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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

EVALUATION SUBJECT:

ET-HP® EPOXY ADHESIVE ANCHORS FOR CRACKED AND UNCRACKED CONCRETE

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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:

ET-HP® 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)

Property evaluated:

Structural

2.0 USES

The ET-HP® 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) with fractional steel threaded rods, metric steel threaded rods, and fractional reinforcing bars.

The ET-HP 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 cast-in-place 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 ET-HP Epoxy Adhesive Anchor System is comprised of the following components:

- ET-HP epoxy adhesive packaged in cartridges
- Adhesive mixing and dispensing equipment
- Equipment for hole cleaning and adhesive injection

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

3.2 Materials:

3.2.1 ET-HP Epoxy: ET-HP Epoxy is an injectable, two-component, 100 percent solids, epoxy adhesive that is mixed in a 1-to-1 volume ratio of hardener to resin. ET-HP is available in 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 ET-HP 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).

3.2.2 Dispensing Equipment: ET-HP epoxy must be dispensed using Simpson Strong-Tie manual dispensing tools, battery-powered dispensing tools or pneumatic dispensing tools as listed in Tables 17, 18, and 19 of this report.

3.2.3 Equipment for Hole Preparation: Hole cleaning equipment consists of brushes and air nozzles. Brushes must be Simpson Strong-Tie hole cleaning brushes, identified by Simpson Strong-Tie catalog number series ETB. See Tables 17, 18, and 19 of 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 Steel Anchor Materials:

3.2.4.1 Threaded Steel Rods: Threaded anchor rods in fractional 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. Metric threaded rods in diameters from 10 mm to 30 mm (0.393 inch to 1.18 inches) must be carbon steel conforming to ISO 898-1 Class 5.8 or 8.8; or stainless steel conforming to ISO 3506-1 Class A4. Tables 5 and 7 of this report provide additional details. Threaded rods must be 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), in fractional sizes from No. 3 to No. 8, and No. 10, must conform to ASTM A615 Grade 60 or ASTM A706 Grade 60. Table 6 in this report provides additional details. Metric deformed steel rebars in sizes from 10 mm to 32 mm must conform to DIN 488 BSt 500. Table 8 of 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 26.6.3.1 (b) or ACI 318-11 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 the 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.

3.3 Concrete:

Normal-weight concrete must comply with Sections 1903 and 1905 of the IBC, as applicable. 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:

4.1.1 General: The design strength of achors 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, -08, -05) and 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 provided in Tables 5 through 15 are based on ACI 318-14 for 2015 IBC and ACI 318-11 for 2012, 2009 and 2006 IBC unless noted otherwise in Sections 4.1.1 through 4.1.11 of this report.

The strength reduction factors, ϕ, as given in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, must be used for load combinations calculated in accordance with Section 1605.2 of the IBC and ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, and given in Tables 5, 6, 7 and 8 for the anchor element types included in this report. Strength reduction factors, ϕ, as 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 static 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 factor, ϕ, are given in Tables 5, 6, 7, and 8 for the anchor element types included in this report.

4.1.3 Static Concrete Breakout Strength in Tension: The nominal 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.

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 Tables 9, 10, and 11 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 MPa) in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

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 and the installation condition (dry or water-saturated concrete). Strength reduction factors, ϕ, listed below and in Tables 12, 13, 14 and 15 are utilized for anchors installed in dry or saturated concrete as follows:

BOND STRENGTH TABLE NUMBER	PERMISSIBLE INSTALLATION CONDITION	BOND STRENGTH	ASSOCIATED STRENGTH REDUCTION FACTOR
12, 13, 14, and 15	Dry concrete	$\tau_{k,n}$	ϕ_{dry}
12, 13, 14, and 15	Water-saturated	$\tau_{k,n}$	ϕ_{sat}

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

4.1.5 Static Steel Strength in Shear: The nominal static 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 the strength reduction factors, ϕ, are given in Tables 5, 6, 7, and 8 for the anchor element types included in this report.

4.1.6 Static Concrete Breakout Strength in Shear: The nominal 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 Tables 9, 10 and 11 of this report. 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_0 given in Tables 9, 10, and 11 for the corresponding anchor steel in lieu of d_a (2015, 2012 and 2009 IBC). In addition, h_{ef} shall be substituted for ℓ_e. In no case shall ℓ_e exceed $8d_0$. The value of f'_c must be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as appliable.

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}, Minimum Anchor Spacing, s_{min}, and Minimum 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, respectively, as applicable, values of s_{min} and c_{min} provided in Tables 1, 2, 3, and 4 of this report must be observed for anchor design and installation. The minimum member thicknesses, h_{min}, described in Tables 1, 2, 3, and 4 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} and $\psi_{cp,Na}$: The modification factor $\psi_{cp,Na}$, must be determined in accordance with ACI 318-14 17.4.5.5 or ACI 318-11 D.5.5.5, as applicable, except as noted below:

For all cases where $c_{Na}/c_{ac}<1.0$, $\psi_{cp,Na}$ determined from ACI 318-14 Eq. 17.4.5.5b or ACI 318-11 Eq. D-27, as applicable, 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 Eq. 17.4.5.5c for ACI 318-14 or Eq. D-27a for ACI 318-11, in lieu of ACI 318-14 17.7.6 or ACI 318-11 D.8.6, as applicable.

