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——

Simpson Strong-Tie Co., Inc.
12246 Holly St.
Riverside, CA 92509

Attn: Jason Oakley, P.E.
(714) 448-9143

RESEARCH REPORT: RR 25744
(CSI # 03 16 00)

BASED UPON ICC ES EVALUATION
REPORT NO. ESR-2508

REEVALUATION DUE
DATE: December 1, 2017
Issued Date: February 1, 2016
Code: 2014 LABC

GENERAL APPROVAL – Reevaluation - SET-XP Epoxy Adhesive Anchors for Cracked and Uncracked Concrete

DETAILS

When in compliance with the use, description, design, installation, conditions of approval and identification of Report No. ESR-2508, reissued July 1, 2015, revised October 2015, of the ICC Evaluation Service, LLC. The report, in its entirety, is attached and made part of this general approval.

The parts of Report No. ESR-2508 which are marked by the asterisks are deleted or revised by the Los Angeles City Building Department from this approval.

The approval is subject to the following conditions:

1.   The design information listed in the attached report and tables are valid for the fasteners only. Connected members shall be checked for their capacity (which may govern).

2.   The anchors shall be identified by labels on the packaging indicating the manufacturer's name and product designation.

3.   Design information, edge distances, spacing and minimum embedment requirements shall be per Tables in ICC-ES Report No. ESR-3187.

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Page 1 of 3

Simpson Strong-Tie
RE: SET-XP Epoxy Adhesive Anchors for Cracked and Uncracked Concrete.

4.   Special inspection in accordance with Section 1705.3 of the 2014 Los Angeles City Building Code shall be provided for anchor installations.

5.   The anchors shall be installed as per the attached manufacturer's instructions except as otherwise stated in this report. Copies of the installation instructions shall be available at each job site.

6.   The adhesive anchors shall not be used to support fire-resistive construction, unless in compliance with Section 5.13 of ICC-ES Report No. ESR-2508.

7.   Minimum concrete cover per Chapter 7 of the ACI 318-11 shall be followed whenever applicable.

8.   Attachment to masonry is outside the scope of this approval.

DISCUSSION

The report is in compliance with the 2014 City of Los Angeles Building Code.

This approval is based on ICC-ES Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete (AC308), dated June 2015.

This general approval will remain effective provided the Evaluation Report is maintained valid and unrevised with the issuing organization. Any revisions to the report must be submitted to this Department, with appropriate fee, for review in order to continue the approval of the revised report.

Addressee to whom this Research Report is issued is responsible for providing copies of it, complete with any attachments indicated, to architects, engineers and builders using items approved herein in design or construction which must be approved by Department of Building and Safety Engineers and Inspectors.

Simpson Strong-Tie
RE: SET-XP Epoxy Adhesive Anchors for Cracked and Uncracked Concrete.

This general approval of an equivalent alternate to the Code is only valid where an engineer and/or inspector of this Department has determined that all conditions of this approval have been met in the project in which it is to be used.

Simpson offers software to assist in the design of anchorage using Simpson products

_____
QUAN NGHIEM, Chief
Engineering Research Section
201 N. Figueroa St., Room 880
Los Angeles, CA 90012
Phone- 213-202-9812
Fax- 213-202-9943

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TLB1500282
1912, ACI 318-08 Appendix D

Attachment: ICC ES Report No. ESR-2508 (17 Pages)

ICC EVALUATION SERVICE

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ESR-2508*

Reissued July 2015
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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:

SIMPSON STRONG-TIE COMPANY INC.
5956 WEST LAS POSITAS BOULEVARD
PLEASANTON, CALIFORNIA 94588
(800) 999-5099
www.strongtie.com

EVALUATION SUBJECT:

SIMPSON STRONG-TIE® SET-XP® EPOXY ADHESIVE ANCHORS FOR CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

* ■ ~~2015,~~ 2012, 2009 and 2006 *International Building Code*® (IBC)

* ■ ~~2015,~~ 2012, 2009 ~~and 2006~~ *International Residential Code*® (IRC)

* ■ ~~2013 *Abu Dhabi International Building Code* (ADIBC)[†]~~

   ~~[†]The ADIBC is based on the 2009 IBC. 2009 IBC code sections referenced in this report are the same sections in the ADIBC.~~

Property evaluated:

Structural

2.0 USES

The Simpson Strong-Tie® SET-XP® Epoxy Adhesive Anchors are used to resist static, wind and earthquake (Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normal-weight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa) ~~[minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1]~~.

The anchor complies with anchors as described in ~~Section 1901.3 of the 2015 IBC,~~ Section 1909 of the 2012 IBC and is an alternative to anchors described in Section 1908 of the 2012 IBC, and Sections 1911 and 1912 of the 2009 and 2006 IBC. The anchors may also be used where an engineering design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 General:

The SET-XP Epoxy Adhesive Anchor System is comprised of the following components:

* SET-XP epoxy adhesive packaged in cartridges

* Adhesive mixing and dispensing equipment

* Equipment for hole cleaning and adhesive injection

SET-XP epoxy adhesive is used with continuously threaded steel rods or deformed steel reinforcing bars. The manufacturer's printed installation instructions (MPII) are included with each adhesive unit package as shown in Figure 1 of this report.

3.2 Materials:

3.2.1 SET-XP Epoxy Adhesive: SET-XP epoxy adhesive is an injectable, two-component, 100 percent solids, epoxy-based adhesive mixed as a 1-to-1 volume ratio of hardener-to-resin. SET-XP is available in 8.5-ounce (251 mL), 22-ounce (650 mL), and 56-ounce (1656 mL) cartridges. The two components combine and react when dispensed through a static mixing nozzle attached to the cartridge. The shelf life of SET-XP in unopened cartridges is two years from the date of manufacture when stored at temperatures between 45°F and 90°F (7°C and 32°C) in accordance with the MPII.

3.2.2 Dispensing Equipment: SET-XP epoxy adhesive must be dispensed using Simpson Strong-Tie manual dispensing tools, battery-powered dispensing tools or pneumatic dispensing tools as listed in Tables 7 and 8 of this report.

3.2.3 Equipment for Hole Preparation: Hole cleaning equipment consists of hole-cleaning brushes and air nozzles. Brushes must be Simpson Strong-Tie hole cleaning brushes, identified by Simpson Strong-Tie catalog number series ETB. See Tables 7 and 8 in this report, and the installation instructions shown in Figure 1, for additional information. Air nozzles must be equipped with an extension capable of reaching the bottom of the drilled hole.

3.2.4 Anchor Materials:

3.2.4.1 Threaded Steel Rods: Threaded anchor rods, having diameters from $^3/_8$ inch to $1^1/_4$ inch (9.5 mm to 31.7 mm), must be carbon steel conforming to ASTM F1554, Grade 36, or ASTM A193, Grade B7; or stainless steel conforming to ASTM A193, Grade B6, B8, or B8M. Table 2 in this report provides additional details. Threaded

*Revised October 2015

* Deleted by the City of Los Angeles

bars must be clean, straight and free of indentations or other defects along their lengths.

3.2.4.2 Steel Reinforcing Bars: Steel reinforcing bars are deformed reinforcing bars (rebar), having sizes from No. 3 to No. 8, and No. 10, must conform to ASTM A615 Grade 60. Table 3 in this report provides additional details. The embedded portions of reinforcing bars must be straight, and free of mill scale, rust, mud, oil, and other coatings that may impair the bond with adhesive. Reinforcing bars must not be bent after installation except as set forth in ACI 318-14 Section 26.6.3.1 (b) or ACI 318-11 Section 7.3.2, as applicable, 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 Ductility: In accordance with ACI 318-14 2.3 or ACI 318-11 D.1, as applicable, in order for a steel 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 of less than 14 percent or a reduction of area less than 30 percent, or both, are considered brittle. Where values are nonconforming or unstated, the steel must be considered brittle.

3.2.5 Concrete: Normal-weight 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) [minimum
* of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

4.0   DESIGN AND INSTALLATION

4.1   Strength Design:

4.1.1   General: The design strength of anchors under the
* 2015 IBC, as well as the 2015 IRC must be determined in accordance with ACI 318-14 and this report. The design strength of anchors under the 2012, 2009 and 2006 IBC,
* as well as the 2012, 2009 and 2006 IRC must be determined in accordance with ACI 318-11 and this report.

