ICC-ES Evaluation Report

ESR-4027

Reissued January 2024	*This report also contains:*
Revised September 2024	- **City of LA Supplement**
Subject to renewal January 2025	- **FL Supplement w/ HVHZ**
	For references to other reports:
	- **See ELC-4027 for *National Building Code of Canada***

DIVISION: 03 00 00—CONCRETE **Section: 03 16 00—Concrete Anchors** **DIVISION: 05 00 00—METALS** **Section: 05 05 19—Post-Installed Concrete Anchors**	**REPORT HOLDER:** **DEWALT**	**EVALUATION SUBJECT:** **AC200+™ ADHESIVE ANCHOR SYSTEM AND POST-INSTALLED REINFORCING BAR CONNECTIONS IN CRACKED AND UNCRACKED CONCRETE (DEWALT)**

1.0 EVALUATION SCOPE

Compliance with the following codes:

■ 2024, 2021, 2018 and 2015 *International Building Code*® (IBC)

■ 2024, 2021, 2018 and 2015 *International Residential Code*® (IRC)

Main references of this report are for the 2024 IBC and IRC. See Table 19 and Table 20 for applicable sections of the code for previous IBC and IRC editions.

Property evaluated:

■ Structural

2.0 USES

The AC200+ Adhesive Anchor System is used as anchorage and the Post-Installed Reinforcing Bar Connections are used as reinforcing bar connections (for development length and splice length) in cracked and uncracked normal-weight or lightweight concrete with a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa) to resist static, wind or earthquake (IBC Seismic Design Categories A through F) tension and shear loads.

The anchor system complies with anchors as described in Section 1901.3 of the 2024 IBC. The anchor systems may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

Post-installed reinforcing bar connections are an alternative to cast-in-place reinforcing bar connection governed by ACI 318-19 and IBC Chapter 19.

3.0 DESCRIPTION

3.1 General:

The AC200+ Adhesive Anchor System and Post-Installed Reinforcing Bar Connections are comprised of AC200+ two-component adhesive filled in cartridges, static mixing nozzles, dispensing tools, hole cleaning equipment, adhesive injection accessories, and steel anchor elements, which are continuously threaded steel rods or deformed reinforcing bars (to form the AC200+ Adhesive Anchor System) or deformed steel reinforcing bars (to form the AC200+ Post-Installed Reinforcing Bar Connections).

AC200+ adhesive may be used with continuously threaded steel rods or deformed steel reinforcing bars. The primary components of the AC200+ Adhesive Anchor System and Post-Installed Reinforcing Bar Connections, including the AC200+ adhesive cartridge, static mixing nozzle, and steel anchor elements, are shown in Figures 1 and 4 of this report. The manufacturer's published installation instructions (MPII), included with each adhesive unit package, are shown in Figure 5 of this report.

3.2 Materials:

3.2.1 AC200+ Adhesive: AC200+ adhesive is an injectable two-component vinylester-urethane hybrid adhesive. The two components are kept separate by means of a labelled dual-cylinder cartridge. The two components combine and react when dispensed through a static mixing nozzle, supplied by DEWALT, which is attached to the cartridge. AC200+ is available in: coaxial cartridges: 9.5-ounce (280 mL) and 14-ounce (420 mL) and side-by-side cartridges: 11.5-ounce (345 ml) and 28-ounce (825 mL).

Each cartridge label is marked with the adhesive expiration date. The shelf life, as indicated by the expiration date, applies to an unopened cartridge stored in a dry, dark, and cool environment.

3.2.2 Hole Cleaning Equipment: Standard hole cleaning equipment and dust extraction system equipment (i.e. suction, vacuum) are available from the report holder.

3.2.2.1 Standard Hole Cleaning: Standard hole cleaning equipment used after drilling is comprised of steel wire brushes supplied by DEWALT and compressed air nozzle (applicable for both post-installed adhesive anchor system and post-installed reinforcing bar connection system). Standard hole cleaning equipment is shown in Figure 5.

3.2.2.2 DustX+™ Extraction System: The DustX+™ extraction system automatically cleans the holes during drilling using hollow drill bits with a carbide head meeting the requirements of ANSI B212.15 and a DEWALT DWV012 / DWV902M vacuum equipped with an automatic filter cleaning system or equivalent approved by DEWALT (applicable for post-installed adhesive anchors and post-installed reinforcing bar connections). After drilling with the DustX+ system, no further hole cleaning is required. See Figure 2 for an illustration of the DustX+™ extraction system.

3.2.3 Dispensers: AC200+ adhesive must be dispensed with manual dispensers, pneumatic dispensers, or electric powered dispensers supplied by DEWALT.

3.2.4 Steel Anchor Elements:

3.2.4.1 Threaded Steel Rods for use in Post-Installed Anchor Applications: Threaded steel rods must be clean and continuously threaded (all-thread) in diameters described in Tables 4 and 10 and Figure 5 of this report. The embedded portions of the threaded rods must be clean, straight, and free of mill scale, rust, mud, oil and other coatings (other than zinc) that may impair the bond with the adhesive. Specifications for grades of threaded rod, including the mechanical properties, and corresponding nuts and washers, are included in Table 2 of this report. Carbon steel threaded rods may be furnished with a minimum 0.0002-inch-thick (0.005 mm) zinc electroplated coating complying with ASTM B633 SC1 or a minimum 0.0021-inch-thick (0.053 mm) mechanically deposited zinc coating complying with ASTM B695, Class 55. The stainless steel threaded rods must comply with Table 2 of this report. Steel grades and types of material (carbon, stainless) for the washers and nuts must match the threaded rods. Threaded steel rods must be clean, straight and free of indentations or other defects along their length. The embedded end may be flat cut or cut on the bias to a chisel point.

3.2.4.2 Steel Reinforcing Bars for use in Post-Installed Anchor Applications: Steel reinforcing bars must be deformed reinforcing bars as described in Table 3 of this report. Tables 7 and 13, and Figure 5 summarize reinforcing bar size ranges. The embedded portions of reinforcing bars must be clean, straight, and free of mill scale, rust, mud, oil and other coatings (other than zinc) that may impair the bond with the adhesive. Reinforcing bars must not be bent after installation except as set forth in ACI 318-19 Section 26.6.3.2 (b) with the additional condition that the bars must be bent cold, and heating of reinforcing bars to facilitate field bending is not permitted.

3.2.4.3 Steel Reinforcing Bars for Use in Post-Installed Reinforcing Bar Connections: Steel reinforcing bars used in post-installed reinforcing bar connections must be deformed reinforcing bars (rebars) as depicted in Figure 3. Tables 17 and 18, and Figure 5 summarize reinforcing bar size ranges. The embedded portions of reinforcing bars must be straight, and free of mill scale, rust, mud, oil and other coatings (other than zinc) that may impair the bond with the adhesive. Reinforcing bars must not be bent after installation, except as set forth in ACI 318-19 Section 26.6.3.2 (b) with the additional condition that the bars must be bent cold, and heating of reinforcing bars to facilitate field bending is not permitted.

3.2.4.4 Ductility: In accordance with ACI 318-19 Section 2.3 in order for a steel anchor element to be considered ductile, the tested elongation must be at least 14 percent and reduction of area must be at least 30 percent. Steel elements with a tested elongation less than 14 percent or a reduction of area less than 30 percent, or both, are considered brittle. Values for various steel materials are provided in Table 2 of this report. Where values are nonconforming or unstated, the steel must be considered brittle.

3.2.4.5 Concrete: Normal-weight and lightweight concrete must comply with Sections 1903 and 1905 of the IBC. The specified compressive strength of the concrete must be from 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

4.0 DESIGN AND INSTALLATION

4.1 Strength Design of Post-Installed Anchors:

4.1.1 General: The design strength of anchors under the 2024 IBC, as well as the 2024 IRC must be determined in accordance with ACI 318-19 and this report.

The strength design of anchors must comply with ACI 318-19 Section 17.5.1.2 except as required in ACI 318-19 Section 17.10.

Design parameters are provided in Table 4 through Table 16 of this report. Strength reduction factors, ϕ, as given in ACI 318-19 Section 17.5.3 must be used for load combinations calculated in accordance with Section 1605.1 of the 2024 IBC, and ACI 318-19 Section 5.3.

4.1.2 Static Steel Strength in Tension: The nominal static steel strength of a single anchor in tension, N_{sa}, in accordance with ACI 318-19 Section 17.6.1.2 and the associated strength reduction factors, ϕ, in accordance with ACI 318-19 Section 17.5.3, are provided in Tables 4, 7, 10 and 13 of this report for the corresponding anchor steel.

4.1.3 Static Concrete Breakout Strength in Tension: The nominal static concrete breakout strength of a single anchor or group of anchors in tension, N_{cb} or N_{cbg}, must be calculated in accordance with ACI 318-19 Section 17.6.2 with the following addition:

The basic concrete breakout strength of a single anchor in tension, N_b, must be calculated in accordance with ACI 318-19 Section 17.6.2.2 using the values of $k_{c,cr}$ and $k_{c,uncr}$ as provided in Tables 5, 8, 11 and 14 of this report. Where analysis indicates no cracking in accordance with ACI 318-19 Section 17.6.2.5, N_b must be calculated using $k_{c,uncr}$ and $\Psi_{c,N}$ = 1.0. For anchors in lightweight concrete see ACI 318-19 Section 17.2.4. The value of f'_c used for calculation must be limited to 8,000 psi (55 MPa) in accordance with ACI 318-19 Section 17.3.1. The value of f'_c used for calculation must be limited to 2,500 psi (17.2 MPa) maximum for metric reinforcing bars in cracked concrete. Additional information for the determination of nominal bond strength in tension is given in Section 4.1.4 of this report.

4.1.4 Static Bond Strength in Tension: The nominal static bond strength of a single adhesive anchor or group of adhesive anchors in tension, N_a or N_{ag}, must be calculated in accordance with ACI 318-19 Section 17.6.5. Bond strength values ($\tau_{k,cr}$, $\tau_{k,uncr}$) are a function of concrete compressive strength, concrete state (cracked, uncracked) and installation conditions (dry concrete, water-saturated concrete, water-filled holes). Drilling method is hammer-drill (i.e., rotary impact drills or rock drills with a carbide drill bit [including hollow drill bits]). Special inspection level is qualified as periodic for all anchors except as shown in Section 4.5 of this report. The selection of continuous special inspection level, with an onsite proof loading program, does not provide a benefit of a lower anchor category or an increase in the associated strength reduction factors for design. The following table summarizes the requirements:

CONCRETE STATE	DRILLING METHOD	BOND STRENGTH	CONCRETE STRENGTH	PERMISSIBLE INSTALLATION CONDITIONS	ASSOCIATED STRENGTH REDUCTION FACTOR
Cracked and Uncracked	Hammer-drill with carbide drill bit or DEWALT hollow bit	$\tau_{k,cr}$ or $\tau_{k,uncr}$	f'_c	Dry concrete	ϕ_d
				Water-saturated concrete	ϕ_{ws}
	Hammer-drill with carbide drill bit			Water-filled holes	ϕ_{wf}

The bond strength values in Tables 6, 9, 12, 15 and 16 of this report correspond to concrete compressive strength f'_c equal to 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c, between 2,500 psi and 8,000 psi (17.2 MPa and 55 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c\ /\ 2{,}500)^{0.10}$. [For **SI:** $(f'_c\ /\ 17.2)^{0.10}$]. The value of f'_c used for calculation must be limited to 2,500 psi (17.2 MPa) maximum for metric reinforcing bars in cracked concrete. Where applicable, the modified bond strength values must be used in lieu of $\tau_{k,cr}$ and $\tau_{k,uncr}$ in ACI 318-19 Eq. 17.6.5.1.2b and 17.6.5.2.1.

The resulting nominal bond strength must be multiplied by the associated strength reduction factor ϕ_d, ϕ_{ws} or ϕ_{wf}, as applicable.

Strength reduction factors for determination of the bond strength are given in Tables 6, 9, 12, 15 and 16 of this report. Adjustments to the bond strength may also be made for increased concrete compressive strength as noted in the footnotes to the corresponding tables and this section. For anchors in lightweight concrete see ACI 318-19 Section 17.2.4.

4.1.5 Static Steel Strength in Shear: The nominal static steel strength of a single anchor in shear as governed by the steel, V_{sa}, in accordance with ACI 318-19 Section 17.7.1.2, and the strength reduction factor, ϕ, in accordance with ACI 318-19 Section 17.5.3, are given in Tables 4, 7, 11 and 13 of this report for the corresponding anchor steel.

4.1.6 Static Concrete Breakout Strength in Shear: The nominal static concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg}, must be calculated in accordance with ACI 318-19 Section 17.7.2, based on information given in Tables 5, 8, 12 and 14 in this report.

The basic concrete breakout strength of a single anchor in shear, V_b, must be calculated in accordance with ACI 318-19 Section 17.7.2.2 using the values of d given in Tables 5, 8, 12 and 14 for the corresponding anchor steel in lieu of d_a. In addition, h_{ef} must be substituted for ℓ_e. In no case shall ℓ_e exceed $8d$. The value of f'_c shall be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318-19 Section 17.3.1.

4.1.7 Static Concrete Pryout Strength in Shear: The nominal static pryout strength of a single anchor or group of anchors in shear, V_{cp} or V_{cpg}, shall be calculated in accordance with ACI 318-19 Section 17.7.3.

4.1.8 Interaction of Tensile and Shear Forces: For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318-19 Section 17.8.

4.1.9 Minimum Member Thickness h_{min}, Anchor Spacing s_{min}, Edge Distance c_{min}: In lieu of ACI 318-19 Section 17.9.2, values of s_{min} and c_{min} described in this report must be observed for anchor design and installation. The minimum member thicknesses, h_{min}, described in this report must be observed for anchor design and installation. For adhesive anchors that will remain untorqued, refer to ACI 318-19 Section 17.9.3.