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

(Eq. 17.4.5.5c for ACI 318-14 or Eq. D-27a for ACI 318-11)

where

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

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

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

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, anchors must be designed in accordance with ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable, except as described below. 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. Modifications to ACI 318 (-08, -05) D 3.3 must be applied under Section 1908.1.9 of the 2009 IBC or Section 1908.1.16 of the 2006 IBC, as applicable.

The nominal steel shear strength, V_{sa}, must be adjusted by $\alpha_{V,seis}$ as given in Tables 5, 6, and 7 for the corresponding anchor steel. The nominal bond strength $\tau_{\kappa,cr}$ must be adjusted by $\alpha_{N,seis}$ as given in Tables 12 and 14 of this report. For Table 13, no adjustment to the bond strength $\tau_{k,cr}$ is required.

As an exception to ACI 318-11 D.3.3.4.2: 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).

Under ACI 318-11 D.3.3.4.3(d), in lieu of requiring the anchor design tensile strength to satisfy the tensile strength requirements of ACI 318-11 D.4.1.1, the anchor design tensile strength shall be calculated from ACI 318-11 D.3.3.4.4.

The following exceptions apply to ACI 318-11 D.3.3.5.2:

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 satisfied:

   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 satisfied:

   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 Appedix 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 (lbf or N).

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 (lbf or N).

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 16 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 Tables 1, 2, 3, and 4 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, -08, -05) 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, $T_{allowable,ASD}$, shall 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 Tables 1, 2, 3, 4, 17, 18, 19 and 20, and in Figure 1. Installation must be in accordance with ACI 318-14 17.8.1 and 17.8.2; ACI 318-11 D.9.1 and D.9.2; or ACI 318 (-08, -05) D.9.1, as applicable. Anchor locations must comply with this report and the plans and specifications approved by the building official. Installation of the ET-HP Epoxy Anchor System must conform to the manufacturer's printed installation instructions (MPII) included in each package unit and as reproduced in Figure 1. The nozzles, brushes, dispensing tools and adhesive retaining caps listed in Tables 17, 18, and 19, supplied by the manufacturer, must be used along with the adhesive cartridges.

Metric threaded rod anchors and reinforcing bars may be used for floor (vertically down) applciations. Fractional threaded rod anchors and reinforcing bars may be used for floor (vertically down), wall (horizontal), and overhead applications. For horizontal and overhead applications with $^3/_8$" anchors and #3 reinforcing bars, inject the adhesive directly to the back of the hole using the adhesive tubing as described in Table 17 cut to convenient lengths. For horizontal and overhead applications with $^1/_2$" through 1-$^1/_4$" anchors and #4 through #10 reinforcing bars, inject the adhesive directly to the back of the hole using the adhesive piston plugs and adhesive tubing cut to convenient lengths, as described in Table 17. Use of anchors in water-filled holes or submerged concrete is beyond the scope of this report.

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.

4.4 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 1714.15 and Table 1704.4 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.

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 318-11 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.

5.0 CONDITIONS OF USE

The Simpson Strong-Tie ET-HP Epoxy 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 ET-HP Epoxy Anchors must be installed in accordance with the manufacturer's printed installation instructions (MPII) as shown in Figure 1 of this report.

5.2 The anchors described in this report must be installed in cracked or 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 values of f'_c used for calculation purposes must not exceed 8,000 psi (55 MPa).

5.4 Anchors must be installed in concrete base materials in holes predrilled 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 ET-HP epoxy anchors are recognized for use to resist short- and long-term loads, including wind and earthquake, subject to the conditions of this report.

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.

5.8 ET-HP 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, with the excetion of metric reinforcing bar which is limited to installation in uncracked concrete, 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 provided in this report.

5.12 Prior to anchor 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, ET-HP 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 carbon steel or stainless steel. The minimum coating weights for zinc-coated steel must comply with ASTM A153.

5.18 Periodic 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 ET-HP epoxy 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

Data in accordance with the ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors in Concrete (AC308), dated October 2017, which incorporates requirements in ACI 355.4-11; and quality-control documentation.

7.0 IDENTIFICATION

7.1 ET-HP epoxy is identified in the field by labels on the cartridge or packaging, bearing the company name (Simpson Strong-Tie Company, Inc.), product name (ET-HP), the batch number, the expiration date, and the evaluation report number (ESR-3372).

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

TABLE 1—ET-HP EPOXY ADHESIVE ANCHOR INSTALLATION INFORMATION – FRACTIONAL THREADED ROD

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	15	25	40	50	60	80	150
Minimum Embedment Depth	$h_{ef,min}$	in.	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^3/_4$	4	5
Maximum Embedment Depth	$h_{ef,max}$	in.	$4^1/_2$	6	$7^1/_2$	9	$10^1/_2$	12	15
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—ET-HP EPOXY ADHESIVE ANCHOR INSTALLATION INFORMATION – FRACTIONAL REINFORCING BAR (REBAR)

