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ICC-ES Evaluation Report
ESR-3584

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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:

UCAN FASTENING PRODUCTS, A DIVISION OF BRITISH FASTENING SYSTEMS LIMITED

EVALUATION SUBJECT:

UCAN FASTENING PRODUCTS FLO-ROK™ FR6 SD ADHESIVE ANCHORS FOR CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

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

Property evaluated:

Structural

2.0 USES

The UCAN Fastening Products FLO-ROK™ FR6 SD 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 1909 and 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 UCAN Fastening Products FLO-ROK™ FR6 SD Anchor System is comprised of the following:

- FLO-ROK™ FR6 SD adhesive packaged in cartridges
- Adhesive mixing and dispensing equipment
- Equipment for cleaning holes and injecting adhesive

The FLO-ROK™ FR6 SD 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 FLO-ROK™ FR6 SD Adhesive: The FLO-ROK™ FR6 SD 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 FLO-ROK™ FR6 SD 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 FLO-ROK™ FR6 SD 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 FLO-ROK™ FR6 SD 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 have 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 Section 7.3.2 of ACI 318, 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 D.1, 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 under 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 (ACI 318) and this report.

The strength design of anchors must comply with ACI 318 D.4.1, except as required in ACI 318 D.3.3.

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 Section D.4.3 must be used for load combinations calculated in accordance with Section 1605.2 of the IBC or Section 9.2 of ACI 318. Strength reduction factors, ϕ, described in ACI 318 Section D.4.4 must be used for load combinations calculated in accordance with Appendix C of ACI 318.

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 D.5.1.2 and the associated strength reduction factor, ϕ, in accordance with D.4.3 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 D.5.2, with the following addition:

The basic concrete breakout strength of a single anchor in tension, N_b, must be calculated in accordance with ACI 318 D.5.2.2 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 D.5.2.6, N_b must be calculated using $k_{c,uncr}$ and $\Psi_{c,N}$ = 1.0. For anchors in lightweight concrete see ACI 318 D.3.6. The value of f'_c used for calculation must be limited to 8,000 psi (55 MPa) in accordance with ACI 318 D.3.7. 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 D.5.5. 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 ACI318 D.6.1.2 and strength reduction factors, ϕ, in accordance with ACI 318 D.4.3 are given in Tables 2 through 4 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 D.6.2 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 D.6.2.2 using the values of d given in Tables 2 through 4 for the corresponding anchor steel in lieu of d_a (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 Section D.3.7.

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 D.6.3.

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 Section D.7.

4.1.9 Minimum Member Thickness, h_{min}, Anchor Spacing, s_{min}, and Minimum Edge Distance, c_{min}: In lieu of ACI 318 D.8.1 and D.8.3, values of s_{min} and c_{min} described in this report must be observed for 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 D.8.4 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 D.5.5.5 except as noted below:

For all cases where $c_{Na}/c_{ac}<1.0$, $\psi_{cp,Na}$ determined from ACI 318 Eq. D-27 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. D-27a for ACI 318, in lieu of ACI 318 D.8.6.

$$c_{ac}=h_{ef}\cdot\left(\frac{\tau_{k,\,uncr}}{1160}\right)^{0.4}\cdot\left[3.1-0.7\frac{h}{h_{ef}}\right] \qquad \text{(Eq. D-27a)}$$

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 D.3.3, except as described below.

The nominal steel shear strength, V_{sa}, 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 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 D.3.3.4.3(d).

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

The following exceptions apply to ACI 318 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 D.6.2 and D.6.3 need not be computed and ACI 318 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 D.6.2 and D.6.3 need not be computed and ACI 318 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 D.3.3.5.3(a) through (c) when the design strength of the anchors is determined in accordance with ACI 318 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:

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

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

where

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

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

ϕN_n = The lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 Appendix D as amended in this report and 2009 IBC Sections 1908.1.9 and 1908.1.10 or 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 Appendix D as amended in this report and 2009 IBC Sections 1908.1.9 and 1908.1.10 or 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 Sections D.7.1, D.7.2 and D.7.3, interaction of tension and shear loads must be calculated as follows:

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

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

For all other cases:

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

4.3 Installation:

Installation parameters are provided in Tables 1, 15, 16, 17, and Figures 3. Installation must be in accordance with ACI 318 D.9.1 and D.9.2. Anchor locations must comply with this report and the plans and specifications approved by the building official. Installation of the FLO-ROK™ FR6 SD adhesive anchor system must conform to the manufacturer's printed installation instructions (MPII) included in each package unit and reproduced in Figure 3. The nozzles, brushes, dispensing tools and resin stoppers supplied by the manufacturer, as shown in Figure 2 and listed in Tables 15, 16, and 17, 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 D.9.2.4.

