10
KB-TZ2 1x9 SS304	9	P	3 7/8	4-5/8	1	3-3/8	6-3/8	0	1-7/8	-	-	-	10
KB-TZ2 1x10-1/2 SS304	10-1/2	R	6	4 5/8	1/2	4-7/8	6-3/8	0	3-3/8	-	-	-	10
KB-TZ2 1x12 SS304	12	T	6	4 5/8	2	6-3/8	6-3/8	1/4	4-7/8	-	-	-	10

Table 54 — Hilti KB-TZ2 SS316 product portfolio

Description	Length (in)	Length ident. letter	Thread length (in)	Nominal embed. 1 (in)	Min. fixture thickness 1 (in)	Max. fixture thickness 1 (in)	Nominal embed. 2 (in)	Min. fixture thickness 2 (in)	Max. fixture thickness 2 (in)	Nominal embed. 3 (in)	Min. fixture thickness 3 (in)	Max. fixture thickness 3 (in)	Package quantity
KB-TZ2 1/4x2-1/2 SS316	2-1/2	C	1-1/4	1-3/4	0	1/2	-	-	-	-	-	-	100
KB-TZ2 1/4x3-1/4 SS316	3-1/4	D	2	1-3/4	0	1-1/4	-	-	-	-	-	-	100
KB-TZ2 1/4x4-1/2 SS316	4-1/2	G	3	1-3/4	1/8	2-1/2	-	-	-	-	-	-	100
KB-TZ2 3/8x2-1/2 SS316	2-1/2	C	1	1-7/8	0	1/4	-	-	-	-	-	-	50
KB-TZ2 3/8x3 SS316	3	D	1-1/2	1-7/8	0	3/4	2-1/2	0	1/4	-	-	-	50
KB-TZ2 3/8x3-1/2 SS316	3-1/2	Ω	2	1-7/8	0	1-1/4	2-1/2	0	3/4	3	0	1/4	50
KB-TZ2 3/8x3-3/4 SS316	3-3/4	E	2-1/4	1-7/8	0	1-1/2	2-1/2	0	1	3	0	1/2	50
KB-TZ2 3/8x5 SS316	5	H	3-1/2	1-7/8	0	2-3/4	2-1/2	0	2-1/4	3	0	1-3/4	50
KB-TZ2 3/8x7 SS316	7	L	4-7/8	1-7/8	1/2	4-3/4	2-1/2	0	4-1/4	3	0	3-3/4	50
KB-TZ2 1/2x3-3/4 SS316	3-3/4	E	1-5/8	2-1/2	0	3/4	3	0	1/4	-	-	-	20
KB-TZ2 1/2x4-1/2 SS316	4-1/2	G	2-3/8	2-1/2	0	1-1/2	3	0	1	3-3/4	0	1/4	20
KB-TZ2 1/2x5-1/2 SS316	5-1/2	I	3-3/8	2-1/2	0	2-1/2	3	0	2	3-3/4	0	1-1/4	20
KB-TZ2 1/2x7 SS316	7	L	4-3/4	2-1/2	1/8	4	3	0	3-1/2	3-3/4	0	2-3/4	20
KB-TZ2 1/2x8-1/2 SS316	8-1/2	O	4-7/8	2-1/2	1-1/2	5-1/2	3	1	5	3-3/4	1/4	4-1/4	20
KB-TZ2 1/2x10 SS316	10	R	4-7/8	2-1/2	3	7	3	2-1/2	6-1/2	3-3/4	1-3/4	5-3/4	20
KB-TZ2 5/8x4-1/4 SS316	4-1/4	F	2-1/4	3-1/4	0	3/8	-	-	-	-	-	-	15
KB-TZ2 5/8x4-3/4 SS316	4-3/4	G	2-3/4	3-1/4	0	7/8	3-3/4	0	3/8	-	-	-	15
KB-TZ2 5/8x6 SS316	6	J	4	3-1/4	0	2-1/8	3-3/4	0	1-5/8	4-1/2	0	7/8	15
KB-TZ2 5/8x7 SS316	7	L	4-7/8	3-1/4	0	3-1/8	3-3/4	0	2-5/8	4-1/2	0	1-7/8	15
KB-TZ2 5/8x8-1/2 SS316	8-1/2	O	6-1/2	3-1/4	0	4-5/8	3-3/4	0	4-1/8	4-1/2	0	3-3/8	15
KB-TZ2 5/8x10 SS316	10	R	7-1/8	3-1/4	1/8	6-1/8	3-3/4	0	5-5/8	4-1/2	0	4-7/8	15
KB-TZ2 3/4x4-3/4 SS316	4-3/4	G	1-3/4	4	0	1/8	-	-	-	-	-	-	10
KB-TZ2 3/4x5-1/2 SS316	5-1/2	I	2-1/2	4	0	7/8	4-1/2	0	3/8	-	-	-	10
KB-TZ2 3/4x6-1/4 SS316	6-1/4	J	3-1/4	4	0	1-5/8	4-1/2	0	1-1/8	5-1/2	0	1/8	10
KB-TZ2 3/4x7 SS316	7	L	4	4	0	2-3/8	4-1/2	0	1-7/8	5-1/2	0	7/8	10
KB-TZ2 3/4x8 SS316	8	N	5	4	0	3-3/8	4-1/2	0	2-7/8	5-1/2	0	1-7/8	10
KB-TZ2 3/4x9 SS316	9	P	6	4	0	4-3/8	4-1/2	0	3-7/8	5-1/2	0	2-7/8	10
KB-TZ2 3/4x10 SS316	10	R	7	4	0	5-3/8	4-1/2	0	4-7/8	5-1/2	0	3-7/8	10
KB-TZ2 3/4x12 SS316	12	T	7	4	1-5/8	7-3/8	4-1/2	1-1/8	6-7/8	5-1/2	1/8	5-7/8	10

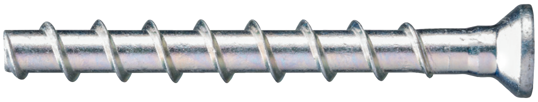
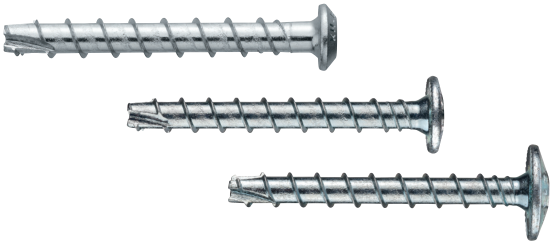
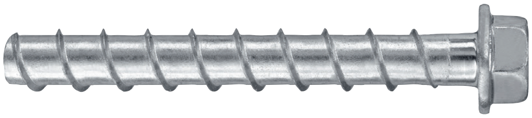
Figure 9 — Anchor head with length identification code and KB-TZ2 head notch embossment



3.3.6 KWIK HUS-EZ SCREW ANCHOR

PRODUCT DESCRIPTION

KWIK HUS EZ carbon steel anchors

Anchor System		Features and Benefits
	Carbon Steel KH-EZ C 1/4" and 3/8"	• OSHA Table 1926.1153 Table 1 complaint installation when installed with Hilti vacuum and DRS system or Hilti SafeSet™ hollow drill bit technology • Easy installation using impact tool or torque wrench • Product and length identification marks helps facilitate quality control after installation • Through fixture installation improves productivity and more accurate installation. • Thread design helps enable quality setting and exceptional load values in wide variety of base material strengths. • 1/4" diameter available in hex head countersunk head and pan head styles. • Anchor is fully removable. • Anchor diameter is same as drill bit diameter. No special diameter bit required. • Suitable for reduced edge distances and spacing. • Corrosion resistant coating allows for use in outdoor moderate corrosive environments (KH-EZ CRC only). • Installation process allows for adjustability.
	Carbon Steel 1/4" KH-EZ P, PM, PL	
	Carbon Steel KH EZ 1/4"-3/4"	
	Carbon Steel KH-EZ CRC 3/8"-3/4"	

Uncracked concrete	Cracked concrete	Grout-filled concrete masonry	Hollowcore concrete	Seismic Design Categories A-F	SafeSet™ System with Hollow Drill Bit	Profis Anchor design software

Approvals/Listings	
ICC-ES (International Code Council)	ESR-3027 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193 ESR-3056 in grout-filled CMU per ICC-ES AC106
City of Los Angeles	City of Los Angeles 2020 LABC Supplement (within ESR-3027 and ESR-3056)
Florida Building Code	2020 FBC w/ HVHZ (within ESR-3027 and ESR-3056)
FM (Factory Mutual)	Pipe hanger components for automatic sprinkler systems for KH-EZ I and KH-EZ E
ANSI/MSS SP-58-2018	Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information.

MATERIAL SPECIFICATIONS

Heat treated carbon steel with a minimum zinc coating of 0.0003 inch (8 µm) thick in accordance with DIN EN ISO 4042.

KH-EZ CRC has mechanically deposited zinc coating with a minimum thickness of 0.0021 inch (53 µm) in accordance with ASTM B695, Class 55.

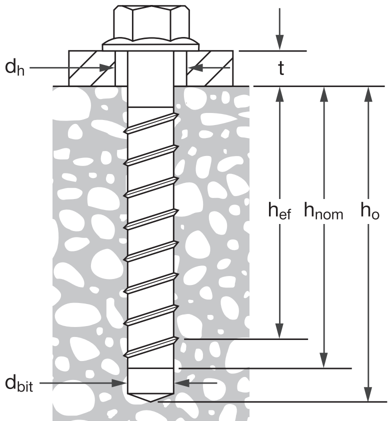
INSTALLATION PARAMETERS

Table 1 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC specifications

Setting information	Symbol	Units	Nominal anchor diameter													
			1/4		3/8				1/2			5/8			3/4	
Head style and coating			Hex, P, PM, PL, C head		Hex, C head		Hex, C head (Including CRC)		Hex head (Including CRC)			Hex head (Including CRC)			Hex head (Including CRC)	
Nominal bit diameter	d_{bit}	in.	1/4		3/8				1/2			5/8			3/4	
Minimum nominal embedment	h_{nom}	in.	1-5/8	2-1/2	1-5/8	2-1/8	2-1/2	3-1/4	2-1/4	3	4-1/4	3-1/4	4	5	4	6-1/4
Minimum effective embedment	h_{ef}	in.	1.18	1.92	1.11	1.54	1.86	2.50	1.50	2.16	3.22	2.39	3.03	3.88	2.92	4.84
Minimum hole depth	h_o	in.	2	2-7/8	1-7/8	2-3/8	2-3/4	3-1/2	2-5/8	3-3/8	4-5/8	3-5/8	4-3/8	5-3/8	4-3/8	6-5/8
Minimum fixture hole diameter	d_h	in.	3/8		1/2				5/8			3/4			7/8	
Anchor Length = h_{nom} + t	ℓ		See ordering information													
Installation torque concrete[1]	T_{inst}	ft-lb (Nm)	18 (24)		19 (26)	40 (54)			45 (61)			85 (115)			95[4] (129)	
Maximum impact wrench torque rating concrete[2]	$T_{impact,max}$	ft-lb (Nm)	157 (213)		157 (213)	450 (610)			137 (186)	450 (610)		590 (800)			590 (800)	
Installation torque masonry KH-EZ (P, PM, PL, C)[1]	T_{inst}	ft-lb (Nm)	21 (28)		22 (30)				34 (46)			38 (52)			70 (95)	
Installation torque masonry for KH-EZ CRC[1]	T_{inst}	ft-lb (Nm)					20 (27)		25 (34)			35 (48)			45 (61)	
Maximum impact wrench torque rating masonry for KH-EZ (P, PM, PL, C)[2,3]	$T_{impact,max}$	ft-lb (Nm)	114 (155)		114 (155)			332 (450)	332 (450)			332 (450)			332 (450)	
Maximum impact wrench torque rating masonry for KH-EZ CRC[2,3]	$T_{impact,max}$	ft-lb (Nm)					100 (136)		100 (136)			332 (450)			332 (450)	
Wrench size		in.	7/16		9/16				3/4			15/16			1-1/8	

1 T_{inst} is the maximum installation torque that may be applied with a torque wrench.
2 Because of variability in measurement procedures, the published torque of an impact tool may not correlate properly with the above setting torques. Over torquing can damage the base material, anchor and/or reduce its holding capacity.
3 For more information on KH-EZ installed in masonry, see ESR-3056 and Design Information for Masonry in this section.
4 Maximum installation torque in concrete for 3/4-in diameter KH-EZ CRC is 95 ft-lbs. (115 Nm).

Figure 1 — Hilti KH-EZ specifications



DESIGN INFORMATION IN CONCRETE PER ACI 318

ACI 318 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-3027 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8 of the North American Product Technical Guide, Volume 2: Anchor Fastening Technical Guide, Edition 22 (PTG Ed. 21). Data tables from ESR-3027 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Table 2 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC design Strength with concrete / pullout failure in uncracked concrete[1,2,3,4]

Nominal anchor diameter in. (mm)	Nominal Embed. Depth in. (mm)	Tension - ϕN_n				Shear - ϕV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
1/4 (6.4)	1-5/8 (41)	585 (2.6)	620 (2.8)	675 (3.0)	765 (3.4)	1,075 (4.8)	1,180 (5.2)	1,360 (6.0)	1,670 (7.4)
	2-1/2 (64)	1,525 (6.8)	1,670 (7.4)	1,930 (8.6)	2,365 (10.5)	2,235 (9.9)	2,450 (10.9)	2,825 (12.6)	3,460 (15.4)
3/8 (9.5)	1-5/8 (41)	910 (4.0)	1,000 (4.4)	1,155 (5.1)	1,415 (6.3)	980 (4.4)	1,075 (4.8)	1,245 (5.5)	1,520 (6.8)
	2-1/8 (54)	1,490 (6.6)	1,635 (7.3)	1,885 (8.4)	2,310 (10.3)	1,605 (7.1)	1,760 (7.8)	2,030 (9.0)	2,485 (11.1)
	2-1/2 (64)	1,980 (8.8)	2,165 (9.6)	2,505 (11.1)	3,065 (13.6)	2,130 (9.5)	2,335 (10.4)	2,695 (12.0)	3,300 (14.7)
	3-1/4 (83)	3,085 (13.7)	3,375 (15.0)	3,900 (17.3)	4,775 (21.2)	6,640 (29.5)	7,275 (32.4)	8,400 (37.4)	10,290 (45.8)
1/2 (12.7)	2-1/4 (57)	1,645 (7.3)	1,800 (8.0)	2,080 (9.3)	2,550 (11.3)	1,770 (7.9)	1,940 (8.6)	2,240 (10.0)	2,745 (12.2)
	3 (76)	2,785 (12.4)	3,050 (13.6)	3,525 (15.7)	4,315 (19.2)	3,000 (13.3)	3,285 (14.6)	3,795 (16.9)	4,645 (20.7)
	4-1/4 (108)	5,070 (22.6)	5,555 (24.7)	6,415 (28.5)	7,855 (34.9)	10,920 (48.6)	11,965 (53.2)	13,815 (61.5)	16,920 (75.3)
5/8 (15.9)	3-1/4 (83)	3,240 (14.4)	3,550 (15.8)	4,100 (18.2)	5,025 (22.4)	3,490 (15.5)	3,825 (17.0)	4,415 (19.6)	5,410 (24.1)
	4 (102)	4,630 (20.6)	5,070 (22.6)	5,855 (26.0)	7,170 (31.9)	9,970 (44.3)	10,920 (48.6)	12,610 (56.1)	15,445 (68.7)
	5 (127)	6,705 (29.8)	7,345 (32.7)	8,485 (37.7)	10,390 (46.2)	14,445 (64.3)	15,825 (70.4)	18,270 (81.3)	22,380 (99.6)
3/4 (19.1)	4 (102)	4,380 (19.5)	4,795 (21.3)	5,540 (24.6)	6,785 (30.2)	9,430 (41.9)	10,330 (45.9)	11,930 (53.1)	14,610 (65.0)
	6-1/4 (159)	9,345 (41.6)	10,235 (45.5)	11,820 (52.6)	14,475 (64.4)	20,125 (89.5)	22,045 (98.1)	25,455 (113.2)	31,175 (138.7)

Table 3 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC design Strength with concrete / pullout failure in cracked concrete[1,2,3,4,5]

Nominal anchor diameter in. (mm)	Nominal embed. in. (mm)	Tension - ϕN_n				Shear - ϕV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
1/4 (6.4)	1-5/8 (41)	300 (1.3)	315 (1.4)	345 (1.5)	390 (1.7)	765 (3.4)	835 (3.7)	965 (4.3)	1,180 (5.2)
	2-1/2 (64)	760 (3.4)	830 (3.7)	960 (4.3)	1,175 (5.2)	1,585 (7.1)	1,735 (7.7)	2,000 (8.9)	2,450 (10.9)
3/8 (9.5)	1-5/8 (41)	475 (2.1)	520 (2.3)	600 (2.7)	730 (3.2)	695 (3.1)	760 (3.4)	880 (3.9)	1,080 (4.8)
	2-1/8 (54)	1,055 (4.7)	1,155 (5.1)	1,335 (5.9)	1,635 (7.3)	1,135 (5.0)	1,245 (5.5)	1,440 (6.4)	1,760 (7.8)
	2-1/2 (64)	1,400 (6.2)	1,535 (6.8)	1,775 (7.9)	2,170 (9.7)	1,510 (6.7)	1,655 (7.4)	1,910 (8.5)	2,340 (10.4)
	3-1/4 (83)	2,185 (9.7)	2,390 (10.6)	2,765 (12.3)	3,385 (15.1)	4,705 (20.9)	5,155 (22.9)	5,950 (26.5)	7,285 (32.4)
1/2 (12.7)	2-1/4 (57)	1,035 (4.6)	1,135 (5.0)	1,310 (5.8)	1,605 (7.1)	1,115 (5.0)	1,220 (5.4)	1,410 (6.3)	1,725 (7.7)
	3 (76)	1,755 (7.8)	1,920 (8.5)	2,220 (9.9)	2,715 (12.1)	1,890 (8.4)	2,070 (9.2)	2,390 (10.6)	2,925 (13.0)
	4-1/4 (108)	3,190 (14.2)	3,495 (15.5)	4,040 (18.0)	4,945 (22.0)	6,875 (30.6)	7,530 (33.5)	8,695 (38.7)	10,650 (47.4)
5/8 (15.9)	3-1/4 (83)	2,040 (9.1)	2,235 (9.9)	2,580 (11.5)	3,165 (14.1)	2,200 (9.8)	2,410 (10.7)	2,780 (12.4)	3,405 (15.1)
	4 (102)	3,140 (14.0)	3,510 (15.6)	3,845 (17.1)	4,515 (20.1)	6,760 (30.1)	7,560 (33.6)	8,280 (36.8)	9,725 (43.3)
	5 (127)	4,225 (18.8)	4,625 (20.6)	5,340 (23.8)	6,540 (29.1)	9,095 (40.5)	9,965 (44.3)	11,505 (51.2)	14,090 (62.7)
3/4 (19.1)	4 (102)	2,755 (12.3)	3,020 (13.4)	3,485 (15.5)	4,270 (19.0)	5,940 (26.4)	6,505 (28.9)	7,510 (33.4)	9,200 (40.9)
	6-1/4 (159)	5,885 (26.2)	6,445 (28.7)	7,440 (33.1)	9,115 (40.5)	12,670 (56.4)	13,880 (61.7)	16,030 (71.3)	19,630 (87.3)

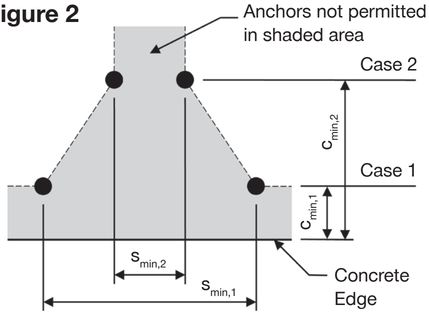
1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in Tables 6 through 15 as necessary. Compare to the steel values in Table 4. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λa as follows: For sand-lightweight, λa = 0.68. For all-lightweight, λa = 0.60.
5 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-in diameter by 1-5/8-in nominal embedment depth - $a_{N,seis}$ = 0.60
All other sizes - $a_{N,seis}$ = 0.75
No reduction needed for seismic shear. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

Table 4 — Steel design strength for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC anchors[1,2]

<table>
<tr><th>Anchor diameter in. (mm)</th><th colspan="6">Nominal embedment depth in. (mm)</th><th>Tensile [3] ϕN_{sa} lb (kN)</th><th>Shear [4] ϕV_{sa} lb (kN)</th><th>Seismic shear [5] $\phi V_{sa,eq}$ lb (kN)</th></tr>
<tr><td>1/4
(6.4)</td><td colspan="3">1-5/8
(41)</td><td colspan="3">2-1/2
(64)</td><td>3,945
(17.5)</td><td>930
(4.1)</td><td>835
(3.7)</td></tr>
<tr><td rowspan="2">3/8
(9.5)</td><td colspan="3">1-5/8
(41)</td><td colspan="3">2-1/8
(54)</td><td>5,980
(26.6)</td><td>2,200
(9.8)</td><td>2,200
(9.8)</td></tr>
<tr><td colspan="3">2-1/2
(64)</td><td colspan="3">3-1/4
(83)</td><td>6,720
(29.9)</td><td>3,110
(13.8)</td><td>1,865
(8.3)</td></tr>
<tr><td>1/2
(12.7)</td><td colspan="2">2-1/4
(57)</td><td colspan="2">3
(76)</td><td colspan="2">4-1/4
(108)</td><td>11,780
(52.4)</td><td>5,545
(24.7)</td><td>3,330
(14.8)</td></tr>
<tr><td>5/8
(15.9)</td><td colspan="2">3-1/4
(83)</td><td colspan="2">4
(102)</td><td colspan="2">5
(127)</td><td>15,735
(70.0)</td><td>6,735
(30.0)</td><td>4,040
(18.0)</td></tr>
<tr><td>3/4
(19.1)</td><td colspan="3">4
(102)</td><td colspan="3">6-1/4
(159)</td><td>20,810
(92.6)</td><td>9,995
(44.5)</td><td>6,935
(30.8)</td></tr>
</table>

1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KH-EZ anchors are to be considered brittle steel elements.
3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
4 Shear values determined by static shear tests with ϕVsa < ϕ 0.60 Ase,V futa as noted in ACI 318 Chapter 17.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

Figure 2



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$

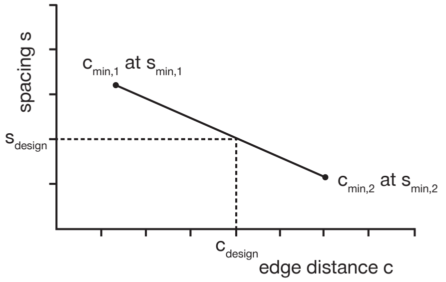


Table 5 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC specifications[1]

Setting information		Symbol	Units	Nominal anchor diameter													
				1/4		3/8				1/2			5/8			3/4	
Effective minimum embedment		h_{ef}	in.	1.18	1.92	1.11	1.54	1.86	2.50	1.50	2.16	3.22	2.39	3.03	3.88	2.92	4.84
Minimum member thickness		h_{min}	in.	3-1/4	4-1/8	3-1/4	3-2/3	4	4-7/8	4-1/2	4-3/4	6-3/4	5	6	7	6	8-1/8
Case 1		$c_{min,1}$	in.	1.50						1.75							
		for $s_{min,1} \geq$	in.	3									4				
Case 2		$c_{min,2}$	in.	2	2.78	2.63	2.75	2.92	3.75	1.75			3.63	4.57	5.81	4.41	7.28
		for $s_{min,2} \geq$	in.	1.50		2.25				3							

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacings.

Table 6 — Load adjustment factors for 1/4-in. diameter Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL and KH-EZ C in uncracked concrete[1,2]

1/4-in. KH-EZ uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Embedment h_{nom}		in. (mm)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-1/2	(38)	0.71	0.63	0.78	0.65	0.59	0.56	0.40	0.21	0.78	0.42	n/a	n/a
	2	(51)	0.78	0.67	1.00	0.77	0.62	0.58	0.61	0.33	1.00	0.65	n/a	n/a
	2-1/2	(64)	0.85	0.72		0.90	0.65	0.60	0.86	0.46		0.90	n/a	n/a
	3	(76)	0.92	0.76		1.00	0.68	0.62	1.00	0.60		1.00	n/a	n/a
	3-1/4	(83)	0.96	0.78			0.70	0.63		0.68			0.88	n/a
	3-1/2	(89)	0.99	0.80			0.71	0.64		0.76			0.92	n/a
	4	(102)	1.00	0.85			0.74	0.66		0.92			0.98	n/a
	4-1/8	(105)		0.86			0.75	0.66		0.97			1.00	0.81
	4-1/2	(114)		0.89			0.77	0.68		1.00				0.84
	5	(127)		0.93			0.80	0.70						0.89
	5-1/2	(140)		0.98			0.83	0.72						0.93
	6	(152)		1.00			0.86	0.74						0.97
	7	(178)					0.92	0.78						1.00
	8	(203)					0.98	0.82						
	9	(229)					1.00	0.86						
	10	(254)						0.89						
	11	(279)						0.93						
	12	(305)						0.97						
	14	(356)						1.00						

Table 7 — Load adjustment factors for 1/4-in. diameter Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL and KH-EZ C in cracked concrete[1,2]

1/4-in. KH-EZ cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Embedment h_{nom}		in. (mm)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-1/2	(38)	0.71	0.63	0.88	0.65	0.59	0.56	0.40	0.21	0.80	0.43	n/a	n/a
	2	(51)	0.78	0.67	1.00	0.77	0.62	0.58	0.62	0.33	1.00	0.66	n/a	n/a
	2-1/2	(64)	0.85	0.72		0.90	0.65	0.60	0.87	0.46		0.90	n/a	n/a
	3	(76)	0.92	0.76		1.00	0.68	0.62	1.00	0.60		1.00	n/a	n/a
	3-1/4	(83)	0.96	0.78			0.70	0.63		0.68			0.89	n/a
	3-1/2	(89)	0.99	0.80			0.71	0.64		0.76			0.92	n/a
	4	(102)	1.00	0.85			0.74	0.66		0.93			0.98	n/a
	4-1/8	(105)		0.86			0.75	0.66		0.97			1.00	0.81
	4-1/2	(114)		0.89			0.77	0.68		1.00				0.85
	5	(127)		0.93			0.80	0.70						0.89
	5-1/2	(140)		0.98			0.83	0.72						0.93
	6	(152)		1.00			0.86	0.74						0.98
	7	(178)					0.92	0.78						1.00
	8	(203)					0.98	0.82						
	9	(229)					1.00	0.86						
	10	(254)						0.90						
	11	(279)						0.94						
	12	(305)						0.98						
	14	(356)						1.00						

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 8 — Load Adjustment Factors for 3/8-in. diameter Hilti KH-EZ, KH-EZ C and KH-EZ CRC in uncracked [1,2]

															Edge distance in shear											
3/8-in. KH-EZ uncracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear [3] f_{AV}				⊥ toward edge f_{RV}				II to and away from edge f_{RV}				Conc. thickness factor in shear [4] f_{HV}			
Embedment h_{nom}		in.	1-5/8	2-1/8	2-1/2	3-1/4	1-5/8	2-1/8	2-1/2	3-1/4	1-5/8	2-1/8	2-1/2	3-1/4	1-5/8	2-1/8	2-1/2	3-1/4	1-5/8	2-1/8	2-1/2	3-1/4	1-5/8	2-1/8	2-1/2	3-1/4
		(mm)	(41)	(54)	(64)	(83)	(41)	(54)	(64)	(83)	(41)	(54)	(64)	(83)	(41)	(54)	(64)	(83)	(41)	(54)	(64)	(83)	(41)	(54)	(64)	(83)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-1/2	(38)	n/a	n/a	n/a	n/a	0.58	0.62	0.63	0.57	n/a	n/a	n/a	n/a	0.49	0.32	0.25	0.08	0.58	0.62	0.50	0.17	n/a	n/a	n/a	n/a
	2	(51)	n/a	n/a	n/a	n/a	0.76	0.75	0.75	0.66	n/a	n/a	n/a	n/a	0.75	0.49	0.38	0.13	0.76	0.75	0.75	0.26	n/a	n/a	n/a	n/a
	2-1/4	(57)	0.84	0.74	0.70	0.65	0.86	0.82	0.81	0.70	0.65	0.62	0.60	0.55	0.90	0.59	0.46	0.16	0.90	0.82	0.81	0.31	n/a	n/a	n/a	n/a
	2-1/2	(64)	0.88	0.77	0.72	0.67	0.95	0.91	0.88	0.75	0.67	0.63	0.61	0.55	1.00	0.69	0.54	0.18	1.00	0.91	0.88	0.37	n/a	n/a	n/a	n/a
	3	(76)	0.95	0.82	0.77	0.70	1.00	1.00	1.00	0.85	0.71	0.66	0.63	0.56		0.90	0.71	0.24		1.00	1.00	0.48	n/a	n/a	n/a	n/a
	3-1/4	(83)	0.99	0.85	0.79	0.72				0.90	0.72	0.67	0.64	0.57		1.00	0.80	0.27				0.54	0.95	n/a	n/a	n/a
	3-1/2	(89)	1.00	0.88	0.81	0.73				0.95	0.74	0.68	0.65	0.58			0.89	0.30				0.61	0.98	n/a	n/a	n/a
	4	(102)		0.93	0.86	0.77				1.00	0.78	0.71	0.68	0.59			1.00	0.37				0.74	1.00	0.91	0.84	n/a
	4-1/2	(114)		0.99	0.90	0.80					0.81	0.73	0.70	0.60				0.44				0.88			0.89	n/a
	4-3/4	(121)		1.00	0.93	0.82					0.83	0.75	0.71	0.60				0.48				0.96			0.91	0.639
	5	(127)			0.95	0.83					0.84	0.76	0.72	0.61				0.52				1.00			0.94	0.655
	6	(152)			1.00	0.90					0.91	0.81	0.76	0.63				0.68							1.00	0.718
	7	(178)				0.97					0.98	0.86	0.81	0.65				0.86								0.775
	8	(203)				1.00					1.00	0.91	0.85	0.67				1.00								0.829
	9	(229)										0.97	0.90	0.69												0.879
	10	(254)										1.00	0.94	0.71												0.927
	11	(279)											0.98	0.74												0.972
	12	(305)											1.00	0.76												1.000
	14	(356)												0.80												
	16	(406)												0.84												
	18	(457)												0.89												
	20	(508)												0.93												
	24	(610)												1.000												

Table 9 — Load Adjustment Factors for 3/8-in. diameter Hilti KH-EZ, KH-EZ C and KH-EZ CRC in cracked [1,2]

															Edge distance in shear											
3/8-in. KH-EZ cracked concrete			Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear [3] f_{AV}				⊥ toward edge f_{RV}				II to and away from edge f_{RV}				Conc. thickness factor in shear [4] f_{HV}			
Embedment h_{nom}		in.	1-5/8	2-1/8	2-1/2	3-1/4	1-5/8	2-1/8	2-1/2	3-1/4	1-5/8	2-1/8	2-1/2	3-1/4	1-5/8	2-1/8	2-1/2	3-1/4	1-5/8	2-1/8	2-1/2	3-1/4	1-5/8	2-1/8	2-1/2	3-1/4
		(mm)	(41)	(54)	(64)	(83)	(41)	(54)	(64)	(83)	(41)	(54)	(64)	(83)	(41)	(54)	(64)	(83)	(41)	(54)	(64)	(83)	(41)	(54)	(64)	(83)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-1/2	(38)	n/a	n/a	n/a	n/a	0.92	0.74	0.66	0.57	n/a	n/a	n/a	n/a	0.49	0.32	0.25	0.09	0.92	0.64	0.50	0.17	n/a	n/a	n/a	n/a
	2	(51)	n/a	n/a	n/a	n/a	1.00	0.90	0.79	0.66	n/a	n/a	n/a	n/a	0.76	0.50	0.39	0.13	1.00	0.90	0.77	0.26	n/a	n/a	n/a	n/a
	2-1/4	(57)	0.84	0.74	0.70	0.65	1.00	0.98	0.85	0.70	0.66	0.62	0.60	0.55	0.90	0.59	0.46	0.16	1.00	0.98	0.85	0.31	n/a	n/a	n/a	n/a
	2-1/2	(64)	0.88	0.77	0.72	0.67	1.00	1.00	0.92	0.75	0.67	0.63	0.61	0.55	1.00	0.69	0.54	0.18	1.00	1.00	0.92	0.37	n/a	n/a	n/a	n/a
	3	(76)	0.95	0.82	0.77	0.70	1.00		1.00	0.85	0.71	0.66	0.63	0.56	1.00	0.91	0.71	0.24	1.00	1.00	1.00	0.48	n/a	n/a	n/a	n/a
	3-1/4	(83)	0.99	0.85	0.79	0.72				0.90	0.73	0.67	0.64	0.57		1.00	0.80	0.27				0.55	0.95	n/a	n/a	n/a
	3-1/2	(89)	1.00	0.88	0.81	0.73				0.95	0.74	0.68	0.65	0.58			0.90	0.31				0.61	0.98	n/a	n/a	n/a
	4	(102)		0.93	0.86	0.77				1.00	0.78	0.71	0.68	0.59			1.00	0.37				0.75	1.00	0.91	0.84	n/a
	4-1/2	(114)		0.99	0.90	0.80					0.81	0.73	0.70	0.60				0.44				0.89		0.97	0.89	n/a
	4-3/4	(121)		1.00	0.93	0.82					0.83	0.75	0.71	0.60				0.48				0.97		1.00	0.92	0.64
	5	(127)			0.95	0.83					0.85	0.76	0.72	0.61				0.52				1.00			0.94	0.66
	6	(152)			1.00	0.90					0.92	0.81	0.77	0.63				0.69							1.00	0.72
	7	(178)				0.97					0.98	0.87	0.81	0.65				0.86								0.78
	8	(203)				1.00					1.00	0.92	0.85	0.67				1.00								0.83
	9	(229)										0.97	0.90	0.69												0.88
	10	(254)										1.00	0.94	0.72												0.93
	11	(279)											0.99	0.74												0.97
	12	(305)											1.00	0.76												1.00
	14	(356)												0.80												
	16	(406)												0.85												
	18	(457)												0.89												
	20	(508)												0.93												
	24	(610)												1.00												

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318-14 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 10 — Load adjustment factors for 1/2-in. diameter Hilti KH-EZ and KH-EZ CRC in uncracked concrete[1,2]

1/2-in. KH-EZ uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Conc. thickness factor in shear[4] f_{HV}		
												⊥ toward edge f_{RV}			II to and away from edge f_{RV}					
Embedment h_{nom}		in.	2-1/4	3	4-1/4	2-1/4	3	4-1/4	2-1/4	3	4-1/4	2-1/4	3	4-1/4	2-1/4	3	4-1/4	2-1/4	3	4-1/4
		(mm)	(57)	(76)	(108)	(57)	(76)	(108)	(57)	(76)	(108)	(57)	(76)	(108)	(57)	(76)	(108)	(57)	(76)	(108)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.68	0.57	0.51	n/a	n/a	n/a	0.40	0.25	0.07	0.68	0.50	0.15	n/a	n/a	n/a
	2	(51)	n/a	n/a	n/a	0.75	0.62	0.54	n/a	n/a	n/a	0.48	0.31	0.09	0.75	0.61	0.18	n/a	n/a	n/a
	2-1/2	(64)	n/a	n/a	n/a	0.91	0.71	0.60	n/a	n/a	n/a	0.68	0.43	0.13	0.91	0.71	0.25	n/a	n/a	n/a
	3	(76)	0.83	0.73	0.66	1.00	0.81	0.66	0.65	0.61	0.55	0.89	0.56	0.17	1.00	0.81	0.33	n/a	n/a	n/a
	3-1/2	(89)	0.88	0.77	0.68		0.93	0.73	0.68	0.63	0.56	1.00	0.71	0.21		0.93	0.42	n/a	n/a	n/a
	4	(102)	0.94	0.81	0.71		1.00	0.80	0.71	0.65	0.57		0.87	0.26		1.00	0.52	n/a	n/a	n/a
	4-1/2	(114)	0.99	0.85	0.73			0.87	0.73	0.67	0.58		1.00	0.31			0.62	0.96	n/a	n/a
	4-3/4	(121)	1.00	0.87	0.75			0.91	0.74	0.68	0.58			0.33			0.67	0.99	0.85	n/a
	5	(127)		0.89	0.76			0.95	0.76	0.69	0.58			0.36			0.72	1.00	0.87	n/a
	6	(152)		0.96	0.81			1.00	0.81	0.73	0.60			0.47			0.95		0.95	n/a
	6-3/4	(171)		1.00	0.85				0.85	0.76	0.61			0.57			1.00		1.00	0.68
	7	(178)			0.86				0.86	0.77	0.62			0.60						0.69
	8	(203)			0.91				0.91	0.80	0.64			0.73						0.73
	9	(229)			0.97				0.96	0.84	0.65			0.87						0.78
	10	(254)			1.00				1.00	0.88	0.67			1.00						0.82
	11	(279)								0.92	0.69									0.86
	12	(305)								0.95	0.70									0.90
	14	(356)								1.00	0.74									0.97
	16	(406)									0.77									1.00
	18	(457)									0.80									
	20	(508)									0.84									
	> 24	(610)									0.91									

Table 11 — Load adjustment factors for 1/2-in. diameter Hilti KH-EZ and KH-EZ CRC in cracked concrete[1,2]

1/2-in. KH-EZ cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Conc. thickness factor in shear[4] f_{HV}		
												⊥ toward edge f_{RV}			II to and away from edge f_{RV}					
Embedment h_{nom}		in.	2-1/4	3	4-1/4	2-1/4	3	4-1/4	2-1/4	3	4-1/4	2-1/4	3	4-1/4	2-1/4	3	4-1/4	2-1/4	3	4-1/4
		(mm)	(57)	(76)	(108)	(57)	(76)	(108)	(57)	(76)	(108)	(57)	(76)	(108)	(57)	(76)	(108)	(57)	(76)	(108)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.82	0.66	0.55	n/a	n/a	n/a	0.45	0.28	0.08	0.82	0.57	0.17	n/a	n/a	n/a
	2	(51)	n/a	n/a	n/a	0.90	0.72	0.58	n/a	n/a	n/a	0.55	0.35	0.10	0.90	0.70	0.21	n/a	n/a	n/a
	2-1/2	(64)	n/a	n/a	n/a	1.00	0.83	0.65	n/a	n/a	n/a	0.77	0.49	0.14	1.00	0.83	0.29	n/a	n/a	n/a
	3	(76)	0.83	0.73	0.66	1.00	0.94	0.72	0.67	0.62	0.56	1.00	0.64	0.19	1.00	0.94	0.38	n/a	n/a	n/a
	3-1/2	(89)	0.88	0.77	0.68		1.00	0.79	0.70	0.64	0.56		0.80	0.24		1.00	0.48	n/a	n/a	n/a
	4	(102)	0.94	0.81	0.71		1.00	0.87	0.72	0.66	0.57		0.98	0.29		1.00	0.59	n/a	n/a	n/a
	4-1/2	(114)	0.99	0.85	0.73			0.95	0.75	0.69	0.58		1.00	0.35			0.70	1.00	n/a	n/a
	4-3/4	(121)	1.00	0.87	0.75			0.99	0.77	0.70	0.59			0.38			0.76		0.88	n/a
	5	(127)		0.89	0.76			1.00	0.78	0.71	0.59			0.41			0.82		0.91	n/a
	6	(152)		0.96	0.81			1.00	0.84	0.75	0.61			0.54			1.00		0.99	n/a
	6-3/4	(171)		1.00	0.85				0.88	0.78	0.62			0.64					1.00	0.70
	7	(178)			0.86				0.89	0.79	0.63			0.68						0.72
	8	(203)			0.91				0.95	0.83	0.65			0.83						0.77
	9	(229)			0.97				1.00	0.87	0.67			0.99						0.81
	10	(254)			1.00					0.91	0.68			1.00						0.86
	11	(279)								0.95	0.70									0.90
	12	(305)								0.99	0.72									0.94
	14	(356)								1.00	0.76									1.00
	16	(406)									0.79									
	18	(457)									0.83									
	20	(508)									0.87									
	> 24	(610)									0.94									

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 12 — Load adjustment factors for 5/8-in. diameter Hilti KH-EZ and KH-EZ CRC in uncracked concrete[1,2]

5/8-in. KH-EZ uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Conc. thickness factor in shear[4] f_{HV}		
												⊥ toward edge f_{RV}			II to and away from edge f_{RV}					
Embedment h_{nom}		in.	3-1/4	4	5	3-1/4	4	5	3-1/4	4	5	3-1/4	4	5	3-1/4	4	5	3-1/4	4	5
		(mm)	(83)	(102)	(127)	(83)	(102)	(127)	(83)	(102)	(127)	(83)	(102)	(127)	(83)	(102)	(127)	(83)	(102)	(127)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.622	0.562	0.514	n/a	n/a	n/a	0.235	0.086	0.063	0.470	0.173	0.125	n/a	n/a	n/a
	2	(51)	n/a	n/a	n/a	0.667	0.596	0.540	n/a	n/a	n/a	0.287	0.106	0.076	0.574	0.211	0.153	n/a	n/a	n/a
	2-1/2	(64)	n/a	n/a	n/a	0.762	0.667	0.592	n/a	n/a	n/a	0.401	0.147	0.107	0.762	0.295	0.214	n/a	n/a	n/a
	3	(76)	0.709	0.665	0.629	0.863	0.741	0.648	0.609	0.556	0.545	0.528	0.194	0.141	0.863	0.388	0.281	n/a	n/a	n/a
	3-1/2	(89)	0.744	0.693	0.650	0.969	0.819	0.705	0.627	0.565	0.553	0.665	0.244	0.177	0.969	0.488	0.354	n/a	n/a	n/a
	4	(102)	0.779	0.720	0.672	1.000	0.901	0.764	0.645	0.574	0.560	0.812	0.298	0.216	1.000	0.597	0.433	n/a	n/a	n/a
	4-1/2	(114)	0.814	0.748	0.693		0.987	0.826	0.663	0.584	0.568	0.969	0.356	0.258		0.712	0.516	n/a	n/a	n/a
	5	(127)	0.849	0.775	0.715		1.000	0.890	0.681	0.593	0.575	1.000	0.417	0.302		0.834	0.605	0.852	n/a	n/a
	5-1/2	(140)	0.884	0.803	0.736			0.956	0.700	0.602	0.583		0.481	0.349		0.962	0.698	0.893	n/a	n/a
	6	(152)	0.918	0.830	0.758			1.000	0.718	0.612	0.590		0.548	0.398		1.000	0.795	0.933	0.668	n/a
	7	(178)	0.988	0.885	0.801				0.754	0.630	0.605		0.691	0.501			1.000	1.000	0.722	0.648
	8	(203)	1.000	0.940	0.844				0.790	0.649	0.620		0.844	0.612					0.772	0.693
	9	(229)		0.995	0.887				0.827	0.667	0.635		1.000	0.730					0.818	0.735
	10	(254)		1.000	0.930				0.863	0.686	0.650			0.855					0.863	0.775
	11	(279)			0.973				0.899	0.705	0.665			0.987					0.905	0.813
	12	(305)			1.000				0.935	0.723	0.680			1.000					0.945	0.849
	14	(356)							1.000	0.760	0.710								1.000	0.917
	16	(406)								0.798	0.740									0.980
	18	(457)								0.835	0.770									1.000
	20	(508)								0.872	0.800									
	24	(610)								0.947	0.860									
	> 30	(762)								1.000	0.951									

Table 13 — Load adjustment factors for 5/8-in. diameter Hilti KH-EZ and KH-EZ CRC in cracked concrete[1,2]

5/8-in. KH-EZ cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Conc. thickness factor in shear[4] f_{HV}		
												⊥ toward edge f_{RV}			II to and away from edge f_{RV}					
Embedment h_{nom}		in.	3-1/4	4	5	3-1/4	4	5	3-1/4	4	5	3-1/4	4	5	3-1/4	4	5	3-1/4	4	5
		(mm)	(83)	(102)	(127)	(83)	(102)	(127)	(83)	(102)	(127)	(83)	(102)	(127)	(83)	(102)	(127)	(83)	(102)	(127)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.630	0.565	0.514	n/a	n/a	n/a	0.267	0.098	0.071	0.533	0.196	0.142	n/a	n/a	n/a
	2	(51)	n/a	n/a	n/a	0.676	0.599	0.540	n/a	n/a	n/a	0.326	0.120	0.087	0.652	0.239	0.174	n/a	n/a	n/a
	2-1/2	(64)	n/a	n/a	n/a	0.772	0.670	0.592	n/a	n/a	n/a	0.455	0.167	0.121	0.772	0.335	0.243	n/a	n/a	n/a
	3	(76)	0.709	0.665	0.629	0.873	0.745	0.648	0.618	0.561	0.549	0.599	0.220	0.159	0.873	0.440	0.319	n/a	n/a	n/a
	3-1/2	(89)	0.744	0.693	0.650	0.981	0.824	0.705	0.638	0.571	0.557	0.754	0.277	0.201	0.981	0.554	0.402	n/a	n/a	n/a
	4	(102)	0.779	0.720	0.672	1.000	0.906	0.764	0.658	0.581	0.565	0.922	0.339	0.245	1.000	0.677	0.491	n/a	n/a	n/a
	4-1/2	(114)	0.814	0.748	0.693		0.992	0.826	0.678	0.591	0.574	1.000	0.404	0.293		0.808	0.586	n/a	n/a	n/a
	5	(127)	0.849	0.775	0.715		1.000	0.890	0.697	0.601	0.582	1.000	0.473	0.343		0.946	0.686	0.888	n/a	n/a
	5-1/2	(140)	0.884	0.803	0.736			0.956	0.717	0.611	0.590		0.546	0.396		1.000	0.792	0.932	n/a	n/a
	6	(152)	0.918	0.830	0.758			1.000	0.737	0.621	0.598		0.622	0.451			0.902	0.973	0.697	n/a
	7	(178)	0.988	0.885	0.801				0.776	0.642	0.614		0.784	0.568			1.000	1.000	0.753	0.676
	8	(203)	1.000	0.940	0.844				0.816	0.662	0.631		0.958	0.694					0.805	0.723
	9	(229)		0.995	0.887				0.855	0.682	0.647		1.000	0.828					0.854	0.767
	10	(254)		1.000	0.930				0.895	0.702	0.663			0.970					0.900	0.808
	11	(279)			0.973				0.934	0.723	0.680			1.000					0.944	0.848
	12	(305)			1.000				0.974	0.743	0.696								0.986	0.885
	14	(356)							1.000	0.783	0.729								1.000	0.956
	16	(406)								0.824	0.761									1.000
	18	(457)								0.864	0.794									
	20	(508)								0.905	0.827									
	24	(610)								0.986	0.892									
	> 30	(762)								1.000	0.990									

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 14 — Load adjustment factors for 3/4-in. diameter Hilti KH-EZ and KH-EZ CRC in uncracked concrete^{1,2}

	3/4-in. KH-EZ uncracked concrete		Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear^3 f_{AV}		Edge distance in shear				Conc. thickness factor in shear^4 f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
	Embedment h_{nom}	in. (mm)	4 (102)	6-1/4 (159)	4 (102)	6-1/4 (159)	4 (102)	6-1/4 (159)	4 (102)	6-1/4 (159)	4 (102)	6-1/4 (159)	4 (102)	6-1/4 (159)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	0.57	0.48	n/a	n/a	0.10	0.05	0.19	0.10	n/a	n/a
	2	(51)	n/a	n/a	0.61	0.50	n/a	n/a	0.12	0.06	0.23	0.12	n/a	n/a
	2-1/2	(64)	n/a	n/a	0.68	0.54	n/a	n/a	0.16	0.08	0.33	0.17	n/a	n/a
	3	(76)	0.67	0.60	0.76	0.58	0.56	0.54	0.21	0.11	0.43	0.22	n/a	n/a
	3-1/2	(89)	0.70	0.62	0.84	0.62	0.57	0.55	0.27	0.14	0.54	0.28	n/a	n/a
	4	(102)	0.73	0.64	0.93	0.67	0.58	0.55	0.33	0.17	0.66	0.34	n/a	n/a
	4-1/2	(114)	0.76	0.65	1.00	0.72	0.59	0.56	0.39	0.20	0.79	0.41	n/a	n/a
	5	(127)	0.79	0.67		0.76	0.60	0.56	0.46	0.24	0.92	0.48	n/a	n/a
	5-1/2	(140)	0.81	0.69		0.81	0.61	0.57	0.53	0.28	1.00	0.55	n/a	n/a
	6	(152)	0.84	0.71		0.86	0.62	0.58	0.61	0.31		0.63	0.69	n/a
	7	(178)	0.90	0.74		0.97	0.64	0.59	0.77	0.40		0.79	0.75	n/a
	8	(203)	0.96	0.78		1.00	0.66	0.60	0.94	0.48		0.97	0.80	n/a
	8-1/8	(206)	0.96	0.78			0.66	0.60	0.96	0.50		0.99	0.80	0.65
	9	(229)	1.00	0.81			0.68	0.62	1.00	0.58		1.00	0.85	0.68
	10	(254)		0.84			0.70	0.63		0.68			0.89	0.72
	11	(279)		0.88			0.72	0.64		0.78			0.94	0.75
	12	(305)		0.91			0.74	0.65		0.89			0.98	0.79
	14	(356)		0.98			0.78	0.68		1.00			1.00	0.85
	16	(406)		1.00			0.82	0.71						0.91
	18	(457)					0.86	0.73						0.96
	20	(508)					0.90	0.76						1.00
	24	(610)					0.98	0.81						
	30	(762)					1.00	0.89						
	> 36	(914)						0.96						

Table 15 — Load adjustment factors for 3/4-in. diameter Hilti KH-EZ and KH-EZ CRC in cracked concrete^{1,2}

	3/4-in. KH-EZ cracked concrete		Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear^3 f_{AV}		Edge distance in shear				Conc. thickness factor in shear^4 f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
	Embedment h_{nom}	in. (mm)	4 (102)	6-1/4 (159)	4 (102)	6-1/4 (159)	4 (102)	6-1/4 (159)	4 (102)	6-1/4 (159)	4 (102)	6-1/4 (159)	4 (102)	6-1/4 (159)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	0.57	0.48	n/a	n/a	0.11	0.06	0.22	0.11	n/a	n/a
	2	(51)	n/a	n/a	0.61	0.50	n/a	n/a	0.13	0.07	0.27	0.14	n/a	n/a
	2-1/2	(64)	n/a	n/a	0.68	0.54	n/a	n/a	0.19	0.10	0.37	0.19	n/a	n/a
	3	(76)	0.67	0.60	0.76	0.58	0.57	0.54	0.24	0.13	0.49	0.25	n/a	n/a
	3-1/2	(89)	0.70	0.62	0.85	0.63	0.58	0.55	0.31	0.16	0.61	0.32	n/a	n/a
	4	(102)	0.73	0.64	0.93	0.67	0.59	0.56	0.38	0.19	0.75	0.39	n/a	n/a
	4-1/2	(114)	0.76	0.65	1.00	0.72	0.60	0.56	0.45	0.23	0.90	0.46	n/a	n/a
	5	(127)	0.79	0.67		0.77	0.61	0.57	0.52	0.27	1.00	0.54	n/a	n/a
	5-1/2	(140)	0.81	0.69		0.81	0.62	0.58	0.60	0.31		0.63	n/a	n/a
	6	(152)	0.84	0.71		0.87	0.63	0.58	0.69	0.36		0.71	0.72	n/a
	7	(178)	0.90	0.74		0.97	0.65	0.60	0.87	0.45		0.90	0.78	n/a
	8	(203)	0.96	0.78		1.00	0.67	0.61	1.00	0.55		1.00	0.83	n/a
	8-1/8	(206)	0.96	0.78			0.68	0.61		0.56			0.84	0.67
	9	(229)	1.00	0.81			0.70	0.63		0.66			0.88	0.71
	10	(254)		0.84			0.72	0.64		0.77			0.93	0.75
	11	(279)		0.88			0.74	0.65		0.89			0.98	0.78
	12	(305)		0.91			0.76	0.67		1.00			1.00	0.82
	14	(356)		0.98			0.80	0.70						0.89
	16	(406)		1.00			0.85	0.72						0.95
	18	(457)					0.89	0.75						1.00
	20	(508)					0.93	0.78						
	24	(610)					1.00	0.84						
	30	(762)						0.92						
	> 36	(914)						1.00						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 16 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Installation in lower flute				Installation in upper flute			
		Tension - ϕN_n		Shear - ϕV_n		Tension - ϕN_n		Shear - ϕV_n	
		f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)
1/4	1-5/8 (41)	545 (2.4)	595 (2.6)	725 (3.2)	725 (3.2)	670 (3.0)	730 (3.2)	725 (3.2)	725 (3.2)
	2-1/2 (64)	1,220 (5.4)	1,410 (6.3)	1,325 (5.9)	1,325 (5.9)	1,275 (5.7)	1,470 (6.5)	1,960 (8.7)	1,960 (8.7)
3/8	1-5/8 (41)	845 (3.8)	975 (4.3)	905 (4.0)	905 (4.0)	970 (4.3)	1,120 (5.0)	2,200 (9.8)	2,200 (9.8)
	2-1/2 (64)	1,455 (6.5)	1,680 (7.5)	905 (4.0)	905 (4.0)	1,900 (8.5)	2,195 (9.8)	3,655 (16.3)	3,655 (16.3)
	3-1/4 (83)	2,550 (11.3)	2,945 (13.1)	2,165 (9.6)	2,165 (9.6)	n/a	n/a	n/a	n/a
1/2	2-1/4 (57)	850 (3.8)	980 (4.4)	965 (4.3)	965 (4.3)	905 (4.0)	1,045 (4.6)	4,710 (21.0)	4,710 (21.0)
	3 (76)	1,990 (8.9)	2,300 (10.2)	1,750 (7.8)	1,750 (7.8)	n/a	n/a	n/a	n/a
	4-1/4 (108)	3,485 (15.5)	4,025 (17.9)	2,155 (9.6)	2,155 (9.6)	n/a	n/a	n/a	n/a
5/8	3-1/4 (83)	2,715 (12.1)	3,135 (13.9)	2,080 (9.3)	2,080 (9.3)	n/a	n/a	n/a	n/a
	5 (127)	6,170 (27.4)	7,125 (31.7)	2,515 (11.2)	2,515 (11.2)	n/a	n/a	n/a	n/a
3/4	4 (102)	2,715 (12.1)	3,135 (13.9)	2,255 (10.0)	2,255 (10.0)	n/a	n/a	n/a	n/a

Table 17 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the soffit of cracked lightweight concrete over metal deck[1,2,3,4,5,6]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Installation in lower flute				Installation in upper flute			
		Tension - ϕN_n[7]		Shear - ϕV_n[8]		Tension - ϕN_n[7]		Shear - ϕV_n[8]	
		f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)
1/4	1-5/8 (41)	280 (1.2)	305 (1.4)	725 (3.2)	725 (3.2)	340 (1.5)	370 (1.6)	725 (3.2)	725 (3.2)
	2-1/2 (64)	605 (2.7)	700 (3.1)	1,325 (5.9)	1,325 (5.9)	635 (2.8)	735 (3.3)	1,960 (8.7)	1,960 (8.7)
3/8	1-5/8 (41)	525 (2.3)	605 (2.7)	905 (4.0)	905 (4.0)	770 (3.4)	890 (4.0)	2,200 (9.8)	2,200 (9.8)
	2-1/2 (64)	1,035 (4.6)	1,195 (5.3)	905 (4.0)	905 (4.0)	1,345 (6.0)	1,555 (6.9)	3,655 (16.3)	3,655 (16.3)
	3-1/4 (83)	1,805 (8.0)	2,085 (9.3)	2,165 (9.6)	2,165 (9.6)	n/a	n/a	n/a	n/a
1/2	2-1/4 (57)	535 (2.4)	620 (2.8)	965 (4.3)	965 (4.3)	640 (2.8)	740 (3.3)	4,710 (21.0)	4,710 (21.0)
	3 (76)	1,255 (5.6)	1,450 (6.4)	1,750 (7.8)	1,750 (7.8)	n/a	n/a	n/a	n/a
	4-1/4 (108)	2,195 (9.8)	2,535 (11.3)	2,155 (9.6)	2,155 (9.6)	n/a	n/a	n/a	n/a
5/8	3-1/4 (83)	1,710 (7.6)	1,975 (8.8)	2,080 (9.3)	2,080 (9.3)	n/a	n/a	n/a	n/a
	5 (127)	3,885 (17.3)	4,485 (20.0)	2,515 (11.2)	2,515 (11.2)	n/a	n/a	n/a	n/a
3/4	4 (102)	1,710 (7.6)	1,975 (8.8)	2,255 (10.0)	2,255 (10.0)	n/a	n/a	n/a	n/a

[1] See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.

[2] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[3] Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{nom} (nominal embedment).

[4] Tabular values are lightweight concrete and no additional reduction factor is needed.

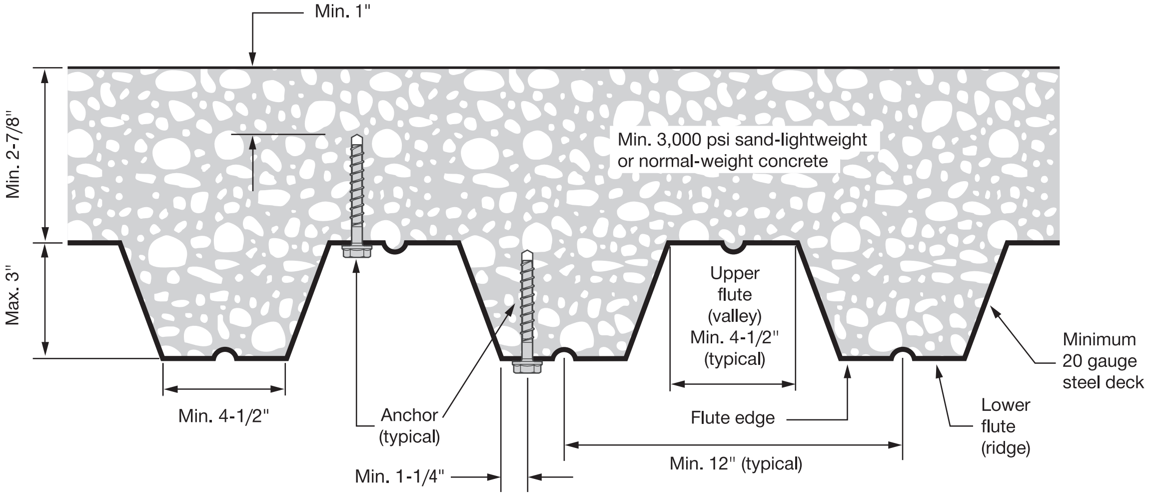
[5] No additional reduction factors for spacing or edge distance need to be applied.

[6] Comparison to steel values in table 4 is not required. Values in tables 16 and 17 control.

[7] Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

[8] For the following anchor sizes, an additional factor for seismic shear must be applied to the cracked concrete tabular values for seismic conditions:
1/4-inch diameter - $\alpha_{v,seis}$ = 0.75
3/8-inch diameter - $\alpha_{v,seis}$ = 0.60
1/2-inch diameter - $\alpha_{v,seis}$ = 0.60
5/8-inch diameter - $\alpha_{v,seis}$ = 0.60
3/4-inch diameter - $\alpha_{v,seis}$ = 0.70

Figure 3 — Installation of Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in soffit of concrete over steel deck floor and roof assemblies[1]



[1] Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum concrete cover above the drilled hole is satisfied. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

Figure 4 — Installation of Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC on the top of sand-lightweight concrete over metal floor and roof assemblies

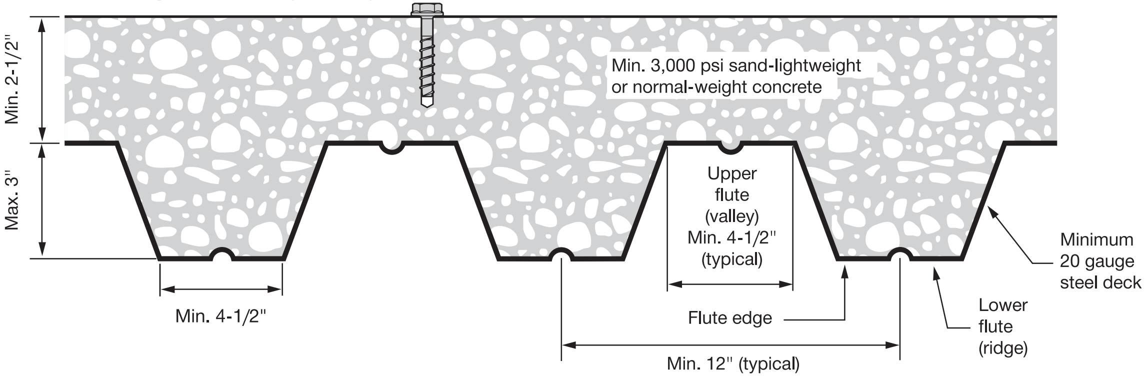


Table 18 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the top of uncracked concrete over metal deck[1,2,3,4,5]

Nominal anchor diameter in.	Nominal embedment depth in. (mm)	Tension - ϕN_n		Shear - ϕV_n	
		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
1/4	1-5/8 (41)	620 (2.8)	675 (3.0)	1,180 (5.2)	1,360 (6.0)
3/8	1-5/8 (41)	1,000 (4.4)	1,155 (5.1)	1,075 (4.8)	1,245 (5.5)

Table 19 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the top of cracked concrete over metal deck[1,2,3,4,5]

Nominal anchor diameter in.	Nominal embed. depth in. (mm)	Tension - ϕN_n		Shear - ϕV_n	
		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
1/4	1-5/8 (41)	315 (1.4)	345 (1.5)	835 (3.7)	965 (4.3)
3/8	1-5/8 (41)	520 (2.3)	600 (2.7)	760 (3.4)	880 (3.9)

1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 20 and 21 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.

4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-inch diameter - $\alpha_{N,seis}$ = 0.60
3/8-inch diameter- $\alpha_{N,seis}$ = 0.75.
No reduction needed for seismic shear. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

Table 20 — Load adjustment factors for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the top of uncracked concrete over metal deck[1,2]

1/4-in. and 3/8-in. KH-EZ uncracked concrete over metal deck			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Anchor diameter d_a	in.	(mm)	1/4 (6.4)	3/8 (9.5)	1/4 (6.4)	3/8 (9.5)	1/4 (6.4)	3/8 (9.5)	1/4 (6.4)	3/8 (9.5)	1/4 (6.4)	3/8 (9.5)	1/4 (6.4)	3/8 (9.5)
Nominal embed. h_{nom}	in.	(mm)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	0.44	0.58	n/a	n/a	0.44	0.58	0.44	0.58	n/a	n/a
	2	(51)	n/a	n/a	0.50	0.67	n/a	n/a	0.50	0.67	0.50	0.67	n/a	n/a
	2-1/2	(64)	n/a	n/a	0.63	0.83	n/a	n/a	0.63	0.83	0.63	0.83	0.78	0.83
	3	(76)	0.92	0.95	0.75	1.00	0.68	0.71	0.75	1.00	0.75	1.00	0.85	0.91
	3-1/4	(83)	0.96	0.99	0.81		0.70	0.72	0.81		0.81		▨	▨
	3-1/2	(89)	0.99	1.00	0.88		0.71	0.74	0.88		0.88		▨	▨
	4	(102)	1.00		1.00		0.74	0.78	1.00		1.00		▨	▨
	4-1/2	(114)					0.77	0.81					▨	▨
	5	(127)					0.80	0.84					▨	▨
	5-1/2	(140)					0.83	0.88					▨	▨
	6	(152)					0.86	0.91					▨	▨
	6-1/2	(165)					0.89	0.95					▨	▨
	7	(178)					0.92	0.98					▨	▨
	7-1/2	(191)					0.95	1.00					▨	▨
	8	(203)					0.98						▨	▨
	9	(229)					1.00						▨	▨

Table 21 — Load adjustment factors for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the top of cracked concrete over metal deck[1,2]

1/4-in. and 3/8-in. KH-EZ cracked concrete over metal deck			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Anchor diameter d_a	in.	(mm)	1/4 (6.4)	3/8 (9.5)	1/4 (6.4)	3/8 (9.5)	1/4 (6.4)	3/8 (9.5)	1/4 (6.4)	3/8 (9.5)	1/4 (6.4)	3/8 (9.5)	1/4 (6.4)	3/8 (9.5)
Nominal embed. h_{nom}	in.	(mm)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)	1-5/8 (41)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	0.99	1.00	n/a	n/a	0.51	0.62	0.99	1.00	n/a	n/a
	2	(51)	n/a	n/a	1.00		n/a	n/a	0.62	0.76	1.00		n/a	n/a
	2-1/2	(64)	n/a	n/a			n/a	n/a	0.87	1.00			0.78	0.83
	3	(76)	0.92	0.95			0.68	0.71	1.00				0.85	0.91
	3-1/4	(83)	0.96	0.99			0.70	0.73					▨	▨
	3-1/2	(89)	0.99	1.00			0.71	0.74					▨	▨
	4	(102)	1.00				0.74	0.78					▨	▨
	4-1/2	(114)					0.77	0.81					▨	▨
	5	(127)					0.80	0.85					▨	▨
	5-1/2	(140)					0.83	0.88					▨	▨
	6	(152)					0.86	0.92					▨	▨
	6-1/2	(165)					0.89	0.95					▨	▨
	7	(178)					0.92	0.98					▨	▨
	7-1/2	(191)					0.95	1.00					▨	▨
	8	(203)					0.98						▨	▨
	9	(229)					1.00						▨	▨

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▨ - For concrete thickness greater than or equal to 3-1/4-inches, the anchor can be designed using either table 2 or table 3 of this section.

DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-3027. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

Table 22 — Steel resistance for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC carbon steel screw anchor[1,2]

Nominal anchor diameter in.	Nominal embedment in. (mm)			Tensile [3] N_{sar} lb (kN)	Shear [4] V_{sar} lb (kN)	Seismic shear [5] $V_{sar,eq}$ lb (kN)
1/4	1-5/8 (41)		2-1/2 (64)	3,370 (15.0)	855 (3.8)	770 (3.4)
3/8	1-5/8 (41)		2-1/8 (54)	5,475 (24.4)	2,030 (9.0)	2,030 (9.0)
	2-1/2 (64)		3-1/4 (83)	6,150 (27.4)	2,865 (12.7)	1,720 (7.7)
1/2	2-1/4 (57)	3 (76)	4-1/4 (108)	10,780 (48.0)	5,110 (22.7)	3,065 (13.6)
5/8	3-1/4 (83)	4 (102)	5 (127)	14,405 (64.1)	6,200 (27.6)	3,720 (16.5)
3/4	4 (102)		6-1/4 (159)	19,050 (84.7)	9,205 (40.9)	6,385 (28.4)

[1] See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.

[2] Hilti KH-EZ carbon steel screw anchors are to be considered brittle steel elements.

[3] Tensile $N_{sar} = A_{se,N} \phi_s f_{uta} R$ as noted in CSA A23.3 Annex D.

[4] Shear determined by static shear tests with $V_{sar} < 0.6 A_{se,V} \phi_s f_{uta} R$ as noted in CSA A23.3 Annex D.

[5] Seismic shear values determined by seismic shear tests with $V_{sar,eq} \leq 0.60 A_{se,V} \phi_s f_{uta} R$ as noted in CSA A23.3 Annex D. See PTG Ed. 21 Section 3.1.9 for additional information on seismic applications.

Table 23 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC design information in accordance with CSA A23.3 Annex D1[1]

Design parameter	Symbol	Units	Nominal anchor diameter														Ref
			1/4		3/8				1/2			5/8			3/4		A23.3
Head Style and coating			Hex, P, PM, PL, C head		Hex, C head		Hex, C head (Including CRC)		Hex head (Including CRC)			Hex head (Including CRC)			Hex head (Including CRC)		
Nominal anchor diameter	d_a	in. (mm)	0.25 (6.4)		0.375 (9.5)				0.5 (12.7)			0.625 (15.9)			0.75 (19.1)		
Effective embedment[2]	h_{ef}	in. (mm)	1.18 (30)	1.92 (49)	1.11 (28)	1.54 (39)	1.86 (47)	2.50 (64)	1.52 (39)	2.16 (55)	3.22 (82)	2.39 (61)	3.03 (77)	3.88 (99)	2.92 (74)	4.84 (123)	
Min. nominal embedment[2]	h_{nom}	in. (mm)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)	2-1/4 (57)	3 (76)	4-1/4 (108)	3-1/4 (83)	4 (102)	5 (127)	4 (102)	6-1/4 (159)	
Minimum concrete thickness[3]	h_{min}	in. (mm)	3-1/4 (83)	4-1/8 (105)	3-1/4 (83)	3-2/3 (93)	4 (102)	4-3/4 (121)	4-1/2 (114)	4-3/4 (121)	6-3/4 (171)	5 (127)	6 (152)	7 (178)	6 (152)	8-1/8 (206)	
Critical edge distance	c_{ac}	in. (mm)	2 (51)	2.78 (71)	2.63 (67)	2.75 (70)	2.92 (74)	3.75 (95)	2.75 (70)	3.75 (95)	5.25 (133)	3.63 (92)	4.57 (116)	5.82 (148)	4.41 (112)	7.28 (185)	
Minimum spacing at critical edge distance	$s_{min,cac}$	in. (mm)	1.5 (38)		2.25 (57)				3 (76)								
Minimum edge distance	c_{min}	in. (mm)	1.50 (38)						1.75 (44)								
Minimum anchor spacing at minimum edge distance	for s >	in. (mm)	3.0 (76)									4 (102)					
Mininimum hole depth in concrete	h_0	in. (mm)	2 (51)	2-7/8 (73)	1-7/8 (48)	2-3/8 (60)	2-3/4 (70)	3-1/2 (89)	2-5/8 (67)	3-3/8 (86)	4-5/8 (117)	3-5/8 (92)	4-3/8 (111)	5-3/8 (137)	4-3/8 (111)	6-5/8 (168)	
Minimum specified ultimate strength	f_{uta}	psi (N/mm²)	125,000 (860)		106,975 (738)		120,300 (830)		112,540 (776)			90,180 (622)			81,600 (563)		
Effective tensile stress area	$A_{se,N}$	in² (mm²)	0.045 (29.0)		0.086 (55.5)				0.161 (103.9)			0.268 (172.9)			0.392 (252.9)		
Steel embed. material resistance factor for reinforcement	ϕ_s	-	0.85														8.4.3
Resistance modification factor for tension, steel failure modes[4]	R	-	0.70														D.5.3
Resistance modification factor for shear, steel failure modes[4]	R	-	0.65														D.5.3
Factored steel resistance in tension	N_{sar}	lb (kN)	3,370 (15.0)		5,475 (24.4)		6,150 (27.4)		10,780 (48.0)			14,405 (64.1)			19,050 (84.7)		D.6.1.2
Factored steel resistance in shear	V_{sar}	lb (kN)	855 (3.8)		2,030 (9.0)		2,865 (12.7)		5,110 (22.7)			6,200 (27.6)			9,205 (40.9)		D.7.1.2
Factored steel resistance in shear, seismic	$V_{sar,eq}$	lb (kN)	770 (3.4)		2,030 (9.0)		1,720 (7.7)		3,065 (13.6)			3,720 (16.5)			6,385 (28.4)		
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	lb	10						11.25								D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	-	7														D.6.2.2
Modification factor for anchor resistance, tension, uncracked concrete[5]	$\psi_{c,N}$	-	1.0														D.6.2.6
Anchor category	-	-	3	1													D.5.3 (c)
Concrete material resistance factor	ϕ_c	-	0.65														8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[6]	R	-	0.75	1.00													D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete[7]	$N_{pr,uncr}$	lb (kN)	665 (3.0)	1,645 (7.3)	NA												D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete[7]	$N_{pr,cr}$	lb (kN)	340 (1.5)	815 (3.6)	510 (2.3)	NA											D.6.3.2
Factored seismic pullout resistance in 20 MPa cracked concrete[7]	$N_{pr,eq}$	lb (kN)	275 (1.2)	815 (3.6)	510 (2.3)	NA											D.6.3.2

1 Design information in this table is taken from ICC-ES ESR-3027, tables 1, 3, and 5, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 on Page 2 of this document.
3 For concrete over metal deck applications where the concrete thickness over the top flute is less than h_{min} in this table, see figure 4 and tables 20 and 21 of this document.
4 The KH-EZ is considered a brittle steel element as defined by CSA A23.3 Annex D section D.2.
5 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
6 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
7 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-3027 for additional information.

