ICC-ES Evaluation Report

ESR-4412

Reissued April 2024

This report also contains:

- FBC Supplement

Subject to renewal April 2025

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: AEROSMITH FASTENING SYSTEMS	EVALUATION SUBJECT: AEROSMITH® SURE-SET® PURE EPOXY ADHESIVE ANCHORS FOR CRACKED AND UNCRACKED CONCRETE	

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2015, 2012, 2009, 2006, and 2003 *International Building Code®* (IBC)
- 2015, 2012, 2009, 2006, and 2003 *International Residential Code®* (IRC)

Property evaluated:

- Structural

2.0 USES

The Aerosmith Sure-Set® Pure Epoxy Adhesive Anchors are used to resist static, wind or 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).

The anchors comply with anchors as described in Section 1901.3 of the 2015 IBC, Section 1909 of the 2012 IBC and are 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, and Sections 1912 and 1913 of the 2003 IBC. The anchors may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 General:

The Sure-Set® Pure Epoxy Anchor System is comprised of the following:

- Sure-Set® Pure Epoxy adhesive packaged in cartridges
- Adhesive mixing and dispensing equipment
- Equipment for cleaning holes and injecting adhesive

The Sure-Set® Pure Epoxy adhesive is used with continuously threaded steel rods or deformed steel reinforcing bars. Installation information, guidelines and parameters are shown in Tables 1, 15, 16, and 17 of this report.

The manufacturer's printed installation instructions (MPII), included with each adhesive cartridge unit, are shown in Figure 3 of this report.

3.2 Materials:

3.2.1 Sure-Set® Pure Epoxy Adhesive: The Sure-Set® Pure Epoxy adhesive is a two-component (resin and hardener) epoxy-based adhesive, supplied in dual chamber cartridges separating the chemical components, which are combined in a 1:1 ratio by volume when dispensed through the system static mixing nozzle. The Sure-Set® Pure Epoxy is available in 250 mL (9 fl. oz.), 400 mL (14 fl. oz.), 600 mL (21 fl. oz.) and 1500 mL (51 fl. oz.) cartridges. The shelf life of the Sure-Set® Pure Epoxy is two years, when stored in the manufacturer's unopened containers at temperatures between 50°F (10 °C) and 77°F (25°C).

3.2.2 Dispensing Equipment: The Sure-Set® Pure Epoxy adhesive must be dispensed using pneumatic or manual actuated dispensing tools listed in Table 17 of this report.

3.2.3 Hole Preparation Equipment: The holes must be cleaned with hole-cleaning brushes and air nozzles. The brush must be the appropriate size brush shown in Tables 15 and 16 of this report, and the air nozzle must be equipped with an extension capable of reaching the bottom of the drilled hole and having an inside bore diameter of not less than $^{1}/_{4}$ inch (6 mm). The holes must be prepared in accordance with the installation instructions shown in Figure 3 of this report.

3.2.4 Steel Anchor Elements:

3.2.4.1 Threaded Steel Rod: Threaded anchor rods must be clean, continuously threaded rods (all-thread) in diameters and types as described in Tables 2 and 4 of this report. Steel design information for the common grades of threaded rod is provided in Tables 2 and 4. Carbon steel threaded rods may be furnished with a zinc electroplated coating or hot-dipped galvanized, or may be uncoated. Threaded steel rods must be straight and free of indentations or other defects along their length.

3.2.4.2 Steel Reinforcing Bars: Steel reinforcing bars must be deformed bars (rebar). Tables 3 and 4 summarize reinforcing bar size ranges, specifications, and grades. The embedded portions of reinforcing bars must be straight, and free of mill scale, rust and other coatings or substances that may impair the bond with the 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 a steel element to be considered ductile, the tested elongation must be at least 14 percent and the 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. Values for various steel materials are provided in Tables 2 through 4 of this report. 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 anchors complying with 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 complying with the 2012, 2009, 2006 and 2003 IBC, as well as the 2012, 2009, 2006 and 2003 IRC, must be determined in accordance with ACI 318-11 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.

A design example in accordance with the 2012 IBC is given in Figure 4 of this report.

Design parameters are provided in Tables 2 through 10 of this report. Strength reduction factors, ϕ, as described 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 or ACI 318-14 5.3 or ACI 318-11 9.2, as applicable. Strength reduction factors, ϕ, described in ACI 318-11 Section D.4.4 must be used for load combinations calculated in accordance with Appendix C of ACI 318-11.

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, in accordance with ACI 318-14 17.3.3 or ACI 314-11 D.4.3, as applicable, are provided in Tables 2, 3, and 4 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 selected values of $k_{c,cr}$ and $k_{c,uncr}$ as provided in the tables 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. 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, whether the concrete is cracked or uncracked, the concrete temperature range, and the installation conditions (dry or water-saturated concrete, water-filled holes). The resulting characteristic bond strength shall be multiplied by the associated strength reduction factor, ϕ_{nn}, as follows corresponding to the level of special inspection provided:

CONCRETE STATE	DRILLING METHOD	PERMISSIBLE INSTALLATION CONDITIONS	BOND STRENGTH	ASSOCIATED STRENGTH REDUCTION FACTOR
Cracked	Hammer-drill	Dry concrete	$\tau_{k,cr}$	ϕ_d
		Water-saturated concrete	$\tau_{k,cr}$	ϕ_{ws}
		Water-filled hole (flooded)	$\tau_{k,cr}$	ϕ_{wf}
Uncracked	Hammer-drill	Dry concrete	$\tau_{k,uncr}$	ϕ_d
		Water-saturated concrete	$\tau_{k,uncr}$	ϕ_{ws}
		Water-filled hole (flooded)	$\tau_{k,uncr}$	ϕ_{wf}

Figure 1 of this report presents a bond strength design selection flowchart. Strength reduction factors for determination of the bond strength are given in Tables 7 through 14 of this report.

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 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 through 4 of this report 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 5 and 6 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 given in Tables 2 through 4 for the corresponding anchor steel in lieu of d_a (2015, 2012 and 2009 IBC) and d_o (IBC 2006). 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 a maximum of 8,000 psi (55 MPa), in accordance with ACI 318-14 17.2.7 or ACI 318-11 Section 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 forces, the interaction of the tension and shear loads must be calculated in accordance with ACI 318-14 17.6 or ACI 318-11 Section D.7, as applicable.

4.1.9 Minimum Member Thickness, h_{min}, 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, as applicable, values of s_{min} and c_{min} described in this report must be observed for anchor design and installation. The minimum member thickness, h_{min}, described in 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 Section D.3.3, as applicable, except as described below.

The nominal steel shear strength, Vsa, must be adjusted by $\alpha_{V,seis}$ as given in Tables 2 through 4 of this report for the corresponding anchor steel.

As an exception to ACI 318-11 Section 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 calculated in accordance with IBC Section 1605.3 (Allowable Stress Design), allowable loads must be established using the following relationships:

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

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

where

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

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

ϕN_n = 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 as amended in this report; ACI 318-08 Appendix D and 2009 IBC Sections 1908.1.9 and 1908.1.10; or ACI 318-05 Appendix D and 2006 IBC Section 1908.1.16, 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 as amended in this report; ACI 318-08 Appendix D and 2009 IBC Sections 1908.1.9 and 1908.1.10; or ACI 318-05 Appendix D and 2006 IBC Section 1908.1.16, 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 19 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, as described in Table 1 of this report, must apply. An example of allowable stress design values for illustrative purposes is shown in Figure 4 of this report.

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:

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

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

For all other cases:

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

4.3 Installation:

Installation parameters are provided in Tables 1, 15, 16, 17, and Figure 3. 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 Sure-Set® Pure Epoxy adhesive anchor system must conform to the manufacturer's printed installation instructions (MPII) included in each package unit and as described in Figure 3. The nozzles, brushes, dispensing tools and resin stoppers shown in Figure 2 and listed in Tables 15, 16, and 17 supplied by the manufacturer, must be used along with the adhesive cartridges. Installation of anchors may be vertically down (floor), horizontal (walls) and vertically overhead. Use of nozzle extension tubes and resin stoppers must be in accordance with Tables 15 and 16.

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. Tables 7 through 14 of this report provide 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 318-11 D.9.2.4, as applicable.

Under the IBC, additional requirements as set forth in Section 1705.1.1 and Table 1705.3 of the 2015 or 2012 IBC and Sections 1705, 1706 or 1707 of the 2009, 2006 and 2003 IBC must be observed, where applicable.

4.4.2 Continuous Special Inspection: Installations made under continuous special inspection with an on-site proof loading program must be performed in accordance with Section 1705.1.1 and Table 1705.3 of the 2015 and 2012 IBC, Section 1704.15 and Table 1704.4 of the 2009 IBC, or Section 1704.13 of the 2006 or 2003 IBC, whereby continuous special inspection is defined in Section 1702.1 of the IBC, and this report. The special inspector must be on the jobsite continuously during anchor installation to verify anchor type, adhesive expiration date, anchor dimensions, concrete type, concrete compressive strength, 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 a 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 67 percent of the load corresponding to the nominal bond strength as calculated from the characteristic bond stress for uncracked concrete modified for edge effects and concrete properties, or 80 percent of the minimum specified anchor element yield strength ($A_{se,N} \cdot f_{ya}$). The proof load must 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 1705.4 of the 2015 and 2012 IBC, Section 1704.15 and Table 1704.4 of the 2009 IBC or Section 1704.13 of the 2006 or 2003 IBC and this report. The special inspector must be on the jobsite initially during anchor installation to verify the 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 published 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 are 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 requires an initial inspection. For ongoing installations over an extended period, the special inspector must make regular inspections to confirm correct handling and installation of the product.

5.0 CONDITIONS OF USE:

The Aerosmith Sure-Set® Pure 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 Sure-Set® Pure Epoxy adhesive anchors must be installed in accordance with the manufacturer's printed installation instructions (MPII) and as shown in Figure 3 of this report.

5.2 The anchors 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 (55.1 MPa).

5.4 Anchors must be installed in concrete base materials in holes predrilled in accordance with the instructions provided in Figure 3 of this report, with carbide-tipped drill bits complying with ANSI B212.15-1994.