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

4.4.2 Continuous Special Inspection: Installations made under continuous special inspection with an on-site proof loading program must be performed in accordance with Section 1705.1.1 of the 2012 IBC, Sections 1704.4 and 1704.15 of the 2009 IBC, or Sections 1704.4 and 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 ($A_{se,N}$ f_{ya}). The proof load shall be maintained at the required load level for a minimum of 10 seconds.

4.4.3 Periodic Special Inspection: Periodic special inspection must be performed where required in accordance with Section 1705.1.1 and Table 1705.3 of the 2012 IBC, Sections 1704.4 and 1704.15 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 UCAN Fastening Products FLO-ROK™ FR6 SD 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 FLO-ROK™ FR6 SD 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 FLO-ROK™ FR6 SD 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 FLO-ROK™ FR6 SD 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, FLO-ROK™ FR6 SD 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 or fire-retardant-treated wood must be zinc-coated carbon steel or stainless steel. The minimum coating weight 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 D.9.2.2 or D.9.2.3.

5.20 FLO-ROK™ FR6 SD 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 16mm require the use of resin stoppers during injection to the back of the hole. ½-inch, $^{9}/_{16}$-inch, $^{5}/_{8}$-inch, 12mm, 14mm, and 16mm 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 facade systems and other applications subject to direct sun exposure.

5.22 FLO-ROK™ FR6 SD adhesive is manufactured and packaged into cartridges 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 June 2019, which incorporates requirements in ACI 355.4-11.

7.0 IDENTIFICATION

7.1 FLO-ROK™ FR6 SD adhesive is identified in the field by labels on the cartridge and packaging, bearing the company name (UCAN Fastening Products), product name (FLO-ROK™ FR6 SD), the batch number, the expiration date, and the evaluation report number (ESR-3584).

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:

UCAN FASTENING PRODUCTS, A DIVISION OF BRITISH FASTENING SYSTEMS LIMITED
155 CHAMPAGNE DRIVE, UNIT 10
TORONTO, ONTARIO M3J 2C6
CANADA
(416) 631-9400
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TABLE 1—FLO-ROK™ FR6 SD 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.