Table 24 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC carbon steel screw anchor factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1.18 (30)	1-5/8 (41)	665 (3.0)	710 (3.2)	750 (3.3)	820 (3.6)	805 (3.6)	900 (4.0)	985 (4.4)	1,135 (5.1)
	1.92 (49)	2-1/2 (64)	1,645 (7.3)	1,840 (8.2)	2,015 (9.0)	2,325 (10.4)	2,225 (9.9)	2,490 (11.1)	2,725 (12.1)	3,145 (14.0)
3/8	1.11 (28)	1-5/8 (41)	980 (4.4)	1,095 (4.9)	1,200 (5.3)	1,385 (6.2)	980 (4.4)	1,095 (4.9)	1,200 (5.3)	1,385 (6.2)
	1.54 (39)	2-1/8 (54)	1,600 (7.1)	1,785 (8.0)	1,960 (8.7)	2,260 (10.1)	1,600 (7.1)	1,785 (8.0)	1,960 (8.7)	2,260 (10.1)
	1.86 (47)	2-1/2 (64)	2,120 (9.4)	2,375 (10.6)	2,600 (11.6)	3,000 (13.3)	2,120 (9.4)	2,375 (10.6)	2,600 (11.6)	3,000 (13.3)
	2.50 (64)	3-1/4 (83)	3,305 (14.7)	3,695 (16.4)	4,050 (18.0)	4,675 (20.8)	3,305 (14.7)	3,695 (16.4)	4,050 (18.0)	4,675 (20.8)
1/2	1.52 (39)	2-1/4 (57)	1,765 (7.8)	1,970 (8.8)	2,160 (9.6)	2,495 (11.1)	1,765 (7.8)	1,970 (8.8)	2,160 (9.6)	2,495 (11.1)
	2.16 (55)	3 (76)	2,990 (13.3)	3,340 (14.9)	3,660 (16.3)	4,225 (18.8)	2,990 (13.3)	3,340 (14.9)	3,660 (16.3)	4,225 (18.8)
	3.22 (82)	4-1/4 (108)	5,440 (24.2)	6,080 (27.0)	6,660 (29.6)	7,690 (34.2)	10,875 (48.4)	12,160 (54.1)	13,320 (59.3)	15,380 (68.4)
5/8	2.39 (61)	3-1/4 (83)	3,475 (15.5)	3,890 (17.3)	4,260 (18.9)	4,920 (21.9)	3,475 (15.5)	3,890 (17.3)	4,260 (18.9)	4,920 (21.9)
	3.03 (77)	4 (102)	4,985 (22.2)	5,573 (24.8)	6,105 (27.2)	7,049 (31.4)	10,736 (47.8)	12,004 (53.4)	13,149 (58.5)	15,183 (67.5)
	3.88 (99)	5 (127)	7,195 (32.0)	8,040 (35.8)	8,810 (39.2)	10,170 (45.2)	14,385 (64.0)	16,085 (71.5)	17,620 (78.4)	20,345 (90.5)
3/4	2.92 (74)	4 (102)	4,695 (20.9)	5,250 (23.4)	5,750 (25.6)	6,640 (29.5)	9,390 (41.8)	10,500 (46.7)	11,505 (51.2)	13,280 (59.1)
	4.84 (123)	6-1/4 (159)	10,020 (44.6)	11,205 (49.8)	12,275 (54.6)	14,170 (63.0)	20,040 (89.2)	22,410 (99.7)	24,545 (109.2)	28,345 (126.1)

Table 25 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC carbon steel screw anchor factored resistance with concrete/pullout failure in cracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1.18 (30)	1-5/8 (41)	340 (1.5)	360 (1.6)	385 (1.7)	415 (1.9)	565 (2.5)	630 (2.8)	690 (3.1)	795 (3.5)
	1.92 (49)	2-1/2 (64)	815 (3.6)	910 (4.1)	1,000 (4.4)	1,155 (5.1)	1,560 (6.9)	1,740 (7.7)	1,910 (8.5)	2,205 (9.8)
3/8	1.11 (28)	1-5/8 (41)	510 (2.3)	570 (2.5)	620 (2.8)	720 (3.2)	685 (3.0)	765 (3.4)	840 (3.7)	970 (4.3)
	1.54 (39)	2-1/8 (54)	1,120 (5.0)	1,250 (5.6)	1,370 (6.1)	1,585 (7.0)	1,120 (5.0)	1,250 (5.6)	1,370 (6.1)	1,585 (7.0)
	1.86 (47)	2-1/2 (64)	1,485 (6.6)	1,660 (7.4)	1,820 (8.1)	2,100 (9.3)	1,485 (6.6)	1,660 (7.4)	1,820 (8.1)	2,100 (9.3)
	2.50 (64)	3-1/4 (83)	2,315 (10.3)	2,590 (11.5)	2,835 (12.6)	3,275 (14.6)	2,315 (10.3)	2,590 (11.5)	2,835 (12.6)	3,275 (14.6)
1/2	1.52 (39)	2-1/4 (57)	1,095 (4.9)	1,225 (5.5)	1,345 (6.0)	1,550 (6.9)	1,095 (4.9)	1,225 (5.5)	1,345 (6.0)	1,550 (6.9)
	2.16 (55)	3 (76)	1,860 (8.3)	2,080 (9.2)	2,275 (10.1)	2,630 (11.7)	1,860 (8.3)	2,080 (9.2)	2,275 (10.1)	2,630 (11.7)
	3.22 (82)	4-1/4 (108)	3,385 (15.1)	3,785 (16.8)	4,145 (18.4)	4,785 (21.3)	6,765 (30.1)	7,565 (33.7)	8,290 (36.9)	9,570 (42.6)
5/8	2.39 (61)	3-1/4 (83)	2,165 (9.6)	2,420 (10.8)	2,650 (11.8)	3,060 (13.6)	2,165 (9.6)	2,420 (10.8)	2,650 (11.8)	3,060 (13.6)
	3.03 (77)	4 (102)	3,139 (14.0)	3,509 (15.6)	3,844 (17.1)	4,439 (19.7)	6,760 (30.1)	7,558 (33.6)	8,279 (36.8)	9,560 (42.5)
	3.88 (99)	5 (127)	4,475 (19.9)	5,005 (22.3)	5,480 (24.4)	6,330 (28.2)	8,950 (39.8)	10,005 (44.5)	10,965 (48.8)	12,660 (56.3)
3/4	2.92 (74)	4 (102)	2,920 (13.0)	3,265 (14.5)	3,580 (15.9)	4,130 (18.4)	5,845 (26.0)	6,535 (29.1)	7,155 (31.8)	8,265 (36.8)
	4.84 (123)	6-1/4 (159)	6,235 (27.7)	6,970 (31.0)	7,635 (34.0)	8,820 (39.2)	12,470 (55.5)	13,945 (62.0)	15,275 (67.9)	17,635 (78.4)

[1] See PTG Ed. 21 Section 3.1.8 to convert factored resistance value to ASD value.

[2] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[3] Apply spacing, edge distance, and concrete thickness factors in tables 6 to 15 as necessary. Compare to the steel values in table 22. The lesser of the values is to be used for the design.

[4] Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60

[5] Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.60 All other sizes - $\alpha_{N,seis}$ = 0.75
No reduction needed for seismic shear. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

Table 26 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Installation in lower flute				Installation in upper flute			
		Tension - N_r		Shear - V_r		Tension - N_r		Shear - V_r	
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 30 MPa (4,350psi) lb (kN)	f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 30 MPa (4,350psi) lb (kN)	f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 30 MPa (4,350psi) lb (kN)	f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 30 MPa (4,350psi) lb (kN)
1/4	1-5/8 (41)	585 (2.6)	660 (2.9)	665 (3.0)	665 (3.0)	720 (3.2)	810 (3.6)	665 (3.0)	665 (3.0)
	2-1/2 (64)	1,200 (5.3)	1,470 (6.5)	1,220 (5.4)	1,220 (5.4)	1,255 (5.6)	1,535 (6.8)	1,805 (8.0)	1,805 (8.0)
3/8	1-5/8 (41)	830 (3.7)	1,020 (4.5)	835 (3.7)	835 (3.7)	950 (4.2)	1,165 (5.2)	2,030 (9.0)	2,030 (9.0)
	2-1/2 (64)	1,430 (6.4)	1,755 (7.8)	835 (3.7)	835 (3.7)	1,865 (8.3)	2,285 (10.2)	3,365 (15.0)	3,365 (15.0)
	3-1/4 (83)	2,505 (11.1)	3,070 (13.7)	1,990 (8.9)	1,990 (8.9)	n/a	n/a	n/a	n/a
1/2	2-1/4 (57)	835 (3.7)	1,020 (4.5)	885 (3.9)	885 (3.9)	890 (4.0)	1,090 (4.8)	4,335 (19.3)	4,335 (19.3)
	3 (76)	1,955 (8.7)	2,395 (10.7)	1,615 (7.2)	1,615 (7.2)	n/a	n/a	n/a	n/a
	4-1/4 (108)	3,425 (15.2)	4,195 (18.7)	1,985 (8.8)	1,985 (8.8)	n/a	n/a	n/a	n/a
5/8	3-1/4 (83)	2,670 (11.9)	3,270 (14.5)	1,915 (8.5)	1,915 (8.5)	n/a	n/a	n/a	n/a
	5 (127)	6,070 (27.0)	7,430 (33.1)	2,315 (10.3)	2,315 (10.3)	n/a	n/a	n/a	n/a
3/4	4 (102)	2,670 (11.9)	3,270 (14.5)	2,075 (9.2)	2,075 (9.2)	n/a	n/a	n/a	n/a

Table 27 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the soffit of cracked lightweight concrete over metal deck[1,2,3,4,5,6]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Installation in lower flute				Installation in upper flute			
		Tension - N_r[7]		Shear - V_r[8]		Tension - N_r[7]		Shear - V_r[8]	
		f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 30 MPa (4,350psi) lb (kN)	f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 30 MPa (4,350psi) lb (kN)	f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 30 MPa (4,350psi) lb (kN)	f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 30 MPa (4,350psi) lb (kN)
1/4	1-5/8 (41)	300 (1.3)	340 (1.5)	665 (3.0)	665 (3.0)	365 (1.6)	445 (2.0)	665 (3.0)	665 (3.0)
	2-1/2 (64)	595 (2.6)	730 (3.2)	1,220 (5.4)	1,220 (5.4)	625 (2.8)	765 (3.4)	1,805 (8.0)	1,805 (8.0)
3/8	1-5/8 (41)	520 (2.3)	635 (2.8)	835 (3.7)	835 (3.7)	755 (3.4)	930 (4.1)	2,030 (9.0)	2,030 (9.0)
	2-1/2 (64)	1,015 (4.5)	1,245 (5.5)	835 (3.7)	835 (3.7)	1,325 (5.9)	1,620 (7.2)	3,365 (15.0)	3,365 (15.0)
	3-1/4 (83)	1,775 (7.9)	2,175 (9.7)	1,990 (8.9)	1,990 (8.9)	n/a	n/a	n/a	n/a
1/2	2-1/4 (57)	525 (2.3)	640 (2.8)	885 (3.9)	885 (3.9)	630 (2.8)	770 (3.4)	4,335 (19.3)	4,335 (19.3)
	3 (76)	1,235 (5.5)	1,510 (6.7)	1,615 (7.2)	1,615 (7.2)	n/a	n/a	n/a	n/a
	4-1/4 (108)	2,155 (9.6)	2,640 (11.7)	1,985 (8.8)	1,985 (8.8)	n/a	n/a	n/a	n/a
5/8	3-1/4 (83)	1,680 (7.5)	2,060 (9.2)	1,915 (8.5)	1,915 (8.5)	n/a	n/a	n/a	n/a
	5 (127)	3,820 (17.0)	4,680 (20.8)	2,315 (10.3)	2,315 (10.3)	n/a	n/a	n/a	n/a
3/4	4 (102)	1,680 (7.5)	2,060 (9.2)	2,075 (9.2)	2,075 (9.2)	n/a	n/a	n/a	n/a

1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compresive strengths is not permitted.

3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{nom} (nominal embedment).

4 Tabular values are lightweight concrete and no additional reduction factor is needed.

5 No additional reduction factors for spacing or edge distance need to be applied.

6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.

7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.60
All other sizes - $\alpha_{N,seis}$ = 0.75.
See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

8 For the following anchor sizes, an additional factor for seismic shear must be applied to the cracked concrete tabular values for seismic conditions:
1/4-inch diameter - $\alpha_{v,seis}$ = 0.75
3/8-inch diameter - $\alpha_{v,seis}$ = 0.60
1/2-inch diameter - $\alpha_{v,seis}$ = 0.60
5/8-inch diameter - $\alpha_{v,seis}$ = 0.60
3/4-inch diameter - $\alpha_{v,seis}$ = 0.70

Table 28 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC steel screw anchor factored resistance in the top of uncracked concrete over metal deck[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r		Shear - V_r	
			f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
1/4	1.18	1-5/8	665	750	805	985
	(30)	(41)	(3.0)	(3.3)	(3.6)	(4.4)
3/8	1.11	1-5/8	980	1,200	980	1,200
	(28)	(41)	(4.4)	(5.3)	(4.4)	(5.3)

Table 29 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC steel anchor factored resistance in the top of cracked concrete over metal deck[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r		Shear - V_r	
			f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
1/4	1.18	1-5/8	340	385	565	690
	(30)	(41)	(1.5)	(1.7)	(2.5)	(3.1)
3/8	1.11	1-5/8	510	620	685	840
	(28)	(41)	(2.3)	(2.8)	(3.0)	(3.7)

1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 20 and 21 as necessary. Compare to the steel values in table 22. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-inch diameter - $\alpha_{N,seis}$ = 0.60
3/8-inch diameter- $\alpha_{N,seis}$ = 0.75.
No reduction needed for seismic shear. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

DESIGN INFORMATION IN MASONRY

Table 30 — Allowable tension loads for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC installed in grout-filled masonry walls (lb)[1,2,3,4,5]

Nominal anchor diameter in.	Embedment in.[6]	Loads @ c_{cr} and s_{cr}	Spacing			Edge distance
			Critical - s_{cr} in.[7]	Minimum - s_{min} in.[7]	Load reduction factor at s_{min} [8]	Critical - c_{cr} Minimum- c_{min} in.[9]
1/4	1-5/8	530[10]	4	2	0.70	4
	2-1/2	910[11]		4	1.00	
3/8	1-5/8	535[11]	4	2	0.70	4
	2-1/2	895	6	4	0.80	
	3-1/4	1,210				
1/2	2-1/4	710	4	2	0.60	4
	3	1,110	8	4		
	4-1/4	1,515				
5/8	3-1/4	1,155	10	4	0.60	4
	5	1,735				
3/4	4	1,680	12	4	0.60	4
	6-1/4	2,035				

Table 31 — Allowable shear loads for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC installed in grout-filled masonry walls (lb)[1,2,3,4,5]

Nominal anchor diameter in.	Embedment in.[6]	Load at c_{cr} and s_{cr}	Spacing			Edge distance			
			Critical - s_{cr} in.[7]	Minimum - s_{min} in.[7]	Load reduction factor at s_{min} [8]	Critical - c_{cr} in.[9]	Minimum - c_{min} in.[9]	Load reduction factor at c_{min}	
								perpendicular to edge	parallel to edge
1/4	1-5/8	675[10]	4	4	1.00	4	4	1.00	1.00
	2-1/2	840[11]						1.00	1.00
3/8	1-5/8	1,140[11]	6	4	0.94	6	4	0.61	1.00
	2-1/2	1,165						0.70	1.00
	3-1/4	1,190						0.70	1.00
1/2	2-1/4	1,845	8	4	0.88	8	4	0.50	1.00
	3	2,055						0.45	0.94
	4-1/4	2,745						0.40	0.89
5/8	3-1/4	3,040	10	4	0.36	10	4	0.36	0.82
	5	3,485						0.34	0.92
3/4	4	3,040	10	4	0.36	10	4	0.36	0.82
	6-1/4	3,485						0.34	0.92

1 All values are for anchors installed in fully grouted masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight, medium-weight or normal-weight.

2 Anchors may not be installed within one inch in any direction of a vertical joint.

3 Linear interpolation of load values between minimum spacing s_{min} and critical spacing s_{cr} and between minimum edge distance c_{min} and critical edge distance c_{cr} is permitted.

4 For combined loading: For 1/4-in. - $\frac{T_{applied}}{T_{allowable}} + \frac{V_{applied}}{V_{allowable}} \le 1$ For 3/8- through 3/4-in. - $\left(\frac{T_{applied}}{T_{allowable}}\right)^{5/3} + \left(\frac{V_{applied}}{V_{allowable}}\right)^{5/3} \le 1$

5 See Figure 5 on Page 21 of this document for anchor locations for anchor locations.

6 Embedment depth is measured from the outside face of the concrete masonry embedment.

7 Critical spacing s_{cr} is the anchor spacing where full load values may be used. The minimum spacing s_{min} is the minimum spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of the adjacent anchor.

8 Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than c_{cr} or s_{cr} must be multiplied by the appropriate load reduction factor based on actual edge distance (c) or spacing (s).

9 The critical edge distance c_{cr} is the edge distance where full load values may be used. The minimum edge distance c_{min} is the minimum edge distance for which values are available and installation is recommended. For tension, c_{cr} equals c_{min}. Edge distance is measured from the center of the anchor to the closest edge.

10 Load values must be reduced by 21% for installations within 1-1/4 inches of the bed joint.

11 Load values must be reduced by 13% for installations within 1-1/4 inches of the bed joint.

Table 32 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC allowable loads installed in top-of-grout-filled concrete masonry walls or horizontal members of wall openings[1,2,3]

Nominal anchor diameter in.	Minimum embedment depth in.	Edge distance[4] in.	Critical spacing[5] in.	Minimum end distance[6] in.	Tension lb	Shear lb	
						Load direction	
						Parallel to edge of masonry wall	Perpendicular to edge of masonry wall
1/4	1 5/8	1 1/2	4	4	205	180	135
		3 3/4			205	275	275
	2 1/2	1 1/2			355	345	155
		3 3/4			390	415	330
3/8	1 5/8	1 1/2	6	6	245	345	175
		3 3/4			245	345	345
	3 1/4	1 1/2			465	490	200
		3 3/4			540	800	625
1/2	2 1/4	1 3/4	8	8	390	460	200
		3 3/4			610	525	500
	4 1/4	1 3/4			540	885	245
		3 3/4			750	1275	550
5/8	5	1 3/4	10	10	975	930	245
		3 3/4			975	2190	630
3/4	6 1/4	3 3/4	12	12	975	2430	630

Table 33 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC allowable loads installed in end-of-wall or vertical members of wall openings[1,2]

Nominal anchor diameter in.	Minimum embedment depth in.	Edge distance[4] in.	Critical spacing[5] in.	Minimum end distance[6] in.	Tension lb	Shear lb	
						Load direction	
						Parallel to edge of masonry wall	Perpendicular to edge of masonry wall
1/4	1 5/8	1 1/2	4	4	360	525	205
		3 3/4			380	595	585
	2 1/2	1 1/2			590	610	225
		3 3/4			755	635	585
3/8	1 5/8	1 1/2	6	6	355	725	215
		3 3/4			465	1010	825
	3 1/4	1 1/2			565	875	240
		3 3/4			1020	1195	1050
1/2	2 1/4	1 3/4	8	8	500	855	260
		3 3/4			525	1100	1050
	4 1/4	1 3/4			650	925	280
		3 3/4			1150	1240	1050
5/8	5	3 3/4	10	10	1605	2215	1050
3/4	6 1/4	3 3/4	12	12	1865	2550	1050

[1] All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight, medium-weight or normal-weight conforming to ASTM C90. Allowable loads are calculated using safety factor of 5.

[2] See figure 6 and 7 for allowable anchor installation locations on the top of grout-filled concrete masonry walls. Anchors may not be installed within one inch of a vertical joint. See figure 7 for anchor installation locations in end-of-wall and vertical members of wall openings.

[3] Anchors may not be installed within 1-1/4" in any direction of a head joint.

[4] For load values at edge distances between listed values linear interpolation is permitted.

[5] Critical spacing equals minimum spacing.

[6] Minimum end distance applicable to top-of-wall and end-of-wall and does not apply for wall openings such as windows.

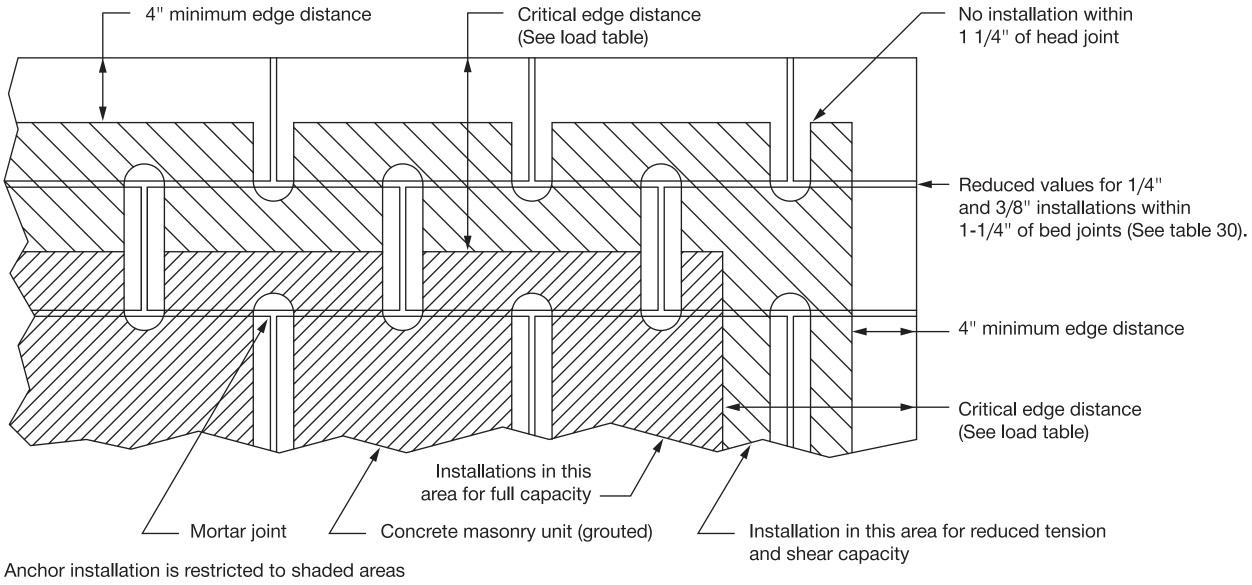


Figure 5 — Acceptable locations (shaded areas) for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC anchors in grout-filled concrete masonry

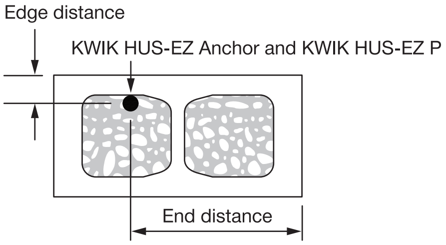


Figure 6 — Edge and end distances for the Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC anchor installed in the top of CMU masonry wall construction

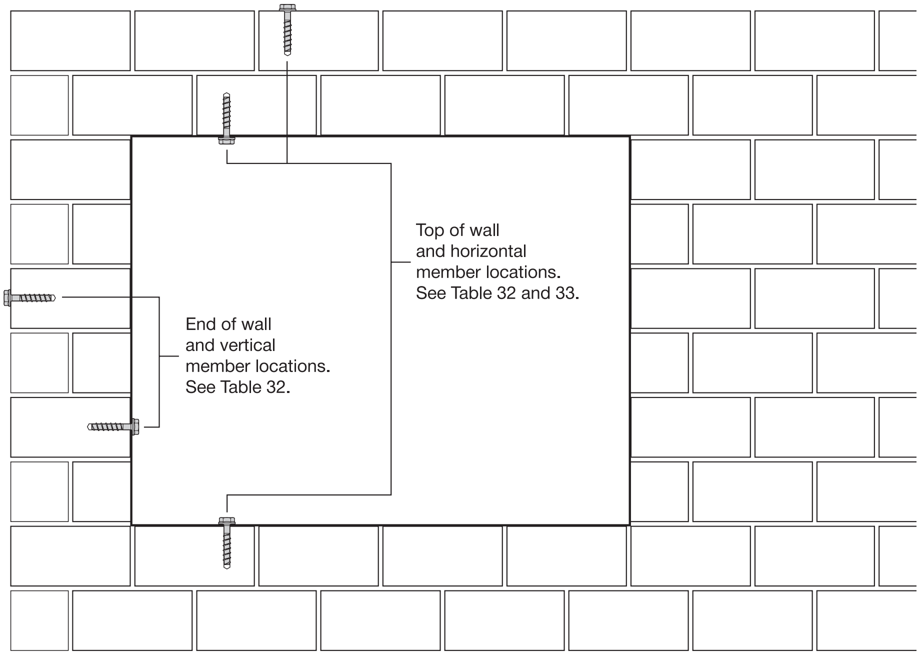


Figure 7 — Anchor locations in end of wall or wall opening applications

DESIGN INFORMATION IN HOLLOW CORE CONCRETE PER ALLOWABLE STRESS DESIGN

Table 34 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC allowable stress design values for installations into hollow core concrete panels[1,2]

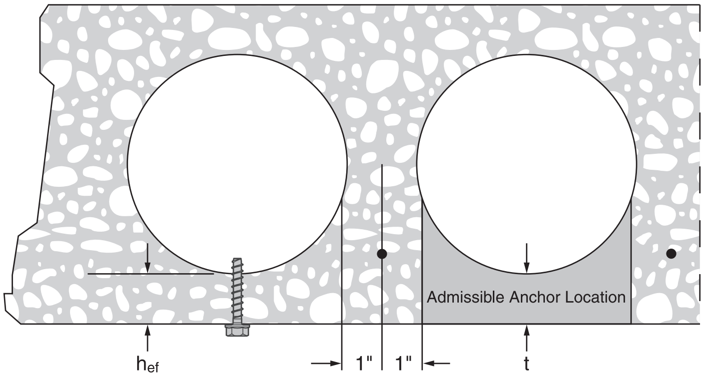
Anchor diameter (inches)	Min. effective embedment h_{ef} (inches)	Allowable load[3]		Ultimate load	
		Tension	Shear	Tension	Shear
1/4	1-1/8	400	610	1600	2440
	1-3/8	455	755	1810	3025
3/8	1-1/8	435	890	1740	3560
	1-3/8	590 (2.6)	1405 (6.3)	2360 (10.5)	5620 (25.0)

1 The admissible anchor location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm admissible anchor location.

2 Minimum compressive strength of prestressed concrete is 7,000 psi. Published ultimate loads represent the average results conducted in local base materials. Due to variations in materials and dimensionl configurations, on-site testing is required to determine the actual performance.

3 Allowable loads calculated with a factor of safety of 4.

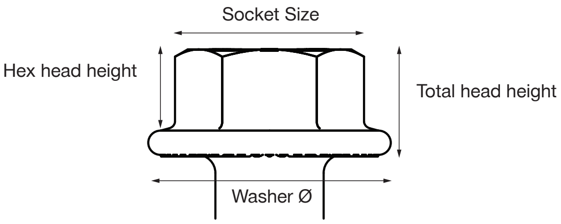
Figure 8 — Installation of Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in hollow core concrete



KH-EZ (CRC)

KH-EZ Ø	Socket Size	Washer Ø	Total head height	Hex head height
1/4”	7/16”	0.65”	0.24”	0.16”
3/8”	9/16”	0.78”	0.35”	0.26”
1/2”	3/4”	1.03”	0.49”	0.35”
5/8”	15/16”	1.28”	0.57”	0.43”
3/4”	1-1/8”	1.48”	0.70”	0.53”

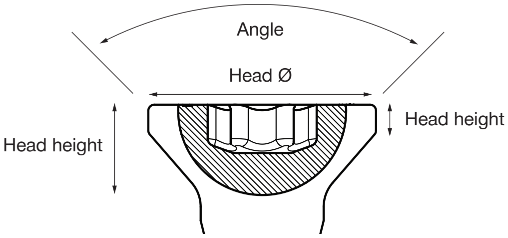
1 KH-EZ CRC does not come in ¼“ diameter.
Ø = diameter



KH-EZ C

KH-EZ Ø	Torx Size	Head Ø	Head height	Flat height	Angle
1/4”	TX30	0.47”	0.16”	0.04”	82°
3/8”	TX50	0.74”	0.28”	0.09”	82°

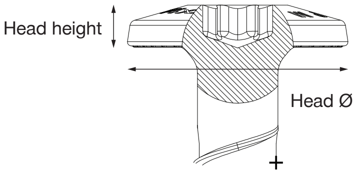
Ø = diameter



KH-EZ P/PM/PL

Pan Size	Torx Size	Head Ø	Head height
P	TX30	0.52”	0.13”
PM	TX30	0.69”	0.13”
PL	TX30	0.86”	0.18”

Ø = diameter



INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at **www.hilti.com**. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION

Order Information

Description	Hole Diameter	Total Length without Anchor Head	Minimum Embedment Depth	Qty (pcs) / Box
KH-EZ P 1/4''x1 7/8''	1/4''	1 7/8	1 5/8	100
KH-EZ P 1/4''x2 5/8''	1/4''	2 5/8	1 5/8	100
KH-EZ PM 1/4''x2 5/8''	1/4''	2 5/8	1 5/8	100
KH-EZ PM 1/4''x1 7/8''	1/4''	1 7/8	1 5/8	100
KH-EZ PL 1/4''x2 5/8''	1/4''	2 5/8	1 5/8	100
KH-EZ C 1/4''x2''	1/4''	2	1 5/8	100
KH-EZ C 1/4''x2 1/2''	1/4''	2 1/2	1 5/8	100
KH-EZ C 1/4''x3''	1/4''	3	1 5/8	100
KH-EZ C 1/4''x4''	1/4''	4	1 5/8	100
KH-EZ 1/4''x1 7/8''	1/4''	1 7/8	1 5/8	100
KH-EZ 1/4''x2 5/8''	1/4''	2 5/8	1 5/8	100
KH-EZ 1/4''x3''	1/4''	3	1 5/8	100
KH-EZ 1/4''x3 1/2''	1/4''	3 1/2	1 5/8	100
KH-EZ 1/4''x4''	1/4''	4	1 5/8	100
KH-EZ 3/8''x1 7/8''	3/8''	1 7/8	1 5/8	50
KH-EZ 3/8''x2 1/8''	3/8''	2 1/8	1 5/8	50
KH-EZ (CRC) 3/8''x3''	3/8''	3	2 1/2	50
KH-EZ 3/8''x3 1/2''	3/8''	3 1/2	2 1/2	50
KH-EZ (CRC) 3/8''x4''	3/8''	4	3 1/4	50
KH-EZ (CRC) 3/8''x5''	3/8''	5	3 1/4	50
KH-EZ C 3/8''x2 1/2''	3/8''	2 1/2	1 5/8	50
KH-EZ C 3/8''x3''	3/8''	3	2 1/2	50
KH-EZ C 3/8''x4''	3/8''	4	2 1/2	50
KH-EZ 1/2''x2 1/2''	1/2''	2 1/2	2 1/4	25
KH-EZ (CRC) 1/2''x3''	1/2''	3	2 1/4	25
KH-EZ 1/2''x3 1/2''	1/2''	3 1/2	2 1/4	25
KH-EZ (CRC) 1/2''x4''	1/2''	4	2 1/4	25
KH-EZ 1/2''x4 1/2''	1/2''	4 1/2	3	25
KH-EZ (CRC) 1/2''x5''	1/2''	5	3	25
KH-EZ (CRC) 1/2''x6''	1/2''	6	3	25
KH-EZ 5/8''x3 1/2''	5/8''	3 1/2	3 1/4	15
KH-EZ 5/8''x4''	5/8''	4	3 1/4	15
KH-EZ (CRC) 5/8''x5 1/2''	5/8''	5 1/2	3 1/4	15
KH-EZ (CRC) 5/8''x6 1/2''	5/8''	6 1/2	3 1/4	15
KH-EZ (CRC) 5/8''x8''	5/8''	8	3 1/4	15
KH-EZ 3/4''x4 1/2''	3/4''	4 1/2	4	10
KH-EZ (CRC) 3/4''x5 1/2''	3/4''	5 1/2	4	10
KH-EZ (CRC) 3/4''x7''	3/4''	7	4	10
KH-EZ 3/4''x8''	3/4''	8	4	10
KH-EZ (CRC) 3/4''x9''	3/4''	9	4	10

3.3.7 KWIK HUS-EZ SS316 SCREW ANCHOR

PRODUCT DESCRIPTION

KWIK HUS EZ SS316 STAINLESS STEEL SCREW ANCHOR

Anchor System		Features and Benefits
	Stainless Steel KH-EZ SS316 1/4" - 1/2"	• OSHA Table 1926.1153 Table 1 compliant installation when installed with Hilti vacuum and DRS system or Hilti SafeSet hollow drill bit technology • Easy installation using impact tool • Product and length identification marks helps facilitate quality control after installation • Through fixture installation improves productivity and more accurate installation. • Full stainless steel 316 screw with carbide cutting elements to help enable quality setting and exceptional load values in a wide variety of base materials. • Anchor is fully removable. • Anchor diameter is same as drill bit diameter. No special diameter bit required. • Suitable for reduced edge distances and spacing. • Corrosion resistant coating allows for use in outdoor corrosive environments. • Installation process allows for adjustability.
	Stainless Steel KH-EZ C SS316 1/4" - 3/8"	

Uncracked concrete

Cracked concrete

Grout-filled concrete masonry

Seismic Design Categories A-F

SafeSet™ System with Hollow Drill Bit

Profis Anchor design software

Approvals/Listings	
ICC-ES (International Code Council)	ESR-3027 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193 ESR-3056 in grout-filled CMU per ICC-ES AC106
City of Los Angeles	City of Los Angeles 2020 LABC Supplement (within ESR-3027 and ESR-3056)
Florida Building Code	2020 FBC w/ HVHZ (within ESR-3027 and ESR-3056)

INSTALLATION PARAMETERS

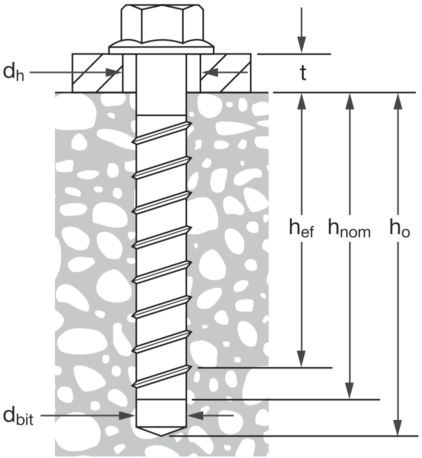
Table 1 — Hilti KH-EZ SS316 and KH-EZ C SS316 specifications

Setting information	Symbol	Units	Nominal anchor diameter							
			1/4		3/8			1/2		
Head style			Hex and C head		Hex and C head			Hex head		
Nominal bit diameter	d_{bit}	in.	1/4		3/8			1/2		
Minimum nominal embedment	h_{nom}	in.	1-5/8	2-1/2	2	2-1/2	3-1/4	2-1/4	3	4-1/4
Minimum effective embedment	h_{ef}	in.	1.19	1.93	1.49	1.92	2.55	1.56	2.20	3.26
Minimum hole depth	h_o	in.	2	2-7/8	2-1/4	2-3/4	3-1/2	2-5/8	3-3/8	4-5/8
Minimum Fixture hole diameter	d_h	in.	3/8		1/2			5/8		
Anchor Length = h_{nom} + t	ℓ		See ordering information							
Maximum impact wrench torque rating concrete[1]	$T_{impact,max}$	ft-lb (Nm)	100 (136)		157 (213)			332 (450)		
Maximum impact wrench torque rating masonry[1,2]	$T_{impact,max}$	ft-lb (Nm)	66 (89)		100 (136)			157 (213)		
Wrench size		in.	7/16		9/16			3/4		

1 Because of variability in measurement procedures, the published torque of an impact tool may not correlate properly with the above setting torques. Over torquing can damage the anchor and/or reduce its holding capacity.

2 For more information on KH-EZ SS316 installed in masonry, see ESR-3056 and Design Information for Masonry in this document.

Figure 1 — Hilti KH-EZ SS316 and KH-EZ C SS316 specifications



DESIGN INFORMATION IN CONCRETE PER ACI 318

ACI 318 Chapter 17 design

The load values contained in this document are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-3027 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8 of the North American Product Technical Guide, Volume 2: Anchor Fastening Technical Guide, Edition 22 (PTG Ed. 21). Data tables from ESR-3027 are not contained in this document, but can be found at www.icc-es.org or at www.hilti.com.

Table 2 — Hilti KH-EZ SS316 and KH-EZ C SS316 design strength based on concrete failure modes in uncracked concrete per ACI 318 Ch. 17[1,2,3,4]

Nominal anchor diameter in.	Effective Embed. in. (mm)"	Nominal embed. in. (mm)"	Tension - ϕN_n				Shear - ϕV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
1/4	1.19 (30)	1 5/8 (41)	855 (3.8)	940 (4.2)	1,085 (4.8)	1,325 (5.9)	1,090 (4.8)	1,195 (5.3)	1,380 (6.1)	1,690 (7.5)
	1.93 (49)	2 1/2 (64)	1,450 (6.4)	1,585 (7.1)	1,830 (8.1)	2,245 (10.0)	2,250 (10.0)	2,465 (11.0)	2,850 (12.7)	3,490 (15.5)
3/8	1.49 (38)	2 (51)	1,595 (7.1)	1,750 (7.8)	2,020 (9.0)	2,470 (11.0)	1,720 (7.7)	1,885 (8.4)	2,175 (9.7)	2,665 (11.9)
	1.92 (49)	2 1/2 (64)	2,335 (10.4)	2,555 (11.4)	2,955 (13.1)	3,615 (16.1)	2,515 (11.2)	2,755 (12.3)	3,180 (14.1)	3,895 (17.3)
	2.55 (65)	3 1/4 (83)	3,575 (15.9)	3,915 (17.4)	4,520 (20.1)	5,535 (24.6)	7,695 (34.2)	8,430 (37.5)	9,735 (43.3)	11,925 (53.0)
1/2	1.56 (40)	2 1/4 (57)	1,445 (6.4)	1,585 (7.1)	1,830 (8.1)	2,240 (10.0)	1,840 (8.2)	2,015 (9.0)	2,330 (10.4)	2,850 (12.7)
	2.20 (56)	3 (76)	2,425 (10.8)	2,655 (11.8)	3,065 (13.6)	3,755 (16.7)	3,085 (13.7)	3,380 (15.0)	3,900 (17.3)	4,775 (21.2)
	3.26 (83)	4 1/4 (108)	4,370 (19.4)	4,790 (21.3)	5,530 (24.6)	6,770 (30.1)	11,125 (49.5)	12,185 (54.2)	14,070 (62.6)	17,235 (76.7)

Table 3 — Hilti KH-EZ SS316 and KH-EZ C SS316 design strength based on concrete failure modes in cracked concrete per ACI 318 Ch.17 [1,2,3,4,5]

Nominal anchor diameter in.	Effective Embed. in. (mm)"	Nominal embed. in. (mm)"	Tension - ϕN_n				Shear - ϕV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
1/4	1.19 (30)	1 5/8 (41)	315 (1.4)	320 (1.4)	335 (1.5)	355 (1.6)	770 (3.4)	845 (3.8)	975 (4.3)	1,195 (5.3)
	1.93 (49)	2 1/2 (64)	495 (2.2)	530 (2.4)	585 (2.6)	670 (3.0)	1,595 (7.1)	1,750 (7.8)	2,020 (9.0)	2,470 (11.0)
3/8	1.49 (38)	2 (51)	980 (4.4)	1,075 (4.8)	1,240 (5.5)	1,520 (6.8)	1,080 (4.8)	1,185 (5.3)	1,370 (6.1)	1,675 (7.5)
	1.92 (49)	2 1/2 (64)	1,440 (6.4)	1,575 (7.0)	1,820 (8.1)	2,230 (9.9)	1,585 (7.1)	1,735 (7.7)	2,000 (8.9)	2,450 (10.9)
	2.55 (65)	3 1/4 (83)	2,250 (10.0)	2,465 (11.0)	2,845 (12.7)	3,485 (15.5)	4,845 (21.6)	5,310 (23.6)	6,130 (27.3)	7,505 (33.4)
1/2	1.56 (40)	2 1/4 (57)	1,125 (5.0)	1,235 (5.5)	1,425 (6.3)	1,745 (7.8)	1,430 (6.4)	1,570 (7.0)	1,810 (8.1)	2,220 (9.9)
	2.20 (56)	3 (76)	1,885 (8.4)	2,065 (9.2)	2,385 (10.6)	2,920 (13.0)	2,400 (10.7)	2,625 (11.7)	3,035 (13.5)	3,715 (16.5)
	3.26 (83)	4 1/4 (108)	3,400 (15.1)	3,725 (16.6)	4,300 (19.1)	5,265 (23.4)	8,655 (38.5)	9,480 (42.2)	10,945 (48.7)	13,405 (59.6)

[1] See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.

[2] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[3] Apply spacing, edge distance, and concrete thickness factors in Tables 6 through 11 as necessary. Compare to the steel values in Table 4. The lesser of the values is to be used for the design.

[4] Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_α as follows:
For sand-lightweight, λ_α = 0.68. For all-lightweight, λ_α = 0.60.

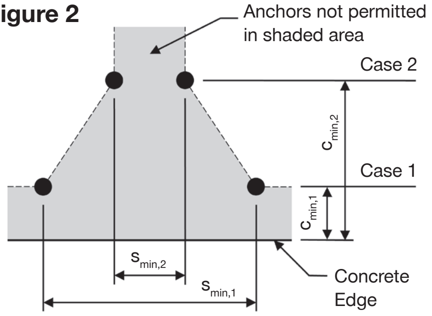
[5] Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.51
All other sizes - $\alpha_{N,seis}$ = 0.75
No reduction needed for seismic shear. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

Table 4 — Steel design strength for Hilti KH-EZ SS316 and KH-EZ C SS316 anchors[1,2]

Anchor diameter in. (mm)	Nominal embedment depth in. (mm)			Tensile [3] ϕN_{sa} lb (kN)	Shear [4] ϕV_{sa} lb (kN)	Seismic shear [5] $\phi V_{sa,eq}$ lb (kN)
1/4 (6.4)	1-5/8 (41	2-1/2 (64)		4,535 (20.2)	1,190 (5.3)	780 (3.5)
3/8 (9.5)	2 (51)	2-1/2 (64)	3-1/4 (83)	9,850 (43.8)	2,835 (12.6)	2,835 (12.6)
1/2 (12.7)	2-1/4 (57)	3 (76)	4-1/4 (108)	15,525 (69.1)	3,115 (13.9)	3,115 (13.9)

1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KH-EZ SS316 and KH-EZ C SS316 screw anchors are to be considered ductile steel elements.
3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.
5 Seismic shear values determined by seismic shear tests with $\phi_{Vsa} \le \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

Figure 2



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \ge s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}(c - c_{min,2})$$

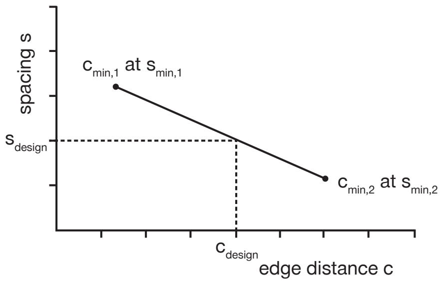


Table 5 — Hilti KH-EZ SS316 and KH-EZ C SS316 specifications[1]

Setting information	Symbol	Units	Nominal anchor diameter							
			1/4		3/8			1/2		
Effective minimum embedment	h_{ef}	in.	1.18	1.92	1.11	1.54	2.50	1.50	2.16	3.22
Minimum member thickness	h_{min}	in.	3-1/4	4-1/8	3-1/4	3-2/3	4-7/8	4-1/2	4-3/4	6-3/4
Case 1	$c_{min,1}$	in.	2		3			1.75		
	for $s_{min,1} \ge$	in.	1.5		2.25			3		
Case 2	$c_{min,2}$	in.	1.5		1.5			1.75		
	for $s_{min,2} \ge$	in.	3		3			3		

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacings.

Table 6 — Load adjustment factors for 1/4-in. diameter KH-EZ SS316 and KH-EZ C SS316 in uncracked concrete[1,2]

1/4-in. KH-EZ SS316 uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to edge f_{RV}			
Embedment h_{nom}		in.	1-5/8	2-1/2	1-5/8	2-1/2	1-5/8	2-1/2	1-5/8	2-1/2	1-5/8	2-1/2	1-5/8	2-1/2
		(mm)	(41)	(64)	(41)	(64)	(41)	(64)	(41)	(64)	(41)	(64)	(41)	(64)
Spacing (s)/edge distance(c_a)/concrete thickness (h) - in. (mm)	1-1/2	(38)	0.710	0.630	0.329	0.244	0.553	0.532	0.177	0.086	0.329	0.171	n/a	n/a
	2	(51)	0.780	0.673	0.420	0.288	0.570	0.543	0.272	0.132	0.420	0.264	n/a	n/a
	2-7/8	(73)	0.903	0.748	0.604	0.373	0.601	0.562	0.469	0.227	0.604	0.373	n/a	n/a
	3	(76)	0.920	0.759	0.630	0.389	0.605	0.565	0.500	0.242	0.630	0.389	n/a	n/a
	3-1/4	(83)	0.955	0.781	0.683	0.421	0.614	0.570	0.564	0.273	0.683	0.421	0.675	n/a
	4	(102)	1.000	0.845	0.840	0.518	0.640	0.586	0.770	0.373	0.840	0.518	0.748	n/a
	4-1/8	(105)		0.856	0.867	0.534	0.644	0.589	0.807	0.391	0.867	0.534	0.760	0.597
	5	(127)		0.932	1.000	0.648	0.675	0.608	1.000	0.521	1.000	0.648	0.837	0.657
	6	(152)		1.000		0.777	0.710	0.630		0.685		0.777	0.917	0.720
	8	(203)				1.000	0.780	0.673		1.000		1.000	1.000	0.831
	10	(254)					0.850	0.716						0.929
	12	(305)					0.920	0.759						1.000
	> 14	(356)					0.990	0.802						

Table 7 — Load adjustment factors for 1/4-in. diameter KH-EZ SS316 and KH-EZ C SS316 in cracked concrete[1,2]

1/4-in. KH-EZ SS316 cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to edge f_{RV}			
Embedment h_{nom}		in.	1-5/8	2-1/2	1-5/8	2-1/2	1-5/8	2-1/2	1-5/8	2-1/2	1-5/8	2-1/2	1-5/8	2-1/2
		(mm)	(41)	(64)	(41)	(64)	(41)	(64)	(41)	(64)	(41)	(64)	(41)	(64)
Spacing (s)/edge distance(c_a)/concrete thickness (h) - in. (mm)	1-1/2	(38)	0.710	0.630	0.876	0.649	0.590	0.559	0.398	0.212	0.796	0.425	n/a	n/a
	2	(51)	0.780	0.673	1.000	0.767	0.620	0.579	0.613	0.327	1.000	0.654	n/a	n/a
	2-7/8	(73)	0.903	0.748		0.994	0.673	0.614	1.000	0.563		0.994	n/a	n/a
	3	(76)	0.920	0.759		1.000	0.680	0.619		0.600		1.000	n/a	n/a
	3-1/4	(83)	0.955	0.781			0.695	0.629		0.677			0.884	n/a
	4	(102)	1.000	0.845			0.741	0.658		0.924			0.981	n/a
	4-1/8	(105)		0.856			0.748	0.663		0.968			0.996	0.808
	5	(127)		0.932			0.801	0.698		1.000			1.000	0.889
	6	(152)		1.000			0.861	0.737						0.974
	8	(203)					0.981	0.816						1.000
	10	(254)					1.000	0.895						
	12	(305)						0.974						
	> 14	(356)						1.000						

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

░ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa).
Check table 5 and figure 2 of this document to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 8 — Load adjustment factors for 3/8-in. diameter KH-EZ SS316 and KH-EZ C SS316 in uncracked concrete[1,2]

3/8-in. KH-EZ SS316 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Conc. thickness factor in shear[4] f_{HV}		
												⊥ toward edge f_{RV}			II to edge f_{RV}					
Embedment h_{nom}		in.	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4
		(mm)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-1/2	(38)	0.668	0.630	0.598	0.282	0.244	0.213	0.542	0.533	0.525	0.126	0.086	0.056	0.253	0.173	0.113	n/a	n/a	n/a
	2	(51)	0.724	0.674	0.631	0.344	0.289	0.245	0.556	0.543	0.533	0.194	0.133	0.087	0.344	0.266	0.174	n/a	n/a	n/a
	2-1/4	(57)	0.752	0.695	0.647	0.378	0.312	0.261	0.563	0.549	0.537	0.232	0.159	0.104	0.378	0.312	0.207	n/a	n/a	n/a
	3	(76)	0.836	0.760	0.696	0.503	0.391	0.313	0.584	0.565	0.549	0.357	0.244	0.160	0.503	0.391	0.313	n/a	n/a	n/a
	3-1/2	(89)	0.891	0.804	0.729	0.587	0.456	0.350	0.598	0.576	0.557	0.450	0.308	0.201	0.587	0.456	0.350	0.626	n/a	n/a
	3-3/4	(95)	0.919	0.826	0.745	0.629	0.488	0.369	0.605	0.581	0.561	0.499	0.341	0.223	0.629	0.488	0.369	0.648	n/a	n/a
	4	(102)	0.947	0.847	0.761	0.671	0.521	0.392	0.612	0.587	0.565	0.550	0.376	0.246	0.671	0.521	0.392	0.669	0.589	n/a
	4-3/4	(121)	1.000	0.912	0.810	0.797	0.618	0.466	0.633	0.603	0.578	0.711	0.486	0.318	0.797	0.618	0.466	0.729	0.642	0.557
	5	(127)		0.934	0.827	0.839	0.651	0.490	0.640	0.609	0.582	0.768	0.525	0.343	0.839	0.651	0.490	0.748	0.659	0.572
	6	(152)		1.000	0.892	1.000	0.781	0.588	0.668	0.630	0.598	1.000	0.691	0.451	1.000	0.781	0.588	0.819	0.722	0.626
	8	(203)			1.000		1.000	0.784	0.724	0.674	0.631		1.000	0.695		1.000	0.784	0.946	0.833	0.723
	10	(254)						0.980	0.780	0.717	0.663			0.971			0.980	1.000	0.932	0.808
	12	(305)						1.000	0.836	0.760	0.696			1.000			1.000		1.000	0.886
	14	(356)							0.891	0.804	0.729									0.957
	16	(406)							0.947	0.847	0.761									1.000
	18	(457)							1.000	0.891	0.794									
	20	(508)								0.934	0.827									
	> 24	(610)								1.000	0.892									

Table 9 — Load adjustment factors for 3/8-in. diameter KH-EZ SS316 and KH-EZ C SS316 in cracked concrete[1,2]

3/8-in. KH-EZ SS316 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear						Conc. thickness factor in shear [4] f_{HV}		
												⊥ toward edge f_{RV}			II to edge f_{RV}					
Embedment h_{nom}		in.	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4
		(mm)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-1/2	(38)	0.668	0.630	0.598	0.753	0.651	0.569	0.580	0.565	0.532	0.336	0.241	0.083	0.671	0.483	0.167	n/a	n/a	n/a
	2	(51)	0.724	0.674	0.631	0.918	0.770	0.652	0.607	0.586	0.542	0.517	0.372	0.128	0.918	0.743	0.257	n/a	n/a	n/a
	2-1/4	(57)	0.752	0.695	0.647	1.000	0.832	0.696	0.621	0.597	0.548	0.617	0.443	0.153	1.000	0.832	0.307	n/a	n/a	n/a
	3	(76)	0.836	0.760	0.696		1.000	0.834	0.661	0.629	0.564	0.949	0.683	0.236		1.000	0.472	n/a	n/a	n/a
	3-1/2	(89)	0.891	0.804	0.729			0.933	0.688	0.651	0.574	1.000	0.860	0.297			0.595	0.867	n/a	n/a
	3-3/4	(95)	0.919	0.826	0.745			0.984	0.701	0.662	0.580		0.954	0.330			0.660	0.897	n/a	n/a
	4	(102)	0.947	0.847	0.761			1.000	0.715	0.672	0.585		1.000	0.363			0.727	0.927	0.830	n/a
	4-3/4	(121)	1.000	0.912	0.810				0.755	0.705	0.601			0.470			0.941	1.000	0.905	0.635
	5	(127)		0.934	0.827				0.768	0.715	0.606			0.508			1.000		0.928	0.651
	6	(152)		1.000	0.892				0.822	0.758	0.627			0.668					1.000	0.714
	8	(203)			1.000				0.929	0.845	0.670			1.000						0.824
	10	(254)							1.000	0.931	0.712									0.921
	12	(305)								1.000	0.755									1.000
	14	(356)									0.797									
	16	(406)									0.840									
	18	(457)									0.882									
	20	(508)									0.924									
	> 24	(610)									1.000									

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check table 5 and figure 2 of this document to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 10 — Load adjustment factors for 1/2-in. diameter KH-EZ SS316 in uncracked concrete[1,2]

1/2-in. KH-EZ SS316 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ toward edge f_{RV}			Edge distance in shear II to edge f_{RV}			Conc. thickness factor in shear [4] f_{HV}		
Embedment h_{nom}	in.	(mm)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.303	0.247	0.357	n/a	n/a	n/a	0.149	0.089	0.073	0.297	0.177	0.147	n/a	n/a	n/a
	2	(51)	n/a	n/a	n/a	0.333	0.266	0.378	n/a	n/a	n/a	0.181	0.108	0.090	0.333	0.217	0.179	n/a	n/a	n/a
	3	(76)	0.821	0.727	0.653	0.481	0.348	0.465	0.580	0.557	0.550	0.333	0.199	0.165	0.481	0.348	0.330	n/a	n/a	n/a
	4	(102)	0.927	0.803	0.704	0.641	0.455	0.560	0.607	0.576	0.567	0.513	0.306	0.254	0.641	0.455	0.508	n/a	n/a	n/a
	4-1/2	(114)	0.981	0.841	0.730	0.721	0.511	0.611	0.620	0.585	0.575	0.612	0.366	0.303	0.721	0.511	0.606	0.693	n/a	n/a
	4-3/4	(121)	1.000	0.860	0.743	0.761	0.540	0.637	0.627	0.590	0.579	0.664	0.397	0.328	0.761	0.540	0.637	0.712	0.600	n/a
	5	(127)		0.879	0.756	0.801	0.568	0.667	0.634	0.595	0.584	0.717	0.428	0.355	0.801	0.568	0.667	0.731	0.615	n/a
	6	(152)		0.955	0.807	0.962	0.682	0.800	0.660	0.614	0.600	0.943	0.563	0.466	0.962	0.682	0.800	0.801	0.674	n/a
	6-3/4	(171)		1.000	0.845	1.000	0.767	0.900	0.680	0.628	0.613	1.000	0.672	0.556	1.000	0.767	0.900	0.849	0.715	0.672
	8	(203)			0.909		0.909	1.000	0.714	0.652	0.634		0.867	0.718		0.909	1.000	0.925	0.778	0.731
	10	(254)			1.000		1.000		0.767	0.689	0.667		1.000	1.000		1.000		1.000	0.870	0.817
	12	(305)							0.821	0.727	0.700								0.953	0.895
	16	(406)							0.927	0.803	0.767								1.000	1.000
	20	(508)							1.000	0.879	0.834									
	> 24	(610)								0.955	0.901									

Table 11 — Load adjustment factors for 1/2-in. diameter KH-EZ SS316 in cracked concrete[1,2]

1/2-in. KH-EZ SS316 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ toward edge f_{RV}			Edge distance in shear II to edge f_{RV}			Conc. thickness factor in shear [4] f_{HV}		
Embedment h_{nom}	in.	(mm)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.808	0.657	0.548	n/a	n/a	n/a	0.352	0.225	0.067	0.703	0.450	0.135	n/a	n/a	n/a
	2	(51)	n/a	n/a	n/a	0.887	0.708	0.580	n/a	n/a	n/a	0.430	0.275	0.082	0.859	0.550	0.165	n/a	n/a	n/a
	3	(76)	0.821	0.727	0.653	1.000	0.929	0.713	0.642	0.606	0.547	0.789	0.505	0.151	1.000	0.929	0.303	n/a	n/a	n/a
	4	(102)	0.927	0.803	0.704		1.000	0.859	0.690	0.641	0.563	1.000	0.777	0.233		1.000	0.466	n/a	n/a	n/a
	4-1/2	(114)	0.981	0.841	0.730			0.937	0.714	0.658	0.571		0.927	0.278		1.000	0.556	0.924	n/a	n/a
	4-3/4	(121)	1.000	0.860	0.743			0.977	0.725	0.667	0.575		1.000	0.302		1.000	0.603	0.949	0.818	n/a
	5	(127)		0.879	0.756			1.000	0.737	0.676	0.579			0.326			0.651	0.974	0.839	n/a
	6	(152)		0.955	0.807				0.785	0.711	0.595			0.428			0.856	1.000	0.919	n/a
	6-3/4	(171)		1.000	0.845				0.820	0.738	0.607			0.511			1.000		0.975	0.653
	8	(203)			0.909				0.880	0.782	0.626			0.659					1.000	0.711
	10	(254)			1.000				0.974	0.852	0.658			0.921						0.794
	12	(305)							1.000	0.923	0.689			1.000						0.870
	16	(406)								1.000	0.752									1.000
	20	(508)									0.816									
	> 24	(610)									0.879									

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check table 5 and figure 2 of this document to calculate permissable edge distance, spacing and concrete thickness combinations.

DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-3027. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to PTG Ed. 21 Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

Table 12 — Steel resistance for Hilti KH-EZ SS316 and KH-EZ C SS316 screw anchor[1,2] 🇨🇦

Nominal anchor diameter in.	Tensile[3] N_{sar} lb (kN)	Shear[4] V_{sar} lb (kN)	Seismic shear[5] $V_{sar,eq}$ lb (kN)
1/4	3,595 (16.0)	1,010 (4.5)	665 (3.0)
3/8	7,810 (34.7)	2,405 (10.7)	2,405 (10.7)
1/2	12,315 (54.8)	2,645 (11.8)	2,645 (11.8)

1 See PTG Ed. 21 section 3.1.8 to convert design strength value to ASD value.
2 Hilti KH-EZ SS316 and KH-EZ C SS316 stainless steel screw anchors are to be considered ductile steel elements.
3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with $V_{sar} < 0.6\ A_{se,V}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \leq 0.60\ A_{se,V}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D. See PTG Ed. 21 section 3.1.8 for additional information on seismic applications.

Table 13 — KH-EZ SS316 and KH-EZ C SS316 design information in accordance with CSA A23.3 Annex D[1]

Design parameter	Symbol	Units	Nominal anchor diameter								Ref
			1/4		3/8			1/2			A23.3
Nominal anchor diameter	d_a	in. (mm)	0.25 (6.4)		0.375 (9.5)			0.5 (12.7)			
Effective embedment [2]	h_{ef}	in. (mm)	1.19 (30)	1.93 (49)	1.49 (38)	1.92 (49)	2.55 (65)	1.56 (40)	2.20 (56)	3.26 (83)	
Min. nominal embedment [2]	h_{nom}	in. (mm)	1-5/8 (41)	2-1/2 (64)	2 (51)	2-1/2 (64)	3-1/4 (83)	2-1/4 (57)	3 (76)	4-1/4 (108)	
Min. concrete thickness	h_{min}	in. (mm)	3-1/4 (83)	4 1/8 (105)	3-1/2 (89)	4 (102)	4 3/4 (121)	4 1/2 (114)	4 3/4 (121)	6 3/4 (171)	
Critical edge distance	c_{ac}	in. (mm)	4.76 (121)	7.72 (196)	5.96 (151)	7.68 (195)	10.20 (259)	6.24 (158)	8.80 (224)	7.50 (191)	
Minimum spacing at critical edge distance	$s_{min,cac}$	in. (mm)	1.5 (38)		2.25 (57)			3 (76)			
Minimum edge distance	c_{min}	in. (mm)	1.5 (38)					1.75 (44)			
Minimum spacing at minimum edge distance	for s >	in. (mm)	3 (76)								
Min. hole depth in concrete	h_0	in. (mm)	2 (51)	2-7/8 (73)	2-1/4 (57)	2-3/4 (70)	3-1/2 (89)	2-5/8 (67)	3-3/8 (86)	4-5/8 (117)	
Min. specified ultimate strength	f_{uta}	psi (N/mm2)	153,000 (1055)		139,300 (961)			120,100 (828)			
Effective tensile stress area	$A_{se,N}$	in2 (mm2)	0.040 (25.8)		0.094 (60.6)			0.172 (111.0)			
Steel embed. material resistance factor for reinforcement	ϕ_s	-	0.85								8.4.3
Resistance modification factor for tension, steel failure modes [3]	R	-	0.70								D.5.3
Resistance modification factor for shear, steel failure modes [3]	R	-	0.65								
Factored steel resistance in tension	N_{sar}	lb (kN)	3,595 (16.0)		7,810 (34.7)			12,315 (54.8)			D.6.1.2
Factored steel resistance in shear	V_{sar}	lb (kN)	1,010 (4.5)		2,405 (10.7)			2,645 (11.8)			D.7.1.2
Factored steel resistance in shear, seismic	$V_{sar,eq}$	lb (kN)	665 (3.0)		2,405 (10.7)			2,645 (11.8)			
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10.0		11.3						
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	-	7.1					8.8			
Modification factor for anchor resistance, tension, uncracked conc. [4]	$\psi_{c,N}$	-	1.0								D.6.2.6
Anchor category	-	-	2	3	1			2			
Concrete material resistance factor	ϕ_c	-	0.65								8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [5]	R	-	0.85	0.75	1.00			0.85			
Factored pullout resistance in 20 MPa uncracked concrete [6]	$N_{pr,uncr}$	lb (kN)	NA								D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete [6]	$N_{pr,cr}$	lb (kN)	340 (1.5)	580 (2.6)	1,060 (4.7)	1,555 (6.9)	NA				D.6.3.2
Factored seismic pullout resistance in 20 MPa cracked concrete [6]	$N_{pr,eq}$	lb (kN)	225 (1.0)	580 (2.6)	1,060 (4.7)	1,555 (6.9)	NA				D.6.3.2

1 Design information in this table is taken from ICC-ES ESR-3027, tables 2 and 4, and converted for use with CSA A23.3 Annex D.

2 See figure 1 of this document.

3 The KH-EZ SS316 and KH-EZ C SS316 is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 Chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-3027 for additional information.

Table 14 — Hilti KH-EZ SS316 and KH-EZ C SS316 screw anchor factored resistance with concrete / pullout failure in uncracked concrete[1,2,3,4]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1.19 (30)	1-5/8 (41)	925 (4.1)	1,030 (4.6)	1,130 (5.0)	1,305 (5.8)	925 (4.1)	1,030 (4.6)	1,130 (5.0)	1,305 (5.8)
	1.93 (49)	2-1/2 (64)	1,680 (7.5)	1,880 (8.4)	2,060 (9.2)	2,380 (10.6)	1,680 (7.5)	1,880 (8.4)	2,060 (9.2)	2,380 (10.6)
3/8	1.49 (38)	2 (51)	1,710 (7.6)	1,915 (8.5)	2,095 (9.3)	2,420 (10.8)	1,710 (7.6)	1,915 (8.5)	2,095 (9.3)	2,420 (10.8)
	1.92 (49)	2-1/2 (64)	2,505 (11.1)	2,800 (12.5)	3,065 (13.6)	3,540 (15.8)	2,505 (11.1)	2,800 (12.5)	3,065 (13.6)	3,540 (15.8)
	2.55 (65)	3-1/4 (83)	3,830 (17.0)	4,285 (19.1)	4,695 (20.9)	5,420 (24.1)	3,830 (17.0)	4,285 (19.1)	4,695 (20.9)	5,420 (24.1)
1/2	1.56 (40)	2-1/4 (57)	1,560 (6.9)	1,745 (7.8)	1,910 (8.5)	2,205 (9.8)	1,560 (6.9)	1,745 (7.8)	1,910 (8.5)	2,205 (9.8)
	2.20 (56)	3 (76)	2,610 (11.6)	2,920 (13.0)	3,195 (14.2)	3,690 (16.4)	2,610 (11.6)	2,920 (13.0)	3,195 (14.2)	3,690 (16.4)
	3.26 (83)	4-1/4 (108)	4,710 (20.9)	5,265 (23.4)	5,765 (25.7)	6,660 (29.6)	9,415 (41.9)	10,530 (46.8)	11,535 (51.3)	13,320 (59.2)

Table 15 — Hilti KH-EZ SS316 and KH-EZ C SS316 screw anchor factored resistance with concrete / pullout failure in cracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1.19 (30)	1-5/8 (41)	330 (1.5)	350 (1.6)	370 (1.7)	405 (1.8)	655 (2.9)	735 (3.3)	805 (3.6)	925 (4.1)
	1.93 (49)	2-1/2 (64)	770 (3.4)	860 (3.8)	945 (4.2)	1,090 (4.8)	1,195 (5.3)	1,335 (5.9)	1,465 (6.5)	1,690 (7.5)
3/8	1.49 (38)	2 (51)	1,055 (4.7)	1,180 (5.3)	1,295 (5.8)	1,495 (6.7)	1,080 (4.8)	1,210 (5.4)	1,325 (5.9)	1,530 (6.8)
	1.92 (49)	2-1/2 (64)	1,550 (6.9)	1,735 (7.7)	1,900 (8.5)	2,195 (9.8)	1,580 (7.0)	1,765 (7.9)	1,935 (8.6)	2,235 (9.9)
	2.55 (65)	3-1/4 (83)	2,420 (10.8)	2,705 (12.0)	2,960 (13.2)	3,420 (15.2)	2,420 (10.8)	2,705 (12.0)	2,960 (13.2)	3,420 (15.2)
1/2	1.56 (40)	2-1/4 (57)	1,220 (5.4)	1,365 (6.1)	1,495 (6.6)	1,725 (7.7)	1,220 (5.4)	1,365 (6.1)	1,495 (6.6)	1,725 (7.7)
	2.20 (56)	3 (76)	2,040 (9.1)	2,285 (10.2)	2,500 (11.1)	2,890 (12.8)	2,040 (9.1)	2,285 (10.2)	2,500 (11.1)	2,890 (12.8)
	3.26 (83)	4-1/4 (108)	3,685 (16.4)	4,120 (18.3)	4,510 (20.1)	5,210 (23.2)	7,365 (32.8)	8,235 (36.6)	9,020 (40.1)	10,420 (46.3)

1 See PTG Ed. 21 section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 11 as necessary. Compare to the steel values in table 12. The lesser of the values is to be used for the design.
4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.51 All other sizes - $\alpha_{N,seis}$ = 0.75
No reduction needed for seismic shear. See PTG Ed. 21 section 3.1.8 for additional information on seismic applications.

DESIGN INFORMATION IN MASONRY

Table 16 — Allowable tension loads for Hilti KH-EZ SS316 and KH-EZ C SS316 installed in grout-filled masonry walls walls (lb)[1,2,3,4,5]

Nominal anchor diameter in.	Embedment in.[6]	Loads @ c_{cr} and s_{cr}	Spacing			Edge distance		
			Critical - s_{cr} in.[7]	Minimum - s_{min} in.[7]	Load reduction factor at s_{min} [8]	Critical - C_{cr} in.[9]	Minimum - C_{min} in.[9]	Load reduction factor at c_{min} [8]
1/4	1-5/8	125	4	4	1.00	4	4	1.00
	2-1/2	194			1.00			1.00
3/8	2	332	6	4	0.74	6	4	0.71
	3-1/4	629			0.62			0.86
1/2	2-1/4	331	8	4	0.56	8	4	0.91
	4-1/4	874			0.56			0.75

Table 17 — Allowable Shear loads for Hilti KH-EZ SS316 and KH-EZ C SS316 installed in grout-filled masonry walls (lb)[1,2,3,4,5]

Nominal anchor diameter in.	Embedment in.[6]	Load at c_{cr} and s_{cr}	Spacing			Edge distance			
								Load reduction factor at c_{min}	
			Critical - s_{cr} in.[7]	Minimum - s_{min} in.[7]	Load reduction factor at s_{min} [8]	Critical - c_{cr} in.[9]	Minimum - c_{min} in.[9]	perpendicular to edge	parallel to edge
1/4	1-5/8	468	4	4	0.95	4	4	1.00	1.00
	2-1/2	574						1.00	1.00
3/8	2	742	6	4		6	4	0.90	1.00
	3-1/4	1,006						0.98	0.99
1/2	2-1/4	1,039	8	4		8	4	0.82	0.97
	4-1/4	1,787						0.48	0.94

1 All values are for anchors installed in fully grouted masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight, medium-weight or normal-weight.

2 Anchors may not be installed within one inch in any direction of a vertical joint.

3 Linear interpolation of load values between minimum spacing s_{min} and critical spacing s_{cr} and between minimum edge distance c_{min} and critical edge distance c_{cr} is permitted.

4 For combined loading: $\left(\frac{T_{applied}}{T_{allowable}}\right) + \left(\frac{V_{applied}}{V_{allowable}}\right) \leq 1$

5 See figure 5 of this document for anchor locations.

6 Embedment depth is measured from the outside face of the concrete masonry embedment.

7 Critical spacing s_{cr} is the anchor spacing where full load values may be used. The minimum spacing s_{min} is the minimum spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of the adjacent anchor.

8 Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than c_{cr} or s_{cr} must be multiplied by the appropriate load reduction factor based on actual edge distance (c) or spacing (s).

9 The critical edge distance c_{cr} is the edge distance where full load values may be used. The minimum edge distance c_{min} is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to the closest edge.