For anchors that will be torqued during installation, the maximum torque, T_{max}, must be reduced for the following anchor sizes with edge distances less than the values given in Tables 5, 8, 11 and 14, as applicable. T_{max} is subject to the edge distance, c_{min}, and anchor spacing, s_{min}, and shall comply with the following requirements:

<table>
<tr><th colspan="4">INSTALLATION TORQUE SUBJECT TO EDGE DISTANCE</th></tr>
<tr><th>NOMINAL ANCHOR SIZE, d</th><th>MINIMUM EDGE DISTANCE, c_{min}</th><th>MINIMUM ANCHOR SPACING, s_{min}</th><th>MAXIMUM TORQUE, T_{max}</th></tr>
<tr><td>5/8 in. to 1 in.
#5 to #8
M16 to M24
ø14 to ø25
15M to 25M</td><td>1.75 in.
(45 mm)</td><td rowspan="2">5d</td><td rowspan="2">0.45·T_{max}</td></tr>
<tr><td>1 1/4 in.
#9 to #10
M27 to M30
ø28 to ø32
30M</td><td>2.75 in.
(70 mm)</td></tr>
</table>

For values of T_{max}, see Figure 5 of this report.

4.1.10 Critical Edge Distance c_{ac} and $\psi_{cp,Na}$: The modification factor $\psi_{cp,Na}$, must be determined in accordance with ACI 318-19 Section 17.6.5.5, except as noted below:

For all cases where $c_{Na}/c_{ac}<1.0$, $\psi_{cp,Na}$ determined from ACI 318-19 Eq. 17.6.5.5.1b, need not be taken less than c_{Na}/c_{ac}. For all other cases, $\psi_{cp,Na}$ shall be taken as 1.0.

The critical edge distance, c_{ac} must be calculated according to ACI 318-19 Eq. 17.6.5.5.1c in lieu of ACI 318-19 Section 17.9.5.

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

(ACI 318-19 Eq. 17.6.5.5.1c)

where

$\left[\frac{h}{h_{ef}}\right]$ need not be taken as larger than 2.4; and where

$\tau_{k,uncr}$ = the characteristic bond strength stated in the tables of this report whereby $\tau_{k,uncr}$ need not be taken as larger than:

$$\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} f'_c}}{\pi \cdot d_a} \quad \text{Eq. (4-1)}$$

4.1.11 Requirements for Seismic Design Categories C, D, E and F: In structures assigned to Seismic Design Category C, D, E or F under the IBC or IRC, anchors must be designed in accordance with ACI 318-19 17.10 except as described below.

The nominal steel shear strength, V_{sa}, must be adjusted by $\alpha_{V,seis}$ as given in Tables 4, 7, 11 and 13 for the corresponding anchor steel. The nominal bond strength $\tau_{k,cr}$ must be adjusted by $\alpha_{N,seis}$ as given in Tables 6, 9, 12 and 15 for threaded rods.

4.2 Strength Design of Post-Installed Reinforcing Bars:

4.2.1 General: The design of straight post-installed deformed reinforcing bars must be determined in accordance with ACI 318-19 rules for cast-in place reinforcing bar development and splices and this report.

Examples of typical applications for the use of post-installed reinforcing bars are illustrated in Figure 3 of this report.

4.2.2 Determination of bar development length l_d: Values of l_d must be determined in accordance with the ACI 318-19 development and splice length requirements for straight cast-in place reinforcing bars.

Exceptions:

1. *For uncoated and zinc-coated (galvanized) post-installed reinforcing bars, the factor Ψ_e shall be taken as 1.0. For all other cases, the requirements in ACI 318-19 Section 25.4.2.5 shall apply.*
2. *When using alternate methods to calculate the development length (e.g., anchor theory), the applicable factors for post-installed anchors generally apply.*

4.2.3 Minimum Member Thickness, h_{min}, Minimum Concrete Cover, $c_{c,min}$, Minimum Concrete Edge Distance, $c_{b,min}$, Minimum Spacing, $s_{b,min}$: For post-installed reinforcing bars, there is no limit on the minimum member thickness. In general, all requirements on concrete cover and spacing applicable to straight cast-in bars designed in accordance with ACI 318-19 shall be maintained.

For post-installed reinforcing bars installed at embedment depths, h_{ef}, larger than 20d (h_{ef} > 20d), the minimum concrete cover shall be as follows:

REBAR SIZE	MINIMUM CONCRETE COVER, $c_{c,min}$
d_b ≤ No. 6 (16mm)	$1^3/_{16}$ in. (30mm)
No. 6 < d_b ≤ No.10 (16mm < d_b ≤ 32mm)	$1^9/_{16}$ in. (40mm)

The following requirements apply for minimum concrete edge and spacing for h_{ef} > 20d:

Required minimum edge distance for post-installed reinforcing bars (measured from the center of the bar):

$c_{b,min} = d_0/2 + c_{c,min}$

Required minimum center-to-center spacing between post-installed bars:

$s_{b,min} = d_0 + c_{c,min}$

Required minimum center-to-center spacing from existing (parallel) reinforcing:

$s_{b,min} = d_b/2 \text{ (existing reinforcing)} + d_0/2 + c_{c,min}$

4.2.4 Design Strength in Seismic Design Categories C, D, E and F: In structures assigned to Seismic Category C, D, E or F under the IBC or IRC, design of straight post-installed reinforcing bars must take into account the provisions of ACI 318-19 Chapter 18.

4.3 Allowable Stress Design (ASD):

4.3.1 General: For anchor system designed using load combinations in accordance with Section 1605.1 of the 2024 IBC (Allowable Stress Design), allowable loads must be established using Eq. (4-2) and Eq. (4-3):

$T_{allowable,ASD} = \phi N_n / \alpha$ Eq. (4-2)

and

$V_{allowable,ASD} = \phi V_n / \alpha$ Eq. (4-3)

where

$T_{allowable,ASD}$ = Allowable tension load (lbf or kN).

$V_{allowable,ASD}$ = Allowable shear load (lbf or kN).

ϕN_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318-19 Chapter 17, and 2024 IBC Section 1905.7, and Section 4.1 of this report, as applicable (lbf or kN).

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318-19 Chapter 17, and 2024 IBC Section 1905.7, and Section 4.1 of this report, as applicable (lbf or kN).

α = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, α must include all applicable factors to account for non-ductile failure modes and required over-strength.

The requirements for member thickness, edge distance and spacing, described in this report must apply.

4.3.2 Interaction of Tensile and Shear Forces: Interaction must be calculated and consistent with ACI 318-19 Section 17.8 as follows:

For shear loads $V \leq 0.2\ V_{allowable,\ ASD}$, the full allowable load in tension shall be permitted.

For tension loads $T \leq 0.2\ T_{allowable,ASD}$, the full allowable load in shear shall be permitted.

For all other cases:

$$\frac{T}{T_{allowable,ASD}} + \frac{V}{V_{allowable,ASD}} \leq 1.2 \qquad \text{(Eq-4.4)}$$

4.4 Installation:

Installation parameters are illustrated in Figure 5 of this report. Installation must be in accordance with ACI 318-19 Section 26.7.2. Anchor and post-installed rebar locations must comply with this report and the plans and specifications approved by the code official. Installation of the AC200+ Adhesive Anchor System and Post-Installed Reinforcing Bar Connections must conform to the manufacturer's printed installation instructions included in each unit package as described in Figure 5 of this report.

The adhesive anchor system may be used for upwardly inclined orientation applications (e.g. overhead). Upwardly included and horizontal orientation applications are to be installed using piston plugs for the $^5/_8$-inch through $1^1/_4$-inch (M16 through M30) diameter threaded steel rods and No. 5 through No. 10 (14 mm through 32 mm) steel reinforcing bars, installed in the specified hole diameter, and attached to the mixing nozzle and extension tube supplied by DEWALT as described in Figure 5 in this report. Upwardly included and horizontal orientation installation for the $^3/_8$-inch and $^1/_2$-inch (M10 and M12) diameter threaded steel rods, and No. 3 and No. 4 (10 mm and 12 mm) steel reinforcing bars may be injected directly to the end of the hole using a mixing nozzle with a hole depth $h_0 \leq 10$" (250 mm).

Installation of anchors in horizontal or upwardly inclined orientations shall be fully restrained from movement throughout the specified curing period through the use of temporary wedges, external supports, or other methods. Where temporary restraint devices are used, their use shall not result in impairment of the anchor shear resistance.

4.5 Special Inspection:

Periodic special inspection must be performed where required in accordance with Section 1705.1.1 and Table 1705.3 of the 2024 IBC and this report. The special inspector must be on the jobsite initially during anchor or post-installed reinforcing bar installation to verify the anchor or post-installed reinforcing bar type and dimensions, adhesive expiration date, concrete type, concrete compressive strength, hole dimensions, hole cleaning procedures, spacing, edge distances, concrete thickness, anchor or post-installed reinforcing bar embedment, tightening torque, and adherence to the manufacturers printed installation instructions.

The special inspector must verify the initial installations of each type and size of adhesive anchor or post-installed reinforcing bar by construction personnel on site. Subsequent installations of the same anchor or post-installed reinforcing bar type and size by the same construction personnel are permitted to be performed in the absence of the special inspector. Any change in the anchor or post-installed reinforcing bar product being installed or the personnel performing the installation requires an initial inspection. For ongoing installations over an extended period, the special inspector must make regular inspections to confirm correct handling and installation of the product.

Continuous special inspection of adhesive anchors or post-installed reinforcing bars installed in horizontal or upwardly inclined orientations to resist sustained tension loads must be performed in accordance with ACI 318-19 Section 26.13.3.2(e).

Under the IBC, additional requirements as set forth in Sections 1705, 1706 or 1707 must be observed, where applicable.

4.6 Compliance with NSF/ANSI Standard 61:

The AC200+ Adhesive Anchor System and Post-Installed Reinforcing Bar Connections comply with the requirements of NSF/ANSI Standard 61, as referenced in Section 605 of the 2024 *International Plumbing Code*® (IPC) and is certified for use as an anchoring adhesive for installing threaded rods less than or equal to 1.3 inches (33 mm) in diameter in concrete for water treatment applications.

5.0 CONDITIONS OF USE:

The AC200+ Adhesive Anchor System and Post-Installed Reinforcing Bar Connections described in this report comply with, or are a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 AC200+ adhesive anchors and post-installed reinforcing bars must be installed in accordance with the manufacturer's printed installation instructions included with each cartridge and provided in Figure 5 of this report.

5.2 The anchors and post-installed reinforcing bars described in this report must be installed in cracked and uncracked normal-weight concrete having a specified compressive strength f'_c = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

5.3 The concrete shall have attained its minimum design strength prior to installation of the anchors and post-installed reinforcing bars.

5.4 The values of f'_c used for calculation purposes must not exceed 8,000 psi (55 MPa). The value of f'_c used for calculation of tension resistance must be limited to 2,500 psi (17.2 MPa) maximum for EU metric reinforcing bars used as anchorage in cracked concrete only.

5.5 Anchors and post-installed reinforcing bars must be installed in concrete base materials in holes predrilled in accordance with the instructions provided in Figure 5 of this report.

5.6 Loads applied to the anchors and post-installed reinforcing bars must be adjusted in accordance with Section 1605.1 of the 2024 IBC for strength design.

5.7 In structures assigned to Seismic Design Categories C, D, E, and F under the IBC or IRC, anchor strength must be adjusted in accordance with Section 4.1.11 of this report and post-installed reinforcing bars must comply with section 4.2.4 of this report.

5.8 AC200+ adhesive anchors and post-installed reinforcing bars are permitted to be installed in concrete that is cracked or that may be expected to crack during the service life of the anchors and post-installed reinforcing bars, subject to the conditions of this report.

5.9 Strength design values are established in accordance with Section 4.1 of this report.

5.10 Post-installed reinforcing bar development and splice lengths are established in accordance with Section 4.2 of this report.

5.11 Minimum anchor spacing and edge distance as well as minimum member thickness must comply with the values described in this report.

5.12 Post-installed reinforcing bar spacing, minimum member thickness, and cover distance must be in accordance with the provisions of ACI 318-19 for cast-in place bars and Section 4.2.3 of this report.

5.13 Prior to installation of anchors and post-installed reinforcing bars, calculations and details demonstrating compliance with this report must be submitted to the code official. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.14 Anchors and post-installed reinforcing bars are not permitted to support fire-resistive construction. Where not otherwise prohibited by the code, AC200+ adhesive anchors and post-installed reinforcing bars are permitted for installation in fire-resistive construction provided that at least one of the following conditions is fulfilled:

- Anchors and post-installed reinforcing bars are used to resist wind or seismic forces only.
- Anchors and post-installed reinforcing bars that support gravity load–bearing structural elements are within a fire-resistive envelope or a fire-resistive membrane, are protected by approved fire-resistive materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchors and post-installed reinforcing bars are used to support non-structural elements.

5.15 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of adhesive anchors and post-installed reinforcing bars subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under such conditions is beyond the scope of this report.

5.16 Use of zinc-plated carbon steel threaded rods or steel reinforcing bars is limited to dry, interior locations.

5.17 Use of hot-dipped galvanized carbon steel and stainless steel rods is permitted for exterior exposure or damp environments.

5.18 Steel anchoring elements in contact with preservative-treated and fire-retardant-treated wood shall be of zinc-coated steel or stainless steel. The minimum coating weights for zinc-coated steel shall be in accordance with ASTM A153.

5.19 Periodic special inspection must be provided in accordance with Section 4.5 in this report. Continuous special inspection for anchors and post-installed reinforcing bars installed in horizontal or upwardly inclined orientations to resist sustained tension loads must be provided in accordance with Section 4.5 of this report.

5.20 Installation of anchors and post-installed reinforcing bars in horizontal or upwardly inclined orientations to resist sustained tension loads must be performed by personnel certified by an applicable certification program in accordance with ACI 318-19 26.7.1(l) and 26.7.2(e).

5.21 AC200+ Adhesive Anchors and Post-Installed Reinforcing Bars may be used to resist tension and shear forces in wall (horizontal) and for overhead (upwardly inclined) installations into concrete with a temperature between 23°F and 104°F (-5°C and 40°C); and between 14°F and 104°F (-10°C and 40°C) for floor (downward) installations.

5.22 Anchors and post-installed reinforcing bars shall not be used for installations where the concrete temperature can vary from 40°F (5°C) or less, to 80°F (27°C) or higher within a 12-hour period. Such applications may include but are not limited to anchorage of building facade systems and other applications subject to direct sun exposure.

