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UCAN

FLO-ROK® FR6-SD INJECTION SYSTEM

REQUEST FOR APPROVAL

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Please review the attached technical data and approve the **FLO-ROK® FR6-SD INJECTION SYSTEM** (Part No. TYPE HERE) for the following application(S) below:

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PROJECT:

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FOR USE BY THE ENGINEER OR/AND ARCHITECT

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☐ ADDITIONAL INFORMATION REQUIRED

☐ REJECTED, REASON FOR REJECTION:

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DATE:

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FLO-ROK FR6-SD INJECTION ADHESIVE ANCHOR

DESCRIPTION

The UCAN FLO-ROK® FR6-SD high performance pure epoxy adhesive is a two-component (resin and hardener) epoxy-based adhesive, supplied in dual chamber cartridges separating the chemical components, which are combined in a 1:1 ratio by volume when dispensed through the systems static mixing nozzle. The FLO-ROK® FR6-SD anchoring adhesive is specifically formulated for continuously threaded steel rod and deformed steel reinforcing bar anchoring to resist static, wind or earthquake (Seismic Design Categories A through F) tension and shear loads in cracked and un-cracked, 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 FLO-ROK® FR6-SD adhesive anchors are designed to be used for floor (vertically down), wall (horizontal), and overhead applications. Horizontal and overhead applications are limited to use with 1-1/4-inch (30 mm) threaded rod and 30M (#10) reinforcing bar, or smaller, when installed in accordance with Installation instructions shown on Page 17,18.

FEATURES

- ICC-ES® listed ESR - 3584
- ACI 318 category 1 anchor for cracked or uncracked concrete
- High strength pure epoxy adhesive
- Suitable for dynamic and vibration loading
- Seismic resistance
- Close to edge fastening
- Ideal for deep hole applications
- Smooth flowing
- Low odour
- Styrene and VOC free
- Extended working time

TYPICAL APPLICATIONS

- Structural steel base plate anchoring
- Vibratory loading applications
- Rebar and doweling
- Safety barriers
- Cranes and lifting equipment
- Racking
- Heavy machinery and robotics installation
- Road and bridge construction
- Parking structure rehabilitation

LISTINING AND APPROVALS

ICC-ES® - ESR 3584

NSF/ANSI Std 61(cerficate for use in potable water)

MTQ
Approved (BC-14-052)

LEED® COMPLIANCE

Credit 4.1 - Low Emitting Materials

COMPLIANCE WITH THE FOLLOWING CODES

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

FLO-ROK FR6-SD INJECTION ADHESIVE ANCHOR

MATERIAL SPECIFICATIONS

CURED EPOXY

Property		Unit	Value	Test Standard
Density		lb/ft^2	106	ASTM D 1875 @ 22˚C/72˚F
		g/cm^3	1.7	
Compressive Strength	24 hrs	psi	8,550	ASTM D 695 @ 22˚C/72˚F
		MPa	59	
	7 days	psi	12,375	
		MPa	85	
Tensile Strength	24hrs	psi	2,610	ASTM D 638 @ 22˚C/72˚F
		MPa	18	
	7 days	psi	3,325	
		MPa	25	
Elongation at Break	24 hrs	%	6.6	ASTM D 638 @ 22˚C/72˚F
	7 days		5.9	
Tensile Modulus	24 hrs	psi	827,000	ASTM D 638 @ 22˚C/72˚F
	7 days	psi	798,000	
Flexural Strength	24 hrs	psi	6,525	ASTM D 790 @ 22˚C/72˚F
		MPa	45	
HDT	7 days	˚F	120	ASTM D 648 @ 22˚C/72˚F
		˚C	49	
Bond Strength	2 days	psi	2,656	ASTM C 882-91
		MPa	18.3	
	14 days	psi	2,736	
		MPa	18.9	
Linear Coefficient of Shrinkage	-	inch	0.0003	ASTM D 2566-86
Water Absorption	-	%	0.08	ASTM D570-98

ANCHOR RODS

Standard Threaded Rod / Carbon steel	F_u	psi	72,500	ISO 898 Grade 5.8
		MPa	500	
	F_y	psi	58,000	
		MPa	400	
High Strength Threaded Rod/Carbon Steel	F_u	psi	125,000	ASTM A193, Grade B7
		MPa	862	
	F_y	psi	105,000	
		MPa	724	
Stainless Steel Threaded Rod	F_u	psi	100.000	ASTM F 593 (AISI 304/316)
		MPa	689	
	F_y	psi	65,000	
		MPa	448	
Carbon Steel Nuts	-	-	-	ASTM A 563
Stainless Steel Nuts	-	-	-	ASTM F 594
Carbon and Stainless Steel Washers	-	-	-	ASTM B18.22.1 Type A Plain

STRENGTH DESIGN

General: The design strength of anchors must be determined in accordance with ACI 318-08 Appendix D and the ESR- 3584 report.

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

Design parameters, including strength reduction factors, φ, corresponding to each limit state, are provided in Tables 3 through 10. Strength reduction factors, φ, as described in ACI 318 Section D.4.4 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.4.5 must be used for load combinations calculated in accordance with Appendix C of ACI 318.

The following amendments to ACI 318 Appendix D must be used as required for the strength design of adhesive anchors. In conformance with ACI 318, all equations are expressed in inch-pound units.

Modify ACI 318 D.4.1.2 as follows:

D.4.1.2 – In Eq. (D-1) and (D-2), φN_n and φV_n are the lowest design strengths determined from all appropriate failure modes. φN_n is the lowest design strength in tension of an anchor or group of anchors as determined from consideration of φN_{sa}, either φN_a or φN_{ag} and either φN_{cb} or φN_{cbg}. φV_n is the lowest design strength in shear of an anchor or group of anchors as determined from consideration of φV_{sa}, either φV_{cb} or φV_{cbg}, and either φV_{cp} or φV_{cpg}. For adhesive anchors subject to tension resulting from sustained loading, refer to D.4.1.4 for additional requirements.