Table 18 — Hilti KH-EZ SS316 allowable loads installed in top of grout-filled concrete masonry walls[1,2,3]

Nominal anchor diameter in.	Minimum embedment depth in.	Edge distance[4] in.	Critical spacing[5] in.	Minimum end distance[6] in.	Tension lb	Shear lb	
						Load direction	
						Parallel to edge of masonry wall	Perpendicular to edge of masonry wall
1/2	4 1/4	1 3/4	8	8	614	809	200

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight, medium-weight or normal-weight conforming to ASTM C90. Allowable loads are calculated using safety factor of 5.

2 See figure 6 and 7 for allowable anchor installation locations on the top of grout-filled concrete masonry walls. Anchors may not be installed within 1-1/4 inch of a vertical joint.

3 Anchors may not be installed within 1-1/4" in any direction of a head joint.

4 For load values at edge distances between listed values linear interpolation is permitted.

5 Critical spacing equals minimum spacing.

6 Minimum end distance applicable to top-of-wall and end-of-wall and does not apply for wall openings such as windows.

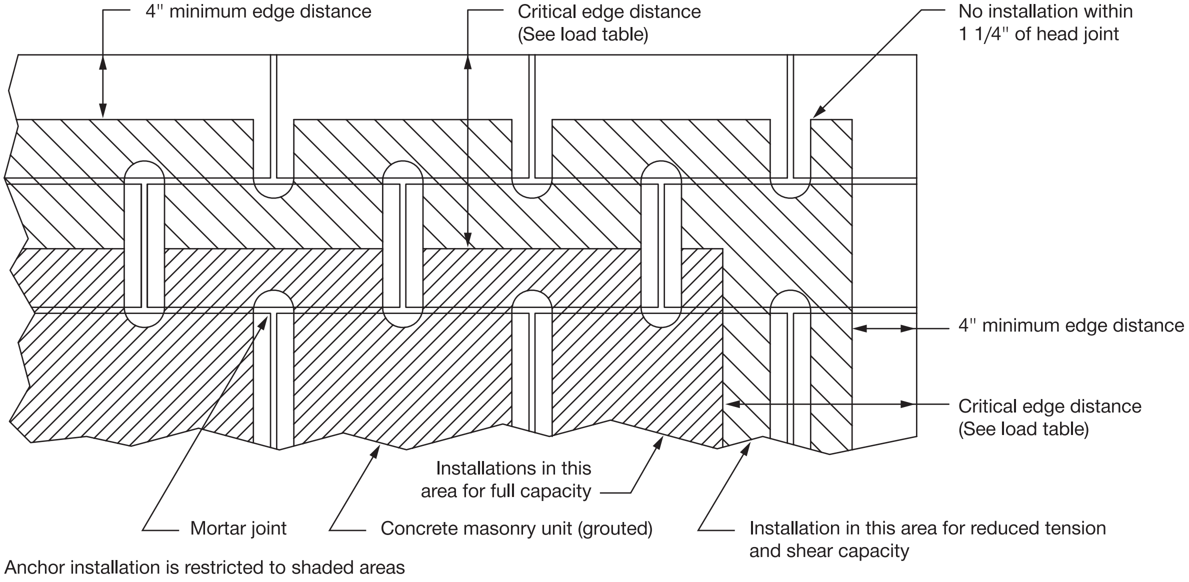


Figure 5 – Acceptable locations (shaded areas) for Hilti KH-EZ SS316 anchors in grout-filled concrete masonry

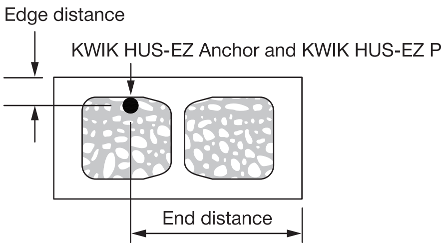
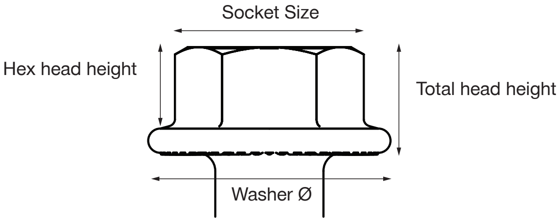


Figure 6 – Edge and end distances for the Hilti KH-EZ SS316 anchor installed in the top of CMU masonry wall construction

KH-EZ SS316

KH-EZ Ø	Socket Size	Washer Ø	Total head height	Hex head height
1/4”	7/16”	0.65”	0.26”	0.16”
3/8”	9/16”	0.78”	0.35”	0.25”
1/2”	3/4”	1.03”	0.49”	0.34”

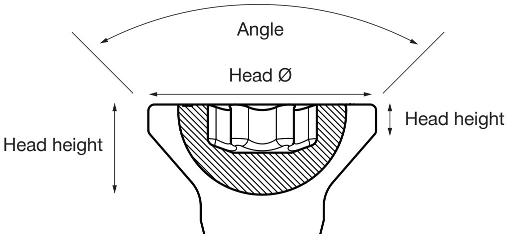
Ø = diameter



KH-EZ C

KH-EZ Ø	Torx Size	Head Ø	Head height	Flat height	Angle
1/4”	TX30	0.45”	0.15”	0.04”	82°
3/8”	TX50	0.74”	0.29”	0.09”	82°

Ø = diameter



INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at **www.hilti.com**. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION



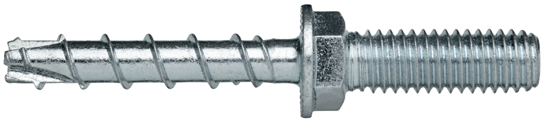
Order Information

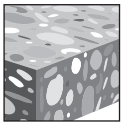
Description	Hole Diameter	Total Length	Minimum Embedment Depth	Qty (pcs) / Box
KH-EZ SS316 1/4''x2''	1/4''	2	1 5/8	100
KH-EZ SS316 1/4''x2 1/2''	1/4''	2 1/2	1 5/8	100
KH-EZ SS316 1/4''x3''	1/4''	3	1 5/8	100
KH-EZ C SS316 1/4''x2''	1/4''	2	1 5/8	100
KH-EZ C SS316 1/4''x2 1/2''	1/4''	2 1/2	1 5/8	100
KH-EZ C SS316 1/4''x3''	1/4''	3	1 5/8	100
KH-EZ SS316 3/8''x2 1/2''	3/8''	2 1/2	2	50
KH-EZ SS316 3/8''x3''	3/8''	3	2	50
KH-EZ SS316 3/8''x4''	3/8''	4	2 1/2	50
KH-EZ SS316 3/8''x5''	3/8''	5	2 1/2	50
KH-EZ C SS316 3/8''x2 1/2''	3/8''	2 1/2	2	50
KH-EZ C SS316 3/8''x3''	3/8''	3	2 1/2	50
KH-EZ C SS316 3/8''x4''	3/8''	4	2 1/2	50
KH-EZ SS316 1/2''x3''	1/2''	3	2 1/4	25
KH-EZ SS316 1/2''x4''	1/2''	4	3	25
KH-EZ SS316 1/2''x5''	1/2''	5	3	25

3.3.8 KWIK HUS-EZ I AND KWIK HUS-EZ E CARBON STEEL SCREW ANCHOR

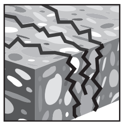
PRODUCT DESCRIPTION

KWIK HUS EZ I and KWIK HUS-EZ E carbon steel anchors

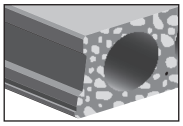
Anchor System		Features and Benefits
	Carbon Steel 1/4", 3/8" KWIK HUS-EZ I	• OSHA compliant installation options including the Hilti SafeSet™ hollow drill bit technology • Easy installation using impact tool or torque wrench • Product and length identification marks facilitate quality control after installation • Thread design enables quality setting and exceptional load values in wide variety of base material strengths • 1/4" diameter available in internally and externally threaded head styles • Anchor is fully removable • Anchor diameter is same as drill bit diameter. No special diameter bit requiredt. • Suitable for reduced edge distances and spacing • Suitable for seismic and non-seismic areas
	Carbon Steel 1/4" KWIK HUS EZ E	



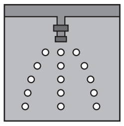
Uncracked concrete



Cracked concrete



Hollowcore concrete



Fire sprinkler listings

SafeSet™ System with Hollow Drill Bit

Profis Anchor design software

Approvals/Listings	
ICC-ES (International Code Council)	ESR-3027 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193
City of Los Angeles	City of Los Angeles 2020 LABC Supplement (within ESR-3027)
FM (Factory Mutual)	Pipe hanger components for automatic sprinkler systems for KH-EZ I and KH-EZ E
ANSI/MSS SP-58-2018	Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information.

INSTALLATION PARAMETERS

Table 1 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E specifications[1,2]

Setting information	Symbol	Units	Nominal anchor diameter					
			1/4					3/8
Head style			KH-EZ E	KH-EZ I				
Internal thread or external thread diameter		in.	3/8	1/4		3/8		1/2
Nominal bit diameter	d_{bit}	in.	1/4					3/8
Nominal embedment	h_{nom}	in.	1-5/8	1-5/8	2-1/2	1-5/8	2-1/2	2-1/8
Effective embedment	h_{ef}	in.	1.18	1.18	1.92	1.18	1.92	1.54
Minimum hole depth	h_o	in.	2	2	2-7/8	2	2-7/8	2-3/8
Installation torque	T_{inst}	ft-lb (N-m)	18 (24)					40 (54)
Wrench size		in.	1/2	3/8		1/2		11/16

1 T_{inst} is the maximum installation torque that may be applied with a torque wrench.

2 See table 5 and figure 2 of section 3.3.6 for spacing, edge distance, and concrete thickness parameters

Figure 1 — KWIK HUS-EZ I anchor installation details

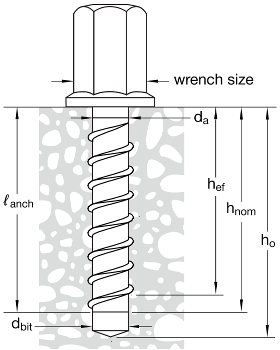
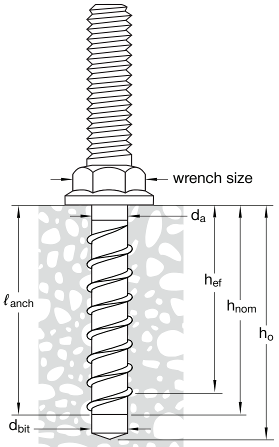


Figure 2 — KWIK HUS-EZ E anchor installation details



DESIGN INFORMATION IN CONCRETE PER ACI 318

ACI 318 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-3027 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-3027 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Table 2 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E design strength with concrete / pullout failure in uncracked concrete[1,2,3,4]

		Tension - ϕN_n							Shear - ϕV_n			
Nominal anchor diameter in.	Nominal embed. depth in. (mm)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 5,000 psi (34.5 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 7,000 psi (48.3 MPa) lb (kN)	f'_c = 8,000 psi (55.2 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
1/4	1-5/8	585	620	675	725	765	800	830	1,075	1,180	1,360	1,670
	(41)	(2.6)	(2.8)	(3.0)	(3.2)	(3.4)	(3.6)	(3.7)	(4.8)	(5.2)	(6.0)	(7.4)
	2-1/2	1,525	1,670	1,930	2,160	2,365	2,555	2,730	2,235	2,450	2,825	3,460
	(64)	(6.8)	(7.4)	(8.6)	(9.6)	(10.5)	(11.4)	(12.1)	(9.9)	(10.9)	(12.6)	(15.4)
3/8	2-1/8	1,490	1,635	1,885	2,110	2,310	2,495	2,665	1,605	1,760	2,030	2,485
	(54)	(6.6)	(7.3)	(8.4)	(9.4)	(10.3)	(11.1)	(11.9)	(7.1)	(7.8)	(9.0)	(11.1)

Table 3 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E design strength with concrete/pullout failure in cracked concrete[1,2,3,4,5]

		Tension - ϕN_n							Shear - ϕV_n			
Nominal anchor diameter in.	Nominal embed. depth in. (mm)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 5,000 psi (34.5 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 7,000 psi (48.3 MPa) lb (kN)	f'_c = 8,000 psi (55.2 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
1/4	1-5/8	300	315	345	370	390	410	425	765	835	965	1,180
	(41)	(1.3)	(1.4)	(1.5)	(1.6)	(1.7)	(1.8)	(1.9)	(3.4)	(3.7)	(4.3)	(5.2)
	2-1/2	760	830	960	1,070	1,175	1,270	1,355	1,585	1,735	2,000	2,450
	(64)	(3.4)	(3.7)	(4.3)	(4.8)	(5.2)	(5.6)	(6.0)	(7.1)	(7.7)	(8.9)	(10.9)
3/8	2-1/8	1,055	1,155	1,335	1,495	1,635	1,765	1,890	1,135	1,245	1,440	1,760
	(54)	(4.7)	(5.1)	(5.9)	(6.7)	(7.3)	(7.9)	(8.4)	(5.0)	(5.5)	(6.4)	(7.8)

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 5 and 6 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.

4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60

5 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.60
1/4-in diameter by 2-1/2-in nominal embedment depth - $\alpha_{N,seis}$ = 0.75
3/8-in diameter by 2-1/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.75
No reduction needed for seismic shear. See Section 3.1.8 for additional information on seismic applications.

Table 4 — Steel design strength for Hilti KWIK HUS-EZ I and KWIK HUS-EZ E anchors[1,2]

Nominal anchor diameter in.	Nominal internal thread diameter in.	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)	Seismic shear[5] ϕV_{sa} lb (kN)
1/4	1/4-20	3,680	815	365
	UNC	(16.4)	(3.6)	(1.6)
	3/8-16	3,680	790	670
	UNC	(16.4)	(3.5)	(3.0)
3/8	1/2-13	5,990	1,130	1,130
	UNC	(26.6)	(5.0)	(5.0)

1 See section 3.1.8 to convert design strength value to ASD value.

2 Hilti KWIK HUS-EZ I anchors are to be considered brittle steel elements.

3 Tension $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

4 Shear determined by static tests with $\phi V_{sa} < \phi\ 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.

5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi\ 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.
See Section 3.1.8 for additional information on seismic applications.

Table 5 — Load adjustment factors for 1/4-in. diameter Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in uncracked concrete[1,2]

1/4-in. KH-EZ uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear ⊥ toward edge f_{RV}		Edge distance in shear II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in.	(mm)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-1/2	(38)	0.71	0.63	0.78	0.65	0.59	0.56	0.40	0.21	0.78	0.42	n/a	n/a
	2	(51)	0.78	0.67	1.00	0.77	0.62	0.58	0.61	0.33	1.00	0.65	n/a	n/a
	2-1/2	(64)	0.85	0.72		0.90	0.65	0.60	0.86	0.46		0.90	n/a	n/a
	3	(76)	0.92	0.76		1.00	0.68	0.62	1.00	0.60		1.00	n/a	n/a
	3-1/4	(83)	0.96	0.78			0.70	0.63		0.68			0.88	n/a
	3-1/2	(89)	0.99	0.80			0.71	0.64		0.76			0.92	n/a
	4	(102)	1.00	0.85			0.74	0.66		0.92			0.98	n/a
	4-1/8	(105)		0.86			0.75	0.66		0.97			1.00	0.81
	4-1/2	(114)		0.89			0.77	0.68		1.00				0.84
	5	(127)		0.93			0.80	0.70						0.89
	5-1/2	(140)		0.98			0.83	0.72						0.93
	6	(152)		1.00			0.86	0.74						0.97
	7	(178)					0.92	0.78						1.00
	8	(203)					0.98	0.82						
	9	(229)					1.00	0.86						
	10	(254)						0.89						
	11	(279)						0.93						
	12	(305)						0.97						
	14	(356)						1.00						

Table 6 — Load adjustment factors for 1/4-in. diameter Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in cracked concrete[1,2]

1/4-in. KH-EZ cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear ⊥ toward edge f_{RV}		Edge distance in shear II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in.	(mm)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)	1-5/8 (41)	2-1/2 (64)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-1/2	(38)	0.71	0.63	0.88	0.65	0.59	0.56	0.40	0.21	0.80	0.43	n/a	n/a
	2	(51)	0.78	0.67	1.00	0.77	0.62	0.58	0.62	0.33	1.00	0.66	n/a	n/a
	2-1/2	(64)	0.85	0.72		0.90	0.65	0.60	0.87	0.46		0.90	n/a	n/a
	3	(76)	0.92	0.76		1.00	0.68	0.62	1.00	0.60		1.00	n/a	n/a
	3-1/4	(83)	0.96	0.78			0.70	0.63		0.68			0.89	n/a
	3-1/2	(89)	0.99	0.80			0.71	0.64		0.76			0.92	n/a
	4	(102)	1.00	0.85			0.74	0.66		0.93			0.98	n/a
	4-1/8	(105)		0.86			0.75	0.66		0.97			1.00	0.81
	4-1/2	(114)		0.89			0.77	0.68		1.00				0.85
	5	(127)		0.93			0.80	0.70						0.89
	5-1/2	(140)		0.98			0.83	0.72						0.93
	6	(152)		1.00			0.86	0.74						0.98
	7	(178)					0.92	0.78						1.00
	8	(203)					0.98	0.82						
	9	(229)					1.00	0.86						
	10	(254)						0.90						
	11	(279)						0.94						
	12	(305)						0.98						
	14	(356)						1.00						

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 5 and figure 2 of section 3.3.6 to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 7 — Load Adjustment Factors for 3/8-in. diameter KWIK HUS-EZ I and KWIK HUS-EZ E in uncracked concrete [1,2]

3/8-in. KH-EZ uncracked concrete	Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear [3] f_{AV}				Edge distance in shear								Conc. thickness factor in shear [4] f_{HV}			
													⊥ toward edge f_{RV}				II to and away from edge f_{RV}							
Embedment h_{nom} in. (mm)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)																								
1-1/2 (38)	n/a	n/a	n/a	n/a	0.58	0.62	0.63	0.57	n/a	n/a	n/a	n/a	0.49	0.32	0.25	0.08	0.58	0.62	0.50	0.17	n/a	n/a	n/a	n/a
2 (51)	n/a	n/a	n/a	n/a	0.76	0.75	0.75	0.66	n/a	n/a	n/a	n/a	0.75	0.49	0.38	0.13	0.76	0.75	0.75	0.26	n/a	n/a	n/a	n/a
2-1/4 (57)	0.84	0.74	0.70	0.65	0.86	0.82	0.81	0.70	0.65	0.62	0.60	0.55	0.90	0.59	0.46	0.16	0.90	0.82	0.81	0.31	n/a	n/a	n/a	n/a
2-1/2 (64)	0.88	0.77	0.72	0.67	0.95	0.91	0.88	0.75	0.67	0.63	0.61	0.55	1.00	0.69	0.54	0.18	1.00	0.91	0.88	0.37	n/a	n/a	n/a	n/a
3 (76)	0.95	0.82	0.77	0.70	1.00	1.00	1.00	0.85	0.71	0.66	0.63	0.56		0.90	0.71	0.24		1.00	1.00	0.48	n/a	n/a	n/a	n/a
3-1/4 (83)	0.99	0.85	0.79	0.72				0.90	0.72	0.67	0.64	0.57		1.00	0.80	0.27				0.54	0.95	n/a	n/a	n/a
3-1/2 (89)	1.00	0.88	0.81	0.73				0.95	0.74	0.68	0.65	0.58			0.89	0.30				0.61	0.98	n/a	n/a	n/a
4 (102)		0.93	0.86	0.77				1.00	0.78	0.71	0.68	0.59			1.00	0.37				0.74	1.00	0.91	0.84	n/a
4-1/2 (114)		0.99	0.90	0.80					0.81	0.73	0.70	0.60				0.44				0.88			0.89	n/a
4-3/4 (121)		1.00	0.93	0.82					0.83	0.75	0.71	0.60				0.48				0.96			0.91	0.639
5 (127)			0.95	0.83					0.84	0.76	0.72	0.61				0.52				1.00			0.94	0.655
6 (152)			1.00	0.90					0.91	0.81	0.76	0.63				0.68							1.00	0.718
7 (178)				0.97					0.98	0.86	0.81	0.65				0.86								0.775
8 (203)				1.00					1.00	0.91	0.85	0.67				1.00								0.829
9 (229)										0.97	0.90	0.69												0.879
10 (254)										1.00	0.94	0.71												0.927
11 (279)											0.98	0.74												0.972
12 (305)											1.00	0.76												1.000
14 (356)												0.80												
16 (406)												0.84												
18 (457)												0.89												
20 (508)												0.93												
24 (610)												1.000												

Table 8 — Load Adjustment Factors for 3/8-in. diameter Hilti KWIK HUS-EZ I and KWIZ HUS-EZ E in cracked concrete [1,2]

3/8-in. KH-EZ cracked concrete	Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear [3] f_{AV}				Edge distance in shear								Conc. thickness factor in shear [4] f_{HV}			
													⊥ toward edge f_{RV}				II to and away from edge f_{RV}							
Embedment h_{nom} in. (mm)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/8 (54)	2-1/2 (64)	3-1/4 (83)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)																								
1-1/2 (38)	n/a	n/a	n/a	n/a	0.92	0.74	0.66	0.57	n/a	n/a	n/a	n/a	0.49	0.32	0.25	0.09	0.92	0.64	0.50	0.17	n/a	n/a	n/a	n/a
2 (51)	n/a	n/a	n/a	n/a	1.00	0.90	0.79	0.66	n/a	n/a	n/a	n/a	0.76	0.50	0.39	0.13	1.00	0.90	0.77	0.26	n/a	n/a	n/a	n/a
2-1/4 (57)	0.84	0.74	0.70	0.65	1.00	0.98	0.85	0.70	0.66	0.62	0.60	0.55	0.90	0.59	0.46	0.16	1.00	0.98	0.85	0.31	n/a	n/a	n/a	n/a
2-1/2 (64)	0.88	0.77	0.72	0.67	1.00	1.00	0.92	0.75	0.67	0.63	0.61	0.55	1.00	0.69	0.54	0.18	1.00	1.00	0.92	0.37	n/a	n/a	n/a	n/a
3 (76)	0.95	0.82	0.77	0.70	1.00		1.00	0.85	0.71	0.66	0.63	0.56	1.00	0.91	0.71	0.24	1.00	1.00	1.00	0.48	n/a	n/a	n/a	n/a
3-1/4 (83)	0.99	0.85	0.79	0.72				0.90	0.73	0.67	0.64	0.57		1.00	0.80	0.27				0.55	0.95	n/a	n/a	n/a
3-1/2 (89)	1.00	0.88	0.81	0.73				0.95	0.74	0.68	0.65	0.58			0.90	0.31				0.61	0.98	n/a	n/a	n/a
4 (102)		0.93	0.86	0.77				1.00	0.78	0.71	0.68	0.59			1.00	0.37				0.75	1.00	0.91	0.84	n/a
4-1/2 (114)		0.99	0.90	0.80					0.81	0.73	0.70	0.60				0.44				0.89		0.97	0.89	n/a
4-3/4 (121)		1.00	0.93	0.82					0.83	0.75	0.71	0.60				0.48				0.97		1.00	0.92	0.64
5 (127)			0.95	0.83					0.85	0.76	0.72	0.61				0.52				1.00			0.94	0.66
6 (152)			1.00	0.90					0.92	0.81	0.77	0.63				0.69							1.00	0.72
7 (178)				0.97					0.98	0.87	0.81	0.65				0.86								0.78
8 (203)				1.00					1.00	0.92	0.85	0.67				1.00								0.83
9 (229)										0.97	0.90	0.69												0.88
10 (254)										1.00	0.94	0.72												0.93
11 (279)											0.99	0.74												0.97
12 (305)											1.00	0.76												1.00
14 (356)												0.80												
16 (406)												0.85												
18 (457)												0.89												
20 (508)												0.93												
24 (610)												1.00												

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 9 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6]

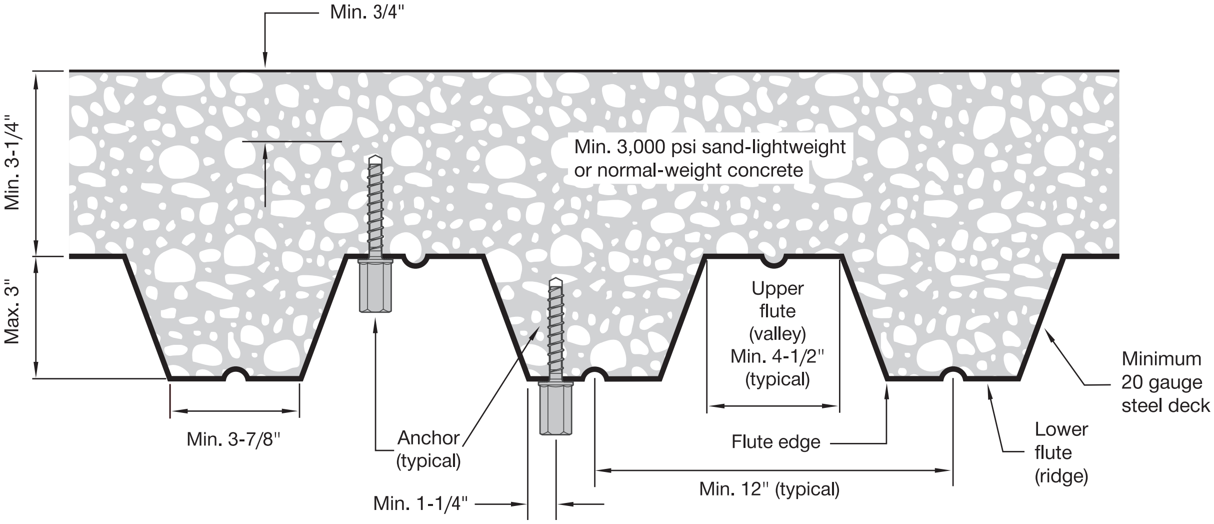
Nominal anchor diameter in.	Nominal internal thread diameter in.	Nominal embed. depth in. (mm)	Installation in lower flute				Installation in upper flute			
			Tension - ϕN_n		Shear - ϕV_n		Tension - ϕN_n		Shear - ϕV_n	
			f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
1/4	1/4-20 UNC	1-5/8 (41)	545 (2.4)	595 (2.6)	515 (2.3)	515 (2.3)	670 (3.0)	730 (3.2)	610 (2.7)	610 (2.7)
		2-1/2 (64)	1,220 (5.4)	1,410 (6.3)	515 (2.3)	515 (2.3)	1,275 (5.7)	1,470 (6.5)	610 (2.7)	610 (2.7)
	3/8-16 UNC	1-5/8 (41)	545 (2.4)	595 (2.6)	615 (2.7)	615 (2.7)	670 (3.0)	730 (3.2)	915 (4.1)	915 (4.1)
		2-1/2 (64)	1,220 (5.4)	1,410 (6.3)	615 (2.7)	615 (2.7)	1,275 (5.7)	1,470 (6.5)	915 (4.1)	915 (4.1)
3/8	1/2-13 UNC	2-1/8 (54)	1,120 (5.0)	1,295 (5.8)	1,430 (6.4)	1,430 (6.4)	1,730 (7.7)	2,000 (8.9)	2,190 (9.7)	2,190 (9.7)

Table 10 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in the soffit of cracked lightweight concrete over metal deck[1,2,3,4,5,6,7,8]

Nominal anchor diameter in.	Nominal internal thread diameter in.	Nominal embed. depth in. (mm)	Installation in lower flute				Installation in upper flute			
			Tension - ϕN_n		Shear - ϕV_n		Tension - ϕN_n		Shear - ϕV_n	
			f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
1/4	1/4-20 UNC	1-5/8 (41)	280 (1.2)	305 (1.4)	515 (2.3)	515 (2.3)	330 (1.5)	360 (1.6)	610 (2.7)	610 (2.7)
		2-1/2 (64)	605 (2.7)	700 (3.1)	515 (2.3)	515 (2.3)	635 (2.8)	735 (3.3)	610 (2.7)	610 (2.7)
	3/8-16 UNC	1-5/8 (41)	280 (1.2)	325 (1.4)	615 (2.7)	615 (2.7)	330 (1.5)	380 (1.7)	915 (4.1)	915 (4.1)
		2-1/2 (64)	605 (2.7)	700 (3.1)	615 (2.7)	615 (2.7)	635 (2.8)	735 (3.3)	915 (4.1)	915 (4.1)
3/8	1/2-13 UNC	2-1/8 (54)	795 (3.5)	920 (4.1)	1,430 (6.4)	1,430 (6.4)	1,225 (5.4)	1,415 (6.3)	2,190 (9.7)	2,190 (9.7)

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{nom} (nominal embedment).
4 Tabular values are lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison of the tabular values to the steel strength is not necessary. Tabular Values control.
7 Tabular values are for static loads only. For seismic tenison loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75.
8 For seismic shear, an additional factor must be applied to the cracked concrete tabular values for seismic conditions:
1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{V,seis}$ = 0.44
1/4-in diameter by 2-1/2-in nominal embedment depth - $\alpha_{V,seis}$ = 0.85
See Section 3.1.8 for additional information on seismic applications.

Figure 2 — Installation of Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in soffit of concrete over steel deck floor and roof assemblies



1 Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum concrete cover above the drilled hole is satisfied. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-3027. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

Table 11 — Steel resistance for Hilti KWIK HUS-EZ I and KWIK HUS-EZ E carbon steel screw anchor[1,2]

Nominal anchor diameter in.	Internal thread diameter (UNC)	Tensile[3] N_{sar} lb (kN)	Shear[4] V_{sar} lb (kN)	Seismic shear[5] $V_{sar,eq}$ lb (kN)
1/4	1/4-20	3,370 (15.0)	750 (3.3)	335 (1.5)
1/4	3/8-16	3,370 (15.0)	725 (3.2)	620 (2.8)
3/8	1/2-13	5,515 (24.5)	1,040 (4.6)	1,040 (4.6)

1 See Section 3.1.8 of Hilti Product Technical Guide Ed 21 to convert factored resistance value to ASD value.

2 Hilti KWIK HUS-EZ I carbon steel screw anchors are to be considered brittle steel elements.

3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.

4 Shear determined by static shear tests with $V_{sar} < 0.6\ A_{se,V}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.

5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \leq 0.60\ A_{se,V}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D. See Section 3.1.8 of Hilti Product Technical Guide Ed 21 for additional information on seismic applications.

Table 12 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E design information in accordance with CSA A23.3 Annex D[1]

Design parameter		Symbol	Units	Nominal anchor diameter			Ref
				1/4		3/8	A23.3
Anchor O.D.		d_a	in. (mm)	0.25 (6.4)		0.375 (9.5)	
Effective embedment[2]		h_{ef}	in. (mm)	1.18 (30)	1.92 (49)	1.54 (39)	
Minimum nominal embedment[2]		h_{nom}	in. (mm)	1-5/8 (41)	2-1/2 (64)	2 1/8 (54)	
Minimum concrete thickness		h_{min}	in. (mm)	3-1/4 (83)	4-1/8 (105)	3 5/8 (92)	
Critical edge distance		c_{ac}	in. (mm)	2.00 (51)	2.78 (71)	2.75 (70)	
Minimum spacing at critical edge distance		$s_{min,cac}$	in. (mm)	1.5 (38)		2.25 (57)	
Minimum edge distance		c_{min}	in. (mm)	1.50 (38)		1.5 (38)	
Minimum anchor spacing at minimum edge distance		for s >	in. (mm)	3.0 (76)		3 (76)	
Mininimum hole depth in concrete		h_0	in. (mm)	2 (51)	2-7/8 (73)	2 3/8 (60)	
Minimum specified ultimate strength		f_{uta}	psi (N/mm^2)	125,000 (862)		106,975 (826)	
Effective tensile stress area		$A_{se,N}$	in^2 (mm^2)	0.045 (29.0)		0.086 (55.5)	
Steel embed. material resistance factor for reinforcement		ϕ_s	-	0.85			8.4.3
Resistance modification factor for tension, steel failure modes[3]		R	-	0.70			D.5.3
Resistance modification factor for shear, steel failure modes[3]		R	-	0.65			D.5.3
Factored steel resistance in tension		N_{sar}	lb (kN)	3,370 (15.0)		5,475 (24.4)	D.6.1.2
Factored steel resistance in shear	1/4-20 UNC internal thread	V_{sar}	lb (kN)	750 (3.3)		N/A	D.7.1.2
Factored steel resistance in shear, seismic		$V_{sar,eq}$	lb (kN)	335 (1.5)		N/A	
Factored steel resistance in shear	3/8-16 UNC internal thread	V_{sar}	lb (kN)	725 (3.2)		N/A	D.7.1.2
Factored steel resistance in shear, seismic		$V_{sar,eq}$	lb (kN)	620 (2.8)		N/A	
Factored steel resistance in shear	1/2-13 UNC internal thread	V_{sar}	lb (kN)	N/A		1040 (4.6)	
Factored steel resistance in shear, seismic		$V_{sar,eq}$	lb (kN)			1040 (4.6)	
Coeff. for factored conc. breakout resistance, uncracked concrete		$k_{c,uncr}$	-	10			D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete		$k_{c,cr}$	-	7			D.6.2.2
Modification factor for anchor resistance, tension, uncracked conc.[4]		$\psi_{c,N}$	-	1.0			D.6.2.6
Anchor category		-	-	3	1	1	D.5.3 (c)
Concrete material resistance factor		ϕ_c	-	0.65			8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]		R	-	0.75	1.00	1.00	D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete[6]		$N_{pr,uncr}$	lb (kN)	665 (3.0)	1,645 (7.3)	N/A	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete[6]		$N_{pr,cr}$	lb (kN)	340 (1.5)	815 (3.6)	N/A	D.6.3.2
Factored seismic pullout resistance in 20 MPa cracked concrete[6]		$N_{pr,eq}$	lb (kN)	275 (1.2)	815 (3.6)	N/A	D.6.3.2

[1] Design information in this table is taken from ICC-ES ESR-3027, tables 6, 7, and 8, and converted for use with CSA A23.3 Annex D.

[2] See figure 1 of this section.

[3] The KWIK HUS-EZ I is considered a brittle steel element as defined by CSA A23.3 Annex D section D.2.

[4] For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

[5] For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

[6] For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-3027 for additional information.

Table 13 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E carbon steel screw anchor factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

							Tension - N_r				Shear - V_r			
Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Effectiveness Factor	Strength Reduction Factor Tension	Concrete material resistance factor	Pullout Strength (2500 psi concrete)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1.18 (30)	1-5/8 (41)	10	0.75	0.65	1305 (5.8)	665 (3.0)	710 (3.2)	750 (3.3)	820 (3.6)	805 (3.6)	900 (4.0)	985 (4.4)	1,135 (5.1)
	1.92 (49)	2-1/2 (64)	10	1	0.65	2350 (10.5)	1,645 (7.3)	1,840 (8.2)	2,015 (9.0)	2,325 (10.3)	2,225 (9.9)	2,490 (11.1)	2,725 (12.1)	3,145 (14.0)
3/8	1.54 (39)	2-1/8 (54)	10	1	0.65	N/A	1,595 (7.1)	1,785 (7.9)	1,955 (8.7)	2,260 (10.0)	1,595 (7.1)	1,785 (7.9)	1,955 (8.7)	2,260 (10.0)

Table 14 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E carbon steel screw anchor factored resistance with concrete/pullout failure in cracked concrete[1,2,3,4,5]

							Tension - N_r				Shear - V_r			
Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Effectiveness Factor	Strength Reduction Factor Tension	Concrete material resistance factor	Pullout Strength (2500 psi concrete)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
d_a in (mm)	h_{ef} (mm)	h_{nom} (mm)	k_{cr}	R	Φ_c	$N_{p,uncr}$ (N/mm²)	20	25	30	40	20	25	30	40
1/4	1.18 (30)	1-5/8 (41)	7	0.75	0.65	665 (3.0)	340 (1.5)	360 (1.6)	385 (1.7)	415 (1.9)	565 (2.5)	630 (2.8)	690 (3.1)	795 (3.5)
	1.92 (49)	2-1/2 (64)	7	1	0.65	1165 (5.2)	815 (3.6)	910 (4.1)	1,000 (4.4)	1,155 (5.1)	1,800 (8.0)	1,740 (7.7)	1,910 (8.5)	2,205 (9.8)
3/8	1.54 (39)	2-1/8 (54)	7	1	0.65	N/A	1,120 (5.0)	1,250 (5.6)	1,370 (6.1)	1,580 (7.0)	1,120 (5.0)	1,250 (5.6)	1,370 (6.1)	1,580 (7.0)

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 5 to 6 as necessary. Compare to the steel values in table 9. The lesser of the values is to be used for the design.

4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60

5 5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:

1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.60

1/4-in diameter by 2-1/2-in nominal embedment depth - $\alpha_{N,seis}$ = 0.75.

No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

Table 15 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6,7]

Nominal anchor diameter in.	Nominal internal thread diameter in.	Nominal embed. depth in. (mm)	Installation in lower flute				Installation in upper flute			
			Tension - N_r		Shear - V_r		Tension - N_r		Shear - V_r	
			f'_c = 20 MPa (2,900 psi) kN	f'_c = 30 MPa (4,350 psi) kN	f'_c = 20 MPa (2,900 psi) kN	f'_c = 30 MPa (4,350 psi) kN	f'_c = 20 MPa (2,900 psi) kN	f'_c = 30 MPa (4,350 psi) kN	f'_c = 20 MPa (2,900 psi) kN	f'_c = 30 MPa (4,350 psi) kN
1/4	1/4-20 UNC	1-5/8 (41)	585 (2.6)	660 (2.9)	475 (2.1)	475 (2.1)	720 (3.2)	810 (3.6)	560 (2.5)	560 (2.5)
		2-1/2 (64)	1,200 (5.3)	1,470 (6.5)			1,255 (5.6)	1,535 (6.8)		
1/4	3/8-16 UNC	1-5/8 (41)	585 (2.6)	660 (2.9)	565 (2.5)	565 (2.5)	720 (3.2)	810 (3.6)	845 (3.8)	845 (3.8)
		2-1/2 (64)	1,200 (5.3)	1,470 (6.5)			1,255 (5.6)	1,535 (6.8)		
3/8	1/2-13 UNC	2-1/8 (54)	1,100 (4.9)	1,345 (6.0)	1,315 (5.8)	1,315 (5.8)	1,865 (8.3)	2,280 (10.1)	2,015 (9.0)	2,015 (9.0)

Table 16 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in the soffit of cracked lightweight concrete over metal deck[1,2,3,4,5,6,7,8]

Nominal anchor diameter in.	Nominal internal thread diameter in.	Nominal embed. depth in. (mm)	Installation in lower flute				Installation in upper flute			
			Tension - N_r		Shear - V_r		Tension - N_r		Shear - V_r	
			f'_c = 20 MPa (2,900 psi) kN	f'_c = 30 MPa (4,350 psi) kN	f'_c = 20 MPa (2,900 psi) kN	f'_c = 30 MPa (4,350 psi) kN	f'_c = 20 MPa (2,900 psi) kN	f'_c = 30 MPa (4,350 psi) kN	f'_c = 20 MPa (2,900 psi) kN	f'_c = 30 MPa (4,350 psi) kN
1/4	1/4-20 UNC	1-5/8 (41)	300 (1.3)	340 (1.5)	475 (2.1)	475 (2.1)	365 (1.6)	415 (1.8)	560 (2.5)	560 (2.5)
		2-1/2 (64)	595 (2.6)	730 (3.2)			625 (2.8)	765 (3.4)		
1/4	3/8-16 UNC	1-5/8 (41)	300 (1.3)	340 (1.5)	565 (2.5)	565 (2.5)	365 (1.6)	415 (1.8)	845 (3.8)	845 (3.8)
		2-1/2 (64)	595 (2.6)	730 (3.2)			625 (2.8)	765 (3.4)		
3/8	1/2-13 UNC	2-1/8 (54)	780 (3.5)	955 (4.2)	1,315 (5.8)	1,315 (5.8)	1,305 (5.8)	1,595 (7.1)	2,015 (9.0)	2,015 (9.0)

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 6 3/8 inches.
4 Tabular value is for lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. For seismic conditions $\alpha_{N,seis}$ = 0.75
8 For seismic shear, an additional factor must be applied to the cracked concrete tabular values for seismic conditions: $\alpha_{v,seis}$, = 0.85
See Section 3.1.8 for additional information on seismic applications.

ALLOWABLE STRESS DESIGN FOR FM SPRINKLER SYSTEMS

Table 17 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E tested load values for FM approval for automatic sprinkler systems[1]

Anchor diamenter in.	Hanger rod size	Nominal embedment in.	FM tension test load lb.	FM maximum pipe diameter in.
1/4	3/8-16 UNC	1-5/8	1,475	4
		2-1/2		
3/8	1/2-13 UNC	2-1/8	3,800	8

1 Tested in accordance with FM Approval Standard for Pipe Hanger Components for Automatic Sprinklers Systems Class Numbers 1951, 1952 and 1953.

DESIGN INFORMATION IN HOLLOW CORE CONCRETE PER ALLOWABLE STRESS DESIGN

Table 18 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E load values for installations into hollow core concrete panels[1,2]

Hanger rod size	anchor diameter in.	Min. effective embedment h_{ef} in.	Min.effective base material thickness t in.	Allowable load[3]		Ultimate load	
				Tension lb	Shear lb[4,5]	Tension lb	Shear lb[4,5]
1/4-20 UNC	1/4	1-3/8	1-3/8	455	485	1,810	1,930
3/8-16 UNC	1/4				755		3,025
1/2-13 UNC	3/8	1-1/8	1-1/8	435	N/A	1,750	N/A

1 The admissible anchor location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm admissible anchor location.

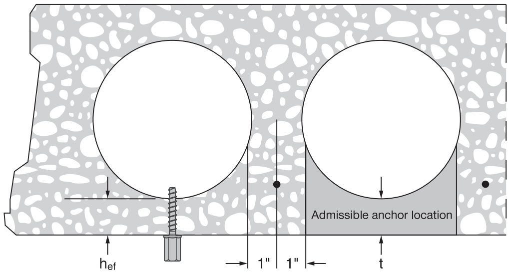
2 Minimum compressive strength of prestressed concrete is 7,000 psi. Published ultimate loads represent the average results conducted in local base materials. Due to variations in materials and dimensionl configurations, on-site testing is required to determine the actual performance.

3 Allowable loads calculated with a factor of safety of 4

4 The bottom of the shear plane adjacent to the top of the coupler.

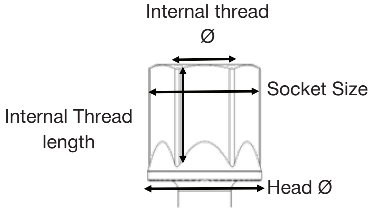
5 Shear values controlled by the steel strength of the screws used to fasten the shear fixture to the KH EZ-I Screw Anchor. The minimum tensile strength of the screw was 125 ksi. Shear design values should consider the screw or threaded rod steel strength.

Figure 3 — Installation of Hilti KWIK HUS–EZ I and KH-EZ E in hollow core concrete



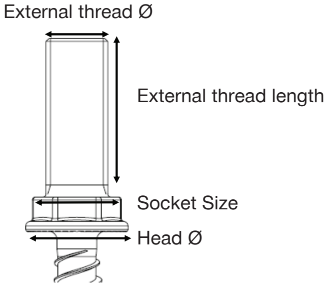
INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.



KH-EZ I

KH-EZ Ø	Socket Size	Head Ø	Internal thread Ø	Internal thread length
1/4''	3/8''	0.59''	1/4''	0.37''
1/4''	1/2''	0.65''	3/8''	0.45''
3/8''	11/16''	0.81''	1/2''	0.46''



KH-EZ E

KH-EZ Ø	Socket Size	Min Socket Height	Head Ø	Internal thread Ø	Internal thread length	Total Head height
1/4''	1/2''	1-1/2''	0.65''	3/8''	1.08''	1.32"

ORDERING INFORMATION[1]

Description	Internal thread diameter	Internal thread length	Drill bit diameter	Minimum embedment	Qty / box
KWIK HUS-EZ 1/4x1-5/8 | 1/4	1/4	3/8	1/4	1-5/8	100
KWIK HUS-EZ 1/4x2-1/2 | 1/4	1/4	3/8	1/4	2-1/2	100
KWIK HUS-EZ 1/4x1-5/8 | 3/8	3/8	7/16	1/4	1-5/8	100
KWIK HUS-EZ 1/4x2-1/2 | 3/8	3/8	7/16	1/4	2-1/2	100
KWIK HUS-EZ 3/8x2-1/8 | 1/2	1/2	1/2	3/8	2-1/8	100
KWIK HUS-EZ 1/4x1-5/8 E 3/8	3/8	1	1/4	1-5/8	100

1 All dimensions in inches.

3.3.9 KB1 EXPANSION ANCHOR

PRODUCT DESCRIPTION

KB1 Expansion Anchor

Anchor System	Features and Benefits
Carbon Steel KB1 	• Instructions For Use (IFU) provides multiple installation methods including Hilti Hollow Drill bit, or no hole cleaning with hammer drill and Hilti Dust Removal System (DRS) for virtually dustless installation (OSHA 1926.1153 Table 1 compliant). • Accurate SafeSet™ installation when using the Hilti SIW-6AT-A22 impact wrench and the SI-AT-A22 Adaptive Torque Module. • Product and length identification marks facilitate quality control after installation. • Maximized thread lengths and multiple embedment depths to accommodate various base plate thicknesses. • Functional coatings and profiled expansion wedges provide increased reliability. • Mechanical expansion allows immediate load application. • Raised impact section (dog point) prevents thread damage during installation.

Uncracked concrete

Cracked concrete

Grout-filled concrete masonry

Seismic Design Categories A-F

Fire sprinkler listings

Profis Engineering design software

Hollow Drill Bit and Adaptive Torque Tool (AT)

Approvals/ Listings	
IAPMO Uniform ES • 2021 International Building Code / International Residential Code (IBC/IRC)	ER-678 in concrete per ACI 318 Ch. 17 / ACI 355.2 ER-677 in grout-filled CMU per AC01
City of Los Angeles	2020 LABC Supplement (within ER-677 & ER-678)
Florida Building Code	2020 FBC Supplement with HVHZ (within ER-677 & ER-678)
FM (Factory Mutual)	Pipe hanger components for automatic sprinkler systems 3/8 (up to 4-inch nominal pipe diameter) 1/2 (up to 8-inch nominal pipe diameter) 3/4 (up to 12-inch nominal pipe diameter)
UL and cUL (Underwriters Laboratory)	Pipe hanger equipment for fire protection services 3/8 (up to 4-inch nominal pipe diameter) 1/2 (up to 8-inch nominal pipe diameter) 5/8 & 3/4 (up to 12-inch nominal pipe diameter)
ANSI/MSS SP-58-2018	Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information.

MATERIAL SPECIFICATIONS

Carbon steel with electroplated zinc

- Hilti KB1 anchor bodies manufactured from carbon steel with Fe/Zn plating per ASTM F1941 to a minimum thickness of 5 µm.
- Nuts conform to the requirements of ASTM A563, Grade A, Hex.
- Washers conform to the requirements of ASTM F844.
- Expansion sleeves (wedges) are manufactured from carbon steel.

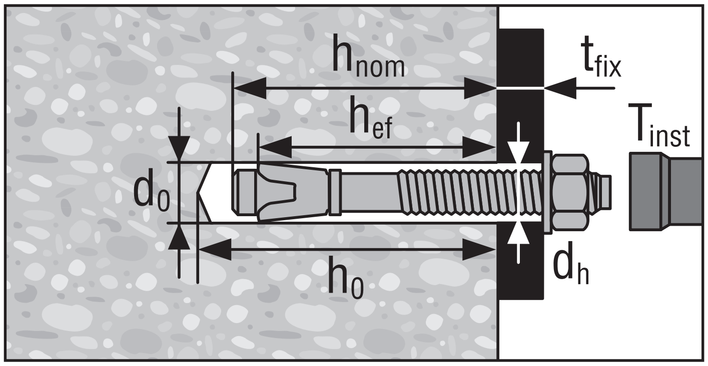
INSTALLATION PARAMETERS

Table 1 — Hilti KB1 setting information for installation in concrete and grout-filled concrete masonry units (CMU)

Setting information	Symbol	Units	Nominal anchor diameter (in)							
			3/8		1/2		5/8		3/4	
Nominal drill bit diameter	d_o	in.	3/8		1/2		5/8		3/4	
Effective minimum embedment	h_{ef}	in.	1-1/2 [1]	2	2	3-1/4	2-3/4	4	3-1/4	4-3/4
		(mm)	(38)	(51)	(51)	(83)	(70)	(102)	(83)	(121)
Nominal minimum embedment	h_{nom}	in.	1-7/8 [1]	2-3/8	2-3/8	3-5/8	3-1/4	4-1/2	4	5-1/2
		(mm)	(48)	(60)	(60)	(92)	(83)	(114)	(102)	(140)
Minimum hole depth	h_0	in.	2-1/8 [1]	2-3/4	2-3/4	4-1/4	3-3/4	4-3/4	4-1/4	5-3/4
		(mm)	(54)	(70)	(70)	(108)	(95)	(121)	(108)	(146)
Fixture hole diameter	d_h	in.	7/16		9/16		11/16		13/16	
		(mm)	(11.1)		(14.3)		(17.5)		(20.6)	
Installation torque Concrete	$T_{inst,conc}$	ft-lb	20		40		60		110	
		(Nm)	(27)		(54)		(81)		(149)	
Installation torque Grout-filled CMU	$T_{inst,CMU}$	ft-lb	15		25		35		50	
		(Nm)	(20)		(34)		(47)		(68)	

[1] Effective embedment, h_{ef} = 1-1/2-in. not applicable for grout-filled CMU base material.

Figure 1 — Hilti KB1 setting information for installation in concrete and grout-filled (CMU)



DESIGN INFORMATION IN CONCRETE PER ACI 318

ACI 318 Chapter 17 Design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of IAPMO UES ER-678 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables refer to section 3.1.8 of the North American Product Technical Guide: Volume 2: Anchor Fastening Technical Guide, Edition 19 (PTG 19). Data tables from ER-678 are not contained in this section but can be found at www.uniform-es.org or at www.hilti.com.

Table 2 — Hilti KB1 design strength based on concrete failure modes in uncracked concrete [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
3/8	1-1/2	1-7/8	1,435	1,570	1,815	2,220	1,545	1,690	1,950	2,390
	(38)	(48)	(6.4)	(7.0)	(8.1)	(9.9)	(6.9)	(7.5)	(8.7)	(10.6)
	2	2-3/8	2,070	2,130	2,230	2,380	2,375	2,605	3,005	3,680
	(51)	(60)	(9.2)	(9.5)	(9.9)	(10.6)	(10.6)	(11.6)	(13.4)	(16.4)
1/2	2	2-3/8	2,205	2,415	2,790	3,420	2,375	2,605	3,005	3,680
	(51)	(60)	(9.8)	(10.7)	(12.4)	(15.2)	(10.6)	(11.6)	(13.4)	(16.4)
	3-1/4	3-5/8	4,570	5,005	5,780	7,080	9,845	10,785	12,450	15,250
	(83)	(92)	(20.3)	(22.3)	(25.7)	(31.5)	(43.8)	(48.0)	(55.4)	(67.8)
5/8	2-3/4	3-1/4	3,145	3,445	3,980	4,875	7,660	8,395	9,690	11,870
	(70)	(83)	(14.0)	(15.3)	(17.7)	(21.7)	(34.1)	(37.3)	(43.1)	(52.8)
	4	4-1/2	5,875	6,435	7,435	9,105	13,440	14,725	17,000	20,820
	(102)	(114)	(26.1)	(28.6)	(33.1)	(40.5)	(59.8)	(65.5)	(75.6)	(92.6)
3/4	3-1/4	4	4,570	5,005	5,780	7,080	9,845	10,785	12,450	15,250
	(83)	(102)	(20.3)	(22.3)	(25.7)	(31.5)	(43.8)	(48.0)	(55.4)	(67.8)
	4-3/4	5-1/2	8,075	8,845	10,215	12,510	17,390	19,050	22,000	26,945
	(121)	(140)	(35.9)	(39.3)	(45.4)	(55.6)	(77.4)	(84.7)	(97.9)	(119.9)

Table 3 — Hilti KB1 design strength based on concrete failure modes in cracked concrete [1,2,3,4,5]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
3/8	1-1/2	1-7/8	1,015	1,110	1,285	1,570	1,095	1,195	1,385	1,695
	(38)	(48)	(4.5)	(4.9)	(5.7)	(7.0)	(4.9)	(5.3)	(6.2)	(7.5)
	2	2-3/8	1,565	1,710	1,975	2,420	1,685	1,845	2,130	2,605
	(51)	(60)	(7.0)	(7.6)	(8.8)	(10.8)	(7.5)	(8.2)	(9.5)	(11.6)
1/2	2	2-3/8	1,565	1,710	1,975	2,420	1,685	1,845	2,130	2,605
	(51)	(60)	(7.0)	(7.6)	(8.8)	(10.8)	(7.5)	(8.2)	(9.5)	(11.6)
	3-1/4	3-5/8	3,235	3,545	4,095	5,015	6,970	7,640	8,820	10,800
	(83)	(92)	(14.4)	(15.8)	(18.2)	(22.3)	(31.0)	(34.0)	(39.2)	(48.0)
5/8	2-3/4	3-1/4	2,520	2,760	3,185	3,905	5,425	5,945	6,865	8,405
	(70)	(83)	(11.2)	(12.3)	(14.2)	(17.4)	(24.1)	(26.4)	(30.5)	(37.4)
	4	4-1/2	4,420	4,840	5,590	6,845	9,520	10,430	12,040	14,750
	(102)	(114)	(19.7)	(21.5)	(24.9)	(30.4)	(42.3)	(46.4)	(53.6)	(65.6)
3/4	3-1/4	4	3,245	3,555	4,105	5,025	8,615	9,435	10,895	13,345
	(83)	(102)	(14.4)	(15.8)	(18.3)	(22.4)	(38.3)	(42.0)	(48.5)	(59.4)
	4-3/4	5-1/2	5,780	6,335	7,315	8,955	15,220	16,670	19,250	23,575
	(121)	(140)	(25.7)	(28.2)	(32.5)	(39.8)	(67.7)	(74.2)	(85.6)	(104.9)

[1] See Section 3.1.8 to convert design strength value to ASD value.

[2] Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

[3] Apply spacing, edge distance, and concrete thickness factors in tables 6 to 13 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.

[4] Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60.

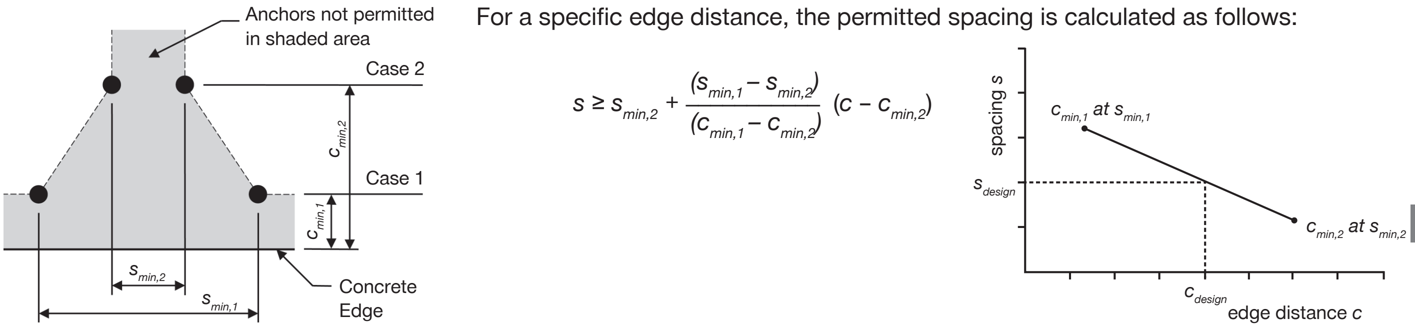
[5] Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.67. No reduction needed for seismic shear. See Section 3.1.8 for additional information on seismic applications.

Table 4 — Hilti KB1 design strength based on steel failure [1,2]

Nominal anchor diameter in.	Tensile [3] ΦN_{sa} lb (kN)	Shear [4] ΦV_{sa} lb (kN)	Seismic Shear [5] ΦV_{sa} lb (kN)
3/8	4,760	1,655	1,655
	(21.2)	(7.4)	(7.4)
1/2	8,145	3,395	3,395
	(36.2)	(15.1)	(15.1)
5/8	12,875	5,790	5,790
	(57.3)	(25.8)	(25.8)
3/4	18,220	6,995	5,950
	(81.0)	(31.1)	(26.5)
3/4x12	15,790	6,460	5,490
	(70.2)	(28.7)	(24.4)

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KB1 anchors are to be considered ductile steel elements, with the exception of the 3/4x12 KB1 which is a brittle steel element.
3 Tensile $\phi N_{sa} = \phi\ A_{se,N}\ f_{uta}$ as noted in ACI 318 Ch. 17.
4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Ch. 17.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Ch. 17. See Section 3.1.8 for additional information on seismic applications.

Figure 2



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}\ (c - c_{min,2})$$

Table 5 — Hilti KB1 installation parameters in concrete [1]

Setting information	Symbol	Units	Nominal anchor diameter (mm)							
			3/8		1/2		5/8		3/4	
Effective minimum embedment	h_{ef}	in.	1-1/2	2	2	3-1/4	2-3/4	4	3-1/4	4-3/4
		(mm)	(38)	(51)	(51)	(83)	(70)	(102)	(83)	(121)
Minimum concrete thickness	h_{min}	in.	3-3/8	4	4	6	5	6	5-1/2	8
		(mm)	(83)	(102)	(102)	(152)	(127)	(152)	(140)	(203)
Case 1	$c_{min,1}$	in.	8	2-1/2	4	2-3/4	5-1/2	4-1/4	9-1/2	4-1/2
		(mm)	(203)	(64)	(102)	(70)	(140)	(108)	(241)	(114)
	for $s_{min,1} \geq$	in.	8	7	8-1/2	7	8	4-1/4	5	7
		(mm)	(203)	(178)	(216)	(178)	(203)	(108)	(127)	(178)
Case 2	$c_{min,2}$	in.	8	6	7	4	8	4-1/4	9-1/2	6-1/2
		(mm)	(203)	(152)	(178)	(102)	(203)	(108)	(241)	(165)
	for $s_{min,2} \geq$	in.	8	3-1/2	5	4	5-1/2	4-1/4	5	4
		(mm)	(203)	(89)	(127)	(102)	(140)	(108)	(127)	(102)

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge distance c, where $c_{min1} < c < c_{min2}$ will determine the permissible spacings.

Table 6 — Load adjustment factors for 3/8-in. diameter Hilti KB1 in uncracked concrete [1,2]

3/8-in. KB1 uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear [4] f_{HV}	
									⊥ Toward edge f_{RV}		∥ To edge f_{RV}			
Embedment h_{ef} in (mm)			1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)
Embedment h_{nom} in (mm)			1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/2	(64)	n/a	n/a	n/a	0.52	n/a	n/a	n/a	0.35	n/a	0.52	n/a	n/a
	3-3/8	(86)	n/a	n/a	n/a	0.68	n/a	n/a	n/a	0.55	n/a	0.68	0.53	n/a
	3-1/2	(89)	n/a	0.79	n/a	0.70	n/a	0.62	n/a	0.59	n/a	0.70	0.54	n/a
	4	(102)	n/a	0.83	n/a	0.80	n/a	0.63	n/a	0.72	n/a	0.80	0.58	0.73
	5	(127)	n/a	0.92	n/a	1.00	n/a	0.67	n/a	1.00	n/a	1.00	0.65	0.82
	6	(152)	n/a	1.00	n/a	1.00	n/a	0.70	n/a	1.00	n/a	1.00	0.71	0.89
	7	(178)	n/a	1.00	n/a		n/a	0.73	n/a		n/a		0.76	0.97
	8	(203)	1.00		1.00		0.67	0.77	1.00		1.00		0.82	1.00
	9	(229)					0.69	0.80					0.87	
	10	(254)					0.71	0.83					0.91	
	11	(279)					0.73	0.87					0.96	
	12	(305)					0.75	0.90					1.00	
	> 14	(356)					0.79	0.97						

Table 7 — Load adjustment factors for 3/8-in. diameter Hilti KB1 in cracked concrete [1,2]

3/8-in. KB1 cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear [4] f_{HV}	
									⊥ Toward edge f_{RV}		∥ To edge f_{RV}			
Embedment h_{ef} in (mm)			1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)
Embedment h_{nom} in (mm)			1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/2	(64)	n/a	n/a	n/a	0.87	n/a	n/a	n/a	0.49	n/a	0.87	n/a	n/a
	3-3/8	(86)	n/a	n/a	n/a	1.00	n/a	n/a	n/a	0.77	n/a	1.00	0.85	n/a
	3-1/2	(89)	n/a	0.79	n/a	1.00	n/a	0.65	n/a	0.82	n/a	1.00	0.86	n/a
	4	(102)	n/a	0.83	n/a	1.00	n/a	0.67	n/a	1.00	n/a	1.00	0.92	0.82
	5	(127)	n/a	0.92	n/a	1.00	n/a	0.71	n/a	1.00	n/a	1.00	1.00	0.91
	6	(152)	n/a	1.00	n/a	1.00	n/a	0.75	n/a		n/a	1.00		1.00
	7	(178)	n/a	1.00	n/a		n/a	0.79	n/a		n/a			
	8	(203)	1.00		1.00		0.93	0.83	1.00		1.00			
	9	(229)					0.98	0.87						
	10	(254)					1.00	0.92						
	11	(279)						0.96						
	12	(305)						1.00						
	> 14	(356)												

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 8 — Load adjustment factors for 1/2-in. diameter Hilti KB1 in uncracked concrete [1,2]

1/2-in. KB1 uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear 3 f_{AV}		Edge distance in shear				Concrete thickness factor in shear 4 f_{HV}	
									⊥ Toward edge f_{RV}		∥ To edge f_{RV}			
Embedment h_{ef} in (mm)			2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)
Embedment h_{nom} in (mm)			2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-3/4	(70)	n/a	n/a	n/a	0.33	n/a	n/a	n/a	0.14	n/a	0.29	n/a	n/a
	3	(76)	n/a	n/a	n/a	0.35	n/a	n/a	n/a	0.16	n/a	0.33	n/a	n/a
	3-1/2	(89)	n/a	n/a	n/a	0.38	n/a	n/a	n/a	0.21	n/a	0.38	n/a	n/a
	4	(102)	n/a	0.71	0.67	0.42	n/a	0.57	0.54	0.25	0.67	0.42	0.67	n/a
	5	(127)	0.92	0.76	0.83	0.50	0.64	0.58	0.76	0.35	0.83	0.50	0.75	n/a
	6	(152)	1.00	0.81	1.00	0.60	0.67	0.60	1.00	0.46	1.00	0.60	0.82	0.63
	7	(178)	1.00	0.86	1.00	0.70	0.69	0.62	1.00	0.59	1.00	0.70	0.88	0.68
	8	(203)		0.91		0.80	0.72	0.63		0.72		0.80	0.94	0.73
	8-1/2	(216)		0.94		0.85	0.74	0.64		0.78		0.85	0.97	0.75
	9	(229)		0.96		0.90	0.75	0.65		0.85		0.90	1.00	0.77
	10	(254)		1.00		1.00	0.78	0.67		1.00		1.00		0.82
	11	(279)					0.81	0.68						0.86
	12	(305)					0.83	0.70						0.89
	14	(356)					0.89	0.73						0.97
	16	(406)					0.94	0.77						1.00
	18	(457)					1.00	0.80						
	20	(508)						0.83						
	> 24	(610)						0.90						

Table 9 — Load adjustment factors for 1/2-in. diameter Hilti KB1 in cracked concrete [1,2]

1/2-in. KB1 cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear 3 f_{AV}		Edge distance in shear				Concrete thickness factor in shear 4 f_{HV}	
									⊥ Toward edge f_{RV}		∥ To edge f_{RV}			
Embedment h_{ef} in (mm)			2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)
Embedment h_{nom} in (mm)			2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-3/4	(70)	n/a	n/a	n/a	0.68	n/a	n/a	n/a	0.16	n/a	0.33	n/a	n/a
	3	(76)	n/a	n/a	n/a	0.71	n/a	n/a	n/a	0.19	n/a	0.38	n/a	n/a
	3-1/2	(89)	n/a	n/a	n/a	0.79	n/a	n/a	n/a	0.24	n/a	0.47	n/a	n/a
	4	(102)	n/a	0.71	1.00	0.86	n/a	0.57	1.00	0.29	1.00	0.58	0.84	n/a
	5	(127)	0.92	0.76	1.00	1.00	0.72	0.59	1.00	0.40	1.00	0.81	0.94	n/a
	6	(152)	1.00	0.81	1.00		0.76	0.61	1.00	0.53	1.00	1.00	1.00	0.66
	7	(178)	1.00	0.86	1.00		0.81	0.63	1.00	0.67	1.00			0.71
	8	(203)	1.00	0.91			0.85	0.65		0.82				0.76
	8-1/2	(216)	1.00	0.94			0.87	0.65		0.90				0.79
	9	(229)		0.96			0.90	0.66		0.98				0.81
	10	(254)		1.00			0.94	0.68		1.00				0.85
	11	(279)					0.98	0.70						0.90
	12	(305)					1.00	0.72						0.94
	14	(356)						0.76						1.00
	16	(406)						0.79						
	18	(457)						0.83						
	20	(508)						0.86						
	> 24	(610)						0.94						

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1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 10 — Load adjustment factors for 5/8-in. diameter Hilti KB1 in uncracked concrete [1,2]

5/8-in. KB1 uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear [4] f_{HV}	
									⊥ Toward edge f_{RV}		∥ To edge f_{RV}			
Embedment h_{ef} in (mm)			2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)
Embedment h_{nom} in (mm)			3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	4-1/4	(108)	n/a	0.68	n/a	0.52	n/a	0.57	n/a	0.26	n/a	0.51	n/a	n/a
	5	(127)	n/a	0.71	n/a	0.58	n/a	0.58	n/a	0.33	n/a	0.58	0.55	n/a
	5-1/2	(140)	0.83	0.73	0.50	0.62	0.58	0.59	0.35	0.38	0.50	0.62	0.58	n/a
	6	(152)	0.86	0.75	0.55	0.67	0.59	0.59	0.40	0.43	0.55	0.67	0.60	0.62
	7	(178)	0.92	0.79	0.64	0.78	0.61	0.61	0.51	0.54	0.64	0.78	0.65	0.67
	8	(203)	0.98	0.83	0.73	0.89	0.62	0.63	0.62	0.66	0.73	0.89	0.70	0.71
	9	(229)	1.00	0.88	0.82	1.00	0.64	0.64	0.74	0.79	0.82	1.00	0.74	0.75
	10	(254)		0.92	0.91		0.65	0.66	0.87	0.92	0.91		0.78	0.80
	12	(305)		1.00	1.00		0.68	0.69	1.00	1.00	1.00		0.85	0.87
	14	(356)					0.71	0.72					0.92	0.94
	16	(406)					0.74	0.75					0.98	1.00
	18	(457)					0.77	0.78					1.00	
	20	(508)					0.80	0.82						
	24	(610)					0.86	0.88						
	> 30	(762)					0.95	0.97						

Table 11 — Load adjustment factors for 5/8-in. diameter Hilti KB1 in cracked concrete [1,2]

5/8-in. KB1 cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear [4] f_{HV}	
									⊥ Toward edge f_{RV}		∥ To edge f_{RV}			
Embedment h_{ef} in (mm)			2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)
Embedment h_{nom} in (mm)			3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	4-1/4	(108)	n/a	0.68	n/a	0.78	n/a	0.57	n/a	0.26	n/a	0.52	n/a	n/a
	5	(127)	n/a	0.71	n/a	0.87	n/a	0.58	n/a	0.33	n/a	0.66	0.66	n/a
	5-1/2	(140)	0.83	0.73	1.00	0.93	0.62	0.59	0.62	0.38	1.00	0.76	0.70	n/a
	6	(152)	0.86	0.75	1.00	1.00	0.63	0.60	0.71	0.43	1.00	0.87	0.73	0.62
	7	(178)	0.92	0.79	1.00		0.65	0.61	0.89	0.55	1.00	1.00	0.79	0.67
	8	(203)	0.98	0.83	1.00		0.68	0.63	1.00	0.67	1.00		0.84	0.71
	9	(229)	1.00	0.88			0.70	0.64		0.80			0.89	0.76
	10	(254)		0.92			0.72	0.66		0.93			0.94	0.80
	12	(305)		1.00			0.76	0.69		1.00			1.00	0.87
	14	(356)					0.81	0.72						0.94
	16	(406)					0.85	0.75						1.00
	18	(457)					0.90	0.79						
	20	(508)					0.94	0.82						
	24	(610)					1.00	0.88						
	> 30	(762)						0.98						

[1] Linear interpolation not permitted

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

[3] Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 12 — Load adjustment factors for 3/4-in. diameter Hilti KB1 in uncracked concrete [1,2]

3/4-in. KB1 uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear ⊥ Toward edge f_{RV}		Edge distance in shear ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Embedment h_{ef} in (mm)			3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)
Embedment h_{nom} in (mm)			4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	4	(102)	n/a	0.64	n/a	n/a	n/a	0.56	n/a	n/a	n/a	n/a	n/a	n/a
	4-1/2	(114)	n/a	0.66	n/a	0.47	n/a	0.56	n/a	0.24	n/a	0.47	n/a	n/a
	5	(127)	0.76	0.68	n/a	0.50	0.57	0.57	n/a	0.28	n/a	0.50	n/a	n/a
	5-1/2	(140)	0.78	0.69	n/a	0.53	0.58	0.58	n/a	0.32	n/a	0.53	0.55	n/a
	6-1/2	(165)	0.83	0.73	n/a	0.60	0.59	0.59	n/a	0.41	n/a	0.60	0.60	n/a
	7	(178)	0.86	0.75	n/a	0.64	0.60	0.60	n/a	0.46	n/a	0.64	0.62	n/a
	8	(203)	0.91	0.78	n/a	0.73	0.61	0.61	n/a	0.56	n/a	0.73	0.67	0.67
	9-1/2	(241)	0.99	0.83	0.79	0.86	0.63	0.63	0.70	0.72	0.79	0.86	0.73	0.73
	10	(254)	1.00	0.85	0.83	0.91	0.64	0.64	0.76	0.78	0.83	0.91	0.75	0.75
	12	(305)		0.92	1.00	1.00	0.67	0.67	1.00	1.00	1.00	1.00	0.82	0.82
	16	(406)		1.00			0.72	0.73					0.94	0.95
	20	(508)					0.78	0.78					1.00	1.00
	24	(610)					0.83	0.84						
	30	(762)					0.92	0.92						
	> 36	(914)					1.00	1.00						

Table 13 — Load adjustment factors for 3/4-in. diameter Hilti KB1 in cracked concrete [1,2]

3/4-in. KB1 cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear ⊥ Toward edge f_{RV}		Edge distance in shear ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Embedment h_{ef} in (mm)			3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)
Embedment h_{nom} in (mm)			4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	4	(102)	n/a	0.64	n/a	n/a	n/a	0.55	n/a	n/a	n/a	n/a	n/a	n/a
	4-1/2	(114)	n/a	0.66	n/a	0.73	n/a	0.56	n/a	0.19	n/a	0.39	n/a	n/a
	5	(127)	0.76	0.68	n/a	0.77	0.59	0.56	n/a	0.23	n/a	0.45	n/a	n/a
	5-1/2	(140)	0.78	0.69	n/a	0.83	0.59	0.57	n/a	0.26	n/a	0.52	0.61	n/a
	6-1/2	(165)	0.83	0.73	n/a	0.93	0.61	0.58	n/a	0.33	n/a	0.67	0.67	n/a
	7	(178)	0.86	0.75	n/a	0.99	0.62	0.59	n/a	0.37	n/a	0.75	0.69	n/a
	8	(203)	0.91	0.78	n/a	1.00	0.64	0.60	n/a	0.46	n/a	0.91	0.74	0.63
	9-1/2	(241)	0.99	0.83	1.00		0.66	0.62	0.97	0.59	1.00	1.00	0.81	0.69
	10	(254)	1.00	0.85			0.67	0.62	1.00	0.64			0.83	0.70
	12	(305)		0.92			0.71	0.65		0.84			0.91	0.77
	16	(406)		1.00			0.77	0.70		1.00			1.00	0.89
	20	(508)					0.84	0.75						0.99
	24	(610)					0.91	0.80						1.00
	30	(762)					1.00	0.87						
	> 36	(914)						0.94						

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 14 — Hilti KB1 design strength in the soffit of uncracked lightweight concrete over metal deck [1,2,3,4,5,6]

			Installation per Figure 3				Installation per Figure 4			
				Tension - ΦN_n		Shear - ΦV_n		Tension - ΦN_n		Shear - ΦV_n
Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Min. conc. thickness [10] in. (mm)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	$f'_c \geq$ 3,000 psi (20.7 MPa) lb (kN)	Min. conc. thickness [10] in. (mm)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	$f'_c \geq$ 3,000 psi (20.7 MPa) lb (kN)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	1,025 (4.6)	1,185 (5.3)	645 (2.9)	n/a	n/a	n/a	n/a
	2 (51)	2-3/8 (60)	2-1/2 (64)	1,600 (7.1)	1,850 (8.2)	1,435 (6.4)	2-1/2 (64)	1,265 (5.6)	1,460 (6.5)	1,815 (8.1)
1/2	2 (51)	2-3/8 (60)	2-1/2 (64)	1,495 (6.7)	1,725 (7.7)	1,480 (6.6)	2-1/2 (64)	1,355 (6.0)	1,565 (7.0)	2,015 (9.0)
	3-1/4 (83)	3-5/8 (92)	2-1/2 (64)	2,725 (12.1)	3,145 (14.0)	2,355 (10.5)	3-1/4 (83)	1,920 (8.5)	2,215 (9.9)	3,105 (13.8)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	2,410 (10.7)	2,785 (12.4)	2,275 (10.1)	3-1/4 (83)	1,505 (6.7)	1,740 (7.7)	2,595 (11.5)
	4 (102)	4-1/2 (114)	2-1/2 (64)	3,300 (14.7)	3,810 (16.9)	3,080 (13.7)	n/a	n/a	n/a	n/a
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	2,285 (10.2)	2,640 (11.7)	3,030 [9] (13.5) [9]	n/a	n/a	n/a	n/a

Table 15 — Hilti KB1 design strength in the soffit of cracked lightweight concrete over metal deck [1,2,3,4,5,6,7]

			Installation per Figure 3				Installation per Figure 4			
				Tension - ΦN_n		Shear - ΦV_n		Tension - ΦN_n		Shear - ΦV_n
Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Min. conc. thickness [10] in. (mm)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	$f'_c \geq$ 3,000 psi (20.7 MPa) lb (kN)	Min. conc. thickness [10] in. (mm)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	$f'_c \geq$ 3,000 psi (20.7 MPa) lb (kN)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	725 (3.2)	835 (3.7)	645 (2.9)	n/a	n/a	n/a	n/a
	2 (51)	2-3/8 (60)	2-1/2 (64)	1,210 (5.4)	1,395 (6.2)	1,435 (6.4)	2-1/2 (64)	955 (4.2)	1,105 (4.9)	1,815 (8.1)
1/2	2 (51)	2-3/8 (60)	2-1/2 (64)	1,060 (4.7)	1,225 (5.4)	1,480 (6.6)	2-1/2 (64)	960 (4.3)	1,110 (4.9)	2,015 (9.0)
	3-1/4 (83)	3-5/8 (92)	2-1/2 (64)	1,930 (8.6)	2,230 (9.9)	2,355 (10.5)	3-1/4 (83)	1,360 (6.0)	1,570 (7.0)	3,105 (13.8)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	1,930 (8.6)	2,230 (9.9)	2,275 (10.1)	3-1/4 (83)	1,205 (5.4)	1,390 (6.2)	2,595 (11.5)
	4 (102)	4-1/2 (114)	2-1/2 (64)	2,480 (11.0)	2,865 (12.7)	3,080 (13.7)	n/a	n/a	n/a	n/a
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	2,000 (8.9)	2,310 (10.3)	3,030 [8,9] (13.5) [8,9]	n/a	n/a	n/a	n/a

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are lightweight concrete and no additional reduction factor for lightweight concrete is needed.
5 Minimum edge distance is 3 x h_{ef} (effective embedment).
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.67. See PTG 19 Section 3.1.8 for additional information on seismic applications.
8 For the 3/4-inch diameter anchor, an additional factor for seismic shear, $\alpha_{N,seis}$ = 0.85, must be applied to the cracked concrete tabular values for seismic conditions. See Section 3.1.8 for additional information on seismic applications.
9 For the 3/4x12 KB1, multiply tabular value by 0.92.
10 Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 3 and 4.