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

5.6 Sure-Set® Pure Epoxy adhesive 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 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 Sure-Set® Pure 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 must be established in accordance with Section 4.1 of this report.

5.10 Allowable stress design values must 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, 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 Anchors are not permitted to support fire-resistive construction. Where not otherwise prohibited by the code, Sure-Set® Pure 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 Use of hot-dipped galvanized carbon steel and stainless steel rods is permitted for exterior exposure or damp environments.

5.17 Steel anchoring materials in contact with preservative-treated wood 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 Special inspection must be provided in accordance with Section 4.4 in 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 Sure-Set® Pure Epoxy adhesive anchors may be used to resist tension and shear forces in floor, wall, and overhead installations only if installation is into concrete with a temperature between 40°F and 104°F (4°C and 40°C) for threaded rods and rebar. Overhead installations for hole diameters larger than $^5/_8$-inch or 16 mm require the use of resin stoppers during injection to the back of the hole. ½-inch-, $^9/_{16}$-inch-, $^5/_8$-inch-, 12 mm-, 14 mm-, and 16 mm-diameter holes may be injected directly to the back of the hole with the use of extension tubing on the end of the nozzle. The anchor must be supported until fully cured (i.e., with wedges, or other suitable means). Where temporary restraint devices are used, their use shall not result in impairment of the anchor shear resistance.

5.21 Anchors shall not be used for installations where the concrete temperature can rise from 40°F (or less) to 80°F (or higher) within a 12-hour period. Such applications may include but are not limited to anchorage of building façade systems and other applications subject to direct sun exposure

5.22 Sure-Set® Pure Epoxy adhesive is manufactured and packaged, 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.

7.0 IDENTIFICATION

7.1 Sure-Set® Pure Epoxy adhesive is identified in the field by labels on the cartridge and packaging, bearing the company name (Aerosmith Fastening Systems), product name (Sure-Set® Pure Epoxy), the batch number, the expiration date, and the evaluation report number (ESR-4412).

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

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

AEROSMITH FASTENING SYSTEMS
5621 DIVIDEND ROAD
INDIANAPOLIS, INDIANA 46241
(317) 243-5959
www.aerosmithfastening.com
contact@aerosmithfastening.com

TABLE 1—SURE-SET® PURE EPOXY ANCHOR SYSTEM INSTALLATION INFORMATION

CHARACTERISTIC		SYMBOL	UNITS	NOMINAL ANCHOR ELEMENT DIAMETER						
Fractional Threaded Rod	Size	d_o	inch	$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
	Drill Size	d_{hole}	inch	$^1/_2$	$^9/_{16}$	$^3/_4$	$^7/_8$	1	$1^1/_8$	$1^3/_8$
Fractional Re-bar	Size	d_o	inch	#3	#4	#5	#6	#7	#8	#10
	Drill Size	d_{hole}	inch	$^9/_{16}$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_8$	$1^3/_8$
Metric Threaded Rod	Size	d_o	mm	M10	M12	M16	M20	-	M24	M30
	Drill Size	d_{hole}	mm	12	14	18	22	-	26	35
Metric Re-bar	Size	d_o	mm	T10	T12	T16	T20	-	T25	T32
	Drill Size	d_{hole}	mm	14	16	20	25	-	32	40
Maximum Tightening Torque		T_{inst}	ft·lb	15	30	60	100	125	150	200
Embedment Depth Range		$h_{ef,min}$	inch	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^3/_4$	4	4	5
		$h_{ef,max}$	inch	$7^1/_2$	10	$12^1/_2$	15	$17^1/_2$	20	25
Minimum Concrete Thickness		h_{min}	inch	$1.5 \cdot h_{ef}$						
Critical Edge Distance		c_{ac}	inch	See Section 4.1.10 of this report						
Minimum Edge Distance		c_{min}	inch	$1^1/_2$	$1^1/_2$	$1^3/_4$	$1^7/_8$	2	2	$2^1/_2$
Minimum Anchor Spacing		s_{min}	inch	$1^1/_2$	$1^1/_2$	$1^3/_4$	$1^7/_8$	2	2	$2^1/_2$

For **SI:** 1 inch = 25.4 mm, 1 ft·lb = 1.356 N·m

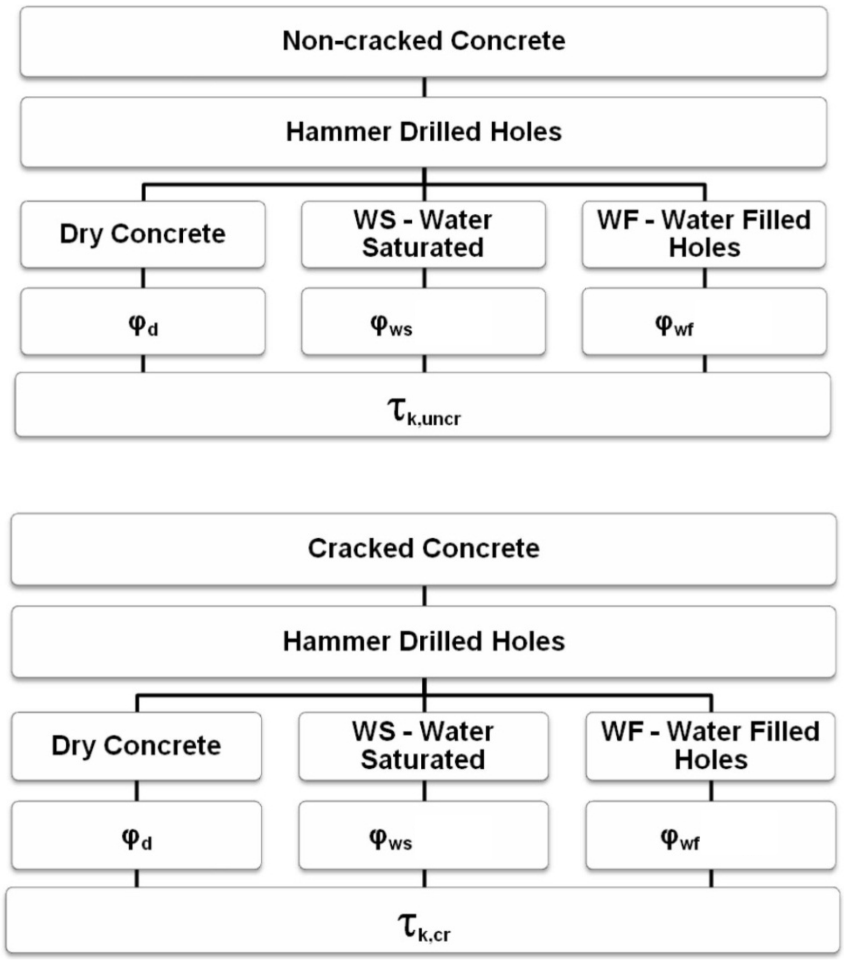


FIGURE 1—FLOWCHART FOR THE ESTABLISHMENT OF DESIGN BOND STRENGTH

TABLE 2—STEEL DESIGN INFORMATION FOR FRACTIONAL CARBON STEEL AND STAINLESS STEEL THREADED ROD[1,2]

	CHARACTERISTIC	SYMBOL	UNITS	NOMINAL ROD DIAMETER, d_o						
	Nominal Size	d_o	inch	$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
	Stress Area[1]	A_{se}	in.^{2}	0.0775	0.1419	0.226	0.334	0.462	0.606	0.969
Carbon Steel Threaded Rod	Strength Reduction Factor for Tension Steel Failure[2]	ϕ	-	0.75						
	Strength Reduction Factor for Shear Steel Failure[2]	ϕ	-	0.65						
	Reduction for Seismic Tension	$\alpha_{N,seis}$	-	1.00						
	Reduction for Seismic Shear	$\alpha_{V,seis}$	-	0.58	0.57	0.57	0.57	0.42	0.42	0.42
	Tension Resistance of Carbon Steel ASTM F1554 Grade 36	N_{sa}	lb (kN)	4,495 (20.0)	8,230 (36.6)	13,110 (58.3)	19,370 (86.2)	26,795 (119.2)	35,150 (156.4)	56,200 (250.0)
	Tension Resistance of Carbon Steel ASTM A193 B7	N_{sa}	lb (kN)	9,690 (43.1)	17,740 (78.9)	28,250 (125.7)	41,750 (185.7)	57,750 (256.9)	75,750 (337.0)	121,125 (538.8)
	Shear Resistance of Carbon Steel ASTM F1554 Grade 36	V_{sa}	lb (kN)	2,250 (10.0)	4,940 (22.0)	7,865 (35.0)	11,625 (51.7)	16,080 (71.5)	21,090 (93.8)	33,720 (150.0)
	Shear Resistance of Carbon Steel ASTM A193 B7	V_{sa}	lb (kN)	4,845 (21.6)	10,645 (47.4)	16,950 (75.4)	25,050 (111.4)	34,650 (154.1)	45,450 (202.2)	72,675 (323.3)
Stainless Steel Threaded Rod	Strength Reduction Factor for Tension Steel Failure[2]	ϕ	-	0.65						
	Strength Reduction Factor for Shear Steel Failure[2]	ϕ	-	0.60						
	Reduction for Seismic Tension	$\alpha_{N,seis}$	-	1.00						
	Reduction for Seismic Shear	$\alpha_{V,seis}$	-	0.51	0.50	0.49	049	0.43	0.43	0.43
	Tension Resistance of Stainless Steel ASTM F593 CW1	N_{sa}	lb (kN)	7,365 (32.8)	13,480 (60.0)	21,470 (95.5)	--	--	--	--
	Tension Resistance of Stainless Steel ASTM F593 CW2	N_{sa}	lb (kN)	--	--	--	25,385 (112.9)	35,110 (156.2)	46,055 (204.9)	73,645 (327.6)
	Tension Resistance of Stainless Steel ASTM F593 SH1	N_{sa}	lb (kN)	8,915 (39.7)	16,320 (72.6)	25,990 (115.6)	--	--	--	--
	Tension Resistance of Stainless Steel ASTM F593 SH2	N_{sa}	lb (kN)	--	--	--	35,070 (156.0)	48,510 (215.8)	63,630 (283.0)	--
	Tension Resistance of Stainless Steel ASTM F593 SH3	N_{sa}	lb (kN)	--	--	--	--	--	--	92,055 (409.5)
	Shear Resistance of Stainless Steel ASTM F593 CW1	V_{sa}	lb (kN)	3,680 (16.4)	6,740 (30.0)	10,735 (47.8)	--	--	--	--
	Shear Resistance of Stainless Steel ASTM F593 CW2	V_{sa}	lb (kN)	--	--	--	12,690 (56.4)	17,555 (78.1)	23,030 (102.4)	36,820 (163.8)
	Shear Resistance of Stainless Steel ASTM F593 SH1	V_{sa}	lb (kN)	4,455 (19.8)	9,790 (43.5)	15,595 (69.4)	--	--	--	--
	Shear Resistance of Stainless Steel ASTM F593 SH2	V_{sa}	lb (kN)	--	--	--	17,535 (78.0)	24,255 (107.9)	31,815 (141.5)	--
	Shear Resistance of Stainless Steel ASTM F593 SH3	V_{sa}	lb (kN)	--	--	--	--	--	--	46,030 (204.8)