Add ACI 318 D.4.1.4 as follows:

D.4.1.4 – For adhesive anchors subjected to tension resulting from sustained loading, a supplementary design analysis shall be performed using Eq. (D-1) whereby N_{ua} is determined from the sustained load alone, e.g., the dead load and that portion of the live load that may be considered as sustained, and φN_n is determined as follows:

D.4.1.4.1 – For single anchors: $\varphi N_n = 0.75\ \varphi N_{ao}$

D.4.1.4.2 – For anchor groups, Equation (D-1) shall be satisfied by taking $\varphi N_n = 0.75\ \varphi N_{ao}$ for that anchor in an anchor group that resists the highest tension load.
D.4.1.4.3 – Where shear loads act concurrently with the sustained tension load, interaction of tension and shear shall be analyzed in accordance with D.4.1.3.

Modify ACI 318 D.4.2.2 in accordance with the 2009 IBC Section 1908.1.10 as follows:

D.4.2.2 – The concrete breakout strength requirements for anchors in tension shall be considered satisfied by the design procedure of D.5.2 provided Equation D-8 is not used for anchor embedments exceeding 25 inches. The concrete breakout strength requirements for anchors in shear with diameters not exceeding 2 inches shall be considered satisfied by the design procedure of D.6.2. For anchors in shear with diameters exceeding 2 inches, shear anchor reinforcement shall be provided in accordance with the procedures of D.6.2.9.

Static Steel Strength in Tension: The nominal steel strength of a single anchor in tension, N_{sa}, must be calculated in accordance with ACI 318 D.5.1.2, and strength reduction factors, φ, in accordance with D.4.4 are given in Tables 3, 4, and 5 for the corresponding anchor steel element.

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 modifications as described in this section. The basic concrete breakout strength in tension, N_b, must be calculated in accordance with ACI 318 Section 5.2 with the following additions:

D.5.2.10 – (2009 and 2003 IBC) or D.5.2.9 (2006 IBC) – The limiting concrete strength of adhesive anchors in tension shall be calculated in accordance with D.5.2.1 to D.5.2.9 under the 2009 IBC or D.5.2.1 to D.5.2.8 under the 2006 IBC, where the value of k_c to be used in Eq. (D-7) shall be:

$K_{c,cr} = 17$ where analysis indicates cracking at service load levels in the vicinity of the anchor (cracked concrete).

$K_{c,uncr} = 24$ where analysis indicates no cracking ($f_t < f_r$) at service load levels in the vicinity of the anchor (uncracked concrete).

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 values of hef, and $k_{c,cr}$ or $k_{c,uncr}$ as described in the ESR -3584 report. The modification factor "λ" must be taken as 1.0. Anchors must not be installed in lightweight concrete. Additional information for the determination of the nominal concrete

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breakout strength (N_{cb} or N_{cbg}) is given in Tables 6 and 7 of this report. The value of f'_c must be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318 D.3.5.

Static Pullout Strength in Tension: In lieu of determining the nominal pullout strength in accordance with ACI 318 D.5.3, the nominal bond strength in tension must be calculated in accordance with the following sections added to ACI 318:

D.5.3.7 – The nominal bond strength of a single adhesive anchor, N_a, or group of adhesive anchors, N_{ag}, in tension shall not exceed:

(a) for a single anchor

$$N_a = \frac{A_{Na}}{A_{Na0}} \psi_{ed,Na} \psi_{p,Na} N_{a0} \quad \text{(D-16a)}$$

(b) for a group of anchors

$$Nag = \frac{A_{Na}}{A_{Nao}} \Psi_{g,na} \Psi_{ec,Na} \Psi_{ed,Na} \Psi_{p,Na} Na0 \quad \text{(D-16b)}$$

where

A_{Na} is the projected area of the failure surface for the anchor or group of anchors that shall be approximated as the base of the rectilinear geometrical figure that results from projecting the failure surface outward a distance, $c_{cr,Na}$, from the centerlines of the anchor, or in the case of a group of anchors, from a line through a row of adjacent anchors. A_{Na} shall not exceed nA_{Na0} where n is the number of anchors in tension in the group. In ACI 318 Figures RD.5.2.1a and RD.5.2.1b, the terms 1.5 h_{ef} and $3.0h_{ef}$ shall be replaced with $c_{cr,Na}$ and $s_{cr,Na}$ respectively.

A_{Na0} is the projected area of the failure surface of a single anchor without the influence of proximate edges in accordance with Eq. (D-16c):

$$A_{Na0} = (S_{cr,Na})^2 \quad \text{(D-16c)}$$

with:

$s_{cr,Na}$ as given by Eq. (D-16d)

D.5.3.8 – The critical spacing scr,Na and critical edge distance ccr,Na must be calculated as follows:

$$scr,Na = 20 \cdot d \cdot \sqrt{\frac{\tau_{k,uncr}}{1,450}} \leq 3 \cdot h_{ef} \quad \text{(D-16d)}$$

$$c_{cr,Na} = \frac{s_{cr,Na}}{2} \quad \text{(D-16e)}$$

D.5.3.9 – The basic strength of a single adhesive anchor in tension in cracked concrete shall not exceed:

$$N_{a0} = \tau_{k,cr} \cdot \pi \cdot d \cdot h_{ef} \quad \text{(D-16f)}$$

where

$\tau_{k,cr}$ = the characteristic bond strength in cracked concrete.

D.5.3.10 – The modification factor for the influence of the failure surface of a group of adhesive anchors is:

$$\psi_{g,Na} = \psi_{g,Na0} + \left[\left(\frac{s}{s_{cr,Na}}\right)^{0.5} \cdot (1-\psi_{g,Na0})\right] \quad \text{(D-16g)}$$

where:

s = actual spacing of the anchors

$$\psi_{g,Na0} = \sqrt{n} - \left[(\sqrt{n}-1) \cdot \left(\frac{\tau_{k,cr}}{\tau_{k,max,cr}}\right)^{1.5}\right] \geq 1.0 \quad \text{(D-16h)}$$

n = the number of tension loaded adhesive anchors in a group.

$$\tau_{k,max,cr} = \frac{k_{c,cr}}{\pi \cdot d} \sqrt{hef \cdot f'c} \quad \text{(D-16i)}$$

The value of f'_c shall be limited to maximum of 8,000 psi (55 MPa) in accordance with ACI 318 Section D.3.5.