Figure 3 — Installation in the soffit of concrete over metal deck floor and roof assemblies – W deck

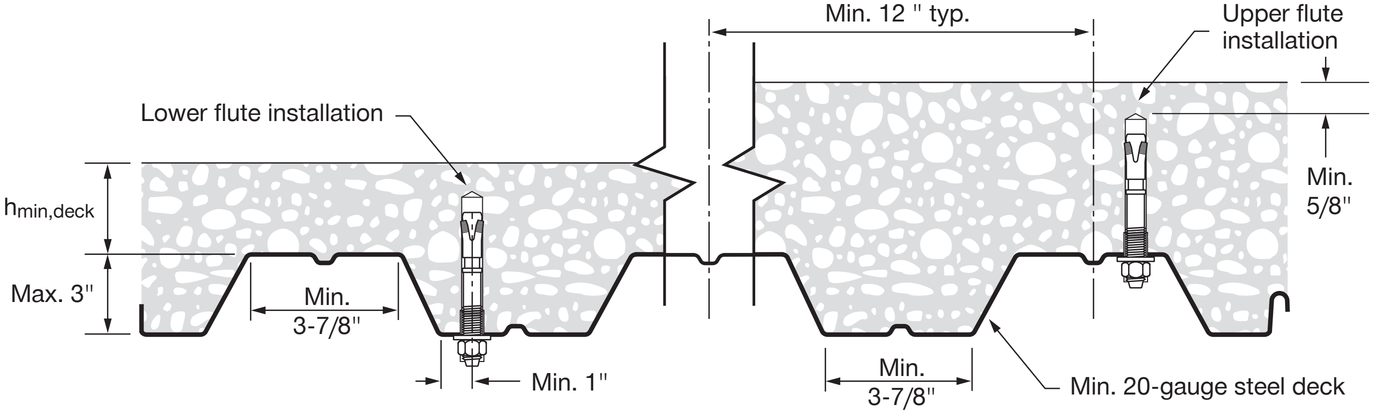
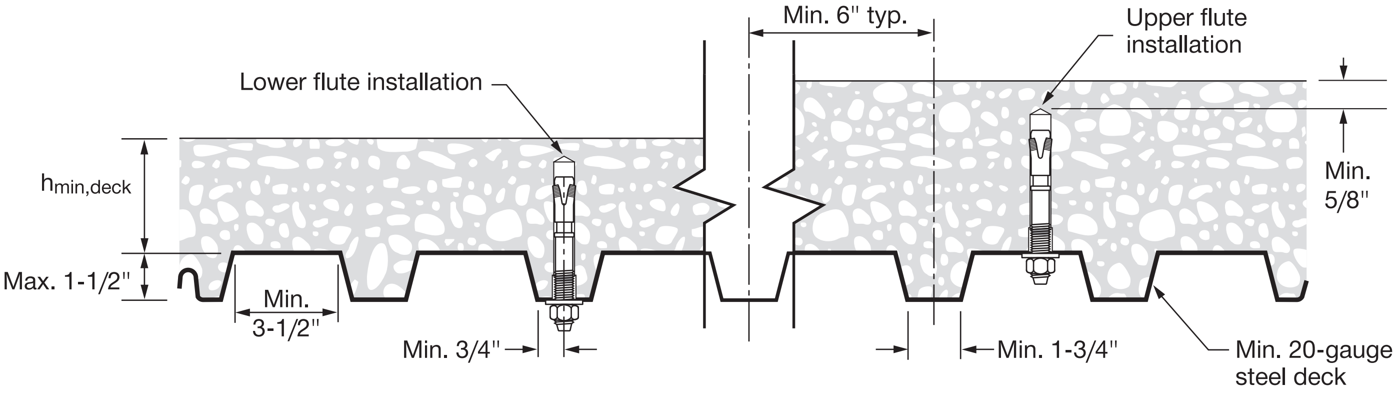


Figure 4 — Installation in the soffit of concrete over metal deck floor and roof assemblies – B deck



DESIGN DATA IN CONCRETE PER CSA A23.3

CSA A23.3 Annex D Design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. Table 19 in this section contains the Limit State Design tables that are based on the published loads in IAPMO Evaluation Report ER 678 and converted for use with CSA A23.3 Annex D. Tables 16 to 18 and Tables 21 and 22 below are Hilti Simplified Design Tables which are pre-factored resistance tables based on the design parameters and variables in Table 19. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363 4458 or at www.hilti.ca.

Table 16 — Hilti KB1 factored resistance based on concrete failure modes in uncracked concrete [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	1-1/2 (38)	1-7/8 (48)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
	2 (51)	2-1/2 (64)	2,125 (9.5)	2,200 (9.8)	2,265 (10.1)	2,375 (10.6)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)
1/2	2 (51)	2-1/2 (64)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)
	3-1/4 (83)	3-5/8 (92)	4,940 (22.0)	5,525 (24.6)	6,050 (26.9)	6,990 (31.1)	9,885 (44.0)	11,050 (49.2)	12,105 (53.8)	13,975 (62.2)
5/8	2-3/4 (70)	3-1/4 (83)	3,385 (15.1)	3,785 (16.8)	4,145 (18.4)	4,785 (21.3)	7,655 (34.0)	8,560 (38.1)	9,375 (41.7)	10,825 (48.2)
	4 (102)	4-1/2 (114)	6,330 (28.2)	7,075 (31.5)	7,750 (34.5)	8,950 (39.8)	13,465 (59.9)	15,055 (67.0)	16,490 (73.4)	19,040 (84.7)
3/4	3-1/4 (83)	4 (102)	4,940 (22.0)	5,525 (24.6)	6,050 (26.9)	6,990 (31.1)	9,885 (44.0)	11,050 (49.2)	12,105 (53.8)	13,975 (62.2)
	4-3/4 (121)	5-1/2 (140)	8,700 (38.7)	9,725 (43.3)	10,655 (47.4)	12,300 (54.7)	17,395 (77.4)	19,450 (86.5)	21,305 (94.8)	24,600 (109.4)

Table 17 — Hilti KB1 factored resistance based on concrete failure modes in cracked concrete [1,2,3,4,5]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	1-1/2 (38)	1-7/8 (48)	1,090 (4.9)	1,220 (5.4)	1,335 (5.9)	1,545 (6.9)	1,090 (4.9)	1,220 (5.4)	1,335 (5.9)	1,545 (6.9)
	2 (51)	2-1/2 (64)	1,680 (7.5)	1,880 (8.4)	2,060 (9.2)	2,375 (10.6)	1,680 (7.5)	1,880 (8.4)	2,060 (9.2)	2,375 (10.6)
1/2	2 (51)	2-1/2 (64)	1,690 (7.5)	1,890 (8.4)	2,070 (9.2)	2,390 (10.6)	1,690 (7.5)	1,890 (8.4)	2,070 (9.2)	2,390 (10.6)
	3-1/4 (83)	3-5/8 (92)	3,510 (15.6)	3,925 (17.4)	4,295 (19.1)	4,960 (22.1)	7,015 (31.2)	7,845 (34.9)	8,595 (38.2)	9,925 (44.1)
5/8	2-3/4 (70)	3-1/4 (83)	2,715 (12.1)	3,040 (13.5)	3,330 (14.8)	3,845 (17.1)	5,435 (24.2)	6,075 (27.0)	6,655 (29.6)	7,685 (34.2)
	4 (102)	4-1/2 (114)	4,780 (21.3)	5,345 (23.8)	5,855 (26.0)	6,760 (30.1)	9,560 (42.5)	10,690 (47.5)	11,710 (52.1)	13,520 (60.1)
3/4	3-1/4 (83)	4 (102)	3,495 (15.5)	3,905 (17.4)	4,280 (19.0)	4,945 (22.0)	8,695 (38.7)	9,725 (43.3)	10,650 (47.4)	12,300 (54.7)
	4-3/4 (121)	5-1/2 (140)	6,235 (27.7)	6,970 (31.0)	7,635 (34.0)	8,815 (39.2)	15,310 (68.1)	17,115 (76.1)	18,750 (83.4)	21,650 (96.3)

1 See PTG 19 Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 13 as necessary. Compare to the steel values in table 18. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.67. No reduction needed for seismic shear. See PTG 19 Section 3.1.8 for additional information on seismic applications

Table 18 — Steel resistance for Hilti KB1 carbon steel anchors[1,2]

Anchor diameter in.	Tensile [3] N_{sar} lb (kN)	Shear [4] V_{sar} lb (kN)	Seismic Shear [5] $V_{sar,eq}$ lb (kN)
3/8	4,315 (19.2)	1,620 (7.2)	1,620 (7.2)
1/2	7,385 (32.8)	3,330 (14.8)	3,330 (14.8)
5/8	11,670 (51.9)	5,675 (25.2)	5,675 (25.2)
3/4	16,520 (73.5)	6,865 (30.5)	5,835 (26.0)
3/4x12	14,455 (64.3)	5,950 (26.5)	5,055 (22.5)

1 See Section 3.1.8 to convert factored resistance value to ASD value.

2 Hilti KB1 anchors are to be considered ductile steel elements, with the exception of the 3/4x12 KB1 which is a brittle steel element.

3 Tensile N_{sar} = Ase,N ϕ_s f_{uta} R as noted in CSA A23.3 Annex D.

4 Shear determined by static shear tests with V_{sar} < 0.6 $_{Ase,V}$ ϕ_s f_{uta} R as noted in CSA A23.3 Annex D.

5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \leq 0.60\ A_{se,V}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D. See Section 3.1.8 for additional information on seismic applications.

3.3.9

Table 19 — Hilti KB1 carbon steel design information in concrete in accordance with CSA A23.3 Annex D [1]

Design parameter	Symbol	Units									Ref
			3/8		1/2		5/8		3/4		A23.3-04
Anchor O.D.	d_a	in. (mm)	0.375 (9.5)		0.5 (12.7)		0.625 (15.9)		0.75 (19.1)		
Effective min. embedment [2]	h_{ef}	in. (mm)	1-1/2 (38)	2 (51)	2 (51)	3-1/4 (83)	2-3/4 (70)	4 (102)	3-1/4 (83)	4-3/4 (121)	
Min. concrete thickness	h_{min}	in. (mm)	See Table 5								
Minimum edge distance	c_{min}	in. (mm)	See Table 5								
Minimum anchor spacing	s_{min}	in. (mm)	See Table 5								
Min. specified yield strength	f_{ya}	psi (N/mm²)	95,100 (656)		84,700 (584)		83,500 (576)		81,200 (560)		
Min. specified ult. strength	f_{ut}	psi (N/mm²)	118,900 (820)		105,900 (730)		104,400 (720)		101,500 (700)		
Effective tensile stress area	$A_{se,N}$	in² (mm²)	0.053 (34)		0.103 (66)		0.164 (106)		0.239 (154)		
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85		0.85		0.85		0.85		8.4.3
Resistance modification factor for tension, steel failure modes [3]	R	-	0.80		0.80		0.80		0.80 [4]		D.5.3
Resistance modification factor for shear, steel failure modes [3]	R	-	0.75		0.75		0.75		0.75 [4]		D.5.3
Factored steel resistance in tension	N_{sar}	lb (kN)	4,315 (19.2)		7,385 (32.8)		11,670 (51.9)		16,520 [4] (73.5)		D.6.1.2
Factored steel resistance in shear	V_{sar}	lb (kN)	1,620 (7.2)		3,330 (14.8)		5,675 (25.2)		6,865 [4] (30.5)		D.7.1.2
Factored steel resistance in shear, seismic	$V_{sar,eq}$	lb (kN)	1,620 (7.2)		3,330 (14.8)		5,675 (25.2)		5,835 [4] (26.0)		
Critical edge distance	c_{ac}	in. (mm)	8 (203)	5 (127)	6 (152)	10 (254)	11 (279)	9 (229)	12 (305)	11 (279)	
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10.0		10.0		10.0		10.0		D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	-	7.1		7.1		7.1		8.8		D.6.2.2
Modification factor for anchor resistance, tension, uncracked conc. [5]	$y_{c,N}$	-	1.0		1.0		1.0		1.0		D.6.2.6
Anchor category	-	-	1		1		1		1		D.5.3 (c)
Concrete material resistance factor	Φ_c	-	0.65		0.65		0.65		0.65		8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [6]	R	-	1.00		1.00		1.00		1.00		D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete [7]	$N_{pr,uncr}$	lb (kN)	n/a	2,190 (9.7)	n/a	n/a	3,390 (15.1)	6,335 (28.2)	n/a	n/a	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete [7]	$N_{pr,cr}$	lb (kN)	n/a	n/a	n/a	n/a	n/a	n/a	3,500 (15.6)	6,235 (27.7)	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete, seismic [7]	$N_{pr,eq}$	lb (kN)	n/a	n/a	n/a	3,335 (14.8)	n/a	n/a	3,500 (15.6)	5,605 (24.9)	D.6.3.2

1 Design information in this table is taken from IAPMO ER-678, dated December 1, 2020,Tables 4 and 5, and converted for use with CSA A23.3 Annex D.

2 See Figure 1 of this document.

3 The KB1 is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2, with the exception of the 3/4x12 KB1 which is considered a brittle steel element with R = 0.70 for steel failure in tension and R = 0.65 for steel failure in shear.

4 For the 3/4x12 KB1, R = 0.70 for steel failure in tension and R = 0.65 for steel failure in shear. Multiply factored steel resistance in tension, N_{sar}, by 0.875, and multiply factored steel resistance in shear, V_{sar}, and seismic shear, $V_{sar,eq}$, by 0.87.

5 For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

6 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

7 For all design cases, $\Psi_{c,P}$ = 1.0. Tabular value for pullout strength is for a concrete compressive strength of 2,900 psi (20.0 MPa). Pullout strength for concrete compressive strength greater than 2,900 psi (20.2 MPa) may be increased by multiplying the tabular pullout strength by $(f'_c / 2,900)n$ for psi, or $(f'_c / 20.2)n$ for MPa, where n is as follows:
3/8-in. diameter: n = 0.16
1/2-in. diameter: n = 0.23
5/8-in and 3/4-in diameter: n = 0.50
NA (not applicable) denotes that pullout strength does not need to be considered for design.

Table 20 — Hilti KB1 factored resistance in the soffit of uncracked lightweight concrete over metal deck [1,2,3,4,5,6]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Installation per Figure 3				Installation per Figure 4			
			Min. conc. thickness [10] in. (mm)	Tension - N_r		Shear - V_r	Min. conc. thickness [10] in. (mm)	Tension - N_r		Shear - V_r
				f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)"	f'_c ≥ 20 MPa (2,900 psi) lb (kN)		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)"	f'_c ≥ 20 MPa (2,900 psi) lb (kN)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	860 (3.8)	1,000 (4.4)	635 (2.8)	n/a	n/a	n/a	n/a
	2 (51)	2-3/8 (60)	2-1/2 (64)	1,580 (7.0)	1,845 (8.2)	1,405 (6.2)	2-1/2 (64)	1,250 (5.6)	2,130 (9.5)	1,815 (8.1)
1/2	2 (51)	2-3/8 (60)	2-1/2 (64)	1,485 (6.6)	1,630 (7.3)	1,455 (6.5)	2-1/2 (64)	1,345 (6.0)	1,830 (8.1)	1,650 (7.3)
	3-1/4 (83)	3-5/8 (92)	2-1/2 (64)	2,705 (12.0)	2,970 (13.2)	2,310 (10.3)	3-1/4 (83)	1,905 (8.5)	2,795 (12.4)	2,515 (11.2)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	2,370 (10.5)	2,905 (12.9)	2,230 (9.9)	3-1/4 (83)	1,480 (6.6)	3,685 (16.4)	3,000 (13.3)
	4 (102)	4-1/2 (114)	2-1/2 (64)	3,245 (14.4)	3,970 (17.7)	3,020 (13.4)	n/a	n/a	n/a	n/a
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	2,245 (10.0)	2,750 (12.2)	2,970 [9] (13.2) [9]	n/a	n/a	n/a	n/a

Table 21 — Hilti KB1 carbon steel factored resistance in the soffit of cracked lightweight concrete over metal deck [1,2,3,4,5,6,7]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Installation per Figure 3				Installation per Figure 4			
			Min. conc. thickness [10] in. (mm)	Tension - N_r		Shear - V_r	Min. conc. thickness [10] in. (mm)	Tension - N_r		Shear - V_r
				f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)"	f'_c ≥ 20 MPa (2,900 psi) lb (kN)		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)"	f'_c ≥ 20 MPa (2,900 psi) lb (kN)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	610 (2.7)	710 (3.2)	635 (2.8)	n/a	n/a	n/a	n/a
	2 (51)	2-3/8 (60)	2-1/2 (64)	1,195 (5.3)	1,390 (6.2)	1,405 (6.2)	2-1/2 (64)	945 (4.2)	1,100 (4.9)	1,780 (7.9)
1/2	2 (51)	2-3/8 (60)	2-1/2 (64)	1,050 (4.7)	1,155 (5.1)	1,455 (6.5)	2-1/2 (64)	950 (4.2)	1,045 (4.6)	1,975 (8.8)
	3-1/4 (83)	3-5/8 (92)	2-1/2 (64)	1,915 (8.5)	2,105 (9.4)	2,310 (10.3)	3-1/4 (83)	1,350 (6.0)	1,480 (6.6)	3,045 (13.5)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	1,900 (8.5)	2,325 (10.3)	2,230 (9.9)	3-1/4 (83)	1,185 (5.3)	1,450 (6.4)	2,545 (11.3)
	4 (102)	4-1/2 (114)	2-1/2 (64)	2,440 (10.9)	2,985 (13.3)	3,020 (13.4)	n/a	n/a	n/a	n/a
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	1,965 (8.7)	2,405 (10.7)	2,970 [8,9] (13.2) [8,9]	n/a	n/a	n/a	n/a

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are lightweight concrete and no additional reduction factor for lightweight concrete is needed.
5 Minimum edge distance is 3 x h_{ef} (effective embedment).
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.67. See Section 3.1.8 for additional information on seismic applications.
8 For the 3/4-inch diameter anchor, an additional factor for seismic shear, $\alpha_{V,seis}$ = 0.85, must be applied to the cracked concrete tabular values for seismic conditions. See Section 3.1.8 for additional information on seismic applications.
9 For the 3/4x12 KB1, multiply tabular value by 0.92.
10 Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 3 and 4.

DESIGN DATA IN GROUT-FILLED CMU

The following design information is the allowable load tables for use in grout-filled CMU block walls that are based on the published loads in IAPMO Evaluation Report ER 677. This data is applicable for both the US and Canada.

Table 22 — Allowable tensile loads for Hilti KB1 in the face of grout-filled concrete masonry unit (CMU) walls [1,3,4,5,6]

					Spacing					Edge Distance				
Nominal anchor diameter	Nominal embedment		Allowable tension capacity at s_{cr} and c_{cr}		Critical spacing, s_{cr}		Minimum spacing, s_{min}[2]		Load reduction factor at s_{min}	Critical edge distance, c_{cr}		Minimum edge distance, c_{min}		Load reduction factor at c_{min}
in.	in.	(mm)	lb	(kN)	in	(mm)	in	(mm)		in	(mm)	in	(mm)	
3/8	2-3/8	(60)	350	(1.6)	8	(203)	3	(76)	0.56	12	(305)	4	(102)	0.87
1/2	2-3/8	(60)	615	(2.7)	8	(203)	4	(102)	0.54					0.88
	3-5/8	(92)	1,055	(4.7)	13	(330)			0.48					0.94
5/8	3-1/4	(83)	965	(4.3)	11	(279)	5	(127)	0.62					0.86
	4-1/2	(114)	1,140	(5.1)	16	(406)			0.76					1.00
3/4	4	(102)	1,085	(4.8)	13	(330)	6	(152)	0.55					0.84
	5-1/2	(140)	1,130	(5.0)	19	(483)			0.69					0.75

Table 23 — Allowable shear loads for Hilti KB1 in the face of grout-filled concrete masonry unit (CMU) walls [1,3,4,5,6]

					Spacing					Edge Distance					
Nominal anchor diameter	Nominal embedment		Allowable shear capacity at s_{cr} and c_{cr}		Critical spacing, s_{cr}		Minimum spacing, s_{min}[2]		Load reduction factor at s_{min}	Critical edge distance, c_{cr}		Minimum edge distance, c_{min}		Perpendicular load reduction factor at c_{min}	Parallel load reduction factor at c_{min}
in.	in.	(mm)	lb	(kN)	in	(mm)	in	(mm)		in	(mm)	in	(mm)		
3/8	2-3/8	(60)	575	(2.6)	8	(203)	3	(76)	0.84	12	(305)	4	(102)	0.94	0.94
1/2	2-3/8	(60)	960	(4.3)	8	(203)	4	(102)						0.72	1.00
	3-5/8	(92)													
5/8	3-1/4	(83)	1,370	(6.1)	11	(279)	5	(127)						0.64	0.83
	4-1/2	(114)													
3/4	4	(102)	1,370	(6.1)	13	(330)	6	(152)						0.64	0.83
	5-1/2	(140)													

1 Values valid for anchors installed in face shells of Type 1, Grade N, lightweight, medium-weight, or normal-weight concrete masonry units conforming to ASTM C90. The masonry units must be fully grouted with coarse grout conforming to the 2018 and 2015 IBC Section 2103.3, or 2012 IBC Section 2103.13. Mortar must comply with 2018 and 2015 IBC Section 2103.2, or 2012 IBC Section 2103.9. Masonry compressive strength must be at least 1,500 psi at the time of anchor installation.

2 Loads tabulated are applicable to anchors spaced a critical distance of 4 times the embedment depth. The anchors may be placed at a minimum spacing, s_{min}, provided that reductions are applied to the tabulated values.

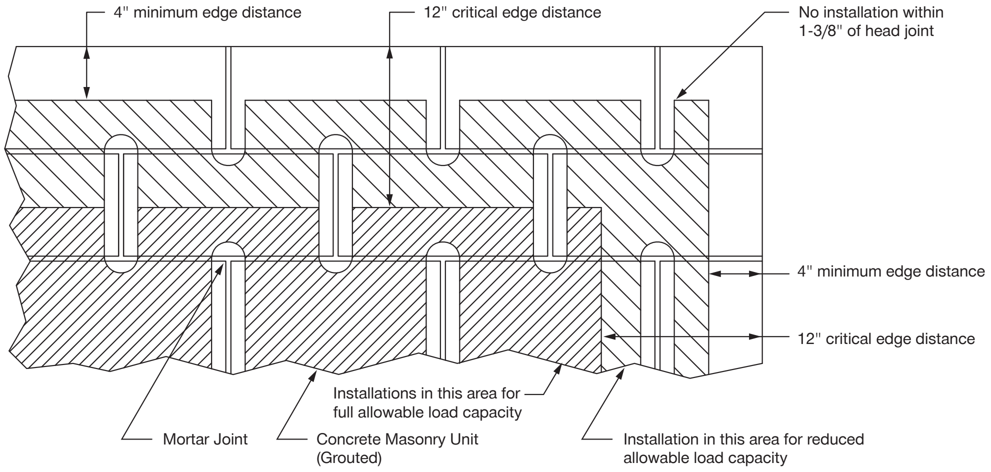
3 Anchors must be installed a minimum of 1-3/8 inches from any vertical mortar joint (head joint) in accordance with Figure 5.

4 Embedment depth must be measured from the outside face of the concrete masonry unit.

5 For intermediate edge distances and spacings, allowable loads may be determined by linearly interpolating between the allowable loads at the two tabulated edge distances.

6 The tabulated allowable loads have calculated based on a safety factor of 5.0

Figure 5 — Acceptable locations (shaded areas) for Hilti KB1 anchors in the face of grout-filled concrete masonry unit (CMU) walls



Anchor installation is restricted to shaded areas

INSTALLATION INSTRUCTIONS

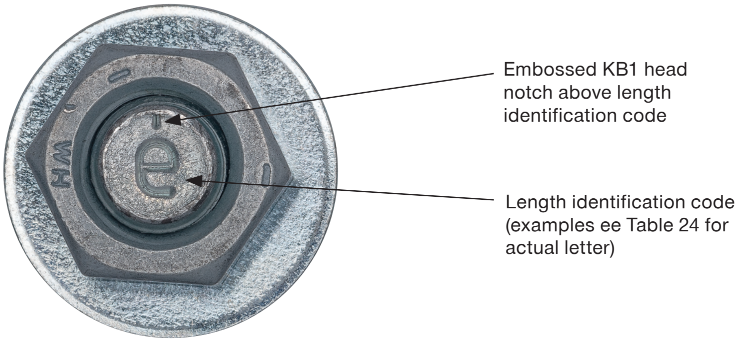
Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION

Table 24 — Hilti KB1 product portfolio

Description	Length (in)	Length ident. letter	Thread length (in)	Nominal embed. 1 (in)	Min. fixture thickness 1 (in)	Max. fixture thickness 1 (in)	Nominal embed. 2 (in)	Min. fixture thickness 2 (in)	Max. fixture thickness 2 (in)	Packaging quantity
KB1 3/8x2 1/2	2-1/2	c	1	1-7/8	0	1/4	-	-	-	50
KB1 3/8x3	3	d	1-5/8	1-7/8	0	3/4	2-3/8	0	1/4	50
KB1 3/8x3 3/4	3-3/4	e	2-3/8	1-7/8	0	1-1/2	2-3/8	0	1	50
KB1 3/8x5	5	h	3-5/8	1-7/8	0	2-3/4	2-3/8	0	2-1/4	50
KB1 1/2x3	3	d	1-1/8	2-3/8	0	1/16	-	-	-	20
KB1 1/2x3 3/4	3-3/4	e	2	2-3/8	0	3/4	-	-	-	20
KB1 1/2x4 1/2	4-1/2	g	2-5/8	2-3/8	0	1-1/2	3-5/8	0	1/4	20
KB1 1/2x5 1/2	5-1/2	i	3-5/8	2-3/8	0	2-1/2	3-5/8	0	1-1/4	20
KB1 1/2x7	7	l	4-1/2	2-3/8	1/2	4	3-5/8	0	2-3/4	20
KB1 5/8x4 1/4	4-1/4	f	2-1/4	3-1/4	0	3/8	-	-	-	15
KB1 5/8x4 3/4	4-3/4	g	2-3/4	3-1/4	0	7/8	-	-	-	15
KB1 5/8x6	6	j	4	3-1/4	0	2-1/8	4-1/2	0	7/8	15
KB1 5/8x7	7	l	5	3-1/4	0	3-1/8	4-1/2	0	1-7/8	15
KB1 5/8x8 1/2	8-1/2	o	6-1/2	3-1/4	0	4-5/8	4-1/2	0	3-3/8	15
KB1 3/4x4 3/4	4-3/4	g	2-1/2	4	0	1/8	-	-	-	10
KB1 3/4x5 1/2	5-1/2	i	3-1/4	4	0	7/8	-	-	-	10
KB1 3/4x7	7	l	4	4	0	2-3/8	5-1/2	0	7/8	10
KB1 3/4x8	8	n	5	4	0	3-3/8	5-1/2	0	1-7/8	10
KB1 3/4x10	10	r	7	4	0	5-3/8	5-1/2	0	3-7/8	10
KB1 3/4x12	12	t	6	4	2-5/8	7-3/8	5-1/2	1-1/8	5-7/8	10

Figure 6 — Bolt head with length identification mark and KB1 head notch embossment

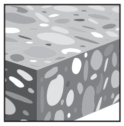


3.3.10 KWIK HUS CARBON STEEL SCREW ANCHOR

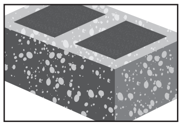
PRODUCT DESCRIPTION

KWIK HUS (KH) Carbon Steel Screw Anchor

Anchor System	Features and Benefits
Carbon Steel KH 	- Quick and easy to install. - Length and diameter identification clearly stamped on head facilitates quality control and inspection after installation. - Through fixture installation improves productivity and accurate installation. - Thread design enables quality setting and exceptional load values in wide variety of base material strengths. - Anchor is fully removable - Anchor size is same as drill bit size and uses standard diameter drill bits. - Suitable for reduced edge distances and spacing. - Suitable for uncracked normal-weight concrete, lightweight concrete



Uncracked
concrete



Grout-filled
concrete masonry

MATERIAL SPECIFICATIONS

Hilti KWIK HUS anchors are manufactured from carbon steel. The anchors are dull zinc plated to a minimum thickness of 8 µm.

INSTALLATION PARAMETERS

Figure 1 — Hilti KWIK HUS anchor installation details

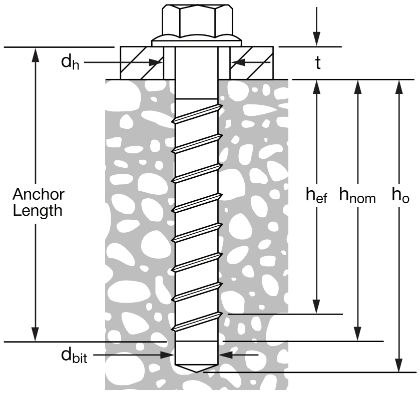


Table 1 — Hilti KWIK HUS specifications

Setting information	Symbol	Units	Nominal anchor diameter									
			3/8			1/2			5/8		3/4	
Nominal bit diameter	d_{bit}	in.	3/8			1/2			5/8		3/4	
Fixture hole diameter	d_h	in.	1/2			5/8			3/4		7/8	
Installation torque[1]	T_{inst}	ft-lb	40			45			85		95	
Maximum impact wrench torque rating[2]	$T_{impact,max}$	ft-lb	114	450		137	450		450		450	
Nominal embedment	h_{nom}	in.	1-5/8	2-1/2	3-1/4	2-1/4	3	4-1/4	3-1/4	5	4	6-1/4
Effective embedment	h_{ef}	in.	1.11	1.86	2.20	1.52	2.16	3.22	2.39	3.88	2.92	4.84
Minimum hole depth	h_o	in.	1-7/8	2-3/4	3-1/2	2-5/8	3-3/8	4-5/8	3-5/8	5-3/8	4-3/8	6-5/8
Critical edge distance	c_{ac}	in.	2.50	3.12	3.74	2.75	3.70	5.25	3.63	5.81	4.41	7.28
Minimum spacing at critical edge distance	$s_{min,cac}$	in.	2.25			3					4	
Minimum edge distance	c_{min}	in.	1.50			1.75						
Minimum spacing at minimum edge distance	s_{min}	in.	3								4	
Minimum concrete thickness	h_{min}	in.	3-1/4	4	4-7/8	3-3/4	4-3/4	6-3/4	5	7	6	8-1/8
Wrench size	-	in.	9/16			3/4			15/16		1-1/8	
Effective tensile stress area	A_{se}	in^2	0.086			0.161			0.268		0.392	
Minimum specified ultimate strength	f_{uta}	psi	107,120			97,140			90,180		81,600	

[1] T_{inst} applies to installations using a calibrated torque wrench.

[2] Because of variability in measurement procedures, the published torque of an impact tool may not correlate properly with the above setting torques. Over-torquing can damage the anchor and/or reduce its holding capacity.

DESIGN INFORMATION IN CONCRETE PER ACI 318

ACI 318 Chapter 17 design

The technical data contained in this section are Hilti Simplified Design Tables. The load values were developed using the Strength Design equations of ACI 318 Chapter 17. KWIK HUS anchor were tested and the test results were evaluated in accordance with ACI 355.2 and AC193. An ICC-ES evaluation report was not published with this information. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8.

Table 2 — Hilti KWIK HUS design strength with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter	Nominal embed. in. (mm)	Tension - ϕN_n				Shear - ϕV_n			
		f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
3/8	1-5/8	910	1,000	1,155	1,415	980	1,075	1,245	1,520
	(41)	(4.0)	(4.4)	(5.1)	(6.3)	(4.4)	(4.8)	(5.5)	(6.8)
	2-1/2	1,980	2,165	2,505	3,065	2,130	2,335	2,695	3,300
	(64)	(8.8)	(9.6)	(11.1)	(13.6)	(9.5)	(10.4)	(12.0)	(14.7)
	3-1/4	2,545	2,790	3,220	3,945	2,740	3,005	3,465	4,245
	(83)	(11.3)	(12.4)	(14.3)	(17.5)	(12.2)	(13.4)	(15.4)	(18.9)
1/2	2-1/4	1,460	1,600	1,850	2,265	1,575	1,725	1,990	2,440
	(57)	(6.5)	(7.1)	(8.2)	(10.1)	(7.0)	(7.7)	(8.9)	(10.9)
	3	2,475	2,710	3,130	3,835	2,665	2,920	3,375	4,130
	(76)	(11.0)	(12.1)	(13.9)	(17.1)	(11.9)	(13.0)	(15.0)	(18.4)
	4-1/4	4,505	4,935	5,700	6,980	9,705	10,635	12,280	15,040
	(108)	(20.0)	(22.0)	(25.4)	(31.0)	(43.2)	(47.3)	(54.6)	(66.9)
5/8	3-1/4	3,240	3,550	4,100	5,025	3,490	3,825	4,415	5,410
	(83)	(14.4)	(15.8)	(18.2)	(22.4)	(15.5)	(17.0)	(19.6)	(24.1)
	5	6,705	7,345	8,485	10,390	14,445	15,825	18,270	22,380
	(127)	(29.8)	(32.7)	(37.7)	(46.2)	(64.3)	(70.4)	(81.3)	(99.6)
3/4	4	4,380	4,795	5,540	6,785	9,430	10,330	11,930	14,610
	(102)	(19.5)	(21.3)	(24.6)	(30.2)	(41.9)	(45.9)	(53.1)	(65.0)
	6-1/4	9,345	10,235	11,820	14,475	20,125	22,045	25,455	31,175
	(159)	(41.6)	(45.5)	(52.6)	(64.4)	(89.5)	(98.1)	(113.2)	(138.7)

1 See section 3.1.8 to convert design strength value to ASD value.

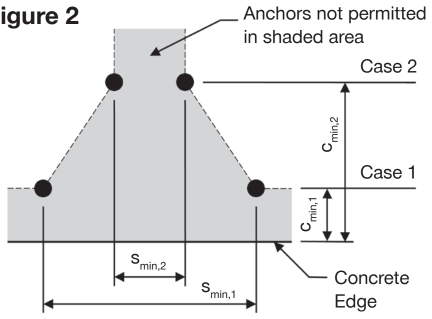
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 4 to 7 as necessary. Compare to steel values in table 3. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Figure 2



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}\,(c - c_{min,2})$$

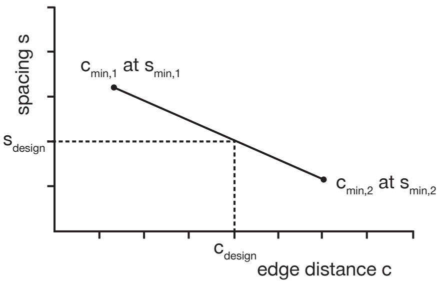


Table 3 — Steel design strength for Hilti KWIK HUS anchors[1,2]

Nominal anchor diameter	Hilti KWIK HUS anchors Tensile[1,3] ϕN_{sa} lb (kN)	 Shear[2,4] ϕV_{sa} lb (kN)
3/8	5,990 (26.6)	3,095 (13.8)
1/2	10,165 (45.2)	4,910 (21.8)
5/8	15,735 (70.0)	6,735 (30.0)
3/4	20,810 (92.6)	9,995 (44.5)

1 See section 3.1.8 to convert design strength value to ASD value.

2 Hilti KWIK HUS anchors are to be considered brittle steel elements.

3 Tensile = $\phi N_{sa} = \phi_s A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17

4 Shear values determined by static shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.

Table 4 — Load adjustment factors for 3/8-in. diameter Hilti KWIK HUS in uncracked concrete[1,2]

3/8-in. KH uncracked concrete		Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Conc. thickness factor in shear[4] f_{HV}		
											⊥ toward edge f_{RV}			II to and away from edge f_{RV}					
Embedment h_{nom}	in. (mm)	1-5/8 (41)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/2 (64)	3-1/4 (83)	1-5/8 (41)	2-1/2 (64)	3-1/4 (83)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-1/2 (38)	n/a	n/a	n/a	0.61	0.59	0.54	n/a	n/a	n/a	0.49	0.25	0.20	0.61	0.50	0.40	n/a	n/a	n/a
	2 (51)	n/a	n/a	n/a	0.80	0.70	0.62	n/a	n/a	n/a	0.75	0.38	0.31	0.80	0.70	0.62	n/a	n/a	n/a
	2-1/4 (57)	0.84	0.70	0.67	0.90	0.76	0.67	0.65	0.60	0.59	0.90	0.46	0.37	0.90	0.76	0.67	n/a	n/a	n/a
	2-1/2 (64)	0.88	0.72	0.69	1.00	0.82	0.72	0.67	0.61	0.60	1.00	0.54	0.43	1.00	0.82	0.72	n/a	n/a	n/a
	3 (76)	0.95	0.77	0.73		0.96	0.82	0.71	0.63	0.61		0.71	0.57		0.96	0.82	n/a	n/a	n/a
	3-1/4 (83)	0.99	0.79	0.75		1.00	0.87	0.72	0.64	0.62		0.80	0.64		1.00	0.87	0.95	n/a	n/a
	3-1/2 (89)	1.00	0.81	0.77			0.94	0.74	0.65	0.63		0.89	0.71			0.94	0.98	n/a	n/a
	4 (102)		0.86	0.80			1.00	0.78	0.68	0.65		1.00	0.87			1.00	1.00	0.84	n/a
	4-1/2 (114)		0.90	0.84				0.81	0.70	0.67			1.00					0.89	n/a
	4-7/8 (124)		0.94	0.87				0.84	0.71	0.69								0.93	0.86
	5 (127)		0.95	0.88				0.84	0.72	0.69								0.94	0.87
	6 (152)		1.00	0.95				0.91	0.76	0.73								1.00	0.96
	7 (178)			1.00				0.98	0.81	0.77									1.00
	8 (203)							1.00	0.85	0.80									
	9 (229)								0.90	0.84									
	10 (254)								0.94	0.88									
	11 (279)								0.98	0.92									
	12 (305)								1.00	0.96									
	14 (356)									1.00									
	16 (406)																		
	18 (457)																		
	20 (508)																		
	24 (610)																		

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 1 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 5 — Load adjustment factors for 1/2-in. diameter Hilti KWIK HUS in uncracked concrete[1,2]

1/2-in. KH uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear[3] f_{AV}			Edge distance in shear						Conc. thickness factor in shear[4] f_{HV}		
												⊥ toward edge f_{RV}			II to and away from edge f_{RV}					
Embedment h_{nom}	in.	(mm)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)	2-1/4 (57)	3 (76)	4-1/4 (108)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	n/a	0.68	0.58	0.51	n/a	n/a	n/a	0.45	0.28	0.08	0.68	0.56	0.17	n/a	n/a	n/a
	2	(51)	n/a	n/a	n/a	0.75	0.63	0.54	n/a	n/a	n/a	0.54	0.34	0.10	0.75	0.63	0.21	n/a	n/a	n/a
	2-1/2	(64)	n/a	n/a	n/a	0.91	0.72	0.60	n/a	n/a	n/a	0.76	0.48	0.14	0.91	0.72	0.29	n/a	n/a	n/a
	3	(76)	0.83	0.73	0.66	1.00	0.82	0.66	0.67	0.62	0.55	1.00	0.63	0.19	1.00	0.82	0.38	n/a	n/a	n/a
	3-1/2	(89)	0.88	0.77	0.68		0.95	0.73	0.69	0.64	0.56		0.80	0.24		0.95	0.47	n/a	n/a	n/a
	3-3/4	(95)	0.91	0.79	0.69		1.00	0.76	0.71	0.65	0.57		0.89	0.26		1.00	0.53	0.91	n/a	n/a
	4	(102)	0.94	0.81	0.71			0.80	0.72	0.66	0.57		0.98	0.29			0.58	0.94	n/a	n/a
	4-1/2	(114)	0.99	0.85	0.73			0.87	0.75	0.68	0.58		1.00	0.35			0.69	1.00	n/a	n/a
	4-3/4	(121)	1.00	0.87	0.75			0.91	0.76	0.69	0.59			0.38			0.75		0.88	n/a
	5	(127)		0.89	0.76			0.95	0.78	0.70	0.59			0.41			0.81		0.91	n/a
	6	(152)		0.96	0.81			1.00	0.83	0.75	0.61			0.53			1.00		0.99	n/a
	6-3/4	(171)		1.00	0.85				0.87	0.78	0.62			0.64					1.00	0.70
	7	(178)			0.86				0.89	0.79	0.63			0.67						0.72
	8	(203)			0.91				0.94	0.83	0.65			0.82						0.76
	9	(229)			0.97				1.00	0.87	0.66			0.98						0.81
	10	(254)			1.00					0.91	0.68			1.00						0.85
	11	(279)								0.95	0.70									0.90
	12	(305)								0.99	0.72									0.94
	14	(356)								1.00	0.76									1.00
	16	(406)									0.79									
	18	(457)									0.83									
	20	(508)									0.87									
	> 24	(610)									0.94									

Table 6 — Load Adjustment Factors for 5/8-in. Diameter Hilti KWIK HUS in uncracked concrete[1,2]

5/8-in. KH uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Embedment h_{nom}	in.	(mm)	3-1/4 (83)	5 (127)	3-1/4 (83)	5 (127)	3-1/4 (83)	5 (127)	3-1/4 (83)	5 (127)	3-1/4 (83)	5 (127)	3-1/4 (83)	5 (127)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	0.62	0.51	n/a	n/a	0.24	0.06	0.47	0.13	n/a	n/a
	2	(51)	n/a	n/a	0.67	0.54	n/a	n/a	0.29	0.08	0.57	0.15	n/a	n/a
	2-1/2	(64)	n/a	n/a	0.76	0.59	n/a	n/a	0.40	0.11	0.76	0.21	n/a	n/a
	3	(76)	0.71	0.63	0.86	0.65	0.61	0.55	0.53	0.14	0.86	0.28	n/a	n/a
	3-1/2	(89)	0.74	0.65	0.97	0.70	0.63	0.55	0.66	0.18	0.97	0.35	n/a	n/a
	4	(102)	0.78	0.67	1.00	0.76	0.65	0.56	0.81	0.22	1.00	0.43	n/a	n/a
	4-1/2	(114)	0.81	0.69		0.83	0.66	0.57	0.97	0.26		0.52	n/a	n/a
	5	(127)	0.85	0.71		0.89	0.68	0.58	1.00	0.30		0.60	0.85	n/a
	5-1/2	(140)	0.88	0.74		0.96	0.70	0.58		0.35		0.70	0.89	n/a
	6	(152)	0.92	0.76		1.00	0.72	0.59		0.40		0.80	0.93	n/a
	7	(178)	0.99	0.80			0.75	0.61		0.50		1.00	1.00	0.65
	8	(203)	1.00	0.84			0.79	0.62		0.61				0.69
	9	(229)		0.89			0.83	0.64		0.73				0.74
	10	(254)		0.93			0.86	0.65		0.86				0.78
	11	(279)		0.97			0.90	0.67		0.99				0.81
	12	(305)		1.00			0.94	0.68		1.00				0.85
	14	(356)					1.00	0.71						0.92
	16	(406)						0.74						0.98
	18	(457)						0.77						1.00
	20	(508)						0.80						
	24	(610)						0.86						
	> 30	(762)						0.95						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 1 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 7 — Load adjustment factors for 3/4-in. diameter Hilti KWIK HUS in uncracked concrete[1,2]

3/4-in. KH uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Embedment h_{nom}		in.	4	6-1/4	4	6-1/4	4	6-1/4	4	6-1/4	4	6-1/4	4	6-1/4
		(mm)	(102)	(159)	(102)	(159)	(102)	(159)	(102)	(159)	(102)	(159)	(102)	(159)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-3/4	(44)	n/a	n/a	0.57	0.48	n/a	n/a	0.10	0.05	0.19	0.10	n/a	n/a
	2	(51)	n/a	n/a	0.61	0.50	n/a	n/a	0.12	0.06	0.23	0.12	n/a	n/a
	2-1/2	(64)	n/a	n/a	0.68	0.54	n/a	n/a	0.16	0.08	0.33	0.17	n/a	n/a
	3	(76)	n/a	n/a	0.76	0.58	n/a	n/a	0.21	0.11	0.43	0.22	n/a	n/a
	3-1/2	(89)	n/a	n/a	0.84	0.62	n/a	n/a	0.27	0.14	0.54	0.28	n/a	n/a
	4	(102)	0.73	0.64	0.93	0.67	0.58	0.55	0.33	0.17	0.66	0.34	n/a	n/a
	4-1/2	(114)	0.76	0.65	1.00	0.72	0.59	0.56	0.39	0.20	0.79	0.41	n/a	n/a
	5	(127)	0.79	0.67		0.76	0.60	0.56	0.46	0.24	0.92	0.48	n/a	n/a
	5-1/2	(140)	0.81	0.69		0.81	0.61	0.57	0.53	0.28	1.00	0.55	n/a	n/a
	6	(152)	0.84	0.71		0.86	0.62	0.58	0.61	0.31		0.63	0.69	n/a
	7	(178)	0.90	0.74		0.97	0.64	0.59	0.77	0.40		0.79	0.75	n/a
	8	(203)	0.96	0.78		1.00	0.66	0.60	0.94	0.48		0.97	0.80	n/a
	8-1/8	(206)	0.96	0.78			0.66	0.60	0.96	0.50		0.99	0.80	0.65
	9	(229)	1.00	0.81			0.68	0.62	1.00	0.58		1.00	0.85	0.68
	10	(254)		0.84			0.70	0.63		0.68			0.89	0.72
	11	(279)		0.88			0.72	0.64		0.78			0.94	0.75
	12	(305)		0.91			0.74	0.65		0.89			0.98	0.79
	14	(356)		0.98			0.78	0.68		1.00			1.00	0.85
	16	(406)		1.00			0.82	0.71						0.91
	18	(457)					0.86	0.73						0.96
	20	(508)					0.90	0.76						1.00
	24	(610)					0.98	0.81						
	30	(762)					1.00	0.89						
	> 36	(914)						0.96						

[1] Linear interpolation not permitted.

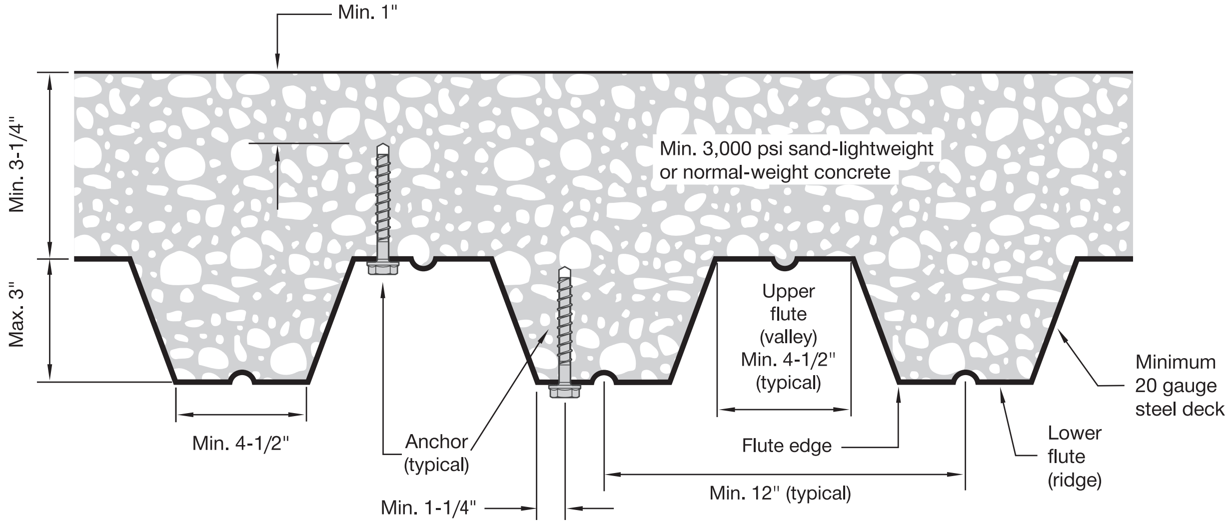
[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 1 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

Figure 3 — Installation of Hilti KWIK HUS in soffit of concrete over steel deck floor and roof assemblies[1]



[1] Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum concrete cover above the drilled hole is satisfied. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

Table 8 — Hilti KWIK HUS in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6,7]

Nominal anchor diameter	Nominal embed. in. (mm)	Installation in lower flute				Installation in upper flute			
		Tension - ϕN_n		Shear - ϕV_n		Tension - ϕN_n		Shear - ϕV_n	
		f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)
3/8	1-5/8 (41)	835 (3.7)	965 (4.3)	1,000 (4.4)	1,000 (4.4)	660 (2.9)	760 (3.4)	2,360 (10.5)	2,360 (10.5)
	2-1/2 (64)	1,455 (6.5)	1,680 (7.5)	905 (4.0)	905 (4.0)	1,900 (8.5)	2,195 (9.8)	3,655 (16.3)	3,655 (16.3)
	3-1/4 (83)	2,550 (11.3)	2,945 (13.1)	2,165 (9.6)	2,165 (9.6)	n/a	n/a	n/a	n/a
1/2	2-1/4 (57)	850 (3.8)	980 (4.4)	965 (4.3)	965 (4.3)	905 (4.0)	1,045 (4.6)	4,710 (21.0)	4,710 (21.0)
	3 (76)	1,990 (8.9)	2,300 (10.2)	1,750 (7.8)	1,750 (7.8)	n/a	n/a	n/a	n/a
	4-1/4 (108)	3,485 (15.5)	4,025 (17.9)	2,155 (9.6)	2,155 (9.6)	n/a	n/a	n/a	n/a
5/8	3-1/4 (83)	2,715 (12.1)	3,135 (13.9)	2,080 (9.3)	2,080 (9.3)	n/a	n/a	n/a	n/a
	5 (127)	6,170 (27.4)	7,125 (31.7)	2,515 (11.2)	2,515 (11.2)	n/a	n/a	n/a	n/a
3/4	4 (102)	2,715 (12.1)	3,135 (13.9)	2,255 (10.0)	2,255 (10.0)	n/a	n/a	n/a	n/a

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{nom} (nominal embedment).

4 Tabular values are lightweight concrete and no additional reduction factor is needed.

5 No additional reduction factors for spacing or edge distance need to be applied.

6 Comparison to steel values in table 3 is not required. Values in tables 8 control.

7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in table 2 of this section. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

Table 9 — Steel resistance for Hilti KWIK HUS screw anchor[1,2]

Anchor diameter in.	Nominal embedment in. (mm)	Tensile N_{sar}[3] lb (kN)	Shear V_{sar}[4] lb (kN)
3/8	1-5/8 (41)	5,480 (24.4)	2,850 (12.7)
	2-1/2 (64)		
	3-1/4 (83)		
1/2	2-1/4 (57)	9,280 (41.3)	4,525 (20.1)
	3 (76)		
	4-1/4 (108)		
5/8	3-1/4 (83)	14,405 (64.1)	6,200 (27.6)
	5 (127)		
3/4	4 (102)	19,050 (84.7)	9,205 (40.9)
	6-1/4 (159)		

[1] See Section 3.1.8 to convert factored resistance value to ASD value.

[2] Hilti KWIK HUS screw anchors are to be considered brittle steel elements.

[3] Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.

[4] Shear determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.

Table 10 — Hilti KWIK HUS screw anchor design information in accordance with CSA A23.3 Annex D[1]

Design parameter	Symbol	Units	Nominal anchor diameter										Ref A23.3
			3/8			1/2			5/8		3/4		
Anchor O.D.	d_a	in. (mm)	0.375 (9.5)			0.5 (12.7)			0.625 (15.9)		0.75 (19.1)		
Effective minimum embedment[2]	h_{ef}	in. (mm)	1.11 (28)	1.86 (47)	2.20 (56)	1.52 (39)	2.16 (55)	3.22 (82)	2.39 (61)	3.88 (99)	2.92 (74)	4.84 (123)	
Minimum concrete thickness	h_{min}	in. (mm)	3-1/4 (83)	4 (102)	4-7/8 (124)	3-3/4 (95)	4-3/4 (121)	6-3/4 (171)	5 (127)	7 (178)	6 (152)	8-1/8 (206)	
Critical edge distance	c_{ac}	in. (mm)	2.10 (53)	2.92 (74)	3.30 (84)	2.75 (70)	3.88 (99)	5.25 (133)	3.63 (92)	5.82 (148)	4.41 (112)	7.28 (185)	
Minimum anchor spacing at critical edge distance	$s_{min,cac}$	in. (mm)	2.25 (57)			3 (76)					4 (102)		
Minimum edge distance	c_{min}	in. (mm)	1.50 (38)			1.75 (44)							
Anchor spacing at minimum edge distance	s_{min}	in. (mm)	3 (76)								4 (102)		
Minimum hole depth in concrete	h_o	in. (mm)	1-7/8 (48)	2-3/4 (70)	3 1/2 (86)	2-5/8 (67)	3-3/8 (86)	4-5/8 (117)	3-5/8 (92)	5-3/8 (137)	4-3/8 (111)	6-5/8 (168)	
Minimum specified ultimate strength	f_{uta}	in. (mm)	107,120 (739)			97,140 (670)			90,180 (622)		81,600 (563)		
Effective tensile stress area	$A_{se,N}$	in. (mm)	0.086 (55.5)			0.161 (103.9)			0.268 (172.9)		0.392 (252.9)		
Steel embedment material resistance factor for reinforcement	ϕ_s	-	0.85										8.4.3
Resistance modification factor for tension, steel failure modes[4]	R	-	0.70										D.5.3
Resistance modification factor for shear, steel failure modes[4]	R	-	0.65										D.5.3
Factored steel resistance in tension	N_{sar}	lb (kN)	5,840 (26.0)		9,200 (40.9)				14,405 (64.1)		19,050 (84.7)		D.6.1.2
Factored steel resistance in shear	V_{sar}	lb (kN)	2,850 (12.7)		4,525 (20.1)				6,200 (27.6)		9,205 (40.9)		D.7.1.2
Coefficient for factored concrete breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10						11.2				D.6.2.2
Modification factor for anchor resistance, tension, uncracked concrete[5]	$\psi_{c,N}$	-	10										D.6.2.6
Anchor category	-	-	1										D.5.3 (c)
Concrete material resistance factor	ϕ_c	-	0.65										8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[6]	R	-	1.00										D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete[7]	$N_{pr,uncr}$	lb (kN)	NA										D.6.3.2

1 Design information in this table is taken from tables 2 of this section and converted with use of CSA A23.3 Annex D.
2 See figure 1 of this section.
3 For concrete over metal deck applications where the concrete thickness over the top flute is less than h_{min} in this table, see figure 3 and table 3 of this section.
4 The KWIK HUS is considered a brittle steel element as defined by CSA A23.3 Annex D section D.2.
5 For all design cases, $\psi_{c,N}$ = 1.0.
6 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
7 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design.

Table 11 — Hilti KWIK HUS screw anchor factored resistance with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	1-1/8 (28)	1-5/8 (41)	970 (4.3)	1,085 (4.8)	1,185 (5.3)	1,370 (6.1)	970 (4.3)	1,085 (4.8)	1,185 (5.3)	1,370 (6.1)
	1-7/8 (47)	2-1/2 (64)	2,105 (9.4)	2,355 (10.5)	2,580 (11.5)	2,980 (13.2)	2,105 (9.4)	2,355 (10.5)	2,580 (11.5)	2,980 (13.2)
	2-3/16 (56)	3-1/4 (83)	2,740 (12.2)	3,060 (13.6)	3,355 (14.9)	3,875 (17.2)	2,740 (12.2)	3,060 (13.6)	3,355 (14.9)	3,875 (17.2)
1/2	1-1/2 (39)	2-1/4 (57)	1,590 (7.1)	1,780 (7.9)	1,950 (8.7)	2,250 (10.0)	1,590 (7.1)	1,780 (7.9)	1,950 (8.7)	2,250 (10.0)
	2 (55)	3 (76)	2,665 (11.9)	2,980 (13.3)	3,265 (14.5)	3,770 (16.8)	2,665 (11.9)	2,980 (13.3)	3,265 (14.5)	3,770 (16.8)
	3-1/4 (82)	4-1/4 (108)	4,850 (21.6)	5,425 (24.1)	5,945 (26.4)	6,860 (30.5)	9,705 (43.2)	10,850 (48.3)	11,885 (52.9)	13,725 (61.1)
5/8	2-3/8 (61)	3-1/4 (83)	3,485 (15.5)	3,900 (17.3)	4,270 (19.0)	4,930 (21.9)	3,485 (15.5)	3,900 (17.3)	4,270 (19.0)	4,930 (21.9)
	4 (99)	5 (127)	7,210 (32.1)	8,060 (35.9)	8,830 (39.3)	10,195 (45.4)	14,420 (64.1)	16,120 (71.7)	17,660 (78.6)	20,390 (90.7)
3/4	2-15/16 (74)	4 (102)	4,660 (20.7)	5,210 (23.2)	5,705 (25.4)	6,590 (29.3)	9,320 (41.4)	10,420 (46.3)	11,415 (50.8)	13,180 (58.6)
	4-13/16 (123)	6-1/4 (159)	9,985 (44.4)	11,165 (49.7)	12,230 (54.4)	14,120 (62.8)	19,970 (88.8)	22,325 (99.3)	24,455 (108.8)	28,240 (125.6)

1 See section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 4 to 7 as necessary. Compare to the steel values in table 9. The lesser of the values is to be used for the design.
4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 12 — Hilti KWIK HUS in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6,7]

Nominal anchor diameter in.	Nominal embedment depth in. (mm)	Installation in lower flute				Installation in upper flute			
		Tension - ϕN_r		Shear - ϕV_r		Tension - ϕN_r		Shear - ϕV_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa ((4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
3/8	1-5/8 (41)	820 (3.6)	1,005 (4.5)	925 (4.1)	925 (4.1)	650 (2.9)	795 (3.5)	2,175 (9.7)	2,175 (9.7)
	2-1/2 (64)	1,430 (6.4)	1,755 (7.8)	835 (3.7)	835 (3.7)	1,865 (8.3)	2,285 (10.2)	3,365 (15.0)	3,365 (15.0)
	3-1/4 (83)	2,505 (11.1)	3,070 (13.7)	1,990 (8.9)	1,990 (8.9)	n/a	n/a	n/a	n/a
1/2	2-1/4 (57)	835 (3.7)	1,020 (4.5)	885 (3.9)	885 (3.9)	890 (4.0)	1,090 (4.8)	4,335 (19.3)	4,335 (19.3)
	3 (76)	1,955 (8.7)	2,395 (10.7)	1,615 (7.2)	1,615 (7.2)	n/a	n/a	n/a	n/a
	4-1/4 (108)	3,425 (15.2)	4,195 (18.7)	1,985 (8.8)	1,985 (8.8)	n/a	n/a	n/a	n/a
5/8	3-1/4 (83)	2,670 (11.9)	3,270 (14.5)	1,915 (8.5)	1,915 (8.5)	n/a	n/a	n/a	n/a
	5 (127)	6,070 (27.0)	7,430 (33.1)	2,315 (10.3)	2,315 (10.3)	n/a	n/a	n/a	n/a
3/4	4 (102)	2,670 (11.9)	3,270 (14.5)	2,080 (9.3)	2,080 (9.3)	n/a	n/a	n/a	n/a

1 See section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{nom} (nominal embedment).
4 Tabular values are lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

DESIGN INFORMATION IN MASONRY

Table 13 — Allowable tension loads for Hilti KWIK HUS installed in grout-filled masonry walls (lb)[1,2,3,4,5]

Nominal anchor diameter	Nominal embedment [3] in.	Loads at c_{cr} and s_{cr}	Spacing			Edge distance		
			Critical - s_{cr} [6] in.	Minimum - s_{min} [6] in.	Load reduction factor at s_{min} [6]	Critical - c_{cr} [7] in.	Minimum c_{min} [8] in.	Load reduction factor [7]
3/8	1-5/8	535	4	2	0.70	4	4	1.00
	2-1/2	895	6	4	0.80			
	3-1/4	1,210						
1/2	2-1/4	710	4	2	0.60	4	4	1.00
	3	1,110	8	4				
	4-1/4	1,515						
5/8	3-1/4	1,155	10	4	0.60	10	4	1.00
	5	1,735						
3/4	4	1,680	12	4	0.60	12	4	1.00
	6-1/4	2,035						

Table 14 — Allowable shear loads for Hilti KWIK HUS installed in grout-filled masonry walls (lb)[1,2,3,4,5]

Nominal anchor diameter	Nominal embedment [3] in.	Loads at c_{cr} and s_{cr}	Spacing			Edge distance			
								Load reduction factor at c_{min}	
			Critical - s_{cr} [6] in.	Minimum - s_{min} [6] in.	Load reduction factor at s_{min} [7]	Critical - c_{cr} [8] in.	Minimum c_{min} [8] in.	Load direction perpendicular to edge	Load direction parallel to edge
3/8	1-5/8	1,140	6	4	0.94	6	4	0.61	1.00
	2-1/2	1,165						0.70	1.00
	3-1/4	1,190						0.70	1.00
1/2	2-1/4	1,845	8	4	0.88	8	4	0.50	1.00
	3	2,055						0.45	0.94
	4-1/4	2,745						0.40	0.89
5/8	3-1/4	3,040	10	4	0.36	10	4	0.36	0.82
	5	3,485						0.34	0.92
3/4	4	3,040	10	4	0.36	12	4	0.36	0.82
	6-1/4	3,485						0.34	0.92

1 All values are for anchors installed in fully-grouted masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight or normal-weight.

2 Anchors may not be installed within 1 inch in any direction of a vertical joint.

3 Embedment depth is measured from the outside face of the concrete masonry embedment.

4 Linear interpolation of load values between minimum spacing (s_{min}) and critical spacing (s_{cr}) and between minimum edge distance (c_{min}) and critical edge distance (c_{cr}) is permitted.

5 For combined loading: $\left(\frac{T_{applied}}{T_{allowable}}\right)^{5/3} + \left(\frac{V_{applied}}{V_{allowable}}\right)^{5/3} \leq 1$

6 Anchor spacing s_{cr} is where full load values in the table may be used. Anchor-to-anchor spacing of less than s_{min} is not recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

7 Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than c_{cr} or s_{cr} must be multiplied by the appropriate load reduction factor based on actual edge distance or anchor spacing.

8 Critical edge distance c_{cr} is where full load values in the table may be used. Edge distance spacing of less than c_{min} is not recommended. Edge distance is measured from the center of the anchor to the closest edge.

Table 15 — Hilti KWIK HUS allowable loads installed in top of grout-filled concrete masonry construction (lb)[1,2]

Nominal anchor diameter	Nominal embedment in.	Minimum edge distance in.	Minimum spacing in.	Minimum end distance in.	Tension	Shear	
						Perpendicular to edge of masonry wall	Parallel to edge of masonry wall
1/2	4-1/4	1-3/4	8	4	680	305	1,110
5/8	5	1-3/4	10	5	1,310	305	1,165

1 All values are for anchors installed in fully-grouted masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight or normal-weight.

2 For combined loading: $\left(\frac{T_{applied}}{T_{allowable}}\right)^{5/3} + \left(\frac{V_{applied}}{V_{allowable}}\right)^{5/3} \leq 1$

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION[1]



Description	Hole diameter	Anchor length See figure 1	Minimum embedment depth	Qty / Box
KH 3/8 x 2-1/8	3/8	2-1/8	1-5/8	50
KH 3/8 x 3	3/8	3	2-1/2	50
KH 3/8 x 3-1/2	3/8	3-1/2	2-1/2	50
KH 3/8 x 4	3/8	4	3-1/4	50
KH 3/8 x 5	3/8	5	3-1/4	30
KH 1/2 x 3	1/2	3	2-1/4	30
KH 1/2 x 3-1/2	1/2	3-1/2	3	25
KH 1/2 x 4	1/2	4	3	25
KH 1/2 x 4-1/2	1/2	4-1/2	4- 1/4	25
KH 1/2 x 5	1/2	5	4-1/4	25
KH 1/2 x 6	1/2	6	4-1/4	25
KH 5/8 x 4	5/8	4	3-1/4	15
KH 5/8 x 5-1/2	5/8	5-1/2	3-1/4	15
KH 5/8 x 6-1/2	5/8	6-1/2	3-1/4	15
KH 3/4 x 4-1/2	3/4	4-1/2	4	10
KH 3/4 x 5-1/2	3/4	5-1/2	4	10
KH 3/4 x 7	3/4	7	4	10
KH 3/4 x 9	3/4	9	4	10

1 All dimensions in inches.

3.3.11 KWIK BOLT 3 STAINLESS STEEL AND HOT-DIPPED GALVANIZED EXPANSION ANCHOR

PRODUCT DESCRIPTION

KWIK Bolt 3 stainless steel anchors and hot-dipped galvanized plating

Anchor System

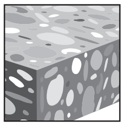
Hot Dipped Galvanized KB3

Stainless Steel KB3

A-18/A22 impact tool

Features and Benefits

- Used with Hilti Dust Removal System (DRS) for dustless drilling and installation (compliant with Table 1 of OSHA 1926.1153 regulations for silica dust exposure).
- Accurate SafeSet™ installation when using the Hilti SIW-6AT-A22 impact wrench and the SI-AT-A22 Adaptive Torque Module
- Length identification code facilitates quality control and inspection after installation.
- Through fixture installation and variable thread lengths improve productivity and accommodate various base plate thicknesses.
- Raised impact section (Dog Point) prevents thread damage during installation.
- Anchor size is same as drill bit size for easy installation. For temporary applications anchors may be driven into drilled holes after usage.
- Mechanical expansion allows immediate load application.