For **SI:** 1 inch = 25.4 mm, 1 in.^{2} = 645.16 mm^2, 1 lb = 0.004448 kN

[1]Values provided for steel threaded rod are based on minimum specified strengths and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b or ACI 318-11 Eq. D-2 and Eq. D-29, as applicable.

[2]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 in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. 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 FRACTIONAL STEEL REINFORCING BAR[1,2]

	CHARACTERISTIC	SYMBOL	UNITS	NOMINAL REINFORCING BAR SIZE, d_o						
				No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 10
Reinforcing bar	Nominal bar diameter	d_o	inch	0.375	0.500	0.625	0.750	0.875	1.000	1.250
	Stress Area	A_{se}	in.^{2}	0.11	0.20	0.31	0.44	0.60	0.79	1.27
	Strength Reduction Factor for Tension Steel Failure	ϕ	-	0.65						
	Strength Reduction Factor for Shear Steel Failure	ϕ	-	0.60						
	Reduction for Seismic Tension	$\alpha_{N,seis}$	-	1.00						
	Reduction for Seismic Shear	$\alpha_{V,seis}$	-	0.70	0.70	0.82	0.82	0.42	0.42	0.42
	Tension Resistance of Carbon Steel ASTM A615 Grade 40	N_{sa}	lb (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	36,000 (160.1)	47,400 (210.8)	76,200 (339.0)
	Tension Resistance of Carbon Steel ASTM A615 Grade 60	N_{sa}	lb (kN)	9,900 (44.0)	18,000 (80.1)	27,900 (124.1)	39,600 (176.1)	54,000 (240.2)	71,100 (316.3)	114,300 (508.4)
	Shear Resistance of Carbon Steel ASTM A615 Grade 40	V_{sa}	lb (kN)	3,960 (17.6)	7,200 (32.0)	11,160 (49.6)	15,840 (70.5)	21,600 (96.1)	28,440 (126.5)	45,720 (203.4)
	Shear Resistance of Carbon Steel ASTM A615 Grade 60	V_{sa}	lb (kN)	5,940 (26.4)	10,800 (48.0)	16,740 (74.5)	23,760 (105.7)	32,400 (144.1)	42,660 (189.8)	68,580 (305.1)

For **SI:** 1 inch = 25.4 mm, 1 in.^{2} = 645.16 mm^2, 1 lb = 0.004448 kN

[1]Values provided for steel threaded rod are based on minimum specified strengths and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b or ACI 318-11 Eq. D-2 and Eq. D-29, as applicable.

[2]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 in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3. 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 4—STEEL DESIGN INFORMATION FOR METRIC THREADED ROD AND REINFORCING BAR[1,2]

	CHARACTERISTIC	SYMBOL	UNITS	NOMINAL ROD DIAMETER, d_o					
Metric Threaded Rod	Nominal Size	d_o	mm	M10	M12	M16	M20	M24	M30
	Stress Area	A_{se}	mm²	58	84	157	245	353	561
	Strength Reduction Factor for Tension Steel Failure	ϕ	-	0.65					
	Strength Reduction Factor for Shear Steel Failure	ϕ	-	0.60					
	Reduction for Seismic Tension	$\alpha_{N,seis}$	-	1.00					
	Reduction for Seismic Shear	$\alpha_{V,seis}$	-	0.58	0.57	0.57	0.42	0.42	0.42
	Tension Resistance of Carbon Steel ISO 898-1 Class 5.8	N_{sa}	kN lb	29.0 (6,519)	42.2 (9,476)	78.5 (17,648)	122.5 (27,539)	176.5 (39,679)	280.5 (63,059)
	Tension Resistance of Carbon Steel ISO 898-1 Class 8.8	N_{sa}	kN lb	46.4 (10,431)	67.4 (15,161)	125.6 (28,236)	196.0 (44,063)	282.4 (63,486)	448.8 (100,894)
	Tension Resistance of Carbon Steel ISO 898-1 Class 12.9	N_{sa}	kN lb	50.0 (11,240)	72.7 (16,336)	135.3 (30,424)	211.2 (47,477)	304.3 (68,406)	483.6 (108,714)
	Tension Resistance of Stainless Steel ISO 3506-1 A4-70	N_{sa}	kN lb	40.6 (9,127)	59.0 (13,266)	109.9 (24,707)	171.5 (38,555)	247.1 (55,550)	392.7 (88,282)
	Tension Resistance of Stainless Steel ISO 3506-1 A4-80	N_{sa}	kN lb	46.4 (10,431)	67.4 (15,161)	125.6 (28,236)	196.0 (44,063)	282.4 (63,486)	448.8 (100,894)
	Shear Resistance of Carbon Steel ISO 898-1 Class 5.8	V_{sa}	kN lb	17.4 (3,912)	25.3 (5,685)	47.1 (10,589)	73.5 (16,523)	105.9 (23,807)	168.3 (37,835)
	Shear Resistance of Carbon Steel ISO 898-1 Class 8.8	V_{sa}	kN lb	27.8 (6,259)	40.5 (9,097)	75.4 (16,942)	117.6 (26,438)	169.4 (38,092)	269.3 (60,537)
	Shear Resistance of Carbon Steel ISO 898-1 Class 12.9	V_{sa}	kN lb	30.0 (6,744)	43.6 (9,802)	81.2 (18,255)	126.7 (28,486)	182.6 (41,044)	290.1 (65,228)
	Shear Resistance of Stainless Steel ISO 3506-1 A4-70	V_{sa}	kN lb	24.4 (5,476)	35.4 (7,960)	65.9 (14,824)	102.9 (23,133)	148.3 (33,330)	235.6 (52,969)
	Shear Resistance of Stainless Steel ISO 3506-1 A4-80	V_{sa}	kN lb	27.8 (6,259)	40.5 (9,097)	75.4 (16,942)	117.6 (26,438)	169.4 (38,092)	269.3 (60,537)

Metric Reinforcing bar	Nominal Size	d_o	mm	T10	T12	T16	T20	T25	T32
	Stress Area	A_{se}	mm²	78.5	113	201	314	491	804
	Strength Reduction Factor for Tension Steel Failure	ϕ	-	0.65					
	Strength Reduction Factor for Shear Steel Failure	ϕ	-	0.60					
	Reduction for Seismic Tension	$\alpha_{N,seis}$	-	1.00					
	Reduction for Seismic Shear	$\alpha_{V,seis}$	-	0.70	0.70	0.82	0.42	0.42	0.42
	Tension Resistance of DIN 488 BSt 500	N_{sa}	kN lb	43.2 (9,706)	62.2 (13,972)	110.6 (24,853)	172.7 (38,825)	270.1 (60,710)	442.2 (99,411)
	Shear Resistance of DIN 488 BSt 500	V_{sa}	kN lb	25.9 (5,824)	37.3 (8,383)	66.3 (14,912)	103.6 (23,295)	162.0 (36,426)	265.3 (59,646)

For **SI:** 1 inch = 25.4 mm, 1 in.² = 645.16 mm², 1 lb = 0.004448 kN

[1]Values provided for steel threaded rod are based on minimum specified strengths and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b or ACI 318-11 Eq. D-2 and Eq. D-29, as applicable.

[2]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, as applicable, are used in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3. 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 5—FRACTIONAL THREADED ROD AND REINFORCING BAR CONCRETE BREAKOUT STRENGTH DESIGN INFORMATION

CHARACTERISTIC		SYMBOL	UNITS	NOMINAL ANCHOR ELEMENT DIAMETER						
US Threaded Rod	Size	d_o	Inch	$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
	Drill Size	d_{hole}	Inch	$^1/_2$	$^9/_{16}$	$^3/_4$	$^7/_8$	1	$1^1/_8$	$1^3/_8$
US Re-bar	Size	d_o	Inch	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 10
	Drill Size	d_{hole}	Inch	$^9/_{16}$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_8$	$1^3/_8$
Embedment Depth Range		$h_{ef,min}$	Inch	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^3/_4$	4	4	5
		$h_{ef,max}$	Inch	$7^1/_2$	10	$12^1/_2$	15	$17^1/_2$	20	25
Minimum Anchor Spacing		s_{min}	Inch	$1^1/_2$	$1^1/_2$	$1^3/_4$	$1^7/_8$	2	2	$2^1/_2$
Minimum Edge Distance		c_{min}	Inch	$1^1/_2$	$1^1/_2$	$1^3/_4$	$1^7/_8$	2	2	$2^1/_2$
Minimum Concrete Thickness		h_{min}	Inch	$1.5 \cdot h_{ef}$						
Critical Edge Distance		c_{ac}	-	See Section 4.1.10 of this report						
Effectiveness Factor for Uncracked Concrete, Breakout		$k_{c,uncr}$	-- (SI)	24 (10)						
Effectiveness Factor for Cracked Concrete, Breakout		$k_{c,cr}$	-- (SI)	17 (7.1)						
$k_{c,uncr} / k_{c,cr}$		--	--	1.41						
Strength Reduction Factor for Tension, Concrete Failure Modes, Condition B[1]		ϕ	--	0.65						
Strength Reduction Factor for Shear, Concrete Failure Modes, Condition B[1]		ϕ	--	0.70						