Characteristic	Symbol	Units	Bar Size						
			#3	#4	#5	#6	#7	#8	#10
Drill Bit Diameter	d_{hole}	in.	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_8$	$1^3/_8$
Minimum Embedment Depth	$h_{ef,min}$	in.	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^3/_4$	4	5
Maximum Embedment Depth	$h_{ef,max}$	in.	$4^1/_2$	6	$7^1/_2$	9	$10^1/_2$	12	15
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

TABLE 3—ET-HP EPOXY ADHESIVE ANCHOR INSTALLATION INFORMATION – METRIC THREADED ROD

Characteristic	Symbol	Units	Nominal Rod Diameter d_o (mm)						
			10	12	16	20	24	27	30
Drill Bit Diameter	d_{hole}	mm	12	14	18	24	28	30	35
Maximum Tightening Torque	T_{inst}	N-m	25	35	50	75	100	120	200
Minimum Embedment Depth	$h_{ef,min}$	mm	60	70	80	90	100	110	120
Maximum Embedment Depth	$h_{ef,max}$	mm	120	144	192	240	288	324	360
Minimum Concrete Thickness	h_{min}	mm	$h_{ef} + 5d_o$						
Critical Edge Distance	c_{ac}	mm	See Section 4.1.10 of this report.						
Minimum Edge Distance	c_{min}	mm	45						70
Minimum Anchor Spacing	s_{min}	mm	76						152

For inch-pounds: 1 mm = 0.04 inch, 1 Nm = 0.738 ft-lb

TABLE 4—ET-HP EPOXY ADHESIVE ANCHOR INSTALLATION INFORMATION – METRIC REINFORCING BAR (REBAR)

Characteristic	Symbol	Units	Bar Size						
			10	12	16	20	25	28	32
Drill Bit Diameter	d_{hole}	mm	14	16	20	25	30	35	40
Minimum Embedment Depth	$h_{ef,min}$	mm	60	70	80	90	100	115	130
Maximum Embedment Depth	$h_{ef,max}$	mm	200	240	320	400	500	560	640
Minimum Concrete Thickness	h_{min}	mm	$h_{ef} + 5d_o$						
Critical Edge Distance	c_{ac}	mm	See Section 4.1.10 of this report.						
Minimum Edge Distance	c_{min}	mm	45						70
Minimum Anchor Spacing	s_{min}	mm	76						152

For inch-pounds: 1 mm = 0.04 inch

TABLE 5—STEEL DESIGN INFORMATION FOR FRACTIONAL 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_o	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.	4,525	8,235	13,110	19,370	26,795	35,150	56,200
Tension Resistance of Steel - ASTM A193, Grade B7			9,750	17,750	28,250	41,750	57,750	75,750	121,125
Tension Resistance of Steel - Stainless Steel ASTM A193, Grade B6 (Type 410)			8,580	15,620	24,860	36,740	50,820	66,660	106,590
Tension Resistance of Steel - Stainless Steel ASTM A193, Grade B8 and B8M (Types 304 and 316)			4,445	8,095	12,880	19,040	26,335	34,540	55,235
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.	2,260	4,940	7,865	11,625	16,080	21,090	33,720
Shear Resistance of Steel - ASTM A193, Grade B7			4,875	10,650	16,950	25,050	34,650	45,450	72,675
Shear Resistance of Steel - Stainless Steel ASTM A193, Grade B6 (Type 410)			4,290	9,370	14,910	22,040	30,490	40,000	63,955
Shear Resistance of Steel - Stainless Steel ASTM A193, Grade B8 and B8M (Types 304 and 316)			2,225	4,855	7,730	11,425	15,800	20,725	33,140
Reduction for Seismic Shear- Carbon Steel- ASTM F1554, Grade 36 and ASTM A193, Grade B7	$\alpha_{V,seis}$	-	0.63		0.85			0.75	
Reduction for Seismic Shear- Stainless Steel- ASTM A193, Grade B6, B8, B8M (Type 410, 304, 316)	$\alpha_{V,seis}$	-	0.60		0.85			0.75	
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 6—STEEL DESIGN INFORMATION FOR FRACTIONAL REINFORCING BAR (REBAR)

Characteristic	Symbol	Units	Bar Size						
			#3	#4	#5	#6	#7	#8	#10
Nominal Diameter	d_o	in.	0.375	0.5	0.625	0.75	0.875	1.0	1.25
Minimum Tensile Stress Area	A_{se}	in.^{2}	0.11	0.20	0.31	0.44	0.60	0.79	1.27
Tension Resistance of Steel - Rebar (ASTM A615 Gr.60)	N_{sa}	lb.	9,900	18,000	27,900	39,600	54,000	71,100	114,300
Tension Resistance of Steel - Rebar (ASTM A706 Gr.60)			8,800	16,000	24,800	35,200	48,000	63,200	101,600
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	0.60	0.79	1.27
Shear Resistance of Steel - Rebar (ASTM A615 Gr. 60)	V_{sa}	lb.	4,950	10,800	16,740	23,760	32,400	42,660	68,580
Shear Resistance of Steel - Rebar (ASTM A706 Gr. 60)			4,400	9,600	14,880	21,120	28,880	37,920	60,960
Reduction factor for Seismic Shear- (ASTM A615 Gr. 60 and A706 Gr. 60)	$\alpha_{V,seis}$	-	0.60		0.80			0.75	
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 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 7—STEEL DESIGN INFORMATION FOR METRIC THREADED ROD