Uncracked concrete

SAFESET

Hollow drill bit adaptive torque tool (AT)

Profis Anchor design software

Approvals/Listings	
ICC-ES (International Code Council) **2018 International Building Code / International Residential Code (IBC/IRC)**	ESR-2302 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193
City of Los Angeles	City of Los Angeles 2020 LABC Supplement (within ESR-2302)
Florida Building Code	2020 FBC with HVHZ
Nuclear Quality Assurance	Qualified under NQA-1 Nuclear Quality Program

MATERIAL SPECIFICATIONS

Carbon steel with hot-dip galvanized plating

Anchor bodies manufactured from carbon steel have the tensile bolt fracture loads shown in table 1.

Carbon steel anchor components have an average zinc plating thickness greater than 43 µm according to ASTM A153, Class C.

Nuts conform to the requirements of ASTM A563, Grade A, Hex.

Washers meet the requirements of ASTM F844.

Stainless steel expansion wedges are manufactured from either AISI Type 304 or Type 316.

Stainless steel

Anchor bodies smaller than 3/4-inch, excluding all KWIK Bolt 3 Countersunk, are produced from AISI Type 304 or Type 316 stainless steel having the bolt fracture loads shown in table 1.

Anchor bodies 3/4-inch and larger, and all stainless steel KWIK Bolt 3 Countersunk anchor bodies, are produced from AISI Type 304 or Type 316 stainless steel having the mechanical properties shown in table 1.

Nuts meet the dimensional requirements of ASTM F594.

Washers meet the dimensional requirements of ANSI B18.22.1, Type A, plain.

Stainless steel expansion wedges for AISI Type 304 are made from either AISI Type 304 or Type 316. Stainless steel expansion wedges for AISI Type 316 anchors are made from type 316. All stainless steel nuts and washers for AISI Type 304 or Type 316 anchors are manufactured from AISI Type 304 or 316, respectively.

Table 1 — Hilti KWIK Bolt 3 Bolt fracture load (lb)[1]

Nominal anchor diameter in.	Hot-dip galvanized	Stainless steel
1/4	no offering	2,900
3/8	no offering	7,200
1/2	12,400	12,400
5/8	19,600	21,900
3/4	28,700	$f_{uta} \geq 76$, $f_{ya} \geq 64$[2]
1	no offering	$f_{uta} \geq 76$, $f_{ya} \geq 64$[2]

1 Bolt fracture loads are determined by testing in a universal tensile machine for quality control at the manufacturing facility. These loads are not intended for design use. See table 12 for the steel design strengths of stainless steel.

2 All 3/4-in. stainless steel, and all 1-in. stainless steel material strengths specified by the tensile and yield strengths expressed in (ksi). Bolt fracture loads not applicable for these models.

INSTALLATION PARAMETERS

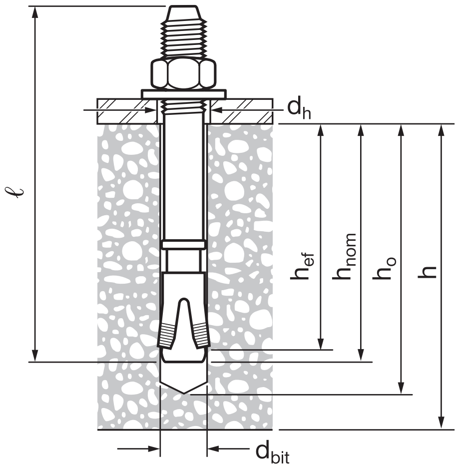


Figure 1 — KWIK Bolt 3 installation

Table 2 — Hilti KWIK Bolt 3 specifications

Setting information	Symbol	Units	Nominal anchor diameter									
			1/4	3/8	1/2		5/8		3/4		1	
Drill bit dia.	d_{bit}	in.	1/4	3/8	1/2		5/8		3/4		1	
Minimum nominal embedment	h_{nom}	in.	1-3/4	2-3/8	2-1/4	3-5/8	3-1/2	4-3/8	4-1/4	5-5/8	4-5/8	6-3/8
		(mm)	(44)	(60)	(57)	(92)	(89)	(111)	(108)	(143)	117	162
Minimum effective embedment	h_{ef}	in.	1-1/2	2	2	3-1/4	3-1/8	4	3-3/4	5	4	5-3/4
		(mm)	(38)	(51)	(51)	(83)	(79)	(102)	(95)	(127)	(102)	(146)
Minimum hole depth	h_o	in.	2	2-5/8	2-5/8	4	3-7/8	4-3/4	4-1/2	5-3/4	5	6-3/4
		(mm)	(51)	(67)	(67)	(102)	(98)	(121)	(114)	(146)	(127)	(171)
Fixture hole dia.	d_h	in.	5/16	7/16	9/16		11/16		13/16		1-1/8	
Anchor length	ℓ		See ordering information									
Installation torque concrete	T_{inst}	ft-lb	4	20	40		60		110		150	
		(Nm)	(5)	(27)	(54)		(81)		(149)		(203)	
Installation torque masonry	T_{inst}	ft-lb	4	15	25		65		120		not recommended	
		(Nm)	(5)	(20)	(34)		(88)		(163)			
Wrench size		in.	7/16	9/16	3/4		15/16		1-1/8		1-1/2	

DESIGN INFORMATION IN CONCRETE PER ACI 318

ACI 318 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-2302 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.7. Data tables from ESR-2302 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Allowable Stress Design or ASD technical information and data tables can be found at www.hilti.com.

Table 3 — Hilti KWIK Bolt 3 stainless steel design strength with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - ϕN_n				Shear - ϕV_n			
			f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
1/4	1-1/2 (38)	1-3/4 (44)	730 (3.2)	770 (3.4)	840 (3.7)	950 (4.2)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
3/8	2 (51)	2-3/8 (60)	1,925 (8.6)	2,110 (9.4)	2,440 (10.9)	2,985 (13.3)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
1/2	2 (51)	2-1/4 (57)	2,150 (9.6)	2,355 (10.5)	2,720 (12.1)	3,335 (14.8)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	3-1/4 (83)	3-1/2 (89)	3,920 (17.4)	4,295 (19.1)	4,960 (22.1)	6,070 (27.0)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	3-1/8 (79)	3-1/2 (89)	4,050 (18.0)	4,435 (19.7)	5,120 (22.8)	6,275 (27.9)	9,280 (41.3)	10,165 (45.2)	11,740 (52.2)	14,380 (64.0)
	4 (102)	4-3/8 (111)	5,090 (22.6)	5,575 (24.8)	6,440 (28.6)	7,885 (35.1)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-3/4 (95)	4-1/4 (108)	5,560 (24.7)	6,090 (27.1)	7,035 (31.3)	8,615 (38.3)	12,200 (54.3)	13,365 (59.5)	15,430 (68.6)	18,900 (84.1)
	5 (127)	5-1/2 (140)	7,040 (31.3)	7,710 (34.3)	8,905 (39.6)	10,905 (48.5)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)
1	4 (102)	4-1/2 (114)	6,240 (27.8)	6,835 (30.4)	7,895 (35.1)	9,665 (43.0)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
	5-3/4 (146)	6-1/4 (159)	10,110 (45.0)	11,070 (49.2)	12,785 (56.9)	15,660 (69.7)	23,165 (103.0)	25,375 (112.9)	29,300 (130.3)	35,885 (159.6)

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 14 to 19 as necessary. Compare to steel values in table 12. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 4 — Steel design strength for Hilti KWIK Bolt 3 stainless steel anchors[1,2]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)
1/4	1-3/4 (44)	1,725 (7.7)	1,090 (4.8)
3/8	2-3/8 (60)	5,175 (23.0)	3,235 (14.4)
1/2	2-1/4 (57)	9,490 (42.2)	2,725 (12.1)
	3-1/2 (89)		4,510 (20.1)
5/8	3-1/2 (89)	14,665 (65.2)	5,820 (25.9)
	4-3/8 (111)		9,295 (41.3)
3/4	4-1/4 (108)	16,200 (72.1)	7,735 (34.4)
	5-1/2 (140)		15,305 (68.1)
1	4-1/2 (114)	31,735 (141.2)	8,130 (36.2)
	6-1/4 (159)		17,775 (79.1)

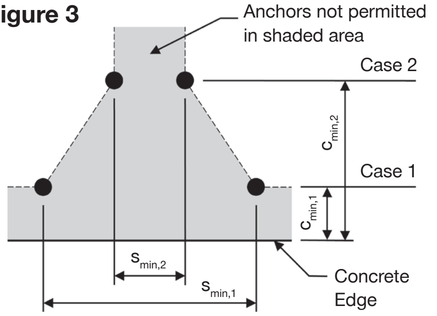
1 See section 3.1.8 to convert design strength value to ASD value.

2 KWIK Bolt 3 stainless steel anchors are to be considered ductile steel elements.

3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17.

Figure 3



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}(c - c_{min,2})$$

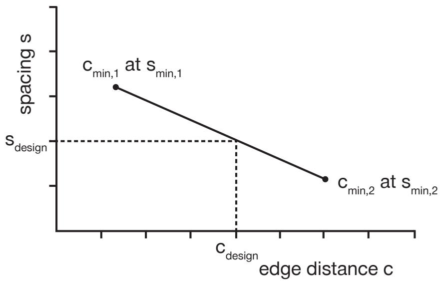


Table 5 — Stainless steel Hilti KWIK Bolt 3 installation parameters[1]

Setting information	Symbol	Units	Nominal anchor diameter d_o														
			1/4	3/8		1/2				5/8			3/4			1	
Effective minimum embedment	h_{ef}	in.	1-1/2	2		2		3-1/4		3-1/8	4		3-3/4		5	4	5-3/4
		(mm)	(38)	(51)		(51)		(83)		(79)	(102)		(95)		(127)	(102)	(146)
Minimum member thickness	h_{min}	in.	4	4	5	4	6	6	8	5	6	8	6	8	8	8	10
		(mm)	(102)	(102)	(127)	(102)	(152)	(152)	(203)	(127)	(152)	(203)	(152)	(203)	(203)	(203)	(254)
Case 1	$c_{min,1}$	in.	1-3/8	2	1-5/8	2-1/2	1-7/8	1-5/8	1-5/8	3-1/4	2-1/2	2-1/2	3-1/4	3	2-7/8	3-1/2	3
		(mm)	(35)	(51)	(41)	(68)	(48)	(41)	(41)	(83)	(64)	(64)	(83)	(76)	(73)	(89)	(76)
	for $s_{min,1} \geq$	in.	1-3/4	4	3-5/8	5	4-5/8	4-1/2	4-1/4	5-5/8	5-1/4	5	7	6-7/8	6-5/8	6-3/4	6-3/4
		(mm)	(44)	(102)	(92)	(127)	(117)	(114)	(108)	(143)	(133)	(127)	(178)	(175)	(168)	(172)	(172)
Case 2	$c_{min,2}$	in.	1-5/8	3-1/4	2-1/2	2-7/8	2-3/8	2-3/8	2-1/8	3-7/8	3	2-3/4	4-1/8	3-3/4	3-3/4	4-1/4	3-3/4
		(mm)	(41)	(83)	(64)	(73)	(60)	(60)	(54)	(98)	(76)	(70)	(105)	(95)	(95)	(108)	(95)
	for $s_{min,2} \geq$	in.	1-1/4	2	1-3/4	2-1/2	2-1/4	2-1/8	1-7/8	3-1/8	2-1/8	2-1/8	4	3-1/2	3-1/2	5	4-3/4
		(mm)	(32)	(51)	(44)	(64)	(57)	(54)	(48)	(79)	(54)	(54)	(102)	(89)	(89)	(127)	(121)

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge .distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacings.

Table 6 — Load adjustment factors for 1/4-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

1/4-in. KB3 stainless steel uncracked uoncrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear[3] f_{AV}	Edge distance in shear		Concrete thickness factor in shear[4] f_{HV}
						⊥ toward edge f_{RV}	II to and away from edge f_{RV}	
Embedment h_{nom}	in.	(mm)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-1/4	(32)	0.64	n/a	0.56	n/a	n/a	n/a
	1-3/8	(35)	0.65	0.53	0.57	0.26	0.51	n/a
	1-1/2	(38)	0.67	0.56	0.57	0.29	0.56	n/a
	2	(51)	0.72	0.68	0.60	0.45	0.68	n/a
	3	(76)	0.83	1.00	0.65	0.83	1.00	n/a
	3-1/2	(89)	0.89		0.67	1.00		n/a
	4	(102)	0.94		0.70			0.88
	4-1/2	(114)	1.00		0.72			0.94
	5	(127)			0.74			0.99
	5-1/2	(140)			0.77			1.00
	6	(152)			0.79			
	7	(178)			0.84			
	8	(203)			0.89			
	9	(229)			0.94			
	10	(254)			0.99			
	11	(279)			1.00			

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

Table 7 — Load adjustment factors for 3/8-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

3/8-in. KB3 stainless steel uncracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear[3] f_{AV}	Edge distance in shear		Concrete thickness factor in shear[4] f_{HV}
						⊥ toward edge f_{RV}	II to and away from edge f_{RV}	
Embedment h_{nom}	in.	(mm)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	2	(51)	0.67	0.51	0.58	0.35	0.51	n/a
	2-1/2	(64)	0.71	0.60	0.60	0.49	0.60	n/a
	3	(76)	0.75	0.69	0.62	0.64	0.69	n/a
	3-1/2	(89)	0.79	0.80	0.64	0.81	0.81	n/a
	4	(102)	0.83	0.91	0.67	0.99	0.99	0.81
	4-1/2	(114)	0.88	1.00	0.69	1.00	1.00	0.86
	5	(127)	0.92		0.71			0.91
	6	(152)	1.00		0.75			1.00
	7	(178)			0.79			
	8	(203)			0.83			
	9	(229)			0.87			
	10	(254)			0.91			
	11	(279)			0.95			
	12	(305)			1.00			
	14	(356)						

Table 8 — Load adjustment factors for 1/2-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

1/2-in. KB3 stainless steel uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Embedment h_{nom}	in.	(mm)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-5/8	(41)	n/a	n/a	n/a	0.39	n/a	n/a	n/a	0.07	n/a	0.15	n/a	n/a
	2	(51)	n/a	n/a	n/a	0.42	n/a	n/a	n/a	0.10	n/a	0.20	n/a	n/a
	2-1/8	(54)	n/a	0.61	n/a	0.43	n/a	0.54	n/a	0.11	n/a	0.22	n/a	n/a
	2-1/2	(64)	0.71	0.63	0.54	0.47	0.61	0.55	0.53	0.14	0.54	0.28	n/a	n/a
	3	(76)	0.75	0.65	0.62	0.52	0.63	0.55	0.70	0.19	0.70	0.37	n/a	n/a
	3-1/2	(89)	0.79	0.68	0.72	0.57	0.65	0.56	0.88	0.23	0.88	0.47	n/a	n/a
	4	(102)	0.83	0.71	0.82	0.62	0.68	0.57	1.00	0.29	1.00	0.57	0.84	n/a
	4-1/2	(114)	0.88	0.73	0.92	0.68	0.70	0.58		0.34		0.68	0.89	n/a
	5	(127)	0.92	0.76	1.00	0.74	0.72	0.59		0.40		0.74	0.94	n/a
	6	(152)	1.00	0.81		0.89	0.76	0.61		0.53		0.89	1.00	0.66
	7	(178)		0.86		1.00	0.81	0.63		0.66		1.00		0.71
	8	(203)		0.91			0.85	0.64		0.81				0.76
	9	(229)		0.96			0.89	0.66		0.97				0.81
	10	(254)		1.00			0.94	0.68		1.00				0.85
	11	(279)					0.98	0.70						0.89
	12	(305)					1.00	0.72						0.93
	14	(356)						0.75						1.00
	16	(406)						0.79						
	18	(457)						0.83						
	20	(508)						0.86						
	> 24	(610)						0.93						

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

Table 9 — Load adjustment factors for 5/8-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

5/8-in. KB3 stainless steel uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Embedment h_{nom}		in. (mm)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	2-1/8	(54)	n/a	0.59	n/a	n/a	n/a	0.53	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	n/a	0.60	n/a	0.37	n/a	0.54	n/a	0.12	n/a	0.23	n/a	n/a
	3	(76)	n/a	0.63	n/a	0.40	n/a	0.55	n/a	0.15	n/a	0.30	n/a	n/a
	3-1/8	(79)	0.67	0.63	n/a	0.41	0.56	0.55	n/a	0.16	n/a	0.32	n/a	n/a
	3-1/4	(83)	0.67	0.64	0.49	0.42	0.56	0.55	0.24	0.17	0.47	0.34	n/a	n/a
	3-1/2	(89)	0.69	0.65	0.51	0.44	0.57	0.56	0.26	0.19	0.51	0.38	n/a	n/a
	4	(102)	0.71	0.67	0.56	0.47	0.58	0.56	0.32	0.23	0.56	0.47	n/a	n/a
	5	(127)	0.77	0.71	0.68	0.55	0.60	0.58	0.45	0.33	0.68	0.55	0.63	n/a
	6	(152)	0.82	0.75	0.81	0.63	0.62	0.59	0.59	0.43	0.81	0.63	0.69	0.62
	7	(178)	0.87	0.79	0.95	0.74	0.64	0.61	0.75	0.54	0.95	0.74	0.74	0.67
	8	(203)	0.93	0.83	1.00	0.84	0.66	0.63	0.91	0.66	1.00	0.84	0.79	0.71
	9	(229)	0.98	0.88		0.95	0.68	0.64	1.00	0.79		0.95	0.84	0.75
	10	(254)	1.00	0.92		1.00	0.70	0.66		0.92		1.00	0.89	0.80
	11	(279)		0.96			0.72	0.67		1.00			0.93	0.83
	12	(305)		1.00			0.74	0.69					0.97	0.87
	14	(356)					0.77	0.72					1.00	0.94
	16	(406)					0.81	0.75						1.00
	18	(457)					0.85	0.78						
	20	(508)					0.89	0.82						
	24	(610)					0.97	0.88						
	> 30	(762)					1.00	0.97						

Table 10 — Load adjustment factors for 3/4-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

3/4-in. KB3 stainless steel uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Embedment h_{nom}		in. (mm)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	2-7/8	(73)	n/a	n/a	n/a	0.43	n/a	n/a	n/a	0.11	n/a	0.23	n/a	n/a
	3	(76)	n/a	n/a	n/a	0.44	n/a	n/a	n/a	0.12	n/a	0.24	n/a	n/a
	3-1/4	(83)	n/a	n/a	0.37	0.46	n/a	n/a	0.20	0.14	0.37	0.27	n/a	n/a
	3-1/2	(89)	n/a	0.62	0.39	0.47	n/a	0.55	0.22	0.15	0.39	0.30	n/a	n/a
	4	(102)	0.68	0.63	0.42	0.51	0.57	0.55	0.27	0.18	0.42	0.37	n/a	n/a
	4-1/2	(114)	0.70	0.65	0.45	0.54	0.58	0.56	0.32	0.22	0.45	0.44	n/a	n/a
	5	(127)	0.72	0.67	0.49	0.58	0.59	0.57	0.38	0.26	0.49	0.52	n/a	n/a
	6	(152)	0.77	0.70	0.57	0.65	0.60	0.58	0.49	0.34	0.57	0.65	0.65	n/a
	7	(178)	0.81	0.73	0.67	0.73	0.62	0.59	0.62	0.43	0.67	0.73	0.70	n/a
	8	(203)	0.86	0.77	0.76	0.82	0.64	0.61	0.76	0.52	0.76	0.82	0.75	0.66
	9	(229)	0.90	0.80	0.86	0.92	0.66	0.62	0.91	0.62	0.91	0.92	0.79	0.70
	10	(254)	0.94	0.83	0.95	1.00	0.67	0.64	1.00	0.73	1.00	1.00	0.83	0.74
	11	(279)	0.99	0.87	1.00		0.69	0.65		0.84			0.87	0.77
	12	(305)	1.00	0.90			0.71	0.66		0.96			0.91	0.81
	14	(356)		0.97			0.74	0.69		1.00			0.99	0.87
	16	(406)		1.00			0.78	0.72					1.00	0.93
	18	(457)					0.81	0.74						0.99
	20	(508)					0.85	0.77						1.00
	24	(610)					0.92	0.82						
	30	(762)					1.00	0.91						
	> 36	(914)						0.99						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

Table 11 — Load adjustment factors for 1-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

1-in. KB3 stainless steel uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear				Concrete thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Embedment h_{nom}	in.	(mm)	4-1/2 (114)	6-1/4 (159)	4-1/2 (114)	6-1/4 (159)	4-1/2 (114)	6-1/4 (159)	4-1/2 (114)	6-1/4 (159)	4-1/2 (114)	6-1/4 (159)	4-1/2 (114)	6-1/4 (159)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	3	(76)	n/a	n/a	n/a	0.43	n/a	n/a	n/a	0.10	n/a	0.20	n/a	n/a
	3-1/2	(89)	n/a	n/a	0.42	0.45	n/a	n/a	0.21	0.12	0.42	0.25	n/a	n/a
	4	(102)	n/a	n/a	0.45	0.48	n/a	n/a	0.26	0.15	0.45	0.30	n/a	n/a
	4-1/2	(114)	n/a	n/a	0.49	0.51	n/a	n/a	0.31	0.18	0.49	0.36	n/a	n/a
	4-3/4	(121)	n/a	0.64	0.50	0.53	n/a	0.56	0.34	0.20	0.50	0.39	n/a	n/a
	5	(127)	0.71	0.64	0.52	0.54	0.59	0.56	0.37	0.21	0.52	0.43	n/a	n/a
	6	(152)	0.75	0.67	0.60	0.60	0.60	0.57	0.48	0.28	0.60	0.56	n/a	n/a
	7	(178)	0.79	0.70	0.70	0.67	0.62	0.58	0.61	0.35	0.70	0.67	n/a	n/a
	8	(203)	0.83	0.73	0.80	0.74	0.64	0.60	0.74	0.43	0.80	0.74	0.74	n/a
	9	(229)	0.88	0.76	0.90	0.82	0.65	0.61	0.89	0.51	0.90	0.82	0.78	n/a
	10	(254)	0.92	0.79	1.00	0.91	0.67	0.62	1.00	0.60	1.00	0.91	0.83	0.69
	11	(279)	0.96	0.82		1.00	0.69	0.63		0.69		1.00	0.87	0.72
	12	(305)	1.00	0.85			0.70	0.64		0.79			0.91	0.76
	14	(356)		0.91			0.74	0.67		1.00			0.98	0.82
	16	(406)		0.96			0.77	0.69					1.00	0.87
	18	(457)		1.00			0.81	0.71						0.92
	20	(508)					0.84	0.74						0.98
	24	(610)					0.91	0.79						1.00
	30	(762)					1.00	0.86						
	> 36	(914)						0.93						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▭ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

Table 12 — Hilti KWIK Bolt 3 hot-dip galvanized design strength with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - ϕN_n				Shear - ϕV_n			
			f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
1/2	2 (51)	2-1/4 (57)	2,205 (9.8)	2,415 (10.7)	2,790 (12.4)	3,420 (15.2)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	3-1/4 (83)	3-1/2 (89)	4,250 (18.9)	4,655 (20.7)	5,375 (23.9)	6,585 (29.3)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	3-1/8 (79)	3-1/2 (89)	4,200 (18.7)	4,605 (20.5)	5,315 (23.6)	6,510 (29.0)	9,280 (41.3)	10,165 (45.2)	11,740 (52.2)	14,380 (64.0)
	4 (102)	4-3/8 (111)	5,860 (26.1)	6,420 (28.6)	7,415 (33.0)	9,080 (40.4)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-3/4 (95)	4-1/4 (108)	5,665 (25.2)	6,205 (27.6)	7,165 (31.9)	8,775 (39.0)	12,200 (54.3)	13,365 (59.5)	15,430 (68.6)	18,900 (84.1)
	5 (127)	5-1/2 (140)	6,615 (29.4)	7,245 (32.2)	8,365 (37.2)	10,245 (45.6)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 23 to 25 as necessary. Compare to steel values in table 21. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ = 0.68; for all-lightweight, λ = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 13 — Steel design strength for Hilti KWIK Bolt 3 hot-dip galvanized anchors[1,2]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Tensile ϕN_{sa} [3] lb (kN)	Shear ϕV_{sa} [4] lb (kN)
1/2	2-1/4 (57)	8,745 (38.9)	2,925 (13.0)
	3-1/2 (89)		3,815 (17.0)
5/8	3-1/2 (89)	13,515 (60.1)	7,565 (33.7)
	4-3/8 (111)		
3/4	4-1/4 (108)	19,080 (84.9)	11,050 (49.2)
	5-1/2 (140)		

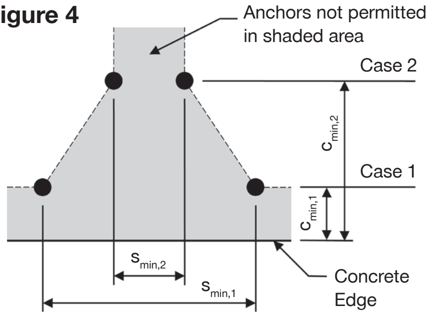
1 See section 3.1.8 to convert design strength value to ASD value.

2 KWIK Bolt 3 carbon steel anchors are to be considered ductile steel elements.

3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.

Figure 4



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}\ (c - c_{min,2})$$

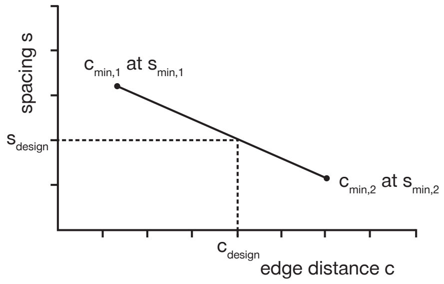


Table 14 — Hot-dip galvanized KWIK Bolt 3 installation parameters[1]

Setting information	Symbol	Units	Nominal anchor diameter d_o									
			1/2				5/8			3/4		
Effective minimum embedment	h_{ef}	in.	2		3-1/4		3-1/8	4		3-3/4		5
		(mm)	(51)		(83)		(79)	(102)		(95)		(127)
Minimum member thickness	h_{min}	in.	4	6	6	8	5	6	8	6	8	8
		(mm)	(102)	(152)	(152)	(203)	(127)	(152)	(203)	(152)	(203)	(203)
Case 1	$c_{min,1}$	in.	3-1/4	2-5/8	2		2-1/4	2	1-78	3-1/2		3-5/8
		(mm)	(83)	(67)	(51)		(57)	(51)	(48)	(89)		(92)
	for $s_{min,1} \geq$	in.	6-1/4	5-1/2	4-7/8		5-1/4	5	4-3/4	7-1/2		7-3/8
		(mm)	(158)	(140)	(124)		(133)	(127)	(121)	(191)		(187)
Case 2	$c_{min,2}$	in.	3-3/4	2-3/4	2-5/8	2-1/4	3-1/2	2-1/2	2-1/4	6-1/2		4-3/4
		(mm)	(95)	(70)	(67)	(57)	(89)	(64)	(57)	(165)		(121)
	for $s_{min,2} \geq$	in.	3-1/8	2-3/4	2-3/8	2-1/8	2-1/2	2-1/8	2-1/8	4		3-7/8
		(mm)	(79)	(70)	(60)	(54)	(64)	(54)	(54)	(102)		(98)

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge .distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacings.

Table 15 — Load adjustment factors for 1/2-in. diameter Hilti KWIK Bolt 3 hot-dip galvanized anchor in uncracked concrete[1,2]

1/2-in. KB3 hot-dip galvanized uncracked concrete			spacing factor in tension f_{AN}		edge distance factor in tension f_{RN}		spacing factor in shear[3] f_{AV}		Edge distance in shear				Conc. thickness factor in shear[4] f_{HV}	
									⊥ toward edge f_{RV}		II to and away from edge f_{RV}			
Embedment h_{nom}		in. (mm)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	2	(51)	n/a	n/a	n/a	0.38	n/a	n/a	n/a	0.10	n/a	0.20	n/a	n/a
	2-3/8	(60)	n/a	0.62	n/a	0.41	n/a	0.54	n/a	0.13	n/a	0.26	n/a	n/a
	2-1/2	(64)	n/a	0.63	n/a	0.42	n/a	0.55	n/a	0.14	n/a	0.28	n/a	n/a
	3	(76)	n/a	0.65	n/a	0.46	n/a	0.55	n/a	0.19	n/a	0.37	n/a	n/a
	3-1/8	(79)	0.76	0.66	n/a	0.48	0.64	0.56	n/a	0.20	n/a	0.40	n/a	n/a
	3-1/4	(83)	0.77	0.67	0.67	0.49	0.64	0.56	0.79	0.21	0.79	0.42	n/a	n/a
	3-1/2	(89)	0.79	0.68	0.72	0.51	0.65	0.56	0.88	0.23	0.88	0.47	n/a	n/a
	4	(102)	0.83	0.71	0.82	0.56	0.68	0.57	1.00	0.29	1.00	0.56	0.84	n/a
	4-1/2	(114)	0.88	0.73	0.92	0.61	0.70	0.58		0.34		0.61	0.89	n/a
	5	(127)	0.92	0.76	1.00	0.67	0.72	0.59		0.40		0.67	0.94	n/a
	6	(152)	1.00	0.81		0.80	0.76	0.61		0.53		0.80	1.00	0.66
	7	(178)	1.00	0.86		0.93	0.81	0.63		0.66		0.93		0.71
	8	(203)		0.91		1.00	0.85	0.64		0.81		1.00		0.76
	9	(229)		0.96			0.89	0.66		0.97				0.81
	10	(254)		1.00			0.94	0.68		1.00				0.85
	11	(279)					0.98	0.70						0.89
	12	(305)					1.00	0.72						0.93
	14	(356)						0.75						1.00
	16	(406)						0.79						
	18	(457)						0.83						
	20	(508)						0.86						
	> 24	(610)						0.93						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 22 and figure 4 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

Table 16 — Load adjustment factors for 5/8-in. diameter Hilti KWIK Bolt 3 hot-dip galvanized anchor in uncracked concrete[1,2]

5/8-in. KB3 hot-dip galvanized uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear ⊥ toward edge f_{RV}		Edge distance in shear II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in.	(mm)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	2	(51)	n/a	n/a	n/a	0.34	n/a	n/a	n/a	0.08	n/a	0.17	n/a	n/a
	2-1/8	(54)	n/a	0.59	n/a	0.34	n/a	0.53	n/a	0.09	n/a	0.18	n/a	n/a
	2-1/4	(57)	n/a	0.59	0.38	0.35	n/a	0.54	0.14	0.10	0.27	0.20	n/a	n/a
	2-1/2	(64)	0.63	0.60	0.41	0.37	0.55	0.54	0.16	0.12	0.32	0.23	n/a	n/a
	3	(76)	0.66	0.63	0.45	0.40	0.56	0.55	0.21	0.15	0.42	0.30	n/a	n/a
	3-1/2	(89)	0.69	0.65	0.50	0.44	0.57	0.56	0.26	0.19	0.50	0.38	n/a	n/a
	4	(102)	0.71	0.67	0.54	0.47	0.58	0.56	0.32	0.23	0.54	0.47	n/a	n/a
	4-1/2	(114)	0.74	0.69	0.60	0.51	0.59	0.57	0.38	0.28	0.60	0.51	n/a	n/a
	5	(127)	0.77	0.71	0.66	0.55	0.60	0.58	0.45	0.33	0.66	0.55	0.63	n/a
	6	(152)	0.82	0.75	0.79	0.63	0.62	0.59	0.59	0.43	0.79	0.63	0.69	0.62
	7	(178)	0.87	0.79	0.92	0.74	0.64	0.61	0.75	0.54	0.92	0.74	0.74	0.67
	8	(203)	0.93	0.83	1.00	0.84	0.66	0.63	0.91	0.66	1.00	0.84	0.79	0.71
	9	(229)	0.98	0.88		0.95	0.68	0.64	1.00	0.79		0.95	0.84	0.75
	10	(254)	1.00	0.92		1.00	0.70	0.66		0.92		1.00	0.89	0.80
	11	(279)		0.96			0.72	0.67		1.00			0.93	0.83
	12	(305)		1.00			0.74	0.69					0.97	0.87
	14	(356)					0.77	0.72					1.00	0.94
	16	(406)					0.81	0.75						1.00
	18	(457)					0.85	0.78						
	20	(508)					0.89	0.82						
	24	(610)					0.97	0.88						
	> 30	(762)					1.00	0.97						

Table 17 — Load adjustment factors for 3/4-in. diameter Hilti KWIK Bolt 3 hot-dip galvanized anchor in uncracked concrete[1,2]

3/4-in. KB3 hot-dip galvanized uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear ⊥ toward edge f_{RV}		Edge distance in shear II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in.	(mm)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	3-1/2	(89)	n/a	n/a	0.41	n/a	n/a	n/a	0.22	n/a	0.41	n/a	n/a	n/a
	3-5/8	(92)	n/a	n/a	0.42	0.49	n/a	n/a	0.23	0.16	0.42	0.32	n/a	n/a
	3-7/8	(98)	n/a	0.63	0.44	0.51	n/a	0.55	0.26	0.18	0.44	0.35	n/a	n/a
	4	(102)	0.68	0.63	0.45	0.52	0.57	0.55	0.27	0.18	0.45	0.37	n/a	n/a
	4-1/2	(114)	0.70	0.65	0.49	0.56	0.58	0.56	0.32	0.22	0.49	0.44	n/a	n/a
	5	(127)	0.72	0.67	0.53	0.59	0.59	0.57	0.38	0.26	0.53	0.52	n/a	n/a
	5-1/2	(140)	0.74	0.68	0.57	0.63	0.60	0.57	0.43	0.30	0.57	0.60	n/a	n/a
	6	(152)	0.77	0.70	0.62	0.67	0.60	0.58	0.49	0.34	0.62	0.67	0.65	n/a
	7	(178)	0.81	0.73	0.72	0.75	0.62	0.59	0.62	0.43	0.72	0.75	0.70	n/a
	8	(203)	0.86	0.77	0.82	0.84	0.64	0.61	0.76	0.52	0.82	0.84	0.75	0.66
	9	(229)	0.90	0.80	0.92	0.95	0.66	0.62	0.91	0.62	0.92	0.95	0.79	0.70
	10	(254)	0.94	0.83	1.00	1.00	0.67	0.64	1.00	0.73	1.00	1.00	0.83	0.74
	11	(279)	0.99	0.87			0.69	0.65		0.84			0.87	0.77
	12	(305)	1.00	0.90			0.71	0.66		0.96			0.91	0.81
	14	(356)		0.97			0.74	0.69		1.00			0.99	0.87
	16	(406)		1.00			0.78	0.72					1.00	0.93
	18	(457)					0.81	0.74						0.99
	20	(508)					0.85	0.77						1.00
	24	(610)					0.92	0.82						
	30	(762)					1.00	0.91						
	> 36	(914)						0.99						

[1] Linear interpolation not permitted.

[2] When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

[3] Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

[4] Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

▨ If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 22 and figure 4 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

Table 18 — Hilti KWIK Bolt 3 stainless steel design strength in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,7,8]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Loads according to figure 5			
			Tension - ϕN_n		Shear - ϕV_n	
			f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)
1/4	1-1/2 (38)	1-3/4 (44)	1,175 (5.2)	1,355 (6.0)	1,315 (5.8)	1,315 (5.8)
3/8	2 (51)	2-3/8 (60)	1,675 (7.5)	1,935 (8.6)	1,675 (7.5)	1,675 (7.5)
1/2	2 (51)	2-1/4 (57)	1,265 (5.6)	1,460 (6.5)	1,135 (5.0)	1,135 (5.0)
	3-1/4 (83)	3-1/2 (89)				
5/8	3-1/8 (79)	3-1/2 (89)	2,880 (12.8)	3,325 (14.8)	3,700 (16.5)	3,700 (16.5)
	4 (102)	4-3/8 (111)				

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).

4 Tabular values are lightweight concrete and no additional reduction factor is needed.

5 No additional reduction factors for spacing or edge distance need to be applied.

6 Comparison to steel values in table 4 is not required. Values in tables 26 control.

7 Comparison to steel values in table 12 is not required. Values in tables 27 control.

8 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

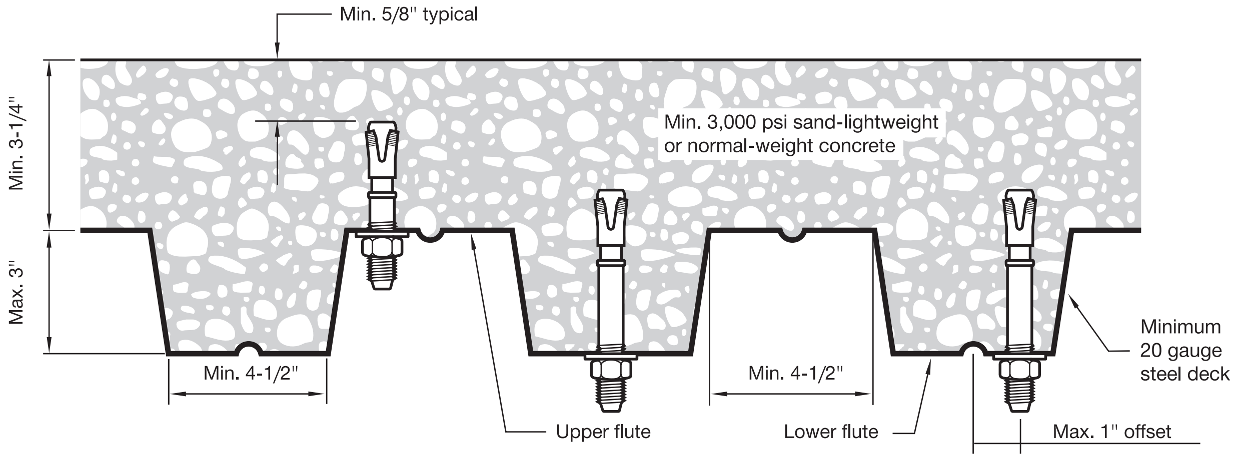


Figure 5 — Installation in concrete over metal deck

DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-2302. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

Table 19 — Steel resistance for Hilti KWIK Bolt 3 stainless steel anchors[1,2]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Tensile N_{sar} [3] lb (kN)	Shear V_{sar} [4] lb (kN)
1/4	1-11/16 (42.9)	1,565 (7.0)	1,070 (4.8)
3/8	2-3/8 (60.3)	4,690 (20.9)	3,175 (14.1)
1/2	2-1/4 (57.2)	8,600 (38.3)	2,675 (11.9)
	3-1/2 (88.9)		4,425 (19.7)
5/8	3-1/2 (88.9)	13,295 (59.1)	5,710 (25.4)
	4-3/8 (111.1)		9,115 (40.5)
3/4	4-1/4 (108.0)	14,690 (65.3)	7,585 (33.7)
	5-1/2 (139.7)		15,010 (66.8)
1	4-5/8 (117.5)	28,770 (128.0)	7,975 (35.5)
	5-7/8 (149.2)		17,430 (77.5)

1 See Section 3.1.8 to convert factored resistance value to ASD value.

2 Hilti KWIK Bolt 3 stainless steel anchors are to be considered ductile steel elements.

3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.

4 Shear determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.

Table 20 — Hilti KWIK Bolt 3 stainless steel design information in accordance with CSA A23.3 Annex D[1]

Design parameter	Symbol	Units	Nominal anchor diameter															Ref
			1/4	3/8		1/2				5/8			3/4			1		A23.3-14
Anchor O.D.	d_a	in.	0.25	0.375		0.5				0.625			0.75			1		
		(mm)	(6.4)	(9.5)		(12.7)				(15.9)			(19.1)			(25.4)		
Effective minimum embedment[2]	h_{ef}	in.	1-1/2	2		2		3-1/4		3-1/8	4		3-3/4		5	4	5-1/4	
		(mm)	(38)	(51)		(51)		(83)		(79)	(102)		(95)		(127)	(102)	(133)	
Minimum concrete thickness[2]	h_{min}	in.	4	4	5	4	6	6	8	5	6	8	6	8	8	8	10	
		(mm)	(102)	(102)	(127)	(102)	(152)	(152)	(203)	(127)	(152)	(203)	(152)	(203)	(203)	(203)	(254)	
Critical edge distance	c_{ac}	in.	3	4-3/8	3-7/8	4-7/8	4	6-3/4	5-3/4	7-3/8	9-1/2	7-1/2	10-1/2	9-1/4	9-3/4	10	11	
		(mm)	(76)	(111)	(98)	(124)	(102)	(171)	(146)	(187)	(241)	(191)	(267)	(235)	(248)	(254)	(279)	
Minimum edge distance	c_{min}	in.	1-3/8	2	1-5/8	2-1/2	1.875	1-5/8	1-5/8	3-1/4	2-1/2	2-1/2	3-1/4	3	2-7/8	3-1/2	3	
		(mm)	(35)	(51)	(41)	(64)	(48)	(41)	(41)	(83)	(64)	(64)	(83)	(76)	(73)	(89)	(76)	
	for s >	in.	1-3/4	4	3-3/8	5	4-5/8	4-1/2	4.25	5-5/8	5-1/4	5	7	6-7/8	6-5/8	6-3/4	6-3/4	
		(mm)	(44)	(102)	(86)	(127)	(117)	(114)	(108)	(143)	(133)	(127)	(178)	(175)	(168)	(171)	(171)	
Minimum anchor spacing	s_{min}	in.	1-1/4	2	1-3/4	2-1/2	2-1/4	2	1-7/8	3-1/8	2-1/8	2-1/8	4	3-1/2	3-1/2	5	4-3/4	
		(mm)	(32)	(51)	(44)	(64)	(57)	(2)	(48)	(79)	(54)	(54)	(102)	(89)	(89)	(127)	(121)	
	for c >	in.	1-5/8	3-1/4	2-1/2	2-7/8	2-3/8	2-3/8	2-1/8	3-7/8	3	2-3/4	4-1/8	3-3/4	3-3/4	4-1/4	3-3/4	
		(mm)	(41)	(83)	(64)	(73)	(60)	(60)	(54)	(98)	(76)	(70)	(105)	(95)	(95)	(108)	(95)	
Minimum hole depth in concrete	h_o	in.	2	2-5/8		2-5/8		4		3-7/8	4-3/4		4-1/2		5-3/4	5	6-3/4	
		(mm)	(50.8)	(67)		(67)		(102)		(98)	(121)		(117)		(146)			
Minimum specified yield strength	f_{ya}	psi	84,800	92,000		92,000				92,000			76,000			76,000		
		(N/mm²)	(585)	(634)		(634)				(634)			(524)			(524)		
Minimum specified ultimate strength	f_{uta}	psi	115,000	115,000		115,000				115,000			90,000			90000		
		(N/mm²)	(793)	(793)		(793)				(793)			(621)			(621)		
Effective tensile stress area	$A_{se,N}$	in²	0.02	0.06		0.11				0.17			0.24			0.47		
		(mm²)	(12.9)	(38.7)		(71.0)				(109.7)			(154.8)			(154.8)		
Steel embedment material resistance factor for reinforcement	ϕ_s	-	0.85															8.4.3
Resistance modification factor for tension, steel failure modes[3]	R	-	0.80															D.5.3
Resistance modification factor for shear, steel failure modes[3]	R	-	0.75															D.5.3
Factored steel resistance in tension	N_{sar}	lb	1,565	4,690		8,600				13,295			14,690			28,770		D.6.1.2
		(kN)	(7.0)	(20.9)		(38.3)				(59.1)			(65.3)			(128.0)		
Factored steel resistance in shear	V_{sar}	lb	1,070	3,175		2,675		4,425		5,710	9,115		7,585		15,010	7,975	17,430	D.7.1.2
		(kN)	(4.8)	(14.1)		(11.9)		(19.7)		(25.4)	(66.8)		(33.7)		(66.8)	(35.5)	(77.5)	
Coeff. for factored concrete breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10															D.6.2.2
Modification factor for anchor resistance, tension, uncracked concrete[4]	$\psi_{c,N}$	-	1.0															D.6.2.6
Anchor category	-	-	2	1														D.5.3 (c)
Concrete material resistance factor	ϕ_c	-	0.65															8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]	R	-	0.85	1.00														D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete[6]	$N_{pr,uncr}$	lb	1,100	2,070		2,315		4,225		4,360	5,485		6,000		7,600	NA	10,905	D.6.3.2
		(kN)	(4.9)	(9.2)		(10.3)		(18.8)		(19.4)	(24.4)		(26.7)		(33.8)		(48.5)	

1 Design information in this table is taken from ICC-ES ESR-2302, dated December 1, 2020 table 4, and converted for use with CSA A23.3 Annex D.

2 See figure 1 of this section.

3 The stainless steel KWIK Bolt 3 is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-2302 for additional information.

Table 21 — Hilti KWIK Bolt 3 stainless steel factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1 1/2 (38)	1-11/16 43	930 (4.1)	1,040 (4.6)	1,140 (5.1)	1,315 (5.8)	1,300 (5.8)	1,455 (6.5)	1,595 (7.1)	1,840 (8.2)
3/8	2 (51)	2-5/16 (59)	2,080 (9.2)	2,325 (10.3)	2,545 (11.3)	2,940 (13.1)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)
1/2	2 (51)	2 3/8 (60)	2,315 (10.3)	2,585 (11.5)	2,835 (12.6)	3,275 (14.6)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)
	3-1/4 (83)	3 5/8 (92)	4,220 (18.8)	4,715 (21.0)	5,165 (23.0)	5,965 (26.5)	9,885 (44.0)	11,050 (49.2)	12,105 (53.8)	13,975 (62.2)
5/8	3-1/8 (79)	3-9/16 (90)	4,360 (19.4)	4,875 (21.7)	5,340 (23.8)	6,165 (27.4)	9,175 (40.8)	10,260 (45.6)	11,240 (50.0)	12,980 (57.7)
	4 (102)	4-7/16 (113)	5,480 (24.4)	6,125 (27.2)	6,710 (29.8)	7,750 (34.5)	13,465 (59.9)	15,055 (67.0)	16,490 (73.4)	19,040 (84.7)
3/4	3-3/4 (95)	4-5/16 (110)	6,000 (26.7)	6,705 (29.8)	7,345 (32.7)	8,480 (37.7)	12,100 (53.8)	13,530 (60.2)	14,820 (65.9)	17,115 (76.1)
	4-3/4 (121)	5-9/16 (141)	7,590 (33.8)	8,485 (37.7)	9,295 (41.3)	10,730 (47.7)	17,395 (77.4)	19,450 (86.5)	21,305 (94.8)	24,600 (109.4)
1	4 (102)	4-5/16 (110)	6,730 (29.9)	7,525 (33.5)	8,245 (36.7)	9,520 (42.3)	13,465 (59.9)	15,055 (67.0)	16,490 (73.4)	19,040 (84.7)
	5 3/4 (146)	5-9/16 (141)	10,895 (48.5)	12,180 (54.2)	13,340 (59.3)	15,405 (68.5)	23,055 (102.6)	25,780 (114.7)	28,240 (125.6)	32,610 (145.0)

1 See section 3.1.8 to convert factored resistance value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 14 to 19 as necessary. Compare to the steel values in table 31. The lesser of the values is to be used for the design.

4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 22 — Steel resistance for Hilti KWIK Bolt 3 hot-dip galvanized carbon steel anchors[1,2]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Tensile N_{sar} [3] lb (kN)	Shear V_{sar} [4] lb (kN)
1/2	2-1/4 (57)	7,930 (35.3)	2,870 (12.8)
	3-1/2 (89)		3,740 (16.6)
5/8	3-1/2 (89)	12,255 (54.5)	7,415 (33.0)
	4-3/8 (111)		
3/4	4-1/4 (108)	17,300 (77.0)	10,840 (48.2)
	5-1/2 (140)		

1 See section 3.1.8 to convert design strength value to ASD value.

2 KWIK Bolt 3 hot-dip galvanized carbon steel anchors are to be considered ductile steel elements.

3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}\ R$ as noted in ACI 318 Chapter 17.

4 Shear values determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}\ R$ as noted in ACI 318 Chapter 17.

Table 23 — Hilti KWIK Bolt 3 hot-dip galvanized carbon steel design information in accordance with CSA A23.3 Annex D[1]

Design parameter	Symbol	Units											Ref A23.3-14
			1/2				5/8			3/4			
Anchor O.D.	d_a	in.	0.5				0.625			0.75			
		(mm)	(12.7)				(15.9)			(19.1)			
Effective minimum embedment[2]	h_{ef}	in.	2		3-1/4		3-1/8	4		3-3/4		4-3/4	
		(mm)	(51)		(83)		(79)	(102)		(95)		(121)	
Minimum concrete thickness	h_{min}	in.	4	6	6	8	5	6	8	6	8	8	
		(mm)	(102)	(152)	(152)	(203)	(127)	(152)	(203)	(152)	(203)	(203)	
Critical edge distance	c_{ac}	in.	4-7/8	3-5/8	7-1/2	5.75	8	9-1/2	8	9-3/4	7-1/2	9-1/2	
		(mm)	(124)	(92)	(191)	(146)	(194)	(241)	(197)	(248)	(191)	(241)	
Minimum edge distance	c_{min}	in.	2-7/8		2-1/8		3-1/4	2-3/8		4-1/4		4	
		(mm)	(73)		(54)		(83)	(60)		(108)		(102)	
	for s >	in.	5-3/4		5-1/4		5-1/2	5-1/2		10		8-1/2	
		(mm)	(146)		(133)		(140)	(140)		(254)		(216)	
Minimum anchor spacing	s_{min}	in.	2-7/8		2		2-3/4	2-3/8		5		4	
		(mm)	(73)		(51)		(70)	(60)		(127)		(102)	
	for c >	in.	4-1/2		3-1/4		4-1/8	4-1/4		9-1/2		7	
		(mm)	(114)		(83)		(105)	(108)		(241)		(178)	
Minimum hole depth in concrete	h_o	in.	2-5/8		4		3-3/4	4-3/4		4-1/2		5-3/4	
		(mm)	(67)		(102)		(98)	(121)		(117)		(146)	
Minimum specified yield strength	f_{ya}	psi	92,000				92,000			76,125			
		(N/mm^2)	(634)				(634)			(525)			
Minimum specified ultimate strength	f_{uta}	psi	115,000				115,000			101,500			
		(N/mm^2)	(793)				(793)			(700)			
Effective tensile stress area	$A_{se,N}$	in^2	0.101				0.162			0.237			
		(mm^2)	(65.0)				(104.6)			(152.8)			
Steel embedment material resistance factor for reinforcement	ϕ_s	-	0.85										8.4.3
Resistance modification factor for tension, steel failure modes[4]	R	-	0.80										D.5.3
Resistance modification factor for shear, steel failure modes[4]	R	-	0.75										D.5.3
Factored steel resistance in tension	N_{sar}	lb	7,930				12,255			17,300			D.6.1.2
		(kN)	(35.3)				(54.5)			(77.0)			
Factored steel resistance in shear	V_{sar}	lb	2,870		3,740		7,415			10,840			D.7.1.2
		(kN)	(12.8)		(16.6)		(33.0)			(48.2)			
Coefficient for factored concrete breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10										D.6.2.2
Modification factor for anchor resistance, tension, uncracked concrete[4]	$\Psi_{c,N}$	-	1.00										D.6.2.6
Anchor category	-	-	1										D.5.3 (c)
Concrete material resistance factor	ϕ_c	-	0.65										8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]	R	-	1.00										D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete[6]	$N_{pr,uncr}$	lb	N/A		4,585		4,540	6,315		NA		7,125	D.6.3.2
		(kN)			(20.4)		(20.2)	(28.1)				(31.7)	

1 Design information in this table is taken from ICC-ES ESR-2302, dated December 1, 2020 table 4, and converted for use with CSA A23.3 Annex D.

2 See figure 1 of this section.

3 The hot-dip galvanized carbon steel KWIK Bolt 3 is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-2302 for additional information.

Table 24 — Hilti KWIK Bolt 3 hot-dip galvanized carbon steel factored resistance with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/2	2 (51)	2 3/8 (60)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)
	3-1/4 (83)	3 5/8 (92)	4,580 (20.4)	5,120 (22.8)	5,610 (25.0)	6,480 (28.8)	9,885 (44.0)	11,050 (49.2)	12,105 (53.8)	13,975 (62.2)
5/8	3-1/8 (79)	3-9/16 (90)	4,535 (20.2)	5,070 (22.5)	5,555 (24.7)	6,410 (28.5)	9,175 (40.8)	10,260 (45.6)	11,240 (50.0)	12,980 (57.7)
	4 (102)	4-7/16 (113)	6,315 (28.1)	7,060 (31.4)	7,730 (34.4)	8,930 (39.7)	13,465 (59.9)	15,055 (67.0)	16,490 (73.4)	19,040 (84.7)
3/4	3-3/4 (95)	4-5/16 (110)	6,050 (26.9)	6,765 (30.1)	7,410 (33.0)	8,555 (38.1)	12,100 (53.8)	13,530 (60.2)	14,820 (65.9)	17,115 (76.1)
	4-3/4 (121)	5-9/16 (141)	7,130 (31.7)	7,975 (35.5)	8,735 (38.9)	10,085 (44.9)	17,395 (77.4)	19,450 (86.5)	21,305 (94.8)	24,600 (109.4)

1 See section 3.1.8 to convert factored resistance value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 23 to 25 as necessary. Compare to the steel values in table 34. The lesser of the values is to be used for the design.

4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 25 — Hilti KWIK Bolt 3 stainless steel factored resistance in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6,7]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Loads according to figure 5		
			Tension - N_r		Shear - V_r
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c ≥ 20 MPa (2,900 psi) lb (kN)
1/4	1-1/2 (38)	1-11/16 (43)	980 (4.4)	1,200 (5.3)	1,290 (5.7)
3/8	2 (51)	2-5/16 (59)	1,650 (7.3)	2,020 (9.0)	1,645 (7.3)
1/2	2 (51)	2-3/8 (60)	1,245 (5.5)	1,520 (6.8)	1,110 (4.9)
	3-1/4 (83)	3-5/8 (92)			
5/8	3-1/8 (79)	3-9/16 (90)	2,830 (12.6)	3,465 (15.4)	3,625 (16.1)
	4 (102)	4-7/16 (113)			

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).

4 Tabular value is for lightweight concrete and no additional reduction factor is needed.

5 No additional reduction factors for spacing or edge distance need to be applied.

6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.

7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

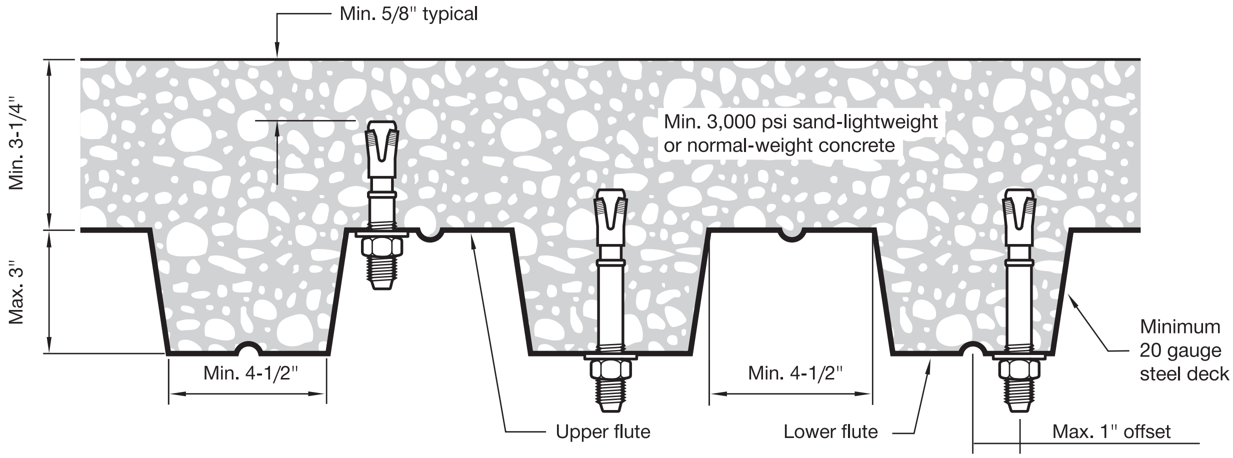


Figure 5 — Installation in concrete over metal deck

DESIGN INFORMATION FOR COUNTERSUNK KWIK BOLT 3

Table 26 — Countersunk Hilti KWIK Bolt 3 allowable loads in normal-weight concrete[1]

Anchor Material	Nominal anchor diameter in.	Embedment depth in. (mm)		f'_c = 3000 psi (20.7 MPa)			
				Tension lb (kN)		Shear[2] lb (kN)	
Carbon Steel	1/4	1-1/8	(29)	365	(1.6)	350	(1.6)
	3/8	1-5/8	(41)	810	(3.6)	750	(3.3)
Stainless Steel	1/4	1-1/8	(29)	320	(1.4)	500	(2.2
	3/8	1-5/8	(41)	670	(3.0)	1330	(5.9)

1 Allowable loads based on using a safety factor of 4.0.

2 Shear values acting thru threads of anchor bolt. If acting through the empty shell, reduce loads by 70%.

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION

KWIK Bolt 3 anchor product line

Size	Length (ℓ)		Thread length (ℓ_{th})		ID stamp	Box	304 SS	316 SS	HDG
	in.	(mm)	in.	(mm)					
1/4 x 1-3/4	1-3/4	(44)	3/4	(18)	A	100	●		
1/4 x 2-1/4	2-1/4	(57)	7/8	(22)	B		●	●	
1/4 x 3-1/4	3-1/4	(83)	2	(51)	D		●		
			7/8	(22)				●	
1/4 x 4-1/2	4-1/2	(114)	2-7/8	(75)	G		●		
3/8 x 2-1/4	2-1/4	(57)	7/8	(22)	B	50	●		
3/8 x 3	3	(76)	1-1/4	(32)	D			●	
			1-1/2	(40)			●		
3/8 x 3-3/4	3-3/4	(95)	1-1/4	(32)	E			●	
			2-1/4	(59)			●		
3/8 x 5	5	(127)	3-1/2	(91)	H		●		
3/8 x 7	7	(178)	5-1/2	(142)	L		●		
1/2 x 2-3/4	2-3/4	(70)	1-1/4	(33)	C	25	●		
1/2 x 3-3/4	3-3/4	(95)	1-5/16	(35)	E			●	
			2-3/16	(56)			●		●
1/2 x 4-1/2	4-1/2	(114)	1-5/16	(35)	G			●	
			2-7/8	(75)			●		●
1/2 x 5-1/2	5-1/2	(140)	1-5/16	(35)	I			●	
			3-3/4	(96)			●		●
1/2 x 7	7	(178)	4-3/4	(121)	L		●		●
5/8 x 3-3/4	3-3/4	(95)	1-1/2	(41)	E	15	●	●	
5/8 x 4-3/4	4-3/4	(121)	1-1/2	(41)	G			●	
			2-3/4	(70)			●		●
5/8 x 6	6	(152)	1-1/2	(41)	J			●	
			4	(102)			●		●
5/8 x 7	7	(178)	4-3/4	(121)					
5/8 x 8-1/2	8-1/2	(216)	6-1/2	(166)	O		●		
5/8 x 10	10	(254)	7	(180)	R		●		
3/4 x 4-3/4	4-3/4	(121)	1-1/2	(41)	G	20	●	●	
			2-7/16	(62)		10			●
						20	●		
3/4 x 5-1/2	5-1/2	(140)	1-1/2	(41)	I	20	●		
			3-7/16	(85)		10			●
						20	●		
3/4 x 7	7	(178)	4-5/8	(119)	L	10			
			4-7/8	(124)			●		
3/4 x 8	8	(203)	5-3/4	(146)	N		●		●
3/4 x 10	10	(254)	5-7/8	(152)	R		●	●	
3/4 x 12	12	(305)	5-7/8	(152)	T		●		
1 x 6	6	(152)	2-1/4	(57)	J	5	●	●	
1 x 9	9	(114)	2-1/4	(57)	P		●		
1 x 12	12	(114)	6	(152)	T		●		

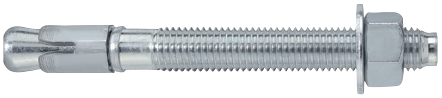
Countersunk KWIK Bolt 3 anchor product line

Size	Length in.	(mm)	Box	Carbon steel	304 SS
C1/4 x 2	2	(51)	100	•	
C1/4 x 3	3	(76)	100	•	•
C1/4 x 5	5	(127)	100	•	
C3/8 x 2-1/4	2-1/4	(57)	100	•	
C3/8 x 3	3	(76)	100	•	
C3/8 x 4	4	(102)	50	•	•
C3/8 x 5	5	(127)	50	•	

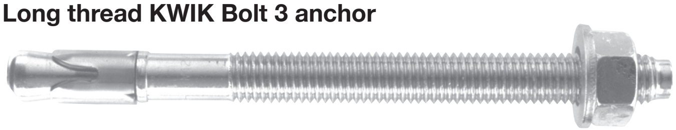
Rod Coupling KWIK Bolt 3 anchor product line

Size	Length in.	(mm)	Thread length in.	(mm)	ID stamp	Box quantity
3/8 x 2-1/4	2-1/4	(57)	7/8	(22)	B	100

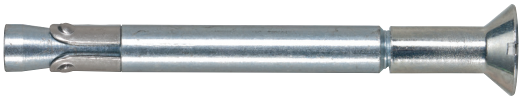
KWIK Bolt 3 anchor



Long thread KWIK Bolt 3 anchor



Countersunk KWIK Bolt 3 anchor



Rod coupling KWIK Bolt 3 anchor 3/8 x 2 1/4

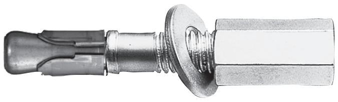


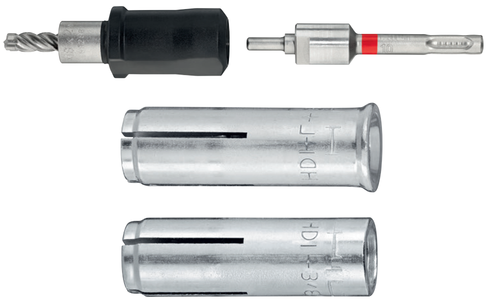
Table 43 — KWIK Bolt 3 length identification system

Length ID marking on bolt head		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
Length of anchor, ℓ_{anch} in.	From	1 ½	2	2 ½	3	3 ½	4	4 ½	5	5 ½	6	6 ½	7	7 ½	8	8 ½	9	9 ½	10	11	12	13	14	15
	Up to but not including	2	2 ½	3	3 ½	4	4 ½	5	5 ½	6	6 ½	7	7 ½	8	8 ½	9	9 ½	10	11	12	13	14	15	16

3.3.12 HDI+, HDI-L+, AND HDI DROP IN ANCHORS

PRODUCT DESCRIPTION

HDI+, HDI-L+, and HDI Drop-in anchors

Anchor System		Features and Benefits
	HDI-L+ and HDI+ with Auto setting tools 1/4” to 1/2”	- Anchor, setting tool and Hilti drill bit form a matched tolerance system to provide reliable fastenings - Allows shallow embedment without sacrificing performance - Lip allows accurate flush surface setting, independent of hole depth for the HDI-L+ - Ideal for repetitive fastenings with threaded rods of equal length - HDI+ and HDI-L+ have an innovative stepped plug that reduces number of hammer blows by up to 50%
	HDI and Manual setting tool 5/8” to 3/4” HDI SS303 1/4" to 3/4" HDI-S 1/2" and 3/4"	- HDI+ and HDI-L+ can be installed with the new HDI+ Setting Tool system (stop drill bit and machine setting tool) for improved productivity - HDI-S speed thread designed to accept coil rods and forms a matched tolerance system for forming applications.

Uncracked concrete

Fire sprinkler listings

Approvals/Listings	
FM (Factory Mutual)	Pipe hanger components for automatic sprinkler systems HDI+ 3/8, HDI-L+ 3/8, HDI+1/2, HDI-L+ 1/2, HDI 5/8 and HDI 3/4
UL and cUL (Underwriters Laboratory)	Pipe hanger equipment for fire protection services HDI+ 3/8, HDI-L+ 3/8, HDI+1/2, HDI-L+ 1/2, HDI 5/8 and HDI 3/4
ANSI/MSS SP-58-2018	Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information.

INSTALLATION PARAMETERS

Table 1 — Hilti HDI+, HDI-L+HDI, HDI-SS303 and HDI-S specifications

Setting Information	Symbol	Units	HDI+, HDI-L+ and HDI-SS303			HDI and HDI-SS303		HDI-S	
			1/4	3/8	1/2	5/8	3/4	1/2	3/4
Insert thread	d	UNC	1/4-20	3/8-16	1/2-13	5/8-11	3/4-10	1/2-6	3/4-4.5
Nominal bit diameter	d_{bit}	in.	3/8	1/2	5/8	27/32	1	5/8	1
Nominal embedment Anchor length Hole depth	h_{nom} ℓ h_o	in. (mm)	1 (25)	1-9/16 (40)	2 (51)	2-9/16 (65)	3-3/16 (81)	2 (51)	3-3/16 (81)
Useable thread length	ℓ_{th}	in. (mm)	7/16 (11)	5/8 (15)	11/16 (17)	7/8 (22)	1-3/8 (34)	11/16 (17)	1-3/8 (34)
Installation torque	T_{inst}	ft-lb (Nm)	4 (5)	11 (15)	22 (30)	37 (50)	80 (109)	22 (30)	80 (109)
Minimum slab thickness	h	in. (mm)	3 (76)	3-1/8 (79)	4 (102)	5-1/8 (130)	6-3/8 (162)	4 (102)	6-3/8 (162)

MATERIAL SPECIFICATIONS

HDI+, HDI-L, HDI and HDI-S anchors are manufactured from mild carbon steel. Anchor bodies are zinc plated in accordance with ASTM B633, AC 1, Type III

HDI SS303 anchors are manufactured from AISI Type 303 stainless steel

DESIGN DATA IN CONCRETE USING ALLOWABLE STRESS DESIGN

Table 2 — Hilti HDI+, HDI-L+ and HDI carbon steel allowable loads in concrete[1,2]

Anchor type	Nominal anchor diameter in.	f'_c = 2,000				f'_c = 4,000				f'_c = 6,000			
		Tension, lb (kN)		Shear, lb (kN)		Tension, lb (kN)		Shear, lb (kN)		Tension, lb (kN)		Shear, lb (kN)	
HDI+	1/4	385	(1.7)	450	(2.0)	510	(2.3)	625	(2.8)	640	(2.8)	700	(3.1)
	3/8	635	(2.8)	965	(4.3)	920	(4.1)	1,250	(5.6)	1,260	(5.6)	1,500	(6.7)
	1/2	945	(4.2)	1,500	(6.7)	1,605	(7.1)	2,125	(9.5)	1,950	(8.7)	2,500	(11.1)
HDI	5/8	1,875	(8.3)	2,500	(11.1)	2,920	(13.0)	3,250	(14.5)	3,715	(16.5)	3,750	(16.7)
	3/4	2,500	(11.1)	3,875	(17.2)	4,065	(18.1)	5,000	(22.2)	5,565	(24.8)	5,500	(24.5)

Table 3 — Hilti HDI+, HDI-L+ and HDI carbon steel ultimate loads in concrete[1]

Anchor type	Nominal anchor diameter in.	f'_c = 2,000				f'_c = 4,000				f'_c = 6,000			
		Tension, lb (kN)		Shear, lb (kN)		Tension, lb (kN)		Shear, lb (kN)		Tension, lb (kN)		Shear, lb (kN)	
HDI+	1/4	1,535	(6.8)	1,800	(8.0)	2,040	(9.1)	2,500	(11.1)	2,555	(11.4)	2,800	(12.5)
	3/8	2,540	(11.3)	3,850	(17.1)	3,685	(16.4)	5,000	(22.2)	5,035	(22.4)	6,000	(26.7)
	1/2	3,780	(16.8)	6,000	(26.7)	6,425	(28.6)	8,500	(37.8)	7,810	(34.7)	10,000	(44.5)
HDI	5/8	7,500	(33.4)	10,000	(44.5)	11,685	(52.0)	13,000	(57.8)	14,865	(66.1)	15,000	(66.7)
	3/4	10,000	(44.5)	15,500	(68.9)	16,260	(72.3)	20,000	(89.0)	22,250	(99.0)	22,000	(97.9)

1 The shear tests were conducted with SAE Grade 5 bolts with minimum yield strength of 85 ksi and minimum tension strength of 120 ksi. Shear testing for the 1/4-in. models were conducted with SAE Grade 8 bolts with minimum yield strength of 120 ksi and minimum tension strength of 150 ksi in 6,000 psi concrete. High-strength bolts were used to force concrete failure modes. When using steel bolts with a lower tensile strength, steel failure must be considered.

2 Allowable loads calculated with a factor of safety of 4.

Table 4 — Hilti HDI+, HDI-L+ and HDI carbon steel allowable loads in lightweight concrete and lightweight concrete poured over metal deck[1,2,3,4]

Anchor type	Nominal anchor diameter in.	3,000 psi lightweight concrete				3,000 psi lightweight concrete over metal deck							
						Upper flute				Lower flute			
		Tension, lb (kN)		Shear, lb (kN)		Tension, lb (kN)		Shear, lb (kN)		Tension, lb (kN)		Shear, lb (kN)	
HDI+	1/4	465	(2.1)	340	(1.5)	530	(2.4)	335	(1.5)	375	(1.7)	250	(1.1)
	3/8	720	(3.2)	940	(4.2)	810	(3.6)	1,010	(4.5)	500	(2.2)	500	(2.2)
	1/2	1,035	(4.6)	1,700	(7.6)	1,035	(4.6)	1,755	(7.8)	625	(2.8)	750	(3.3)
HDI	5/8	1,465	(6.5)	2,835	(12.6)	1,035	(4.6)	1,755	(7.8)	875	(3.9)	875	(3.9)
	3/4	2,075	(9.2)	3,680	(16.4)	1,250	(5.6)	1,755	(7.8)	1,250	(5.6)	1,000	(4.4)

1 The shear tests were conducted with SAE Grade 5 bolts with minimum yield strength of 85 ksi and minimum tension strength of 120 ksi. Shear testing for the 1/4-in. models were conducted with SAE Grade 8 bolts with minimum yield strength of 120 ksi and minimum tension strength of 150 ksi in 6,000 psi concrete. High-strength bolts were used to force concrete failure modes. When using steel bolts with a lower tensile strength, steel failure must be considered.

2 Minimum compressive strength of structural lightweight concrete is 3,000 psi.

3 See figure 1 for typical details.

4 Allowable loads calculated with a factor of safety of 4.

Table 5 — Hilti HDI stainless steel allowable loads in concrete[1,2]

Nominal anchor diameter in.	f'_c = 4,000				f'_c = 6,000			
	Tension, lb (kN)		Shear, lb (kN)		Tension, lb (kN)		Shear, lb (kN)	
1/4	480	(2.1)	600	(2.7)	740	(3.3)	600	(2.7)
3/8	1,040	(4.6)	1,230	(5.5)	1,460	(6.5)	1,230	(5.5)
1/2	1,840	(8.2)	2,760	(12.3)	2,410	(10.7)	2,760	(12.3)
5/8	2,630	(11.7)	4,510	(20.1)	3,770	(16.8)	4,510	(20.1)
3/4	3,830	(17.0)	5,580	(24.8)	5,030	(22.4)	5,580	(24.8)

1 Shear testing conducted with 18-8 stainless steel bolts.

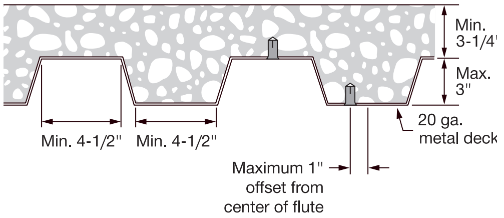
2 Allowable loads calculated with a factor of safety of 4.