A design example according to the 2012 IBC based on ACI 318-11 is given in Figure 2 of this report.

Design parameters are based on ACI 318-14 for use with
* the 2015 IBC, and ACI 318-11 for use with the 2012, 2009 and 2006 IBC unless noted otherwise in Section 4.1.1 through 4.1.11 of this report.

The strength design of anchors must comply with ACI 318-14 17.3.1 or ACI 318-11 D.4.1, as applicable, except as required in ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable.

Design parameters are provided in Tables 2, 3, 4, 5A, and 5B of this report. Strength reduction factors, ϕ, as given in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, and noted in Tables 2, 3, 4, 5A, and 5B of this report, must be used for load combinations calculated in accordance with Section 1605.2 of the IBC or ACI 318-14 5.3 or ACI 318-11 9.2, as applicable. Strength reductions factors, ϕ, described in ACI 318-11 D.4.4 must be used for load combinations calculated in accordance with ACI 318-11 Appendix C.

4.1.2   Static Steel Strength in Tension: The nominal steel strength of a single anchor in tension, N_{sa}, in accordance with ACI 318-14 17.4.1.2 or ACI 318-11 D.5.1.2, as applicable, and the associated strength reduction factors, ϕ, in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are provided in Tables 2 and 3 of this report for the anchor element types included in this report.

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 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, with the following addition:

The basic concrete breakout strength of a single anchor in tension, N_b, must be calculated in accordance with ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2, as applicable, using the values of $k_{c,cr}$ and $k_{c,uncr}$, as described in Table 4 of this report. Where analysis indicates no cracking in accordance with ACI 318-14 17.4.2.6 or ACI 318-11 D.5.2.6, as applicable, N_b must be calculated using $k_{c,uncr}$ and $\Psi_{c,N}$ = 1.0. For anchors in lightweight concrete see ACI 318-14 17.2.6 or ACI 318-11 D.3.6, as applicable. The value of f'_c used for calculation must be limited to 8,000 psi (55.1 MPa) maximum for uncracked concrete in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable. The value of f'_c used for calculation must be limited to 2,500 psi (17.2 MPa) maximum for cracked concrete regardless of in-situ concrete strength.

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 318-14 17.4.5 or ACI 318-11 D.5.5, as applicable. Bond strength values are a function of the concrete condition (cracked or uncracked), the concrete temperature range, the installation conditions (dry or water saturated concrete), and the special inspection level provided. Strength reduction factors, ϕ, listed below and in Tables 5A and 5B are utilized for anchors installed in dry or saturated concrete in accordance with the level of inspection provided (periodic or continuous), as applicable.

SPECIAL INSPECTION LEVEL	PERMISSIBLE INSTALLATION CONDITION	BOND STRENGTH	ASSOCIATED STRENGTH REDUCTION FACTOR
Continuous	Dry concrete	τ_k	$\phi_{dry,ci}$
Continuous	Water-saturated	τ_k	$\phi_{sat,ci}$
Periodic	Dry concrete	τ_k	$\phi_{dry,pi}$
Periodic	Water-saturated	τ_k	$\phi_{sat,pi}$

τ_k in the table above refers to $\tau_{k,cr}$ or $\tau_{k,uncr}$.

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 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable, and strength reduction factors, ϕ, in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are given in Tables 2 and 3 of this report for the anchor element types included in this report.

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 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, based on information given in Table 4. The basic concrete breakout strength of a single anchor in shear, V_b, must be calculated in accordance with ACI 318-14 17.5.2.2 or ACI 318-11 D.6.2.2, as applicable, using the values of d as described in Table 4 of this report for the corresponding anchor steel in lieu of d_a (2015, 2012 and 2009 IBC) and d_o (2006 IBC). In addition, h_{ef} must be

substituted for ℓ_e. In no case shall ℓ_e exceed 8d. The value of f'_c must be limited to 8,000 psi (55.1 MPa), in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

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 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable.

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 318-14 17.6 or ACI 318-11 D.7, as applicable.

4.1.9 Minimum Member Thickness, h_{min}, Anchor Spacing, s_{min}, and Edge Distance, c_{min}: In lieu of ACI 318-14 17.7.1 and 17.7.3 or ACI 318-11 D.8.1 and D.8.3, as applicable, values of s_{min} and c_{min} provided in Table 1 of this report must be observed for anchor design and installation. The minimum member thicknesses, h_{min}, described in Table 1 of this report, must be observed for anchor design and installation. For adhesive anchors that will remain untorqued, ACI 318-14 17.7.4 or ACI 318-11 D.8.4, as applicable, applies.

4.1.10 Critical Edge Distance c_{ac}: In lieu of ACI 318-14 17.7.6 or ACI 318-11 D.8.6, as applicable, c_{ac} must be determined as follows:

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

where

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

τ_{uncr} = characteristic bond strength stated in Tables 5A and 5B of this report where by τ_{uncr} need not be taken as larger than:

$$\tau_{uncr} = \frac{k_{uncr}\sqrt{h_{ef}f'_c}}{\pi\cdot d_a}$$

4.1.11 Design Strength in 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, the design must be performed according to ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. ~~Modifications to ACI 318-14 17.2.3 shall be applied under Section 1905.1.8 of the 2015 IBC.~~ For the 2012 IBC, Section 1905.1.9 shall be omitted. The nominal steel shear strength, V_{sa}, must be adjusted by $\alpha_{V,seis}$ as given in Tables 2 and 3 of this report for the anchor element types included in this report. The nominal bond strength $\tau_{k,cr}$ in Table 5A must be adjusted by $\alpha_{N,seis}$. For Table 5B, no adjustment to the bond strength $\tau_{k,cr}$ is required.

Modify ACI 318-11 D.3.3.4.2, D.3.3.4.3(d), and D.3.3.5.2 to read as follows:

ACI 318-11 D.3.3.4.2 - Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments shall be designed in accordance with ACI 318-11 D.3.3.4.3. The anchor design tensile strength shall be determined in accordance with ACI 318-11 D.3.3.4.4.

Exception:

1. Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the force determined in accordance with ASCE 7 Equation 12.11-1 or 12.14-10 shall be deemed to satisfy ACI 318-11 D.3.3.4.3(d).

ACI 318-11 D.3.3.4.3(d) – The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include E, with E increased by Ω_0. The anchor design tensile strength shall be calculated from ACI 318-11 D.3.3.4.4.

ACI 318-11 D.3.3.5.2 – Where the shear component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor shear force associated with the same load combination, anchors and their attachments shall be designed in accordance with ACI 318-11 D.3.3.5.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with ACI 318-11 D.6.

Exceptions:

1. For the calculation of the in-plane shear strength of anchor bolts attaching wood sill plates of bearing or non-bearing walls of light-frame wood structures to foundations or foundation stem walls, the in-plane shear strength in accordance with ACI 318-11 D.6.2 and D.6.3 need not be computed and ACI 318-11 D.3.3.5.3 need not apply provided all of the following are met:

1.1. The allowable in-plane shear strength of the anchor is determined in accordance with AF&PA NDS Table 11E for lateral design values parallel to grain.

1.2. The maximum anchor nominal diameter is $^5/_8$ inch (16 mm).

1.3. Anchor bolts are embedded into concrete a minimum of 7 inches (178 mm).

1.4. Anchor bolts are located a minimum of $1^3/_4$ inches (45 mm) from the edge of the concrete parallel to the length of the wood sill plate.

1.5. Anchor bolts are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the wood sill plate.

1.6. The sill plate is 2-inch or 3-inch nominal thickness.

2. For the calculation of the in-plane shear strength of anchor bolts attaching cold-formed steel track of bearing or non-bearing walls of light-frame construction to foundations or foundation stem walls, the in-plane shear strength in accordance with ACI 318-11 D.6.2 and D.6.3, need not be computed and ACI 318-11 D.3.3.5.3 need not apply provided all of the following are met:

2.1. The maximum anchor nominal diameter is $^5/_8$ inch (16 mm).

2.2. Anchors are embedded into concrete a minimum of 7 inches (178 mm).

2.3. Anchors are located a minimum of $1^3/_4$ inches (45 mm) from the edge of the concrete parallel to the length of the track.

2.4. Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.

2.5. The track is 33 to 68 mil designation thickness.

Allowable in-plane shear strength of exempt anchors, parallel to the edge of concrete shall be permitted to be determined in accordance with AISI S100 Section

E3.3.1.