D.5.3.11 – The modification factor for eccentrically loaded adhesive anchor groups is:

$$\Psi_{ec,Na} = \frac{1}{1+\frac{2e'}{N_{scr,Na}}} \leq 1.0 \qquad \text{(D-16j)}$$

Eq. (D-16j) is valid for $e'_N \leq \frac{s}{2}$

If the loading on an anchor group is such that only some anchors are in tension, only those anchors that are in tension shall be considered when determining the eccentricity e'_N for use in Eq. (D-16j).
In the case where eccentric loading exists about two orthogonal axes, the modification factor $\Psi_{ec,Na}$ shall be computed for each axis individually and the product of these factors used as $\Psi_{ec,Na}$ in Eq. (D-16b).

D.5.3.12 – The modification factor for edge effects for single adhesive anchors or anchor groups loaded in tension is:

$$\Psi_{ed,Na} = 1.0 \qquad \text{(D-16l)}$$

where ca,min ≥ ccr,Na
or

$$\Psi_{ed,Na} = \left(0.7+0.3\,\frac{c_{a,min}}{c_{cr,Na}}\right) \leq 1.0 \qquad \text{(D-16m)}$$

when $c_{a,min} \leq c_{cr,Na}$

D.5.3.13 – When an adhesive anchor or group of adhesive anchors is located in a region of a concrete member where analysis indicates no cracking at service load levels, the nominal strength, N_a or N_{ag}, of a single adhesive anchor or a group of adhesive anchors shall be calculated according to Eq. (D-16a) and Eq. (D-16b) with $\tau_{k,uncr}$ (see Tables 8 through 10) substituted for $\tau_{k,cr}$ in the calculation of the basic strength, N_{a0}, in accordance with Eq. (D-16f). The factor, $\psi_{g,Na0}$, shall be calculated in accordance with Eq. (D-16h), whereby the value of $\tau_{k,uncr}$ shall be substituted for $\tau_{k,cr}$ and the value of $\tau_{k,max,uncr}$ shall be calculated in accordance with Eq.
(D-16n) and substituted for $\tau_{k,max,cr}$ in Eq. (D-16h).

$$\tau_{k,max,uncr} = \frac{k_{c,uncr}}{\pi \cdot d}\sqrt{h_{ef}\text{-}f'c} \qquad \text{(D-16n)}$$

The value of f'_c must be limited to maximum of 8,000 psi (55 MPa) in accordance with ACI 318 Section D.3.5.
D.5.3.14 – When an adhesive anchor or a group of adhesive anchors is located in a region of a concrete member where analysis indicated no cracking at service load levels, the modification factor, $\Psi_{p,Na}$, shall be taken as:

$$\Psi_{p,Na} = 1.0 \text{ when } ca,_{min} \geq c_{ac} \qquad \text{(D-16o)}$$

or

$$\Psi_{p,Na} = \frac{max\backslash c_{a,min};\, c_{cr,Na}\backslash}{c_{ac}} \text{ when } c_{a,min} < c_{ac} \qquad \text{(D-16p)}$$

where
c_{ac} must be determined in accordance with Section 4.1.10 of the ESR - 3584 report.
For all other cases, $\Psi_{p,na}$ = 1.0 (e.g., when cracked concrete is considered).
Additional information for the determination of nominal bond strength in tension is given in Section 4.1.8 of this report.

Static Steel Strength in Shear: The nominal static steel strength of a single anchor in shear, $V_{sa,}$ in accordance with ACI318 D.6.1.2, is given in Tables 3 through 5. The strength reduction factor, φ, corresponding to the steel element selected, is also given in Tables 3 through 5, for use with load combinations of ACI 318 9.2 as set forth in D.4.4.

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 6 and 7. The basic concrete breakout strength in shear, V_b, must be calculated in accordance with ACI 318 D.6.2.2 using the applicable values of d_o as described in Tables 3 through 5 in lieu of d_a (2009 IBC). In addition, h_{ef} must be substituted for l_e. In no case shall l_e exceed $8d_o$. The value of f'_c must be limited to a maximum of 8,000 psi (55 MPa), in accordance with ACI 318 Section D.3.5.

Static Concrete Pryout Strength in Shear: In lieu of determining the nominal pryout strength in accordance with ACI 318 Section D.6.3.1, nominal pryout strength in shear must be calculated in accordance with the following sections added to ACI 318:

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D.6.3.2 – The nominal pryout strength of an adhesive anchor, V_{cp}, or group of adhesive anchors, V_{cpg}, shall not exceed:
(a) for a single adhesive anchor:
$V_{cp}= min\backslash k_{cp}N_a \; ; \; k_{cp}N_{cb}\backslash$ (D–30a)
(b) for a group of adhesive anchors:
$V_{cpg}= min\backslash \; k_{cp}N_{ag} \; ; \; k_{cp}N_{cbg}\backslash$ (D–30b) ((D
where:
k_{cp} = 1.0 for h_{ef} < 2.5 inches
k_{cp} = 2.0 for $h_{ef} \geq$ 2.5 inches
N_a shall be calculated in accordance with Eq. (D-16a)
N_{ag} shall be calculated in accordance with Eq. (D-16b)
N_{cb}, N_{cbg} are determined in accordance with D.5.2

Bond Strength Determination: Bond strength values are a function of the concrete condition (cracked or uncracked), the installation conditions (dry, water-saturated, water filled), and the special inspection level provided. Strength reduction factors, φ, listed in Figure 1 and Tables 7 through 9, are utilized for anchors installed in dry concrete, water-saturated concrete, or concrete where the holes are filled with water at the time the anchors are installed, in accordance with the level of inspection provided (periodic or continuous), as applicable. Bond strength values must be modified with the factor κ_{ws} for cases wherein the holes are drilled in water-saturated concrete, or κ_{wf} for cases where anchors are installed in water-filled holes in concrete, as shown in Figure 1. The applicable values of φ, κ, and $\tau_{k,cr}$ or $\tau_{k,uncr}$ must be selected from Tables 8 through 10. Tabulated bond strength values are applicable for concrete strength f'_c = 2,500 psi, or greater. No increase in bond strength is permitted for installation in concrete with compressive strengths greater than f'_c = 2,500 psi.

Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: In lieu of ACI 318 D.8.3, values of cmin and smin described in this report must be observed for design and installation. Likewise, in lieu ACI 318 D.8.5, the minimum member thickness, hmin, described in this report must be observed for anchor design and installation.
In determining minimum edge distance, cmin, the following section must be added to ACI 318:
D.8.8 – For adhesive anchors that will remain untorqued, the minimum edge distance shall be based on minimum cover requirements for reinforcement in Section 7.7. For adhesive anchors that will be torqued, the minimum edge distance and spacing shall be taken from Tables 1, 6, and 7

Critical Edge Distance c_{ac}: In lieu of ACI 318 D.8.6, c_{ac} must be determined as follows:

$$c_{ac}=h_{ef}\cdot\left(\frac{\tau_{k,uncr}}{1160}\right)^{0.4}\cdot \max\left[3.1-0.7\,\frac{h}{h_{ef}}\,;1.4\right] \qquad \text{Eq. (4–1)}$$

where $\tau_{k,uncr}$ is the characteristic bond strength in uncracked concrete, h is the member thickness, and h_{ef} is the embedment depth.
$\tau_{k,uncr}$ need not be taken as greater than:

$$\tau_{k,uncr} = \frac{kuncr\,\sqrt{h_{ef}\cdot f'_c}}{\pi d}$$

Design Strength in Seismic Design Categories C, D, E and F: In structures assigned to Seismic Design Category C, D, E or F under the IBC or IRC, the design must be performed according to ACI 318 D.3.3, and the anchor strength must be adjusted in accordance with the 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16. For brittle steel elements, the anchor strength must be adjusted in accordance with ACI 318-08 D.3.3.5 or D.3.3.6, or ACI 318-05 D.3.3.5. The nominal steel shear strength, V_{sa}, must be adjusted by $\alpha_{V,seis}$ as given in Tables 2 through 4 for the corresponding anchor steel. An adjustment to the nominal bond strength, $\tau_{k,cr}$ by $\alpha_{N,seis}$ is not required since $\alpha_{N,seis}$ = 1.0 for all cases.

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.

Allowable Stress Design (ASD):

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

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

where

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

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

φN_n = The lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 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 11 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, must apply. An example of allowable stress design values for illustrative purposes is shown on page 16.

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

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

For all other cases:

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

FIGURE 1—FLOWCHART FOR THE ESTABLISHMENT OF DESIGN BOND STRENGTH

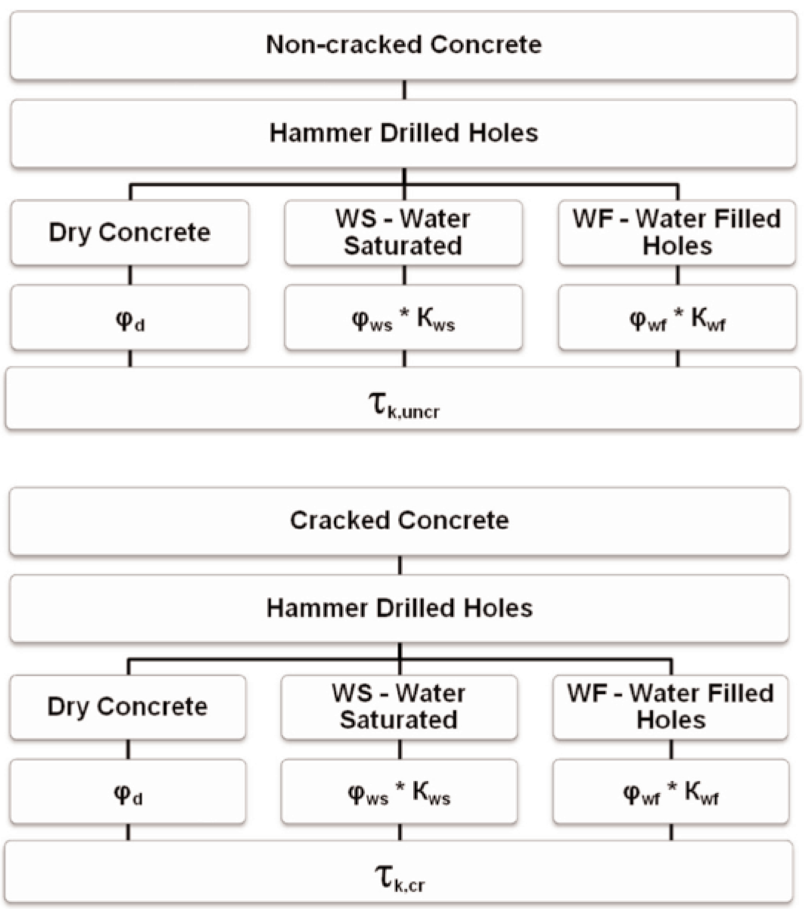

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TABLE 1 - FR6 SD ANCHOR SYSTEM INSTALLATION INFORMATION

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	1	14	18	22	-	26	35
Metric Re-bar(CAN)	Size	M	-	10M	-	15M	20M	-	25M	30M
	Drill Size	d_{hole}	inch	9/16	-	3/4	61/64	-	1-1/4	1-1/2
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 Strength Design Above						
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

Installation:
Installation parameters are provided in Tables 1, 11, 12, 14, and Figures 3. Anchor locations must comply with this report and the plans and specifications approved by the building official. Installation of the EX1 adhesive anchor system must conform to the manufacturer's published installation instructions (MPII) included in each package unit and as described in Figure 3. The nozzles, brushes, dispensing tools and resin stoppers shown in Figure 2 and listed in Tables 11, 12, and 13 supplied by the manufacturer, must be used along with the adhesive cartridges. Installation of anchors may be vertically down (floor), horizontal (walls) and vertically overhead. Use of nozzle extension tubes and resin stoppers must be in accordance with Tables 11 and 12.