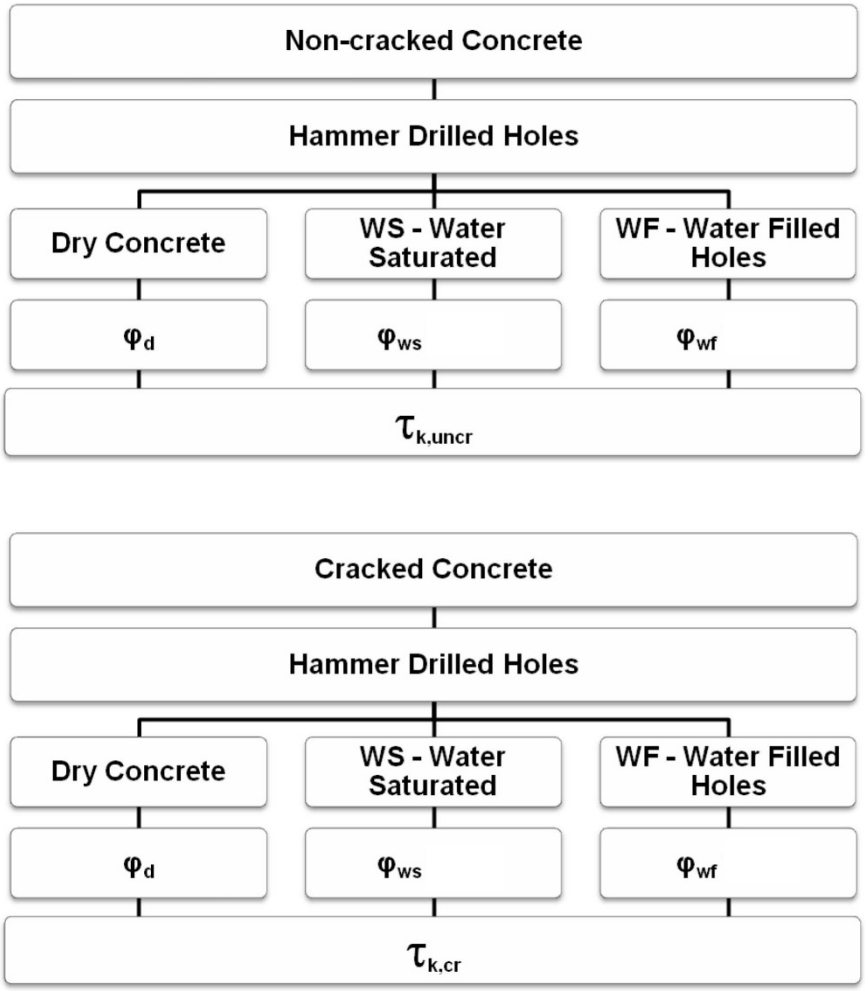


FIGURE 1—FLOWCHART FOR THE ESTABLISHMENT OF DESIGN BOND STRENGTH

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 (32.84)	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 Eq. (D-2) and Eq. (D-29).
[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 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	6,600	12,000	18,600	26,400	36,000	47,400	76,200
			(kN)	(29.4)	(53.4)	(82.7)	(117.4)	(160.1)	(210.8)	(339.0)
	Tension Resistance of Carbon Steel ASTM A615 Grade 60	N_{sa}	lb	9,900	18,000	27,900	39,600	54,000	71,100	114,300
			(kN)	(44.0)	(80.1)	(124.1)	(176.1)	(240.2)	(316.3)	(508.4)
	Shear Resistance of Carbon Steel ASTM A615 Grade 40	V_{sa}	lb	3,960	7,200	11,160	15,840	21,600	28,440	45,720
			(kN)	(17.6)	(32.0)	(49.6)	(70.5)	(96.1)	(126.5)	(203.4)
	Shear Resistance of Carbon Steel ASTM A615 Grade 60	V_{sa}	lb	5,940	10,800	16,740	23,760	32,400	42,660	68,580
			(kN)	(26.4)	(48.0)	(74.5)	(105.7)	(144.1)	(189.8)	(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 Eq. (D-2) and Eq. (D-29).
[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 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}	mm^2	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}	mm^2	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 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 Eq. (D-2) and Eq. (D-29).

[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 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 D.4.3. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 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 D.4.3. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4.