5.23 AC200+ adhesive is manufactured under a quality-control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors in Concrete (AC308), dated February 2023 (editorially revised February 2024), which incorporates requirements in ACI 355.4-19 and ACI 355.4-11 for use in cracked and uncracked concrete; including, but not limited to, tests under freeze/thaw conditions, tests under sustained load, tests for installation direction, tests at elevated temperatures, tests for resistance to alkalinity, tests for resistance to sulfur and tests for seismic tension and shear.

Data in accordance with AC308, Table 3.8, which includes requirements for the qualification of post-installed reinforcing bar connections has also been provided.

7.0 IDENTIFICATION

7.1 The ICC-ES mark of conformity, electronic labelling, or the evaluation report number (ICC-ES ESR-4027) along with the name, registered trademark, or registered logo of the report holder or listee must be included in the product label

7.2 In addition, AC200+ adhesive is identified by packaging labelled with the company's name (DEWALT) and address, anchor name, the lot number and the expiration date. Threaded rods, nuts, washers, and deformed reinforcing bars must be standard steel anchor elements and must conform to applicable national or international specifications as set forth in Tables 2 and 3 of this report.

7.3 The report holder's contact information is the following:

DEWALT
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TOWSON, MARYLAND 21286
(800) 524-3244
www.DEWALT.com
anchors@DEWALT.com

TABLE 1A—DESIGN USE AND REPORT TABLE INDEX FOR POST-INSTALLED ADHESIVE ANCHORS

POST-INSTALLED ADHESIVE ANCHORS – COMMON TREADED RODS AND REINFORCING BARS						
DESIGN STRENGTH[1]		THREADED ROD (FRACTIONAL)	DEFORMED REINFORCING BAR (FRACTIONAL)	THREADED ROD (METRIC)	DEFORMED REINFORCING BAR (METRIC)	
					EU	CA
Steel	N_{sa}, V_{sa}	Table 4	Table 7	Table 10	Table 13	Table 13
Concrete	N_{cb}, N_{cbg}, V_{cb}, V_{cbg}, V_{cp}, V_{cpg}	Table 5	Table 8	Table 11	Table 14	Table 14
Bond[2]	N_a, N_{ag}	Table 6	Table 9	Table 12	Table 15	Table 16

Concrete Type	Concrete State	Threaded Rod Diameter (inch)	Reinforcing Bar Size (No.)	Drilling Method[3]	Minimum and Maximum Embedment	Seismic Design Categories[4]
Normal-weight and lightweight	Cracked	3/8, 1/2, 5/8, 3/4, 7/8, 1, 1 1/4	3, 4, 5, 6, 7, 8, 9, 10	Hammer-drill	Table 6	A through F
	Uncracked	3/8, 1/2, 5/8, 3/4, 7/8, 1, 1 1/4	3, 4, 5, 6, 7, 8, 9, 10	Hammer-drill	Table 9	A and B

Concrete Type	Concrete State	Threaded Rod Diameter (mm)	Reinforcing Bar Size, EU and CA (Ø and M)	Drilling Method[3]	Minimum and Maximum Embedment	Seismic Design Categories[4]
Normal-weight and lightweight	Cracked	10, 12, 16, 20, 24, 27, 30	10, 12, 14, 16, 20, 25, 28, 32	Hammer-drill	Table 15	A through F
			10, 15, 20, 25, 30		Table 16	
	Uncracked	10, 12, 16, 20, 24, 27, 30	10, 12, 14, 16, 20, 25, 28, 32	Hammer-drill	Table 15	A and B
			10, 15, 20, 25, 30		Table 16	

For **SI:** 1 inch = 25.4 mm. For **pound-inch** units: 1 mm = 0.03937 inch.

[1]Reference ACI 318-19 Section 17.5.1 for post-installed adhesive anchors. The controlling strength is decisive from all appropriate failure modes (i.e. steel, concrete, bond) and design assumptions.
[2]See Section 4.1.4 of this report for bond strength determination of post-installed adhesive anchors.
[3]Hammer-drill, i.e. rotary impact drills or rock drills with a carbide drill bit (including hollow drill bits).
[4]See Section 4.1.11 for requirements for seismic design of post-installed adhesive anchors, where applicable.

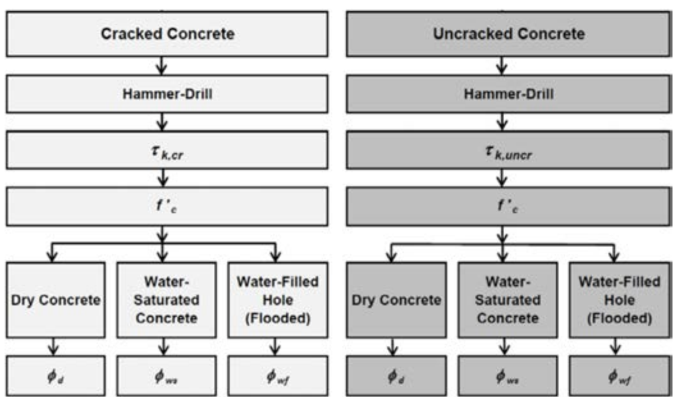

FIGURE A—FLOWCHART FOR THE ESTABLISHMENT OF DESIGN BOND STRENGTH FOR POST-INSTALLED ADHESIVE ANCHORS

TABLE 1B—DESIGN USE AND REPORT TABLE INDEX FOR POST-INSTALLED REINFORCING BAR CONNECTIONS[1]

POST-INSTALLED REINFORCING BARS (Table 17)			
Concrete Type	Reinforcing Bar Size	Drilling Method[2]	Seismic Design Categories[3]
Normal-weight and lightweight	#3, #4, #5, #6, #7, #8, #9, #10	Hammer-drill	A through F
	Ø10, Ø12, Ø14, Ø16, Ø20, Ø25, Ø28, Ø32	Hammer-drill	A through F
	10M, 15M, 20M, 25M, 30M	Hammer-drill	A through F

For **SI:** 1 inch = 25.4 mm. For **pound-inch** units: 1 mm = 0.03937 inch.

[1]Determination of development length for post-installed reinforcing bar connections in accordance with this report; see Section 4.2 of this report for requirements.
[2]Hammer-drill, i.e. rotary impact drills or rock drills with a carbide drill bit (including hollow drill bits).
[3]See Section 4.2.4 for requirements for seismic design of post-installed reinforcing bar connections, where applicable.

TABLE 2—SPECIFICATIONS AND PHYSICAL PROPERTIES OF COMMON CARBON AND STAINLESS STEEL THREADED ROD MATERIALS[1]

	THREADED ROD SPECIFICATION		MIN. SPECIFIED ULTIMATE STRENGTH, f_{uta}	MINIMUM SPECIFIED YIELD STRENGTH 0.2 PERCENT OFFSET, f_{ya}	f_{uta}/f_{ya}	ELONGATION, MIN. PERCENT[11]	REDUCTION OF AREA, MIN. PERCENT	SPECIFICATION FOR NUTS[12]
CARBON STEEL	ASTM A193[2] Grade B7	psi (MPa)	125,000 (860)	105,000 (720)	1.19	16	50	ASTM A194 / A563 Grade D
	ASTM A36[3] / F1554[4], Grade 36	psi (MPa)	58,000 (400)	36,000 (250)	1.61	23	40	ASTM A194 / A563 Grade A
	ASTM F1554[4] Grade 55	psi (MPa)	75,000 (515)	55,000 (380)	1.36	23	40	
	ASTM F1554[4] Grade 105	psi (MPa)	125,000 (860)	105,000 (725)	1.19	15	45	ASTM A194 / A563 Grade DH
	ASTM A449[5] (3/8" to1" dia.)	psi (MPa)	120,000 (830)	92,000 (635)	1.30	14	35	
	ASTM A449[5] (1-1/4" dia.)	psi (MPa)	105,000 (720)	81,000 (560)	1.30	14	35	
	ASTM F568M[6] Class 5.8 (equivalent to ISO 898-1)	psi (MPa)	72,500 (500)	58,000 (400)	1.25	10	35	A563 Grade D DIN 934 (8-A2K)[13]
	ISO 898-1[7] Class 5.8	MPa (psi)	500 (72,500)	400 (58,000)	1.25	22	-	EN ISO 4032 Grade 6
	ISO 898-1[7] Class 8.8	MPa (psi)	800 (118,000)	640 (92,800)	1.25	12	52	EN ISO 4032 Grade 8
STAINLESS STEEL	ASTM F593[8] CW1 3/8 to 5/8 in.	psi (MPa)	100,000 (690)	65,000 (450)	1.54	20	-	ASTM F594 Alloy Group 1, 2 or 3
	ASTM F593[8] CW2 3/4 to 1-1/4 in.	psi (MPa)	85,000 (590)	45,000 (310)	1.89	25	-	
	ASTM A193/A193M[9] Grade B8/B8M2, Class 2B	psi (MPa)	95,000 (655)	75,000 (515)	1.27	25	40	ASTM A194/A194M
	ISO 3506-1[10] A4-70 M10-M24	MPa (psi)	700 (101,500)	450 (65,250)	1.56	40	-	EN ISO 4032
	ISO 3506-1[10] A4-50 M27-M30	MPa (psi)	500 (72,500)	210 (30,450)	2.38	40	-	EN ISO 4032

[1]Adhesive must be used with continuously threaded carbon or stainless steel rod (all-thread) having thread characteristics complying with ANSI B1.1 UNC Coarse Thread Series.
[2]Standard Specification for Alloy-Steel and Stainless steel Bolting Materials for High temperature of High Pressure service and Other Special Purpose Applications.
[3]Standard Specification for Carbon Structural steel
[4]Standard Specification for Anchor Bolts, Steel 36, 55 and 105-ksi Yield Strength
[5]Standard Specification for Hex Cap Screws, Bolts and Studs, Heat Treated, 120/105/50 ksi Minimum Tensile Strength, General Use.
[6]Standard Specification for Carbon and Alloy Steel external Threaded Metric Fasteners
[7]Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel - Part 1: Bolts, Screws and Studs
[8]Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
[9]Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
[10]Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, Screws and Studs
[11]Based on 2-in. (50 mm) gauge length except for ASTM A193, which is based on a gauge length of 4d.
[12]Nuts and washers of other grades and style having specified proof load stress greater than the specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than the minimum tensile strength of the specified threaded rod.
[13]Nuts for metric rods.
[14]Minimum percent reduction of area not reported in the referenced standard.

TABLE 3—SPECIFICATIONS AND PHYSICAL PROPERTIES OF COMMON STEEL REINFORCING BARS

REINFORCING SPECIFICATION	UNITS	MINIMUM SPECIFIED ULTIMATE STRENGTH, f_{uta}	MINIMUM SPECIFIED YIELD STRENGTH, f_{ya}
ASTM A615[2], A767[4], Grade 80	psi (MPa)	100,000 (690)	80,000 (550)
ASTM A615[1], A767[3] Grade 75	psi (MPa)	100,000 (690)	75,000 (520)
ASTM A615[1], A767[3], A996[4] Grade 60	psi (MPa)	80,000 (550)	60,000 (414)
ASTM A706[2], A767[3] Grade 60	psi (MPa)	80,000 (550)	60,000 (414)
ASTM A615[1], Grade 40	psi (MPa)	60,000 (415)	40,000 (275)
DIN 488[5] BSt 500	MPa (psi)	550 (79,750)	500 (72,500)
CAN/CSA-G30.18[6] Grade 400	MPa (psi)	540 (78,300)	400 (58,000)

[1]Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
[2]Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
[3]Standard Specification for Zinc-Coated (Galvanized) steel Bars for Concrete Reinforcement.
[4]Standard Specification for Rail-Steel and Axle-steel Deformed bars for Concrete Reinforcement.
[5]Reinforcing steel, reinforcing steel bars; dimensions and masses
[6]Billet-Steel Bars for Concrete Reinforcement.

TABLE 4—STEEL DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD[1]

DESIGN INFORMATION		Symbol	Units	Nominal Rod Diameter (inch)						
				3/8	1/2	5/8	3/4	7/8	1	1 1/4
Threaded rod O.D.		d	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.250 (31.8)
Threaded rod effective cross-sectional area		A_{se}	in.² (mm²)	0.0775 (50)	0.1419 (92)	0.2260 (146)	0.3345 (216)	0.4617 (298)	0.6057 (391)	0.9691 (625)
ASTM A36/F1554, Grade 36	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	4,495 (20.0)	8,230 (36.6)	13,110 (58.3)	19,400 (86.3)	26,780 (119.1)	35,130 (156.3)	56,210 (250.0)
		V_{sa}	lb (kN)	2,695 (12.0)	4,940 (22.0)	7,860 (35.0)	11,640 (51.8)	16,070 (71.4)	21,080 (93.8)	33,725 (150.0)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.60						
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ASTM F1554 Grade 55	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	5,815 (25.9)	10,645 (47.6)	16,950 (75.5)	25,090 (111.7)	34,630 (154.1)	45,430 (202.1)	72,685 (323.1)
		V_{sa}	lb (kN)	3,490 (15.5)	6,385 (28.6)	10,170 (45.3)	15,055 (67)	20,780 (92.5)	27,260 (121.3)	43,610 (193.9)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.60						
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ASTM A193 Grade B7 ASTM F1554 Grade 105	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	9,685 (43.1)	17,735 (78.9)	28,250 (125.7)	41,810 (186.0)	57,710 (256.7)	75,710 (336.8)	121,135 (538.8)
		V_{sa}	lb (kN)	5,810 (25.9)	10,640 (47.3)	16,950 (75.4)	25,085 (111.6)	34,625 (154.0)	45,425 (202.1)	72,680 (323.3)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.60						
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ASTM A449	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	9,300 (41.4)	17,030 (76.2)	27,120 (120.9)	40,140 (178.8)	55,405 (246.7)	72,685 (323.7)	101,755 (450.0)
		V_{sa}	lb (kN)	5,580 (24.8)	10,220 (45.7)	16,270 (72.5)	24,085 (107.3)	33,240 (148)	43,610 (194.2)	61,055 (270.0)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.60						
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ASTM F568M Class 5.8	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	5,620 (25)	10,290 (46)	16,385 (73)	24,250 (108)	33,470 (149)	43,910 (195.5)	70,260 (312.5)
		V_{sa}	lb (kN)	3,370 (15)	6,175 (27.6)	9,830 (43.8)	14,550 (64.8)	20,085 (89.4)	26,350 (117.3)	42,155 (187.5)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.60						
	Strength reduction factor for tension[2]	ϕ	-	0.65						
	Strength reduction factor for shear[2]	ϕ	-	0.60						
ASTM F593 CW Stainless	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	28,430 (126.5)	39,245 (174.6)	51,485 (229.0)	82,370 (366.4)
		V_{sa}	lb (kN)	4,650 (20.7)	8,515 (37.9)	13,560 (60.3)	17,060 (75.9)	23,545 (104.7)	30,890 (137.4)	49,425 (219.8)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.60						
	Strength reduction factor for tension[2]	ϕ	-	0.65						
	Strength reduction factor for shear[2]	ϕ	-	0.60						
ASTM A193/A193M Grade B8/B8M2, Class 2B	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	7,365 (32.8)	13,480 (60.3)	21,470 (95.6)	31,780 (141.5)	43,860 (195.2)	57,540 (256.1)	92,065 (409.4)
		V_{sa}	lb (kN)	4,420 (19.7)	8,090 (36.2)	12,880 (57.4)	19,070 (84.9)	26,320 (117.1)	34,525 (153.7)	55,240 (245.6)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.60						
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						

[1]Values provided for common rod material types based on specified strengths and calculated in accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2(b). Nuts and washers must comply with requirements for the rod.
[2]The strength reduction factor applies when the load combinations from the IBC or ACI 318-19 are used and the requirements of ACI 318-19 Section 17.5.3 are met.