TABLE 2 - GEL AND CURING TIME

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

TABLE 3—STEEL DESIGN INFORMATION FOR FRACTIONAL CARBON STEEL AND STAINLESS STEEL THREADED ROD[1,2]

	Characteristic	Symbol	Units	Nominal Rod Diameter, d_o						
	Nominal Size	do	inch	3/8	1/2	5/8	3/4	7/8	1	1-1/4
	Stress Area[1]	Ase	in.2	0.0775	0.1419	0.226	0.334	0.462	0.606	0.969
Carbon Steel Threaded Rod	**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 ISO 898-1 Class 5.8	Nsa	lb (kN)	5,620 (25.0)	10,290 (45.8)	16,385 (72.9)	24,250 (107.9)	33.475 (148.9)	43,910 (195.3)	70,260 (312.5)
	Tension Resistance of Carbon Steel ASTM A193 B7	Nsa	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 ISO 898-1 Class 5.8	Vsa	lb (kN)	2,810 (12.5)	6,175 (27.5)	9,830 (43.7)	14,550 (64.7)	20,085 (89.3)	26,345 (117.2)	42,155 (187.5)
	Shear Resistance of Carbon Steel ASTM A193 B7	Vsa	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	Nsa	lb (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	--	--	--	--
	Tension Resistance of Stainless Steel ASTM F593 CW2	Nsa	lb (kN)	--	--	--	28,390 (126.3)	39,270 (174.7)	51,510 (229.1)	82,365 (366.4)
	Tension Resistance of Stainless Steel ASTM F593 SH1	Nsa	lb (kN)	8,915 (39.7)	16,320 (72.6)	25,990 (115.6)	--	--	--	--
	Tension Resistance of Stainless Steel ASTM F593 SH2	Nsa	lb (kN)	--	--	--	35,070 (156.0)	48,510 (215.8)	63,630 (283.0	--
	Tension Resistance of Stainless Steel ASTM F593 SH3	Nsa	lb (kN)	--	--	--	--	--	--	92,055 (409.5)
	Shear Resistance of Stainless Steel ASTM F593 CW1	Vsa	lb (kN)	3,875 (17.2)	7,095 (31.6)	11,300 (50.3)	--	--	--	--
	Shear Resistance of Stainless Steel ASTM F593 CW2	Vsa	lb (kN)	--	--	--	14,195 (63.1)	19,635 (87.3)	25,755 (114.6)	41,185 (183.2)
	Shear Resistance of Stainless Steel ASTM F593 SH1	Vsa	lb (kN)	4,455 (19.8)	9,790 (43.5)	15,595 (69.4)	--	--	--	--
	Shear Resistance of Stainless Steel ASTM F593 SH2	Vsa	lb (kN)	--	--	--	17,535 (78.0)	24,255 (107.9)	31,815 (141.5)	--
	Shear Resistance of Stainless Steel ASTM F593 SH3	Vsa	lb (kN)	--	--	--	--	--	--	46,030 (204.8)

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

1Values provided for steel threaded rod are based on minimum specified strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20).

2The 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.4.4. 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.4.5.

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TABLE 4—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	Ø					0.65			
	Strength Reduction Shear for Tension Steel Failure	Ø					0.65			
	Reduction for Seismic Tension	$\alpha_{N,seis}$	-				1.00			
	Reduction for Seismic Shear	$\alpha_{N,seis}$	-	0.70	0.70	0.82	0.82	0.42	0.42	0.42
	Tension Resistance of Carbon Steel ASTM A615 Grade 40	N_{sa}	lb (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	36,000 (160.1)	47,400 (210.8)	76,200 (339.0)
	Tension Resistance of Carbon Steel ASTM A615 Grade 60	N_{sa}	lb (kN)	9,900 (44.0)	18,000 (80.1)	27,900 (124.1)	39,600 (176.1)	54,000 (240.2)	71,100 (316.3)	114,300 (508.4)
	Tension Resistance of Carbon Steel ASTM A615 Grade 40	V_{sa}	lb (kN)	3,960 (17.6)	7,200 (32.0)	11,160 (49.6)	15,840 (70.5)	21,600 (96.1)	28,440 (126.5)	45,720 (203.4)
	Tension Resistance of Carbon Steel ASTM A615 Grade 60	V_{sa}	lb (kN)	5,940 (26.4)	10,800 (48.0)	16,740 (74.5)	23,760 (105.7)	32,400 (144.1)	42,660 (189.8)	68,580 (305.1)

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

[1]Values provided for steel threaded rod are based on minimum specified strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20).

[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.4.4. 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.4.5.

TABLE 5—STEEL DESIGN INFORMATION FOR CANADIAN METRIC REINFORCING BAR

	Characteristic	Symbol	Units	Reinforcing Bar Size				
				10M	15M	20M	25M	30M
Reinforcing bar	**Nominal bar diameter**	d_o	mm	11.3	16	19.5	25.2	29.9
	Stress Area	A_{se}	mm.^{2}	100	200	300	500	700
	Strength Reduction Factor for Tension Steel Failure	Ø				0.65		
	Strength Reduction Shear for Tension Steel Failure	Ø				0.65		
	Reduction for Seismic Tension	$\alpha_{N,seis}$	-			1.00		
	Reduction for Seismic Shear	$\alpha_{V,seis}$	-	0.70	0.82	0.82	0.42	0.42
	Tension Resistance of Carbon Steel CSA G 30.18 Grade 500	N_{sa}	lb (kN)	12,140 (54)	24,279 (108)	36,419 (162)	60,699 (270)	84,978 (378)
	Tension Resistance of Carbon Steel CSA G 30.18 Grade 500	N_{sa}	lb (kN)	15,175 (67.5)	30,349 (135)	45,524 (202.5)	75,873 (337.5)	106,223 (472.5)
	Shear Resistance of Carbon Steel CSA G30.18 Grade 400	V_{sa}	lb (kN)	7,284 (32.4)	14,568 (64.8)	21,872 (97.2)	36,419 (162)	50,978 (226,8)
	Shear Resistance of Carbon Steel CSA G30.18 Grade 500	V_{sa}	lb (kN)	16,403 (40.5)	32,805 (81)	49,208 (121.5)	82,013 (202.5)	114,818 (283.5)

TABLE 6—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	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		c_{ac}	-	See Strength Design Above						
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]		Ø	--	0.65						
Strength Reduction Factor for Shear, Concrete Failure Modes, Condition B[1]		Ø	--	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.4.4.
The tabulated value of ø 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.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ø must be determined in accordance with ACI 318 D.4.5.