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/mm^2	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm^2	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/mm^2	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm^2	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/mm^2	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm^2	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/mm^2	N/A		5.0				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	520	490	550	520	485	450	385
				N/mm^2	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/mm^2	7.8		9.3				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	965	915	1025	965	900	840	715
				N/mm^2	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/mm^2	6.0		7.1				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	735	695	780	735	685	640	545
				N/mm^2	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/mm^2	N/A		5.0			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	540	510	550	520	485	170	145
				N/mm^2	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/mm^2	8.1		9.3			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1000	945	1025	965	900	320	270
				N/mm^2	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/mm^2	6.2		7.1			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	765	720	780	735	685	245	205
				N/mm^2	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 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, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 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/mm^2	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm^2	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/mm^2	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm^2	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/mm^2	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm^2	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/mm^2	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm^2	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/mm^2	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm^2	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/mm^2	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm^2	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/mm^2	5.0					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	540	510	550	520	485	200	175
				N/mm^2	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/mm^2	9.3					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1000	945	1025	965	900	380	320
				N/mm^2	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/mm^2	7.1					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	765	720	780	735	685	290	245
				N/mm^2	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 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, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 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/mm^2	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm^2	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/mm^2	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm^2	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/mm^2	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm^2	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/mm^2	N/A		5.0				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	520	490	550	520	485	450	385
				N/mm^2	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/mm^2	7.8		9.3				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	965	915	1025	965	900	840	715
				N/mm^2	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/mm^2	6.0		7.1				
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	735	695	780	735	685	640	545
				N/mm^2	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/mm^2	N/A		5.0			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	540	510	550	520	485	170	145
				N/mm^2	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/mm^2	8.1		9.3			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1000	945	1025	965	900	320	270
				N/mm^2	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/mm^2	6.2		7.1			N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	765	720	780	735	685	245	205
				N/mm^2	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 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, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 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/mm^2	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm^2	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/mm^2	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm^2	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/mm^2	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm^2	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/mm^2	5.0						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	620	585	550	520	485	450	385
				N/mm^2	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/mm^2	9.3						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1150	1090	1025	965	900	840	715
				N/mm^2	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/mm^2	7.1						
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	875	830	780	735	685	640	545
				N/mm^2	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/mm^2	5.0					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	540	510	550	520	485	200	175
				N/mm^2	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/mm^2	9.3					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1000	945	1025	965	900	380	320
				N/mm^2	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/mm^2	7.1					N/A	
		Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	765	720	780	735	685	290	245
				N/mm^2	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 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, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 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, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 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, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 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 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, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 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]

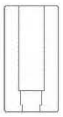
Design Information			Symbol	Units	Nominal Reinforcing Bar Diameter					
					M10	M12	M16	M20	M25	M32
Minimum Effective Installation Depth			$h_{ef,min}$	in.	2.4	2.8	3.1	3.5	3.9	5.0
				mm	60	70	80	90	100	128
Maximum Effective Installation Depth			$h_{ef,max}$	in.	7.9	9.4	12.6	15.7	19.7	25.2
				mm	200	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, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4.
[7]For sustained loads, bond strengths must be multiplied by 0.73.

FIGURE 2—UCAN FASTENING PRODUCTS FLO-ROK™ FR6 SD ADHESIVE ANCHORING SYSTEM

TABLE 15—INSTALLATION PARAMETERS (FRACTIONAL SIZES)

Threaded Rod Installations							
Anchor Size	**Drilled Hole Size**	**Cleaning Brush Size**	**Nozzle Types** PAM 6	PAM 6HF	**Extension Tube Required?**	**Resin Stopper Required?**	**Notes**
							
3/8"	1/2"	S14H/F	✓		Y1 > 3.5" h_{ef}	N	
1/2"	9/16"	S16H/F	✓		Y1 > 3.5" h_{ef}	N	
5/8"	3/4"	S22H/F	✓	✓	Y2 > 10" h_{ef}	FR6 P18>10" h_{ef}	PAM 6HF nozzle required at hef > 8"
3/4"	7/8"	S24H/F		✓	Y2 > 10" h_{ef}	FR6 P18>10" h_{ef}	
7/8"	1"	S27H/F		✓	Y2 > 10" h_{ef}	FR6 P22>10" h_{ef}	
1"	1-1/8"	S31H/F		✓	Y2 > 10" h_{ef}	FR6 P22>10" h_{ef}	
1-1/4"	1-3/8"	S38H/F		✓	Y2 > 10" h_{ef}	FR6 P30>10" h_{ef}	
Reinforcing Bar Installations							
Anchor Size	**Drilled Hole Size**	**Cleaning Brush Size**	**Nozzle Types** PAM 6	PAM 6HF	**Extension Tube Required?**	**Resin Stopper Required?**	**Notes**
							
#3	9/16"	S14H/F	✓		Y1 > 3.5" h_{ef}	N	
#4	5/8"	S16H/F	✓	✓	Y1 > 3.5" h_{ef}	N	PAM 6HF nozzle required at hef > 3.5"
#5	3/4"	S22H/F	✓	✓	Y2 > 10" h_{ef}	FR6 P18>10" h_{ef}	PAM 6HF nozzle required at hef > 8"
#6	7/8"	S24H/F		✓	Y2 > 10" h_{ef}	FR6 P18>10" h_{ef}	
#7	1"	S27H/F		✓	Y2 > 10" h_{ef}	FR6 22>10" h_{ef}	
#8	1-1/8"	S31H/F		✓	Y2 > 10" h_{ef}	FR6 P22>10" h_{ef}	
#10	1-3/8"	S38H/F		✓	Y2 > 10" h_{ef}	FR6 30>10" h_{ef}	