For **SI:** 1 inch = 25.4 mm, 1 in.^{2} = 645.16 mm^2, 1 lb = 0.004448 kN

[1]Condition B applies where supplemental reinforcement is not provided as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. 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, as applicable, are used in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. 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—METRIC THREADED ROD AND REINFORCING BAR CONCRETE BREAKOUT STRENGTH DESIGN INFORMATION

CHARACTERISTIC		SYMBOL	UNITS	NOMINAL ANCHOR ELEMENT DIAMETER					
SI Threaded Rod	Size	d_o	mm	M10	M12	M16	M20	M24	M30
	Drill Size	d_{hole}	mm	12	14	18	22	26	35
SI Re-bar	Size	d_o	mm	T10	T12	T16	T20	T25	T32
	Drill Size	d_{hole}	mm	14	16	20	25	32	40
Embedment Depth Range		$h_{ef,min}$	inch	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^3/_4$	4	5
		$h_{ef,max}$	inch	$7^1/_2$	10	$12^1/_2$	15	20	25
Minimum Anchor Spacing		s_{min}	inch	$1^1/_2$	$1^1/_2$	$1^3/_4$	$1^7/_8$	2	$2^1/_2$
Minimum Edge Distance		c_{min}	inch	$1^1/_2$	$1^1/_2$	$1^3/_4$	$1^7/_8$	2	$2^1/_2$
Minimum Concrete Thickness		h_{min}	inch	$1.5 \cdot h_{ef}$					
Critical Edge Distance		--	--	See Section 4.1.10 of this report					
Effectiveness Factor for Uncracked Concrete, Breakout		k_{uncr}	-- (SI)	24 (10)					
Effectiveness Factor for Cracked Concrete, Breakout		k_{cr}	-- (SI)	17 (7.1)					
k_{uncr} / k_{cr}		--	--	1.41					
Strength Reduction Factor for Tension, Concrete Failure Modes, Condition B		ϕ	--	0.65					
Strength Reduction Factor for Shear, Concrete Failure Modes, Condition B		ϕ	--	0.70					

For **SI:** 1 inch = 25.4 mm, 1 in.^{2} = 645.16 mm^2, 1 lb = 0.004448 kN

[1]Condition B applies where supplemental reinforcement is not provided as set forth in ACI 318-14 or ACI 318-11 D.4.3, as applicable. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.2 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. 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.4.5.

TABLE 7—FRACTIONAL THREADED ROD BOND STRENGTH DESIGN INFORMATION FOR ANCHORS INSTALLED WITH PERIODIC SPECIAL INSPECTION[1,7]

DESIGN INFORMATION			SYMBOL	UNITS	NOMINAL THREADED ROD DIAMETER						
					3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Minimum Effective Installation Depth			$h_{ef,min}$	in.	2 3/8	2 3/4	3 1/8	3 1/2	4	4	5
				mm	60	70	79	89	102	102	127
Maximum Effective Installation Depth			$h_{ef,max}$	in.	7 1/2	10	12 1/2	15	17 1/2	20	25
				mm	191	254	318	381	445	508	635
Dry Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725						
				N/mm²	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm²	4.3	4.0	3.8	3.6	3.3	3.1	2.7
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350						
				N/mm²	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm²	7.9	7.5	7.0	6.7	6.2	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030						
				N/mm²	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm²	6.1	5.7	5.4	5.1	4.7	4.4	3.8
	Anchor Category, dry concrete		–	-	1	1	1	1	1	1	1
	Strength Reduction Factor		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Water Saturated Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	N/A		725				
				N/mm²	N/A		5.0				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	520	490	550	520	485	450	385
				N/mm²	3.6	3.4	3.8	3.6	3.3	3.1	2.7
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,135		1,350				
				N/mm²	7.8		9.3				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	965	915	1025	965	900	840	715
				N/mm²	6.7	6.3	7.0	6.7	6.2	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	865		1,030				
				N/mm²	6.0		7.1				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	735	695	780	735	685	640	545
				N/mm²	5.1	4.8	5.4	5.1	4.7	4.4	3.8
	Anchor Category, water saturated concrete		–	-	3	3	3	3	3	3	3
	Strength Reduction Factor		ϕ_{ws}	-	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Water-filled Hole	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	N/A		725			N/A	
				N/mm²	N/A		5.0			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	540	510	550	520	485	170	145
				N/mm²	3.7	3.5	3.8	3.6	3.3	1.2	1.0
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,175		1,350			N/A	
				N/mm²	8.1		9.3			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1000	945	1025	965	900	320	270
				N/mm²	6.9	6.5	7.0	6.7	6.2	2.2	1.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	895		1,030			N/A	
				N/mm²	6.2		7.1			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	765	720	780	735	685	245	205
				N/mm²	5.3	5.0	5.4	5.1	4.7	1.7	1.4
	Anchor Category, water-filled hole		–	-	3	3	3	3	3	3	3
	Strength Reduction Factor		ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45	0.45

For **SI:** 1 inch = 25.4 mm, 1 in.² = 645.16 mm², 1 lb = 0.004448 kN

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. Bond strength values must not be increased for increased concrete compressive strength.

[2]Temperature Category A: Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 176°F (80°C)

[3]Temperature Category B, Range 1 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 130°F (55°C)

[4]Temperature Category B, Range 2 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 162°F (72°C)

[5]Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.

[6]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 in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. 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.

[7] For sustained loads, bond strengths must be multiplied by 0.73.

TABLE 8—FRACTIONAL THREADED ROD BOND STRENGTH DESIGN INFORMATION FOR ANCHORS INSTALLED WITH CONTINUOUS SPECIAL INSPECTION[1,7]

DESIGN INFORMATION			SYMBOL	UNITS	NOMINAL THREADED ROD DIAMETER						
					3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Minimum Effective Installation Depth			$h_{ef,min}$	in.	2 3/8	2 3/4	3 1/8	3 1/2	4	4	5
				mm	60	70	79	89	102	102	127
Maximum Effective Installation Depth			$h_{ef,max}$	in.	7 1/2	10	12 1/2	15	17 1/2	20	25
				mm	191	254	318	381	445	508	635
Dry Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725						
				N/mm²	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm²	4.3	4.0	3.8	3.6	3.3	3.1	2.7
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350						
				N/mm²	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm²	7.9	7.5	7.0	6.7	6.2	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030						
				N/mm²	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm²	6.1	5.7	5.4	5.1	4.7	4.4	3.8
	Anchor Category, dry concrete		–	-	1	1	1	1	1	1	1
	Strength Reduction Factor		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Water Saturated Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725						
				N/mm²	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm²	4.3	4.0	3.8	3.6	3.3	3.1	2.7
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350						
				N/mm²	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm²	7.9	7.5	7.0	6.7	6.2	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030						
				N/mm²	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm²	6.1	5.7	5.4	5.1	4.7	4.4	3.8
	Anchor Category, water saturated concrete		–	-	3	3	2	2	2	2	2
	Strength Reduction Factor		ϕ_{ws}	-	0.45	0.45	0.55	0.55	0.55	0.55	0.55
Water-filled Hole	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725					N/A	
				N/mm²	5.0					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	540	510	550	520	485	200	175
				N/mm²	3.7	3.5	3.8	3.6	3.3	1.4	1.2
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350					N/A	
				N/mm²	9.3					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1000	945	1025	965	900	380	320
				N/mm²	6.9	6.5	7.0	6.7	6.2	2.6	2.2
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030					N/A	
				N/mm²	7.1					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	765	720	780	735	685	290	245
				N/mm²	5.3	5.0	5.4	5.1	4.7	2.0	1.7
	Anchor Category, water-filled hole		–	-	3	3	2	2	2	3	3
	Strength Reduction Factor		ϕ_{wf}	-	0.45	0.45	0.55	0.55	0.55	0.45	0.45

For **SI:** 1 inch = 25.4 mm, 1 in.² = 645.16 mm², 1 lb = 0.004448 kN

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. Bond strength values must not be increased for increased concrete compressive strength.

[2]Temperature Category A: Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 176°F (80°C)

[3]Temperature Category B, Range 1 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 130°F (55°C)

[4]Temperature Category B, Range 2 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 162°F (72°C)

[5]Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.

[6]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 in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. 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.

[7]For sustained loads, bond strengths must be multiplied by 0.73.

TABLE 9—FRACTIONAL REINFORCING BAR BOND STRENGTH DESIGN INFORMATION FOR ANCHORS INSTALLED WITH PERIODIC SPECIAL INSPECTION [1,7]

DESIGN INFORMATION			SYMBOL	UNITS	REINFORCING BAR SIZE						
					No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 10
Nominal Diameter			d_a	in.	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Minimum Effective Installation Depth			$h_{ef,min}$	in.	2 3/8	2 3/4	3 1/8	3 1/2	4	4	5
				mm	60	70	79	89	102	102	127
Maximum Effective Installation Depth			$h_{ef,max}$	in.	7 1/2	10	12 1/2	15	17 1/2	20	25
				mm	191	254	318	381	445	508	635
Dry Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725						
				N/mm²	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm²	4.3	4.0	3.8	3.6	3.3	3.1	2.7
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350						
				N/mm²	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm²	7.9	7.5	7.0	6.7	6.2	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030						
				N/mm²	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm²	6.1	5.7	5.4	5.1	4.7	4.4	3.8
	Anchor Category, dry concrete		–	-	1	1	1	1	1	1	1
	Strength Reduction Factor		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Water Saturated Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	N/A		725				
				N/mm²	N/A		5.0				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	520	490	550	520	485	450	385
				N/mm²	3.6	3.4	3.8	3.6	3.3	3.1	2.7
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,135		1,350				
				N/mm²	7.8		9.3				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	965	915	1025	965	900	840	715
				N/mm²	6.7	6.3	7.0	6.7	6.2	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	865		1,030				
				N/mm²	6.0		7.1				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	735	695	780	735	685	640	545
				N/mm²	5.1	4.8	5.4	5.1	4.7	4.4	3.8
	Anchor Category, water saturated concrete		–	-	3	3	3	3	3	3	3
	Strength Reduction Factor		ϕ_{ws}	-	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Water-filled Hole	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	N/A		725			N/A	
				N/mm²	N/A		5.0			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	540	510	550	520	485	170	145
				N/mm²	3.7	3.5	3.8	3.6	3.3	1.2	1.0
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,175		1,350			N/A	
				N/mm²	8.1		9.3			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1000	945	1025	965	900	320	270
				N/mm²	6.9	6.5	7.0	6.7	6.2	2.2	1.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	895		1,030			N/A	
				N/mm²	6.2		7.1			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	765	720	780	735	685	245	205
				N/mm²	5.3	5.0	5.4	5.1	4.7	1.7	1.4
	Anchor Category, water-filled hole		–	-	3	3	3	3	3	3	3
	Strength Reduction Factor		ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45	0.45

For **SI:** 1 inch = 25.4 mm, 1 in.² = 645.16 mm², 1 lb = 0.004448 kN

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. Bond strength values must not be increased for increased concrete compressive strength.