Table 6 — Hilti HDI-S speed thread allowable loads in concrete[1]

Nominal anchor diameter in.	f'_c = 4,000				f'_c = 6,000			
	Tension, lb (kN)		Shear, lb (kN)		Tension, lb (kN)		Shear, lb (kN)	
1/2	1,785	(7.9)	1,570	(7.0)	2,345	(10.4)	1,570	(7.0)
3/4	4,065	(18.1)	3,700	(16.5)	5,565	(24.8)	3,700	(16.5)

1 Allowable loads calculated with a factor of safety of 4.

Figure 1 — Installation of Hilti HDI+ and HDI drop-in anchor in the soffit of concrete over metal deck floor and roof assemblies W – deck



Combined shear and tension loading

$$\left(\frac{N_d}{N_{rec}}\right)^{5/3} + \left(\frac{V_d}{V_{rec}}\right)^{5/3} \leq 1.0$$

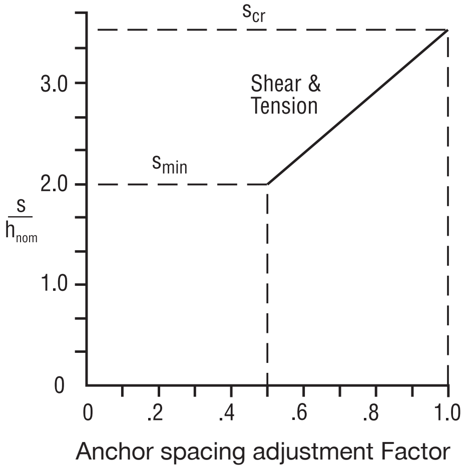
Anchor spacing and edge distance guidelines

Anchor spacing adjustment factors

s = Actual Spacing

$s_{min} = 2.0\ h_{nom}$

$s_{cr} = 3.5\ h_{nom}$

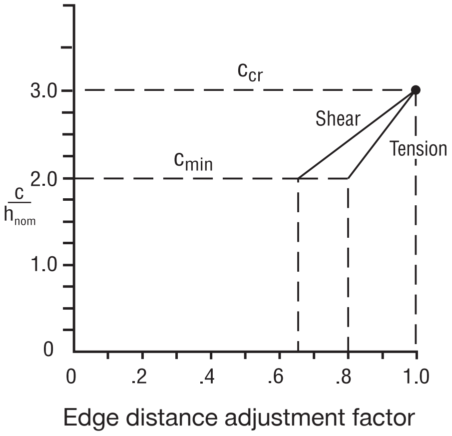


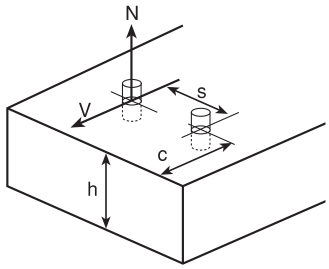
Edge distance adjustment factors

c = Actual edge distance

$c_{min} = 2.0\ h_{nom}$

$c_{cr} = 3.0\ h_{nom}$





Influence of anchor spacing and edge distance f_A and f_R

Anchor Size		h_{nom}	
in.	(mm)	in.	(mm)
1/4	(6.4)	1	(25)
3/8	(9.5)	1-9/16	(40)
1/2	(12.7)	2	(51)
5/8	(15.8)	2-9/16	(65)
3/4	(19.1)	3-3/16	(81)

h_{nom} = nominal embedment depth

Table 7 — Load adjustment factors for Hilti HDI drop-in anchors in concrete

Load adjustment factors for anchor spacing f_A							Load adjustment factors for edge distance f_R											
Tension/shear loads							Tension f_{RN}							Shear f_{RV}				
Spacing s		Anchor diameter					Edge distance c		Anchor diameter					Anchor diameter				
in.	(mm)	1/4	3/8	1/2	5/8	3/4	in.	(mm)	1/4	3/8	1/2	5/8	3/4	1/4	3/8	1/2	5/8	3/4
2	(51)	.50					2	(51)	.80					.65				
2-1/2	(64)	.67					2-1/2	(64)	.90					.83				
3	(76)	.83	.50				3	(76)	1.0	.80				1.0	.65			
3-1/2	(89)	1.0	.58				3-1/2	(89)		.85					.73			
4	(102)		.69	.50			4	(102)		.91	.80				.85	.65		
4-1/2	(114)		.79	.58			4-1/2	(114)		.98	.85				.96	.74		
5	(127)		.90	.67	.50		5	(127)		1.0	.90	.80			1.0	.83	.65	
5-1/2	(140)		1.0	.75	.55		5-1/2	(140)			.95	.83				.91	.70	
6	(152)			.83	.61	.50	6	(152)			1.0	.87				1.0	.77	
7	(178)			1.0	.74	.57	6-1/2	(165)				.91	.80				.84	.65
8	(203)				.87	.67	7	(178)				.95	.84				.91	.72
9	(229)				1.0	.77	8	(203)				1.0	.90				1.0	.83
10	(254)					.88	9	(229)					.96					.94
11	(279)					.98	10	(254)					1.0					1.0
12	(305)					1.0												

$s_{min} = 2.0\ h_{nom} \qquad s_{cr} = 3.5\ h_{nom}$

$$f_A = 0.33\ \frac{s}{h_{nom}} - 0.17$$

for $s_{cr} > s > s_{min}$

$c_{min} = 2.0\ h_{nom} \qquad c_{cr} = 3.0\ h_{nom}$

$$f_{RN} = 0.2\ \frac{c}{h_{nom}} + 0.4$$

for $c_{cr} > c > c_{min}$

$c_{min} = 2.0\ h_{nom} \qquad c_{cr} = 3.0\ h_{nom}$

$$f_{RV} = 0.35\ \frac{c}{h_{nom}} - 0.05$$

for $c_{cr} > c > c_{min}$

INSTALLATION INSTRUCTIONS

Manufacturer's Printed Installation Instructions (MPII) are included with each product package. They can also be viewed or downloaded at www.hilti.com. Because of the possibility of changes, always verify that downloaded MPII are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the MPII.

ORDERING INFORMATION[1]

HDI+, HDI-L+ and HDI

Carbon steel

Description	Description	Description	Anchor thread size	Qty / box
HDI+ 1/4	**HDI-L+ 1/4**	-	1/4	100
HDI+ 3/8	**HDI-L+ 3/8**	-	3/8	50
HDI+ 1/2	**HDI-L+ 1/2**	HDI-S 1/2"	1/2	50
HDI 5/8	**–**	-	5/8	25
HDI 3/4	**–**	HDI-S 3/4"	3/4	25

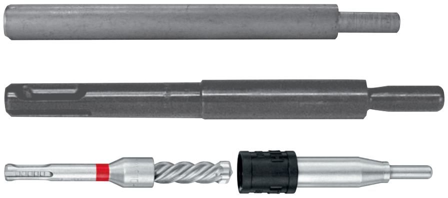
HDI-SS303 anchors

Stainless steel

Description	Anchor thread size	Qty / box
HDI 1/4 SS303	1/4	100
HDI 3/8 SS303	3/8	50
HDI 1/2 SS303	1/2	50
HDI 5/8 SS303	5/8	25
HDI 3/4 SS303	3/4	25

Setting Tools for HDI+ and HDI-L+

Anchor thread size	Description
1/4	HST 1/4 Setting tool
	HSD-MM 1/4 (TE-C-24D6 1/4 Setting tool)
	HDI+ Setting Tool includes a TE-CX 3/8x1 carbide bit
3/8	HST 3/8 Setting tool
	HSD-MM 3/8 (TE-C-24SD10 3/8 Setting tool)
	HDI+ Setting Tool includes a TE-CX 1/2x1-9/16 carbide bit
1/2	HST 1/2 Setting tool
	HSD-MM 1/2 (TE-C-24SD12 1/2 Setting tool)
	HDI+ Setting Tool includes a TE-CX 5/8x2 carbide bit



Setting tools for HDI and HDI-SS303 anchors

Description	Sets anchor size	Qty
HST 1/4" Hand Setting Tool	1/4" HDI SS303	1
HST 3/8" Hand Setting Tool	3/8" HDI SS303	1
HST 1/2" Hand Setting Tool	1/2" HDI SS303 / HDI-S	1
HST 5/8" Hand Setting Tool	5/8" HDI / HDI SS303	1
HST 3/4" Hand Setting Tool	3/4" HDI / HDI SS303 / HDI-S	1

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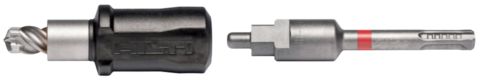
[1] All dimensions in inches

3.3.13 HDI-P TZ DROP-IN ANCHORS

PRODUCT DESCRIPTION

HDI-P TZ Flush anchors

Anchor System		Features and Benefits
	Carbon steel HDI-P TZ	• Drop-in anchor with optimized length for reliable fastenings in post-tensioned cable concrete slabs • Suitable for uncracked and cracked concrete including seismic areas • Productive installation with HDI-P TZ automatic setting tool with hammer drill • Used with Hilti Dust Removal System (DRS) for compliance with Table 1 of OSHA 1926.1153 regulations for silica dust exposure • Shallow drilling for fast installations • Easy installation with Auto Setting Tool • Lip provides flush installation, consistent anchor depth, and easy rod alignment • Auto Setting Tool includes stop drill bit and setting tool, no tool change necessary
	Auto-setting tool HDI-P TZ	
	Hand-setting tool HDI-P TZ	

Uncracked concrete

Cracked concrete

Hollow core concrete

Seismic design categories A-F

Fire sprinkler listings

Approvals/Listings	
ICC-ES (International Code Council)	ESR-4236 in concrete per ACI 318 Ch. 17 / ACI 355.2 / ICC-ES AC193
City of Los Angeles	2017 LABC Supplement (within ESR-4236)
Florida Building Code	2017 FBC Supplement (within ESR-4236)
FM (Factory Mutual)	Pipe hanger components for automatic sprinkler systems for 3/8 (4-inch nominal pipe diameter)
UL (Underwriters Laboratory)	Pipe hanger equipment for fire protection services for 3/8 (4-inch nominal pipe diameter)
ANSI/MSS SP-58-2018	Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information.

MATERIAL SPECIFICATIONS

HDI-P TZ drop-in anchors are manufactured from carbon steel with zinc plating per DIN EN ISO 4042 A2K.

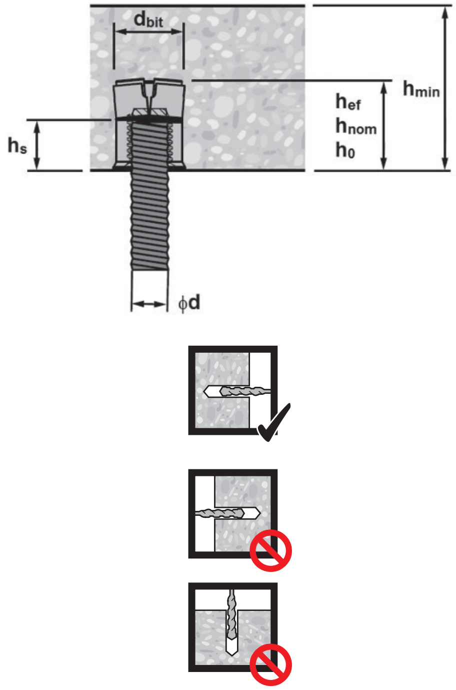
INSTALLATION PARAMETERS

Table 1 — Hilti HDI-P TZ setting information

Setting information	Symbol	Unit	Nominal anchor size / internal thread dia. (in)	
			3/8	
Internal thread diameter	d	in.	3/8	
Nominal bit diameter	d_{bit}	in.	9/16	
Nominal embedment	h_{nom}	in. (mm)	3/4 (19)	
Hole depth in base material	h_0	in. (mm)	3/4 (19)	
Effective embedment	h_{ef}	in. (mm)	3/4 (19)	
Thread engagement length	h_a	in. (mm)	3/8 (10)	
Maximum installation torque for threaded element	T_{max}	ft-lb (Nm)	5 (7)	
Minimum base material thickness — concrete	h_{min}	in. (mm)	2-1/2 (64)	4 (102)
Minimum edge distance — concrete	c_{min}	in. (mm)	6 (152)	2-1/2 (64)
Minimum anchor spacing — concrete	s_{min}	in. (mm)	8 (203)	3 (76)
Minimum base material thickness — hollow core concrete panels	h_{min}	in. (mm)	1/3/8 (35)	
Minimum edge distance — hollow core concrete panels	c_{min}	in. (mm)	6 (152)	
Minimum anchor spacing — hollow core concrete panels	s_{min}	in. (mm)	8 (203)	

For **SI:** 1 inch = 25.4mm, 1 ft-lb = 1.356 Nm

Figure 1 — Hilti HDI-P TZ installation parameters



DESIGN DATA IN CONCRETE PER ACI 318

ACI 318 Chapter 17 Design

The design tables in Tables 2 to 4 are Hilti Simplified Design Tables. The load values were developed using the design parameters and variables of ICC Evaluation Services ESR-4236 and the equations within ACI 318 Chapter 17 as amended by ICC-ES AC193. The strength design capacities calculated from the tables below are to be compared to the factored loads determined from strength design load combinations. For a detailed explanation of the Hilti Simplified Design Tables, refer to Section 3.1.8. Data tables from ESR-4236 are not contained in this section, but can be found at www.hilti.com or www.icc-es.org.

Table 2 — Hilti HDI-P TZ design strength based on concrete failure modes in uncracked concrete per ACI 318 14 Ch. 17 [1,2,3,4,5]

Nominal anchor diameter in.	Nominal embed. in. (mm)	Tension (lesser of concrete breakout / pullout) - φN_n				Shear (lesser of concrete breakout or pryout) - φV_n			
		f'_c = 2500 psi (17.2 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 6000 psi (41.4 MPa) lb (kN)	f'_c = 2500 psi (17.2 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 6000 psi (41.4 MPa) lb (kN)
3/8	3/4 (19)	310 (1.4)	340 (1.5)	395 (1.8)	485 (2.1)	350 (1.6)	385 (1.7)	445 (2.0)	545 (2.4)

Table 3 — Hilti HDI-P TZ design strength based on concrete failure modes in cracked concrete per ACI 318 14 Ch. 17 [1,2,3,4,5,6,7]

Nominal anchor diameter in.	Nominal embed. in. (mm)	Tension (lesser of concrete breakout / pullout) - φN_n				Shear (lesser of concrete breakout or pryout) - φV_n			
		f'_c = 2500 psi (17.2 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 6000 psi (41.4 MPa) lb (kN)	f'_c = 2500 psi (17.2 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 6000 psi (41.4 MPa) lb (kN)
3/8	3/4 (19)	190 (0.8)	200 (0.9)	220 (1.0)	255 (1.1)	250 (1.1)	270 (1.2)	315 (1.4)	385 (1.7)

The following footnotes apply to both Table 2 and 3:

1 See Section 3.1.8.6 of the Anchor Tech Guide Ed. 17 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for a single anchor with a minimum edge distance of 6-1/2-in (166mm) and a minimum spacing of 8-in (204mm). For a 6-in (153mm) edge distance multiply uncracked concrete tension and shear values by 0.92. No reduction needed for cracked concrete.
4 Compare to the steel values in Table 4. The lesser of the values is to be used for the design.
5 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, $\lambda_a = 0.68$. For all-lightweight, $\lambda_a = 0.60$.
6 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis} = 0.74$.
7 No additional reduction needed for seismic shear for concrete breakout or pryout failure. See Section 3.1.8.7 of the Anchor Tech Guide Ed. 17 for additional information on seismic applications.

Table 4 — Hilti HDI-P TZ design strength based on steel failure per ACI 318 Ch. 17 [1,2,3]

Nominal anchor diameter in.	Steel strength of HDI-P TZ anchor			Steel strength of ASTM A36 threaded rod		
	Tensile[4] φN_{sa} lb (kN)	Shear[5] φV_{sa} lb (kN)	Seismic Shear[6,9] φV_{sa} lb (kN)	Tensile[4] $\varphi N_{sa,rod}$ lb (kN)	Shear[7] $\varphi V_{sa,rod}$ lb (kN)	Seismic Shear[8,9] $\varphi V_{sa,rod,eq}$ lb (kN)
3/8	4,065 (18.1)	585 (2.6)	585 (2.6)	3,370 (15.0)	1,885 (8.4)	1,320 (5.9)

1 See Section 3.1.8.6 of the Anchor Tech Guide Ed. 17 to convert design strength value to ASD value.
2 Steel strength in tension and shear determined from the lesser of the HDI-P TZ or the inserted threaded rod.
3 Hilti HDI-P TZ anchors are considered a brittle steel element. ASTM A36 threaded rod is considered a ductile steel element.
4 Tensile $\varphi N_{sa} = \varphi A_{se,N} f_{uta}$ as noted in ACI 318 Ch. 17.
5 Shear values for HDI-P TZ determined by static shear tests with $\varphi V_{sa} \leq \varphi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
6 Seismic shear values for HDI-P TZ determined by seismic shear tests with $\varphi V_{sa} < \varphi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
7 Shear values for threaded rod determined by $\varphi V_{sa,rod} = \varphi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
8 Seismic shear values for threaded rod determined by $\varphi V_{sa,rod,eq} = \varphi\ 0.70\ V_{sa,rod}$.
9 See Section 3.1.8.7 of the Anchor Tech Guide Ed. 17 for additional information on seismic applications

DESIGN DATA IN CONCRETE PER CSA A23.3

CSA A23.3 Annex D Design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. Tables 8 and 9 in this section contains the Limit State Design tables that are based on the published loads in ICC Evaluation Services ESR-4236 and converted for use with CSA A23.3 Annex D. Tables 5 to 7 below are Hilti Simplified Design Tables which are pre-factored resistance tables based on the design parameters and variables in Tables 8 and 9. All the figures in the previous ACI 318 14 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

Table 5 — Hilti HDI-P TZ factored resistance based on concrete failure modes in uncracked concrete per CSA A23.3 Annex D [1,2,3,4,5]

Nominal anchor diameter in.	Nominal embed. in. (mm)	Tension (lesser of concrete breakout / pullout) - N_r				Shear (lesser of concrete breakout or pryout) - V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	3/4 (19)	325 (1.5)	365 (1.6)	400 (1.8)	460 (2.1)	380 (1.7)	425 (1.9)	465 (2.1)	540 (2.4)

Table 6 — Hilti HDI-P TZ factored resistance based on concrete failure modes in cracked concrete per CSA A23.3 Annex D [1,2,3,4,5,6,7]

Nominal anchor diameter in.	Nominal embed. in. (mm)	Tension (lesser of concrete breakout / pullout) - N_r				Shear (lesser of concrete breakout or pryout) - V_r			
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
3/8	3/4 (19)	195 (0.9)	210 (0.9)	220 (1.0)	245 (1.1)	270 (1.2)	300 (1.3)	330 (1.5)	380 (1.7)

The following footnotes apply to both Table 5 and 6:

1 See Section 3.1.8.6 of the Anchor Tech Guide Ed. 17 to convert design strength value to ASD value.

2 Linear interpolation between concrete compressive strengths is not permitted.

3 Tabular values are for a single anchor with a minimum edge distance of 6-1/2-in (166mm) and a minimum spacing of 8-in (204mm). For a 6-in (153mm) edge distance multiply uncracked concrete tension and shear values by 0.92. No reduction needed for cracked concrete.

4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.68. For all-lightweight, λ_a = 0.60.

5 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.74.

6 No additional reduction needed for seismic shear for concrete breakout or pryout failure. See Section 3.1.8.7 of the Anchor Tech Guide Ed. 17 for additional information on seismic applications.

Table 7 — Hilti HDI-P TZ factored resistance based on steel failure per CSA A23.3 Annex D [1,2,3]

Nominal anchor diameter in.	Steel strength of HDI-P TZ anchor			Steel strength of ASTM A36 threaded rod		
	Tensile[4] N_{sar} lb (kN)	Shear[5] V_{sar} lb (kN)	Seismic Shear[6,9] $V_{sar,eq}$ lb (kN)	Tensile[4] N_{sar} lb (kN)	Shear[7] V_{sar} lb (kN)	Seismic Shear[8,9] $V_{sar,eq}$ lb (kN)
3/8	3,720 (16.5)	540 (2.4)	540 (2.4)	3,055 (13.6)	1,720 (7.7)	1,200 (5.3)

1 See Section 3.1.8.6 of the Anchor Tech Guide Ed. 17 to convert design strength value to ASD value.

2 Steel strength in tension and shear determined from the lesser of the HDI-P TZ or the inserted threaded rod.

3 Hilti HDI-P TZ anchors are considered a brittle steel element. ASTM A36 threaded rod is considered a ductile steel element.

4 Tensile $N_{sar} = A_{se,N}\ \varphi_s\ f_{uta}$ as noted in CSA A23.3 Annex D.

5 Shear values for HDI-P TZ determined by static shear tests with $V_{sar} \leq 0.6\ A_{se,V}\ \varphi s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.

6 Seismic shear values for HDI-P TZ determined by seismic shear tests with $V_{sar,eq} \leq 0.60\ A_{se,V}\ \varphi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.

7 Shear values for threaded rod determined by $V_{sar} = 0.6\ A_{se,V}\ \varphi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.

8 Seismic shear values for threaded rod determined by $V_{sar,rod,eq} = 0.70\ V_{sar,rod}$.

9 See Section 3.1.8.7 of the Anchor Tech Guide Ed. 17 for additional information on seismic applications.

Table 8 — Design information, Hilti HDI-P TZ, in accordance with CSA A23.3[1]

Setting information	Symbol	Unit	Nominal anchor size/internal thread dia. (in)	Ref
			3/8	CSA A23.3
Anchor O.D.	d_a	in. (mm)	0.561 (14.25)	
Effective embedment	h_{ef}	in. (mm)	3/4 (19)	
Steel embed. material resistance factor for reinforcement	φ_s	-	0.85	8.4.3
Resistance modification factor for tension, steel failure modes [2,3]	$R_{s,N}$	-	0.70	D.5.3 b)
Min. specified yield strength	f_{ya}	psi (N/mm^2)	70,400 (484)	
Min. specified ultimate strength	f_{uta}	psi (N/mm^2)	88,000 (605)	
Effective-cross sectional steel area in tension	$A_{se,N}$	in^2 (mm^2)	0.071 (45.8)	
Factored steel resistance in tension [4]	N_{sa}	lb (kN)	6,250 (27.8)	D.6.1.2 Eq. D.2
Concrete material resistance factor	φ_c	-	0.65	8.4.2
Anchor category	-	-	1	D.5.3 c)
Resistance modification factor for tension, concrete failure [3]	$R_{c,N}$	-	0.60	
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	in-lb (SI)	24 (10.0)	D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	in-lb (SI)	17 (7.1)	D.6.2.2
Modification factor for anchor resistance, tension, uncracked conc. [5]	$\psi_{c,N}$	-	1.0	D.6.2.6
Critical edge distance	c_{ac}	in. (mm)	6 (152)	
Factored pullout resistance in 20 MPa uncracked concrete [6]	$N_{pr,uncr}$	lb (kN)	N/A	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete [6]	$N_{pr,cr}$	lb (kN)	495 (2.2)	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete, seismic [6]	$N_{pr,eq}$	lb (kN)	490 (2.2)	D.6.3.2
Resistance modification factor for shear, steel failure modes [2,3]	$R_{s,V}$	-	0.65	D.5.3 b)
Factored steel resistance in shear [7]	V_{sa}	lb (kN)	975 (4.3)	D7.1.2
Factored steel resistance in shear, seismic [7]	$V_{sa,eq}$	lb (kN)	975 (4.3)	
Resistance modification factor for shear, concrete failure modes [3]	$R_{c,V}$	-	0.70	
Coefficient for pryout resistance	k_{cp}	-	1.0	D.7.3

1 Design information is taken from ICC-ES ESR-4236, dated July 2018, table 2, and converted for use with CSA A23.3 Annex D.

2 The HDI-P TZ is considered a brittle steel element as defined by CSA A23.3 Annex D Section D.2.

3 All values of R are applicable with the load combinations of CSA A23.3 Chapter 8. For concrete failure modes, no increase for Condition A is permitted.

4 $N_{sar} = N_{sa}\ \varphi_s\ R_{s,N}$ where N_{sa} tabular value above is precalculated from $A_{se,N}\ f_{uta}$.

5 For all design cases, $\psi_{c,N} = 1.0$. The appropriate effectiveness factor for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

6 For all design cases, $\psi_{c,P} = 1.0$. Tabular value for pullout resistance is for a concrete compressive strength of 20 MPa (2,900 psi). Pullout resistance for concrete compressive strength greater than 20 MPa (2,900 psi) may be increased by multiplying the tabular pullout resistance by $(f'_c / 20)^{0.35}$ for MPa or $(f'_c / 2{,}900)^{0.35}$ for psi. NA (not applicable) denotes that pullout strength does not need to be considered for design.

7 Shear and seismic shear tests are all performed in cracked concrete member per ICC-ES AC193 section 9.4 and 9.6 respectively. Value of $V_{sa(eq)} < 0.6\ A_{se,V}\ f_{uta}$ for all cases. Multiply V_{sa} tabular value above by $\varphi_s\ R_{s,V}$ to get V_{sar} and $V_{sar,eq}$.

Table 9 - Steel design information for inserted threaded rod, in accordance with CSA A23.3[1]

Setting information	Symbol	Unit	Nominal anchor size / internal thread dia. (in)
			3/8
Nominal rod diameter	d_{rod}	in.	0.375
Steel embed. material resistance factor for reinforcement	φ_s	-	0.85
Resistance modification factor for tension, steel failure modes, ASTM A36 steel material [2]	$R_{s,N}$	-	0.80
Min. specified ult. strength, ASTM A36 steel material	f_{uta}	psi (MPa)	58,000 (400)
Rod effective cross-sectional area	$A_{se,rod}$	in.^{2} (mm^2)	0.0775 (50)
Factored steel resistance in tension ASTM A36 steel material [3]	$N_{sa,rod}$	lb (kN)	4,495 (20.0)
Factored steel resistance in tension, seismic ASTM A36 steel material [3]	$N_{sa,rod,eq}$	lb (kN)	4,495 (20.0)
Resistance modification factor for steel in shear ASTM A36 steel material [2]	$R_{sa,rod,V}$	-	0.75
Factored steel resistance in shear ASTM A36 steel material [4]	$V_{sa,rod}$	lb (kN)	2,695 (12.0)
Factored steel resistance, seismic ASTM A36 steel material [4]	$V_{sa,rod,eq}$	lb (kN)	1,885 (8.4)

1 Values provided for steel element material types, or equivalent, based on minimum specified strengths and calculated in accordance with CSA A23.3 14 Eq. D.2 and Eq. D.30, as applicable.

2 All values of R are applicable with the load combinations of CSA A23.3 Chapter 8. Values correspond to a ductile steel element.

3 $N_{sar,rod(eq)} = N_{sa,rod(eq} \varphi_s R_{s,N}$ where $N_{sa,rod(eq)}$ tabular value above is precalculated from $A_{se,rod}$ f_{uta}. N_{sar} shall be the lower of $N_{sar,rod}$ or $N_{sar,HDI\text{-}P\ TZ}$ for static steel strength in tension; for seismic loads, $N_{sar,eq}$ shall be the lower of $N_{sar,rod,eq}$ or $N_{sar,eq}$, HDI-P TZ.

4 $V_{sar,rod(eq)} = V_{sa,rod(eq)} \varphi_s R_{s,V}$ where $V_{sa,rod}$ tabular value above is precalculated from 0.6 $A_{se,rod}$ f_{uta}, and $V_{sa,rod,eq}$ must be taken as 0.7 $V_{sa,rod}$. V_{sar} shall be the lower of $V_{sar,rod}$ or $V_{sar,HDI\text{-}P\ TZ}$ for static steel strength in tension; for seismic loading, $V_{sar,eq}$ shall be the lower of $V_{sar,eq}$,rod or $V_{sar,eq,HDI\text{-}P\ TZ}$.

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com or www.hilti.ca. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION

Description	Item number
Flush anchor HDI-P TZ 3/8"	2204029
HDI-P TZ 3/8" MC (1200 PCS / MC)	3596870
HDI-P TZ 3/8" (1/3 Pallet = 9600 PCS)	3596872
HDI-P TZ 3/8" Pallet	3597043
HDI-P TZ 3/8" (300) with auto set tool	3597044
HDI-P TZ 3/8" (600) with auto set tool	3597045
HDI-P TZ 3/8" (1200) with 3 auto set tools	3597046

Accessories

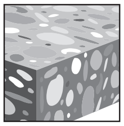
Description	Item number
Auto setting tool HDI-P TZ 3/8"	2204112
Setting tool HST HDI-P TZ 3/8"x20	2204110

3.3.14 HDI-P DROP-IN ANCHORS

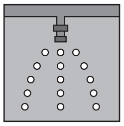
PRODUCT DESCRIPTION

HDI-P Drop-in Anchors

Anchor System	Features and Benefits
HDI-P Drop-in Anchor 	• Optimized anchor length to allow reliable fastenings in hollow core panels, precast plank and post tensioned slabs • Shallow drilling enables fast installation • Lip provides flush installation, consistent anchor depth and easy rod alignment • HSD-G 3/8 setting tool with hand guard leaves mark on flange when anchor is set properly to enable inspection and verification of proper expansion



Uncracked concrete



Fire sprinkler listings

MATERIAL SPECIFICATIONS

The HDI-P is manufactured from mild carbon steel, which is zinc plated for corrosion protection in accordance with ASTM B633, SC 1, Type III.

Approvals/Listings	
FM (Factory Mutual)	Pipe hanger components for automatic sprinkler systems for ¾=8-in. model
ANSI/MSS SP-58-2018	Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information

FM APPROVED

DESIGN DATA IN CONCRETE USING ALLOWABLE STRESS DESIGN

Technical data

Table 1 — Hilti HDI-P loads in normal-weight concrete and hollow core concrete panels

Nominal anchor diameter	Length in. (mm)	Nom. bit dia. in.	Ultimate loads, lb (kN)				Allowable loads, lb (kN)[3]			
			f'_c = 4,000 psi concrete		Hollow core[1,2]		f'_c = 4,000 psi concrete		Hollow core[1,2]	
			Tension	Shear	Tension	Shear	Tension	Shear	Tension	Shear
1/4	5/8 (15.9)	3/8	1,430 (6.4)	1,870 (8.3)	1,550 (6.9)	2,275 (10.1)	285 (1.3)	375 (1.7)	310 (1.4)	455 (2.0)
3/8	3/4 (19.1)	1/2	1,900 (8.5)	3,000 (13.3)	2,100 (9.3)	4,000 (17.8)	380 (1.7)	600 (2.7)	420 (1.9)	800 (3.6)
1/2	1 (25.4)	5/8	3,000 (13.3)	6,075 (27.0)	3,110 (13.8)	5,495 (24.5)	600 (2.7)	1215 (5.4)	620 (2.8)	1,100 (4.9)

[1] The Admissible Anchor Location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm Admissible Anchor Location.

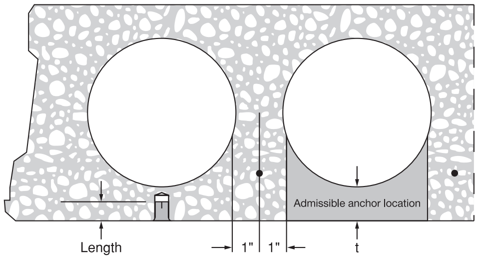
[2] Minimum compressive strength of hollow core panels is 7,000 psi at the time of installation. The minimum thickness "t" is 1-3/8 inches.

[3] Allowable loads calculated with a 5:1 factor-of-safety.

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com (Canada). Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

Figure 1 — Installation of Hilti HDI-P in hollow core concrete



ORDERING INFORMATION

HDI-P anchor

Description	Bit diameter	Qty / box
HDI-P 1/4	3/8	100
HDI-P 3/8	1/2	100
HDI-P 1/2	5/8	50

Setting tools for HDI-P anchors

Description
HST-P 1/4 Hand Setting Tool
HST-P 3/8 Hand Setting Tool
HSD-G 3/8 Hand Setting Tool with hand guard
HST-P 1/2 Hand Setting Tool

INSTALLATION INSTRUCTIONS

Manufacturer's Printed Installation Instructions (MPII) are included with each product package. They can also be viewed or downloaded at www.hilti.com. Because of the possibility of changes, always verify that downloaded MPII are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the MPII.

ORDERING INFORMATION[1]

HDI+, HDI-L+ and HDI

Carbon steel

Description	Description	Anchor thread size	Qty / box
HDI+ 1/4	**HDI-L+ 1/4**	1/4	100
HDI+ 3/8	**HDI-L+ 3/8**	3/8	50
HDI+ 1/2	**HDI-L+ 1/2**	1/2	50
HDI 5/8	**–**	5/8	25
HDI 3/4	**–**	3/4	25

HDI-SS anchors

Stainless steel

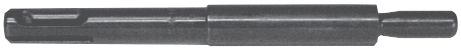
Description	Anchor thread size	Qty / box
HDI 1/4 SS303	1/4	100
HDI 3/8 SS303	3/8	50
HDI 1/2 SS303	1/2	50
HDI 5/8 SS303	5/8	25
HDI 3/4 SS303	3/4	25

Setting tools for HDI and HDI-SS anchors

Description	Anchor thread size
HST 5/8 Setting Tool	5/8
HST 3/4 Setting Tool	3/4

Setting Tools for HDI+ and HDI-L+

Anchor thread size	Description
1/4	HST 1/4 Setting tool
	HSD-MM 1/4 (TE-C-24D6 1/4 Setting tool)
	HDI+ Setting Tool includes a TE-CX 3/8x1 carbide bit
3/8	HST 3/8 Setting tool
	HSD-MM 3/8 (TE-C-24SD10 3/8 Setting tool)
	HDI+ Setting Tool includes a TE-CX 1/2x1-9/16 carbide bit
1/2	HST 1/2 Setting tool
	HSD-MM 1/2 (TE-C-24SD12 1/2 Setting tool)
	HDI+ Setting Tool includes a TE-CX 5/8x2 carbide bit



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[1] All dimensions in inches

3.3.15 KCM-WF/PD CAST-IN ANCHORS

PRODUCT DESCRIPTION

KCM-WF/PD cast-in anchors

Anchor System		Features and Benefits
	KCM-WF internally threaded cast-in anchors for wood	• Application-relevant multi-thread configurations allow for the installation of different diameters of threaded rods. KCM-WF/PD have color coded perforated Foam inserts to prevent concrete intrusion • KCM-WF have notched nails that snap off easily at the concrete surface after the wood forms are stripped. • KCM-WF nails above the head lock the metal head to the plastic body preventing head popping off due to rebar hits • KCM-WF nail and anchor design profile reduce the risk of anchor knock over due to accidental rebar hit • KCM-PD has a design without nails for fastening to pan joist deck • Wider base of the KCM-PD allows for easy fastening to pan joist deck.
	KCM-PD internally threaded cast in anchors for pan deck	
	KCM-WF setting tool	

Uncracked concrete

Cracked concrete

Seismic design categories A-F

Fire sprinkler listings

Approvals/Listings	
ICC-ES (International Code Council) **2015 International Building Code / International Residential Code (IBC/IRC)**	ESR-4145 in concrete per ACI 318 Ch. 17 / ICC-ES AC446
City of Los Angeles	2017 LABC Supplement (within ESR-4145)
FM (Factory Mutual)	Pipe hanger components for automatic sprinkler systems for 3/8 through 3/4
UL and cUL (Underwriters Laboratory)	Pipe hanger equipment for fire protection services for 3/8 through 3/4
ANSI/MSS SP-58-2018	Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information.

ICC ES

LA DBS DEPARTMENT OF BUILDING AND SAFETY

FM APPROVED

c UL us LISTED

MATERIAL SPECIFICATIONS

KCM-WF and KCM-PD anchors have an insert body made from carbon steel with an engineered plastic flange. The insert body is zinc plated per ASTM B633 Fe/Zn 5 Type III.

INSTALLATION PARAMETERS

Table 1 — Hilti KCM-WF and KCM-PD specification table

Design Information	Symbol	Units	1/4"-3/8"	3/8"-1/2"	3/8"-1/2"-5/8"	3/8"-1/2"-5/8"-3/4"
Insert type	-	-	WF and PD	Only WF	WF and PD	WF and PD
Plastic housing color	-	-	Green	Orange	Red	Grey
Effective embedment	h_{ef}	in. (mm)	1.12 (28)	1.63 (41)	2.04 (52)	3.0 (76)
Min. member thickness	h_{min}	in. (mm)	2.5 (64)	2.5 (64)	3 (76)	4 (10)
Outside diameter of anchor steel body	d_a	in. (mm)	0.50 (12.8)	0.66 (16.9)	0.87 (22.1)	1.02 (25.9)
Bearing area	A_{brg}	$in.^2$ (mm^2)	0.91 (590)	1.00 (643)	1.23 (792)	2.25 (1,451)
Minimum anchor spacing[1]	s_{min}	in. (mm)	2.00 (50.8)	2.64 (67.1)	3.48 (88.4)	4.08 (103.6)

[1] Minimum anchor spacing values correspond to $4d_a$ for an un-torqued anchor as specified by ACI 318 17.7.1.

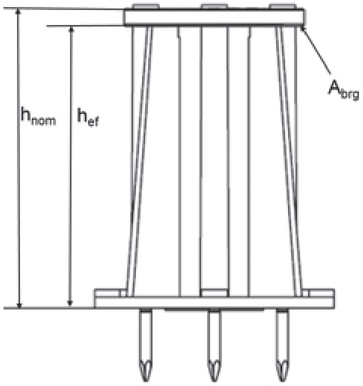


Figure 1 — KCM-WF Anchor

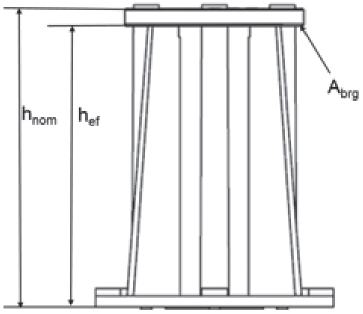
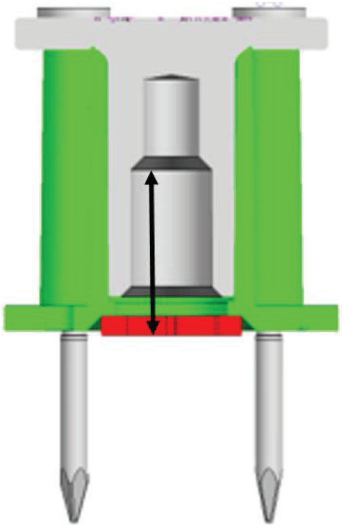


Figure 2 — KCM-PD Anchor

Thread engagement measurements

Anchor body	Rod Dia. [in.]	Thread Engagment [in.] Plastic on/Metal tube on [in.]
1/4" + 3/8"	1/4"	1.1
	3/8"	0.7
3/8" + 1/2"	*3/8"*	1.5
	1/2"	0.9
3/8" + 1/2" + 5/8"	*3/8"*	1.9
	1/2"	1.5
	5/8"	0.9
3/8" + 1/2" + 5/8" + 3/4"	*3/8"*	2.8
	1/2"	2.3
	5/8"	1.7
	3/4"	0.9



DESIGN DATA IN CONCRETE PER ACI 318

ACI 318 Chapter 17 Design

The technical data contained in this section are Hilti Simplified Design Tables. The load values were developed using the Strength Design parameters and variables of ESR-4145 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-4145 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Table 2 — Hilti KCM-WF and KCM-PD cast-in insert design strength with concrete/pullout failure in uncracked concrete [1,2,3,4,5]

Nominal anchor internal diameter	Effective embedment depth in. (mm)	Tension - φN_n				Shear - φV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
1/4"-3/8"	1.12 (28)	1,240 (5.5)	1,355 (6.0)	1,570 (7.0)	1,920 (8.5)	1,240 (5.5)	1,355 (6.0)	1,570 (7.0)	1,920 (8.5)
3/8"-1/2"	1.63 (41)	2,180 (9.7)	2,390 (10.6)	2,760 (12.3)	3,380 (15.0)	2,180 (9.7)	2,390 (10.6)	2,760 (12.3)	3,380 (15.0)
3/8"-1/2"-5/8"	2.04 (52)	3,055 (13.6)	3,345 (14.9)	3,865 (17.2)	4,735 (21.1)	3,055 (13.6)	3,345 (14.9)	3,865 (17.2)	4,735 (21.1)
3/8"-1/2"-5/8"-3/4"	3.00 (76)	5,455 (24.3)	5,975 (26.6)	6,900 (30.7)	8,450 (37.6)	10,910 (48.5)	11,950 (53.2)	13,800 (61.4)	16,900 (75.2)

1 See Section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between concrete compressive strengths is not permitted.

3 Tabular values are for single anchor located at edge distance (c) and spacing (s) greater than 24". For anchors with edge distance or spacing less than 24" use ACI 318 to calculate load reduction factor. Compare the value to the steel values (threaded rod and inserts) in Tables 4 and 5. The lesser of the values is to be used for the design.

4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.85. For all-lightweight, λ_a = 0.75

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 3 — Hilti KCM-WF and KCM-PD cast-in insert design strength with concrete / pullout failure in cracked concrete [1,2,3,4,5]

Nominal anchor internal diameter	Effective embedment depth in. (mm)	Tension - φN_n				Shear - φV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
1/4"-3/8"	1.12 (28)	990 (4.4)	1,085 (4.8)	1,255 (5.6)	1,535 (6.8)	990 (4.4)	1,085 (4.8)	1,255 (5.6)	1,535 (6.8)
3/8"-1/2"	1.63 (41)	1,745 (7.8)	1,910 (8.5)	2,210 (9.8)	2,705 (12.0)	1,745 (7.8)	1,910 (8.5)	2,210 (9.8)	2,705 (12.0)
3/8"-1/2"-5/8"	2.04 (52)	2,445 (10.9)	2,675 (11.9)	3,090 (13.7)	3,785 (16.8)	2,445 (10.9)	2,675 (11.9)	3,090 (13.7)	3,785 (16.8)
3/8"-1/2"-5/8"-3/4"	3.00 (76)	4,360 (19.4)	4,780 (21.3)	5,520 (24.6)	6,760 (30.1)	8,725 (38.8)	9,560 (42.5)	11,040 (49.1)	13,520 (60.1)

1 See Section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between concrete compressive strengths is not permitted.

3 Tabular values are for single anchor located at edge distance (c) and spacing (s) greater than 24". For anchors with edge distance or spacing less than 24" use ACI 318 to calculate load reduction factor. Compare the value to the steel values (threaded rod and inserts) in Tables 4 and 5. The lesser of the values is to be used for the design.

4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.85. For all-lightweight, λ_a = 0.75.

5 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear.

Table 4 — Design strength for steel failure of common threaded rods[1,5]

Nominal rod diameter in.	Grade A36 threaded rod			ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod			ASTM A 307, Grade A threaded rod		
	Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN)	Shear[3] $\phi V_{sa,rod}$ lb (kN)	Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN)	Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN)	Shear[3] $\phi V_{sa,rod}$ lb (kN)	Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN)	Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN)	Shear[3] $\phi V_{sa,rod}$ lb (kN)	Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN)
1/4	1,390 (6.2)	720 (3.2)	505 (2.2)	3,000 (13.3)	1,550 (6.9)	1,085 (4.8)	1,425 (6.3)	740 (3.3)	518 (2.3)
3/8	3,395 (15.1)	1,750 (7.8)	1,225 (5.4)	7,315 (32.5)	3,780 (16.8)	2,646 (11.8)	3,490 (15.5)	1,815 (8.1)	1,271 (5.7)
1/2	6,175 (27.5)	3,210 (14.3)	2,245 (10.0)	13,315 (59.2)	6,915 (30.8)	4,841 (21.5)	6,375 (28.4)	3,315 (14.7)	2,321 (10.3)
5/8	9,835 (43.7)	5,110 (22.7)	3,575 (15.9)	21,190 (94.3)	11,020 (49.0)	7,714 (34.3)	10,165 (45.2)	5,285 (23.5)	3,700 (16.5)
3/4	14,550 (64.7)	7,565 (33.7)	5,295 (23.6)	31,405 (139.7)	16,305 (72.5)	11,414 (50.8)	15,040 (66.9)	7,820 (34.8)	5,474 (24.3)

1 See Section 3.1.8 for additional information on seismic applications.

2 Tensile values determined by static tension tests with $\phi N_{sa} = \phi\ A_{se,N}\ f_{uta}$ as noted in ACI 318 Chapter 17. Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic tension loads.

3 Shear values determined by static shear tests with $\phi V_{sa} = \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17. Only the largest size of threaded rod specified for each insert must be used for applications resisting shear loads.

4 Seismic shear values determined by seismic shear tests with $\phi\ V_{sa} \leq \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318, Chapter 17. Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic shear load.

5 Values are for the threaded rod only. The capacity of the insert must be also be determined from Table 5. The design strength of concrete must be in accordance with ACI 318 Chapter 17 and Tables 2 to 3 as necessary. Compare the values (threaded rod, inserts, and concrete). The lesser of the values is to be used for the design.

Table 5 — Design strength for steel failure of KCM-WF and KCM-PD inserts[1]

Design information	1/4"-3/8"	3/8"-1/2"	3/8"-1/2"-5/8"	3/8"-1/2"-5/8"-3/4"
	WF and PD	Only WF	WF and PD	WF and PD
Design steel strength of insert in tension, $\phi N_{sa,insert}$ lb (kN)	5,315 (23.6)	8,775 (39.0)	10,920 (48.6)	17,795 (79.2)
Design seismic steel strength of insert in tension,[2] $\phi N_{sa,insert,eq}$ lb (kN)	5,315 (23.6)	8,775 (39.0)	10,920 (48.6)	17,795 (79.2)
Design steel strength of insert in shear,[2] $\phi V_{sa,insert}$ lb (kN)	1,775 (7.9)	3,490 (15.5)	5,785 (25.7)	11,140 (49.6)
Design seismic steel strength of insert in shear,[2] $\phi V_{sa,insert,eq}$ lb (kN)	1,775 (7.9)	3,490 (15.5)	5,785 (25.7)	11,140 (49.6)

1 Values are for the inserts only. The capacity of the threaded rods must be also determined from Table 4. The design strength of concrete must be in accordance with ACI 318 Chapter 17 and Tables 2 to 3 as necessary. Compare the values (threaded rod, inserts, and concrete). The lesser of the values is to be used for the design.

2 Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic tension, static shear, and seismic shear loads.

DESIGN DATA IN CONCRETE PER CSA A23.3

CSA A23.3 Annex D design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-4145. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

Table 6 — Hilti KCM-WF/PD design information in accordance with CSA A23.3 (R2014) Annex D [1]

Design parameter	Symbol	Units	Nominal anchor diameter				Ref A23.3-14
			1/4"-3/8"	3/8"-1/2"	3/8"-1/2"-5/8"	3/8"-1/2"-5/8"-3/4"	
Outside diameter of anchor steel body	d_a	in. (mm)	0.5 (13)	0.66 (17)	0.87 (22)	1.02 (26)	
Effective embedment	h_{ef}	in. (mm)	1.12 (28)	1.63 (41)	2.04 (52)	3 (76)	
Min. concrete thickness	h_{min}	in. (mm)	2-1/2 (64)		3 (76)	4 (102)	
Minimum edge distance	c_{min}	in. (mm)	1-1/2 (38)				
Minimum anchor spacing	s_{min}	in. (mm)	2.00 (51)	2.64 (67)	3.48 (88)	4.08 (104)	
Steel embed. material resistance factor for reinforcement	ϕ_s		0.85				8.4.3
Resistance modification factor for tension, steel failure modes [2]	R		0.70				D.5.3
Resistance modification factor for shear, steel failure modes [2]	R		0.65				D.5.3
Factored steel resistance in tension	N_{sar}	lb. (kN)	4,864 (21.6)	8,033 (35.7)	9,996 (44.4)	16,291 (72.4)	D.6.1.2
Factored steel resistance in tension, seismic [4]	$N_{sar,eq}$	lb. (kN)	4,864 (21.6)	8,033 (35.7)	9,996 (44.4)	16,291 (72.4)	D.6.1.2
Factored steel resistance in shear[4]	V_{sar}	lb. (kN)	1,633 (7.3)	3,216 (14.3)	5,326 (23.7)	10,260 (45.6)	D.7.1.2
Factored steel resistance in shear, seismic[4]	$V_{sar,eq}$	lb. (kN)	1,633 (7.3)	3,216 (14.3)	5,326 (23.7)	10,260 (45.6)	D.7.1.2
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10				D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	-	10				D.6.2.2
Modification factor for anchor resistance, tension, uncracked conc.	$\Psi_{c,N}$	-	1.25				D.6.2.6
Modification factor for anchor resistance, tension, cracked conc.	$\Psi_{c,N}$		1.0				D.6.2.6
Anchor category	-	-	cast-in				D.5.3 (c)
Concrete material resistance factor	ϕ_c	-	0.65				8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [3]	R	-	1.00				

1 Design information in this table is taken from ICC-ES ESR-4145, dated 4/2018, and converted for use with CSA A23.3 (R2014) Annex D.

2 The carbon steel KCM-WF/PD is considered a brittle steel element as defined by CSA A23.3 (R2014) Annex D section D.2.

3 For use with the load combinations of CSA A23.3 (R2014) chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 (R2014) section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

4 Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic tension, static shear, and seismic shear loads.

Table 7 — Hilti KCM-WF/PD cast-in insert design strength with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in. (mm)	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4"-3/8"	1.12 (28)	1.12 (28)	1,235 (5.5)	1,380 (6.1)	1,515 (6.7)	1,750 (7.8)	1,235 (5.5)	1,380 (6.1)	1,515 (6.7)	1,750 (7.8)
3/8"-1/2"	1.63 (41)	1.63 (41)	2,175 (9.7)	2,435 (10.8)	2,665 (11.9)	3,075 (13.7)	2,175 (9.7)	2,435 (10.8)	2,665 (11.9)	3,075 (13.7)
3/8"-1/2"-5/8"	2.04 (52)	2.04 (52)	3,045 (13.6)	3,405 (15.2)	3,730 (16.6)	4,305 (19.2)	3,045 (13.6)	3,405 (15.2)	3,730 (16.6)	4,305 (19.2)
3/8"-1/2"-5/8"-3/4"	3.00 (76)	3.00 (76)	5,435 (24.2)	6,075 (27.0)	6,655 (29.6)	7,685 (34.2)	10,865 (48.3)	12,150 (54.1)	13,310 (59.2)	15,370 (68.4)

1 See section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for single anchor located at edge distance (c) and spacing (s) greater than 24". For anchors with edge distance or spacing less than 24" use CSA A23.3 to calculate load reduction factor. Compare the value to the steel values in Tables 6 and 9. The lesser of the values is to be used for the design.
4 Tablular values are for normal weight concrete only.
For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, $\lambda_a = 0.85$; for all-lightweight, $\lambda_a = 0.75$.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 8 — Hilti KCM-WF/PD cast-in insert design strength with concrete / pullout failure in cracked concrete[1,2,3,4,5]

Nominal anchor diameter in. (mm)	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4"-3/8"	1.12 (28)	1.12 (28)	990 (4.4)	1,105 (4.9)	1,210 (5.4)	1,400 (6.2)	990 (4.4)	1,105 (4.9)	1,210 (5.4)	1,400 (6.2)
3/8"-1/2"	1.63 (41)	1.63 (41)	1,740 (7.7)	1,945 (8.7)	2,130 (9.5)	2,460 (10.9)	1,740 (7.7)	1,945 (8.7)	2,130 (9.5)	2,460 (10.9)
3/8"-1/2"-5/8"	2.04 (52)	2.04 (52)	2,435 (10.8)	2,725 (12.1)	2,985 (13.3)	3,445 (15.3)	2,435 (10.8)	2,725 (12.1)	2,985 (13.3)	3,445 (15.3)
3/8"-1/2"-5/8"-3/4"	3.00 (76)	3.00 (76)	4,345 (19.3)	4,860 (21.6)	5,325 (23.7)	6,145 (27.3)	8,695 (38.7)	9,720 (43.3)	10,650 (47.4)	12,295 (54.7)

1 See section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for single anchor located at edge distance (c) and spacing (s) greater than 24". For anchors with edge distance or spacing less than 24" use CSA A23.3 to calculate load reduction factor. Compare the value to the steel values in Tables 6 and 9. The lesser of the values is to be used for the design.
4 Tablular values are for normal weight concrete only.
For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, $\lambda_a = 0.85$; for all-lightweight, $\lambda_a = 0.75$.
5 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis} = 0.75$. No reduction needed for seismic shear.

Table 9 — Design strength for steel failure of common threaded rods used with KCM-WF/PD cast-in inserts[1,2,3]

Nominal rod diameter in.	Grade A36 threaded rod			ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod			ASTM A 307, Grade A threaded rod		
	Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN)	Shear[5] $V_{sar,rod}$ lb (kN)	Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN)	Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN)	Shear[5] $V_{sar,rod}$ lb (kN)	Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN)	Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN)	Shear[5] $V_{sar,rod}$ lb (kN)	Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN)
1/4	1,260 (5.6)	705 (3.1)	495 (2.2)	2,720 (12.1)	1,520 (6.8)	1,064 (4.7)	1,290 (5.7)	725 (3.2)	508 (2.3)
3/8	3,075 (13.7)	1,720 (7.7)	1,205 (5.4)	6,630 (29.5)	3,705 (16.5)	2,594 (11.5)	3,160 (14.1)	1,780 (7.9)	1,246 (5.5)
1/2	5,600 (24.9)	3,150 (14.0)	2,205 (9.8)	12,070 (53.7)	6,785 (30.2)	4,750 (21.1)	5,780 (25.7)	3,250 (14.5)	2,275 (10.1)
5/8	8,915 (39.7)	5,010 (22.3)	3,505 (15.6)	19,210 (85.4)	10,805 (48.1)	7,564 (33.6)	9,215 (41.0)	5,185 (23.1)	3,630 (16.1)
3/4	13,190 (58.7)	7,420 (33.0)	5,195 (23.1)	28,475 (126.7)	15,990 (71.1)	11,193 (49.8)	13,635 (60.7)	7,670 (34.1)	5,369 (23.9)

1 See section 3.1.8 to convert design strength value to ASD value.

2 Hilti KCM-WF/PD anchors are to be considered brittle steel elements

3 See Section 3.1.8 for additional information on seismic applications.

4 Tensile $N_{sar} = \phi_s A_{se,N} R f_{ut}$ as noted in CSA A23.3 Annex D. Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic tension loads.

5 Shear values determined by static shear tests with $V_{sar} < \phi_s 0.60 A_{se,V} f_{ut}$ R. as noted in CSA A23.3 Annex D. Only the largest size of threaded rod specified for each insert must be used for applications resisting shear loads.

6 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < \phi_s 0.60 A_{se,V} f_{ut}$ R. as noted in CSA A23.3 Annex D. Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic shear loads.

Table 10 — UL LLC and FM approvals[1,2]

Design information	1/4"-3/8"			3/8"-1/2"			3/8"-1/2"-5/8"			3/8"-1/2"-5/8"-3/4"		
	WF and PD			Only WF			WF and PD			WF and PD		
Nominal rod diameter	**UL max pipe size (in.)**	**UL test load (lb)**	**FM max pipe size (in.)**	**UL max pipe size (in.)**	**UL test load (lb)**	**FM max pipe size (in.)**	**UL max pipe size (in.)**	**UL test load (lb)**	**FM max pipe size (in.)**	**UL max pipe size (in.)**	**UL test load (lb)**	**FM max pipe size (in.)**
3/8	4	1,500	4	4	1,500	4	4	1,500	-	4	1,500	4
1/2	-	-	-	8	4,050	8	8	4,050	-	8	4,050	8
5/8	-	-	-	-	-	-	8	4,050	-	12	7,900	12
3/4	-	-	-	-	-	-	-	-	-	12	7,900	12

1 UL LLC Listing based on successful completion of testing in accordance with UL 203.
2 FM Approval based on successful completion of testing in accordance with FM 1952.

ORDERING INFORMATION[1]

KCM – WF cast-in anchor for use in wood forms

Description	Sleeve color[2]	Qty / box
KCM – WF 1/4"-3/8"	Green	250
KCM – WF 3/8"-1/2"	Orange	150
KCM – WF 3/8"-1/2"-5/8"	Red	100
KCM – WF 3/8"-1/2"-5/8"-3/4"	Grey	25

KCM – PD cast-in anchor for use in pan joist deck

Description	Sleeve color[2]	Qty / box
KCM – PD 1/4"-3/8"	Green	250
KCM – PD 3/8"-1/2"-5/8"	Red	100
KCM – PD 3/8"-1/2"-5/8"-3/4"	Grey	25

[1] All dimensions in inches
[2] Identifies anchor size

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com (US), or www.hilti.ca (Canada). Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

3.3.16 KCM-MD CAST IN ANCHOR

PRODUCT DESCRIPTION

KCM-MD cast-in anchors

Anchor System		**Features and Benefits**
	Internally threaded short plate cast-in anchors for metal deck (KCM-MD SP)	- Application-relevant multi-thread configurations - Color-coded plastic anchor housing identifies the internal thread diameters - Pre-installed screws increase productivity for attaching the anchor to the metal deck - KCM-MD SP — Color-coded plastic plug prevents concrete intrusion and allows for differentiation between anchors of the same thread configuration - KCM-MD SP — Plastic protective tube extends below the metal deck to protect the internal threads from concrete, sprayed-on fireproofing, or sprayed-on insulation - KCM-MD LP — Multi-thread cast-in anchor, which can be installed at any location on the metal deck including in the incline. - KCM-MD LP — Metal protective tube extends below the metal deck to protect the internal threads from concrete, sprayed-on fireproofing, or sprayed-on insulation. - KCM-MD LP — Anchor installs to the top of the flutes of the metal deck, so anchoring point is at consistent height throughout, which is ideal for pre-fabricated hangers
	Internally threaded long plate cast-in anchors for metal deck (KCM-MD LP)	

Uncracked concrete

Cracked concrete

Seismic Design Categories A-F

Fire sprinkler listings

Approvals/ Listings

ICC-ES (International Code Council) 2018 International Building Code / International Residential Code (IBC/IRC)	ESR-4145 in concrete per ACI 318 Ch. 17 / ICC-ES AC446
City of Los Angeles	2018 LABC Supplement (within ESR-4145)
Florida Building Code	2017 FBC with HVHZ
UL LLC (Underwriters Laboratory LLC)	Pipe Hanger Equipment for Fire Protection Services for 3/8 through 3/4 (See Tables 19A and 19B)
FM (Factory Mutual) Pipe	Hanger Components for Automatic Sprinkler Systems for 3/8 through 3/4 (See Tables 19A and 19B)
ANSI/MSS SP-58-2018	Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information.

LISTED

APPROVED

MATERIAL SPECIFICATIONS

KCM-MD short plate and long plate anchors KCM-MD have an insert body made from carbon steel with an engineered plastic flange. The insert body is zinc plated per ASTM B633 Fe/Zn 5 Type III.

INSTALLATION PARAMETERS

Table 1A — Hilti KCM-MD Short Plate cast-in anchor installation information

Design information	Symbol	Units	Nominal anchor diameter (in.)			
			SP 1/4"-3/8"	SP 3/8"-1/2"	SP 3/8"-1/2"-5/8"	SP 5/8"-3/4"
Plastic section color	-	-	Green	Orange	Red	Grey
Effective embedment	h_{ef}	in.	1.76	2	2.5	2.5
		(mm)	(45)	(51)	(64)	(64)
Nominal embedment	h_{nom}	in.	1.88	2.13	2.63	2.65
		(mm)	(48)	(54)	(67)	(67)
Metal hole saw diameter	d_{bit}	in.	9/16	11/16	13/16	15/16
Steel head thickness	t_{sh}	mm	3.3	3.3	3.3	3.7
Min. concrete cover over metal deck — upper flute install (see Figure 4A)	$h_{upper,min}$	in.	2.5	2.5	3.25	3.25
		(mm)	(64)	(64)	(83)	(83)
Min. concrete cover over metal deck — lower flute install (see Figures 4B and 4C)	$h_{lower,min}$	in.	2.5	2.5	2.5	2.5
		(mm)	(64)	(64)	(64)	(64)
Min. metal deck gauge	-	-	20			
Min. anchor spacing	s_{min}	in.	5.28	6	7.5	7.5
		(mm)	(134)	(152)	(191)	(191)

Table 1B — Hilti KCM-MD Long Plate cast-in anchor installation information

Design information	Symbol	Units	Nominal anchor diameter (in.)			
			LP 1/4"-3/8"	LP 3/8"-1/2"	LP 3/8"-1/2"-5/8"	LP 5/8"-3/4"
Plastic section color	-	-	Green	Orange	Red	Grey
Effective embedment	h_{ef}	in.	1.76	2	2.5	2.5
		(mm)	(45)	(51)	(64)	(64)
Nominal embedment	h_{nom}	in.	1.96	2.21	2.71	2.72
		(mm)	(50)	(56)	(69)	(69)
Metal hole saw diameter	d_{bit}	in.	1/2	5/8	3/4	7/8
Steel head thickness	t_{sh}	mm	3.3	3.3	3.3	3.7
Min. concrete cover over metal deck (see Figures 4B, 4C and 4D)	$h_{lower,min}$	in.	2.5	2.5	3.25	3.25
		(mm)	(64)	(64)	(83)	(83)
Min. metal deck gauge	-	-	20			
Min. anchor spacing	s_{min}	in.	5.28	6	7.5	7.5
		(mm)	(134)	(152)	(191)	(191)

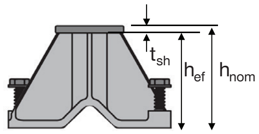


Figure 1 — KCM-MD SP

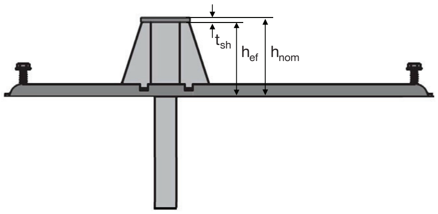


Figure 2 — KCM-MD LP

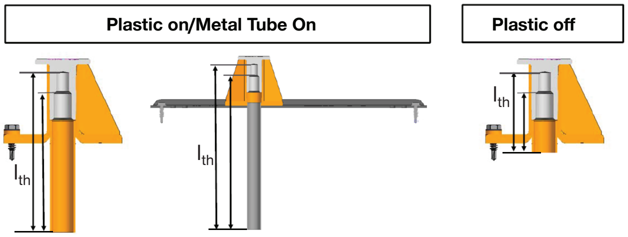


Figure 3 — KCM-MD Thread engagement measurement

Table 2 — Thread engagement length measured for various threaded sizes

Anchor	Anchor body	Rod diameter (in.)	Thread engagement length (l_{th})		
			Plastic on/ Metal tube on (in.)	Plastic off (in.)	Comments
Short plate	1/4" - 3/8"	1/4"	3.9	2.2	-Perforated tube is 1.75" -Base to perforation is 1/2"
		3/8"	3.5	1.7	
	3/8" - 1/2"	3/8"	4.2	2.4	
		1/2"	3.5	1.7	
	3/8" - 1/2" - 5/8"	3/8"	4.7	3.0	
		1/2"	4.2	2.5	
		5/8"	3.5	1.7	
	5/8" - 3/4"	5/8"	4.6	2.9	
		3/4"	3.9	2.1	
Long Plate	1/4"-3/8"	1/4"	6.4	-	-Metal is not broken off and measured -Tube is 4.75"
		3/8"	6.0	-	
	3/8"-1/2"	3/8"	6.8	-	-Metal is not broken off and measured -Tube is 4.75"
		1/2"	6.1	-	
	3/8"-1/2"-5/8"	3/8"	7.3	-	-Metal is not broken off and measured -Tube is 4.75"
		1/2"	6.8	-	
		5/8"	6.1	-	
	5/8"-3/4"	5/8"	6.9	-	-Metal is not broken off and measured -Tube is 4.5"
		3/4"	6.1	-	

DESIGN INFORMATION IN CONCRETE PER ACI 318

ACI 318 Chapter 17

The technical data contained in this section are Hilti Simplified Design Tables. The load values were developed using the Strength Design parameters and variables of ESR- 4145 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8 of the Hilti Product Technical Guide Volume 2 Edition 19. Data tables from ESR-4145 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Table 3A — Design strength for steel failure of KCM-MD Short Plate anchor[1,2,3,4]

DESIGN INFORMATION	Symbol	Units	Insert Type								
			SP 1/4”-3/8”		**SP** 3/8”-1/2”		**SP** 3/8”-1/2”-5/8”			**SP** 5/8”-3/4”	
Nominal rod diameter in.			1/4	3/8	3/8 [5]	1/2	3/8	1/2 [5]	5/8	5/8 [5]	3/4
Design steel strength of insert in tension	$\Phi N_{sa,insert}$	lb (kN)	5,395 (24.0)		8,775 (39.0)		8,010 (35.6)			7,815 (34.8)	
Design seismic steel strength of insert in tension	$\Phi N_{sa,insert,eq}$	lb (kN)	-	5,395 (24)	8,775 (39)	8,775 (39)	-	8,010 (36)	8,010 (36)	7,815 (35)	7,815 (35)
Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figures 4A											
Design steel strength of insert in shear	$\Phi V_{sa,insert}$	lb (kN)	-	2,810 (21)	-	5,295 (39)	-	-	7,180 (53)	-	8,255 (61)
Design seismic steel strength of insert in shear	$\Phi V_{sa,insert,eq}$	lb (kN)	-	2,810 (21)	-	5,295 (39)	-	-	7,180 (53)	-	8,255 (61)
Installations in lower flute of metal deck (i.e. W-deck) according to Figures 4B											
Design steel strength of insert in shear	$\Phi V_{sa,insert}$	lb (kN)	-	2,060 (21)	1,995 (9)	2,510 (39)	-	3,180 (14)	3,265 (53)	2,815 (13)	3,265 (61)
Design seismic steel strength of insert in shear	$\Phi V_{sa,insert,eq}$	lb (kN)	-	2,060 (21)	1,995 (9)	2,510 (39)	-	2,225 (10)	3,265 (53)	2,815 (13)	3,265 (61)
Installations in lower flute of metal deck (i.e. B-deck) according to Figures 4C											
Design steel strength of insert in shear	$\Phi V_{sa,insert}$	lb (kN)	-	1,895 (8)	-	2,380 (11)	-	-	3,350 (15)	-	
Design seismic steel strength of insert in shear	$\Phi V_{sa,insert,eq}$	lb (kN)	-	1,895 (8)	-	2,380 (11)	-	-	3,015 (13)		

Table 3B — Design strength for steel failure of KCM-MD Long Plate anchor[1,2,3,4]

DESIGN INFORMATION	Symbol	Units	Insert Type								
			LP 1/4”-3/8”		**LP** 3/8”-1/2”		**LP** 3/8”-1/2”-5/8”			**LP** 5/8”-3/4”	
Nominal rod diameter in.			1/4	3/8	3/8 [5]	1/2	3/8	1/2 [5]	5/8	5/8 [5]	3/4
Design steel strength of insert in tension	$\Phi N_{sa,insert}$	lb (kN)	5,395 (24.0)		8,775 (39.0)		8,010 (35.6)			7,815 (34.8)	
Design seismic steel strength of insert in tension	$\Phi N_{sa,insert,eq}$	lb (kN)	-	5,395 (24)	8,775 (39)	8,775 (39)	-	8,010 (36)	8,010 (36)	7,815 (35)	7,815 (35)
Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figures 4A											
Design steel strength of insert in shear	$\Phi V_{sa,insert}$	lb (kN)	-	2,810 (13)	-	5,295 (24)	-	-	7,180 (32)	-	8,255 (37)
Design seismic steel strength of insert in shear	$\Phi V_{sa,insert,eq}$	lb (kN)	-	2,810 (13)	-	5,295 (24)	-	-	7,180 (32)	-	8,255 (37)
Installations in lower flute of metal deck (i.e. W-deck) according to Figures 4B											
Design steel strength of insert in shear	$\Phi V_{sa,insert}$	lb (kN)	-	3,515 (15.6)	2,605 (12)	3,985 (18)	-	2,425 (10.8)	4,625 (20.6)	2,815 (12.5)	4,625 (21)
Design seismic steel strength of insert in shear	$\Phi V_{sa,insert,eq}$	lb (kN)	-	3,515 (16)	2,605 (12)	3,985 (18)	-	2,425 (11)	4,625 (21)	2,815 (13)	4,625 (21)
Installations in lower flute of metal deck (i.e. B-deck) according to Figures 4C											
Design steel strength of insert in shear	$\Phi V_{sa,insert}$	lb (kN)	-	2,890 (12.9)	-	4,525 (20.1)	-	-	5,750 (25.6)	-	7,150 (31.8)
Design seismic steel strength of insert in shear	$\Phi V_{sa,insert,eq}$	lb (kN)	-	2,890 (13)	-	4,525 (20)	-	-	5,750 (26)	-	7,150 (32)
Installations over flute incline of metal deck (i.e. W-deck) according to Figures 4D											
Design steel strength of insert in shear	$\Phi V_{sa,insert}$	lb (kN)	-	1,030 (4.6)	-	2,665 (11.9)	-	-	5,985 (26.6)	-	5,985 (27)
Design seismic steel strength of insert in shear	$\Phi V_{sa,insert,eq}$	lb (kN)	-	1,030 (4.6)	-	2,135 (9.5)	-	-	3,370 (15.0)	-	5,685 (25)

1 See Section 3.1.8.6 to convert design strength value to ASD value.

2 Hilti KCM-MD Inserts are considered as brittle steel elements

3 Tension values are for the inserts only. The capacity of the threaded rods must be also determined from Table 10. The design strength of concrete must be obtained from tables 4 to 9. Compare the tension values of threaded rod, inserts, and concrete. The lesser of the values is to be used for the design.

4 Shear values are for the inserts only. The capacity of the threaded rods must be also determined from Table 10. The calculation of concrete shear strength is not required. Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.

5 Only threaded rod ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 is permitted to be used for the applications resisting shear, seismic shear, or seismic tension loads.