Key:
Y1 Requires 3/8" diameter extension tube fitted to PAM 6 nozzle
Y2 Requires 9/16" diameter extension tube fitted to QPAM 6HF nozzle
FR6 P18 Use 18 mm diameter resin stopper
FR6 P22 Use 22 mm diameter resin stopper
FR6 P30 Use 30 mm diameter resin stopper
N Not required
H Brush with handle
F Brush with ferrule

TABLE 16—INSTALLATION PARAMETERS (METRIC SIZES)

Threaded Rod Installations							
Anchor Size	**Drilled Hole Size**	**Cleaning Brush Size**	**Nozzle Types** PAM 6	PAM 6HF	**Extension Tube Required?**	**Resin Stopper Required?**	**Notes**
							
M10	12	S14H/F	✓		Y1 > 90 mm h_{ef}	N	
M12	14	S16H/F	✓		Y1 > 90 mm h_{ef}	N	
M16	18	S22H/F	✓	✓	Y2 > 250 mm h_{ef}	FR6 P18> 250mm h_{ef}	PAM 6HF nozzle required at hef > 200mm
M20	22	S24H/F		✓	Y2 >250 mm h_{ef}	FR6 P18> 250mm h_{ef}	
M24	26	S31H/F		✓	Y2 >250 mm h_{ef}	FR6 P22> 250mm h_{ef}	
M30	35	S38H/F		✓	Y2 >250 mm h_{ef}	FR6 P22> 250mm h_{ef}	

Reinforcing Bar Installations							
Anchor Size	**Drilled Hole Size**	**Cleaning Brush Size**	**Nozzle Types** PAM 6	PAM 6HF	**Extension Tube Required?**	**Resin Stopper Required?**	**Notes**
							
T10	14	S16H/F	✓		Y1 > 90 mm h_{ef}	N	
T12	16	S18H/F	✓	✓	Y1 > 90 mm h_{ef}	N	PAM 6HF nozzle required at hef > 90 mm
T16	20	S22H/F	✓	✓	Y2 > 250 mm h_{ef}	FR6 P18> 250mm h_{ef}	PAM 6HF nozzle required at hef > 200 mm
T20	25	S27H/F		✓	Y2 > 250 mm h_{ef}	FR6 P22> 250mm h_{ef}	
T25	32	S35H/F		✓	Y2 > 250 mm h_{ef}	FR6 22> 250mm h_{ef}	
T32	40	S43H/F		✓	Y2 > 250 mm h_{ef}	FR6 P30> 250mm h_{ef}	

Key:

Y1	Requires 10 mm diameter extension tube fitted to PAM 6 nozzle
Y2	Requires14 mm diameter extension tube fitted to PAM 6HF nozzle
FR6	P 18 Use 18 mm diameter resin stopper
FR6	P22 Use 22 mm diameter resin stopper
FR6	P30 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	
		PAM 6	PAM 6HF High Flow
FR 6-9 SD	 250ml Manual - PA 250	✓	
FR 6-14 SD	 400ml Manual - PA 400	✓	✓
FR 6-20 SD	 600ml Manual - PA 2000	✓	✓
FR 6-50 SD	 1500ml Pneumatic - PA 1500	✓	✓

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.

UCAN **FLO-ROK® 6 SD**
Product Information Sheet
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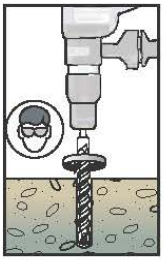
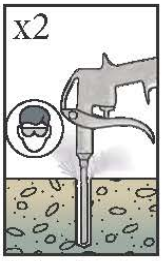
FLO-ROK® FR6 SD

Before beginning installation ensure the worker is equipped with appropriate personal protection equipment, rotary hammer drill, compressed air nozzle, hole cleaning brush, good quality dispensing tool – either manual or power operated, chemical cartridge with mixing nozzle and extension tube, if needed. Refer to technical data "Installation Parameters" 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, port up, in cool conditions (10°C to 25°C) out of direct sunlight.