3. *In light-frame construction, bearing or nonbearing walls, shear strength of concrete anchors less than or equal to 1 inch [25 mm] in diameter attaching a sill plate or track to foundation or foundation stem wall need not satisfy ACI 318-11 D.3.3.5.3(a) through (c) when the design strength of the anchors is determined in accordance with ACI 318-11 D.6.2.1(c).*

4.2 Allowable Stress Design (ASD):

4.2.1 General: For anchors designed using load combinations in accordance with IBC Section 1605.3 (Allowable Stress Design), allowable loads shall be established using Eq. (4-2) or Eq. (4-3):

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

and

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

where:

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

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

ϕN_n = The lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318- ★ 14 Chapter 17 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Sections 1908.1.9 and 1908.1.10, ACI 318-05 Appendix D and 2006 IBC Section 1908.1.16, and Section 4.1 of this report, as applicable.

ϕV_n = The lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318-14 Chapter ★ 17 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Sections 1908.1.9 and 1908.1.10, ACI 318-05 Appendix D and 2006 IBC Section 1908.1.16, and Section 4.1 of this report, as applicable.

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.

Table 6 provides an illustration of calculated Allowable Stress Design (ASD) values for each anchor diameter at minimum embedment depth.

The requirements for member thickness, edge distance and spacing, described in Table 1 of this report, must apply.

4.2.2 Interaction of Tensile and Shear Forces: In lieu of ACI 318-14 17.6.1, 17.6.2, and 17.6.3 or ACI 318-11 D.7.1, D.7.2 and D.7.3, as applicable, interaction of tension and shear loads must be calculated as follows:

If $T_{applied} \leq 0.2\ T_{allowable,ASD}$, then the full allowable strength in shear, $V_{allowable,ASD}$, shall be permitted.

If $V_{applied} \leq 0.2\ V_{allowable,ASD}$, then the full allowable strength in tension, $T_{allowable,ASD}$, must be permitted.

For all other cases:

$$\frac{T_{applied}}{T_{allowable,\ ASD}} + \frac{V_{applied}}{V_{allowable,ASD}} \leq 1.2 \qquad \text{Eq. (4-4)}$$

4.3 Installation:

Installation parameters are provided in Table 1, 7, 8, 9 and in Figure 1. Installation must be in accordance with ACI 318-14 17.8.1 and 17.8.2 or ACI 318-11 D.9.1 and D.9.2, as applicable. Anchor locations must comply with this report and the plans and specifications approved by the building official. Installation of the SET-XP Epoxy Adhesive Anchor System must conform to the manufacturer's printed installation instructions included in each package unit and as described in Figure 1. The nozzles, brushes, dispensing tools and adhesive retaining caps listed in Tables 7 and 8, supplied by the manufacturer, must be used along with the adhesive cartridges.

The anchors may be used for floor (vertically down), wall (horizontal), and overhead applications.

4.4 Special Inspection:

4.4.1 General:

Installations may be made under continuous special inspection or periodic special inspection, as determined by the registered design professional. See Section 4.1.4 and Tables 5A and 5B of this report for special inspection requirements, including strength reduction factors, ϕ, corresponding to the type of inspection provided.

Continuous special inspection of adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be performed in accordance with ACI 318-14 17.8.2.4 or ACI 318 D.9.2.4, as applicable.

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

4.4.2 Continuous Special Inspection

Installations made under continuous special inspection with an onsite proof loading program must be performed in accordance with Section 1705.1.1 and Table 1705.3 of the 2015 and 2012 IBC, 2009 IBC Sections 1704.4 and 1704.15, or 2006 IBC Section 1704.13, whereby continuous special inspection is defined in IBC Section 1702.1 and this report. The special inspector must be on the jobsite continuously during anchor installation to verify anchor type, adhesive identification and expiration date, anchor dimensions, concrete type, concrete compressive strength, hole drilling method, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque and adherence to the manufacturer's printed installation instructions.

The proof loading program must be established by the registered design professional. As a minimum, the following requirements must be addressed in the proof loading program:

1. Frequency of proof loading based on anchor type, diameter, and embedment;

2. Proof loads by anchor type, diameter, embedment and location;

3. Acceptable displacements at proof load;

4. Remedial action in the event of failure to achieve proof load or excessive displacement.

Unless otherwise directed by the registered design professional, proof loads must be applied as confined tension tests. Proof load levels must not exceed the lesser of 50 percent of expected peak load based on adhesive bond strength nor 80 percent of the anchor yield strength. The proof load shall be maintained at the required load level for a minimum of 10 seconds.

4.4.3 Periodic Special Inspection

* Periodic special inspection must be performed where required in accordance with Section 1705.1.1 and Table 1705.3 of the ~~2015 and~~ 2012 IBC, Sections 1704.4 and 1704.15 of the 2009 IBC, or Section 1704.13 of the 2006 IBC and this report. The special inspector must be on the jobsite initially during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, adhesive identification and expiration date, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque and adherence to the manufacturer's printed installation instructions.

The special inspector must verify the initial installations of each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same construction personnel is permitted to be performed in the absence of the special inspector. Any change in the anchor product being installed or the personnel performing the installation must require 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.

4.5 Compliance with NSF/ANSI Standard 61:

SET-XP Epoxy Adhesive Anchor Systems comply with requirements of NSF/ANSI Standard 61, as referenced in Section 605 of the 2006 International Plumbing Code (IPC) for products used in water distribution systems. SET-XP Epoxy Adhesive Anchor Systems may have a maximum exposed surface area to volume ratio of 216 square inches per 1000 gallons (3785 L) of potable water and/or drinking water treatment chemicals. The focus of NSF/ANSI Standard 61 as it pertains to adhesive anchors is to ensure that the contaminants or impurities imparted from the adhesive products to the potable water do not exceed acceptable levels.

5.0 CONDITION OF USE

The Simpson Strong-Tie SET-XP Epoxy Adhesive Anchor System described in this report complies with or is a suitable alternative to what is specified in the codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 SET-XP epoxy adhesive anchors must be installed in accordance with the manufacturer's printed installation instructions as shown in Figure 1 of this report.

5.2 The anchors 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) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

5.3 The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.1 MPa) for uncracked concrete. The value of f'_c used for calculation purposes must not exceed 2500 psi (17.2 MPa) for tension resistance in cracked concrete.

5.4 Anchors must be installed in concrete base materials in holes predrilled with carbide-tipped drill bits complying with ANSI B212.15-1994 in accordance with the instructions provided in Figure 1 of this report.

5.5 Loads applied to the anchors must be adjusted in accordance with Section 1605.2 of the IBC for strength design and in accordance with Section 1605.3 of the IBC for allowable stress design.

5.6 SET-XP epoxy adhesive anchors are recognized for use to resist short- and long-term loads, including wind and earthquake loads, subject to the conditions of this report.

5.7 In structures assigned to Seismic Design Category C, D, E, or F under the IBC or IRC, anchor strength must be adjusted in accordance with Section 4.1.11 of this report

5.8 SET-XP Epoxy Adhesive Anchors are permitted to be installed in concrete that is cracked or that may be expected to crack during the service life of the anchor, subject to the conditions of this report.

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

5.10 Allowable design values shall be established in accordance with Section 4.2 of this report.

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

5.12 Prior to installation, 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.

5.13 Fire-resistive construction: Anchors are not permitted to support fire-resistive construction. Where not otherwise prohibited in the code, SET-XP epoxy adhesive anchors are permitted for installation in fire-resistive construction provided at least one of the following conditions is fulfilled:

- Anchors are used to resist wind or seismic forces only.

- Anchors 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 are used to support nonstructural elements.

5.14 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of adhesive anchors 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.

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

5.16 Hot-dipped galvanized carbon steel threaded rods with coating weights in accordance with ASTM A153 Class C and D, or stainless steel threaded rods,

are permitted for exterior exposure or damp environments.

5.17 Steel anchoring materials in contact with preservative-treated and fire-retardant-treated wood must be zinc-coated steel or stainless steel. The minimum coating weights for zinc-coated steel must comply with ASTM A153.

5.18 Special inspection must be provided in accordance with Section 4.4 of this report. Continuous special inspection for anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads must be provided in accordance with Section 4.4 of this report.