TABLE 5—CONCRETE BREAKOUT DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION	Symbol	Units	Nominal Rod Diameter (inch)						
			$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
Effectiveness factor for cracked concrete	$k_{c,cr}$	in-lb (SI)	17 (7)						
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	in-lb (SI)	24 (10)						
Min. anchor spacing	s_{min}	in. (mm)	$1^7/_8$ (48)	$2^1/_2$ (64)	3 (76)	$3^3/_4$ (95)	$4^1/_4$ (108)	$4^3/_4$ (121)	$5^7/_8$ (149)
Min. edge distance	c_{min}	in. (mm)	$1^5/_8$ (41)	$1^3/_4$ (45)	2 (51)	$2^3/_8$ (60)	$2^1/_2$ (64)	$2^3/_4$ (70)	$3^1/_4$ (82)
					For edge distances to $1^3/_4$-inch (44 mm) See Section 4.1.9 of this report.				For edge distances to $2^3/_4$-inch (70 mm) see Section 4.1.9.
Min. member thickness	h_{min}	in. (mm)	$h_{ef} + 1^1/_4$ (h_{ef} + 30)		$h_{ef} + 2d_0$[3]				
Critical edge distance - splitting (for uncracked concrete only)	c_{ac}	-	See Section 4.1.10 of this report.						
Strength reduction factor for tension, concrete failure modes, Condition B (supplemental reinforcement not present)[2]	ϕ	-	0.65						
Strength reduction factor for shear, concrete failure modes, Condition B (supplemental reinforcement not present)[2]	ϕ	-	0.70						

[1]Additional setting information is described in Figure 5, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-19 Section 17.5.3. The strength reduction factor applies when the load combinations from the IBC or ACI 318-19 are used and the requirements of ACI 318-19 Section 17.5.3 are met.
[3] d_0 = hole diameter.

TABLE 6—BOND STRENGTH DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION		Symbol	Units	Nominal Rod Diameter (inch)						
				$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
Minimum embedment		$h_{ef,min}$	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 embedment		$h_{ef,max}$	in. (mm)	$7^1/_2$ (191)	10 (254)	$12^1/_2$ (318)	15 (381)	$17^1/_2$ (445)	20 (508)	25 (635)
Temperature range A[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	2601 (17.9)	2415 (16.6)	2262 (15.6)	2142 (14.8)	2054 (14.2)	2000 (13.8)	1990 (13.7)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	1041 (7.2)	1041 (7.2)	1111 (7.7)	1219 (8.4)	1212 (8.4)	1206 (8.3)	1146 (7.9)
Temperature range B[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	2263 (15.6)	2101 (14.5)	1968 (13.6)	1863 (12.8)	1787 (12.3)	1740 (12.0)	1732 (11.9)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	905 (6.2)	906 (6.2)	966 (6.7)	1060 (7.3)	1054 (7.3)	1049 (7.2)	997 (6.9)
Temperature range C[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	1631 (11.2)	1514 (10.4)	1418 (9.8)	1343 (9.3)	1288 (8.9)	1254 (8.6)	1248 (8.6)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	652 (4.5)	653 (4.5)	696 (4.8)	764 (5.3)	760 (5.2)	756 (5.2)	719 (5.0)
Dry concrete	Anchor category	–	-	1						
	Strength reduction factor	ϕ_d	-	0.65						
Water-saturated concrete	Anchor category	–	-	2						
	Strength reduction factor	ϕ_{ws}	-	0.55						
Water-filled holes	Anchor category	–		3						
	Strength reduction factor	ϕ_{wf}		0.45						
Reduction factor for seismic tension		$\alpha_{N,seis}$	-	0.95						

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. For concrete compressive strength, f'_c between 2,500 psi and 8,000 psi, the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2500)^{0.10}$. See Section 4.1.4 of this report.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C); Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C); Temperature range C: Maximum short term temperature = 320°F (160°C), maximum long term temperature = 212°F (100°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[3]Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short-term loads only such as wind and seismic, bond strengths may be increased by 23 percent for temperature range C.

Most Widely Accepted and Trusted

TABLE 7—STEEL DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING BARS[1]

DESIGN INFORMATION		Symbol	Units	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
				Nominal Bar Size							
Reinforcing bar O.D.		d	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.125 (28.6)	1.250 (31.8)
Reinforcing bar effective cross-sectional area		A_{se}	in.² (mm²)	0.110 (71)	0.200 (129)	0.310 (200)	0.440 (284)	0.600 (387)	0.790 (510)	1.000 (645)	1.270 (819)
ASTM A615, A767 Grade 80	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	11,000 (48.9)	20,000 (89.0)	31,000 (137.9)	44,000 (195.7)	60,000 (266.9)	79,000 (351.4)	100,000 (444.8)	127,000 (564.9)
		V_{sa}	lb (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	36,000 (160.1)	47,400 (210.8)	60,000 (266.9)	76,200 (338.9)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.65							
	Strength reduction factor for tension[2]	ϕ	-	0.65							
	Strength reduction factor for shear[2]	ϕ	-	0.60							
ASTM A615, A767 Grade 75	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	11,000 (48.9)	20,000 (89.0)	31,000 (137.9)	44,000 (195.7)	60,000 (266.9)	79,000 (351.4)	100,000 (444.8)	127,000 (564.9)
		V_{sa}	lb (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	36,000 (160.1)	47,400 (210.8)	60,000 (266.9)	76,200 (338.9)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.65							
	Strength reduction factor for tension[2]	ϕ	-	0.65							
	Strength reduction factor for shear[2]	ϕ	-	0.60							
ASTM A615, A767, A996 Grade 60	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	8,800 (39.1)	16,000 (71.2)	24,800 (110.3)	35,200 (156.6)	48,000 (213.5)	63,200 (281.1)	80,000 (355.9)	101,600 (452.0)
		V_{sa}	lb (kN)	5,280 (23.5)	9,600 (42.7)	14,880 (66.2)	21,120 (93.9)	28,800 (128.1)	37,920 (168.7)	48,000 (213.5)	60,960 (271.2)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.65							
	Strength reduction factor for tension[2]	ϕ	-	0.65							
	Strength reduction factor for shear[2]	ϕ	-	0.60							
ASTM A706 Grade 60	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	8,800 (39.1)	16,000 (71.2)	24,800 (110.3)	35,200 (156.6)	48,000 (213.5)	63,200 (281.1)	80,000 (355.9)	101,600 (452.0)
		V_{sa}	lb (kN)	5,280 (23.5)	9,600 (42.7)	14,880 (66.2)	21,120 (93.9)	28,800 (128.1)	37,920 (168.7)	48,000 (213.5)	60,960 (271.2)
	Reduction for seismic shear	$\alpha_{V,seis}$	-	0.65							
	Strength reduction factor ϕ for tension[2]	ϕ	-	0.75							
	Strength reduction factor ϕ for shear[2]	ϕ	-	0.65							
ASTM A615 Grade 40	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	In accordance with ASTM A615, Grade 40 bars are furnished only in sizes No. 3 through No. 6			
		V_{sa}	lb (kN)	3,960 (17.6)	7,200 (32.0)	11,160 (49.6)	15,840 (70.5)				
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.65							
	Strength reduction factor for tension[2]	ϕ	-	0.65							
	Strength reduction factor for shear[2]	ϕ	-	0.60							

[1]Values provided for common bar material types based on specified strengths and calculated in accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2(b).
[2]The strength reduction factor applies when the load combinations from the IBC or ACI 318-19 are used and the requirements of ACI 318-19 Section 17.5.3 are met.

FIGURE 1—INSTALLATION PARAMETERS FOR THREADED RODS AND REINFORCING BARS

TABLE 8—CONCRETE BREAKOUT DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION	Symbol	Units	Nominal Bar Size							
			No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No.10
Effectiveness factor for cracked concrete	$k_{c,cr}$	in-lb (SI)	17 (7)							
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	in.-lb. (SI)	24 (10)							
Min. anchor spacing	s_{min}	in. (mm)	1 7/8 (48)	2 1/2 (64)	3 (76)	3 3/4 (95)	4 1/4 (108)	4 3/4 (121)	5 1/4 (133)	5 7/8 (149)
Min. edge spacing	c_{min}	in. (mm)	1 5/8 (41)	1 3/4 (45)	2 (51)	2 3/8 (60)	2 1/2 (64)	2 3/4 (70)	3 (76)	3 1/4 (82)
					For edge distances to 1 3/4-inch (45 mm) See Section 4.1.9 of this report.					For edge distances to 2 3/4-inch (70 mm) see Section 4.1.9.
Min. member thickness	h_{min}	in. (mm)	h_{ef} + 1 1/4 (h_{ef} + 30)		$h_{ef} + 2d_0$[3]					
Critical edge spacing – splitting (for uncracked concrete only)	c_{ac}	-	See Section 4.1.10 of this report.							
Strength reduction factor for tension, concrete failure modes, Condition B (supplemental reinforcement not present)[2]	ϕ	-	0.65							
Strength reduction factor for shear, concrete failure modes, Condition B (supplemental reinforcement not present)[2]	ϕ	-	0.70							

[1]Additional setting information is described in Figure 5, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-19 Section 17.5.3. The strength reduction factor applies when the load combinations from the IBC or ACI 318-19 are used and the requirements of ACI 318-19 Section 17.5.3 are met.
[3]d_0 = hole diameter.

TABLE 9—BOND STRENGTH DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION		Symbol	Units	Nominal Bar Size							
				No.3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No.10
Minimum embedment		$h_{ef,min}$	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 embedment		$h_{ef,max}$	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)
Temperature range A[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	2,200 (15.2)	2,100 (14.5)	2,030 (14.0)	1,970 (13.6)	1,920 (13.2)	1,880 (13.0)	1,845 (12.7)	1,815 (12.5)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	1,090 (7.5)	1,055 (7.3)	1,130 (7.8)	1,170 (8.1)	1,175 (8.1)	1,155 (8.0)	1,140 (7.9)	1,165 (8.0)
Temperature range B[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	1,915 (13.2)	1,830 (12.6)	1,765 (12.2)	1,715 (11.8)	1,670 (11.5)	1,635 (11.3)	1,615 (11.1)	1,580 (10.9)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	945 (6.5)	915 (6.3)	980 (6.8)	1,015 (7.0)	1,020 (7.0)	1,005 (6.9)	995 (6.8)	1,010 (7.0)
Temperature range C[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	1,380 (9.5)	1,315 (9.1)	1,270 (8.8)	1,235 (8.5)	1,205 (8.3)	1,180 (8.1)	1,155 (8.0)	1,140 (7.8)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	680 (4.7)	660 (4.6)	705 (4.9)	735 (5.1)	735 (5.1)	725 (5.0)	715 (4.9)	730 (5.0)
Dry concrete	Anchor category	–	-	1							
	Strength reduction factor	ϕ_d	-	0.65							
Water-saturated concrete	Anchor category	–	-	2							
	Strength reduction factor	ϕ_{ws}	-	0.55							
Water-filled holes	Anchor Category	–		3							
	Strength reduction factor	ϕ_{wf}		0.45							
Reduction factor for seismic tension		$\alpha_{N,seis}$	-	0.95		1.00					

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. For concrete compressive strength f'_c between 2,500 psi and 8,000 psi, tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.10}$. See Section 4.1.4 of this report.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C); Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C); Temperature range C: Maximum short term temperature = 320°F (160°C), maximum long term temperature = 212°F (100°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[3]Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short term loads only, such as wind and seismic, bond strengths may be increased by 23 percent for temperature range C.