Hole Preparation

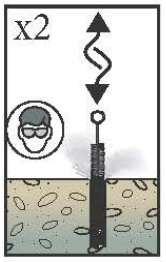


1. Drill the hole to the specified hole diameter and depth using rotary hammer drill in hammer "ON" mode with a UCAN carbide tipped drill bit, conforming to ANSI B212.15-1994 of the appropriate size.



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

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

5. Repeat 3

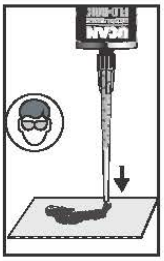
6. Repeat 2

FIGURE 3—INSTALLATION DETAILS

Injection Cartridge Preparation

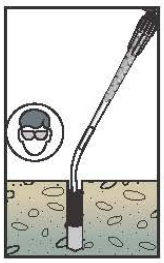
7. Select the appropriate static mixer nozzle, checking that the mixing elements are present and correct (do not modify the mixer). Remove port closure and attach mixer nozzle to the cartridge. Check the dispensing tool is in good working order. Place the cartridge into the dispensing tool.

Note: FR6 SD may only be installed in base material that is between the temperatures of 5°C and 40°C. The product must be conditioned to a minimum of 10°C. For gel and cure time data, refer to products label or UCAN's Technical Manual



8. Dispense a small amount of resin to waste until an even-colored mixture is extruded. The cartridge is now ready for use.

Floor and Wall Anchoring



9. **Deep hole (10" & over)**
As specified in "Installation Parameters" (Refer to UCAN Technical Manual), attach an extension tube with resin stopper 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).

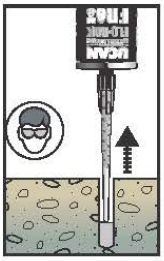
Note: The PAM 6HF nozzle is supplied in two sections. One section contains the mixing elements and the other section is an extension piece. Connect the two sections by pushing them firmly together until a positive engagement is felt.

Continues...

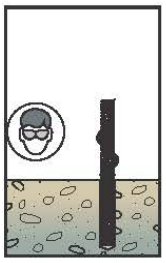
FIGURE 3—INSTALLATION DETAILS

UCAN **FLO-ROK® 6 SD**
Product Information Sheet
www.ucanfast.com

Floor and Wall Anchoring - Continued

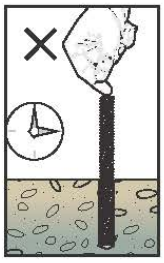


10. Insert the mixing nozzle or extension tube with resin stopper (see figure 9) to the bottom of the hole. Dispense the resin and slowly withdraw the nozzle from the hole. Ensure no air voids are created as the nozzle is withdrawn. Inject resin until the hole is approximately 1/2 - 2/3 full and remove the nozzle from the hole.

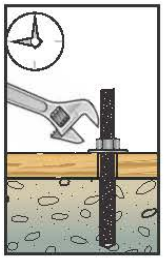


11. Select the threaded rod or rebar ensuring it is free from oil or other contaminants, and mark with the required embedment depth. Insert the threaded rod or rebar into the hole using a back and forth twisting motion to ensure complete cover, until it reaches the bottom of the hole. Excess resin will be pushed out from the hole evenly around the threaded rod or rebar and there shall be no air gaps between the threaded rod or rebar 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 Working and Load Timetable (UCAN Technical Manual) to determine the appropriate cure time.



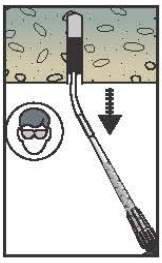
14. Position the fixture and tighten the anchor to the appropriate installation torque.

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

V-1

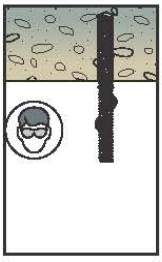
FIGURE 3—INSTALLATION DETAILS (Continued)

Overhead Anchoring



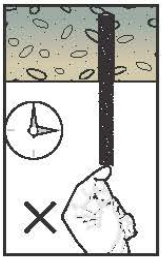
9a. As specified in "Installation Parameters" (Refer to UCAN Technical Manual), attach an extension tube with resin stopper to the end of the mixing nozzle with a push fit. (The extension tubes may be pushed into the resin stoppers and are held in place with a coarse internal thread).