[2]Temperature Category A: Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 176°F (80°C)

[3]Temperature Category B, Range 1 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 130°F (55°C)

[4]Temperature Category B, Range 2 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 162°F (72°C)

[5]Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.

[6]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, as applicable, are used in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. 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.

[7]For sustained loads, bond strengths must be multiplied by 0.73.

TABLE 10—FRACTIONAL REINFORCING BAR BOND STRENGTH DESIGN INFORMATION FOR ANCHORS INSTALLED WITH CONTINUOUS SPECIAL INSPECTION [1,7]

DESIGN INFORMATION			SYMBOL	UNITS	REINFORCING BAR SIZE						
					No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 10
Nominal Diameter			d_a	in.	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Minimum Effective Installation Depth			$h_{ef,min}$	in.	2 3/8	2 3/4	3 1/8	3 1/2	4	4	5
				mm	60	70	79	89	102	102	127
Maximum Effective Installation Depth			$h_{ef,max}$	in.	7 1/2	10	12 1/2	15	17 1/2	20	25
				mm	191	254	318	381	445	508	635
Dry Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725						
				N/mm²	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm²	4.3	4.0	3.8	3.6	3.3	3.1	2.7
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350						
				N/mm²	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm²	7.9	7.5	7.0	6.7	6.2	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030						
				N/mm²	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm²	6.1	5.7	5.4	5.1	4.7	4.4	3.8
	Anchor Category, dry concrete		–	-	1	1	1	1	1	1	1
	Strength Reduction Factor		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Water Saturated Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725						
				N/mm²	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm²	4.3	4.0	3.8	3.6	3.3	3.1	2.7
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350						
				N/mm²	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm²	7.9	7.5	7.0	6.7	6.2	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030						
				N/mm²	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm²	6.1	5.7	5.4	5.1	4.7	4.4	3.8
	Anchor Category, water saturated concrete		–	-	3	3	2	2	2	2	2
	Strength Reduction Factor		ϕ_{ws}	-	0.45	0.45	0.55	0.55	0.55	0.55	0.55
Water-filled Hole	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725					N/A	
				N/mm²	5.0					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	540	510	550	520	485	200	175
				N/mm²	3.7	3.5	3.8	3.6	3.3	1.4	1.2
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350					N/A	
				N/mm²	9.3					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1000	945	1025	965	900	380	320
				N/mm²	6.9	6.5	7.0	6.7	6.2	2.6	2.2
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030					N/A	
				N/mm²	7.1					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	765	720	780	735	685	290	245
				N/mm²	5.3	5.0	5.4	5.1	4.7	2.0	1.7
	Anchor Category, water-filled hole		–	-	3	3	2	2	2	3	3
	Strength Reduction Factor		ϕ_{wf}	-	0.45	0.45	0.55	0.55	0.55	0.45	0.45

For **SI:** 1 inch = 25.4 mm, 1 in.² = 645.16 mm², 1 lb = 0.004448 kN

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. Bond strength values must not be increased for increased concrete compressive strength.

[2]Temperature Category A: Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 176°F (80°C)

[3]Temperature Category B, Range 1 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 130°F (55°C)

[4]Temperature Category B, Range 2 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 162°F (72°C)

[5]Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.

[6]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 in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. 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.

[7]For sustained loads, bond strengths must be multiplied by 0.73.

TABLE 11—METRIC THREADED ROD BOND STRENGTH DESIGN INFORMATION FOR ANCHORS INSTALLED WITH PERIODIC SPECIAL INSPECTION [1,7]

DESIGN INFORMATION			SYMBOL	UNITS	NOMINAL THREADED ROD DIAMETER					
					M10	M12	M16	M20	M24	M30
Minimum Effective Installation Depth			$h_{ef,min}$	in.	2.4	2.8	3.1	3.5	3.8	4.7
				mm	60	70	80	90	96	120
Maximum Effective Installation Depth			$h_{ef,max}$	in.	7.9	9.4	12.6	15.7	18.9	23.6
				mm	200	240	320	400	480	600
Dry Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725					
				N/mm²	5.0					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	615	590	550	510	465	400
				N/mm²	4.2	4.1	3.8	3.5	3.2	2.8
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350					
				N/mm²	9.3					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1140	1100	1025	945	865	750
				N/mm²	7.9	7.6	7.0	6.5	6.0	5.2
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030					
				N/mm²	7.1					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	870	840	780	720	660	570
				N/mm²	6.0	5.8	5.4	5.0	4.6	3.9
	Anchor Category, dry concrete		–	-	1	1	1	1	1	1
	Strength Reduction Factor		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65
Water Saturated Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	N/A		725			
				N/mm²	N/A		5.0			
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	520	490	550	510	465	400
				N/mm²	3.6	3.4	3.8	3.5	3.2	2.8
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,135		1,350			
				N/mm²	7.8		9.3			
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	960	925	1025	945	865	750
				N/mm²	6.6	6.4	7.0	6.5	6.0	5.2
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	865		1,030			
				N/mm²	6.0		7.1			
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	730	705	780	720	660	570
				N/mm²	5.0	4.9	5.4	5.0	4.6	3.9
	Anchor Category, water saturated concrete		–	-	3	3	3	3	3	3
	Strength Reduction Factor		ϕ_{ws}	-	0.45	0.45	0.45	0.45	0.45	0.45
Water-filled Hole	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	N/A		725		N/A	
				N/mm²	N/A		5.0		N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	535	515	550	510	N/A	N/A
				N/mm²	3.7	3.6	3.8	3.5	N/A	N/A
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,175		1,350		N/A	
				N/mm²	8.1		9.3		N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	995	960	1025	945	330	285
				N/mm²	6.9	6.6	7.0	6.5	2.3	2.0
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	895		1,030		N/A	
				N/mm²	6.2		7.1		N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	760	730	780	720	250	215
				N/mm²	5.2	5.0	5.4	5.0	1.7	1.5
	Anchor Category, water-filled hole		–	-	3	3	3	3	3	3
	Strength Reduction Factor		ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45

For **SI:** 1 inch = 25.4 mm, 1 in.^{2} = 645.16 mm^2, 1 lb = 0.004448 kN

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. Bond strength values must not be increased for increased concrete compressive strength.

[2]Temperature Category A: Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 176°F (80°C)

[3]Temperature Category B, Range 1 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 130°F (55°C)

[4]Temperature Category B, Range 2 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 162°F (72°C)

[5]Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.

[6]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, as applicable, are used in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. 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.

[7]For sustained loads, bond strengths must be multiplied by 0.73.

TABLE 12—METRIC THREADED ROD BOND STRENGTH DESIGN INFORMATION FOR ANCHORS INSTALLED WITH CONTINUOUS SPECIAL INSPECTION [1,7]

DESIGN INFORMATION			SYMBOL	UNITS	NOMINAL THREADED ROD DIAMETER					
					M10	M12	M16	M20	M24	M30
Minimum Effective Installation Depth			$h_{ef,min}$	in.	2.4	2.8	3.1	3.5	3.8	4.7
				mm	60	70	80	90	96	120
Maximum Effective Installation Depth			$h_{ef,max}$	in.	7.9	9.4	12.6	15.7	18.9	23.6
				mm	200	240	320	400	480	600
Dry Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725					
				N/mm²	5.0					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	615	590	550	510	465	400
				N/mm²	4.2	4.1	3.8	3.5	3.2	2.8
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350					
				N/mm²	9.3					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1140	1100	1025	945	865	750
				N/mm²	7.9	7.6	7.0	6.5	6.0	5.2
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030					
				N/mm²	7.1					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	870	840	780	720	660	570
				N/mm²	6.0	5.8	5.4	5.0	4.6	3.9
	Anchor Category, dry concrete		–	-	1	1	1	1	1	1
	Strength Reduction Factor		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65
Water Saturated Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725					
				N/mm²	5.0					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	615	590	550	510	465	400
				N/mm²	4.2	4.1	3.8	3.5	3.2	2.8
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350					
				N/mm²	9.3					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1140	1100	1025	945	865	750
				N/mm²	7.9	7.6	7.0	6.5	6.0	5.2
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030					
				N/mm²	7.1					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	870	840	780	720	660	570
				N/mm²	6.0	5.8	5.4	5.0	4.6	3.9
	Anchor Category, water saturated concrete		–	-	3	3	2	2	2	2
	Strength Reduction Factor		ϕ_{ws}	-	0.45	0.45	0.55	0.55	0.55	0.55
Water-filled Hole	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725				N/A	
				N/mm²	5.0				N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	615	590	550	510	210	N/A
				N/mm²	4.2	4.1	3.8	3.5	1.5	N/A
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350				N/A	
				N/mm²	9.3				N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1140	1100	1025	945	390	335
				N/mm²	7.9	7.6	7.0	6.5	2.7	2.3
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030				N/A	
				N/mm²	7.1				N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	870	840	780	720	295	255
				N/mm²	6.0	5.8	5.4	5.0	2.0	1.8
	Anchor Category, water-filled hole		–	-	3	3	2	2	3	3
	Strength Reduction Factor		ϕ_{wf}	-	0.45	0.45	0.55	0.55	0.45	0.45

For **SI:** 1 inch = 25.4 mm, 1 in.^{2} = 645.16 mm^2, 1 lb = 0.004448 kN

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. Bond strength values must not be increased for increased concrete compressive strength.