Characteristic	Symbol	Units	Nominal Rod Diameter (mm)						
			10	12	16	20	24	27	30
Nominal Diameter	d_o	mm	10	12	16	20	24	27	30
Minimum Tensile Stress Area	A_{se}	mm^2	58	84.3	157	245	353	459	561
Tension Resistance of Steel - ISO 898-1 Class 5.8	N_{sa}	kN	29.0	42.0	78.5	122.5	176.5	229.5	280.5
Tension Resistance of Steel - ISO 898-1 Class 8.8			46.5	67.5	125.5	196.0	282.5	367.0	449.0
Tension Resistance of Steel - Stainless Steel ISO 3506 -1 Class A4[2]			40.6	59.0	109.9	171.5	247.1	183.1	223.8
Strength Reduction Factor for Tension - Steel Failure[1]	ϕ	-	0.65						
Minimum Shear Stress Area	A_{se}	mm^2	58	84.3	157	245	353	459	561
Shear Resistance of Steel - ISO 898-1 Class 5.8	V_{sa}	kN	14.5	25.5	47.0	73.5	106.0	137.5	168.5
Shear Resistance of Steel - ISO 898-1 Class 8.8			23.0	40.5	75.5	117.5	169.5	220.5	269.5
Shear Resistance of Steel - Stainless Steel ISO 3506 -1 Class A4[2]			20.3	35.4	65.9	102.9	148.3	109.9	134.3
Reduction for Seismic Shear- Carbon Steel- ISO 898-1 Class 5.8 and Class 8.8	$\alpha_{V,seis}$	-	0.63		0.85			0.75	
Reduction for Seismic Shear- Stainless Steel- ISO 3506-1 Class A4[2]	$\alpha_{V,seis}$	-	0.60		0.85			0.75	
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 ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

[2]A4-70 Stainless (M10-M24); A4-50 Stainless (M27 & M30)

TABLE 8—STEEL DESIGN INFORMATION FOR METRIC REINFORCING BAR (REBAR)

Characteristic	Symbol	Units	Bar Size						
			10	12	16	20	25	28	32
Nominal Diameter	d_o	mm	10	12	16	20	25	28	32
Minimum Tensile Stress Area	A_{se}	mm^2	78.5	113.1	201.1	314.2	490.9	615.8	804.2
Tension Resistance of Steel - Rebar (DIN 488 BSt 500)	N_{sa}	kN	43.0	62.0	110.5	173.0	270.0	338.5	442.5
Strength Reduction Factor for Tension - Steel Failure[1]	ϕ	-	0.65						
Minimum Shear Stress Area	A_{se}	mm^2	78.5	113.1	201.1	314.2	490.9	615.8	804.2
Shear Resistance of Steel - Rebar (DIN 488 BSt 500)	V_{sa}	kN	26.0	37.5	66.5	103.0	162.0	203.0	265.5
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 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 9—CONCRETE BREAKOUT AND PRYOUT DESIGN INFORMATION FOR FRACTIONAL THREADED ROD AND REBAR

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_o	in.	0.375	0.5	0.625	0.75	0.875	1	1.25
Minimum Embedment Depth	$h_{ef,min}$	in.	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^3/_4$	4	5
Maximum Embedment Depth	$h_{ef,max}$	In.	$4^1/_2$	6	$7^1/_2$	9	$10^1/_2$	12	15
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	$k_{c,uncr}$	-	24						
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	-	17						
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, 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 318-11 D.4.4 for Condition B.

TABLE 10—CONCRETE BREAKOUT AND PRYOUT DESIGN INFORMATION FOR METRIC THREADED ROD

Characteristic	Symbol	Units	Nominal Rod Diameter d_0 (mm)						
			10	12	16	20	24	27	30
Minimum Embedment Depth	$h_{ef,min}$	mm	60	70	80	90	100	110	120
Maximum Embedment Depth	$h_{ef,max}$	mm	120	144	192	240	288	324	360
Minimum Concrete Thickness	h_{min}	mm	$h_{ef} + 5d_o$						
Critical Edge Distance	c_{ac}	mm	See Section 4.1.10 of this report.						
Minimum Edge Distance	c_{min}	mm	45						70
Minimum Anchor Spacing	s_{min}	mm	76						152
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	-	10						
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	-	7.1						
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, 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 318-11 D.4.4 for Condition B.

TABLE 11—CONCRETE BREAKOUT AND PRYOUT DESIGN INFORMATION FOR METRIC REINFORCING BAR (REBAR)

Characteristic	Symbol	Units	Nominal Rebar Diameter d_o (mm)						
			10	12	16	20	25	28	32
Minimum Embedment Depth	$h_{ef,min}$	mm	60	70	80	90	100	115	130
Maximum Embedment Depth	$h_{ef,max}$	mm	200	240	320	400	500	560	640
Minimum Concrete Thickness	h_{min}	mm	$h_{ef} + 5d_o$						
Critical Edge Distance	c_{ac}	mm	See Section 4.1.10 of this report.						
Minimum Edge Distance	c_{min}	mm	45						70
Minimum Anchor Spacing	s_{min}	mm	76						152
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	-	10						
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, 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 318-11 D.4.4 for Condition B.