5.19 Installation of anchors in horizontal or upwardly inclined orientations to resist sustained tension loads shall be performed by personnel certified by an applicable certification program in accordance with ACI 318-14 17.8.2.2 or 17.8.2.3, or ACI 318-11 D.9.2.2 or D.9.2.3, as applicable.

5.20 SET-XP epoxy adhesive is manufactured and packaged into cartridges by Simpson Strong-Tie Company Inc., in Addison, Illinois, under a quality-control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors in Concrete (AC308), dated June 2015, which incorporates requirements in ACI 355.4-11.

6.2 Data in accordance with NSF/ANSI Standard 61, Drinking Water Systems Components-Health Effects, for the SET-XP adhesive.

7.0 IDENTIFICATION

7.1 SET-XP Epoxy Adhesive is identified in the field by labels on the cartridge or packaging, bearing the company name (Simpson Strong-Tie Company, Inc.), product name (SET-XP), the batch number, the expiration date, and the evaluation report number (ESR-2508).

7.2 Threaded rods, nuts, washers and deformed reinforcing bars are standard elements and must conform to applicable national or international specifications.

TABLE 1—SET-XP EPOXY ADHESIVE ANCHOR INSTALLATION INFORMATION

Characteristic	Symbol	Units	Nominal Rod Diameter d_o (inch)						
			$3/8$	$1/2$	$5/8$	$3/4$	$7/8$	1	$1 1/4$
Drill Bit Diameter	d_{hole}	in.	$1/2$	$5/8$	$3/4$	$7/8$	1	$1 1/8$	$1 3/8$
Maximum Tightening Torque	T_{inst}	ft-lb	10	20	30	45	60	80	125
Permitted Embedment Depth Range Minimum/Maximum	$h_{ef,min}$	in.	$2 3/8$	$2 3/4$	$3 1/8$	$3 1/2$	$3 3/4$	4	5
	$h_{ef,max}$	in.	$7 1/2$	10	$12 1/2$	15	$17 1/2$	20	25
Minimum Concrete Thickness	h_{min}	in.	h_{ef} + $5d_o$						
Critical Edge Distance	c_{ac}	in.	See Section 4.1.10 of this report.						
Minimum Edge Distance	c_{min}	in.	$1 3/4$						$2 3/4$
Minimum Anchor Spacing	s_{min}	in.	3						6

For **SI:** = 1 inch = 25.4 mm, 1 ft-lb = 1.356 Nm.

TABLE 2—STEEL DESIGN INFORMATION FOR THREADED ROD

Characteristic	Symbol	Units	Nominal Rod Diameter (inch)						
			$3/8$	$1/2$	$5/8$	$3/4$	$7/8$	1	$1 1/4$
Nominal Diameter	d	in.	0.375	0.5	0.625	0.75	0.875	1	1.25
Minimum Tensile Stress Area	A_{se}	in.^{2}	0.078	0.142	0.226	0.334	0.462	0.606	0.969
Tension Resistance of Steel - ASTM F1554, Grade 36	N_{sa}	lb.	4525	8235	13110	19370	26795	35150	56200
Tension Resistance of Steel - ASTM A193, Grade B7			9750	17750	28250	41750	57750	75750	121125
Tension Resistance of Steel - Stainless Steel ASTM A193, Grade B6 (Type 410)			8580	15620	24860	36740	50820	66660	106590
Tension Resistance of Steel - Stainless Steel ASTM A193, Grade B8 and B8M (Types 304 and 316)			4445	8095	12880	19040	26335	34540	55235
Strength Reduction Factor for Tension - Steel Failure[1]	ϕ	-	0.75						
Minimum Shear Stress Area	A_{se}	in.^{2}	0.078	0.142	0.226	0.334	0.462	0.606	0.969
Shear Resistance of Steel - ASTM F1554, Grade 36	V_{sa}	lb.	2260	4940	7865	11625	16080	21090	33720
Shear Resistance of Steel - ASTM A193, Grade B7			4875	10650	16950	25050	34650	45450	72675
Shear Resistance of Steel - Stainless Steel ASTM A193, Grade B6 (Type 410)			4290	9370	14910	22040	30490	40000	63955
Shear Resistance of Steel - Stainless Steel ASTM A193, Grade B8 and B8M (Types 304 and 316)			2225	4855	7730	11425	15800	20725	33140
Reduction for Seismic Shear - ASTM A307, Grade C	$\alpha_{V,seis}$	-	0.87	0.78	0.68	0.68	0.68	0.68	0.65
Reduction for Seismic Shear - ASTM A193, Grade B7			0.87	0.78	0.68	0.68	0.68	0.68	0.65
Reduction for Seismic Shear - Stainless Steel ASTM A193, Grade B6 (Type 410)			0.69	0.82	0.75	0.75	0.75	0.83	0.72
Reduction for Seismic Shear - Stainless Steel ASTM A193, Grade B8 and B8M (Types 304 and 316)			0.69	0.82	0.75	0.75	0.75	0.83	0.72
Strength Reduction Factor for Shear - Steel Failure[1]	ϕ	-	0.65						

[1]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3, or ACI 318-11 9.2 are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 3—STEEL DESIGN INFORMATION FOR REINFORCING BAR (REBAR)

Characteristic	Symbol	Units	Bar Size						
			#3	#4	#5	#6	#7	#8	#10
Nominal Diameter	d	in.	0.375	0.5	0.625	0.75	0.875	1	1.25
Minimum Tensile Stress Area	A_{se}	in.^{2}	0.11	0.20	0.31	0.44	0.6	0.79	1.23
Tension Resistance of Steel - Rebar (ASTM A615 Gr.60)	N_{sa}	lb.	9900	18000	27900	39600	54000	71100	110700
Strength Reduction Factor for Tension - Steel Failure[1]	ϕ	-	0.65						
Minimum Shear Stress Area	A_{se}	in.^{2}	0.11	0.20	0.31	0.44	0.6	0.79	1.23
Shear Resistance of Steel - Rebar (ASTM A615 Gr. 60)	V_{sa}	lb.	4950	10800	16740	23760	32400	42660	66420
Reduction for Seismic Shear – Rebar (ASTM A615Gr. 60)	$\alpha_{V,seis}$	-	0.85	0.88	0.84	0.84	0.77	0.77	0.59
Strength Reduction Factor for Shear - Steel Failure[1]	ϕ	-	0.60						

[1]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3, or ACI 318-11 9.2 are used. If the load combinations of or ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 4—CONCRETE BREAKOUT AND PRYOUT DESIGN INFORMATION FOR THREADED ROD/REBAR ANCHORS

Characteristic	Symbol	Units	Nominal Rod/Rebar Diameter						
			$^3/_8$" or #3	$^1/_2$" or #4	$^5/_8$" or #5	$^3/_4$" or #6	$^7/_8$" or #7	1" or #8	$1^1/_4$" or #10
Nominal Diameter	d	in.	0.375	0.5	0.625	0.75	0.875	1	1.25
Permitted Embedment Depth Range Min. / Max.	$h_{ef,min}$	in.	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^3/_4$	4	5
	$h_{ef,max}$	In.	$7^1/_2$	10	$12^1/_2$	15	$17^1/_2$	20	25
Minimum Concrete Thickness	h_{min}	in.	$h_{ef} + 5d_o$						
Critical Edge Distance	c_{ac}	in.	See Section 4.1.10 of this report.						
Minimum Edge Distance	c_{min}	in.	$1^3/_4$						$2^3/_4$
Minimum Anchor Spacing	s_{min}	in.	3						6
Effectiveness Factor for Uncracked Concrete	$k_{c,cr}$	-	17						
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	-	24						
Strength Reduction Factor - Concrete Breakout Failure in Tension[1]	ϕ	-	0.65						
Strength Reduction Factor - Concrete Breakout Failure in Shear[1]	ϕ	-	0.70						
Strength Reduction Factor - Pryout Failure[1]	ϕ	-	0.70						

[1]The tabulated values of ϕ applies when both the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3, or ACI 318-11 9.2 are used and the requirements of ACI 318-14 17.3.3 (c) or ACI 318-11 D.4.3(c), as applicable, for Condition B are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4(c) for Condition B.