TABLE 10—STEEL DESIGN INFORMATION FOR METRIC THREADED ROD[1]

DESIGN INFORMATION		Symbol	Units	Nominal Rod Diameter (mm) M10	M12	M16	M20	M24	M27	M30
Threaded rod O.D.		d	mm (in.)	10 (0.39)	12 (0.47)	16 (0.63)	20 (0.79)	24 (0.94)	27 (1.06)	30 (1.18)
Threaded rod effective cross-sectional area		A_{se}	mm² (in.²)	58.0 (0.090)	84.3 (0.131)	157 (0.243)	245 (0.380)	353 (0.547)	459 (0.711)	561 (0.870)
ISO 898-1 Class 5.8	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	kN (lb)	29.0 (6,518)	42.2 (9,473)	78.5 (17,643)	122.5 (27,532)	176.5 (39,668)	229.5 (51,580)	280.5 (63,043)
		V_{sa}	kN (lb)	17.4 (3,911)	25.3 (5,684)	47.1 (10,586)	73.5 (16,519)	105.9 (23,801)	137.7 (30,948)	168.3 (37,826)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.60						
	Strength reduction factor for tension[2]	ϕ	-	0.65						
	Strength reduction factor for shear[2]	ϕ	-	0.60						
ISO 898-1 Class 8.8	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	kN (lb)	46.4 (10,428)	67.4 (15,157)	125.6 (28,229)	196 (44,051)	282.4 (63,470)	367.2 (82,528)	448.8 (100,868)
		V_{sa}	kN (lb)	27.8 (6,257)	40.5 (9,094)	75.4 (16,937)	117.6 (26,431)	169.4 (38,082)	220.3 (49,517)	269.3 (60,521)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.60						
	Strength reduction factor for tension[2]	ϕ	-	0.65						
	Strength reduction factor for shear[2]	ϕ	-	0.60						
ISO 3506-1, A4 stainless steel[3]	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	kN (lb)	40.6 (9,125)	59 (13,263)	109.9 (24,700)	171.5 (38,545)	247.1 (55,536)	229.5 (51,580)	280.5 (63,043)
		V_{sa}	kN (lb)	24.4 (5,475)	35.4 (7,958)	65.9 (14,820)	102.9 (23,127)	148.3 (33,322)	137.7 (30,948)	168.3 (37,826)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.60						
	Strength reduction factor for tension[2]	ϕ	-	0.65						
	Strength reduction factor for shear[2]	ϕ	-	0.60						

[1]Values provided for common rod material types based on specified strengths and calculated in accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2(b). Nuts and washers must comply with requirements for the rod.
[2]The strength reduction factor applies when the load combinations from the IBC or ACI 318-19 are used and the requirements of ACI 318-19 Section 17.5.3 are met.
[3]A4-70 Stainless steel (M8-M24); A4-50 Stainless steel (M27-M30).

TABLE 11—CONCRETE BREAKOUT DESIGN INFORMATION FOR METRIC THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION	Symbol	Units	Nominal Rod Diameter (mm) M10	M12	M16	M20	M24	M27	M30
Effectiveness factor for cracked concrete	$k_{c,cr}$	SI (in-lb)	7 (17)						
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	SI (in-lb)	10 (24)						
Min. anchor spacing	s_{min}	mm (in.)	50 (2)	60 ($2^{3}/_{8}$)	75 (3)	95 ($3^{3}/_{4}$)	115 ($4^{1}/_{2}$)	125 (5)	140 ($5^{1}/_{2}$)
Min. edge distance	c_{min}	mm (in.)	40 ($1^{5}/_{8}$)	45 ($1^{3}/_{4}$)	50 (2)	60 ($2^{3}/_{8}$)	65 ($2^{1}/_{2}$)	75 (3)	80 ($3^{1}/_{8}$)
					For edge distances to 45 mm ($1^{3}/_{4}$-inch) see Section 4.1.9 of this report.				For edge distances to 70 mm ($2^{3}/_{4}$-inch) see Section 4.1.9.
Min. member thickness	h_{min}	mm (in.)	h_{ef} + 30 (h_{ef} + $1^{1}/_{4}$)		$h_{ef} + 2d_0$ [3]				
Critical edge distance - splitting (for uncracked concrete only)	c_{ac}	-	See Section 4.1.10 of this report.						
Strength reduction factor for tension, concrete failure modes, Condition B (supplemental reinforcement not present)[2]	ϕ	-	0.65						
Strength reduction factor for shear, concrete failure modes, Condition B (supplemental reinforcement not present)[2]	ϕ	-	0.70						

[1]Additional setting information is described in Figure 5, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-19 Section 17.5.3. The strength reduction factor applies when the load combinations from the IBC or ACI 318-19 are used and the requirements of ACI 318-19 Section 17.5.3 are met.
[3] d_0 = hole diameter.

TABLE 12—BOND STRENGTH DESIGN INFORMATION FOR METRIC THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION		Symbol	Units	Nominal Rod Diameter (inch)						
				M10	M12	M16	M20	M24	M27	M30
Minimum embedment		$h_{ef,min}$	mm (in.)	60 (2.4)	70 (2.8)	80 (3.1)	90 (3.5)	96 (3.8)	108 (4.3)	120 (4.7)
Maximum embedment		$h_{ef,max}$	mm (in.)	200 (7.9)	240 (9.4)	320 (12.6)	400 (15.7)	480 (18.9)	540 (21.3)	600 (23.6)
Temperature range A[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	N/mm² (psi)	17.7 (2,571)	16.9 (2,453)	15.6 (2,256)	14.6 (2,112)	13.9 (2,020)	13.7 (1,985)	13.7 (1,980)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	N/mm² (psi)	7.2 (1,039)	7.2 (1,043)	7.7 (1,110)	8.4 (1,217)	8.3 (1,209)	8.3 (1,204)	7.9 (1,149)
Temperature range B[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	N/mm² (psi)	15.4 (2,237)	14.7 (2,134)	13.5 (1,963)	12.7 (1,837)	12.1 (1,757)	11.9 (1,727)	11.9 (1,723)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	N/mm² (psi)	6.2 (904)	6.3 (908)	6.7 (966)	7.3 (1,058)	7.2 (1,052)	7.2 (1,047)	6.9 (999)
Temperature range C[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	N/mm² (psi)	11.1 (1,612)	10.6 (1,538)	9.8 (1,415)	9.1 (1,324)	8.7 (1,266)	8.6 (1,245)	8.6 (1,241)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	N/mm² (psi)	4.5 (651)	4.5 (654)	4.8 (696)	5.3 (763)	5.2 (758)	5.2 (755)	5.0 (720)
Dry concrete	Anchor category	–	-	1						
	Strength reduction factor	ϕ_d	-	0.65						
Water-saturated concrete	Anchor category	–	-	2						
	Strength reduction factor	ϕ_{ws}	-	0.55						
Water-filled holes	Anchor category	–		3						
	Strength reduction factor	ϕ_{wf}		0.45						
Reduction factor for seismic tension		$\alpha_{N,seis}$	-	0.95						

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. For concrete compressive strength, f'_c between 2,500 psi and 8,000 psi, the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2500)^{0.10}$. See Section 4.1.4 of this report.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C); Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C); Temperature range C: Maximum short term temperature = 320°F (160°C), maximum long term temperature = 212°F (100°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[3]Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short-term loads only such as wind and seismic, bond strengths may be increased by 23 percent for temperature range C.

TABLE 13—STEEL DESIGN INFORMATION FOR COMMON METRIC EU AND METRIC CANADIAN REINFORCING BARS [1]

DESIGN INFORMATION		Symbol	Units	Nominal Bar Size (EU)							
				Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Reinforcing bar O.D.		d	mm (in.)	10 (0.315)	12 (0.394)	14 (0.472)	16 (0.551)	20 (0.630)	25 (0.787)	28 (1.102)	32 (1.260)
Reinforcing bar effective cross-sectional area		A_{se}	mm² (in.²)	78.5 (0.112)	113.1 (0.175)	153.9 (0.239)	201.1 (0.312)	314.2 (0.487)	490.9 (0.761)	615.8 (0.954)	804.2 (1.247)
DIN 488 BSt 500	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	kN (lb)	43.2 (9,739)	62.2 (14,024)	84.7 (19,088)	110.6 (24,932)	172.8 (38,956)	270.0 (60,868)	338.7 (76,353)	442.3 (99,727)
		V_{sa}	kN (lb)	25.9 (5,843)	37.3 (8,414)	50.8 (11,453)	66.4 (14,959)	103.7 (23,373)	162.0 (36,521)	203.2 (45,812)	265.4 (59,836)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.65							
	Strength reduction factor for tension[2]	ϕ	-	0.65							
	Strength reduction factor for shear[2]	ϕ	-	0.60							

DESIGN INFORMATION		Symbol	Units	Nominal Bar Size (CA)				
				10 M	15 M	20 M	25 M	30 M
Reinforcing bar O.D.		d	mm (in.)	11.3 (0.445)	16.0 (0.630)	19.5 (0.768)	25.2 (0.992)	29.9 (1.177)
Reinforcing bar effective cross-sectional area		A_{se}	mm² (in.²)	100.3 (0.155)	201.1 (0.312)	298.6 (0.463)	498.8 (0.773)	702.2 (1.088)
CAN/CSA-G30.18 Grade 400	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	kN (lb)	54.0 (12,175)	108.5 (24.410)	161.5 (36,255)	270.0 (60,550)	380.0 (85,240)
		V_{sa}	kN (lb)	32.5 (7,305)	65.0 (14,645)	97.0 (21,755)	161.5 (36,330)	227.5 (51,145)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.65				
	Strength reduction factor for tension[2]	ϕ	-	0.65				
	Strength reduction factor for shear[2]	ϕ	-	0.60				

[1]Values provided for common bar material types based on specified strengths and calculated in accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2(b).
[2]The strength reduction factor applies when the load combinations from the IBC or ACI 318-19 are used and the requirements of ACI 318-19 Section 17.5.3 are met.

TABLE 14—CONCRETE BREAKOUT DESIGN INFORMATION COMMON EU METRIC AND CANADIAN METRIC REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION	Symbol	Units	Nominal Bar Size (EU and CA)												
			ø 10	10 M	ø 12	ø 14	15 M	ø 16	ø 20	20 M	ø 25	25 M	ø 28	30 M	ø 32
Effectiveness factor for cracked concrete	$k_{c,cr}$	SI (in-lb)	7 (17)												
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	SI (in-lb)	10 (24)												
Min. anchor spacing	s_{min}	mm (in.)	50 (2)	55 $(2^{1}/_{8})$	60 $(2^{3}/_{8})$	70 $(2^{3}/_{4})$	80 $(3^{1}/_{8})$	75 (3)	95 $(3^{3}/_{4})$	100 $(3^{7}/_{8})$	120 $(4^{5}/_{8})$	125 (5.0)	130 $(5^{1}/_{4})$	150 $(5^{7}/_{8})$	
Min. edge spacing	c_{min}	mm (in.)	40 $(1^{5}/_{8})$	40 $(1^{3}/_{4})$	45 $(1^{3}/_{4})$	50 (2)	50 (2)		60 $(2^{3}/_{8})$	60 $(2^{3}/_{8})$	70 $(2^{3}/_{4})$	75 (3)		85 $(3^{1}/_{8})$	
						For edge distances to 45 mm $(1^{3}/_{4}$-inch) see Section 4.1.9 of this report.							For edge distances to 70 mm $(2^{3}/_{4}$-inch) see Section 4.1.9.		
Min. member thickness	h_{min}	in. (mm)	$h_{ef} + 1^{1}/_{4}$ $(h_{ef} + 30)$			$h_{ef} + 2d_0$ [3]									
Critical edge spacing – splitting (for uncracked concrete only)	c_{ac}	-	See Section 4.1.10 of this report.												
Strength reduction factor for tension, concrete failure modes, Condition B (supplemental reinforcement not present)[2]	ϕ	-	0.65												
Strength reduction factor for shear, concrete failure modes, Condition B (supplemental reinforcement not present)[2]	ϕ	-	0.70												

[1]Additional setting information is described in Figure 5, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-19 Section 17.5.3. The strength reduction factor applies when the load combinations from the IBC or ACI 318-19 are used and the requirements of ACI 318-19 Section 17.5.3 are met.
[3]d_0 = hole diameter.

TABLE 15—BOND STRENGTH DESIGN INFORMATION COMMON EU METRIC REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION		Symbol	Units	Nominal Bar Size (EU)							
				ø 10	ø 12	ø 14	ø 16	ø 20	ø 25	ø 28	ø 32
Minimum embedment		$h_{ef,min}$	mm (in.)	60 (2.4)	70 (2.8)	75 (3.0)	80 (3.1)	90 (3.5)	100 (3.9)	112 (4.4)	128 (5.0)
Maximum embedment		$h_{ef,max}$	mm (in.)	200 (7.9)	240 (9.4)	280 (11.0)	320 (12.6)	400 (15.7)	500 (19.7)	560 (22.0)	640 (25.2)
Temperature range A[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	N/mm² (psi)	15.1 (2,183)	14.6 (2,121)	14.0 (2,025)	14.0 (2,025)	13.5 (1,954)	13.0 (1,886)	12.8 (1,852)	12.5 (1,813)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	N/mm² (psi)	7.5 (1,082)	7.3 (1,060)	7.9 (1,144)	8.2 (1,193)	8.2 (1,188)	8.0 (1,158)	7.9 (1,144)	8.0 (1,163)
Temperature range B[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	N/mm² (psi)	13.1 (1,899)	12.7 (1,845)	12.1 (1,762)	12.1 (1,762)	11.7 (1,700)	11.3 (1,640)	11.1 (1,611)	10.9 (1,577)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	N/mm² (psi)	6.5 (942)	6.4 (922)	6.9 (996)	7.2 (1,038)	7.1 (1,034)	6.9 (1,008)	6.9 (995)	7.0 (1,012)
Temperature range C[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	N/mm² (psi)	9.4 (1,369)	9.2 (1,329)	8.8 (1,270)	8.8 (1,270)	8.4 (1,225)	8.2 (1,182)	8.0 (1,161)	7.8 (1,136)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	N/mm² (psi)	4.7 (678)	4.6 (665)	4.9 (718)	5.2 (748)	5.1 (745)	5.0 (726)	4.9 (717)	5.0 (729)
Dry concrete	Anchor category	–	-	1							
	Strength reduction factor	ϕ_d	-	0.65							
Water-saturated concrete	Anchor category	–	-	2							
	Strength reduction factor	ϕ_{ws}	-	0.55							
Water-filled holes	Anchor category	–	-	3							
	Strength reduction factor	ϕ_{wf}	-	0.45							
Reduction factor for seismic tension		$\alpha_{N,seis}$	-	0.95		1.00					

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. For concrete compressive strength f'_c between 2,500 psi and 8,000 psi, tabulated characteristic bond strength may not be increased. See Section 4.1.4 of this report.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C); Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C); Temperature range C: Maximum short term temperature = 320°F (160°C), maximum long term temperature = 212°F (100°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[3]Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short term loads only, such as wind and seismic, bond strengths may be increased by 23 percent for temperature range C.