TABLE 12—ET-HP EPOXY ANCHOR BOND STRENGTH DESIGN INFORMATION- FRACTIONAL THREADED ROD FOR TEMPERATURE RANGE 1[1,2]

Condition	Characteristic		Symbol	Units	Nominal Rod Diameter d_o (inch)						
					$^3/_8$"	$^1/_2$"	$^5/_8$"	$^3/_4$"	$^7/_8$"	1"	$1^1/_4$"
Uncracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	psi	1,055	1,025	1,000	970	940	910	850
	Permitted 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	$h_{ef,max}$		$4^1/_2$	6	$7^1/_2$	9	$10^1/_2$	12	15
Cracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,cr}$	psi	430	535	430	560	520	445	375
	Permitted Embedment Depth Range	Minimum	$h_{ef,min}$	in.	3	3	$3^1/_8$	$3^1/_2$	$3^3/_4$	4	5
		Maximum	$h_{ef,max}$		$4^1/_2$	6	$7^1/_2$	9	$10^1/_2$	12	15
Reduction for Seismic Tension[4]			$\alpha_{N,seis}$	-	0.78	0.85	0.85	0.85	0.82	0.70	0.78
Periodic Inspection	Anchor Category- Dry Concrete		-	-	1						
	Strength Reduction Factor - Dry Concrete		ϕ_{dry}	-	0.65						
	Anchor Category- Water-saturated Concrete		-	-	3						
	Strength Reduction Factor - Water-saturated Concrete		ϕ_{sat}	-	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 load combinations including sustained loads, multiply bond strength by 0.37.
[4]See Section 4.1.11 for additional information regarding seismic design requirements.

TABLE 13—ET-HP EPOXY ANCHOR BOND STRENGTH DESIGN INFORMATION- FRACTIONAL REINFORCING BAR (REBAR) FOR TEMPERATURE RANGE 1[1,2]

Condition	Characteristic		Symbol	Units	Bar Size						
					#3	#4	#5	#6	#7	#8	#10
	Nominal Diameter		d_0	in.	0.375	0.5	0.625	0.75	0.875	1.0	1.25
Uncracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	psi	995	970	940	910	885	855	800
	Permitted 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	$h_{ef,max}$		$4^1/_2$	6	$7^1/_2$	9	$10^1/_2$	12	15
Cracked Concrete	Characteristic Bond Strength[3,4]		$\tau_{k,cr}$	psi	345	380	415	450	480	515	580
	Permitted Embedment Depth Range	Minimum	$h_{ef,min}$	in.	3	3	$3^1/_8$	$3^1/_2$	$3^3/_4$	4	5
		Maximum	$h_{ef,max}$		$4^1/_2$	6	$7^1/_2$	9	$10^1/_2$	12	15
Periodic Inspection	Anchor Category- Dry Concrete		-	-	1						
	Strength Reduction Factor - Dry Concrete		ϕ_{dry}	-	0.65						
	Anchor Category- Water-saturated Concrete		-	-	3						
	Strength Reduction Factor - Water-saturated Concrete		ϕ_{sat}	-	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 load combinations including sustained loads, multiply bond strength by 0.37.
[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 14—ET-HP EPOXY ANCHOR BOND STRENGTH DESIGN INFORMATION- METRIC THREADED ROD FOR TEMPERATURE RANGE 1[1,2]

Condition	Characteristic		Symbol	Units	Nominal Rod Diameter d_0 (mm)						
					10	12	16	20	24	27	30
Uncracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	MPa	5.7						
	Permitted Embedment Depth Range	Minimum	$h_{ef,min}$	mm	60	70	80	90	100	110	120
		Maximum	$h_{ef,max}$		120	144	192	240	288	324	360
Cracked Concrete	Characteristic Bond Strength[3]		$\tau_{k,cr}$	MPa	1.4	2.1	2.1	3.4	3.6	3.1	2.6
	Permitted Embedment Depth Range	Minimum	$h_{ef,min}$	mm	75	75	80	90	100	110	120
		Maximum	$h_{ef,max}$		120	144	192	240	288	324	360
Reduction for Seismic Tension[4]			$\alpha_{N,seis}$	-	0.78	0.85	0.85	0.85	0.82	0.70	0.78
Periodic Inspection	Anchor Category- Dry Concrete		-	-	1						
	Strength Reduction Factor - Dry Concrete		ϕ_{dry}	-	0.65						
	Anchor Category- Water-saturated Concrete		-	-	3						
	Strength Reduction Factor - Water-saturated Concrete		ϕ_{sat}	-	0.45						

[1]Temperature Range 1: Maximum short term temperature of 65°C. Maximum long term temperature of 43°C.
[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 load combinations including sustained loads, multiply bond strength by 0.37.
[4]See Section 4.1.11 for additional information regarding seismic design requirements.