TABLE 5A—SET-XP EPOXY ADHESIVE ANCHOR THREADED ROD BOND STRENGTH DESIGN INFORMATION FOR TEMPERATURE RANGE 1[1,2]

Condition			Characteristic		Symbol	Units	Nominal Rod Diameter						
							3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Dry Concrete	Continuous Inspection	Uncracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	psi	1,330	1,985	1,830	1,670	1,525	1,360	1,070
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	2 3/8	2 3/4	3 1/8	3 1/2	3 3/4	4	5
				Maximum	$h_{ef,max}$		7 1/2	10	12 1/2	15	17 1/2	20	25
		Cracked Concrete[4,5]	Characteristic Bond Strength[3]		$\tau_{k,cr}$	psi	1,025	880	750	665	610	595	595
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	3	4	5	6	7	8	10
				Maximum	$h_{ef,max}$		7 1/2	10	12 1/2	15	17 1/2	20	25
		Anchor Category, dry concrete			-	-	1						
		Strength Reduction Factor - dry concrete			$\phi_{dry,ci}$	-	0.65						
	Periodic Inspection	Uncracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	psi	1,330	1,985	1,830	1,670	1,525	1,360	1,070
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	2 3/8	2 3/4	3 1/8	3 1/2	3 3/4	4	5
				Maximum	$h_{ef,max}$		7 1/2	10	12 1/2	15	17 1/2	20	25
		Cracked Concrete[4,5]	Characteristic Bond Strength[3]		$\tau_{k,cr}$	psi	1,025	880	750	665	610	595	595
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	3	4	5	6	7	8	10
				Maximum	$h_{ef,max}$		7 1/2	10	12 1/2	15	17 1/2	20	25
		Anchor Category, dry concrete			-	-	2						
		Strength Reduction Factor - dry concrete			$\phi_{dry,pi}$	-	0.55						
Water-Saturated Concrete	Continuous Inspection	Uncracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	psi	N/A	1,130	1,045	950	N/A	N/A	N/A
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	2 3/8	2 3/4	3 1/8	3 1/2	3 3/4	4	5
				Maximum	$h_{ef,max}$		7 1/2	10	12 1/2	15	17 1/2	20	25
		Cracked Concrete[4,5]	Characteristic Bond Strength[3]		$\tau_{k,cr}$	psi	585	500	425	380	350	340	340
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	3	4	5	6	7	8	10
				Maximum	$h_{ef,max}$		7 1/2	10	12 1/2	15	17 1/2	20	25
		Anchor Category, water-saturated concrete			-	-	3						
		Strength Reduction Factor – water-saturated concrete			$\phi_{sat,ci}$	-	0.45						
	Periodic Inspection	Uncracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	psi	N/A	955	N/A	N/A	N/A	N/A	N/A
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	2 3/8	2 3/4	3 1/8	3 1/2	3 3/4	4	5
				Maximum	$h_{ef,max}$		7 1/2	10	12 1/2	15	17 1/2	20	25
		Cracked Concrete[4,5]	Characteristic Bond Strength[3]		$\tau_{k,cr}$	psi	490	420	360	320	295	285	285
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	3	4	5	6	7	8	10
				Maximum	$h_{ef,max}$		7 1/2	10	12 1/2	15	17 1/2	20	25
		Anchor Category, water-saturated concrete			-	-	3						
		Strength Reduction Factor – water-saturated concrete			$\phi_{sat,pi}$	-	0.45						

[1]Temperature Range 1: Maximum short term temperature of 150°F. Maximum long term temperature of 110°F.
[2]Short term concrete temperatures are those that occur over short intervals (diurnal cycling). Long term temperatures are constant over a significant time period.
[3]For sustained load conditions, bond strengths must be multiplied by 0.58.
[4]As detailed in Section 4.1.11 of this report, bond strength values for 7/8" anchors must be multiplied by $\alpha_{N,seis} = 0.80$.
[5]As detailed in Section 4.1.11 of this report, bond strength values for 1" anchors must be multiplied by $\alpha_{N,seis} = 0.92$.

TABLE 5B—SET-XP EPOXY ADHESIVE ANCHOR REBAR BOND STRENGTH DESIGN INFORMATION FOR TEMPERATURE RANGE 1[1,2]

Condition			Characteristic		Symbol	Units	Nominal Rebar Size						
							#3	#4	#5	#6	#7	#8	#10
Dry Concrete	Continuous Inspection	Uncracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	psi	1,545	1,500	1,460	1,415	1,370	1,330	1,240
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^3/_4$	4	5
				Maximum	$h_{ef,max}$		$7^1/_2$	10	$12^1/_2$	15	$17^1/_2$	20	25
		Cracked Concrete[4]	Characteristic Bond Strength[3]		$\tau_{k,cr}$	psi	625	1,265	1,140	1,015	885	760	475
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	3	4	5	6	7	8	10
				Maximum	$h_{ef,max}$		$7^1/_2$	10	$12^1/_2$	15	$17^1/_2$	20	25
		Anchor Category, dry concrete			-	-	1						
		Strength Reduction Factor - dry concrete			$\phi_{dry,ci}$	-	0.65						
	Periodic Inspection	Uncracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	psi	1,545	1,500	1,460	1,415	1,370	1,330	1,240
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^3/_4$	4	5
				Maximum	$h_{ef,max}$		$7^1/_2$	10	$12^1/_2$	15	$17^1/_2$	20	25
		Cracked Concrete[4]	Characteristic Bond Strength[3]		$\tau_{k,cr}$	psi	625	1,265	1,140	1,015	885	760	475
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	3	4	5	6	7	8	10
				Maximum	$h_{ef,max}$		$7^1/_2$	10	$12^1/_2$	15	$17^1/_2$	20	25
		Anchor Category, dry concrete			-	-	2						
		Strength Reduction Factor - dry concrete			$\phi_{dry,pi}$	-	0.55						
Water-Saturated Concrete	Continuous Inspection	Uncracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	psi	N/A	N/A	N/A	N/A	N/A	N/A	N/A
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^3/_4$	4	5
				Maximum	$h_{ef,max}$		$7^1/_2$	10	$12^1/_2$	15	$17^1/_2$	20	25
		Cracked Concrete[4]	Characteristic Bond Strength[3]		$\tau_{k,cr}$	psi	355	720	650	580	505	435	270
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	3	4	5	6	7	8	10
				Maximum	$h_{ef,max}$		$7^1/_2$	10	$12^1/_2$	15	$17^1/_2$	20	25
		Anchor Category, water-saturated concrete			-	-	3						
		Strength Reduction Factor – water-saturated concrete			$\phi_{sat,ci}$	-	0.45						
	Periodic Inspection	Uncracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	psi	N/A	N/A	N/A	N/A	N/A	N/A	N/A
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^3/_4$	4	5
				Maximum	$h_{ef,max}$		$7^1/_2$	10	$12^1/_2$	15	$17^1/_2$	20	25
		Cracked Concrete[4]	Characteristic Bond Strength[3]		$\tau_{k,cr}$	psi	300	605	545	485	425	365	230
			Embedment Depth Range	Minimum	$h_{ef,min}$	in.	3	4	5	6	7	8	10
				Maximum	$h_{ef,max}$		$7^1/_2$	10	$12^1/_2$	15	$17^1/_2$	20	25
		Anchor Category, water-saturated concrete			-	-	3						
		Strength Reduction Factor – water-saturated concrete			$\phi_{sat,pi}$	-	0.45						

[1]Temperature Range 1: Maximum short term temperature of 150°F. Maximum long term temperature of 110°F.
[2]Short term concrete temperatures are those that occur over short intervals (diurnal cycling). Long term temperatures are constant over a significant time period.
[3]For sustained load conditions, bond strengths must be multiplied by 0.58.
[4]As detailed in Section 4.1.11 of this report, bond strength values for rebar need not be modified ($\alpha_{N,seis}$ = 1.0).