TABLE 7—CANADIAN METRIC REINFORCING BAR CONCRETE BREAKOUT STRENGTH DESIGN INFORMATION[1]

Characteristic	Symbol	Units	Bar size				
			10M	**15 M**	**20M**	**25M**	**30M**
Embedment Depth Range	$h_{ef,min}$	inch	2-3/8	3-1/8	3-1/2	4	5
	$h_{ef,max}$	inch	7-1/2	12-1/2	15	20	25
Minimum Anchor Spacing	s_{min}	inch	1-1/2	1-3/4	1-7/8	2	2-1/2
Minimum Edge Distance	c_{min}	inch	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	c_{ac}	-	See Strength Design Above				
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]	Ø	--	0.65				
Strength Reduction Factor for Shear, Concrete Failure Modes, Condition B[1]	Ø	--	0.70				

[1]Condition B applies where supplemental reinforcement is not provided as set forth in ACI 318 D.4.4.
The tabulated value of ø 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.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ø must be determined in accordance with ACI 318 D.4.5.

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TABLE 8—FRACTIONAL THREADED ROD BOND STRENGTH DESIGN INFORMATION[1]

Design Information		Symbol	Units	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
Temperature Category A[2,5]	Characteristic Bond Strength in Non-cracked Concrete	$t_{k,uncr}$	psi	530						
			N/mm²	3.7						
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	450	425	400	375	350	330	280
			N/mm²	3.1	2.9	2.8	2.6	2.4	2.3	1.9
Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$t_{k,uncr}$	psi	1,820						
			N/mm²	12.6						
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	1,550	1,465	1,380	1,300	1,215	1,130	965
			N/mm²	10.7	10.1	9.5	9.0	8.4	7.8	6.6
Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$t_{k,uncr}$	psi	735						
			N/mm²	5.1						
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	625	590	560	525	490	455	390
			N/mm²	4.3	4.1	3.9	3.6	3.4	3.1	2.7
Permissible Installation Conditions[6,7]	Dry Concrete	$\varnothing_d$	Periodic Inspection	0.65						
		k_d		1.00						
	Water-saturated Concrete	$\varnothing_{ws}$		0.45						
		k_{ws}		0.84	1.00					
	Water-filled Hole	$\varnothing_{wf}$		0.45						
		k_{wf}		0.87	1.00			0.38		
	Dry Concrete	$\varnothing_d$	Continuous Inspection	0.65						
		k_d		1.00						
	Water-saturated Concrete	$\varnothing_{ws}$		0.45	0.55					
		k_{ws}		1.00	1.00					
	Water-filled Hole	$\varnothing_{wf}$		0.45	0.55			0.45		
		k_{wf}		1.00	1.00			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: 68°F (20°C); Maximum Short Term Temperature: 110°F (43°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 ø 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.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ø must be determined in accordance with ACI 318 D.4.5.

[7]Additional *k* factor for installation condition.

TABLE 9—FRACTIONAL REINFORCING BAR BOND STRENGTH DESIGN INFORMATION[1]

Design Information		Symbol	Units	Nominal Reinforcing Bar Diameter						
				No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 10
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
Temperature Category A[2,5]	**Characteristic Bond Strength in Non-cracked Concrete**	$\tau_{k,uncr}$	psi	530						
			N/mm²	3.7						
	Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	450	425	400	375	350	330	280
			N/mm²	3.1	2.9	2.8	2.6	2.4	2.3	1.9
Temperature Category B, Range 1[3,5]	**Characteristic Bond Strength in Non-cracked Concrete**	$\tau_{k,uncr}$	psi	1,820						
			N/mm²	12.6						
	Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	1,550	1,465	1,380	1,300	1,215	1,130	965
			N/mm²	10.7	10.1	9.5	9.0	8.4	7.8	6.6
Temperature Category B, Range 2[4,5]	**Characteristic Bond Strength in Non-cracked Concrete**	$\tau_{k,uncr}$	psi	735						
			N/mm²	5.1						
	Characteristic Bond Strength in Cracked Concrete	$\tau_{k,cr}$	psi	625	590	560	525	490	455	390
			N/mm²	4.3	4.1	3.9	3.6	3.4	3.1	2.7
Permissible Installation Conditions[6,7]	**Dry Concrete**	$Ø_d$	Periodic Inspection	0.65						
		k_d		1.00						
	Water-saturated Concrete	$Ø_{ws}$		0.45						
		k_{ws}		0.84	1.00					
	Water-filled Hole	$Ø_{wf}$		0.45						
		k_{wf}		0.87	1.00			0.38		
	Dry Concrete	$Ø_d$	Continuous Inspection	0.65						
		k_d		1.00						
	Water-saturated Concrete	$Ø_{ws}$		0.45	0.55					
		k_{ws}		1.00	1.00					
	Water-filled Hole	$Ø_{wf}$		0.45	0.55			0.45		
		k_{wf}		1.00	1.00			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: 68°F (20°C); Maximum Short Term Temperature: 110°F (43°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 ø 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.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ø must be determined in accordance with ACI 318 D.4.5.

[7]Additional *k* factor for installation condition.

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TABLE 10— CANDIAN METRIC REINFORCING BAR BOND STRENGTH DESIGN INFORMATION[1]