TABLE 15—ET-HP EPOXY ANCHOR BOND STRENGTH DESIGN INFORMATION- METRIC REINFORCING BAR (REBAR) FOR TEMPERATURE RANGE 1[1,2]

Condition	Characteristic		Symbol	Units	Bar Size						
					10	12	16	20	25	28	32
	Nominal Diameter		d_0	mm	10	12	16	20	25	28	32
Uncracked Concrete, Dry Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	MPa	5.0						
	Permitted Embedment Depth Range	Minimum	$h_{ef,min}$	mm	60	70	80	90	100	115	130
		Maximum	$h_{ef,max}$		200	240	320	400	500	560	640
	Anchor Category- Dry Concrete[4]		-	-	1						
	Strength Reduction Factor - Dry Concrete[4]		ϕ_{dry}	-	0.55						
Uncracked Concrete, Water-saturated Concrete	Characteristic Bond Strength[3]		$\tau_{k,uncr}$	MPa	5.0					3.7	
	Permitted Embedment Depth Range	Minimum	$h_{ef,min}$	mm	60	70	80	90	100	115	130
		Maximum	$h_{ef,max}$		200	240	320	400	500	560	640
Periodic Inspection	Anchor Category- Water-saturated Concrete[4]		-	-	3						
	Strength Reduction Factor - Water-saturated Concrete[4]		ϕ_{sat}	-	0.45						

[1]Temperature Range 1: Maximum short term temperature of 65°C. Maximum long term temperature of 43°C.
[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 load combinations including sustained loads, multiply bond strength by 0.37.
[4]Anchor Category and strength reduction factor based on periodic inspection provided during installation.

TABLE 16—EXAMPLE ET-HP EPOXY ADHESIVE ANCHOR ALLOWABLE STRESS DESIGN TENSION VALUES FOR ILLUSTRATIVE PURPOSES IN ACCORDANCE WITH ACI 318-11 AND THIS REPORT

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)
$^3/_8$	$^1/_2$	$2^3/_8$	480
$^1/_2$	$^5/_8$	$2^3/_4$	720
$^5/_8$	$^3/_4$	$3^1/_8$	997
$^3/_4$	$^7/_8$	$3^1/_2$	1,300**
$^7/_8$	1	$3^3/_4$	1,574
1	$1^1/_8$	4	1,858
$1^1/_4$	$1^3/_8$	5	2,711

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 + 1.6 L
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. $c_{a1} = c_{a2} \geq c_{ac}$
15. $h \geq h_{min}$

**** Illustrative Procedure (reference Table 5, 9 and 12 of this report):**
$^3/_4$" ET-HP Epoxy Anchor (ASTM A193, Grade B7 Threaded Rod) with an Effective Embedment, $h_{ef} = 3\ ^1/_2$"
Step 1: Calculate Static Steel Strength in Tension per ACI 318-14 17.4.1 or ACI 318-11 Section D.5.1 = $\phi_{sa}N_{sa}$ = 0.75 x 41,750 = 31,313 lbs.
Step 2: Calculate Static Concrete Breakout Strength in Tension per ACI 318-14 17.4.2 or ACI 318-11 Section D.5.2 = $\phi_{cb}N_{cb}$ = 0.65 x 7,857 = 5,107 lbs.
Step 3: Calculate Static Bond Strength in Tension per ACI 318-14 17.4.5 or ACI 318-11 Section D.5.5 = $\phi_p N_a$ = 0.65 x 2,960 = 1,924 lbs.
Step 4: The controlling value (from Steps 1, 2 and 3 above) per ACI 318-14 17.3.1 or ACI 318-11 Section 4.1 = ϕN_n = 1,924lbs.
Step 5: Divide the controlling value by the conversion factor α per section 4.2.1 of this report:
$T_{allowable,ASD} = \phi N_n/\alpha$ = 1,924 / 1.48 = 1,300 lbs.

TABLE 17—INSTALLATION DETAILS FOR FRACTIONAL THREADED ROD AND REINFORCING BAR (REBAR)

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]	Adhesive Tubing Part Number[3]	Adhesive Piston Plug Part Number[3]
3/8 or #3	1/2	ETB6	EMN22i	EDT22S, EDTA22P, EDTA22CKT, EDTA56P	ARC37-RP25	PPFT25	Not Availble[4]
1/2 or #4	5/8	ETB6			ARC50-RP25		PP62-RP10
5/8 or #5	3/4	ETB6			ARC62-RP25		PP75-RP10
3/4 or #6	7/8	ETB8			ARC75-RP25		PP87-RP10
7/8 or #7	1	ETB10			ARC87-RP25		PP100-RP10
1 or #8	1 1/8	ETB10			ARC100-RP25		PP112-RP10
1 1/4 or #10	1 3/8	ETB12			ARC125-RP25		PP137-RP10

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, Adhesive Piston Plugs and Adhesive Tubing are to be used for all horizontal and overhead anchor installations.
[4]For 3/8-inch rod and #3 horizontal and overhead installations, inject adhesive directly to the back of the hole using Adhesive Tubing only.

TABLE 18—INSTALLATION DETAILS FOR METRIC THREADED ROD[3]

Anchor Diameter (mm)	Drill Bit Diameter[1,2] (mm)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Numbers
10	12	ETB6	EMN22i	EDT22S, EDTA22P, EDTA22CKT, EDTA56P
12	14	ETB6		
16	18	ETB6		
20	24	ETB8		
24	28	ETB10		
27	30	ETB10		
30	35	ETB12		

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 use for horizontal and overhead anchor installations for metric threaded rod is not permiited.