TABLE 6—EXAMPLE SET-XP EPOXY ADHESIVE ANCHOR ALLOWABLE STRESS DESIGN TENSION VALUES FOR ILLUSTRATIVE PURPOSES

Nominal Anchor Diameter, d_o (inches)	Drill Bit Diameter, d_{hole} (inches)	Effective Embedment Depth, h_{ef} (inches)	Allowable Tension Load, $\phi N_n/\alpha$ (lbs)
$^3/_8$	$^1/_2$	$2^3/_8$	946
$^1/_2$	$^5/_8$	$2^3/_4$	2181
$^5/_8$	$^3/_4$	$3^1/_8$	2857
$^3/_4$	$^7/_8$	$3^1/_2$	3450
$^7/_8$	1	$3^3/_4$	3825
1	$1^1/_8$	4	4215**
$1^1/_4$	$1^3/_8$	5	5892

Design Assumptions:
1. Single Anchor with static tension load only.
2. Vertical downward installation direction.
3. Inspection Regimen = Continuous.
4. Installation temperature = 50 - 110°F.
5. Long term temperature = 110°F.
6. Short term temperature = 150°F.
7. Dry hole condition - carbide drilled hole.
8. Embedment = $h_{ef,min}$.
9. Concrete determined to remain uncracked for the life of the anchorage.
10. Load combinations from ACI 318-14 5.3 or ACI 318-11 9.2 (no seismic loading).
11. 30% Dead Load (D) and 70% Live Load (L); Controlling load combination is 1.2 D + 1.6L
12. Calculation of α based on weighted average: α = 1.2D + 1.6L = 1.2(0.3) + 1.6(0.7) = 1.48
13. Normal weight concrete: f'_c = 2500 psi
14. c_{a1} = c_{a2} ≥ c_{ac}
15. h ≥ h_{min}

** Illustrative Procedure (reference Table 2, 4 and 5A of this report):
1" SET-XP Epoxy Adhesive Anchor (ASTM A193, Grade B7 Threaded Rod) with an Effective Embedment, h_{ef} = 4"
Step 1: Calculate Static Steel Strength in Tension per ACI 318-14 17.4.1 or ACI 318-11 D.5.1 = $\phi_{sa}N_{sa}$ = 0.75 x 75,750 = 56,810 lbs.
Step 2: Calculate Static Concrete Breakout Strength in Tension per ACI 318-14 17.4.2 or ACI 318-11 D.5.2 = $\phi_{cb}N_{cb}$ = 0.65 x 9,600 = 6,240 lbs.
Step 3: Calculate Static Bond Strength in Tension per ACI 318-14 17.4.5 or ACI 318-11 D.5.5 = $\phi_p N_a$ = 0.65 x 9,912 = 6,443 lbs.
Step 4: The controlling value (from Steps 1, 2 and 3 above) per ACI 318-14 17.3.1 or ACI 318-11 D.4.1 = ϕN_n = 6,240lbs.
Step 5: Divide the controlling value by the conversion factor α per Section 4.2.1 of this report:
$T_{allowable,ASD}$ = $\phi N_n/\alpha$ = 6,240 / 1.48 = 4,215 lbs.

TABLE 7—INSTALLATION DETAILS FOR THREADED ROD ANCHORS

Anchor Diameter (in)	Drill Bit Diameter[1,2] (in)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Number	Adhesive Retaining Cap Part Number[3]
$^3/_8$	$^1/_2$	ETB6	EMN22i	CDT10, EDT22B, EDT22AP, EDT22CKT, EDT56AP	ARC37-RP25
$^1/_2$	$^5/_8$	ETB6			ARC50-RP25
$^5/_8$	$^3/_4$	ETB6			ARC62-RP25
$^3/_4$	$^7/_8$	ETB8			ARC75-RP25
$^7/_8$	1	ETB10			ARC87-RP25
1	$1^1/_8$	ETB10			ARC100-RP25
$1^1/_4$	$1^3/_8$	ETB12			ARC125-RP25

For **SI:** = 1 inch = 25.4 mm.

[1]Rotary Hammer must be used to drill all holes.
[2]Drill bits must meet the requirements of ANSI B212.15.
[3]Adhesive Retaining Caps are to be used for horizontal and overhead anchor installations only.

**TABLE 8—INSTALLATION DETAILS FOR REINFORCING BAR ANCHORS**

Anchor Diameter (in)	Drill Bit Diameter[1,2] (in)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Number	Adhesive Retaining Cap Part Number[3]
#3	$^1/_2$	ETB6			ARC37-RP25
#4	$^5/_8$	ETB6			ARC50-RP25
#5	$^3/_4$	ETB6			ARC62-RP25
#6	$^7/_8$	ETB8	EMN22i	CDT10, EDT22B, EDT22AP, EDT22CKT, EDT56AP	ARC75-RP25
#7	1	ETB10			ARC87-RP25
#8	$1^1/_8$	ETB10			ARC100-RP25
#10	$1^3/_8$	ETB12			ARC125-RP25

For **SI:** = 1 **inch** = 25.4 mm.

[1]Rotary Hammer must be used to drill all holes.
[2]Drill bits must meet the requirements of ANSI B212.15.
[3]Adhesive Retaining Caps are to be used for horizontal and overhead anchor installations only.

TABLE 9—CURE SCHEDULE[1]

Concrete Temperature		Gel Time (minutes)	Cure Time[1] (hours)
(°F)	(°C)		
50	10	75	72
70	21	45	24
90	32	35	24
110	43	20	24

For **SI:** = 1°F = (c x $^9/_5$) + 32.

[1]For water-saturated concrete, the cure times should be doubled.

1   HOLE PREPARATION

For horizontal, vertical and overhead applications.

4 seconds (min.)
80 psi min.

4 cycles (min.)

4 seconds (min.)
80 psi min.
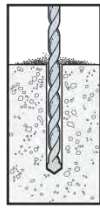
1. **Drill**–Drill hole to specified diameter and depth.
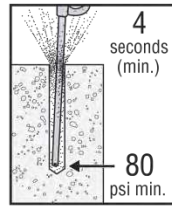
2. **Blow**–Remove dust from hole with oil-free compressed air for a minimum of 4 seconds. Compressed air nozzle MUST reach the bottom of the hole.
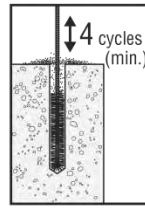
3. **Brush**–Clean with a nylon brush for a minimum of 4 cycles. Brush MUST reach the bottom of the hole. Brush should provide resistance to insertion. If no resistance is felt, the brush is worn and must be replaced.
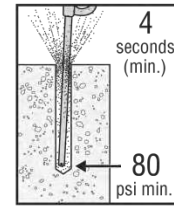
4. **Blow**–Remove dust from hole with oil-free compressed air for a minimum of 4 seconds. Compressed air nozzle MUST reach the bottom of the hole.

Note: Refer to Tables A, B and C for proper drill bit size and brush part number.

2   CARTRIDGE PREPARATION

1. **Check**–Check cartridge expiration date. **Do not use expired product.** Product is usable until end of printed expiration month.
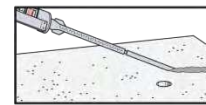
2. **Open**–Open cartridge per package instructions.
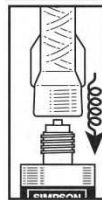
3. **Attach**–Attach proper Simpson Strong-Tie® nozzle to cartridge. Do not modify nozzle.
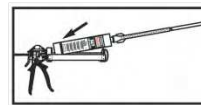
4. **Insert**–Insert cartridge into dispensing tool.

5. **Dispense**–Dispense adhesive to the side until properly mixed (uniform color).

Note: Review MSDS prior to use. Refer to Tables A, B and C for proper nozzle and dispensing tool part number. Refer to Tables F and G for proper adhesive storage temperatures, permitted concrete temperature range and adhesive gel times.
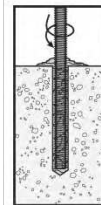
3   FILLING THE HOLE: Vertical Anchorage

Prepare the hole per instructions "Hole Preparation".
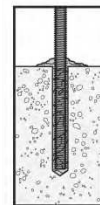
Dry and Damp Holes:
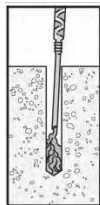
1. **Fill**–Fill hole ½ - ⅔ full, starting from the bottom to prevent air pockets. Withdraw nozzle as hole fills up. Nozzle extensions may be needed for deep holes.

2. **Insert**–Insert clean, oil free anchor (marked with the required embedment depth), turning slowly until the anchor contacts the bottom of the hole.
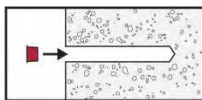
Threaded rod or rebar

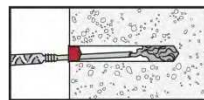3. **Do not disturb**– Do not disturb, load or torque anchor until fully cured.

Note: Refer to Table F for proper gel times and cure times and Tables D and E for maximum tightening torque.