<table>
<tr><th colspan="2" rowspan="2">Design Information</th><th rowspan="2">Symbol</th><th rowspan="2">Units</th><th colspan="5">Reinforcing Bar Size</th></tr>
<tr><th>10M</th><th>15 M</th><th>20M</th><th>25M</th><th>30M</th></tr>
<tr><td colspan="2" rowspan="2">Minimum Effective Installation Depth</td><td rowspan="2">$h_{ef,min}$</td><td>in.</td><td>2-3/8</td><td>3-1/8</td><td>3-1/2</td><td>4</td><td>5</td></tr>
<tr><td>mm</td><td>60</td><td>79</td><td>89</td><td>102</td><td>127</td></tr>
<tr><td colspan="2" rowspan="2">Maximum Effective Installation Depth</td><td rowspan="2">$h_{ef,max}$</td><td>in.</td><td>7-1/2</td><td>12-1/2</td><td>15</td><td>20</td><td>25</td></tr>
<tr><td>mm</td><td>191</td><td>318</td><td>381</td><td>508</td><td>635</td></tr>
<tr><td rowspan="4">Temperature Category A[2,5]</td><td rowspan="2">Characteristic Bond Strength in Non-cracked Concrete</td><td rowspan="2">$t_{k,uncr}$</td><td>psi</td><td colspan="5">530</td></tr>
<tr><td>N/mm^2</td><td colspan="5">3.7</td></tr>
<tr><td rowspan="2">Characteristic Bond Strength in Cracked Concrete</td><td rowspan="2">$t_{k,cr}$</td><td>psi</td><td>450</td><td>400</td><td>375</td><td>330</td><td>280</td></tr>
<tr><td>N/mm^2</td><td>3.1</td><td>2.8</td><td>2.6</td><td>2.3</td><td>1.9</td></tr>
<tr><td rowspan="4">Temperature Category B, Range 1[3,5]</td><td rowspan="2">Characteristic Bond Strength in Non-cracked Concrete</td><td rowspan="2">$t_{k,uncr}$</td><td>psi</td><td colspan="5">1,820</td></tr>
<tr><td>N/mm^2</td><td colspan="5">12.6</td></tr>
<tr><td rowspan="2">Characteristic Bond Strength in Cracked Concrete</td><td rowspan="2">$t_{k,cr}$</td><td>psi</td><td>1,550</td><td>1,380</td><td>1,300</td><td>1,130</td><td>965</td></tr>
<tr><td>N/mm^2</td><td>10.7</td><td>9.5</td><td>9.0</td><td>7.8</td><td>6.6</td></tr>
<tr><td rowspan="4">Temperature Category B, Range 2[4,5]</td><td rowspan="2">Characteristic Bond Strength in Non-cracked Concrete</td><td rowspan="2">$t_{k,uncr}$</td><td>psi</td><td colspan="5">735</td></tr>
<tr><td>N/mm^2</td><td colspan="5">5.1</td></tr>
<tr><td rowspan="2">Characteristic Bond Strength in Cracked Concrete</td><td rowspan="2">$t_{k,cr}$</td><td>psi</td><td>625</td><td>560</td><td>525</td><td>455</td><td>390</td></tr>
<tr><td>N/mm^2</td><td>4.3</td><td>3.9</td><td>3.6</td><td>3.1</td><td>2.7</td></tr>
<tr><td rowspan="12">Permissible Installation Conditions[6,7]</td><td rowspan="2">Dry Concrete</td><td>$Ø_d$</td><td rowspan="6">Periodic Inspection</td><td colspan="5">0.65</td></tr>
<tr><td>k_d</td><td colspan="5">1.00</td></tr>
<tr><td rowspan="2">Water-saturated Concrete</td><td>$Ø_{ws}$</td><td colspan="5">0.45</td></tr>
<tr><td>k_{ws}</td><td>0.84</td><td colspan="4">1.00</td></tr>
<tr><td rowspan="2">Water-filled Hole</td><td>$Ø_{wf}$</td><td colspan="5">0.45</td></tr>
<tr><td>k_{wf}</td><td>0.87</td><td colspan="2">1.00</td><td colspan="2">0.38</td></tr>
<tr><td rowspan="2">Dry Concrete</td><td>$Ø_d$</td><td rowspan="6">Continuous Inspection</td><td colspan="5">0.65</td></tr>
<tr><td>k_d</td><td colspan="5">1.00</td></tr>
<tr><td rowspan="2">Water-saturated Concrete</td><td>$Ø_{ws}$</td><td>0.45</td><td colspan="4">0.55</td></tr>
<tr><td>k_{ws}</td><td>1.00</td><td colspan="4">1.00</td></tr>
<tr><td rowspan="2">Water-filled Hole</td><td>$Ø_{wf}$</td><td>0.45</td><td colspan="2">0.55</td><td colspan="2">0.45</td></tr>
<tr><td>k_{wf}</td><td>1.00</td><td colspan="2">1.00</td><td colspan="2">0.45</td></tr>
</table>

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: 68°F (20°C); Maximum Short Term Temperature: 110°F (43°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 ø 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.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ø must be determined in accordance with ACI 318 D.4.5.

[7]Additional *k* factor for installation condition.

TABLE 11—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)**	**Alowable Tension Load (lb) 2,500 psi Concrete**	**Controlling Failure Mode**
3/8"	2.375	1,820	1,929	Breakout Strength
	7.500	1,820	4,910	Steel Strength
1/2"	2.750	1,820	2,403	Breakout Strength
	10.00	1,820	8,990	Steel Strength
5/8"	3.125	1,820	2,911	Breakout Strength
	12.50	1,820	14,316	Steel Strength
3/4"	3.50	1,820	3,451	Breakout Strength
	15.00	1,820	21,157	Steel Strength
7/8"	4.000	1,820	4,216	Breakout Strength
	17.50	1,820	29,265	Steel Strength
1"	4.000	1,820	4,216	Breakout Strength
	20.00	1,820	38,387	Steel Strength
1-1/4"	4.000	1,820	4,216	Breakout Strength
	25.00	1,820	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 70°F to 110°F
5. Long term temperature 70°F
6. Short term temperature 110°F
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 $\alpha = 1.2(0.3) + 1.6(0.7) = 1.48$
13. f'_c = 2,500 psi (normal weight concrete)
14. $c_{ac1} = c_{ac2} \geq c_{ac}$
15. $h \geq h_{min}$

FLO-ROK FR6-SD INJECTION ADHESIVE ANCHOR

UCAN

ILLUSTRATIVE PROCEDURE TO CALCULATE ALLOWABLE STRESS DESIGN TENSION VALUE

2KPS EX1 Anchor 1/2" Diameter, using an enbedment of 2.75", with the design assumptions given in table 11