TABLE 19—INSTALLATION DETAILS FOR METRIC REINFORCING BAR (REBAR)[3]

Anchor Diameter (mm)	Drill Bit Diameter[1,2] (mm)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Number
10	14	ETB6	EMN22i	EDT22S, EDTA22P, EDTA22CKT, EDTA56P
12	16	ETB6		
16	20	ETB8		
20	25	ETB10		
25	30	ETB10		
28	35	ETB12		
32	40	ETB12		

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 use for horizontal and overhead anchor installations for metric reinforcing bar is not permitted.

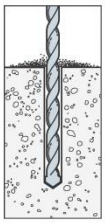
TABLE 20—CURE SCHEDULE[1]

Concrete Temperature		Gel Time (minutes)	Cure Time[1] (hours)
(°F)	(°C)		
50	10	45	72
60	16	30	24
80	27	20	24
100	38	15	24

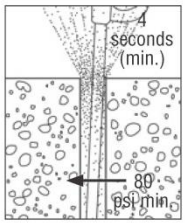
For **SI:** °F = (°C x 9/5) + 32.

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

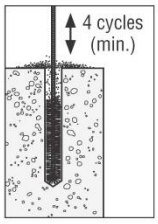
1 Hole Preparation – Horizontal, Vertical and Overhead Applications



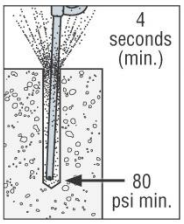
1. Drill.
Drill hole to specified diameter and depth.



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.



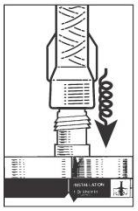
4. Blow.
Remove dust from hole with oil-free compressed air for a minimum of 4 seconds. Compressed air nozzle must reach the bottom of the hole.

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

2 Cartridge Preparation

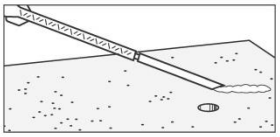
1. Check.
Check expiration date on product label. **Do not use expired product.** Product is usable until end of printed expiration month.

2. Open.
Open cartridge per package instructions.



3. Attach.
Attach proper Simpson Strong-Tie® nozzle and extension to cartridge. Do not modify nozzle.

4. Insert.
Insert cartridge into dispensing tool.



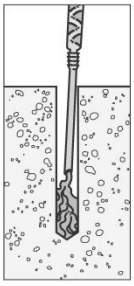
5. Dispense.
Dispense adhesive to the side until properly mixed (uniform color).

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.

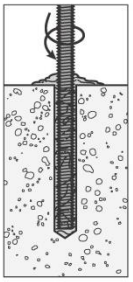
3A Filling the Hole – Vertical Anchorage

Prepare the hole per "Hole Preparation."

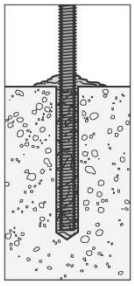
DRY AND DAMP HOLES:



1. Fill.
Fill hole ½ to ⅔ full, starting from bottom of hole to prevent air pockets. Withdraw nozzle as hole fills up.



2. Insert.
Insert clean, oil-free anchor (marked with the required embedment depth), turning slowly until the anchor contacts the bottom of the hole.



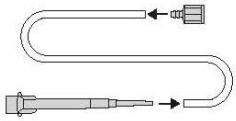
3. Do not disturb.
Do not disturb anchor until fully cured.

Note: Refer to Table F for proper gel times and cure times and Table D and E for maximum tightening torgue. Nozzle extensions may be needed for deep holes.

FIGURE 1—INSTALLATION DETAILS

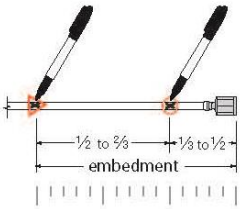
3B Filling the Hole – Horizontal and Overhead Anchorage with Piston Plug System

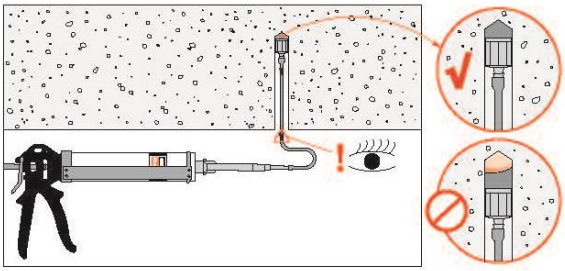
Prepare the hole per "Hole Preparation."