Table 4 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of uncracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4C	
		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)
SP 1/4”-3/8”	1.88 (48)	2,910 (12.9)	3,360 (14.9)	605 (2.7)	700 (3.1)
SP 3/8”-1/2”	2.13 (54)	3,610 (16.1)	4,170 (18.5)	635 (2.8)	735 (3.3)
SP 3/8”-1/2"-5/8"	2.63 (67)	4,580 (20.4)	5,290 (23.5)	695 (3.1)	805 (3.6)
SP 5/8”-3/4”	2.65 (67)	4,580 (20.4)	5,290 (23.5)	-	-
LP 1/4”-3/8”	1.96 (50)	2,910 (12.9)	3,360 (14.9)	2,910 (12.9)	3,360 (14.9)
LP 3/8”-1/2"	2.21 (56)	3,610 (16.1)	4,170 (18.5)	3,610 (16.1)	4,170 (18.5)
LP 3/8”-1/2"-5/8"	2.71 (69)	4,580 (20.4)	5,290 (23.5)	4,580 (20.4)	5,290 (23.5)
LP 5/8”-3/4"	2.72 (69)	4,580 (20.4)	5,290 (23.5)	4,580 (20.4)	5,290 (23.5)

Table 5 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4C	
		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)
SP 1/4”-3/8”	1.88 (48)	2,325 (10.3)	2,685 (11.9)	485 (2.2)	560 (2.5)
SP 3/8”-1/2"	2.13 (54)	2,890 (12.9)	3,335 (14.8)	505 (2.2)	585 (2.6)
SP 3/8”-1/2""-5/8"	2.63 (67)	3,660 (16.3)	4,225 (18.8)	555 (2.5)	640 (2.8)
SP 5/8”-3/4”	2.65 (67)	3,660 (16.3)	4,225 (18.8)	-	-
LP 1/4”-3/8”	1.96 (50)	2,325 (10.3)	2,685 (11.9)	2,325 (10.3)	2,685 (11.9)
LP 3/8”-1/2"	2.21 (56)	2,890 (12.9)	3,335 (14.8)	2,890 (12.9)	3,335 (14.8)
LP 3/8”-1/2"-5/8"	2.71 (69)	3,660 (16.3)	4,225 (18.8)	3,660 (16.3)	4,225 (18.8)
LP 5/8”-3/4"	2.72 (69)	3,660 (16.3)	4,225 (18.8)	3,660 (16.3)	4,225 (18.8)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Tables 3A and 3B and threaded rod steel strength values in Table 10. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 3A and 3B for shear calculations.

Table 6 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 3-7/8” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4B		Inclined per Figure 4D	
		Tension - ΦN_n		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)
SP 1/4”-3/8”	1.88 (48)	2,910 (12.9)	3,360 (14.9)	1,400 (6.2)	1,615 (7.2)	-	-
SP 3/8”-1/2"	2.13 (54)	3,610 (16.1)	4,170 (18.5)	1,850 (8.2)	2,135 (9.5)	-	-
SP 3/8”-1/2"-5/8"	2.63 (67)	4,580 (20.4)	5,290 (23.5)	2,120 (9.4)	2,450 (10.9)	-	-
SP 5/8”-3/4”	2.65 (67)	4,580 (20.4)	5,290 (23.5)	2,120 (9.4)	2,450 (10.9)	-	-
LP 1/4”-3/8”	1.96 (50)	2,910 (12.9)	3,360 (14.9)	4,895 (21.8)	5,650 (25.1)	2,910 (12.9)	3,360 (14.9)
LP 3/8”-1/2"	2.21 (56)	3,610 (16.1)	4,170 (18.5)	4,895 (21.8)	5,650 (25.1)	3,610 (16.1)	4,170 (18.5)
LP 3/8”-1/2"-5/8"	2.71 (69)	4,580 (20.4)	5,290 (23.5)	6,565 (29.2)	7,580 (33.7)	4,580 (20.4)	5,290 (23.5)
LP 5/8”-3/4"	2.72 (69)	4,580 (20.4)	5,290 (23.5)	6,565 (29.2)	7,580 (33.7)	4,580 (20.4)	5,290 (23.5)

Table 7 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 3-7/8” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4B		Inclined per Figure 4D	
		Tension - ΦN_n		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)
SP 1/4”-3/8”	1.88 (48)	2,325 (10.3)	2,685 (11.9)	1,120 (5.0)	1,295 (5.8)	-	-
SP 3/8”-1/2"	2.13 (54)	2,890 (12.9)	3,335 (14.8)	1,480 (6.6)	1,710 (7.6)	-	-
SP 3/8”-1/2"-5/8"	2.63 (67)	3,660 (16.3)	4,225 (18.8)	1,695 (7.5)	1,955 (8.7)	-	-
SP 5/8”-3/4”	2.65 (67)	3,660 (16.3)	4,225 (18.8)	1,695 (7.5)	1,955 (8.7)	-	-
LP 1/4”-3/8”	1.96 (50)	2,325 (10.3)	2,685 (11.9)	3,915 (17.4)	4,520 (20.1)	2,325 (10.3)	2,685 (11.9)
LP 3/8”-1/2"	2.21 (56)	2,890 (12.9)	3,335 (14.8)	3,915 (17.4)	4,520 (20.1)	2,890 (12.9)	3,335 (14.8)
LP 3/8”-1/2""-5/8"	2.71 (69)	3,660 (16.3)	4,225 (18.8)	5,250 (23.4)	6,060 (27.0)	3,660 (16.3)	4,225 (18.8)
LP 5/8”-3/4"	2.72 (69)	3,660 (16.3)	4,225 (18.8)	5,250 (23.4)	6,060 (27.0)	3,660 (16.3)	4,225 (18.8)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Tables 3A and 3B and threaded rod steel strength values in Table 10. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 3A and 3B for shear calculations.

Table 8 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of uncracked Sand-Lightweight concrete Over Metal Deck (W profile with 4-1/2” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4B		Inclined per Figure 4D	
		Tension - ΦN_n		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)
SP 1/4”-3/8”	1.88	2,910	3,360	1,400	1,615	-	-
	(48)	(12.9)	(14.9)	(6.2)	(7.2)		
SP 3/8”-1/2"	2.13	3,610	4,170	1,850	2,135	-	-
	(54)	(16.1)	(18.5)	(8.2)	(9.5)		
SP 3/8”-1/2"-5/8"	2.63	4,580	5,290	2,120	2,450	-	-
	(67)	(20.4)	(23.5)	(9.4)	(10.9)		
SP 5/8”-3/4”	2.65	4,580	5,290	2,120	2,450	-	-
	(67)	(20.4)	(23.5)	(9.4)	(10.9)		
LP 1/4”-3/8”	1.96	2,910	3,360	4,895	5,650	2,910	3,360
	(50)	(12.9)	(14.9)	(21.8)	(25.1)	(12.9)	(14.9)
LP 3/8”-1/2"	2.21	3,610	4,170	4,895	5,650	3,610	4,170
	(56)	(16.1)	(18.5)	(21.8)	(25.1)	(16.1)	(18.5)
LP 3/8”-1/2"-5/8"	2.71	4,580	5,290	6,565	7,580	4,580	5,290
	(69)	(20.4)	(23.5)	(29.2)	(33.7)	(20.4)	(23.5)
LP 5/8”-3/4"	2.72	4,580	5,290	6,565	7,580	4,580	5,290
	(69)	(20.4)	(23.5)	(29.2)	(33.7)	(20.4)	(23.5)

Table 9 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 4-1/2” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4B		Inclined per Figure 4D	
		Tension - ΦN_n		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 3000 psi (20.7 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)
SP 1/4”-3/8”	1.88	2,325	2,685	1,120	1,295	-	-
	(48)	(10.3)	(11.9)	(5.0)	(5.8)		
SP 3/8”-1/2"	2.13	2,890	3,335	1,480	1,710	-	-
	(54)	(12.9)	(14.8)	(6.6)	(7.6)		
SP 3/8”-1/2"-5/8"	2.63	3,660	4,225	1,695	1,955	-	-
	(67)	(16.3)	(18.8)	(7.5)	(8.7)		
SP 5/8”-3/4”	2.65	3,660	4,225	1,695	1,955	-	-
	(67)	(16.3)	(18.8)	(7.5)	(8.7)		
LP 1/4”-3/8”	1.96	2,325	2,685	3,915	4,520	2,325	2,685
	(50)	(10.3)	(11.9)	(17.4)	(20.1)	(10.3)	(11.9)
LP 3/8”-1/2"	2.21	2,890	3,335	3,915	4,520	2,890	3,335
	(56)	(12.9)	(14.8)	(17.4)	(20.1)	(12.9)	(14.8)
LP 3/8”-1/2"-5/8"	2.71	3,660	4,225	5,250	6,060	3,660	4,225
	(69)	(16.3)	(18.8)	(23.4)	(27.0)	(16.3)	(18.8)
LP 5/8”-3/4"	2.72	3,660	4,225	5,250	6,060	3,660	4,225
	(69)	(16.3)	(18.8)	(23.4)	(27.0)	(16.3)	(18.8)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Tables 3A and 3B and threaded rod steel strength values in Table 10. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 3A and 3B for shear calculations.

Table 10 — Design strength for steel failure of common threaded rods[1,5]

Nominal anchor diameter	Grade A36 threaded rod			ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod			ASTM A 307, Grade A threaded rod		
	Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN)	Shear[3] $\phi V_{sa,rod}$ lb (kN)	Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN)	Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN)	Shear[3] $\phi V_{sa,rod}$ lb (kN)	Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN)	Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN)	Shear[3] $\phi V_{sa,rod}$ lb (kN)	Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN)
1/4	1,390 (6.2)	720 (3.2)	505 (2.2)	3,000 (13.3)	1,550 (6.9)	1,085 (4.8)	1,425 (6.3)	740 (3.3)	520 (2.3)
3/8	3,395 (15.1)	1,750 (7.8)	1,225 (5.4)	7,315 (32.5)	3,780 (16.8)	2,645 (11.8)	3,490 (15.5)	1,815 (8.1)	1,270 (5.7)
1/2	6,175 (27.5)	3,210 (14.3)	2,245 (10.0)	13,315 (59.2)	6,915 (30.8)	4,840 (21.5)	6,375 (28.4)	3,315 (14.7)	2,320 (10.3)
5/8	9,835 (43.7)	5,110 (22.7)	3,575 (15.9)	21,190 (94.3)	11,020 (49.0)	7,715 (34.3)	10,165 (45.2)	5,285 (23.5)	3,700 (16.5)
3/4	14,550 (64.7)	7,565 (33.7)	5,295 (23.6)	31,405 (139.7)	16,305 (72.5)	11,415 (50.8)	15,040 (66.9)	7,820 (34.8)	5,475 (24.4)

1 See Section 3.1.8.7 for additional information on seismic applications.
2 Tensile values determined by static tension tests with $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
3 Shear values determined by static shear tests with $\phi V_{sa} = \phi\ 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17. .
4 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi\ 0.60 A_{se,V} f_{uta}$ as noted in ACI 318, Chapter 17.
5 Shear values are for the threaded rods only. The capacity of the insert must be also determined from Table 3A or 3B. The calculation of concrete shear strength is not required. Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.

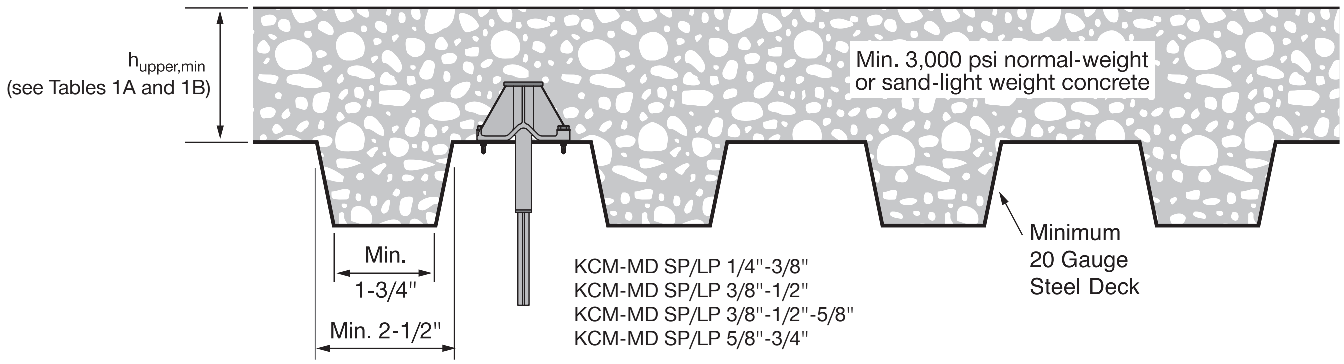


Figure 4A —Installation in the soffit of concrete filled metal deck floor and roof assemblies-over upper flute (B-deck and W-deck)

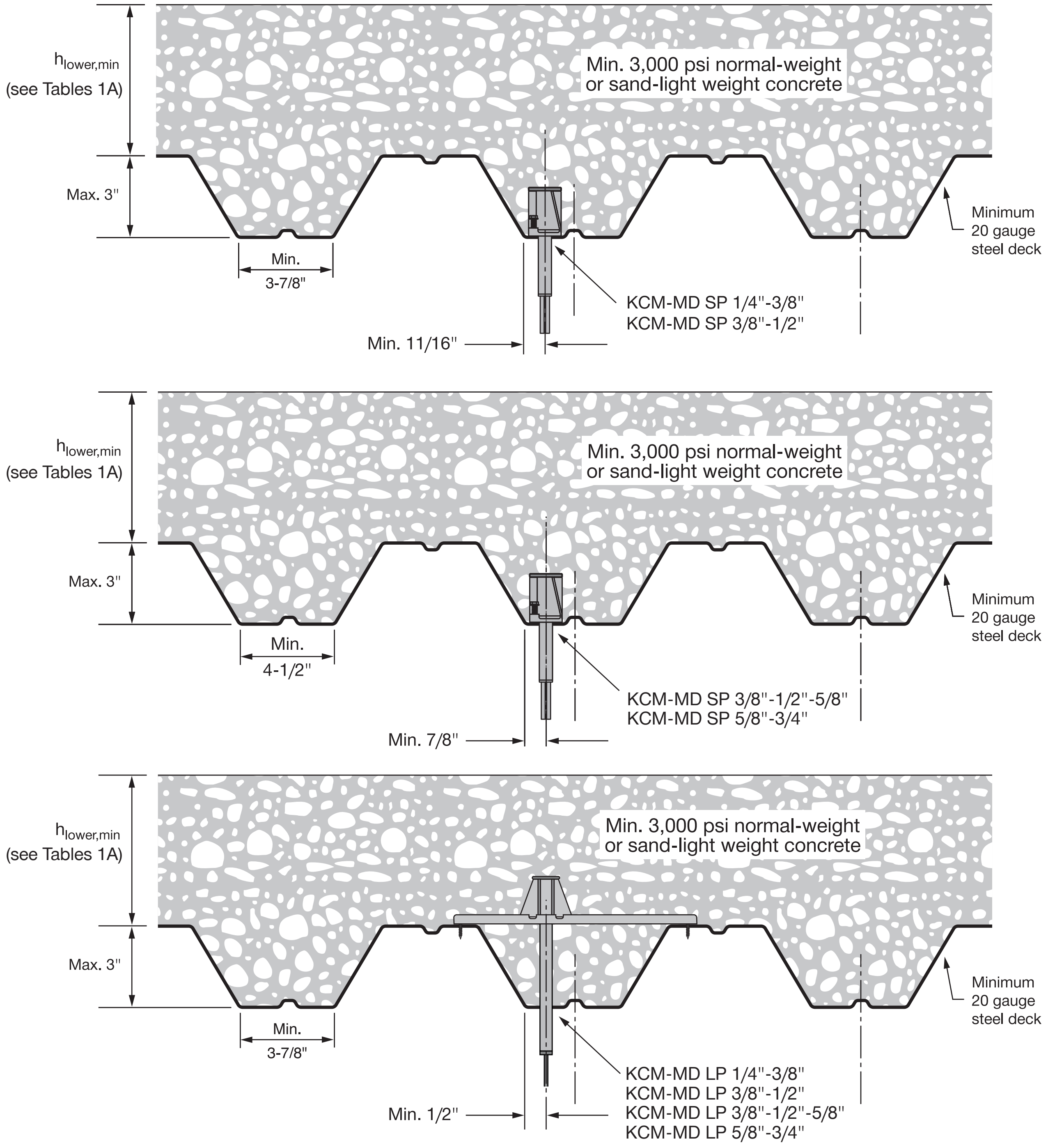


Figure 4B —Installation in the soffit of concrete filled metal deck floor and roof assemblies-over upper flute (W-deck)

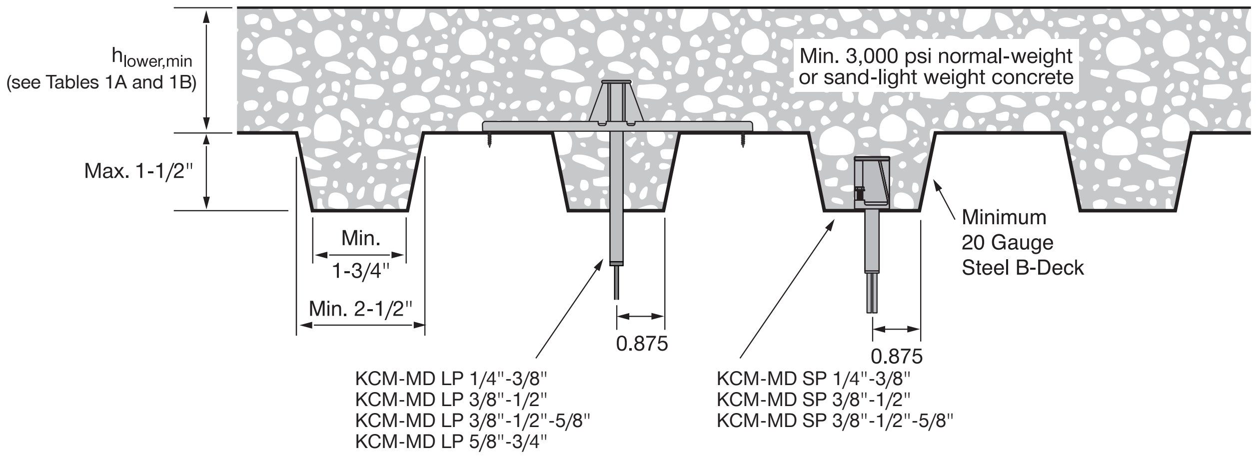


Figure 4C — Installation in the soffit of concrete filled metal deck floor and roof assemblies-over lower flute (B-deck)

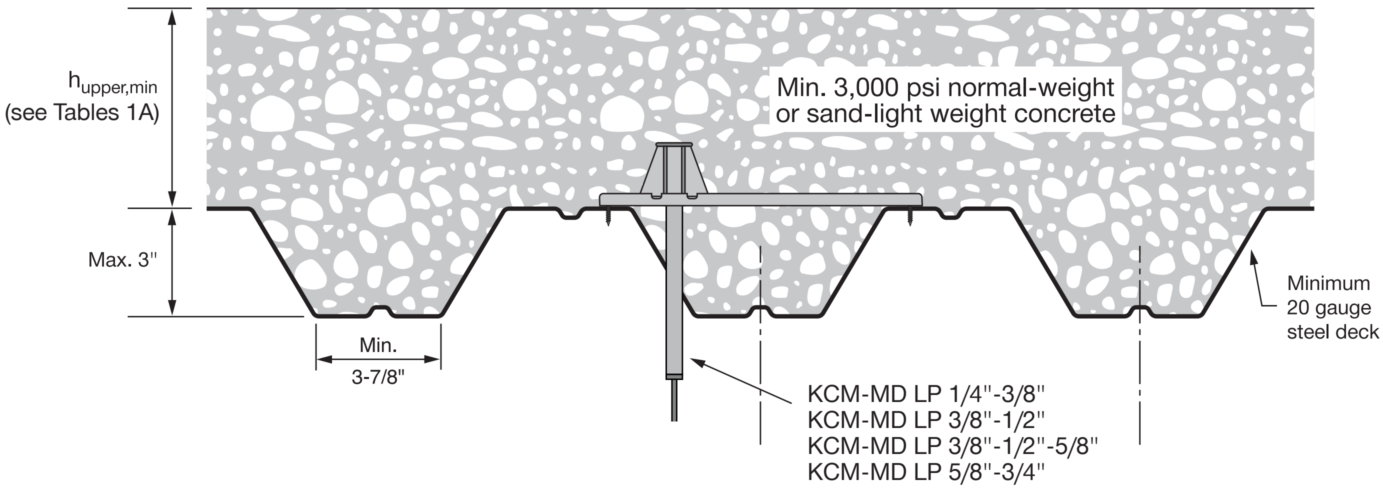


Figure 4D — Installation in the soffit of concrete filled metal deck floor and roof assemblies-over flute incline (W-deck)

DESIGN DATA IN CONCRETE PER CSA A23.3

CSA A23.3 Annex D Design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-4145. These tables are followed by factored resistance tables. The factored resitance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to PTG ED. 19, Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

Table 11A — Design strength for steel failure of KCM-MD Short Plate anchor[1,2,3,4]

Design information	Insert Type								
	SP		SP		SP			SP	
	1/4”-3/8”		3/8”-1/2”		3/8”-1/2”-5/8”			5/8”-3/4”	
Nominal rod diameter in.	1/4	3/8	3/8 [5]	1/2	3/8	1/2 [5]	5/8	5/8 [5]	3/4
Anchor O.D., d_a in (mm)	0.52 (13)		0.67 (17)		0.88 (22)			1.00 (25)	
Effective embedment, h_{ef} in (mm)	1.76 (45)		2 (51)		2.5 (64)			2.5 (64)	
Min. specified ult. Strength, f_{ut} lb (kN)	8,300 (36.9)		13,500 (60.1)		16,800 (74.8)			22,500 (100.1)	
Anchor category	Cast-In								
Concrete material resistance factor, Φ_c	0.65								
Resistance modification factor for tension and shear, concrete failure modes, Condition B, R	1.00								
Steel embed. material resistance factor for reinforcement, Φ_s	0.85								
Resistance modification factor for tension, steel failure modes, R	0.70								
Resistance modification factor for shear, steel failure modes, R	0.65								
Factored steel strength of insert in tension, $\Phi N_{sa,insert}$ lb (kN)	4,940 (22.0)		8,030 (35.7)		7,330 (32.6)			7,155 (31.8)	
Factored seismic steel strength of insert in tension, $\Phi N_{sa,insert,eq}$ lb (kN)	-	4,940 (22)	8,030 (36)	8,030 (36)	-	7,330 (33)	7,330 (33)	7,155 (32)	7,155 (32)
Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figures 4A									
Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN)	-	2,590 (12)	-	4,875 (22)	-	-	6,615 (29)	-	7,600 (34)
Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN)	-	2,590 (12)	-	4,875 (22)	-	-	6,615 (29)	-	7,600 (34)
Installations in lower flute of metal deck (i.e. W-deck) according to Figures 4B									
Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN)	-	1,900 (8)	1,835 (8)	2,310 (10)	-	2,930 (13)	3,005 (13)	2,590 (12)	3,005 (13)
Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN)	-	1,900 (8)	1,835 (8)	2,310 (10)	-	2,050 (9)	3,005 (13)	2,590 (12)	3,005 (13)
Installations in lower flute of metal deck (i.e. B-deck) according to Figures 4C									
Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN)	-	1,745 (8)	-	2,190 (10)	-	-	3,085 (14)	-	-
Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN)	-	1,745 (8)	-	2,190 (10)	-	-	2,775 (12)	-	-

1 Design information in this table is taken from ICC-ES ESR-4145, Table 4A, and converted for use with CSA A23.3 (R2014) Annex D.

2 The carbon steel KCM-MD is considered a brittle steel element as defined by CSA A23.3 (R2014) Annex D section D.2.

3 Tension values are for the inserts only. The capacity of the threaded rods must be also determined from Table 18. The design strength of concrete must be obtained from tables 12 to 17. Compare the tension values of threaded rod, inserts, and concrete. The lesser of the values is to be used for the design.

4 Shear values are for the inserts only. The capacity of the threaded rods must be also determined from Table 18. The calculation of concrete shear strength is not required. Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.

5 Only threaded rod ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 is permitted to be used for the applications resisting shear, seismic shear, or seismic tension loads.

Table 11B — Design strength for steel failure of KCM-MD Long Plate anchor[1,2,3,4]

Design information	Insert Type								
	LP 1/4"-3/8"		LP 3/8"-1/2"		LP 3/8"-1/2"-5/8"			LP 5/8"-3/4"	
Nominal rod diameter (in.)	1/4	3/8	3/8[5]	1/2	3/8	1/2[5]	5/8	5/8[5]	3/4
Anchor O.D., d_a in (mm)	0.52 (13.2)		0.67 (17.0)		0.88 (22.4)			1.00 (25.4)	
Effective embedment, h_{ef} in (mm)	1.76 (45)		2 (50.8)		2.5 (63.5)			2.5 (63.5)	
Min. specified ult. Strength, f_{ut} lb (kN)	8,300 (36.9)		13,500 (60.1)		16,800 (74.8)			22,500 (100.1)	
Anchor category	Cast-In								
Concrete material resistance factor, Φ_c	0.65								
Resistance modification factor for tension and shear, concrete failure modes, Condition B, R	1.00								
Steel embed. material resistance factor for reinforcement, Φ_s	0.85								
Resistance modification factor for tension, steel failure modes, R	0.70								
Resistance modification factor for shear, steel failure modes, R	0.65								
Factored steel strength of insert in tension, $\Phi N_{sa,insert}$ lb (kN)	4,940 (22.0)		8,030 (35.7)		7,330 (32.6)			7,155 (31.8)	
Factored seismic steel strength of insert in tension, $\Phi N_{sa,insert,eq}$ lb (kN)	-	4,940 (22.0)	8,030 (35.7)	8,030 (35.7)	-	7,330 (32.6)	7,330 (32.6)	7,155 (31.8)	7,155 (31.8)
Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figures 4A									
Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN)	-	2,590 (11.5)	-	4,875 (21.7)	-	-	6,615 (29.4)	-	7,600 (33.8)
Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN)	-	2,590 (11.5)	-	4,875 (21.7)	-	-	6,615 (29.4)	-	7,600 (33.8)
Installations in lower flute of metal deck (i.e. W-deck) according to Figures 4B									
Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN)	-	2,985 (13.3)	2,400 (10.7)	3,670 (16.3)	-	2,230 (9.9)	4,260 (19.0)	5,935 (26.4)	4,260 (19.0)
Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN)	-	2,985 (13.3)	2,400 (10.7)	3,670 (16.3)	-	2,230 (9.9)	4,260 (19.0)	5,935 (26.4)	4,260 (19.0)
Installations in lower flute of metal deck (i.e. B-deck) according to Figures 4C									
Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN)	-	2,660 (11.8)	-	4,165 (18.5)	-	-	5,295 (23.6)	-	6,585 (29.3)
Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN)	-	2,660 (11.8)	-	4,165 (18.5)	-	-	5,295 (23.6)	-	6,585 (29.3)
Installations over flute incline of metal deck (i.e. W-deck) according to Figures 4D									
Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN)	-	950 (4.2)	-	2,455 (10.9)	-	-	5,510 (24.5)	-	5,510 (24.5)
Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN)	-	950 (4.2)	-	1,965 (8.7)	-	-	3,100 (13.8)	-	5,235 (23.3)

1 Design information in this table is taken from ICC-ES ESR-4145, Table 4B, and converted for use with CSA A23.3 (R2014) Annex D.

2 The carbon steel KCM-MD is considered a brittle steel element as defined by CSA A23.3 (R2014) Annex D section D.2.

3 Tension values are for the inserts only. The capacity of the threaded rods must be also determined from Table 18. The design strength of concrete must be obtained from tables 12 to 17.
Compare the tension values of threaded rod, inserts, and concrete. The lesser of the values is to be used for the design.

4 Shear values are for the inserts only. The capacity of the threaded rods must be also determined from Table 18. The calculation of concrete shear strength is not required.
Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.

5 Only threaded rod ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 is permitted to be used for the applications resisting shear, seismic shear, or seismic tension loads.

Table 12 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

Anchor	Nominal embed. in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4C	
		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 1/4”-3/8”	1.88 (48)	2,655 (11.8)	3,250 (14.5)	555 (2.5)	675 (3.0)
SP 3/8”-1/2"	2.13 (54)	3,300 (14.7)	4,040 (18.0)	580 (2.6)	710 (3.2)
SP 3/8”-1/2"-5/8"	2.63 (67)	4,180 (18.6)	5,120 (22.8)	635 (2.8)	775 (3.4)
SP 5/8”-3/4”	2.65 (67)	4,180 (18.6)	5,120 (22.8)	-	-
LP 1/4”-3/8”	1.96 (50)	2,655 (11.8)	3,250 (14.5)	2,655 (11.8)	3,250 (14.5)
LP 3/8”-1/2"	2.21 (56)	3,300 (14.7)	4,040 (18.0)	3,300 (14.7)	4,040 (18.0)
LP 3/8”-1/2"-5/8"	2.71 (69)	4,180 (18.6)	5,120 (22.8)	4,180 (18.6)	5,120 (22.8)
LP 5/8”-3/4"	2.72 (69)	4,180 (18.6)	5,120 (22.8)	4,180 (18.6)	5,120 (22.8)

Table 13 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

Anchor	Nominal embed. in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4C	
		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 1/4”-3/8”	1.88 (48)	2,125 (9.5)	2,600 (11.6)	440 (2.0)	540 (2.4)
SP 3/8”-1/2"	2.13 (54)	2,640 (11.7)	3,230 (14.4)	465 (2.1)	565 (2.5)
SP 3/8”-1/2"-5/8"	2.63 (67)	3,345 (14.9)	4,095 (18.2)	505 (2.2)	620 (2.8)
SP 5/8”-3/4”	2.65 (67)	3,345 (14.9)	4,095 (18.2)	-	-
LP 1/4”-3/8”	1.96 (50)	2,125 (9.5)	2,600 (11.6)	2,125 (9.5)	2,600 (11.6)
LP 3/8”-1/2"	2.21 (56)	2,640 (11.7)	3,230 (14.4)	2,640 (11.7)	3,230 (14.4)
LP 3/8”-1/2"-5/8"	2.71 (69)	3,345 (14.9)	4,095 (18.2)	3,345 (14.9)	4,095 (18.2)
LP 5/8”-3/4"	2.72 (69)	3,345 (14.9)	4,095 (18.2)	3,345 (14.9)	4,095 (18.2)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Tables 11A or 11B and threaded rod steel strength values in Table 18. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 11A or 11B for shear calculations.

Table 14 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 3-7/8” width)[1,2,3,4,5,6,7,8]

Anchor	Nominal embed. in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4B		Inclined per Figure 4D	
		Tension - N_r		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 1/4”-3/8”	1.88	2,655	3,250	1,280	1,565	-	-
	(48)	(11.8)	(14.5)	(5.7)	(7.0)		
SP 3/8”-1/2"	2.13	3,300	4,040	1,685	2,065	-	-
	(54)	(14.7)	(18.0)	(7.5)	(9.2)		
SP 3/8”-1/2"-5/8"	2.63	4,180	5,120	1,935	2,370	-	-
	(67)	(18.6)	(22.8)	(8.6)	(10.5)		
SP 5/8”-3/4”	2.65	4,180	5,120	1,935	2,370	-	-
	(67)	(18.6)	(22.8)	(8.6)	(10.5)		
LP 1/4”-3/8”	1.96	2,655	3,250	4,470	5,475	2,655	3,250
	(50)	(11.8)	(14.5)	(19.9)	(24.4)	(11.8)	(14.5)
LP 3/8”-1/2"	2.21	3,300	4,040	4,470	5,475	3,300	4,040
	(56)	(14.7)	(18.0)	(19.9)	(24.4)	(14.7)	(18.0)
LP 3/8”-1/2"-5/8"	2.71	4,180	5,120	5,990	7,340	4,180	5,120
	(69)	(18.6)	(22.8)	(26.6)	(32.6)	(18.6)	(22.8)
LP 5/8”-3/4"	2.72	4,180	5,120	5,990	7,340	4,180	5,120
	(69)	(18.6)	(22.8)	(26.6)	(32.6)	(18.6)	(22.8)

Table 15 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 3-7/8” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal embed. in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4B		Inclined per Figure 4D	
		Tension - N_r		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 1/4”-3/8”	1.88	2,125	2,600	1,025	1,250	-	-
	(48)	(9.5)	(11.6)	(4.6)	(5.6)		
SP 3/8”-1/2"	2.13	2,640	3,230	1,350	1,655	-	-
	(54)	(11.7)	(14.4)	(6.0)	(7.4)		
SP 3/8”-1/2"-5/8"	2.63	3,345	4,095	-	-	-	-
	(67)	(14.9)	(18.2)				
SP 5/8”-3/4”	2.65	3,345	4,095	-	-	-	-
	(67)	(14.9)	(18.2)				
LP 1/4”-3/8”	1.96	2,125	2,600	3,575	4,380	2,125	2,600
	(50)	(9.5)	(11.6)	(15.9)	(19.5)	(9.5)	(11.6)
LP 3/8”-1/2"	2.21	2,640	3,230	3,575	4,380	2,640	3,230
	(56)	(11.7)	(14.4)	(15.9)	(19.5)	(11.7)	(14.4)
LP 3/8”-1/2"-5/8"	2.71	3,345	4,095	4,795	5,870	3,345	4,095
	(69)	(14.9)	(18.2)	(21.3)	(26.1)	(14.9)	(18.2)
LP 5/8”-3/4"	2.72	3,345	4,095	4,795	5,870	3,345	4,095
	(69)	(14.9)	(18.2)	(21.3)	(26.1)	(14.9)	(18.2)

[1] See Section 3.1.8.6 to convert design strength value to ASD value.
[2] Linear interpolation between concrete compressive strengths is not permitted.
[3] Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
[4] Tabular values are for normal weight or sand-light weight concrete.
[5] No additional reduction factors for spacing or edge distance need to be applied.
[6] Compare tabular value to the insert steel strength values in Tables 11A or 11B and threaded rod steel strength values in Table 18. The lesser of the values is to be used for the design.
[7] Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
[8] For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 11A or 11B for shear calculations.

Table 16 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 4-1/2” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal embed. in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4B		Inclined per Figure 4D	
		Tension - N_r		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 1/4”-3/8”	1.88 (48)	2,655 (11.8)	3,250 (14.5)	1,280 (5.7)	1,565 (7.0)	-	-
SP 3/8”-1/2"	2.13 (54)	3,300 (14.7)	4,040 (18.0)	1,685 (7.5)	2,065 (9.2)	-	-
SP 3/8”-1/2"-5/8"	2.63 (67)	4,180 (18.6)	5,120 (22.8)	1,935 (8.6)	2,370 (10.5)	-	-
SP 5/8”-3/4”	2.65 (67)	4,180 (18.6)	5,120 (22.8)	1,935 (8.6)	2,370 (10.5)	-	-
LP 1/4”-3/8”	1.96 (50)	2,655 (11.8)	3,250 (14.5)	4,470 (19.9)	5,475 (24.4)	2,655 (11.8)	3,250 (14.5)
LP 3/8”-1/2"	2.21 (56)	3,300 (14.7)	4,040 (18.0)	4,470 (19.9)	5,475 (24.4)	3,300 (14.7)	4,040 (18.0)
LP 3/8”-1/2"-5/8"	2.71 (69)	4,180 (18.6)	5,120 (22.8)	5,990 (26.6)	7,340 (32.6)	4,180 (18.6)	5,120 (22.8)
LP 5/8”-3/4"	2.72 (69)	4,180 (18.6)	5,120 (22.8)	5,990 (26.6)	7,340 (32.6)	4,180 (18.6)	5,120 (22.8)

Table 17 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 4-1/2” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal embed. in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4B		Inclined per Figure 4D	
		Tension - N_r		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 1/4”-3/8”	1.88 (48)	2,125 (9.5)	2,600 (11.6)	1,025 (4.6)	1,250 (5.6)	-	-
SP 3/8”-1/2"	2.13 (54)	2,640 (11.7)	3,230 (14.4)	1,350 (6.0)	1,655 (7.4)	-	-
SP 3/8”-1/2"-5/8"	2.63 (67)	3,345 (14.9)	4,095 (18.2)	1,550 (6.9)	1,895 (8.4)	-	-
SP 5/8”-3/4”	2.65 (67)	3,345 (14.9)	4,095 (18.2)	1,550 (6.9)	1,895 (8.4)	-	-
LP 1/4”-3/8”	1.96 (50)	2,125 (9.5)	2,600 (11.6)	3,575 (15.9)	4,380 (19.5)	2,125 (9.5)	2,600 (11.6)
LP 3/8”-1/2"	2.21 (56)	2,640 (11.7)	3,230 (14.4)	3,575 (15.9)	4,380 (19.5)	2,640 (11.7)	3,230 (14.4)
LP 3/8”-1/2""5/8"	2.71 (69)	3,345 (14.9)	4,095 (18.2)	4,795 (21.3)	5,870 (26.1)	3,345 (14.9)	4,095 (18.2)
LP 5/8”-3/4"	2.72 (69)	3,345 (14.9)	4,095 (18.2)	4,795 (21.3)	5,870 (26.1)	3,345 (14.9)	4,095 (18.2)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Tables 11A or 11B and threaded rod steel strength values in Table 18. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 11A or 11B for shear calculations.

Table 18 — Design strength for steel failure of common threaded rods used with KCM-MD cast-in anchor [1,2,3]

Nominal anchor diameter	Grade A36 threaded rod			ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod			ASTM A 307, Grade A threaded rod		
	Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN)	Shear[5] $V_{sar,rod}$ lb (kN)	Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN)	Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN)	Shear[5] $V_{sar,rod}$ lb (kN)	Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN)	Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN)	Shear[5] $V_{sar,rod}$ lb (kN)	Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN)
1/4	1,260 (5.6)	705 (3.1)	495 (2.2)	2,720 (12.1)	1,520 (6.8)	1,065 (4.7)	1,290 (5.7)	725 (3.2)	505 (2.2)
3/8	3,075 (13.7)	1,720 (7.7)	1,205 (5.4)	6,630 (29.5)	3,705 (16.5)	2,595 (11.5)	3,160 (14.1)	1,780 (7.9)	1,245 (5.5)
1/2	5,600 (24.9)	3,150 (14.0)	2,205 (9.8)	12,070 (53.7)	6,785 (30.2)	4,750 (21.1)	5,780 (25.7)	3,250 (14.5)	2,275 (10.1)
5/8	8,915 (39.7)	5,010 (22.3)	3,505 (15.6)	19,210 (85.4)	10,805 (48.1)	7,565 (33.7)	9,215 (41.0)	5,185 (23.1)	3,630 (16.1)
3/4	13,190 (58.7)	7,420 (33.0)	5,195 (23.1)	28,475 (126.7)	15,990 (71.1)	11,195 (49.8)	13,635 (60.7)	7,670 (34.1)	5,370 (23.9)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Hilti KCM-MD anchors are to be considered brittle steel elements
3 See PTG ed. 17, Section 3.1.8.7 for additional information on seismic applications.
4 Tensile $N_{sar} = \phi_s A_{se} R f_{ut}$ as noted in CSA A23.3 Annex D.
5 Shear values determined by static shear tests with $V_{sar} < \phi_s 0.60 A_{se,V} f_{ut} R$. as noted in CSA A23.3 Annex D.
6 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < \phi_s 0.60 A_{se,V} f_{ut} R$. as noted in CSA A23.3 Annex D.

Table 19A — UL cUL LLC and FM approvals for KCM-MD Short Plate Anchors [1,2]

Design information		SP 1/4"-3/8"			SP 3/8"-1/2"			SP 3/8"-1/2"-5/8"			SP 5/8"-3/4"		
Nominal rod diameter (in.)	Metal deck soffit	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)
3/8	Upper flute	4	1,500	4	4	1,500	4	4	1,500	4	-	-	-
	Lower flute	4	1,500	4	4	1,500	4	4	1,500	-	-	-	-
1/2	Upper flute	-	-	-	8	4,050	8	8	4,050	8	-	-	-
	Lower flute	-	-	-	8	4,050	8	8	4,050	-	-	-	-
5/8	Upper flute	-	-	-	-	-	-	12	7,900	12	12	7,900	12
	Lower flute	-	-	-	-	-	-	8	4,050	-	8	4,050	-
3/4	Upper flute	-	-	-	-	-	-	-	-	-	12	7,900	12
	Lower flute	-	-	-	-	-	-	-	-	-	8	4,050	-

Table 19B — UL cUL LLC and FM approvals for KCM-MD Long Plate Anchors [1,2]

Design information		LP 1/4"-3/8"			LP 3/8"-1/2"			LP 3/8"-1/2"-5/8"			LP 5/8"-3/4"		
Nominal rod diameter (in.)	Metal deck soffit	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)
3/8	Upper flute	4	1,500	4	4	1,500	4	4	1,500	4	-	-	-
	Lower flute	-	-	-	-	-	-	-	-	-	-	-	-
1/2	Upper flute	-	-	-	8	4,050	8	8	4,050	8	-	-	-
	Lower flute	-	-	-	-	-	-	-	-	-	-	-	-
5/8	Upper flute	-	-	-	-	-	-	12	7,900	12	12	7,900	12
	Lower flute	-	-	-	-	-	-	-	-	-	-	-	-
3/4	Upper flute	-	-	-	-	-		-	-	-	12	7,900	12
	Lower flute	-	-	-	-	-		-	-	-	-	-	-

1 UL LLC Listing based on successful completion of testing in accordance with UL 203.
2 FM Approval based on successful completion of testing in accordance with FM 1952.

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com and www.hilti.ca. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION[1]

KCM-MD Short Plate and Long Plate cast-in anchors for use in metal deck

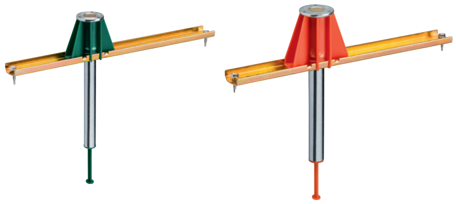
Description	Sleeve color [2]	Qty / box	Hole saw diameter
KCM-MD SP 1/4"-3/8"	Green	90	9/16"
KCM-MD SP 3/8"-1/2"	Orange	75	11/16"
KCM-MD SP 3/8"-1/2"-5/8"	Red	45	13/16"
KCM-MD SP 5/8"-3/4"	Grey	40	15/16"
KCM-MD LP 1/4”-3/8”	Green	25	1/2”
KCM-MD LP 3/8"-1/2"	Orange	20	5/8”
KCM-MD LP 3/8”-1/2”-5/8”	Red	15	3/4”
KCM-MD LP 5/8”-3/4”	Grey	15	7/8”

1 All dimensions in inches
2 Identifies anchor size

3.3.17 KCC-WF AND KCC-MD CAST-IN ANCHOR

PRODUCT DESCRIPTION

KCC-WF and KCC-MD cast-in anchors

Anchor System		Features and Benefits
	Internally threaded cast-in anchors for wood form construction (KCC-WF)	- Quick push-to-connect technology offers ultimate productivity - Ideal for pre-assembled / pre-fabricated hanger assemblies - KCC-WF — Color-coded foam covering protects inner threads from concrete intrusion - KCC-WF — Nails through the head helps prevent anchor from being knocked over and from head popping off due to rebar hits - KCC-MD SP and LP — Pre-assembled self-tapping screws reduce installation time - KCC-MD SP and LP — Color-coded plastic plugs protect inner threads from concrete, sprayed-on fireproofing, or sprayed-on insulation - KCC-MD LP — Pre-assembled spanner plate offers flexibility with installation at any location on the metal deck including the incline - KCC-MD LP — Anchor installs to the top of the flutes, so anchoring point is at consistent height throughout, which is ideal for pre-fabricated hangers
	Internally threaded short plate cast-in anchors for lightweight concrete over metal deck construction (KCC-MD SP)	
	Internally threaded long plate cast-in anchors for lightweight concrete over metal deck construction (KCC-MD LP)	

Uncracked concrete

Cracked concrete

Seismic Design Categories A-F

Fire sprinkler listings

Approvals/ Listings

ICC-ES (International Code Council) 2018 International Building Code / International Residential Code (IBC/IRC)	ESR-4145 in concrete per ACI 318 Ch. 17 / ICC-ES AC446
City of Los Angeles	2020 LABC Supplement (within ESR-4145)
Florida Building Code	2017 FBC with HVHZ
UL LLC (Underwriters Laboratory LLC)	Pipe Hanger Equipment for Fire Protection Services for 3/8 through 1/2 (See Table 28)
FM (Factory Mutual) Pipe	Hanger Components for Automatic Sprinkler Systems for 3/8 through 1/2 (See Table 28)
ANSI/MSS SP-58-2018	Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information.

MATERIAL SPECIFICATIONS

KCC-WF and KCC-MD (short plate and long plate) have an insert body made from carbon steel with an engineered plastic flange. The insert body is zinc plated per ASTM B633 Fe/Zn 5 Type III.

INSTALLATION PARAMETERS

Table 1 — Hilti KCC-WF, KCC-MD SP and KCC-MD LP cast-in anchor installation information

Design Information	Symbol	Units	KCC-WF		KCC-MD SP		KCC-MD LP	
Insert thread	d	UNC	3/8-16	1/2-13	3/8-16	1/2-13	3/8-16	1/2-13
Plastic housing color	-	-	Dark Green	Dark Orange	Dark Green	Dark Orange	Dark Green	Dark Orange
Outside diameter of anchor steel body	d_a	in. (mm)	0.67 (17)	0.87 (22)	0.67 (17)	0.87 (22)	0.67 (17)	0.87 (22)
Bearing area	A_{brg}	in.² (mm²)	1.0 (643)	1.2 (774)	1.0 (643)	1.2 (774)	1.0 (643)	1.2 (774)
Effective embedment	h_{ef}	in. (mm)	1.63 (41)	2.04 (52)	2.00 (51)	2.50 (64)	2.00 (51)	2.50 (64)
Nominal embedment	h_{nom}	in. (mm)	1.76 (45)	2.17 (55)	2.13 (54)	2.63 (67)	2.21 (56)	2.71 (69)
Metal hole saw diameter	d_{bit}	in.	N/A	N/A	11/16	13/16	5/8	3/4
Steel head thickness	t_{sh}	mm	3.3					
Minimum member thickness — wood form installation	h_{min}	in. (mm)	2.5 (64)	3 (76)	N/A	N/A	N/A	N/A
Minimum concrete cover over metal deck — all installations (see Figures 5A, 5B, 5C and 5D)	$h_{deck,min}$	in. (mm)	N/A	N/A	2.5 (64)	3.25 (83)	2.5 (64)	3.25 (83)
Minimum metal deck gauge	-	-	N/A		20			
Minimum anchor spacing	S_{min}	in. (mm)	2.6 (67)	3.5 (88)	6.0 (152)	7.5 (191)	6.0 (152)	7.5 (191)
Minimum edge distance	C_{min}	in. (mm)	1.5 (38)	1.5 (38)	6.0 (152)	7.5 (191)	6.0 (152)	7.5 (191)
Thread engagement length — see Figure 4	l_{th}	in.	1.6	1.9	N/A	N/A	N/A	N/A
Thread engagement length Plastic on/ Metal tube on — see Figure 4	l_{th}	in.	N/A	N/A	4.3	4.7	6.9	7.3
Thread engagement length Plastic off — see Figure 4	l_{th}	in.	N/A	N/A	2.5	2.9	N/A	N/A

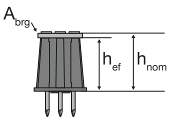


Figure 1 — KCC-WF

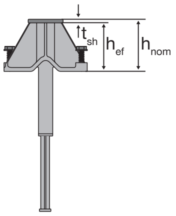


Figure 2 — KCC-MD SP

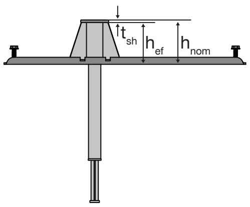
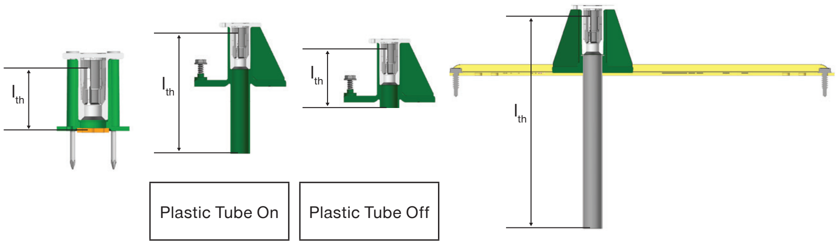


Figure 3 — KCC-MD LP



(a) KCC-WF

(b) KCC-MD SP

(c) KCC-MD LP (Metal Tube On)

Figure 4 — KCC Thread Engagement Measurement

DESIGN INFORMATION IN CONCRETE PER ACI 318

ACI 318 Chapter 17

The technical data contained in this section are Hilti Simplified Tables. The load values were developed using the Strength Design parameters and variables of ESR-4145 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-4145 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Table 2 — Design strength for steel failure of KCC-WF inserts[1,2,3,4]

DESIGN INFORMATION	Symbol	Units	Insert type	
			KCC-WF	
Nominal rod diameter	-	in.	3/8	1/2
Design steel strength of insert in tension	$\phi_{Nsa,insert}$	lb	2,625	3,515
		(kN)	(11.7)	(15.6)
Design seismic steel strength of insert in tension	$\phi_{Nsa,insert,eq}$	lb	2,625	3,515
		(kN)	(11.7)	(15.6)
Design steel strength of insert in shear	$\phi_{Vsa,insert}$	lb	3,220	3,340
		(kN)	(14.3)	(14.9)
Design seismic steel strength of insert in shear	$\phi_{Vsa,insert}$	lb	3,220	3,340
		(kN)	(14.3)	(14.9)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Hilti KCC-WF Inserts are considered brittle steel elements
3 Values are for the insert only. The capacity of the threaded rod must be also be determined from Table 16. The design strength of concrete must be in accordance with ACI 318 Chapter 17 and Tables 3 to 4 as necessary. Compare the values (threaded rod, inserts, and concrete). The lesser of the values is to be used for the design.
4 Only threaded rods ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 are allowed to be used for applocations resisting shear, seismic shear or seismic tension loads.

Table 3 — Hilti KCC-WF cast-in insert design strength with concrete / pullout failure in uncracked concrete [1,2,3,4,5,6]

Nominal anchor internal diameter	Effective embedment depth in. (mm)	Tension - ΦN_n				Shear - ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
3/8"	1.63	2,185	2,390	2,760	3,385	2,185	2,390	2,760	3,385
	(41)	(9.7)	(10.6)	(12.3)	(15.1)	(9.7)	(10.6)	(12.3)	(15.1)
1/2"	2.04	3,055	3,350	3,865	4,735	3,055	3,350	3,865	4,735
	(52)	(13.6)	(14.9)	(17.2)	(21.1)	(13.6)	(14.9)	(17.2)	(21.1)

Table 4 — Hilti KCC-WF cast-in insert design strength with concrete / pullout failure in cracked concrete [1,2,3,4,5,6]

Nominal anchor internal diameter	Effective embedment depth in. (mm)	Tension - ΦN_n				Shear - ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
3/8"	1.63	1,745	1,910	2,210	2,705	1,745	1,910	2,210	2,705
	(41)	(7.8)	(8.5)	(9.8)	(12.0)	(7.8)	(8.5)	(9.8)	(12.0)
1/2"	2.04	2,445	2,680	3,095	3,790	2,445	2,680	3,095	3,790
	(52)	(10.9)	(11.9)	(13.8)	(16.9)	(10.9)	(11.9)	(13.8)	(16.9)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for single anchors located at edge distance (c) and spacing (s) greater than $3h_{ef}$. For anchors with edge distance or spacing less than $3h_{ef}$ use ACI 318 to calculate load reduction factor. Compare the calculated value to the steel values (threaded rod and inserts) in Tables 16 and 2. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.85. For all-lightweight, λ_a = 0.75.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear.
6 Compare tabular value to the insert steel strength values in Table 2 and threaded rod steel strength values in Table 16 The lesser of the values is to be used for the design.

Table 5 — Load adjustment factors for KCC-WF 3/8" in uncracked concrete [1,2]

KCC-WF 3/8" uncracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear [3] f_{AV}	Edge distance in shear		Concrete thickness factor in shear [4] f_{HV}
						⊥ Toward edge f_{RV}	∥ To edge f_{RV}	
Embedment		in	1.63	1.63	1.63	1.63	1.63	1.63
h_{ef}		(mm)	(41)	(41)	(41)	(41)	(41)	(41)
Min. conc. thickness h_{min} (in.)			2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2	(38)	n/a	0.713	n/a	0.282	0.564	n/a
	2	(51)	n/a	0.859	n/a	0.434	0.859	n/a
	2-1/2	(64)	n/a	1.000	n/a	0.607	1.000	0.691
	2-5/8	(67)	0.768		0.625	0.653		0.708
	3	(76)	0.807		0.643	0.798		0.757
	3-1/2	(89)	0.858		0.667	1.000		0.818
	4	(102)	0.909		0.691			0.874
	4-1/2	(114)	0.960		0.715			0.927
	5	(127)	1.000		0.739			0.978
	5-1/2	(140)			0.763			1.000
	6	(152)			0.787			
	7	(178)			0.834			
	8	(203)			0.882			
	10	(254)			0.978			
	12	(305)			1.000			

Table 6 — Load adjustment factors for KCC-WF 3/8" in cracked concrete [1,2]

KCM-WF 1/4"-3/8" cracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear [3] f_{AV}	Edge distance in shear		Concrete thickness factor in shear [4] f_{HV}
						⊥ Toward edge f_{RV}	∥ To edge f_{RV}	
Embedment		in	1.63	1.63	1.63	1.63	1.63	1.63
h_{ef}		(mm)	(41)	(41)	(41)	(41)	(41)	(41)
Min. conc. thickness h_{min} (in.)			2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2	(38)	n/a	0.713	n/a	0.252	0.504	n/a
	2	(51)	n/a	0.859	n/a	0.388	0.775	n/a
	2-1/2	(64)	n/a	1.000	n/a	0.542	1.000	0.666
	2-5/8	(67)	0.768		0.616	0.583		0.682
	3	(76)	0.807		0.633	0.712		0.729
	3-1/2	(89)	0.858		0.655	0.897		0.788
	4	(102)	0.909		0.677	1.000		0.842
	4-1/2	(114)	0.960		0.699			0.893
	5	(127)	1.000		0.722			0.941
	5-1/2	(140)			0.744			0.987
	6	(152)			0.766			1.000
	7	(178)			0.810			
	8	(203)			0.854			
	10	(254)			0.943			
	12	(305)			1.000			

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 (or CSA A23.3 (R2014) Annex D).

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

Table 7 — Load adjustment factors for KCC-WF 1/2" in uncracked concrete [1,2]

KCM-WF 1/2" uncracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear [3] f_{AV}	Edge distance in shear		Concrete thickness factor in shear [4] f_{HV}
						⊥ Toward edge f_{RV}	∥ To edge f_{RV}	
Embedment h_{ef}		in	2.04	2.04	2.04	2.04	2.04	2.04
		(mm)	(52)	(52)	(52)	(52)	(52)	(52)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2	(38)	n/a	0.631	n/a	0.281	0.561	n/a
	2	(51)	n/a	0.741	n/a	0.432	0.741	n/a
	2-1/2	(64)	n/a	0.859	n/a	0.604	0.859	n/a
	3	(76)	n/a	0.984	n/a	0.794	0.984	0.756
	3-1/2	(89)	0.786	1.000	0.667	1.000	1.000	0.817
	4	(102)	0.827		0.691			0.873
	4-1/2	(114)	0.868		0.714			0.926
	5	(127)	0.908		0.738			0.976
	5-1/2	(140)	0.949		0.762			1.000
	5-3/4	(146)	0.970		0.774			
	6	(152)	0.990		0.786			
	7	(178)	1.000		0.833			
	8	(203)			0.881			
	9	(229)			0.929			
	10	(254)			0.976			
	12	(305)			1.000			

Table 8 — Load adjustment factors for KCC-WF 1/2" in cracked concrete [1,2]

KCM-WF 3/8"-1/2" cracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear [3] f_{AV}	Edge distance in shear		Concrete thickness factor in shear [4] f_{HV}
						⊥ Toward edge f_{RV}	∥ To edge f_{RV}	
Embedment h_{ef}		in	2.04	2.04	2.04	2.04	2.04	2.04
		(mm)	(52)	(52)	(52)	(52)	(52)	(52)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2	(38)	n/a	0.631	n/a	0.251	0.501	n/a
	2	(51)	n/a	0.741	n/a	0.386	0.741	n/a
	2-1/2	(64)	n/a	0.859	n/a	0.539	0.859	n/a
	3	(76)	n/a	0.984	n/a	0.709	0.984	0.728
	3-1/2	(89)	0.786	1.000	0.655	0.893	1.000	0.786
	4	(102)	0.827		0.677	1.000		0.841
	4-1/2	(114)	0.868		0.699			0.892
	5	(127)	0.908		0.721			0.940
	5-1/2	(140)	0.949		0.743			0.986
	5-3/4	(146)	0.970		0.754			1.000
	6	(152)	0.990		0.765			
	7	(178)	1.000		0.809			
	8	(203)			0.853			
	9	(229)			0.898			
	10	(254)			0.942			
	12	(305)			1.000			

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 (or CSA A23.3 (R2014) Annex D).

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

Table 9 — Design strength for steel failure of KCC-MD Short Plate and Long Plate inserts [1,2,3,4,5]

Design information	Symbol	Units	Insert Type			
			SP 3/8”	SP 1/2”	LP 3/8”	LP 1/2”
Nominal rod diameter		in.	3/8	1/2	3/8	1/2
Design steel strength of insert in tension	$\phi N_{sa,insert}$	lb (kN)	2,625 (11.7)	3,515 (15.6)	2,625 (11.7)	3,515 (15.6)
Design seismic steel strength of insert in tension	$\phi N_{sa,insert,eq}$	lb (kN)	2,625 (11.7)	3,515 (15.6)	2,625 (11.7)	3,515 (15.6)
Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figure 5A						
Design steel strength of insert in shear	$\phi_{Vsa,insert}$	lb (kN)	2,810 (12.5)	3,340 (14.9)	2,810 (12.5)	3,340 (14.9)
Design seismic steel strength of insert in shear	$\phi V_{sa,insert,eq}$	lb (kN)	2,810 (12.5)	2,810 (12.5)	2,810 (12.5)	3,340 (14.9)
Installations in lower flute of metal deck (i.e. W-deck) according to Figure 5B						
Design steel strength of insert in shear	$\phi V_{sa,insert}$	lb (kN)	2,060 (9.2)	2,510 (11.2)	2,970 (13.2)	3,340 (14.9)
Design seismic steel strength of insert in shear	$\phi V_{sa,insert,eq}$	lb (kN)	2,060 (9.2)	2,510 (11.2)	2,970 (13.2)	3,340 (14.9)
Installations in lower flute of metal deck (i.e. B-deck) according to Figure 5C						
Design steel strength of insert in shear	$\phi V_{sa,insert}$	lb (kN)	1,895 (8.4)	2,380 (11)	2,890 (12.9)	3,340 (14.9)
Design seismic steel strength of insert in shear	$\phi V_{sa,insert,eq}$	lb (kN)	1,895 (8.4)	2,380 (11)	2,890 (12.9)	3,340 (14.9)
Installations over flute incline of metal deck (i.e. W-deck) according to Figure 5D						
Design steel strength of insert in shear	$\phi V_{sa,insert}$	lb (kN)	N/A		1,030 (4.6)	2,665 (11.9)
Design seismic steel strength of insert in shear	$\phi V_{sa,insert,eq}$	lb (kN)			1,030 (4.6)	2,135 (9,5)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Hilti KCC-MD Inserts are considered brittle steel elements
3 Tension values are for the inserts only. The capacity of the threaded rods must be also determined from Table 16. The design strength of concrete must be obtained from tables 10 to 15. Compare the tension values of threaded rod, inserts, and concrete. The lesser of the values is to be used for the design.
4 Shear values are for the inserts only. The capacity of the threaded rods must be also determined from Table 16. The calculation of concrete shear strength is not required. Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.
5 Only threaded rod ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 is permitted to be used for the applications resisting shear, seismic shear, or seismic tension loads.

Table 10 — Hilti KCC Short Plate and Long Plate tension design strength in the soffit of uncracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4C	
		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
SP 3/8”	2.13 (54)	3,610 (16.1)	4,170 (18.5)	635 (2.8)	735 (3.3)
SP 1/2”	2.63 (67)	4,580 (20.4)	5,290 (23.5)	695 (3.1)	805 (3.6)
LP 3/8”	2.21 (56)	3,610 (16.1)	4,170 (18.5)	3,610 (16.1)	4,170 (18.5)
LP 1/2”	2.71 (69)	4,580 (20.4)	5,290 (23.5)	4,580 (20.4)	5,290 (23.5)

Table 11 — Hilti KCC-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 4A		Lower flute per Figure 4C	
		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
SP 3/8”	2.13 (54)	2,890 (12.9)	3,335 (14.8)	505 (2.2)	585 (2.6)
SP 1/2”	2.63 (67)	3,660 (16.3)	4,225 (18.8)	555 (2.5)	640 (2.8)
LP 3/8”	2.21 (56)	2,890 (12.9)	3,335 (14.8)	2,890 (12.9)	3,335 (14.8)
LP 1/2”	2.71 (69)	3,660 (16.3)	4,225 (18.8)	3,660 (16.3)	4,225 (18.8)

[1] See Section 3.1.8.6 to convert design strength value to ASD value.
[2] Linear interpolation between concrete compressive strengths is not permitted.
[3] Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x hef (effective embedment).
[4] Tabular values are for normal weight or sand-light weight concrete.
[5] No additional reduction factors for spacing or edge distance need to be applied.
[6] Compare tabular value to the insert steel strength values in Table 9 and threaded rod steel strength values in Table 16. The lesser of the values is to be used for the design.
[7] Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
[8] For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 9 for shear calculations.

Table 12 — Hilti KCC-MD Short Plate and Long Plate tension design strength in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 3-7/8” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 5A		Lower flute per Figure 5B		Inclined per Figure 5D	
		Tension - ΦN_n		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
SP 3/8”	2.13 (54)	3,610 (16.1)	4,170 (18.5)	1,850 (8.2)	2,135 (9.5)	-	-
SP 1/2”	2.63 (67)	4,580 (20.4)	5,290 (23.5)	2,120 (9.4)	2,450 (10.9)	-	-
LP 3/8”	2.21 (56)	3,610 (16.1)	4,170 (18.5)	4,895 (21.8)	5,650 (25.1)	3,610 (16.1)	4,170 (18.5)
LP 1/2”	2.71 (69)	4,580 (20.4)	5,290 (23.5)	6,565 (29.2)	7,580 (33.7)	4,580 (20.4)	5,290 (23.5)

Table 13 — Hilti KCC-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 3-7/8” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 5A		Lower flute per Figure 5B		Inclined per Figure 5D	
		Tension - ΦN_n		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
SP 3/8”	2.13 (54)	2,890 (12.9)	3,335 (14.8)	1,480 (6.6)	1,710 (7.6)	-	-
SP 1/2”	2.63 (67)	3,660 (16.3)	4,225 (18.8)	1,695 (7.5)	1,955 (8.7)	-	-
LP 3/8”	2.21 (56)	2,890 (12.9)	3,335 (14.8)	3,915 (17.4)	4,520 (20.1)	2,890 (12.9)	3,335 (14.8)
LP 1/2”	2.71 (69)	3,660 (16.3)	4,225 (18.8)	5,250 (23.4)	6,060 (27.0)	3,660 (16.3)	4,225 (18.8)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Table 9 and threaded rod steel strength values in Table 16. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 9 for shear calculations.

Table 14 — Hilti KCC-MD Short Plate and Long Plate tension design strength in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 4-1/2” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 5A		Lower flute per Figure 5B		Inclined per Figure 5D	
		Tension - ΦN_n		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
SP 3/8”	2.13	3,610	4,170	1,850	2,135	-	-
	(54)	(16.1)	(18.5)	(8.2)	(9.5)		
SP 1/2”	2.63	4,580	5,290	2,120	2,450	-	-
	(67)	(20.4)	(23.5)	(9.4)	(10.9)		
LP 3/8”	2.21	3,610	4,170	4,895	5,650	3,610	4,170
	(56)	(16.1)	(18.5)	(21.8)	(25.1)	(16.1)	(18.5)
LP 1/2”	2.71	4,580	5,290	6,565	7,580	4,580	5,290
	(69)	(20.4)	(23.5)	(29.2)	(33.7)	(20.4)	(23.5)

Table 15 — Hilti KCC-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 4-1/2” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal Embed. Depth in. (mm)	Upper flute per Figure 5A		Lower flute per Figure 5B		Inclined per Figure 5D	
		Tension - ΦN_n		Tension - ΦN_n		Tension - ΦN_n	
		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
SP 3/8”	2.13	2,890	3,335	1,480	1,710	-	-
	(54)	(12.9)	(14.8)	(6.6)	(7.6)		
SP 1/2”	2.63	3,660	4,225	1,695	1,955	-	-
	(67)	(16.3)	(18.8)	(7.5)	(8.7)		
LP 3/8”	2.21	2,890	3,335	3,915	4,520	2,890	3,335
	(56)	(12.9)	(14.8)	(17.4)	(20.1)	(12.9)	(14.8)
LP 1/2”	2.71	3,660	4,225	5,250	6,060	3,660	4,225
	(69)	(16.3)	(18.8)	(23.4)	(27.0)	(16.3)	(18.8)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Table 9 and threaded rod steel strength values in Table 16. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 9 for shear calculations.

Table 16 — Design strength for steel failure of common threaded rods [1,5]

Nominal anchor diameter	Grade A36 threaded rod			ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod			ASTM A 307, Grade A threaded rod		
	Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN)	Shear[3] $\phi V_{sa,rod}$ lb (kN)	Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN)	Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN)	Shear[3] $\phi V_{sa,rod}$ lb (kN)	Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN)	Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN)	Shear[3] $\phi V_{sa,rod}$ lb (kN)	Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN)
3/8	3,395	1,750	1,225	7,315	3,780	2,646	3,490	1,815	1,271
	(15.1)	(7.8)	(5.4)	(32.5)	(16.8)	(11.8)	(15.5)	(8.1)	(5.7)
1/2	6,175	3,210	2,245	13,315	6,915	4,841	6,375	3,315	2,321
	(27.5)	(14.3)	(10.0)	(59.2)	(30.8)	(21.5)	(28.4)	(14.7)	(10.3)

1 See PTG Ed. 19, Section 3.1.8.7 for additional information on seismic applications.
2 Tensile values determined by static tension tests with $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
3 Shear values determined by static shear tests with $\phi V_{sa} = \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17.
4 Seismic shear values determined by seismic shear tests with ϕ Vsa $\le \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318, Chapter 17.
5 Values are for the threaded rod only. The capacity of the insert must be also be determined from Tables 2 and 9. The design strength of concrete must be in accordance with ACI 318 Chapter 17 and Tables 10 to 15 as necessary. Compare the values (threaded rod, inserts, and concrete). The lesser of the values is to be used for the design.