[2]Temperature Category A: Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 176°F (80°C)

[3]Temperature Category B, Range 1 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 130°F (55°C)

[4]Temperature Category B, Range 2 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 162°F (72°C)

[5]Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.

[6]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, as applicable, are used in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, or applicable. 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.

[7]For sustained loads, bond strengths must be multiplied by 0.73.

TABLE 13—METRIC REBAR BOND STRENGTH DESIGN INFORMATION FOR ANCHORS INSTALLED WITH PERIODIC SPECIAL INSPECTION [1,7]

DESIGN INFORMATION			SYMBOL	UNITS	NOMINAL REINFORCING BAR DIAMETER M10	M12	M16	M20	M25	M32
Minimum Effective Installation Depth			$h_{ef,min}$	in.	2.4	2.8	3.1	3.5	3.9	5.0
				mm	60	70	80	90	100	128
Maximum Effective Installation Depth			$h_{ef,max}$	in.	7.9	9.4	12.6	15.7	19.7	25.2
				mm	200	240	320	400	500	640
Dry Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725					
				N/mm²	5.0					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	615	590	550	510	455	380
				N/mm²	4.2	4.1	3.8	3.5	3.1	2.6
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350					
				N/mm²	9.3					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1140	1100	1025	945	845	710
				N/mm²	7.9	7.6	7.0	6.5	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030					
				N/mm²	7.1					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	870	840	780	720	645	540
				N/mm²	6.0	5.8	5.4	5.0	4.5	3.7
	Anchor Category, dry concrete		–	-	1	1	1	1	1	1
	Strength Reduction Factor		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65
Water Saturated Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	N/A		725			
				N/mm²	N/A		5.0			
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	520	490	550	510	455	380
				N/mm²	3.6	3.4	3.8	3.5	3.1	2.6
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,135		1,350			
				N/mm²	7.8		9.3			
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	960	925	1025	945	845	710
				N/mm²	6.6	6.4	7.0	6.5	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	865		1,030			
				N/mm²	6.0		7.1			
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	730	705	780	720	645	540
				N/mm²	5.0	4.9	5.4	5.0	4.5	3.7
	Anchor Category, water saturated concrete		–	-	3	3	3	3	3	3
	Strength Reduction Factor		ϕ_{ws}	-	0.45	0.45	0.45	0.45	0.45	0.45
Water-filled Hole	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	N/A		725		N/A	
				N/mm²	N/A		5.0		N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	535	515	550	510	N/A	N/A
				N/mm²	3.7	3.6	3.8	3.5	N/A	N/A
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,175		1,350		N/A	
				N/mm²	8.1		9.3		N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	995	960	1025	945	330	285
				N/mm²	6.9	6.6	7.0	6.5	2.3	2.0
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	895		1,030		N/A	
				N/mm²	6.2		7.1		N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	760	730	780	720	245	205
				N/mm²	5.2	5.0	5.4	5.0	1.7	1.4
	Anchor Category, water-filled hole		–	-	3	3	3	3	3	3
	Strength Reduction Factor		ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45

For **SI:** 1 inch = 25.4 mm, 1 in.² = 645.16 mm², 1 lb = 0.004448 kN

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. Bond strength values must not be increased for increased concrete compressive strength.
[2]Temperature Category A: Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 176°F (80°C)
[3]Temperature Category B, Range 1 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 130°F (55°C)
[4]Temperature Category B, Range 2 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 162°F (72°C)
[5]Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.
[6]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, as applicable, are used in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. 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.
[7]For sustained loads, bond strengths must be multiplied by 0.73.

TABLE 14—METRIC REBAR BOND STRENGTH DESIGN INFORMATION FOR ANCHORS INSTALLED WITH CONTINUOUS SPECIAL INSPECTION [1,7 7]

DESIGN INFORMATION			SYMBOL	UNITS	NOMINAL REINFORCING BAR DIAMETER					
					M10	M12	M16	M20	M25	M32
Minimum Effective Installation Depth			$h_{ef,min}$	in.	2.4	2.8	3.1	3.5	3.9	5.0
				mm	60	70	80	90	100	128
Maximum Effective Installation Depth			$h_{ef,max}$	in.	7.9	9.4	12.6	15.7	19.7	25.2
				mm	200	240	320	400	500	640
Dry Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725					
				N/mm²	5.0					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	615	590	550	510	455	380
				N/mm²	4.2	4.1	3.8	3.5	3.1	2.6
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350					
				N/mm²	9.3					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1140	1100	1025	945	845	710
				N/mm²	7.9	7.6	7.0	6.5	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030					
				N/mm²	7.1					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	870	840	780	720	645	540
				N/mm²	6.0	5.8	5.4	5.0	4.5	3.7
	Anchor Category, dry concrete		–	-	1	1	1	1	1	1
	Strength Reduction Factor		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65
Water Saturated Concrete	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725					
				N/mm²	5.0					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	615	590	550	510	455	380
				N/mm²	4.2	4.1	3.8	3.5	3.1	2.6
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350					
				N/mm²	9.3					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1140	1100	1025	945	845	710
				N/mm²	7.9	7.6	7.0	6.5	5.8	4.9
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030					
				N/mm²	7.1					
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	870	840	780	720	645	540
				N/mm²	6.0	5.8	5.4	5.0	4.5	3.7
	Anchor Category, water saturated concrete		–	-	3	3	2	2	2	2
	Strength Reduction Factor		ϕ_{ws}	-	0.45	0.45	0.55	0.55	0.55	0.55
Water-filled Hole	Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	725				N/A	
				N/mm²	5.0				N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	615	590	550	510	205	N/A
				N/mm²	4.2	4.1	3.8	3.5	1.4	N/A
	Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,350				N/A	
				N/mm²	9.3				N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1140	1100	1025	945	330	320
				N/mm²	7.9	7.6	7.0	6.5	2.6	2.2
	Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$\tau_{k,uncr}$	psi	1,030				N/A	
				N/mm²	7.1				N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	870	840	780	720	290	245
				N/mm²	6.0	5.8	5.4	5.0	2.0	1.7
	Anchor Category, water-filled hole		–	-	3	3	2	2	3	3
	Strength Reduction Factor		ϕ_{wf}	-	0.45	0.45	0.55	0.55	0.45	0.45

For **SI:** 1 inch = 25.4 mm, 1 in.^{2} = 645.16 mm^2, 1 lb = 0.004448 kN

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. Bond strength values must not be increased for increased concrete compressive strength.

[2]Temperature Category A: Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 176°F (80°C)

[3]Temperature Category B, Range 1 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 130°F (55°C)

[4]Temperature Category B, Range 2 = Maximum Long Term Temperature: 110°F (43°C); Maximum Short Term Temperature: 162°F (72°C)

[5]Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.

[6]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, as applicable, are used in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. 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.

[7]For sustained loads, bond strengths must be multiplied by 0.73.

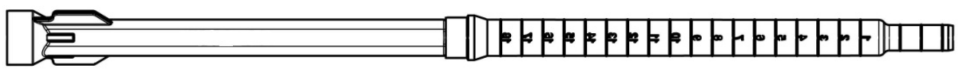
PE-10/Sure-Set® Pure Epoxy

PE-14/Sure-Set® Pure Epoxy

PE-21/Sure-Set® Pure Epoxy

PE-51/Sure-Set® Pure Epoxy

Mixer Nozzle "MN1021

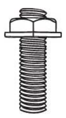
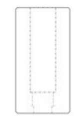


Mixer Nozzle "MN1021L"

Left to right: 3/8" (9 mm) Ø ET38 extension tube, 9/16" (14 mm) Ø ET916 extension tube, resin stoppers (ES30, ES22 & ES18)

FIGURE 2—AEROSMITH SURE-SET® PURE EPOXY ADHESIVE ANCHORING SYSTEM

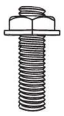
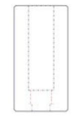
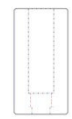
TABLE 15—INSTALL PARAMETERS (FRACTIONAL SIZES)

THREADED ROD INSTALLATIONS							
Anchor Size	**Drilled Hole Size**	**Cleaning Brush Size**	**Nozzle Type MN1021**	**Nozzle Type MN1021L**	**Extension Tube Required?**	**Resin Stopper Required?**	**Notes**
							
3/8"	1/2"	716BRSH	✔		ET38 > 3.5" h_{ef}	N	
1/2"	9/16"	916BRSH	✔		ET38 > 3.5" h_{ef}	N	
5/8"	3/4"	34BRSH	✔	✔	ET916 > 10" h_{ef}	ES18>10"h_{ef}	MN1021L nozzle required at h_{ef} > 8"
3/4"	7/8"	78BRSH		✔	ET916 > 10" h_{ef}	ES18>10"h_{ef}	
7/8"	1"	1BRSH		✔	ET916 > 10" h_{ef}	ES22>10"h_{ef}	
1"	1 1/8"	114BRSH		✔	ET916 > 10" h_{ef}	ES22>10"h_{ef}	
1 1/4"	1 3/8"	138BRSH		✔	ET916 > 10" h_{ef}	ES30>10"h_{ef}	
REINFORCING BAR INSTALLATIONS							
Anchor Size	**Drilled Hole Size**	**Cleaning Brush Size**	**Nozzle Type MN1021**	**Nozzle Type MN1021L**	**Extension Tube Required?**	**Resin Stopper Required?**	**Notes**
							