Step 1:

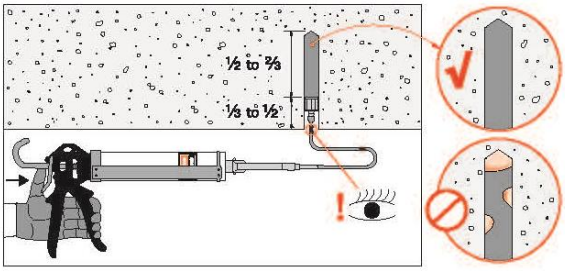
- Attach the piston plug to one end of the flexible tubing (PPFT25). (Refer to Table A).
- Cut tubing to the length needed for the application, mark tubing as noted below and attach other end of tubing to the mixing nozzle
- If using a pneumatic dispensing tool, regulate air pressure to 80–100 psi





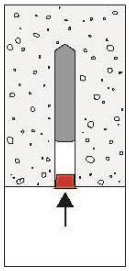
Step 2:

- Insert the piston plug to the back of the drilled hole and dispense adhesive



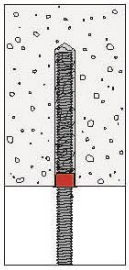
Step 3:

- Fill the hole ½ to ⅔ full
- **Note:** as adhesive is dispensed into the drilled hole, the piston plug will slowly displace out of the hole due to back pressure, preventing air gaps



Step 4:

- Install the appropriate Simpson Strong-Tie adhesive retaining cap. (Refer to Table A)



Step 5:

- Place either threaded rod or rebar through the adhesive retaining cap and into adhesive-filled hole
- Turn rod/rebar slowly until the insert bottoms out
- 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 resistant methods).

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

FIGURE 1—INSTALLATION DETAILS (CONTINUED)

Table A - Installation Details for Fractional Threaded Rod Anchors and Reinforcing Bar

Anchor Diameter or Bar Size (in)	Drill Bit Diameter[1,2] (in)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Number	Adhesive Retaining Cap Part Number[3]	Adhesive Tubing Part Number[3]	Adhesive Piston Plug Part Number[3]
3/8 or #3	1/2	ETB6	EMN22i	EDT22S, EDTA22P, EDTA22CKT, EDTA56AP	ARC37-RP25	PPFT25	Not Available[4]
1/2 or #4	5/8	ETB6			ARC50-RP25		PP62-RP10
5/8 or #5	3/4	ETB6			ARC62-RP25		PP75-RP10
3/4 or #6	7/8	ETB8			ARC75-RP25		PP87-RP10
7/8 or #7	1	ETB10			ARC87-RP25		PP100-RP10
1 or #8	1 1/8	ETB10			ARC100-RP25		PP112-RP10
1 1/4 or #10	1 3/8	ETB12			ARC125-RP25		PP137-RP10

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, Adhesive Piston Plugs and Adhesive Tubing are to be used for all horizontal and overhead anchor installations only.
4. For 3/8" horizontal and overhead installations, inject adhesive directly to the back of the hole using Adhesive Tubing only.

Table B - Installation Details for Metric Threaded Rod Anchors[3]

Anchor Diameter (mm)	Drill Bit Diameter[1,2] (mm)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Number
10	12	ETB6	EMN22i	EDT22S, EDTA22P, EDTA22CKT, EDTA56AP
12	14	ETB6		
16	18	ETB6		
20	24	ETB8		
24	28	ETB10		
27	30	ETB10		
30	35	ETB12		

1. Rotary Hammer must be used to drill all holes.
2. Drill bits must meet the requirements of ANSI B212.15.
3. Adhesive for horizontal and overhead anchor installations for metric threaded rod is not permiited.

Table C - Installation Details for Metric Reinforcing Bar[3]

Anchor Diameter (mm)	Drill Bit Diameter[1,2] (mm)	Brush Part Number	Nozzle Part Number	Dispensing Tool Part Number
10	14	ETB6	EMN22i	EDT22S, EDTA22P, EDTA22CKT, EDTA56AP
12	16	ETB6		
16	20	ETB8		
20	25	ETB10		
25	30	ETB10		
28	35	ETB12		
32	40	ETB12		

1. Rotary Hammer must be used to drill all holes.
2. Drill bits must meet the requirements of ANSI B212.15.
3. Adhesive for horizontal and overhead anchor installations for metric reinforcing bar is not permitted.

Table D – Fractional Threaded Rod Anchor Tightening Torque, Embedment Depth and Placement Details

Anchor Diameter (in)	Maximum Tightening Torque T_{inst} (ft-lbs)	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)
	15	2 3/8	4 1/2	3	1 3/4	$h_{ef} + 5d_o$
1/2	25	2 3/4	6			
5/8	40	3 1/8	7 1/2			
3/4	50	3 1/2	9			
7/8	60	3 3/4	10 1/2			
1	80	4	12			
1 1/4	150	5	15	6	2 3/4	

Table E – Metric Threaded Rod Anchor Tightening Torque, Embedment Depth and Placement Details

Anchor Diameter (mm)	Maximum Tightening Torque T_{inst} (N-m)	Min. Emb. Depth $h_{ef,min}$ (mm)	Max. Emb. Depth $h_{ef,max}$ (mm)	Min. Anchor Spacing S_{min} (mm)	Min. Edge Distance C_{min} (mm)	Min. Concrete Thickness h_{min} (mm)
10	25	60	120	76	45	$h_{ef} + 5d_o$
12	35	70	144			
16	50	80	192			
20	75	90	240			
24	100	100	288			
27	120	110	324			
30	200	120	360	152	70	

Table F – Cure Schedule

Concrete Temperature (°F)	Concrete Temperature (°C)	Gel Time (minutes)	Cure Time[1] (hours)
50	10	45	72
60	16	30	24
80	27	20	24
100	38	15	24

1. For water-saturated concrete, the cure times must be doubled.

Table G – Storage Information

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

FIGURE 1—INSTALLATION DETAILS (CONTINUED)