TABLE 16—BOND STRENGTH DESIGN INFORMATION COMMON CANADIAN METRIC REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION		Symbol	Units	Nominal Bar Size (CA)				
				10 M	15 M	20 M	25 M	30 M
Minimum embedment		$h_{ef,min}$	mm (in.)	70 (2.8)	80 (3.1)	90 (3.5)	100 (3.9)	120 (4.7)
Maximum embedment		$h_{ef,max}$	mm (in.)	225 (8.9)	320 (12.6)	390 (15.4)	505 (19.8)	600 (23.5)
Temperature range A[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	N/mm² (psi)	14.5 (2,110)	13.2 (1,916)	12.5 (1,814)	11.7 (1,690)	11.1 (1,612)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	N/mm² (psi)	7.2 (1,041)	7.5 (1,087)	7.2 (1,045)	6.7 (965)	6.3 (915)
Temperature range B[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	N/mm² (psi)	12.7 (1,836)	11.5 (1,667)	10.9 (1,578)	10.1 (1,470)	9.7 (1,402)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	N/mm² (psi)	6.2 (906)	6.5 (946)	6.3 (909)	5.8 (840)	5.5 (796)
Temperature range C[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	N/mm² (psi)	9.1 (1,323)	8.3 (1,201)	7.8 (1,137)	7.3 (1,059)	7.0 (1,010)
	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	N/mm² (psi)	4.5 (653)	4.7 (682)	4.5 (655)	4.2 (605)	4.0 (574)
Dry concrete	Anchor category	–	-	1				
	Strength reduction factor	ϕ_d	-	0.65				
Water-saturated concrete	Anchor category	–	-	2				
	Strength reduction factor	ϕ_{ws}	-	0.55				
Water-filled holes	Anchor category	–	-	3				
	Strength reduction factor	ϕ_{wf}	-	0.45				
Reduction factor for seismic tension		$\alpha_{N,seis}$	-	0.95		1.00		

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. For concrete compressive strength f'_c between 2,500 psi and 8,000 psi, tabulated characteristic bond strength may not be increased. See Section 4.1.4 of this report.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C); Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C); Temperature range C: Maximum short term temperature = 320°F (160°C), maximum long term temperature = 212°F (100°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[3]Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short term loads only, such as wind and seismic, bond strengths may be increased by 23 percent for temperature range C.

The DEWALT drilling systems shown below collect and remove dust with a HEPA dust extractor during the hole drilling operation in dry base materials using hammer-drills (see step 1 of the manufacturer's published installation instructions).

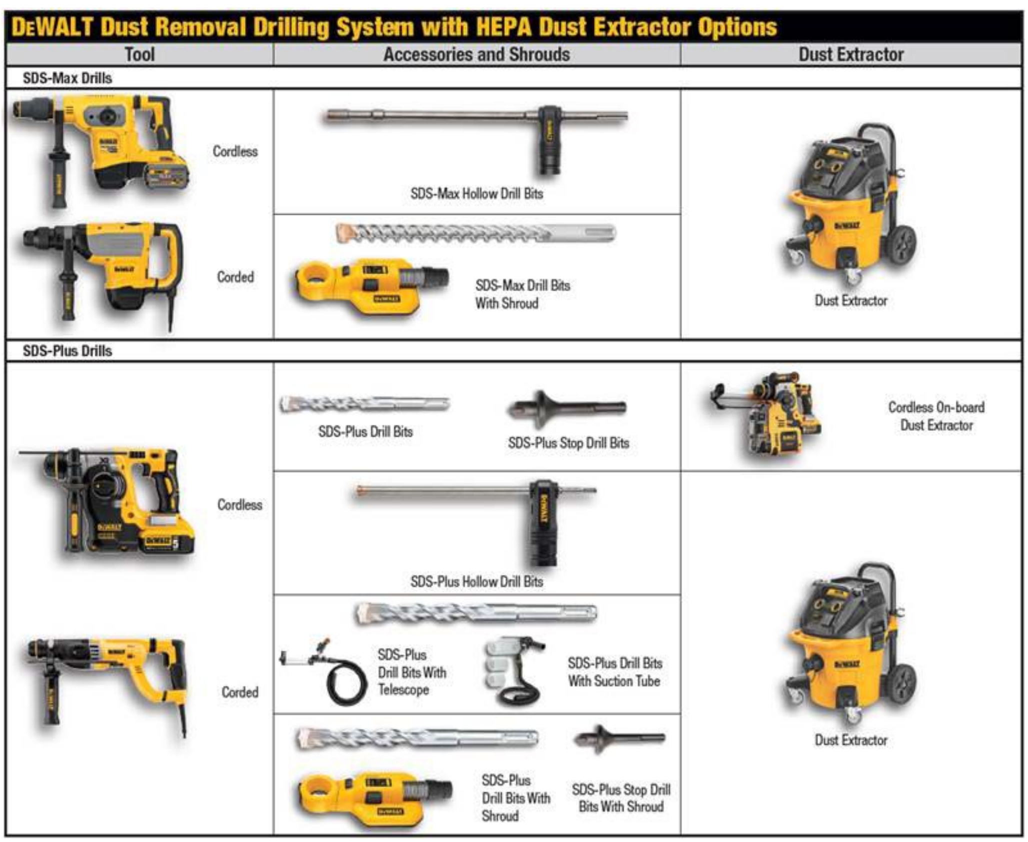

FIGURE 2—EXAMPLES DEWALT DUST REMOVAL DRILLING SYSTEMS WITH HEPA DUST EXTRACTORS FOR ILLUSTRATION

TABLE 17—DEVELOPMENT LENGTHS FOR COMMON REINFORCING BAR CONNECTIONS PROVIDED FOR ILLUSTRATION[1,2,3,7]

FRACTIONAL REINFORCING BARS

DESIGN INFORMATION	SYMBOL	REFERENCE STANDARD	UNITS	NOMINAL REBAR SIZE (US)							
				#3	#4	#5	#6	#7	#8	#9	#10
Nominal rebar diameter	d_b	ASTM A615/A706, Grade 60 (f_y = **60 ksi**)	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.128 (28.6)	1.270 (32.3)
Nominal rebar area	A_b		in^2 (mm^2)	0.11 (71)	0.20 (127)	0.31 (198)	0.44 (285)	0.60 (388)	0.79 (507)	1.00 (645)	1.27 (817)
Development length in f'_c = **2,500 psi** concrete[4,5]	l_d	ACI 318-19 25.4.2.4	in. (mm)	12.0 (305)	14.4 (366)	18.0 (457)	21.6 (549)	31.5 (800)	36.0 (914)	40.6 (1031)	45.7 (1161)
Development length in f'_c = **3,000 psi** concrete[4,5]			in. (mm)	12.0 (305)	13.1 (334)	16.4 (417)	19.7 (501)	28.8 (730)	32.9 (835)	37.1 (942)	41.7 (1060)
Development length in f'_c = **4,000 psi** concrete[4,5]			in. (mm)	12.0 (305)	12.0 (305)	14.2 (361)	17.1 (434)	24.9 (633)	28.5 (723)	32.1 (815)	36.2 (920)
Development length in f'_c = **6,000 psi** concrete[4,5]			in. (mm)	12.0 (305)	12.0 (305)	12.0 (305)	13.9 (354)	20.3 (516)	23.2 (590)	26.2 (666)	29.5 (750)
Development length in f'_c = **8,000 psi** concrete[4,5]			in. (mm)	12.0 (305)	12.0 (305)	12.0 (305)	12.1 (307)	17.6 (443)	20.1 (511)	22.7 (577)	25.6 (649)

METRIC REINFORCING BARS

DESIGN INFORMATION	SYMBOL	REFERENCE STANDARD	UNITS	NOMINAL REBAR SIZE (EU)							
				Ø10	Ø12	Ø14	Ø16	Ø20	Ø25	Ø28	Ø32
Nominal rebar diameter	d_b	DIN 488, BSt 500 (BS 4449: 2005) (f_y = **72.5 ksi**)	mm (in)	10 (0.394)	12 (0.472)	14.0 (0.551)	16 (0.630)	20 (0.787)	25 (0.984)	28 (1.102)	32 (1.260)
Nominal rebar area	A_b		mm^2 (in^2)	78.5 (0.12)	113 (0.18)	154 (0.23)	201 (0.31)	314 (0.49)	491 (0.76)	616 (0.96)	804 (1.25)
Development length in f'_c = **2,500 psi** concrete[4,6]	l_d	ACI 318-19 25.4.2.4	mm (in)	348 (13.7)	417 (16.4)	487 (19.2)	556 (21.9)	870 (34.2)	1087 (42.8)	1217 (47.9)	1392 (54.8)
Development length in f'_c = **3,000 psi** concrete[4,6]			mm (in)	318 (12.5)	381 (15.0)	445 (17.5)	508 (20.0)	794 (31.3)	992 (39.1)	1112 (43.8)	1271 (50.0)
Development length in f'_c = **4,000 psi** concrete[4,6]			mm (in)	305 (12.0)	330 (13.0)	385 (15.2)	439 (17.3)	688 (27.1)	859 (33.8)	963 (37.9)	1100 (43.3)
Development length in f'_c = **6,000 psi** concrete[4,6]			mm (in)	305 (12.0)	305 (12.0)	314 (12.4)	359 (14.2)	562 (22.1)	702 (27.6)	786 (30.9)	899 (35.4)
Development length in f'_c = **8,000 psi** concrete[4,6]			mm (in)	305 (12.0)	305 (12.0)	305 (12.0)	311 (12.3)	486 (29.1)	608 (23.9)	681 (26.8)	778 (30.6)

DESIGN INFORMATION	SYMBOL	REFERENCE STANDARD	UNITS	NOMINAL REBAR SIZE (CA)				
				10M	15M	20M	25M	30M
Nominal rebar diameter	d_b	CAN/CSA G30.18, Grade 400 (f_y = **58 ksi**)	mm (in)	11.3 (0.445)	16.0 (0.630)	19.5 (0.768)	25.2 (0.992)	29.9 (1.177)
Nominal rebar area	A_b		mm^2 (in^2)	100 (0.16)	200 (0.31)	300 (0.46)	500 (0.77)	700 (1.09)
Development length in f'_c = **2,500 psi** concrete[4,6]	l_d	ACI 318-19 25.4.2.4	mm (in)	315 (12.4)	445 (17.5)	678 (26.7)	876 (34.5)	1041 (41.0)
Development length in f'_c = **3,000 psi** concrete[4,6]			mm (in)	305 (12.0)	407 (16.0)	620 (24.4)	800 (31.5)	950 (37.4)
Development length in f'_c = **4,000** psi concrete[4,6]			mm (in)	305 (12.0)	353 (13.9)	536 (21.1)	693 (27.3)	823 (32.4)
Development length in f'_c = **6,000 psi** concrete[4,6]			mm (in)	305 (12.0)	305 (12.0)	438 (17.3)	566 (22.3)	672 (26.4)
Development length in f'_c = **8,000 psi** concrete[4,6]			mm (in)	305 (12.0)	305 (12.0)	379 (14.9)	490 (19.3)	582 (22.9)

For **SI**: 1 inch ≡ 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa; for **pound-inch** units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

[1]Calculated development lengths in accordance with Section 4.2.2 of this report and ACI 318-19 Section 25.4.2.4 for reinforcing bars are valid for static, wind, and earthquake loads.

[2]Calculated development lengths in SDC C through F must comply with ACI 318-19 Chapter 18 and Section 4.2.4 of this report.

[3]For Class B splices, minimum length of lap for tension lap splices is $1.3 l_d$ in accordance with ACI 318-19 Section 25.5.2.

[4]For lightweight concrete, λ = 0.75; therefore multiply development lengths by 1.33 (increase development length by 33 percent), unless the provisions of ACI 318-19 Section 25.4.2.5 are met to permit alternate values of λ (e.g for sand-lightweight concrete, λ = 0.85; therefore multiply development lengths by 1.18). Refer to ACI 318-19 Section 19.2.4.

[5] $\left(\frac{c_b+K_{tr}}{d_b}\right) = 2.5$, ψ_t=1.0, ψ_e=1.0, ψ_s=0.8 for $d_b \le$ #6,1.0 for $d_b >$ #6. Refer to ACI 318-19 Section 25.4.2.5.

[6] $\left(\frac{c_b+K_{tr}}{d_b}\right) = 2.5$, ψ_t=1.0, ψ_e=1.0, ψ_s=0.8 for $d_b \le$ 19 mm, 1.0 for $d_b >$ 19 mm. Refer to ACI 318-19 Section 25.4.2.5.

[7]Calculations may be performed for other steel grades and concrete compressive strengths per ACI 318-19 Chapter 25.