#3	9/16"	916BRSH	✔		ET38 > 3.5" h_{ef}	N	
#4	5/8"	58BRSH	✔	✔	ET38 > 3.5" h_{ef}	N	MN1021L nozzle required at h_{ef} > 3.5"
#5	3/4"	34BRSH	✔	✔	ET916> 10" h_{ef}	ES18>10"h_{ef}	MN1021L nozzle required at h_{ef} > 8"
#6	7/8"	78BRSH		✔	ET916 > 10" h_{ef}	ES18>10"h_{ef}	
#7	1"	1BRSH		✔	ET916 > 10" h_{ef}	ES22>10"h_{ef}	
#8	1 1/8"	114BRSH		✔	ET916 > 10" h_{ef}	ES22>10"h_{ef}	
#10	1 3/8"	138BRSH		✔	ET916 > 10" h_{ef}	ES30>10"h_{ef}	

Key:

ET38	Requires 3/8"-diameter extension tube fitted to MN1021 nozzle
ET916	Requires 9/16"-diameter extension tube fitted to MN1021L nozzle
ES18	Use 18 mm-diameter resin stopper
ES22	Use 22 mm-diameter resin stopper
ES30	Use 30 mm-diameter resin stopper
N	Not required
H	Brush with handle
F	Brush with ferrule

TABLE 16—INSTALL PARAMETERS (METRIC SIZES)

THREADED ROD INSTALLATIONS							
Anchor Size	**Drilled Hole Size**	**Cleaning Brush Size**	**Nozzle Type**		**Extension Tube Required?**	**Resin Stopper Required?**	**Notes**
			MN1021	**MN1021L**			
							
M10	12	716BRSH	✔		ET38 >90 mm h_{ef}	N	
M12	14	916BRSH	✔		ET38 > 90 mm h_{ef}	N	
M16	18	34BRSH	✔	✔	ET916 > 250 mm h_{ef}	ES18> 250 mm h_{ef}	MN1021L nozzle required at h_{ef} > 200 mm
M20	22	78BRSH		✔	ET916 > 250 mm h_{ef}	ES18> 250 mm h_{ef}	
M24	26	1BRSH		✔	ET916 > 250 mm h_{ef}	ES22> 250 mm h_{ef}	
M30	35	138BRSH		✔	ET916 > 250 mm h_{ef}	ES30> 250 mm h_{ef}	
REINFORCING BAR INSTALLATIONS							
Anchor Size	**Drilled Hole Size**	**Cleaning Brush Size**	**Nozzle Type**		**Extension Tube Required?**	**Resin Stopper Required?**	**Notes**
			MN1021	**MN1021L**			
							
T10	14	916BRSH	✔		ET38 > 90 mm h_{ef}	N	
T12	16	58BRSH	✔	✔	ET38 > 90 mm h_{ef}	N	MN1021L nozzle required at h_{ef} > 90 mm
T16	20	34BRSH	✔	✔	ET916 > 250 mm h_{ef}	ES18> 250 mm h_{ef}	MN1021L nozzle required at h_{ef} > 200 mm
T20	25	78BRSH		✔	ET916 > 250 mm h_{ef}	ES22> 250 mm h_{ef}	
T25	32	1BRSH		✔	ET916 > 250 mm h_{ef}	ES22> 250 mm h_{ef}	
T32	40	114BRSH		✔	ET916 > 250 mm h_{ef}	ES30> 250 mm h_{ef}	

Key:

ET38	Requires 10 mm-diameter extension tube fitted to MN1021 nozzle
ET916	Requires14 mm-diameter extension tube fitted to MN1021L nozzle
ES18	Use 18 mm-diameter resin stopper
ES22	Use 22 mm-diameter resin stopper
ES30	Use 30 mm-diameter resin stopper
N	Not required
H	Brush with handle
F	Brush with ferrule

TABLE 17—ALLOWABLE COMBINATIONS OF CARTRIDGE, MIXER NOZZLE AND DISPENSING TOOL

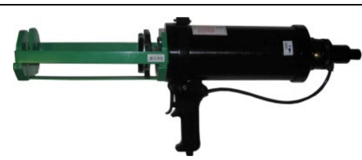
CARTRIDGE REFERENCE	ALLOWABLE APPLICATOR TOOLS	ALLOWABLE NOZZLE TYPES	
		MN1021	MN1021L
PE-10/Pure Epoxy	 Cox 300 mL Manual (26:1 mechanical advantage)	✔	
PE-14/Pure Epoxy	 Cox 400 mL Manual (26:1 mechanical advantage)	✔	✔
PE-22/Pure Epoxy	 Newborn 600 mL Manual (26:1 mechanical advantage)	✔	✔
	 Newborn 600 mL Pneumatic		
PE-51/Pure Epoxy	 Newborn 1500 mL Pneumatic	✔	✔

TABLE 18—GEL AND CURE TIMES[1]

SUBSTRATE TEMPERATURE (°C)	SUBSTRATE TEMPERATURE (°F)	GEL TIME	CURE TIME
4 to 9	40 to 49	20 mins	24 hours
10 to 15	50 to 59		12 hours
15 to 22	59 to 72	15 mins	8 hours
22 to 25	72 to 77	11 mins	7 hours
25 to 30	77 to 86	8 mins	6 hours
30 to 35	86 to 95	6 mins	5 hours
35 to 40	95 to 104	4 mins	4 hours
40	104	3 mins	3 hours

[1]Cartridge must be conditioned to a minimum 10°C / 50°F

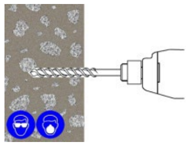
AEROSMITH SURE-SET® PURE EPOXY: MPII

Before commencing installation ensure the installer is equipped with appropriate personal protection equipment, SDS Hammer Drill, Air Lance, Hole Cleaning Brush, good quality dispensing tool – either manual or power operated, adhesive cartridge with mixing nozzle, and extension tube with resin stopper as required in Tables 15 and 16. Refer to Figure 2, Table 1, Table 15, Table 16, and Table 17 for parts specification or guidance for individual items or dimensions.

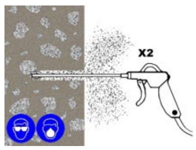
Important: check the expiration date on the cartridge **(do not use expired material**) and that the cartridge has been stored in its original packaging, the correct way up, in cool conditions (50°F to 77°F) out of direct sunlight.

Solid Substrate Installation Method

1. Using the SDS Hammer Drill in rotary hammer mode for drilling, with a carbide tipped drill bit conforming to ANSI B212.15-1994 of the appropriate size, drill the hole to the specified hole diameter and depth.

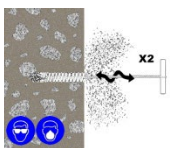


2. Select the correct Air Lance, insert to the bottom of the hole and depress the trigger for 2 seconds. The compressed air must be clean – free from water and oil – and at a minimum pressure of 90 psi (6 bar).



   Perform the blowing operation twice.

3. Select the correct size Hole Cleaning Brush. Ensure that the brush is in good condition and the correct diameter. Insert the brush to the bottom of the hole, using a brush extension if needed to reach the bottom of the hole and withdraw with a twisting motion. *There should be positive interaction between the steel bristles of the brush and the sides of the drilled hole*.



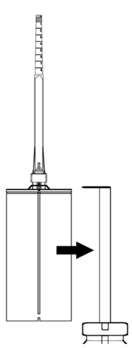
   Perform the brushing operation twice.

4. Repeat 2 (blowing operation) twice.

5. Repeat 3 (brushing operation) twice.

6. Repeat 2 (blowing operation) twice.

7. Select the appropriate static mixer nozzle, checking that the mixing elements are present and correct **(do not modify the mixer)**. Attach mixer nozzle to the cartridge. Check the Dispensing Tool is in good working order. Place the cartridge into the dispensing tool.

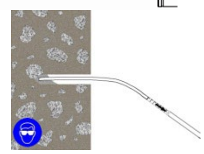


Note: The MN1021L nozzle is in two sections. One section contains the mixing elements and the other section is an extension piece. Connect the extension piece to the mixing section by pushing the two sections firmly together until a positive engagement is felt.

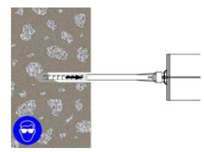
Note: Sure-Set® Pure Epoxy may only be installed between concrete temperatures of 40°F to 104°F for horizontal to downward installation direction, and 50°F to 104°F for horizontal to overhead direction. The product must be conditioned to a minimum of 50°F. For gel and cure time data, refer to Table 18.

8. Extrude some resin to waste until an even-colored mixture is extruded, The cartridge is now ready for use.

9. As specified in Figure 2, Table 11, and Table 12, attach an extension tube with resin stopper (if required) to the end of the mixing nozzle with a push fit. (The extension tubes may be pushed into the resin stoppers and are held in place with a coarse internal thread).



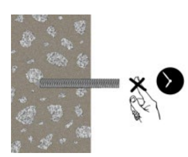
10. Insert the mixing nozzle to the bottom of the hole. Extrude the resin and slowly withdraw the nozzle from the hole. **Ensure no air voids are created** as the nozzle is withdrawn. Inject resin until the hole is approximately ½ to $^{3}/_{4}$ full and remove the nozzle from the hole.



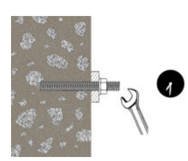
11. Select the steel anchor element ensuring it is free from oil or other contaminants, and mark with the required embedment depth. Insert the steel element into the hole using a back and forth twisting motion to ensure complete cover, until it reaches the bottom of the hole. Adhesive must completely fill the annular gap between the steel element and the concrete. Excess resin will be expelled from the hole evenly around the steel element and there shall be no gaps between the anchor element and the wall of the drilled hole.

12. Clean any excess resin from around the mouth of the hole.

13. Do not disturb the anchor until at least the minimum cure time has elapsed. Refer to the Table 18 Gel and Cure Times to determine the appropriate cure time.



14. Position the fixture and tighten the anchor to the appropriate installation torque.

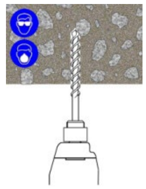


Do not over-torque the anchor as this could adversely affect its performance.