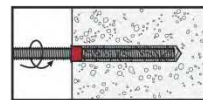**3   FILLING THE HOLE: Horizontal and Overhead Anchorage**

Prepare the hole per instructions "Hole Preparation".

1. **Install**–Install Simpson Strong-Tie® ARC adhesive retaining cap. (ARC required. Refer to Tables A, B and C.)
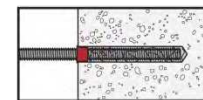
2. **Fill**–Fill hole ½ - ⅔ full, starting from the bottom to prevent air pockets. Withdraw nozzle as hole fills up. Nozzle extensions may be needed for deep holes.

3. **Insert**–Insert clean, oil free anchor (marked with the required embedment depth), turning slowly until the anchor contacts the bottom of the hole. There should be no gaps between the anchor and the sides of the hole.

Threaded rod or rebar

4. **Do not disturb**–Do not disturb, load or torque anchor until fully cured. For overhead installations, the anchor must be secured from movement during the cure time (e.g. wedges or other restraint methods).

Threaded rod or rebar

Note: Refer to Table F for proper gel times and cure times and Tables D and E for maximum tightening torque.

FIGURE 1–INSTALLATION DETAILS

Table A - Installation Details for Threaded Rod Anchors

Anchor Diameter (in)	Drill Bit Diameter[1,2] (in)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Number	Adhesive Retaining Cap Part Number[3]
$^3/_8$	$^1/_2$	ETB6			ARC37-RP25
$^1/_2$	$^5/_8$	ETB6			ARC50-RP25
$^5/_8$	$^3/_4$	ETB6		CDT10, EDT22B, EDT22AP, EDT22CKT, EDT56AP	ARC62-RP25
$^3/_4$	$^7/_8$	ETB8	EMN22i		ARC75-RP25
$^7/_8$	1	ETB10			ARC87-RP25
1	$1^1/_8$	ETB10			ARC100-RP25
$1^1/_4$	$1^3/_8$	ETB12			ARC125-RP25

[1]Rotary Hammer must be used to drill all holes.
[2]Drill bits must meet the requirements of ANSI B212.15.
[3]Adhesive Retaining Caps are to be used for horizontal and overhead anchor installations only.

Table B - Installation Details for Reinforcing Bar Anchors

Anchor Diameter (in)	Drill Bit Diameter[1,2] (in)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Numbers	Adhesive Retaining Cap Part Number[3]
#3	$^1/_2$	ETB6			ARC37-RP25
#4	$^5/_8$	ETB6			ARC50-RP25
#5	$^3/_4$	ETB6		CDT10, EDT22B, EDT22AP, EDT22CKT, EDT56AP	ARC62-RP25
#6	$^7/_8$	ETB8	EMN22i		ARC75-RP25
#7	1	ETB10			ARC87-RP25
#8	$1^1/_8$	ETB10			ARC100-RP25
#10	$1^3/_8$	ETB12			ARC125-RP25

[1]Rotary Hammer must be used to drill all holes.
[2]Drill bits must meet the requirements of ANSI B212.15.
[3]Adhesive Retaining Caps are to be used for horizontal and overhead anchor installations only.

Table D - Anchor Tightening Torque, Embedment Depth and Placement Details

Anchor Diameter (in)	Maximum Tightening Torque T_{inst} (ft-lb)	Min. Emb. Depth $h_{ef,min}$ (in)	Max. Emb. Depth $h_{ef,max}$ (in)	Min. Anchor Spacing s_{min} (in)	Min. Edge Distance c_{min} (in)	Min. Concrete Thickness h_{min} (in)
$^3/_8$	10	$2^3/_8$	$7^1/_2$			
$^1/_2$	20	$2^3/_4$	10			
$^5/_8$	30	$3^1/_8$	$12^1/_2$			
$^3/_4$	45	$3^1/_2$	15	3	$1^3/_4$	$h_{ef} + 5d_o$
$^7/_8$	60	$3^3/_4$	$17^1/_2$			
1	80	4	20			
$1^1/_4$	125	5	25	6	$2^3/_4$	

Table C - Cure Schedule

| Concrete Temperature		Gel Time	Cure Time[1]
(°F)	(°C)	(minutes)	(hours)
50	10	75	72
70	21	45	24
90	32	35	24
110	43	20	24

[1]For water-saturated concrete, the cure times should be doubled.

Table E - Storage Information

Storage Temperature		Shelf Life (months)
(°F)	(°C)	
45 to 90	7 to 32	24

FIGURE 1—INSTALLATION DETAILS (Continued)

Determine if a single ½" diameter ASTM A193 Grade B7 anchor rod in SET-XP™ epoxy adhesive with a minimum 4½" embedment ($h_{ef} = 4½$") installed 1¾" from the edge of a 12" deep spandrel beam is adequate for a strength level tension load of 1,040 lb. for wind and a reversible strength level shear load of 440 lb. for wind. The anchor will be in the tension zone, away from other anchors in f'_c = 3,000 psi normal-weight concrete (dry). Continuous inspection will be provided.
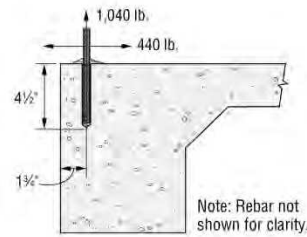
CALCULATIONS AND DISCUSSION	**REFERENCE**

1. Determine the Factored Tension and Shear Design Loads: — *ACI 318, 9.2.1*

$N_{ua} = 1.0W = 1.0 \times 1,040 = 1,040$ lb.

$V_{ua} = 1.0W = 1.0 \times 440 = 440$ lb.

2. Design Considerations: — *D.4.1.1*

This is a combined tension & shear interaction problem where values for both ϕN_n and ϕV_n need to be determined. ϕN_n is the lesser of the design tension strength controlled by: steel (ϕN_{sa}), concrete breakout (ϕN_{cb}), or adhesive (ϕN_a). ϕV_n is the lesser of the design shear strength controlled by: steel (ϕV_{sa}), concrete breakout (ϕV_{cb}), or pryout (ϕV_{cp}).

3. Steel capacity under tension loading: — *D.5.1*

$\phi N_{sa} \geq N_{ua}$ — *Table D.4.1.1*

$N_{sa} = 17,750$ lb. — *Table 2*

$\phi = 0.75$ — *Table 2*

Calculating for ϕN_{sa}:

$\phi N_{sa} = 0.75 \times 17,750 = 13,313$ lb. > 1,040 lb. – OK

4. Concrete breakout capacity under tension loading: — *D.5.2*

$\phi N_{cb} \geq N_{ua}$ — *Table D.4.1.1*

$$N_{cb} = \frac{A_{Nc}}{A_{Nco}} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$$ — *Eq. (D-3)*

where:

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$$ — *Eq. (D-6)*

substituting:

$$\phi N_{cb} = \phi \frac{A_{Nc}}{A_{Nco}} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$$

where:

$k_c = k_{cr} = 17$ — *Table 4*
(Anchor is installed in a tension zone, therefore, cracking is assumed at service loads)

$\lambda_a = \lambda = 1.0$ (Normal-weight concrete) — *8.6.1 & D.3.6*

$\Psi_{cp,N} = 1.0$ — *D.5.2.7*

$$\Psi_{ed,N} = 0.7 + 0.3 \frac{c_{a,min}}{1.5 h_{ef}}$$ when $c_{a,min} < 1.5 h_{ef}$ — *Eq. (D-10)*

by observation, $c_{a,min} < 1.5 h_{ef}$

$$\Psi_{ed,N} = 0.7 + 0.3 \frac{1.75}{1.5(4.5)} = 0.78$$

$\Psi_{c,N} = 1.0$ — *D.5.2.6*
(assuming cracking at service loads)

$\phi = 0.65$ for Condition B — *Table 4*
(no supplementary reinforcement provided)

$A_{Nco} = 9 h_{ef}^2$ — *Eq. (D-5)*
$\quad = 9(4.5)^2$
$\quad = 182.25$ in.²

$A_{Nc} = (c_{a1} + 1.5 h_{ef})(2 \times 1.5 h_{ef})$ — *Fig. RD.5.2.1(a)*
$\quad = (1.75 + 1.5(4.5))(2 \times 1.5(4.5))$
$\quad = 114.75$ in.²

$$\frac{A_{Nc}}{A_{Nco}} = \frac{114.75}{182.25} = 0.63$$

Calculating for ϕN_{cb}:

$\phi N_{cb} = 0.65 \times 0.63 \times 1.0 \times 0.78 \times 1 \times 17 \times 1 \times \sqrt{2,500} \times (4.5)^{1.5} = 2,592$ lb. > 1,040 lb. – OK

FIGURE 2—EXAMPLE CALCULATION

CALCULATIONS AND DISCUSSION	REFERENCE

5. Adhesive anchor capacity under tension loading: *D.5.5*

$$\phi N_a \geq N_{ua}$$ *Table D.4.1.1*

$$N_a = \frac{A_{Na}}{A_{Nao}}\, \Psi_{ed,Na}\Psi_{cp,Na}N_{ba}$$ *Eq. (D-18)*

$$N_{ba} = \lambda_a\tau_{cr}\pi d_a h_{ef} = 1 \times 880 \times \pi \times 0.5 \times 4.5 = 6{,}220 \text{ lb.}$$ *Eq. (D-22)*

$$c_{Na} = 10d_a\sqrt{\frac{\tau_{uncr}}{1{,}100}}$$ *Eq. (D-21)*

$$c_{Na} = 10(0.5)\sqrt{\frac{1{,}985}{1{,}100}} = 6.72 \text{ in.}$$

$$A_{Nao} = (2c_{Na})^2 = (2 \times 6.72)^2 = 180.63 \text{ in.}^2$$ *Eq. (D-20)*

$$A_{Na} = (c_{a1} + c_{Na})(2c_{Na}) = (1.75 + 6.72)(13.44) = 113.84 \text{ in.}^2$$ *Fig. RD.5.5.1*

$$\Psi_{ed,Na} = \left(0.7 + 0.3\frac{c_{a,min}}{c_{Na}}\right) \leq 1.0 \quad Since\ c_{a,min} < c_{Na}$$ *Eq. (D-25)*

$$\Psi_{ed,Na} = \left(0.7 + 0.3\frac{c_{a,min}}{c_{Na}}\right) = \left(0.7 + 0.3\frac{1.75}{6.72}\right) = 0.78$$

$$\Psi_{cp,Na} = 1.0$$ *D.5.5.5*

$$\phi = 0.65 \text{ for dry concrete}$$ *Table 5*

Calculating for ϕN_a:

$$\phi N_a = 0.65 \times \frac{113.84}{180.63} \times 0.78 \times 1 \times 6{,}220 = 1{,}987 \text{ lb.} > 1{,}040 \text{ lb.} - OK$$

6. Check all failure modes under tension loading: *D.4.1.1*
Summary:
Steel capacity   = 13,313 lb.
Concrete breakout capacity = 2,592 lb.
Adhesive capacity   = 1,987 lb. ← **Controls**
∴ $\phi N_n = $ **1,987 lb. as adhesive capacity controls**

7. Steel capacity under shear loading: *D.6.1*

$$\phi V_{sa} \geq V_{ua}$$ *Table D.4.1.1*
$$V_{sa} = 10{,}650 \text{ lb.}$$ *Table 2*
$$\phi = 0.65$$ *Table 2*
Calculating for ϕV_{sa}:
$$\phi V_{sa} = 0.65 \times 10{,}650 = 6{,}923 \text{ lb.} > 440 \text{ lb.} - OK$$

CALCULATIONS AND DISCUSSION	REFERENCE

8. Concrete breakout capacity under shear loading: *D.6.2*

$$\phi V_{cb} \geq V_{ua}$$ *Table D.4.1.1*

$$V_{cb} = \frac{A_{Vc}}{A_{Vo}}\,\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_b$$ *Eq. (D-30)*

where:

$$V_b = \left(7\left(\frac{\ell_e}{d_a}\right)^{0.2}\sqrt{d_a}\right)\lambda_a\sqrt{f'_c}\,(c_{a1})^{1.5}$$ *Eq. (D-33)*

substituting:

$$\phi V_{cb} = \phi\,\frac{A_{Vc}}{A_{Vo}}\,\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}\left(7\left(\frac{\ell_e}{d_a}\right)^{0.2}\sqrt{d_a}\right)\lambda_a\sqrt{f'_c}\,(c_{a1})^{1.5}$$

where:

$\phi = 0.70$ *for Condition B*
(no supplementary reinforcement provided)   *Table 4*

$$A_{Vco} = 4.5c_{a1}^2$$ *Eq. (D-32)*
$$= 4.5(1.75)^2$$
$$\therefore A_{Vco} = 13.78 \text{ in.}^2$$

$$A_{Vc} = 2(1.5c_{a1})(1.5c_{a1})$$ *Fig. RD.6.2.1(a)*
$$= 2(1.5(1.75))(1.5(1.75))$$
$$\therefore A_{Vc} = 13.78 \text{ in.}^2$$

$$\frac{A_{Vc}}{A_{Vco}} = \frac{13.78}{13.78} = 1$$

$$h_a = 12 \text{ in.}$$

$$\Psi_{h,V} = 1.0 \text{ since } h_a > 1.5c_{a1}$$ *D.6.2.8*

$$\Psi_{ed,V} = 1.0 \text{ since } c_{a2} > 1.5c_{a1}$$ *Eq. (D-37)*

$$\Psi_{c,V} = 1.0$$ *D.6.2.7*
(assuming cracking at service loads)

$$\lambda_a = \lambda = 1.0 \text{ (Normal-weight concrete)}$$ *8.6.1 & D.3.6*

$$d_a = 0.5 \text{ in.}$$

$$\ell_e = 8d_0 = 8(0.5) = 4 \text{ in.}$$ *D.6.2.2*

$$c_{a1} = 1.75 \text{ in.}$$

$$\phi V_{cb} = 0.70 \times 1 \times 1 \times 1 \times 1 \times 7 \times \left(\frac{4}{0.5}\right)^{0.2} \times \sqrt{0.5} \times 1$$
$$\times \sqrt{3{,}000} \times (1.75)^{1.5} = 666 \text{ lb.} > 440 \text{ lb.} - OK$$

9. Concrete pryout capacity   *D.6.3*

$$V_{cp} = \min[k_{cp}N_a; k_{cp}N_{cb}]$$ *Eq. (D-40)*

$$k_{cp} = 2.0 \text{ for } h_{ef} \geq 2.5"$$

$$N_a = 3{,}057 \text{ lb. } from\ adhesive\text{-}capacity\ calculation\ without\ \phi\ factor$$

$$N_{cb} = 3{,}988 \text{ lb. } from\ concrete\text{-}breakout\ calculation\ without\ \phi\ factor$$

$$V_{cp} = (2.0)(3{,}057) = 6{,}114 \text{ lb. } controls$$

$$\phi = 0.7$$ *Table 4*

$$\phi V_{cp} = (0.7)(6{,}114) = 4{,}280 \text{ lb.} > 440 \text{ lb.} - OK$$

FIGURE 2—EXAMPLE CALCULATION (CONTINUED)

CALCULATIONS AND DISCUSSION	REFERENCE

10. Check all failure modes under shear loading: D.4.1.1

Summary:

Steel capacity   = 6,923 lb.

Concrete breakout capacity = 666 lb. ← **Controls**

Pryout capacity   = 4,280 lb.

∴ ϕV_n = **666 lb. as concrete breakout capacity controls**

11. Check interaction of tension and shear forces: D.7

If $V_{ua} / (\phi V_n) \leq 0.2$, then the full tension
design strength is permitted. D.7.1

By observation, this is not the case.

If $N_{ua} / (\phi N_n) \leq 0.2$, then the full shear
design strength is permitted D.7.2

By observation, this is not the case.

Therefore:

$$\frac{N_{ua}}{\phi N_n} + \frac{V_{ua}}{\phi V_n} \leq 1.2$$ Eq. (D-42)

$$\frac{1,040}{1,987} + \frac{440}{666} = 0.52 + 0.66 = 1.18 < 1.2 - OK$$

12. Summary

A single ½" diameter ASTM A193 Grade B7 anchor rod in SET-XP™
epoxy adhesive at a 4½" embedment depth is adequate to resist
the applied strength level tension and shear wind loads of 1,040 lb. and
440 lb., respectively.

FIGURE 2—EXAMPLE CALCULATION (CONTINUED)