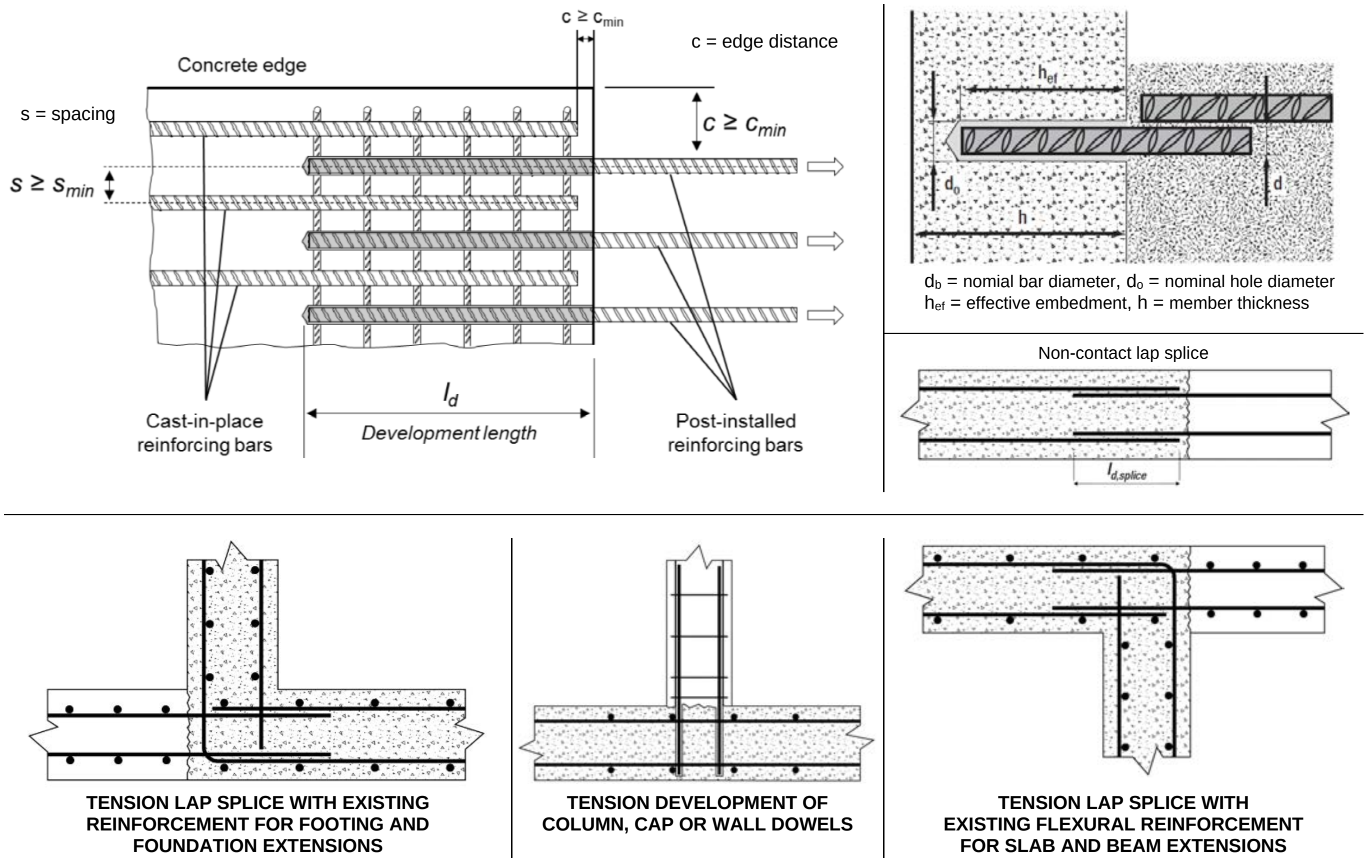

FIGURE 3—INSTALLATION DETAIL FOR POST-INSTALLED REINFORCING BAR CONNECTIONS (Top Pictures), EXAMPLES OF DEVELOPMENT LENGTH APPLICATION DETAILS FOR POST-INSTALLED REINFORCING BAR CONNECTIONS PROVIDED FOR ILLUSTRATION (Bottom Pictures)

TABLE 18—INSTALLATION PARAMETERS FOR COMMON POST-INSTALLED REINFORCING BAR CONNECTIONS[3]

FRACTIONAL REINFORCING BARS										
PARAMETER	SYMBOL	UNITS	NOMINAL REBAR SIZE (US)							
			#3	#4	#5	#6	#7	#8	#9	#10
Nominal hole diameter[1]	d_o	in.	1/2	5/8	3/4	7/8	1	1 1/8	1 3/8	1 1/2
Effective embedment[2]	h_{ef}	in.	Up to 22 1/2	Up to 30	Up to 37 1/2	Up to 45	Up to 52 1/2	Up to 60	Up to 67 1/2	Up to 75

METRIC REINFORCING BARS										
PARAMETER	SYMBOL	UNITS	NOMINAL REBAR SIZE (EU)							
			Ø10	Ø12	Ø14	Ø16	Ø20	Ø25	Ø28	Ø32
Nominal hole diameter[1]	d_o	mm	14	16	18	20	25	32	35	40
Effective embedment[2]	h_{ef}	mm	Up to 600	Up to 720	Up to 840	Up to 1200	Up to 1440	Up to 1500	Up to 1680	Up to 1920

PARAMETER	SYMBOL	UNITS	NOMINAL REBAR SIZE (CA)				
			10M	15M	20M	25M	30M
Nominal hole diameter[1]	d_o	in.	9/16	3/4	1	1 1/4	1 1/2
Effective embedment[2]	h_{ef}	mm	Up to 680	Up to 960	Up to 1170	Up to 1510	Up to 1795

For **SI**: 1 inch ≡ 25.4 mm,; for **pound-inch** units: 1 mm = 0.03937 inches.

[1]For any case, it must be possible for the reinforcing bar (rebar) to be inserted into the cleaned drill hole without resistance.

[2]Consideration should be given regarding the commercial availability of carbide drill bits (including hollow bits), as applicable, with lengths necessary to achieve the effective embedment or development length determined for post-installed reinforcing bar connections.

[3]The DEWALT DustX+ extraction system can be used to automatically clean holes drilled in concrete with a hammer-drill. See Figure 2 for an illustration of the DustX+ extraction system. The DustX+ extraction system is qualified for use in dry concrete and water saturated concrete, however, drilling in dry concrete is recommended by DEWALT when using hollow drill bits.

FIGURE 4—AC200+ ADHESIVE ANCHOR SYSTEM INCLUDING TYPICAL STEEL ANCHOR ELEMENTS

TABLE 19— APPLICABLE SECTIONS OF THE IBC CODE UNDER EACH EDITION OF THE IBC

2024 IBC	2021 IBC	2018 IBC	2015 IBC
Section 1605.1		Section 1605.2 or 1605.3	
Section 1705.1.1			
Table 1705.3			
Section 1705			
Section 1706			
Section 1707			
Section 1901.3			
Section 1905.7	Section 1905.1.8		

TABLE 20— APPLICABLE SECTIONS OF ACI 318 UNDER EACH EDITION OF THE IBC

2024 IBC	2021 IBC	2018 IBC	2015 IBC
ACI 318-19		ACI 318-14	
2.3		2.3	
5.3		5.3	
Chapter 17		Chapter 17	
17.2.4		17.2.6	
17.3.1		17.2.7	
17.5.1		17.3.1.1	
17.5.1.2		17.3.1	
17.5.3		17.3.3	
17.6.1.2		17.4.1.2	
Eq. 17.6.1.2		17.4.1.2	
17.6.2		17.4.2	
17.6.2.2		17.4.2.2	
17.6.2.5		17.4.2.6	
17.6.5		17.4.5	
Eq 17.6.5.1.2b		Eq 17.4.5.1d	
Eq 17.6.5.2.1		Eq 17.4.5.2	
17.6.5.5		17.4.5.5	
Eq. 17.6.5.5.1b		Eq. 17.4.5.5b	
Eq. 17.6.5.5.1c		Eq. 17.4.5.5c	
17.7.1.2		17.5.1.2	
Eq. 17.7.1.2(b)		Eq. 17.5.1.2b	
17.7.2		17.5.2	
17.7.2.2		17.5.2.2	
17.7.3		17.5.3	
17.8		17.6	
17.9.2		17.7.1 and 17.7.3	
17.9.3		17.7.4	
17.9.5		17.7.6	
17.10		17.2.3	
Chapter 18		Chapter 18	
19.2.4		19.2.4	
Chapter 25		Chapter 25	
25.4.2.4		25.4.2.3	
25.4.2.5		25.4.2.4	
25.5.2		25.5.2	
26.6.3.2 (b)		26.6.3.1 (b)	
26.7.2		17.8.1 and 17.8.2	
26.7.1(l) and 26.7.2(e)		17.8.2.2 or 17.8.2.3	
26.13.3.2(e)		17.8.2.4, 26.7.1(h) and 26.13.3.2(c)	

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DEWALT ANCHORS & FASTENERS

AC200+ Instruction Card

Follow steps #1 through #10 for recommended installation

1. Setting instructions for Adhesive Anchors and Post-installed Rebar Connections in solid base material

Drilling

1. Drill a hole into the base material with rotary hammer drill (i.e. percussion drill) and a carbide drill bit to the size and embedment required by the selected steel hardware element (see Table III). Tolerances of carbide drill bits including hollow drill bits must meet ANSI Standard B212.15

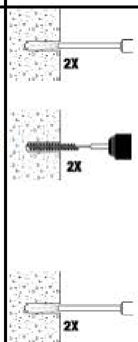
Precaution: Wear suitable eye and skin protection. Avoid inhalation of dusts during drilling and/or removal (*see dust extraction equipment by DEWALT to minimize dust emissions*).

Note: In case of standing water in the drilled hole (flooded hole condition), all the water has to be removed from the hole (e.g. vacuum, compressed air, etc.) prior to cleaning.

Drilling in dry concrete is recommended when using hollow drill bits (vacuum must be on).

→ *Go to Step 3 for holes drilled with DustX+™ extraction system (no further hole cleaning is required). Otherwise go to Step 2a for hole cleaning instructions.*

Hole cleaning

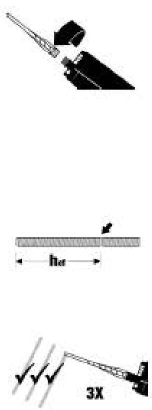


2a. Starting from the bottom or back of the anchor hole, blow the hole clean with compressed air (min. 6 bar / 90 psi) a minimum of two times. If the back of the drilled hole is not reached an extension shall be used with the mixing nozzle.

2b. Determine brush diameter (see Tables 3a and 3b) for the drilled hole. Brush the hole with the selected wire brush a minimum of two times (2x). A brush extension (supplied by DEWALT) must be used for drill hole depth > 6" (150mm). The wire brush diameter must be checked periodically during use (see Table 3a or 3b as applicable). The brush should resist insertion into the drilled hole - if not the brush is too small and must be replaced with the proper brush diameter. If the back of the drilled hole is not reached a brush extension shall be used.

2c. Finally blow the hole clean again with compressed air (min. 6 bar / 90 psi) a minimum of two times, until return air stream is free of noticeable dust. If the back of the drilled hole is not reached an extension shall be used. When finished the hole should be clean and free of dust, debris, ice, grease, oil or other foreign material.

Preparing



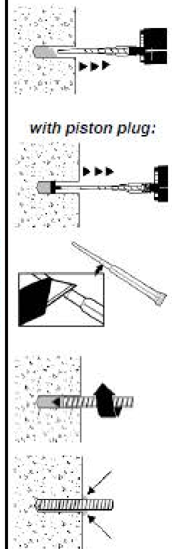
3. Check adhesive expiration date on cartridge label. Do not use expired product. Review Safety Data Sheet (SDS) before use. Cartridge adhesive temperature must be between 41°F - 104°F (5°C - 40°C) when in use; except for installations in base material temperatures between 14ºF and 23ºF (-10ºC and -5ºC) the cartridge adhesive temperature must be conditioned to 50ºF (10ºC) minimum. Review working and cure times. Consideration should be given to the reduced gel (working) time of the adhesive in warm temperatures. For the permitted range of the base material temperature see Table 2; installations installations into concrete with a temperature between 14°F and 22°F (-10°C and -6°C) are for downward installations only. Attach a supplied mixing nozzle to the cartridge. Do not modify the mixer in any way and make sure the mixing element is inside the nozzle. Load the cartridge into the correct dispensing tool.

Note: Always use a new mixing nozzle with new cartridges of adhesive and also for all work interruptions exceeding the published gel (working) time of the adhesive.

4. Prior to inserting the anchor rod or rebar into the filled drilled hole, the position of the embedment depth has to be marked on the anchor. Verify anchor element is straight and free of surface damage.

5. Adhesive must be properly mixed to achieve published properties. Prior to dispensing adhesive into the drilled hole, separately dispense at least three full strokes of adhesive through the mixing nozzle until the adhesive is a consistent gray color. Review and note the published working and cure times (see Table 2) prior to injection of the mixed adhesive into the cleaned anchor hole. Consideration should be given to the reduced gel (working) time of the adhesive in warm temperatures.

Installation



6. Fill the cleaned hole approximately two-thirds full with mixed adhesive starting from the bottom or back of the anchor hole. Slowly withdraw the mixing nozzle as the hole fills to avoid creating air pockets or voids. For embedment depths greater than 7-1/2" an extension tube supplied by DEWALT must be used with the mixing nozzle if the bottom or back of the hole is not reached with the mixing nozzle only.

Piston plugs (see Table 3a or 3b) must be used with and attached to mixing nozzle and extension tube for:
- overhead installations and installations between horizontal and overhead (upwardly inclined)
- all installations with drill hole depth d_0 >10" (250mm) with anchor rod 5/8" to 1-1/4" (M16 to M30) diameter and rebar sizes #5 to #10 (Ø14 to Ø32)

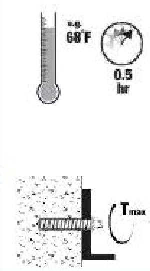
Insert piston plug to the back of the drilled hole and inject as described in the method above. During installation the piston plug will be naturally extruded from the drilled hole by the adhesive pressure.
- In the case that flexible tubing is used (Cat. #PFC1640600), the mixing nozzle may be trimmed at the perforation on the front port before attachment of the tubing.

Attention! Do not install anchors overhead or upwardly inclined without installation hardware supplied by DEWALT and also receiving proper training and/or certification. Contact DEWALT for details prior to use.

7. The anchor should be free of dirt, grease, oil or other foreign material. Push clean threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. Observe the gel (working) time.

8. Be sure that the anchor is fully seated at the bottom of the hole and that some adhesive has flowed from the hole and all around the top of the anchor. Following installation of the anchor, remove excess adhesive. For overhead applications and applications between horizontal and overhead the anchor must be secured from moving/falling during the cure time (e.g. wedges). Minor adjustments to the anchor may be performed during the gel time but the anchor shall not be moved after placement and during cure.

Curing and fixture



9. Allow the adhesive anchor to cure to the specified full curing time prior to applying any load (see Table 2).

Do not disturb, torque or load the anchor until it is fully cured.

10. After full curing of the adhesive anchor, a fixture can be installed to the anchor and tightened up to the maximum torque (shown in Table 4) by using a calibrated torque wrench.

Take care not to exceed the maximum torque for the selected anchor.