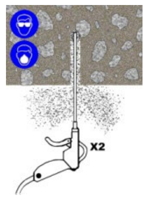
FIGURE 3—INSTALLATION DETAILS

Overhead Substrate Installation

1. Using the SDS Hammer Drill in rotary hammer mode for drilling, with a carbide tipped drill bit conforming to ANSI B212.15-1994 of the appropriate size, drill the hole to the specified hole diameter and depth.

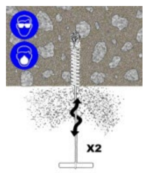


2. Select the correct Air Lance, insert to the bottom of the hole and depress the trigger for 2 seconds. The compressed air must be clean – free from water and oil – and at a minimum pressure of 90 psi (6 bar).



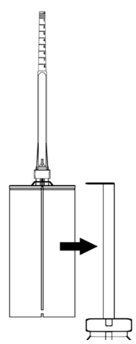
   Perform the blowing operation twice.

3. Select the correct size Hole Cleaning Brush. Ensure that the brush is in good condition and the correct diameter. Insert the brush to the bottom of the hole, using a brush extension if needed to reach the bottom of the hole, and withdraw with a twisting motion. *There should be positive interaction between the steel bristles of the brush and the sides of the drilled hole*.



   Perform the brushing operation twice.

4. Repeat 2 (blowing operation) twice.
5. Repeat 3 (brushing operation) twice.
6. Repeat 2 (blowing operation) twice.
7. Select the appropriate static mixer nozzle checking that the mixing elements are present and correct **(do not modify the mixer)**. Attach mixer nozzle to the cartridge. Check the Dispensing Tool is in good working order. Place the cartridge into the dispensing tool.



   Note: The MN1021L nozzle is in two sections. One section contains the mixing elements and the other section is an extension piece. Connect the extension piece to the mixing section by pushing the two sections firmly together until a positive engagement is felt.

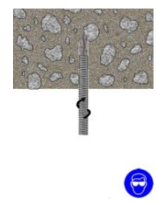
   Note: Sure-Set® Pure Epoxy may only be installed between concrete Temperatures of 50°F and 104°F for overhead and upwardly inclined installations. The product must be Conditioned to a minimum of 50°F.
   For gel and cure time data, refer to Table 18.

8. Extrude some resin to waste until an even-colored mixture is extruded, The cartridge is now ready for use.

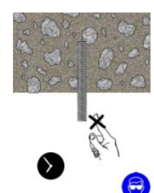
9. As specified in Figure 2, Table 11, and Table 12, attach an extension tube with resin stopper (if required) to the end of the mixing nozzle with a push fit. (The extension tubes may be pushed into the resin stoppers and are held in place with a coarse internal thread).

10. Insert the mixing nozzle, extension tube, or resin stopper (see Tables 15 and 16) to the end of the hole. Extrude the resin and slowly withdraw the nozzle from the hole. **Ensure no air voids are created** as the nozzle is withdrawn. Inject resin until the hole is approximately ½ to $^{3}/_{4}$ full and remove the nozzle from the hole.

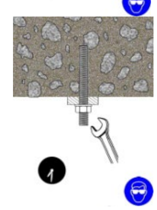
11. Select the steel anchor element ensuring it is free from oil or other contaminants, and mark with the required embedment depth. Insert the steel element into the hole using a back and forth twisting motion to ensure complete cover, until it reaches the bottom of the hole. Adhesive must completely fill the annular gap between the steel element and the concrete. Excess resin will be expelled from the hole evenly around the steel element and there shall be no gaps between the anchor element and the wall of the drilled hole.



12. Clean any excess resin from around the mouth of the hole.
13. Do not disturb the anchor until at least the minimum cure time has elapsed. Refer to Table 18 Gel and Cure Times to determine the appropriate cure time.



14. Position the fixture and tighten the anchor to the appropriate installation torque.



    Do not over-torque the anchor as this could adversely affect its performance.

FIGURE 3—INSTALLATION DETAILS (Continued)

TABLE 19—EXAMPLE OF ALOWABLE STRESS DESIGN (ASD) TENSION VALUES FOR ILLUSTRATIVE PURPOSES

EXAMPLE ALLOWABLE STRESS DESIGN (ASD) CALCULATION FOR ILLUSTRATIVE PURPOSES				
Anchor Diameter (in.)	Embedment Depth Max / Min (in.)	Characteristic Bond Strength $\tau_{k,uncr}$ (psi)	Allowable Tension Load (lb) 2500 psi - 8000 psi Concrete	Controlling Failure Mode
3/8"	2.375	1,350	1,929	Breakout Strength
	7.500	1,350	4,910	Steel Strength
1/2"	2.750	1,350	2,403	Breakout Strength
	10.000	1,350	8,990	Steel Strength
5/8"	3.125	1,350	2,911	Breakout Strength
	12.500	1,350	14,316	Steel Strength
3/4"	3.500	1,350	3,451	Breakout Strength
	15.000	1,350	21,157	Steel Strength
7/8"	4.000	1,350	4,216	Breakout Strength
	17.500	1,350	29,265	Steel Strength
1"	4.000	1,350	4,216	Breakout Strength
	20.000	1,350	38,387	Steel Strength
1 1/4"	4.000	1,350	4,216	Breakout Strength
	25.000	1,350	61,381	Steel Strength

Design Assumptions:

1. Single anchor in static tension only, Grade B7 threaded rod.
2. Vertical downwards installation.
3. Inspection regimen = Periodic.
4. Installation temperature 70F to 110F
5. Long term temperature 110F
6. Short term temperature 130F
7. Dry condition (carbide drilled hoe).
8. Embedment (h_{ef}) = min / max for each diameter.
9. Concrete determined to remain uncracked for life of anchor.
10. Load combinations from ACI 318-11 Section 9.2 (no seismic loading).
11. 30% dead load and 70% live load. Controlling load combination 1.2D + 1.6L
12. Calculation of weighted average for α = 1.2(0.3) + 1.6(0.7) = 1.48
13. f'_c = 2500 psi (normal weight concrete)
14. $c_{ac1} = c_{ac2} \geq c_{ac}$
15. $h \geq h_{min}$

ILLUSTRATIVE PROCEDURE TO CALCULATE ALLOWABLE STRESS DESIGN TENSION VALUE

Aerosmith® Sure-Set® Pure Epoxy Anchor 1/2" Diameter, using an embedment of 2.75", with the design assumptions given in Table 19 (for use with the 2012 IBC, based on ACI 318-11 Appendix D)

Procedure		Calculation
Step 1: Calculate steel strength of a single anchor in tension per ACI 318-11 D.5.1.2 (Table 2 of this report).	ϕN_{sa}	$= \phi N_{sa}$ $=0.65 \times 17740$ **$=11531$ lb**
Step 2: Calculate breakout strength of a single anchor in tension per ACI 318-11 D.5.2 (Table 5 of this report).	N_b	$= k_{c,uncr}\, \lambda_a \sqrt{(f'_c)}\, h_{ef}^{1.5}$ $=(24) \times (1.0) \times (2500)^{0.5} \times (2.75)^{1.5}$ $=5472$ lb
	ϕN_{cb}	$= \phi\, (A_{NC} / A_{NC0})\, \psi_{ed,N}\, \psi_{c,N}\, \psi_{cp,N}\, N_b$ $=0.65 \times 1.0 \times 1.0 \times 1.0 \times 1.0 \times 5472$ **$=3557$ lb**
Step 3: Calculate bond strength of a single anchor in tension per ACI 318-11 D.5.5 (Table 8 of this report).	N_{ba}	$= \lambda_a\, \tau_{k,uncr}\, \pi\, d\, h_{ef}$ $=1.0 \times 1350 \times 3.141 \times 0.5 \times 2.75$ $=5830$ lb
	ϕN_a	$= \phi\, (A_{Na} / A_{Na0})\, \psi_{ed,Na}\, \psi_{cp,Na}\, N_{ba}$ $=0.65 \times 1.0 \times 1.0 \times 1.0 \times 5830$ **$=3789$ lb**
Step 4: Determine controlling resistance strength in tension per ACI 318-11 D 4.1.1 and D 4.1.2.	**3557**	lb = controlling resistance (breakout)
Step 5: Calculate Allowable Stress Design conversion factor for loading condition per ACI 318-11 Section 9.2.	α	$= 1.2DL + 1.6LL$ $= 1.2*0.3 + 1.6*0.7$ **$= 1.48$**
Step 6: Calculate Allowable Stress Design value per Section 4.2 of this report.	$T_{allowable,ASD}$	$= 3557 / 1.48$ **$= 2403$ lb**

FIGURE 4—SAMPLE CALCULATIONS

ICC-ES Evaluation Report

ESR-4412 FBC Supplement

Reissued April 2024

This report is subject to renewal April 2025.

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

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

REPORT HOLDER:

AEROSMITH FASTENING SYSTEMS

EVALUATION SUBJECT:

AEROSMITH® SURE-SET® PURE EPOXY ADHESIVE ANCHORS FOR CRACKED AND UNCRACKED CONCRETE

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that Aerosmith Sure-Set® Pure Epoxy Adhesive Anchors for Cracked and Uncracked Concrete, described in ICC-ES evaluation report ESR-4412, have also been evaluated for compliance with the codes noted below.

Applicable code editions:

- 2017 *Florida Building Code—Building*
- 2017 *Florida Building Code—Residential*

2.0 CONCLUSIONS

The Aerosmith Sure-Set® Pure Epoxy Adhesive Anchors for Cracked and Uncracked Concrete, described in Sections 2.0 through 7.0 of the evaluation report ESR-4412, comply with the *Florida Building Code—Building* and the *Florida Building Code—Residential*, provided the design and installation are in accordance with the 2015 *International Building Code®* provisions noted in the evaluation report.

Use of the Aerosmith Sure-Set® Pure Epoxy Adhesive Anchors for Cracked and Uncracked Concrete for compliance with the High-Velocity Hurricane Zone provisions of the *Florida Building Code—Building* has not been evaluated and is outside the scope of this supplemental report.

For products falling under Florida Rule 9N-3, verification that the report holder's quality assurance program is audited by a quality assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official, when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the evaluation report, reissued April 2024.