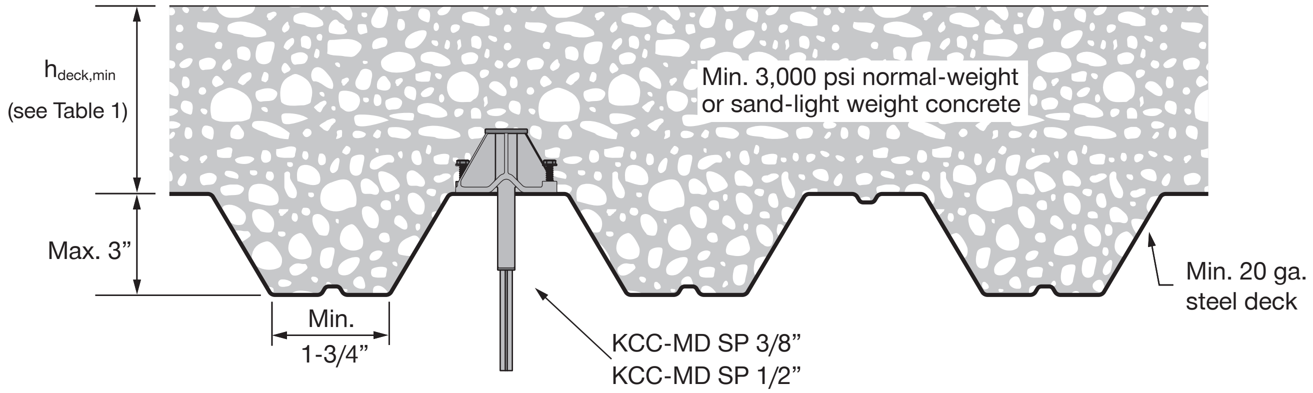


Figure 5A — Installation of KCC-MD inserts in the soffit of concrete filled metal deck floor and roof assemblies-over upper flute (B-deck and W-deck)

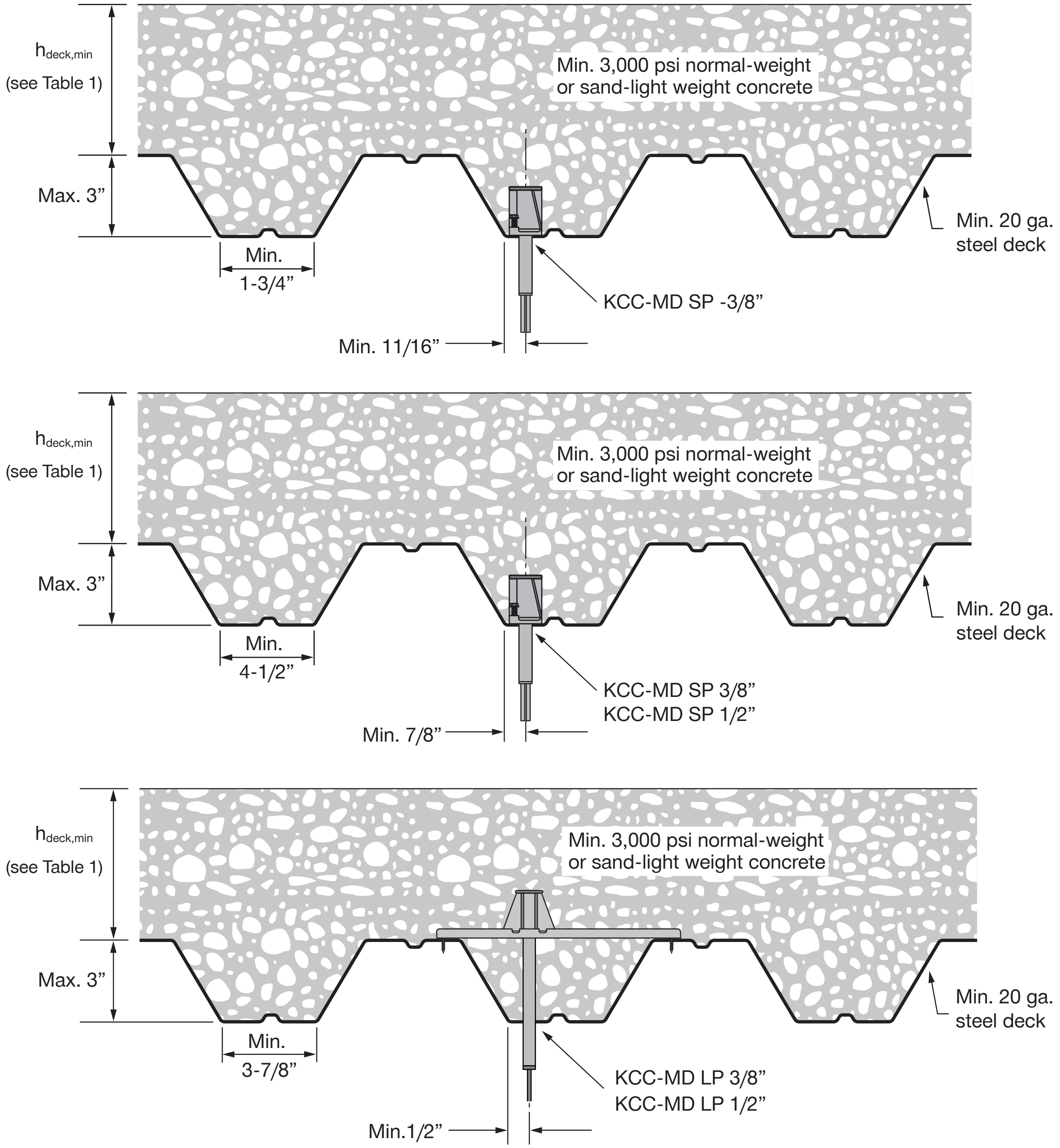


Figure 5B —Installation of KCC-MD inserts in the soffit of concrete filled metal deck floor and roof assemblies-over lower flute (W-deck)

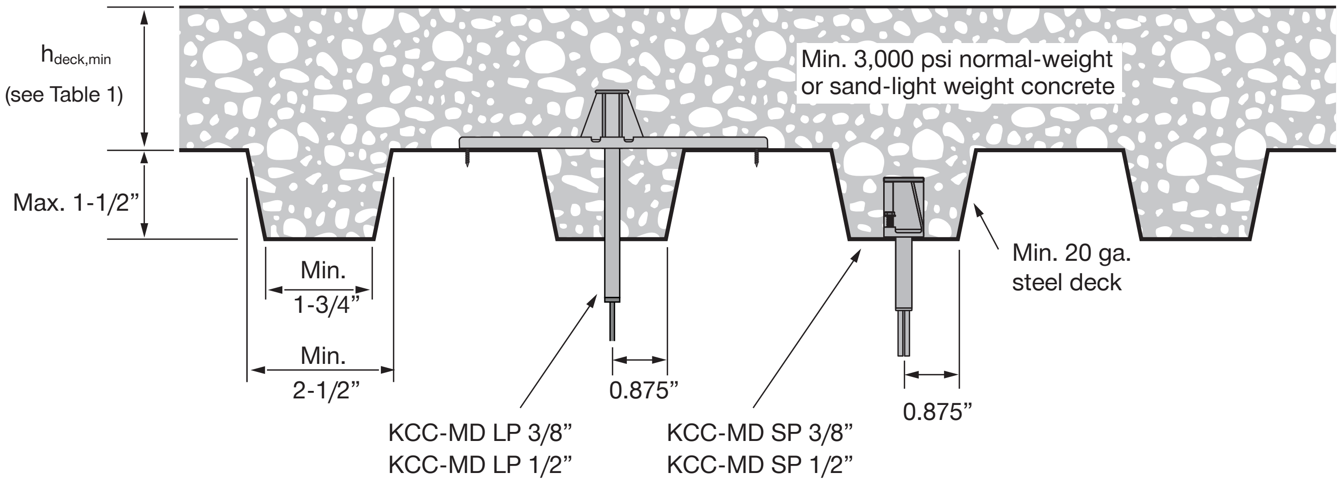


Figure 5C — Installation of KCC-MD inserts in the soffit of concrete filled metal deck floor and roof assemblies-over lower flute (B-deck)

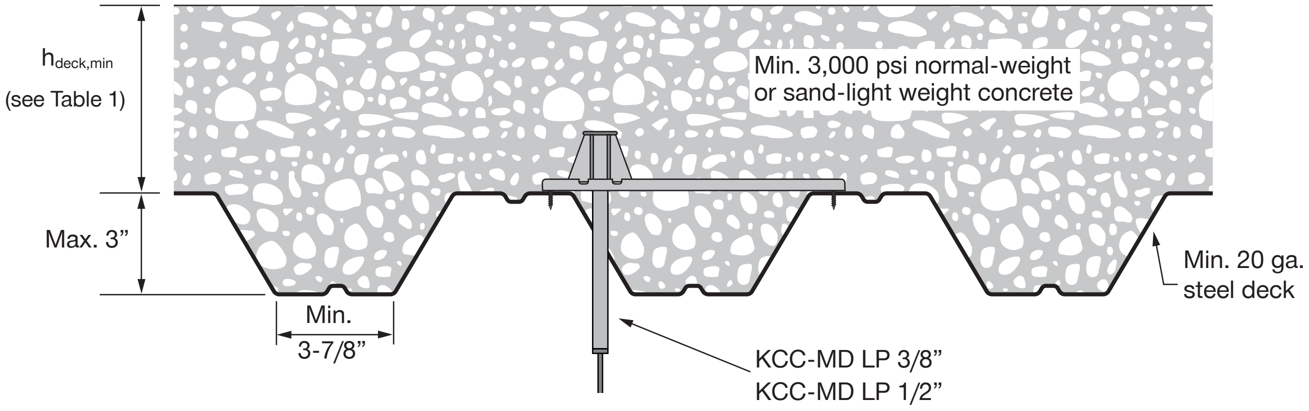


Figure 5D — Installation of KCC-MD inserts in the soffit of concrete filled metal deck floor and roof assemblies-over flute incline (W-deck)

DESIGN DATA IN CONCRETE PER CSA A23.3

CSA A23.3 Annex D Design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-4145. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing of edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to PTG ED. 19, Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

Table 17 — Hilti KCC-WF insert design information in accordance with CSA A23.3 (R2014) Annex D [1,4]

Design parameter	Symbol	Units	Nominal anchor diameter		Ref A23.3-14
			3/8"	1/2”	
Outside diameter of anchor steel body	d_a	in. (mm)	0.67 (17)	0.87 (22)	
Effective embedment	h_{ef}	in. (mm)	1.63 (41)	2.04 (52)	
Minimum member thickness	h_{min}	in. (mm)	2.5 (51)	3 (76)	
Minimum edge distance	c_{min}	in. (mm)	1-1/2 (38)		
Minimum anchor spacing	s_{min}	in. (mm)	2.6 (67)	3.5 (88)	
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85		8.4.3
Resistance modification factor for tension, steel failure modes [2]	R	-	0.70		D.5.3
Resistance modification factor for shear, steel failure modes [2]	R	-	0.65		D.5.3
Factored steel resistance in tension	N_{sar}	lb (kN)	2,404 (10.7)	3,219 (14.3)	D.6.1.2
Factored steel resistance in tension, seismic	$N_{sar,eq}$	lb (kN)	2,404 (10.7)	3,219 (14.3)	D.6.1.2
Factored steel resistance in shear	V_{sar}	lb (kN)	2,735 (12.2)	3,075 (13.7)	D.7.1.2
Factored steel resistance in shear, seismic	$V_{sar,eq}$	lb (kN)	2,735 (12.2)	3,075 (13.7)	D.7.1.2
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10		D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	-	10		D.6.2.2
Modification factor for anchor resistance, tension, uncracked conc.	$\Psi_{c,N}$	-	1.25		D.6.2.6
Modification factor for anchor resistance, tension, cracked conc.	$\Psi_{c,N}$		1.0		D.6.2.6
Anchor category	-	-	cast-in		D.5.3 (c)
Concrete material resistance factor	Φ_c	-	0.65		8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [3]	R	-	1.00		D.5.3 (c)

1 Design information in this table is taken from ICC-ES ESR-4145, and converted for use with CSA A23.3 (R2014) Annex D.

2 The carbon steel KCC-WF is considered a brittle steel element as defined by CSA A23.3 (R2014) Annex D section D.2.

3 For use with the load combinations of CSA A23.3 (R2014) chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 (R2014) section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

4 Values are for the insert only. The capacity of the threaded rod must be also be determined from Table 27. The design strength of concrete must be in accordance with CSA A23.3 (R2014) and Tables 18 to 19 as necessary. Compare the values (threaded rod, inserts, and concrete). The lesser of the values is to be used for the design.

Table 18 — Hilti KCC-WF cast-in insert design strength with concrete / pullout failure in uncracked concrete [1,2,3,4,5,6]

Nominal anchor internal diameter	Effective embedment depth in. (mm)	Tension - ΦN_n				Shear - ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
3/8"	1.63	2,185	2,390	2,760	3,385	2,185	2,390	2,760	3,385
	(41)	(9.7)	(10.6)	(12.3)	(15.1)	(9.7)	(10.6)	(12.3)	(15.1)
1/2"	2.04	3,055	3,350	3,865	4,735	3,055	3,350	3,865	4,735
	(52)	(13.6)	(14.9)	(17.2)	(21.1)	(13.6)	(14.9)	(17.2)	(21.1)

Table 19 — Hilti KCC-WF cast-in insert design strength with concrete / pullout failure in cracked concrete [1,2,3,4,5,6]

Nominal anchor internal diameter	Effective embedment depth in. (mm)	Tension - ΦN_n				Shear - ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
3/8"	1.63	1,745	1,910	2,210	2,705	1,745	1,910	2,210	2,705
	(41)	(7.8)	(8.5)	(9.8)	(12.0)	(7.8)	(8.5)	(9.8)	(12.0)
1/2"	2.04	2,445	2,680	3,095	3,790	2,445	2,680	3,095	3,790
	(52)	(10.9)	(11.9)	(13.8)	(16.9)	(10.9)	(11.9)	(13.8)	(16.9)

[1] See PTG Ed. 19, Section 3.1.8.6 to convert design strength value to ASD value.

[2] Linear interpolation between concrete compressive strengths is not permitted.

[3] Tabular values are for single anchors located at edge distance (c) and spacing (s) greater than $3h_{ef}$. For anchors with edge distance or spacing less than $3h_{ef}$ use ACI 318 to calculate load reduction factor. Compare the calculated value to the steel values (threaded rod and inserts) in Tables 17 and 27. The lesser of the values is to be used for the design.

[4] Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows:
For sand-lightweight, λ_a = 0.85. For all-lightweight, λ_a = 0.75.

[5] Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear.

[6] Compare tabular value to the insert steel strength values in Table 17 and threaded rod steel strength values in Table 27 The lesser of the values is to be used for the design.

Table 20 — Design strength for steel failure of KCC-MD Short Plate and Long Plate inserts [1,2,3,4,5]

Design information	Symbol	Units	Insert Type			
			SP 3/8"	SP 1/2"	LP 3/8"	LP 1/2"
Nominal rod diameter (in.)	-	in.	3/8	1/2	3/8	1/2
Anchor O.D.	d_a	in. (mm)	0.67 (17)	0.87 (22)	0.67 (17)	0.87 (22)
Effective embedment	h_{ef}	in. (mm)	2.00 (51)	2.50 (64)	2.00 (51)	2.50 (64)
Min. specified ult. Strength, f_{ut} lb (kN)	f_{ut}	lb (kN)	4,040 (18.0)	5,410 (24.1)	4,040 (18.0)	5,410 (24.1)
Anchor category	-	-	Cast-In			
Concrete material resistance factor	ϕ_c	-	0.65			
Resistance modification factor for tension and shear, concrete failure modes, Condition B	R	-	1.00			
Steel embed. material resistance factor for reinforcement	ϕ_s	-	0.85			
Resistance modification factor for tension, steel failure modes	R	-	0.70			
Resistance modification factor for shear, steel failure modes	R	-	0.65			
Factored steel strength of insert in tension,	$\phi_{Nsa,insert}$	lb (kN)	2,405 (10.7)	3,220 (14.3)	2,405 (10.7)	3,220 (14.3)
Factored seismic steel strength of insert in tension	$\phi_{Nsa,insert,eq}$	lb (kN)	2,405 (11)	3,220 (14)	2,405 (11)	3,220 (14.3)
Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figures 5A						
Factored steel strength of insert in shear	$\phi_{Vsa,insert}$	lb (kN)	2,590 (12)	3,075 (14)	2,590 (12)	3,075 (14)
Factored seismic steel strength of insert in shear	$\phi_{Vsa,insert,eq}$	lb (kN)	2,590 (12)	4,875 (22)	2,590 (12)	4,875 (22)
Installations in lower flute of metal deck (i.e. W-deck) according to Figures 5B						
Factored steel strength of insert in shear	$\phi_{Vsa,insert}$	lb (kN)	1,900 (8)	2,310 (10)	2,735 (12)	3,075 (14)
Factored seismic steel strength of insert in shear	$\phi_{Vsa,insert,eq}$	lb (kN)	1,900 (8)	2,310 (10)	2,735 (12)	3,075 (14)
Installations in lower flute of metal deck (i.e. B-deck) according to Figures 5C						
Factored steel strength of insert in shear	$\phi_{Vsa,insert}$	lb (kN)	1,745 (8)	2,190 (10)	2,660 (12)	3,075 (14)
Factored seismic steel strength of insert in shear	$\phi_{Vsa,insert,eq}$	lb (kN)	1,745 (8)	2,190 (10)	2,660 (12)	3,075 (14)
Installations in lower flute of metal deck (i.e. W-deck) according to Figures 5D						
Factored steel strength of insert in shear	$\phi_{Vsa,insert}$	lb (kN)	N/A		950 (4)	2,455 (11)
Factored seismic steel strength of insert in shear	$\phi_{Vsa,insert,eq}$	lb (kN)			950 (4)	1,965 (9)

1 Design information in this table is taken from ICC-ES ESR-4145, Table 4, and converted for use with CSA A23.3 (R2014) Annex D.

2 The carbon steel KCC-MD is considered a brittle steel element as defined by CSA A23.3 (R2014) Annex D section D.2.

3 Tension values are for the inserts only. The capacity of the threaded rods must be also determined from Table 27. The design strength of concrete must be obtained from tables 21-27. Compare the tension values of threaded rod, inserts, and concrete. The lesser of the values is to be used for the design.

4 Shear values are for the inserts only. The capacity of the threaded rods must be also determined from Table 27. The calculation of concrete shear strength is not required. Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.

5 Only threaded rod ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 is permitted to be used for the applications resisting shear, seismic shear, or seismic tension loads.

Table 21 — Hilti KCC-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

Anchor	Nominal embed. in. (mm)	Upper flute per Figure 5A		Lower flute per Figure 5C	
		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 3/8”	2.13 (54)	3,300 (14.7)	4,040 (18.0)	580 (2.6)	710 (3.2)
SP 1/2”	2.63 (67)	4,180 (18.6)	5,120 (22.8)	635 (2.8)	775 (3.4)
LP 3/8”	2.21 (56)	3,300 (14.7)	4,040 (18.0)	3,300 (14.7)	4,040 (18.0)
LP 1/2”	2.71 (69)	4,180 (18.6)	5,120 (22.8)	4,180 (18.6)	5,120 (22.8)

Table 22 — Hilti KCC-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

Anchor	Nominal embed. in. (mm)	Upper flute per Figure 5A		Lower flute per Figure 5C	
		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 3/8”	2.13 (54)	2,640 (11.7)	3,230 (14.4)	465 (2.1)	565 (2.5)
SP 1/2”	2.63 (67)	3,345 (14.9)	4,095 (18.2)	505 (2.2)	620 (2.8)
LP 3/8”	2.21 (56)	2,640 (11.7)	3,230 (14.4)	2,640 (11.7)	3,230 (14.4)
LP 1/2”	2.71 (69)	3,345 (14.9)	4,095 (18.2)	3,345 (14.9)	4,095 (18.2)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Table 17 and threaded rod steel strength values in Table 27. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 20 for shear calculations.

Table 23 — Hilti KCC-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 3-7/8” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal embed. in. (mm)	Upper flute per Figure 5A		Lower flute per Figure 5B		Inclined per Figure 5D	
		Tension - N_r		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 3/8”	2.13	3,300	4,040	1,685	2,065	-	-
	(54)	(14.7)	(18.0)	(7.5)	(9.2)		
SP 1/2”	2.63	4,180	5,120	1,935	2,370	-	-
	(67)	(18.6)	(22.8)	(8.6)	(10.5)		
LP 3/8”	2.21	3,300	4,040	4,470	5,475	3,300	4,040
	(56)	(14.7)	(18.0)	(19.9)	(24.4)	(14.7)	(18.0)
LP 1/2”	2.71	4,180	5,120	5,990	7,340	4,180	5,120
	(69)	(18.6)	(22.8)	(26.6)	(32.6)	(18.6)	(22.8)

Table 24 — Hilti KCC-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 3-7/8” width) [1,2,3,4,5,6,7,8]

Nominal anchor diameter in.	Nominal embed. in. (mm)	Upper flute per Figure 5A		Lower flute per Figure 5B		Inclined per Figure 5D	
		Tension - N_r		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 3/8”	2.13	2,640	3,230	1,350	1,655	-	-
	(54)	(11.7)	(14.4)	(6.0)	(7.4)		
SP 1/2”	2.63	3,345	4,095	1,550	1,895	-	-
	(67)	(14.9)	(18.2)	(6.9)	(8.4)		
LP 3/8”	2.21	2,640	3,230	3,575	4,380	2,640	3,230
	(56)	(11.7)	(14.4)	(15.9)	(19.5)	(11.7)	(14.4)
LP 1/2”	2.71	3,345	4,095	4,795	5,870	3,345	4,095
	(69)	(14.9)	(18.2)	(21.3)	(26.1)	(14.9)	(18.2)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Compare tabular value to the insert steel strength values in Table 17 and threaded rod steel strength values in Table 27. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 20 for shear calculations.

Table 25 — Hilti KCC-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 4-1/2” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal embed. in. (mm)	Upper flute per Figure 5A		Lower flute per Figure 5B		Inclined per Figure 5D	
		Tension - N_r		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 3/8”	2.13 (54)	3,300 (14.7)	4,040 (18.0)	1,685 (7.5)	2,065 (9.2)	-	-
SP 1/2”	2.63 (67)	4,180 (18.6)	5,120 (22.8)	1,935 (8.6)	2,370 (10.5)	-	-
LP 3/8”	2.21 (56)	3,300 (14.7)	4,040 (18.0)	4,470 (19.9)	5,475 (24.4)	3,300 (14.7)	4,040 (18.0)
LP 1/2”	2.71 (69)	4,180 (18.6)	5,120 (22.8)	5,990 (26.6)	7,340 (32.6)	4,180 (18.6)	5,120 (22.8)

Table 26 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 4-1/2” width) [1,2,3,4,5,6,7,8]

Anchor	Nominal embed. in. (mm)	Upper flute per Figure 5A		Lower flute per Figure 5B		Inclined per Figure 5D	
		Tension - N_r		Tension - N_r		Tension - N_r	
		f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
SP 3/8”	2.13 (54)	2,640 (11.7)	3,230 (14.4)	1,350 (6.0)	1,655 (7.4)	-	-
SP 1/2”	2.63 (67)	3,345 (14.9)	4,095 (18.2)	1,550 (6.9)	1,895 (8.4)	-	-
LP 3/8”	2.21 (56)	2,640 (11.7)	3,230 (14.4)	3,575 (15.9)	4,380 (19.5)	2,640 (11.7)	3,230 (14.4)
LP 1/2”	2.71 (69)	3,345 (14.9)	4,095 (18.2)	4,795 (21.3)	5,870 (26.1)	3,345 (14.9)	4,095 (18.2)

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Table 17 and threaded rod steel strength values in Table 27. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 20 for shear calculations.

Table 27 — Design strength for steel failure of common threaded rods used with KCC-WF and KCC-MD cast-in anchor [1,2,3]

Nominal anchor diameter	Grade A36 threaded rod			ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod			ASTM A 307, Grade A threaded rod		
	Tensile[4] $\phi N_{sar,rod}$ or $\phi N_{sar,eq,rod}$ lb (kN)	Shear[5] $\phi V_{sar,rod}$ lb (kN)	Seismic Shear[6] $\phi V_{sar,eq,rod}$ lb (kN)	Tensile[4] $\phi N_{sar,rod}$ or $\phi N_{sar,eq,rod}$ lb (kN)	Shear[5] $\phi V_{sar,rod}$ lb (kN)	Seismic Shear[6] $\phi V_{sar,eq,rod}$ lb (kN)	Tensile[4] $\phi N_{sar,rod}$ or $\phi N_{sar,eq,rod}$ lb (kN)	Shear[5] $\phi V_{sar,rod}$ lb (kN)	Seismic Shear[6] $\phi V_{sar,eq,rod}$ lb (kN)
1/4	1,260 (5.6)	705 (3.1)	495 (2.2)	2,720 (12.1)	1,520 (6.8)	1,064 (4.7)	1,290 (5.7)	725 (3.2)	508 (2.3)
3/8	3,075 (13.7)	1,720 (7.7)	1,205 (5.4)	6,630 (29.5)	3,705 (16.5)	2,594 (11.5)	3,160 (14.1)	1,780 (7.9)	1,246 (5.5)

1 See section 3.1.8.6 to convert design strength value to ASD value.
2 Hilti KCC-WF and KCC-MD anchors are to be considered brittle steel elements
3 See Section 3.1.8.7 for additional information on seismic applications.
4 Tensile $N_{sar} = \phi_s A_{se,N} R f_{ut}$ as noted in CSA A23.3 Annex D.
5 Shear values determined by static shear tests with $V_{sar} < \phi_s 0.60 A_{se,V} f_{ut}$ R. as noted in CSA A23.3 Annex D.
6 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < \phi_s 0.60 A_{se,V} f_{ut}$ R. as noted in CSA A23.3 Annex D.

Table 28 — UL cUL LLC and FM approvals for KCC-WF, KCC-MD Short Plate and KCC-MD Long Plate Anchors [1,2]

Design information		WF and SP-MD 3/8"			WF and SP-MD 1/2"			LP 3/8"			LP 1/2"		
Nominal rod diameter (in.)	Metal deck soffit or Wood Form	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)	UL max pipe size (in.)	Test load (lb)	FM max pipe size (in.)
3/8	Wood Form	4	1,500	4	-	-	-	4	1,500	4	-	-	-
	Upper flute	4	1,500	4	-	-	-	4	1,500	4	-	-	-
	Lower flute	4	1,500	4	-	-	-	4	1,500	4	-	-	-
1/2	Wood Form	-	-	-	8	4,050	8	-	-	-	8	4,050	8
	Upper flute	-	-	-	8	4,050	8	-	-	-	8	4,050	8
	Lower flute	-	-	-	8	4,050	8	-	-	-	8	4,050	8

1 UL LLC Listing based on successful completion of testing in accordance with UL 203.
2 FM Approval based on successful completion of testing in accordance with FM 1952.

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed of downloaded online at www.hilti.com and www.hilti.ca. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION

KCC-WF and KCC-MD Short Plate and Long Plate cast-in anchors for use in metal deck[1]

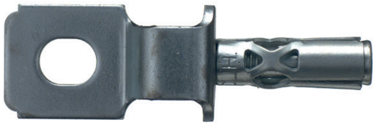
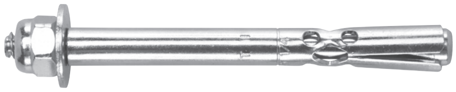
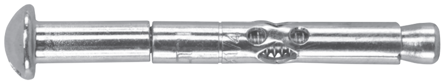
Description	Anchor color [2]	Qty / box	Hole saw diameter
KCC-WF 3/8"	Dark Green	150	N/A
KCC-WF 1/2"	Dark Orange	100	N/A
KCC-MD SP 3/8"	Dark Green	75	11/16"
KCC-MD SP 1/2"	Dark Orange	45	13/16"
KCC-MD LP 3/8"	Dark Green	20	5/8"
KCC-MD LP 1/2"	Dark Orange	15	3/4"

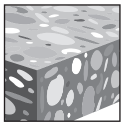
1 All dimensions in inches
2 Identifies anchor size

3.3.18 HLC SLEEVE ANCHOR

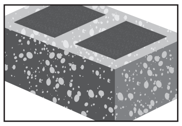
PRODUCT DESCRIPTION

HLC Sleeve anchors

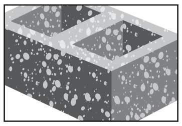
Anchor System		Features and Benefits
	Bolt head — HLC-H	- Anchor suitable for through-hole installation - Anchor and masonry bit are the same diameter - Good selection of anchor diameters, lengths and head configurations offer versatility - Load data for concrete, hollow masonry, solid masonry and brick - Extrusions on sleeve prevent the anchor from spinning in hole during installation or dropping out of overhead hole prior to applying installation torque.
	Hex Nut — HLC-HX	
	Flat Phillips Head — HLC-FPH	
	Tie-Wire Head — HLC-T	
	Acorn Nut — HLC-AC	
	Round Head Slotted — HLC-RS	
	Rod Coupling — HLC-RC	



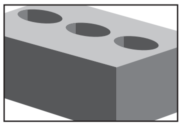
Uncracked concrete



Grout-filled concrete masonry



Ungrouted concrete masonry



Hollow brick

MATERIAL SPECIFICATIONS

Carbon steel epansion sleeves and spacer sleeves are manufactured from cold rolled steel.

Carbon steel anchors are zinc plated in accordance with ASTM B633, SC 1, TYPE III.

Stainless steel anchor components are manufactured from AISI Type 304 stainless steel.

Table 1 — Hilti HLC Sleeve anchor specification table

Setting information	Symbol		Nominal anchor diameter					
			1/4	5/16	3/8	1/2	5/8	3/4
Thread size	UNC	in.	3/16-24	1/4-20	5/16-18	3/8-16	1/2-13	5/8-11
Nominal bit diameter	d_{bit}	in.	1/4	5/16	3/8	1/2	5/8	3/4
Minimum nominal embedment	h_{nom}	in.	1	1	1-1/4	1-1/2	2	2
		(mm)	(25)	(25)	(32)	(38)	(51)	(51)
Minimum hole depth	h_o	in.	1-3/8	1-3/8	1-3/4	2-1/8	2-5/8	2-5/8
		(mm)	(35)	(35)	(45)	(54)	(67)	(67)
Installation torque	T_{inst}^{1}	ft-lb	-	12	18	35	-	-
		(Nm)	-	(16)	(24)	(47)	-	-
	T_{inst}^{2}	ft-lb	2	5	10	15	60	90
		(Nm)	(3)	(7)	(14)	(20)	(81)	(122)

1 HLC-H Bolt Head model.

2 HLC-HX, HLC-FPH, HLC-AC, HLC-RS and HLC-RC models.

Table 2 — Carbon steel sleeve anchor allowable loads in concrete[1]

Nominal anchor diameter	Bolt diameter in.	Nominal embedment in. (mm)	f'_c = 2,000 psi		f'_c = 4,000 psi		f'_c = 6,000 psi	
			Tension lb (kN)	Shear [2] lb (kN)	Tension lb (kN)	Shear [2] lb (kN)	Tension lb (kN)	Shear [2] lb (kN)
1/4	3/16	1 (25)	225 (1.0)	305 (1.4)	250 (1.1)	305 (1.4)	250 (1.1)	305 (1.4)
5/16	1/4	1 (25)	350 (1.5)	560 (2.5)	450 (2.0)	560 (2.5)	500 (2.2)	560 (2.5)
3/8	5/16	1-1/4 (32)	450 (2.0)	870 (3.9)	565 (2.5)	870 (3.9)	700 (3.1)	890 (4.4)
1/2	3/8	1-1/2 (38)	675 (3.0)	1,250 (5.6)	925 (4.1)	1,325 (5.9)	1,100 (4.9)	1,325 (5.9)
5/8	1/2	2 (51)	1,035 (4.6)	1,750 (7.8)	1,500 (6.7)	2,295 (10.2)	1,950 (8.7)	2,295 (10.2)
3/4	5/8	2 (51)	1,125 (5.0)	1,750 (7.8)	1,500 (6.7)	3,000 (13.3)	1,950 (8.7)	3,010 (13.4)

1 Based on a safety factor of 4.0.

2 For 1/4- and 3/8-in. flat phillips and round head anchors, shear values should be reduced by 57% due to the potential of the shear acting through the hollow portion of the head.

Table 3 — Stainless steel sleeve anchor allowable loads[1]

Nominal anchor diameter	Nominal embedment in. (mm)	f'_c = 2,000 psi		f'_c = 4,000 psi		Hollow C-90 concrete block[2]	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
1/4	1-1/8 (29)	235 (1.0)	450 (2.0)	300 (1.3)	450 (2.0)	200 (0.9)	400 (1.8)
5/16	1-1/4 (32)	310 (1.4)	675 (3.0)	410 (1.8)	675 (3.0)	335 (1.5)	600 (2.7)
3/8	1-1/2 (38)	450 (2.0)	1,000 (4.4)	600 (2.7)	1,000 (4.4)	470 (2.1)	890 (4.0)

1 Based on using a safety factor of 4.
2 ASTM Specification C90, Type II.

Table 4 — Carbon steel sleeve anchor allowable loads in grout-filled block[1,2,3,4,5,6,7]

Nominal anchor diameter	Nominal embedment in. (mm)	Edge distance in. (mm)	Tension lb (kN)	Shear lb (kN)
1/4	1 (25)	4 (101)	290 (1.3)	305 (1.4)
		≥ 12 (305)		
5/16	1 (25)	4 (101)	385 (1.7)	500 (2.2)
		≥ 12 (305)		
3/8	1-1/4 (32)	4 (101)	435 (1.9)	725 (3.2)
		≥ 12 (305)		
1/2	1-1/2 (38)	4 (101)	605 (2.7)	865 (3.8)
		≥ 12 (305)		1,145 (5.1)
5/8	2 (51)	4 (101)	710 (3.2)	1,050 (4.7)
		≥ 12 (305)		1,815 (8.1)
3/4	2 (51)	4 (101)	840 (3.7)	1,050 (4.7)
		≥ 12 (305)		1,970 (8.8)

1 Values are for lightweight, medium-weight or normal-weight concrete masonry units conforming to ASTM C90 with 2,000 psi grout conforming to ASTM C474.
2 Embedment depth is measured from the outside face of the concrete masonry unit.
3 Values are for anchors located in the grouted cell, bed joint, cross web or any combination of the above.
4 For anchors installed in the T joint or head joint reduce tension values by 20%.
5 Values for edge distances between 4 inches and 12 inches may be calculated by linear interpolation.
6 Anchors are limited to one per unit cell.
7 Based on using a safety factor of 4.

Table 5 — Carbon steel sleeve anchor allowable loads in hollow concrete block[1,2,3,4]

Nominal Anchor Diameter	Nominal embedment in. (mm)	Tension lb (kN)	Shear lb (kN)
1/4	1 (25)	350 (1.5)	305 (1.4)
5/16	1 (25)	375 (1.7)	560 (2.5)
3/8	1-1/4 (32)	435 (1.9)	800 (3.5)
1/2	1-1/2 (38)	565 (2.5)	1,125 (5.0)

1 Based on using a safety factor of 4.
2 ASTM Specification C90, Type II.
3 Installation in the mortar joints is outside the scope of the published data.
4 Anchors are limited to one per unit cell with a minimum edge distance of 12 inches.

Table 6 — Carbon steel sleeve anchor allowable loads in clay brick[1,2,3,4]

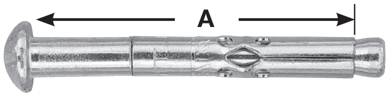
Nominal Anchor Diameter	Nominal embedment in. (mm)	Tension lb (kN)	Shear lb (kN)
1/4	1 (25)	350 (1.5)	305 (1.4)
5/16	1 (25)	345 (1.5)	530 (2.3)
3/8	1-1/4 (32)	375 (1.7)	850 (3.8)
1/2	1-1/2 (38)	435 (1.9)	1,230 (5.5)

1 Based on using a safety factor of 4.
2 Due to wide strength variations encountered in masonry, these values should be considered as guide values.
3 Installation in the mortar joints is outside the scope of the published data.
4 Minimum anchor spacing shall be two (2) complete bricks in any direction. Minimum edge distance shall be the lesser of two (2) complete bricks or 16 inches in any direction.

INSTALLATION INSTRUCTIONS

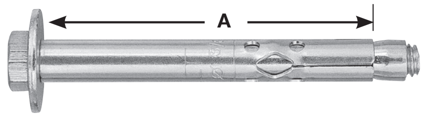
Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

ORDERING INFORMATION[1]



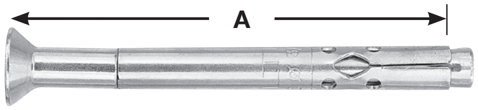
Round head slotted (RS)

Description	Nominal bit diameter	Bolt thread	Minimum embedment	Fastens materials up to	Qty / box
HLC-RS 1/4 x 1-1/4	1/4	3/16-24	1	1/4	100
HLC-RS 1/4 x 2	1/4	3/16-24	1	1	100
HLC-RS 1/4 x 4	1/4	3/16-24	1	3	100



Bolt head (H)

Description	Nominal bit diameter	Bolt thread	Minimum embedment	Fastens materials up to	Qty / box
HLC-H 5/16 x 1-5/8	5/16	1/4-20	1	5/8	100
HLC-H 5/16 x 2-5/8	5/16	1/4-20	1	1-5/8	100
HLC-H 3/8 x 1-7/8	3/8	5/16-18	1-1/4	5/8	50
HLC-H 3/8 x 3	3/8	5/16-18	1-1/4	1-3/4	50
HLC-H 1/2 x 2-1/4	1/2	3/8-16	1-1/2	3/4	50
HLC-H 1/2 x 3	1/2	3/8-16	1-1/2	1-1/2	25
HLC-H 1/2 x 4	1/2	3/8-16	1-1/2	2-1/2	25



Flat phillips head (FPH)

Description	Nominal bit diameter	Bolt thread	Minimum embedment	Fastens materials up to	Qty / box
HLC-FPH 1/4 x 1-3/8	1/4	3/16-24	1	3/8	100
HLC-FPH 1/4 x 2	1/4	3/16-24	1	1	100
HLC-FPH 1/4 x 3	1/4	3/16-24	1	2	100
HLC-FPH 1/4 x 4	1/4	3/16-24	1	3	100
HLC-FPH 3/8 x 2-7/8	3/8	5/16-18	1-1/4	1-1/2	50
HLC-FPH 3/8 x 4	3/8	5/16-18	1-1/4	2-3/4	50
HLC-FPH 3/8 x 5	3/8	5/16-18	1-1/4	3-3/4	25
HLC-FPH 3/8 x 6	3/8	5/16-18	1-1/4	4-3/4	25

[1] All dimensions in inches

Definition of nomenclature

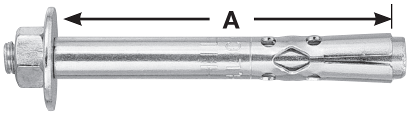
Outside diameter of sleeve, see tables
for threaded bolt diameter

HLC-AC 1/4 X 1-3/8

Nut configuration

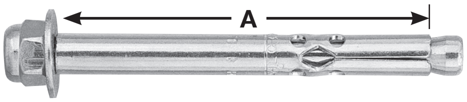
The overall length from bottom
of washer to end of sleeve

Hex nut (HX)



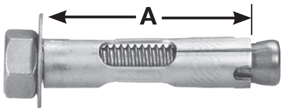
Description	Nominal bit diameter	Bolt thread	Minimum embedment	Fastens materials up to	Qty / box
HLC-HX 5/16 x 1-5/8	5/16	1/4-20	1	1/2	100
HLC-HX 5/16 x 2-5/8	5/16	1/4-20	1	1 -1/2	100
HLC-HX 3/8 x 1-7/8	3/8	5/16-18	1-1/4	5/8	50
HLC-HX 3/8 x 3	3/8	5/16-18	1-1/4	1-3/4	50
HLC-HX 1/2 x 2-1/4	1/2	3/8-16	1-1/2	3/4	25
HLC-HX 1/2 x 3	1/2	3/8-16	1-1/2	1-1/2	25
HLC-HX 1/2 x 4	1/2	3/8-16	1-1/2	2-1/2	25
HLC-HX 1/2 x 6	1/2	3/8-16	1-1/2	4-1/2	15
HLC-HX 5/8 x 2-1/4	5/8	1/2-13	2	1/4	25
HLC-HX 5/8 x 4-1/4	5/8	1/2-13	2	2-1/4	10
HLC-HX 5/8 x 6	5/8	1/2-13	2	4	10
HLC-HX 3/4 x 2-1/2	3/4	5/8-11	2	1/2	10
HLC-HX 3/4 x 4-1/4	3/4	5/8-11	2	1-3/4	10
HLC-HX 3/4 x 6-1/4	3/4	5/8-11	2	3-3/4	10

Acorn head (AC)



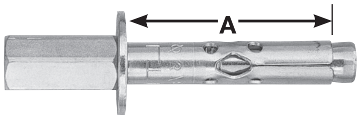
Description	Nominal bit diameter	Bolt thread	Minimum embedment	Fastens materials up to	Qty / box
HLC-AC 1/4 x 1-3/8	1/4	3/16-24	1	3/8	100
HLC-AC 1/4 x 2-1/4	1/4	3/16-24	1	1-1/4	100

304SS sleeve anchors



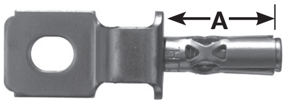
Description	Nominal bit diameter	Bolt thread	Minimum embedment	Fastens materials up to	Qty / box
HLC-HX 304SS 1/4 x 2-1/4	1/4	3/16-24	1-1/8	1-1/8	100
HLC-HX 304SS 5/16 x 1-1/2	5/16	1/4-20	1-1/4	1/4	100
HLC-HX 304SS 5/16 x 2-1/2	5/16	1/4-20	1-1/4	1-1/4	100
HLC-HX 304SS 3/8 x 1-7/8	3/8	5/16-18	1-1/2	3/8	50
HLC-HX 304SS 3/8 x 3	3/8	5/16-18	1-1/2	1-1/2	50

Rod coupling (RC)



Description	Nominal bit diameter	Bolt thread	Minimum embedment	Fastens materials up to	Qty / box
HLC-RC 3/8 x 1-7/8	3/8	5/16-18	1-1/4	5/16 x 3/8	50
HLC-RC 1/2 x 2-1/4	1/2	3/8-16	1-1/2	3/8 x 1/2	25

Tie-wire head (T)



Description	Nominal bit diameter	Bolt thread	Minimum embedment	Qty / box
HLC-T 1/4 x 1-3/8	1/4"	3/16-24	1-3/8	50

1 All dimensions in inches

Definition of nomenclature

Outside diameter of sleeve, see tablesfor threaded bolt diameter

HLC-AC 1/4 X 1-3/8

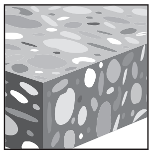
Nut configuration The overall length from bottom of washer to end of sleeve

3.3.19 KWIK-CON+ CONCRETE AND MASONRY SCREW

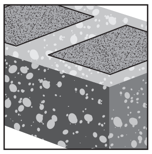
PRODUCT DESCRIPTION

KWIK-CON+ concrete and masonry screw anchors

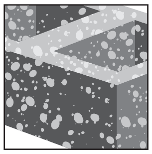
Anchor System		Features and Benefits
	KWIK-CON+ fastener	- Zinc coating with proprietary finish that exceeds 1000 hours of protection from red rust per ASTM B117 - Salt spray testing per ASTM G85 - Coating is more durable than zinc plating alone - Base material specific carbide tipped bits optimize performance in concrete or masonry - Torx Hex washer head for fast secure installations into base material - Torx or Phillips flat head for countersunk applications - Load data available for installations in concrete, grout-filled and hollow concrete masonry units (CMU) and brick - Available in AISI Type 410 Stainless Steel
	KWIK-CON+ drive tool and installation accessories	



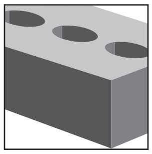
Uncracked concrete



Grout-filled concrete masonry



Ungrouted concrete masonry



Brick

Approvals/Listings	
Metro-Dade County	NOA 19-1113.04

Table 1 — Material Properties

Property	Carbon Steel		Stainless Steel	
	Fastener Diameter (inches)		Fastener Diameter (inches)	
	3/16	1/4	3/16	1/4
Minimum Tensile Strength (ksi)	150		130	
Minimum Yield Strength (ksi)	120		105	
Coating	Zinc with organic top coat		N/A	

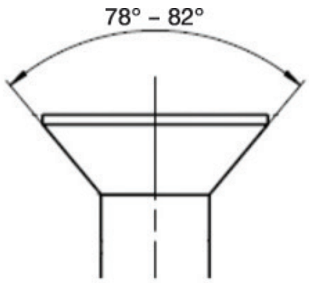


Figure 1 — Flathead KWIK CON+ Head Angle

Table 2 — Physical Dimensions

Characteristic	Nominal anchor diameter (inches)					
	3/16			1/4		
Head Style	Tapered Flat Head	Tapered Flat Head	5/16-in. Hex Washer	Tapered Flat Head	Tapered Flat Head	5/16-in. Hex Washer
Internal recess	#3 Phillips	T-25 TORX	T-25 TORX	#3 Phillips	T-27 TORX	T-25 TORX
Maximum Head Diameter (inches)	0.507	0.385	0.433	0.507	0.507	0.433
Major Thread Diameter (inches)	0.217			0.283		
Minor Diameter (inches)	0.145			0.190		
Shank Diameter (inches)	0.170			0.224		

INSTALLATION

Table 3 — KWIK CON+ Installation Specifications

Setting information	Symbol	Nominal anchor diameter (inches)			
		3/16		1/4	
Embedment (inches)	h_{nom}	1	1-3/4	1	1-3/4
Nominal drill bit diameter (inches)[1]	d_{bit}	3/16		1/4	
Minimum fixture hole diameter (inches)	d_h	1/4		5/16	
Minimum hole depth (inches)	h_o	1-1/4	2	1-1/4	2
Minimum member thickness (inches)	h_{min}	2-1/2	3-1/4	2-1/2	3-1/4
Minimum anchor spacing (inches)	s_{min}	2-1/4		2-1/2	
Critical anchor spacing (inches)	s_{cr}	3	4	3	4
Minimum edge distance (inches)	c_{min}	1-1/8		1-1/2	
Critical edge distance (inches)	c_{cr}	2-1/2	3-1/2	2-1/2	3-1/2

[1] Requires matched tolerance drill bit from Hilti, TKC drill bits for concrete, TKB drill bits for other materials.

Table 4 — Load adjustment factors for Hilti KWIK CON+ screw anchors in concrete

Load adjustment factors for anchor spacing f_A						Load adjustment factors for edge distance f_R											
Tension/Shear loads						Tension						Shear					
Embedment (inches)		1	1-3/4	1	1-3/4	Embedment (inches)		1	1-3/4	1	1-3/4	1	1-3/4	1	1-3/4
Spacing (s)		Anchor diameter				Edge Distance		Anchor Diameter				Anchor Diameter			
in.	(mm)	3/16		1/4		in.	(mm)	3/16		1/4		3/16		1/4	
2-1/4	(57)	0.80	0.80			1-1/8	(29)	0.80	0.80			0.30	0.30		
2-1/2	(64)	0.87	0.83	0.80	0.80	1-1/4	(32)	0.82	0.81			0.36	0.34		
2-3/4	(70)	0.93	0.86	0.90	0.86	1-1/2	(38)	0.85	0.83	0.80	0.80	0.49	0.41	0.30	0.30
3	(76)	1.00	0.89	1.00	0.89	1-3/4	(44)	0.89	0.85	0.85	0.83	0.62	0.48	0.48	0.39
3-1/4	(83)		0.91		0.91	2	(51)	0.93	0.87	0.90	0.85	0.75	0.56	0.65	0.48
3-1/2	(89)		0.94		0.94	2-1/4	(57)	0.96	0.89	0.95	0.88	0.87	0.63	0.83	0.56
3-3/4	(95)		0.97		0.97	2-1/2	(64)	1.00	0.92	1.00	0.90	1.00	0.71	1.00	0.65
4	(102)		1.00		1.00	3	(76)		0.96		0.95		0.85		0.83
						3-1/2	(89)		1.00		1.00		1.00		1.00

[1] Reduction factors are multiplicative and linear interpolation between s_{cr} and s_{min}, c_{cr} and c_{min} is permitted.

DESIGN INFORMATION IN CONCRETE PER ALLOWALBLE STRESS DESIGN

Table 5 — Tension and shear allowable loads in concrete [1, 2,3]

Nominal anchor diameter (in.)	Nominal embedment in. (mm)	f'_c = 2,000 psi		f'_c = 4,000 psi		f'_c = 6,000 psi	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
3/16	1 (25)	100 (0.4)	260 (1.2)	125 (0.6)	260 (1.2)	185 (0.8)	280 (1.3)
3/16	1-3/4 (44)	275 (1.2)	260 (1.2)	295 (1.3)	265 (1.2)	325 (1.5)	300 (1.3)
1/4	1 (25)	190 (0.9)	325 (1.4)	240 (1.1)	390 (1.7)	275 (1.2)	540 (2.4)
1/4	1-3/4 (44)	425 (1.9)	560 (2.5)	475 (2.1)	600 (2.8)	525 (2.3)	600 (2.7)

1 Screws installed in holes drilled with Hilti TKC carbide bits.
2 Allowable loads are based on a factor of safety of 4.
3 Apply spacing and edge distance reduction factors in Table 4 as needed.

Table 6 — Tension and shear ultimate loads in concrete[1]

Nominal anchor diameter (in.)	Nominal embedment in. (mm)	f'_c = 2,000 psi		f'_c = 4,000 psi		f'_c = 6,000 psi	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
3/16	1 (25)	400 (1.8)	1,050 (4.7)	500 (2.2)	1,050 (4.7)	750 (3.3)	1,150 (5.1)
3/16	1-3/4 (44)	1,100 (4.9)	1,050 (4.7)	1,180 (5.3)	1,070 (4.8)	1,300 (5.8)	1,200 (5.3)
1/4	1 (25)	760 (3.4)	1,300 (5.8)	970 (4.3)	1,575 (7.0)	1,100 (4.9)	2,175 (9.7)
1/4	1-3/4 (44)	1,700 (7.6)	2,250 (10.0)	1,900 (8.5)	2,400 (11.3)	2,100 (9.34)	2,400 (10.7)

1 Screws installed in holes drilled with TKC bits.

Table 7 — Tension and shear allowable loads in grout-filled and hollow concrete masonry units (CMU)[1,2,3,4,5]

Nominal anchor diameter (in.)	Nominal embedment in. (mm)	Tension lb (kN)	Shear lb (kN)
3/16	1 (25)	150 (0.7)	225 (1.0)
3/16	1-3/4 (44)	290 (1.3)	300 (1.3)
1/4	1 (25)	165 (0.7)	275 (1.2)
1/4	1-3/4 (44)	310 (1.4)	400 (1.8)

1 All values for anchors installed in grout-filled or hollow concrete masonry (CMU) with a minimum prism strength of 1,500 psi. CMU may be lightweight, medium-weight or normal-weight conforming to ASTM C90.
2 Screws installed in holes drilled with TKB bits.
3 Allowable loads calculated using a factor of safety of 4.
4 Installation in the mortar joints is outside the scope of the published data.
5 C_{min}, S_{min} equals 4 inches

Table 8 — Tension and shear allowable loads in brick[1,2,3,4,5]

Nominal anchor diameter (in.)	Nominal embedment in. (mm)	Tension lb (kN)	Shear lb (kN)
3/16	1 (25)	125 (0.6)	235 (1.0)
3/16	1-3/4 (44)	350 (1.6)	300 (1.3)
1/4	1 (25)	205 (0.9)	415 (1.8)
1/4	1-3/4 (44)	350 (1.6)	500 (2.2)

1 This test was performed on individual specimens of ASTM C62 common brick. Due to the wide variations encountered in the compressive strength of brick, these values should be considered guide values.
2 Allowable loads are based on a factor of safety of 4.
3 Installation in the mortar joints is outside the scope of the published data.
4 KWIK CON+ installed with TKB bits.
5 C_{min}, S_{min} equals 4 inches

Load values are for anchors installed a minimum of sixteen diameters on center and a minimum edge distance of sixteen diameters. Anchor spacing may be reduced to twelve diameters provided loads are reduced by 20 percent. Edge distance may be reduced to six diameters provided loads are reduced by 20 percent in tension and 70 percent in shear.

Combined shear and tension loading

$$\left(\frac{N_d}{N_{rec}}\right) + \left(\frac{V_d}{V_{rec}}\right) \leq 1.0$$

INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) / Operating Instructions (OI) throughout the document are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the (IFU)/Operating Instructions (OI).

ORDERING INFORMATION[1]

KWIK-CON+ fasteners

5/16 - in. Magnetic nut setter or T-25 TORX bit

Description	Diameter	Total length	Thread length	Shank length
KWIK-CON+ 3/16 X 1-1/4 THH	3/16	1-1/4	1-1/4	0
KWIK-CON+ 3/16 X 1-3/4 THH	3/16	1-3/4	1-3/4	0
KWIK-CON+ 3/16 X 2-1/4 THH	3/16	2-1/4	1-3/4	1/2
KWIK-CON+ 3/16 X 2-3/4 THH	3/16	2-3/4	1-3/4	1
KWIK-CON+ 3/16 X 3-1/4 THH	3/16	3-1/4	1-3/4	1-1/2

5/16 - in. Magnetic nut setter or T-25 TORX bit

Description	Diameter	Total length	Thread length	Shank length
KWIK CON+ 1/4 X 1-1/4 THH	1/4	1-1/4	1-1/4	0
KWIK CON+ 1/4 X 1-3/4 THH	1/4	1-3/4	1-3/4	0
KWIK CON+ 1/4 X 2-1/4 THH	1/4	2-1/4	1-3/4	1/2
KWIK CON+ 1/4 X 2-3/4 THH	1/4	2-3/4	1-3/4	1
KWIK CON+ 1/4 X 3-1/4 THH	1/4	3-1/4	1-3/4	1-1/2
KWIK CON+ 1/4 X 3-3/4 THH	1/4	3-3/4	1-3/4	2
KWIK CON+ 1/4 X 4 THH	1/4	4	1-3/4	2-1/4
KWIK CON+ 1/4 X 1-1/4 THH SS	1/4	1-1/4	1-1/4	0
KWIK CON+ 1/4 X 2-1/4 THH SS	1/4	2-1/4	1-3/4	1/2

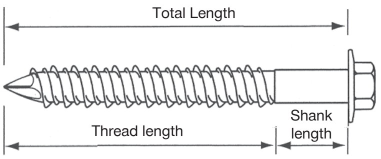
T-25 TORX bit

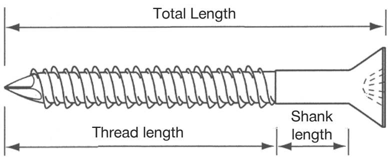
Description	Diameter	Total length	Thread length	Shank length
KWIK-CON+ 3/16 X 1-1/4 TFH	3/16	1-1/4	1-1/8	0
KWIK-CON+ 3/16 X 1-3/4 TFH	3/16	1-3/4	1-5/8	0
KWIK CON+ 3/16 X 2-1/4 TFH	3/16	2-1/4	1-3/4	1/2
KWIK-CON+ 3/16 X 2-3/4 TFH	3/16	2-3/4	1-3/4	7/8
KWIK-CON+ 3/16 X 3-1/4 TFH	3/16	3-1/4	1-3/4	1-3/8
KWIK-CON+ 3/16 X 3-3/4 TFH	3/16	3-3/4	1-3/4	1-7/8

T-27 TORX bit

Description	Diameter	Total length	Thread length	Shank length
KWIK CON+ 1/4 X 1-1/4 TFH	1/4	1-1/4	1-1/4	0
KWIK CON+ 1/4 X 1-3/4 TFH	1/4	1-3/4	1-3/4	0
KWIK CON+ 1/4 X 2-1/4 TFH	1/4	2-1/4	1-3/4	1/2
KWIK CON+ 1/4 X 2-3/4 TFH	1/4	2-3/4	1-3/4	1
KWIK CON+ 1/4 X 3-1/4 TFH	1/4	3-1/4	1-3/4	1-1/2
KWIK CON+ 1/4 X 4 TFH	1/4	4	1-3/4	2-1/4

1 All dimensions in inches





#3 Phillips bit

Description	Diameter	Total length	Thread length	Shank length
KWIK CON+ 3/16 X 1-1/4 PFH	3/16	1-1/4	1-1/4	0
KWIK CON+ 3/16 X 2-1/4 PFH	3/16	2-1/4	1-3/4	1/2
KWIK CON+ 3/16 X 3-1/4 PFH	3/16	2-3/4	1-3/4	1
KWIK CON+ 3/16 X 2-3/4 PFH	3/16	3-1/4	1-3/4	1-1/2
KWIK CON+ 3/16 X 2-3/4 PFH SS	3/16	1-1/4	1-1/4	0
KWIK CON+ 3/16 X 1-1/4 PFH SS	3/16	2-3/4	1-3/4	1

#3 Phillips bit

Description	Diameter	Total length	Thread length	Shank length
KWIK CON+ 1/4 X 1-1/4 PFH	1/4	1-1/4	1-1/4	0
KWIK CON+ 1/4 X 2-1/4 PFH	1/4	2-1/4	1-3/4	1/2
KWIK CON+ 1/4 X 2-3/4 PFH	1/4	2-3/4	1-3/4	1
KWIK CON+ 1/4 X 3-1/4 PFH	1/4	3-1/4	1-3/4	1-1/2
KWIK CON+ 1/4 X 3-3/4 PFH	1/4	3-3/4	1-3/4	2

KWIK-CON+ hex driver system

Description	Qty / pack
KWIK-CON Hex Driver Deluxe Kit	1
KWIK-CON Hex Driver	1
5/16-in. Hex Driver for all THH	1
5/16-in. Hex Nut Setter/Depth Locator	1
Insert Bit Holder/Depth Locator	1
#3 Phillips Driver for all PFH	1
T-25 TORX Driver for 3/16-in. TFH	1

KWIK-CON+ matched tolerance drill bits

Description
For 1/4-in. KWIK-CON+ Applications in normal-weight concrete
TKC Large Concrete Bit SDS+ Hex
TKC Large Concrete Bit Smooth Shank
For 1/4-in. KWIK-CON+ Applications in lightweight concrete, brick or CMU
TKB Large CMU Bit SDS+ Hex
TKB Large CMU Bit Smooth Shank
For 3/16-in. KWIK-CON+ Applications in normal-weight concrete
TKC Small Concrete Bit SDS+ Hex
TKC Small Concrete Bit Smooth Shank
For 3/16-in. KWIK-CON+ Applications in lightweight concrete, brick or CMU
TKB Small CMU Bit SDS+ Hex
TKB Small Block Bit Smooth Shank

4.0 REFERENCE

4.1 REFERENCE STANDARDS

4.1.1 ASTM STANDARDS FOR MATERIALS

Standard	Title
A36	Standard Specification for Structural Steel
A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
A563	Standard Specification for Carbon and Alloy Steel Nuts
A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
B117	Standard Practice for Operating Salt Spray (Fog) Apparatus
B695	Specifications for Coatings of Zinc Mechanically Deposited on Iron and Steel
C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C33	Standard Specification for Concrete Aggregates
C34	Standard Specification for Structural Clay Load-Bearing Wall Tile
C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C62	Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
C90	Standard Specification for Load-Bearing Concrete Masonry Units
C150	Standard Specification for Portland Cement
C270	Standard Specification for Mortar for Unit Masonry
C330	Standard Specification for Lightweight Aggregates for Structural Concrete
C332	Standard Specification for Lightweight Aggregates for Insulating Concrete
C652	Standard Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)
C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
C942	Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
D638	Standard Test Method for Tensile Properties of Plastics
D648	Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
D695	Standard Test Method for Compressive Properties of Rigid Plastics
E8	Standard Test Methods for Tension Testing of Metallic Materials
E119	Standard Test Methods for Fire Tests of Building Construction and Materials
E488	Standard Test Methods for Strength of Anchors in Concrete Elements
E1190	Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members
E1512	Standard Test Methods for Testing Bond Performance of Bonded Anchors
F436	Standard Specification for Hardened Steel Washers
F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs
F594	Standard Specification for Stainless Steel Nuts
F606	Standard Test Methods for Determining the Mechanical Properties of Externally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
F844	Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
F1554	Standard Specification for Anchor Bolts, 36, 55, and 105-ksi Yield Strength
F1941-16	Electrodeposited Coatings on Mechanical Fasteners
G85	Standard Practice for Modified Salt Spray (Fog) Testing

4.1.2 ASTM PLATING STANDARDS

Standard	Title
A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
B633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
B695	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

4.1.3 FEDERAL SPECIFICATIONS

Standard	Title
A-A-1922A	Shield, Expansion (Caulking Anchors, Single Lead)
A-A-1923A	Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
A-A-1924A	Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors)
A-A-55615	Shield, Expansion (Wood Screw and Lag Bolt Self-Threading Anchors)
A-A-55614	Shield, Expansion (Non-drilling Expansion Anchors)

4.1.4 ANSI STANDARDS

Standard	Title
B18.2.2	Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
B18.22.1	Plain Washers (Inch Series)
B212.15	Carbide-Tipped Masonry Drills and Blanks for Carbide – Tipped Masonry Drills
Standard 61	Drinking Water System Components – Health Effects

4.2 TECHNICAL REFERENCES

4.2.1 METRIC CONVERSIONS AND EQUIVALENTS

The Metric Conversion Act of 1975, as amended by the Omnibus Trade and Competitiveness Act of 1988, establishes the SI or System International metric system as the preferred system of measurement in the United States.

Many products are currently manufactured and supplied in SI or hard metric sizes such as anchor bolts of 10 mm, 12 mm, 26 mm, etc. diameter. Where the inch-pound system is given or used, soft metric conversion can sometimes be used. This is not the case when selecting a drill bit for installing mechanical anchors, where it is critical to only use the specified Imperial or Metric diameter bit. The soft conversion diameters for anchor bolts is given by Table 1. Standard metric conversion factors commonly used for fastening products are given in Tables 2 and 3.

Table 1— Diameters

in.	Hard metric conversion mm	Use for soft metric mm
1/4	6.35	6
5/16	7.94	8
3/8	9.52	10
1/2	12.70	12
5/8	15.88	16
3/4	19.05	20
1	25.40	25
1-1/4	31.75	32

Table 2 — Imperial units to SI units

To convert	Into	Multiply by
Length		
inch (in.)	millimeter (mm)	25.4000
foot (ft)	meter (m)	0.3048
Area		
square inch (in^2)	square millimeter (mm^2)	645.1600
square inch (in^2)	square centimeter (cm^2)	6.4516
square foot (ft^2)	square meter (m^2)	0.0929
Volume		
cubic inch (in^3)	cubic centimeter (cm^3)	16.3871
cubic foot (ft^3)	cubic meter (m^3)	0.0283
gallon (US gal)	liter (L)	3.7854
Force		
pound force (lbf)	newton (N)	4.4482
pound force (lbf)	kilonewton (kN)	0.0044
Pressure		
pound/square inch (psi)	newton/square millimeter (N/mm^2)	0.0069
pound/square inch (psi)	mega pascal (MPa)	0.0069
Kip/square inch (ksi)	mega pascal (MPa)	6.8946
pounds/square foot (psf)	newton/square meter (N/m^2)	47.8801
Torque or Bending Moment		
foot pound (ft-lb)	newton meter (N/m)	1.3558
inch pound (in-lb)	newton meter (N/m)	0.1130
Diaphragm Shear		
pounds/foot (plf)	newton/meter (N/m)	14.5939

Table 3 — SI units to Imperial units

To convert	Into	Multiply by
Length		
millimeter (mm)	inch (in.)	0.0394
meter (m)	foot (ft)	3.2808
Area		
square millimeter (mm^2)	square inch (in^2)	0.0016
square centimeter (cm^2)	square inch (in^2)	0.1550
square meter (m^2)	square foot (ft^2)	10.7639
Volume		
cubic centimeter (cm^3)	cubic inch (in^3)	0.0610
cubic meter (m^3)	cubic foot (ft^3)	35.3147
liter (L)	gallon (US gal)	0.2642
Force		
newton (N)	pound force (lbf)	0.2248
kilonewton (kN)	pound force (lbf)	224.8089
Pressure		
newton/square millimeter (N/mm^2)	pound/square inch (psi)	145.0400
mega pascal (MPa)	pound/square inch (psi)	145.0400
mega pascal (MPa)	Kip/square inch (ksi)	0.1450
newton/square meter (N/m^2)	pounds/square foot (psf)	0.0209
Torque or Bending Moment		
newton meter (N/m)	foot pound (ft-lb)	0.7376
newton meter (N/m)	inch pound (in-lb)	8.8496
Diaphragm Shear		
newton/meter (N/m)	pounds/lineal foot (plf)	0.0685

4.2.2 MECHANICAL PROPERTIES OF MATERIALS

Table 4 — Mechanical properties of carbon steel

Grade designation	Nominal size in.	Min. yield strength ksi	(MPa)	Min. ultimate strength ksi	(MPa)
ASTM A36	All	36	(248)	58	(400)
ASTM A193, B7	1/4 thru 2-1/2	105	(724)	125	(862)
AISI 1038 (As Rec'd)	1/4 thru 1-1/4	41	(282)	75	(517)
AISI 11L41	over 5/8 thru 1	75	(517)	90	(620)
AISI 1110 M (As Rec'd)	1/4 thru 5/8	44	(303)	53	(365)
AISI 12L14	5/8 thru 1-1/2	60	(414)	78	(538)
AISI 1010 (As Rec'd)	1/4 thru 3/4	44	(303)	53	(365)
ASTM A307	1/4 thru 4	–	–	60	(414)
ASTM A325	1/2 thru 1	92	(634)	120	(827)
	over 1 thru 1-1/2	81	(558)	105	(724)
ASTM A449	1/4 thru 1	92	(634)	120	(827)
	over 1 thru 1-1/2	81	(558)	105	(724)
ASTM A510	3/8 thru 3/4	70	(480)	87	(600)
SAE Grade 2	1/4 thru 3/4	57	(393)	74	(510)
	over 3/4 thru 1-1/2	36	(248)	60	(414)
SAE Grade 5	1/4 thru 1	92	(634)	120	(827)
	over 1 thru 1-1/2	81	(558)	105	(724)
SAE Grade 8	1/4 thru 1-1/2	130	(896)	150	(1034)
ISO 898-1 Class 5.8	All	58	(400)	72.5	(500)
ISO 898-1 Class 8.8	All	92.8	(640)	116	(800)

Table 5 — Mechanical properties of stainless steel

Grade ASTM/AISI	Nominal size in.	Yield strength ksi	(MPa)	Ultimate strength ksi	(MPa)
F593 / 304 / 316	1/4 thru 5/8	65	(448)	100	(689)
	3/4 thru 1-1/2	45	(310)	85	(586)
A193, B8 / 304 / 316	1/4 thru 1-1/2	30	(205)	75	(515)
A276 / 304	1/4 thru 9/16	76	(524)	90	(620)
	Larger than 9/16	64	(441)	75	(524)
A276 / 316	1/4 thru 9/16	76	(524)	90	(620)
	Larger than 9/16	64	(441)	75	(524)
A493 / 304	All	60	(414)	90	(627)
A582 / 303	All	60	(414)	100	(689)
DIN 267 Part 11, A4-70	All	65.3	(450)	101.5	(700)

4.2.3 BOLT THREAD DATA

Table 6 — Basic dimensions for UNC Coarse Thread Series—ANSI B1.1-1982

Nominal size	Basic diameter		Threads per Inch (n)	Area		
	Major in. (D)	Minor in.		Nominal in^2	Minor[1] in^2	Tensile stress[2] in^2
No. 10	0.1900	0.1449	24	0.0284	0.0145	0.0175
No. 12	0.2160	0.1709	24	0.0366	0.0206	0.0242
1/4	0.2500	0.1959	20	0.0491	0.0269	0.0318
5/16	0.3125	0.2524	18	0.0767	0.0454	0.0524
3/8	0.3750	0.3073	16	0.1104	0.0678	0.0775
7/16	0.4375	0.3602	14	0.1503	0.0933	0.1063
1/2	0.5000	0.4167	13	0.1963	0.1257	0.1419
9/16	0.5625	0.4723	12	0.2485	0.1620	0.1819
5/8	0.6250	0.5266	11	0.3068	0.2017	0.2260
3/4	0.7500	0.6417	10	0.4418	0.3019	0.3345
7/8	0.8750	0.7547	9	0.6013	0.4192	0.4617
1	1.0000	0.8647	8	0.7854	0.5509	0.6057
1-1/8	1.1250	0.9704	7	0.9940	0.6929	0.7633
1-1/4	1.2500	1.0954	7	1.2272	0.8896	0.9691

[1] Minor area = $0.7854 (D - 1.3/n)^2$

[2] Tensile stress area = $0.7854 (D - 0.9743/n)^2$

Figure 1 - Basic profile for screw threads

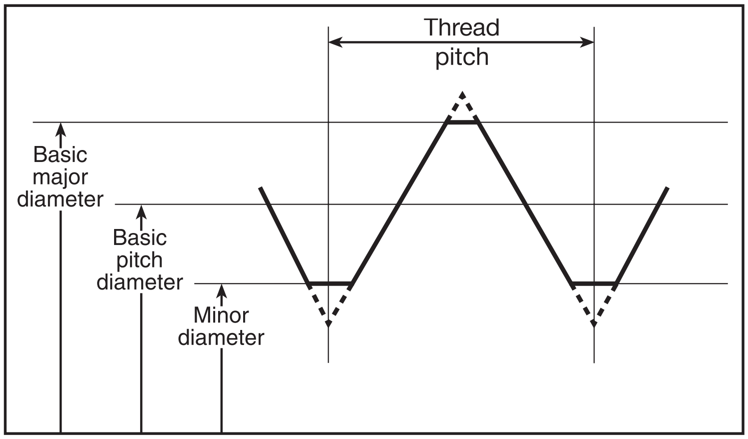


Table 7 — Basic dimensions for M profile metric thread series – ANSI B1.13M-1979

Nominal size	Basic diameter		Thread pitch mm (P)	Area	
	Major mm (D)	Minor mm		Nominal mm^2	Tensile stress[1] mm^2
M8	8	6.62	1.25	50.3	36.6
M10	10	8.34	1.50	78.5	58.0
M12	12	10.07	1.75	113.1	84.3
M16	16	13.80	2.00	201.1	157.0
M20	20	17.25	2.50	314.2	245.0
M24	24	20.70	3.00	452.4	353.0

[1] Tensile stress area = $0.7854 (D - 0.9382 P)^2$

4.2.4 CONCRETE REINFORCING BAR DATA

Table 8 — ASTM basic dimensions for deformed steel bars for concrete reinforcement, Imperial units

Bar designation No.[1]	Nominal weight lb/ft	Nominal dimensions[2]		
		Diameter in.	Area in^2	Perimeter in.
3	0.376	0.375	0.11	1.178
4	0.668	0.500	0.20	1.571
5	1.043	0.625	0.31	1.963
6	1.502	0.750	0.44	2.356
7	2.044	0.875	0.60	2.749
8	2.670	1.000	0.79	3.142
9	3.400	1.128	1.00	3.544
10	4.303	1.270	1.27	3.990
11	5.313	1.410	1.56	4.430
14	7.65	1.693	2.25	5.32
18	13.60	2.257	4.00	7.09

1 Bar designation numbers are based on the number of eighths of an inch included in the nominal diameter.
2 The nominal dimensions of a deformed bar are approximate, being shown as equivalent to those of a plain round bar having the same weight per foot as the deformed bar.

Table 9 — ASTM basic dimensions for deformed steel bars for concrete reinforcement, SI units

Bar designation No.[1]	Nominal mass kg/m	Nominal dimensions[2]		
		Diameter mm	Area mm^2	Perimeter mm
10	0.560	9.5	71	29.9
13	0.994	12.7	129	39.9
16	1.552	15.9	199	49.9
19	2.235	19.1	284	59.8
22	3.042	22.2	387	69.8
25	3.973	25.4	510	79.8
29	5.060	28.7	645	90.0
32	6.404	32.3	819	101.3
36	7.907	35.8	1006	112.5
43	11.38	43.0	1452	135.1
57	20.24	57.3	2581	180.0

1 Bar designation numbers approximate the number of millimeters of the nominal diameter of the bar.
2 The nominal dimensions of a deformed bar are approximate, being shown as equivalent to those of a plain round bar having the same mass per meter as the deformed bar.

Table 10 — CSA G30.12 & G30.16 basic dimensions for deformed steel bars for concrete reinforcement, SI units (Canada only)

Bar number[1]	Nominal mass kg/m	Nominal dimensions[2]		
		Diameter mm	Area mm^2	Perimeter mm
10M	0.785	11.3	100	36
15M	1.570	16.00	200	50
20M	2.355	19.5	300	61
25M	3.925	25.2	500	79
30M	5.495	29.9	700	94
35M	7.850	35.7	1000	112
45M	11.775	43.7	1500	137
55M	19.625	56.4	2500	177

1 Bar numbers are based on the rounded off nominal diameter of the bars.
2 Nominal dimensions are equivalent to those of a plain round bar having the same mass per meter as the deformed bar.

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Table 1 — HIT-HY 200 V3 Design Strength (Factored Resistance) for HIT-Z(-R) Rods in Uncracked Concrete[1,2,3,4,5,6,7,8]

Anchor Diameter in. (mm)	Effective Embed. Depth in. (mm)	Tension – ΦN_n or N_r				Shear – ΦV_n or V_r				
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 8,000 psi (55.2 MPa) lb (kN)
3/8 (9.5)	2-3/8 (60)	2,855 (12.7)	3,125 (13.9)	3,610 (16.1)	4,425 (19.7)	3,075 (13.7)	3,370 (15.0)	3,890 (17.3)	4,765 (21.2)	5,500 (24.5)
	4-1/2 (114)	5,560 (24.7)	5,560 (24.7)	5,560 (24.7)	5,560 (24.7)	16,035 (71.3)	17,570 (78.2)	20,285 (90.2)	24,845 (110.5)	26,690 (127.6)
1/2 (12.7)	2-3/4 (70)	3,555 (15.8)	3,895 (17.3)	4,500 (20.0)	5,510 (24.5)	7,660 (34.1)	8,395 (37.3)	9,690 (43.1)	11,870 (52.8)	13,705 (61.0)
	6 (152)	7,935 (35.3)	7,935 (35.3)	7,935 (35.3)	7,935 (35.3)	24,690 (109.8)	27,045 (120.3)	31,230 (138.9)	38,250 (170.1)	44,170 (196.5)
5/8 (15.9)	3-3/4 (95)	5,665 (25.2)	6,205 (27.6)	7,165 (31.9)	8,775 (39.0)	12,200 (54.3)	13,365 (59.5)	15,430 (68.6)	18,900 (84.1)	21,825 (97.1)
	7-1/2 (191)	14,950 (66.5)	14,950 (66.5)	14,950 (66.5)	14,950 (66.5)	34,505 (153.5)	37,800 (168.1)	43,650 (194.2)	53,455 (237.8)	61,725 (274.6)

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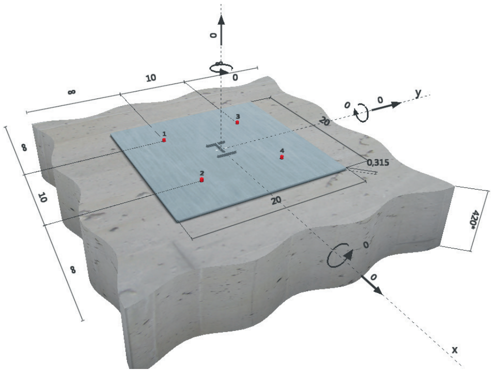

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