9b. Insert the extension tube with resin stopper to the bottom of the hole. Dispense 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 1/2 - 2/3 full and remove the nozzle from the hole.

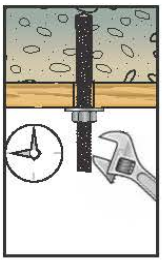


10. **Select the appropriate threaded rod** or rebar ensuring it is free from oil or other contaminants, and mark with the required embedment depth. Insert the threaded rod or rebar into the hole using a back and forth twisting motion, to ensure complete cover, until it reaches the bottom of the hole. Excess resin will be pushed out from the hole evenly around the threaded rod or rebar and there shall be no air gaps between the threaded rod or rebar and the wall of the drilled hole. During initial curing period, it maybe necessary to support rod.

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



12. Do not disturb the anchor until at least the minimum cure time has elapsed. Refer to the Working and Load Timetable (UCAN Technical Manual) to determine the appropriate cure time.



13. 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.

For more information refer to
UCAN TECHNICAL MANUAL
www.tinyurl.com/ucanfr6d

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 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
FLO-ROK™ FR6 SD 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 D.5.1.2 (Table 2 of this report).	ϕN_{sa} = ϕN_{sa} =0.65 x 17740 **=11531 lb**
Step 2:	Calculate breakout strength of a single anchor in tension per ACI 318 D.5.2 (Table 5 of this report).	N_b = $k_{c,uncr} \lambda_a \sqrt{(f'_c)} h_{ef}^{1.5}$ =(24) x(1.0) x $(2500)^{0.5}$ x $(2.75)^{1.5}$ =5472 lb
		ϕN_{cb} = $\phi (A_{NC} / A_{NC0}) \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$ =0.65 x 1.0 x 1.0 x 1.0 x 1.0 x 5472 **=3557 lb**
Step 3:	Calculate bond strength of a single anchor in tension per ACI 318 D.5.5 (Table 8 of this report).	N_{ba} = $\lambda_a \tau_{k,uncr} \pi d h_{ef}$ =1.0 x 1350 x 3.141 x 0.5 x 2.75 =5830 lb
		ϕN_a = $\phi (A_{Na} / A_{Na0}) \psi_{ed,Na} \psi_{cp,Na} N_{ba}$ =0.65 x 1.0 x 1.0 x 1.0 x 5830 **=3789 lb**
Step 4:	Determine controlling resistance strength in tension per ACI 318 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 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

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:

UCAN FASTENING PRODUCTS, A DIVISION OF BRITISH FASTENING SYSTEMS LIMITED

EVALUATION SUBJECT:

UCAN FASTENING PRODUCTS FLO-ROK™ FR6 SD 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 UCAN Fastening Products FLO-ROK™ FR6 SD Adhesive Anchors for Cracked and Uncracked Concrete, described in ICC-ES evaluation report ESR-3584, have also been evaluated for compliance with the codes noted below.

Applicable code editions:

- 2014 *Florida Building Code—Building*
- 2014 *Florida Building Code—Residential*

2.0 CONCLUSIONS

The UCAN Fastening Products FLO-ROK™ FR6 SD Adhesive Anchors for Cracked and Uncracked Concrete, described in Sections 2.0 through 7.0 of the evaluation report ESR-3584, comply with the *Florida Building Code—Building* and the *Florida Building Code—Residential*, provided the design and installation are in accordance with the 2012 *International Building Code*® provisions noted in the report and the following provisions apply:

- Design wind loads must be based on Section 1609 of the Florida Building Code—Building or Section 301.2.1.1 of the Florida Building Code—Residential, as applicable.
- Load combinations must be in accordance with Section 1605.2 or Section 1605.3 of the Florida Building Code—Building, as applicable.

Use of the UCAN Fastening Products FLO-ROK™ FR6 SD 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 August 2022.