2. Gel (working) times and curing times

Temperature of base material					Gel (working) time	Full curing time
14 °F	(-10 °C)	to	22 °F	(-6 °C)	60 mins	24 hrs
23 °F	(-5 °C)	to	31 °F	(-1 °C)	50 mins	5 hrs
32 °F	(0 °C)	to	40 °F	(+4 °C)	25 mins	3.5 hrs
41 °F	(+5 °C)	to	49 °F	(+9 °C)	15 mins	2 hrs
50 °F	(+10 °C)	to	58 °F	(+14 °C)	10 mins	1 hrs
59 °F	(+15 °C)	to	67 °F	(+19 °C)	6 mins	40 mins
68 °F	(+20 °C)	to	85 °F	(+29 °C)	3 mins	30 mins
86 °F	(+30 °C)	to	104 °F	(+40 °C)	2 mins	30 mins

FIGURE 5—MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII)

3a. Standard hole cleaning equipment | piston plug info (fractional sizes)[1]

Threaded Rod [inch]	Rebar [inch]	d₀, Drill bit - Ø [inch]	Brush - Ø (size)	Brush - Ø [inch]	Cat. #	Piston plug (size)	Cat. # Standard	Cat. # Premium
3/8"	-	7/16	13.5	0.528	PFC1671050	Piston plugs not required		
-	#3	1/2	14.3	0.562	PFC1671100			
1/2"	-	9/16	16.3	0.654	PFC1671150			
-	#4	5/8	18.3	0.720	PFC1671200			
5/8"	-	11/16	20.0	0.787	PFC1671225	11/16"	08258-PWR	-
-	#5	3/4	21.5	0.846	PFC1671250	3/4"	08259-PWR	PFC1691520
3/4"	#6	7/8	24.8	0.976	PFC1671300	7/8"	08300-PWR	PFC1691530
7/8"	#7	1	28.5	1.122	PFC1671350	1"	08301-PWR	PFC1691540
1"	#8	1 1/8	31.8	1.252	PFC1671400	1-1/8"	08303-PWR	PFC1691550
1-1/4"	#9	1 3/8	38.2	1.504	PFC1671450	1-3/8"	08305-PWR	PFC1691560
-	#10	1 1/2	41.4	1.630	PFC1671500	1-1/2"	08309-PWR	PFC1691570

[1]Note for Tables 3a and 3b: if the DEWALT DustX+ extraction system is used to automatically clean the holes during drilling, standard hole cleaning (brushing and blowing following drilling) is not required.

3b. Standard hole cleaning equipment | piston plug info (EU & CA metric sizes)[1]

Threaded Rod [mm]	Rebar EU [mm]	Rebar CA [mm]	d₀, Drill bit - Ø EU [mm]	d₀, Drill bit - Ø CA [inch]	Brush - Ø [mm]	Brush - Ø [inch]	Cat. # EU	Cat. # CA	Piston plug (size) EU	Piston plug (size) CA	Cat. # EU	Cat. # CA
M10	-		12	-	13.5	0.53	DFC1670120	-	Piston plugs not required			
M12	10	10M	14	9/16	15.5	0.61	DFC1670140	PFC1671150				
-	12		16	-	17.5	0.69	DFC1670160	-				
-	15M		-	3/4	19	0.75	PFC1671250	-	3/4"		-	08259-PWR
M16	14		18	-	20	0.79	DFC1670180	-	18mm		DFC1690100	-
-	16		20	-	22	0.87	DFC1670190	-	20mm		DFC1690150	-
M20	-		22	-	24	0.94	DFC1670220	-	22mm		DFC1690180	-
-	20	20M	25	1	27	1.06	DFC1670240	PFC1671350	25mm	1"	DFC1690250	08301-PWR
M24	-		28	-	30	1.18	DFC1670280	-	28mm		DFC1690300	-
M27	-		30	-	31.8	1.25	DFC1670310	-	30mm		DFC1690310	-
-	25	25M	32	1¹/₄	34	1.34	DFC1670320	PFC1671425	32mm	1¹/₄"	DFC1690350	08290-PWR
M30	28		35	-	37	1.46	DFC1670330	-	35mm		DFC1690400	-
-	30M		-	1¹/₂	-	1.50	PFC1691570	-	1¹/₂"		-	08291-PWR
-	32		40	-	43.5	1.71	DFC1670340	-	40mm		DFC1690420	-

4. Adhesive Anchor property / setting information (fractional and metric sizes)

	Nominal threaded rod (fractional) Units: inch, ft.-lb.							Nominal threaded rod (metric) Units: mm, N-m						
Nominal Anchor Size	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1-1/4"	M10	M12	M16	M20	M24	M27	M30
d_a = Nominal anchor diameter	0.375	0.500	0.625	0.750	0.875	1.00	1.250	10	12	16	20	24	27	30
d_o (d_{bit}) = Nominal ANSI drill bit size	7/16	9/16	11/16	7/8	1	1-1/8	1-3/8	12	14	18	22	28	30	35
T_{max} = Maximum torque	15⁽¹⁾	30	44	66	96	147	221	20	40	80	120	170	250	300
$h_{ef,min}$ = Minimum embedment	2-3/8	2-3/4	3-1/8	3-1/2	3-1/2	4	5	60	70	80	90	96	108	120
$h_{ef,max}$ = Maximum embedment	7-1/2	10	12-1/2	15	17-1/2	20	25	200	240	320	400	480	540	600
s_{min} = Min. spacing	1-7/8	2-1/2	3	3-5/8	4-1/4	4-3/4	5-7/8	50	60	80	100	120	135	150
c_{min} = Min. edge distance w/100% T_{max}	1-5/8	1-3/4	2	2-3/8	2-1/2	2-3/4	3-1/4	45	45	55	60	70	75	80
c_{min} = Min. edge distance w/45% T_{max}	-		1-3/4				2-3/4	-		45			70	
h_{min} = Minimum member thickness	h_{ef} + 1-1/4		h_{ef} + $2d_o$					h_{ef} + 30		h_{ef} + $2d_o$				
Nominal Post-installed Rebar Size														
$h_{ef,max}$ = Maximum embedment for Post-installed Rebar Connections														

	Reinforcing bar (fractional) Units: inch, ft.-lb.							
Nominal Anchor Size	#3	#4	#5	#6	#7	#8	#9	#10
d_a = Nominal anchor diameter	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4
d_o (d_{bit}) = Nominal ANSI drill bit size	1/2	5/8	3/4	7/8	1	1-1/8	1-3/8	1-1/2
T_{max} = Maximum torque	15⁽¹⁾	30	44	66	96	147	185	221
$h_{ef,min}$ = Minimum embedment	2-3/8	2-3/4	3-1/8	3-1/2	3-1/2	4	4-1/2	5
$h_{ef,max}$ = Maximum embedment	7-1/2	10	12-1/2	15	17-1/2	20	22-1/2	25
s_{min} = Min. spacing	1-7/8	2-1/2	3	3-5/8	4-1/4	4-3/4	5-1/4	5-7/8
c_{min} = Min. edge distance w/100% T_{max}	1-5/8	1-3/4	2	2-3/8	2-1/2	2-3/4	3	3-1/4
c_{min} = Min. edge distance w/45% T_{max}	-		1-3/4				2-3/4	
h_{min} = Minimum member thickness	h_{ef} + 1-1/4		h_{ef} + $2d_o$					
Nominal Post-installed Rebar Size								
$h_{ef,max}$ = Maximum embedment for Post-installed Rebar Connections	22-1/2	30	37-1/2	45	52-1/2	60	67-1/2	75

	Reinforcing bar (metric) Units: mm, N-m												
Nominal Anchor Size	Ø10	10M	Ø12	Ø14	15M	Ø16	Ø20	20M	Ø25	25M	Ø28	30M	Ø32
d_a = Nominal anchor diameter	10		12	14	15	16	20		25		28	30	32
d_o (d_{bit}) = Nominal ANSI drill bit size	14	9/16"	16	18	3/4"	20	25	1"	32	1¹/₄"	35	1¹/₂"	40
T_{max} = Maximum torque	20		40	45	80	80	120		175		250	275	300
$h_{ef,min}$ = Minimum embedment	60		70	75	80	80	90		100		112	120	128
$h_{ef,max}$ = Maximum embedment	200		240	280	300	320	400		500		560	600	640
s_{min} = Min. spacing	50		60	70	80	80	100		125		140	150	160
c_{min} = Min. edge distance w/100% T_{max}	45		45	50	55		60		70		75	70	85
c_{min} = Min. edge distance w/45% T_{max}	-			45							70		
h_{min} = Minimum member thickness	h_{ef} + 30			h_{ef} + $2d_o$									
Nominal Post-installed Rebar Size													
$h_{ef,max}$ = Maximum embedment for Post-installed Rebar Connections	600	680	720	840	960	960	1170	1200	1500	1500	1680	1795	1920

¹⁾ for ASTM 36 and F1554 Grade 36, T_{max} = 11 ft.-lb.

5. Adhesive Anchor and Post-installed Rebar Connection systems and accessories

Dispensing tools		Cartridges	Mixing nozzles
Manual and powered caulking guns	Cat. #08437-PWR –Manual Cat. #DCE560D1 – Cordless battery	9.5 fl. oz. AC200+ Quick-Shot cartridge with mixing nozzle	AC200+ mixing nozzle Cat. #PFC1641600
Manual dispensers	Cat. #08485-PWR – Manual	11.5 fl. oz. AC200+ dual cartridge with mixing nozzle	AC200+ mixing nozzle Cat. #PFC1641600
	Cat. #08414-PWR – Manual	14 fl. oz. AC200+ coaxial cartridge with mixing nozzle	
Manual and powered dispensers	Cat. #08494-PWR – Manual Cat. #DCE595D1 – Cordless battery Cat. #08496-PWR – Pneumatic	28 fl. oz. AC200+ dual cartridge with mixing nozzle	AC200+ mixing nozzle Cat. #PFC1641600

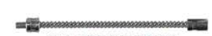
Piston plugs	Compressed air nozzle	SDS connector for brush	Brush extension w/handle
 See Table 3a or 3b for sizes and Cat. #	 Note: if the back of the drilled hole is not reached an extension to the air nozzle must be used	 Cat. #PFC1671830	 Cat. #PFC1671000
		Extension tubes for nozzles	**Brush extension**
		 Cat. #08281-PWR or #08297-PWR (Cat. #PFC1640600 for flex tubing)	 Cat. #PFC1671820

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FIGURE 5—MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII) (Continued)

ICC-ES Evaluation Report

ESR-4027 City of LA Supplement

Reissued January 2024

Revised September 2024

This report is subject to renewal January 2025.

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DIVISION: 03 00 00—CONCRETE
Section: 03 16 00—Concrete Anchors

DIVISION: 05 00 00—METALS
Section: 05 05 19—Post-Installed Concrete Anchors

REPORT HOLDER:

DEWALT

EVALUATION SUBJECT:

AC200+™ ADHESIVE ANCHOR SYSTEM AND POST-INSTALLED REINFORCING BAR CONNECTIONS IN CRACKED AND UNCRACKED CONCRETE (DEWALT)

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the AC200+ Adhesive Anchor System and Post-Installed Reinforcing Bar Connections in cracked and uncracked concrete, described in ICC-ES evaluation report ESR-4027, have also been evaluated for compliance with the codes noted below as adopted by Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:

- 2023 *City of Los Angeles Building Code* (LABC)
- 2023 *City of Los Angeles Residential Code* (LARC)

2.0 CONCLUSIONS

The AC200+ Adhesive Anchor System and Post-Installed Reinforcing Bar Connections in cracked and uncracked concrete, described in Sections 2.0 through 7.0 of the evaluation report ESR-4027, comply with LABC Chapter 19, and the LARC, and are subjected to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The AC200+ Adhesive Anchor System and Post-Installed Reinforcing Bar Connections described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-4027.
- The design, installation, conditions of use and labeling of the AC200+ Adhesive Anchor System and Post-Installed Reinforcing Bar Connections are in accordance with the 2021 *International Building Code®* (IBC) provisions noted in the evaluation report ESR-4027.
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.
- Under the LARC, an engineered design in accordance with LARC Section R301.1.3 must be submitted.
- The allowable and strength design values listed in the evaluation report and tables are for the connection of the anchors or reinforcing bars to the concrete. The connection between the anchors or the reinforcing bars and the connected members shall be checked for capacity (which may govern).
- For use in wall anchorage assemblies to flexible diaphragm applications, anchors shall be designed per the requirements of City of Los Angeles Information Bulletin P/BC 2023-071.

This supplement expires concurrently with the evaluation report, reissued January 2024 and revised September 2024.

ICC-ES Evaluation Report

ESR-4027 FL Supplement w/ HVHZ

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1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the AC200+ adhesive anchors and Post-Installed Reinforcing Bar Connections in Cracked and Uncracked Concrete, described in ICC-ES evaluation report ESR-4027, have also been evaluated for compliance with the codes noted below.

Applicable code editions:

- 2023 *Florida Building Code—Building*
- 2023 *Florida Building Code—Residential*

2.0 CONCLUSIONS

The AC200+ adhesive anchors and Post-Installed Reinforcing Bar Connections in Cracked and Uncracked Concrete, described in Sections 2.0 through 7.0 of the evaluation report ESR-4027, comply with the *Florida Building Code—Building* and the *Florida Building Code—Residential*. The design requirements must be determined in accordance with the *Florida Building Code—Building* or the *Florida Building Code—Residential,* as applicable. The installation requirements noted in ICC-ES evaluation report ESR-4027 for the 2021 *International Building Code*® meet the requirements of the *Florida Building Code—Building* or the *Florida Building Code—Residential*, as applicable.

Use of the AC200+ adhesive anchors and Post-Installed Reinforcing Bar Connections in Cracked and Uncracked Concrete have also been found to be in compliance with the High-Velocity Hurricane Zone provisions of the *Florida Building Code—Building* and the *Florida Building Code—Residential* with the following condition:

For connections subject to uplift, the connection must be designed for no less than 700 pounds (3114 N).

For products falling under Florida Rule 61G20-3, verification that the report holder's quality-assurance program is audited by a quality-assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official, when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the evaluation report, reissued January 2024 and Revised September 2024.