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.	$\varphi N_{sa} = \varphi N_{sa}$ $= 0.65 \times 17740$ $= \mathbf{13305}$
Step 2:	Calculate breakout strength of a single anchor in tension per ACI 318 D 5. 2 Table 5 of this report	$N_b = k_{c,uncr} \sqrt{(f'c)}\ h_{ef}^{1.5}$ $= 24 \times (2500)$^0.5 $\times$ 2.75^1.5 $= 5472$ $\varphi N_{cb} = (A_{nc} / A_{nco})\ \Psi_{ed,N} \Psi_{c,N}\ \Psi_{cp,N} N_b$ $= 0.65 \times 1 \times 1 \times 1 \times 1 \times 5472$ **= 3557**
Step 3:	Calculate bond strength of a single anchor in tension per Eq D-16a and Table 7 of this report.	$N_{ao} = \tau_{k,uncr} \pi\ d h_{ef}$ $= 1820 \times 3.141 \times 0.5 \times 2.75$ $= 7860$ $\varphi N_{ao} = (A_{na} / A_{na0})\ \Psi_{ed,Na} \Psi_{c,Na} N_{ao}$ $= 0.65 \times 7860$ **= 5109**
Step 4:	Determine controlling resistance strength in tension per ACI 318 D 4. 1. 1. and D 4. 1. 2.	**3557** lbs = controlling resistance (breakout)
Step 5:	Calculate Allowable Stress Design conversion factor for loading condition per ACI 318 Section 9. 2.	$\alpha = 1.2DL + 1.6LL$ $= 1.2 \times 0.3 + 1.6 \times 0.7$ **= 1.48**
Step 6:	Calculate Allowable Stress Design value per Section 4. 2 of this report.	$T_{allowable,ASD} = 3557 / 1.48$ **= 2403 lbs**

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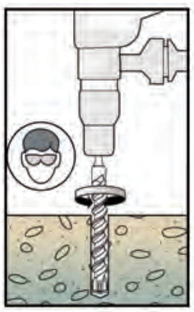
UCAN FLO-ROK® FR6-SD INSTALLATION DETAILS

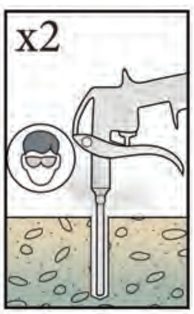
Before beginning installation ensure the worker is equipped with appropriate personal protection equipment, rotary hammer drill, compressed air nozzle, hole cleaning brush, good quality dispensing tool – either manual or power operated, chemical cartridge with mixing nozzle and extension tube, if needed. Refer to technical data "Installation Parameters" for parts specication or guidance for indiidual 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

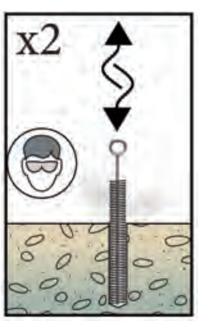


1. Drill the hole to the specied hole diameter and depth using rotary hammer drill in hammer "ON" mode with a UCAN carbide tipped drill bit, conforming to ANSI B212.15-1994 of the appropriate size.



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 positie interaction between the steel bristles of the brush and the sides of the drilled hole.

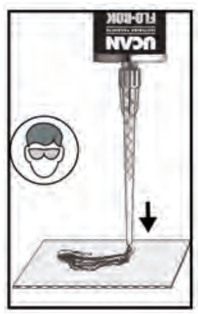
Perform the brushing operation twice.

4. Repeat 2
5. Repeat3
6. Repeat 2

Injection Cartridge preparation

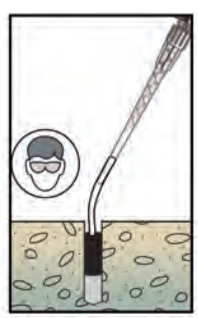
7. Select the appropriate static mixer nozzle, checking that the mixing elements are present and correct (do not modify the mixer). Remoe port closure and attach mixer nozzle to the cartridge. Check the dispensing tool is in good working order. Place the cartridge into the dispensing tool.

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

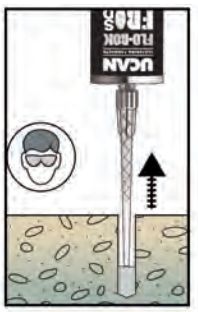


9. **Deep hole (10" & over)**
As specied in "Installation Parameters" (Refer to UCAN Technical Manual), attach an extension tube with resin stopper to the end of the mixing nozzle with a push fit. (The extension tubes may be pushed into the resin stoppers and are held in place with a coarse internal 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 positie engagement is felt.

FLO-ROK FR6-SD INJECTION ADHESIVE ANCHOR

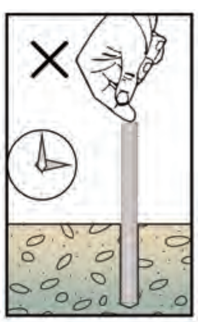
Floor and Wall Anchoring - Continued



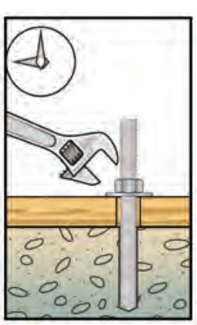
10. Insert the mixing nozzle or extension tube with resin stopper (see figure 9) to the bottom of the hole. Dispense the resin and slowly withdraw the nozzle from the hole. Ensure no air voids are created as the nozzle is withdrawn. Inject resin until the hole is approximately 1/2 - 2/3 full and remove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



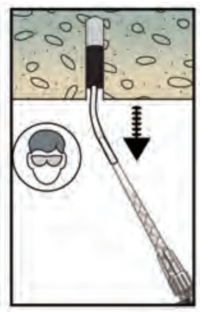
13. Do not disturb the anchor until at least the minimum cure time has elapsed. Refer to the Working and Load Timetable (UCAN Technical Manual) to determine the appropriate cure time.



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

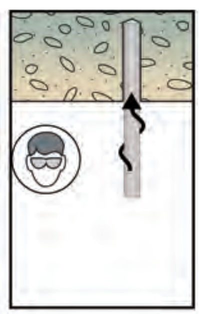
Do not over-torque the anchor as this could adversely affect its performance.

Overhead Anchoring



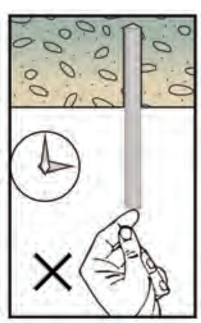
9a. As specied in "Installation Parameters" (Refer to UCAN Technical Manual), attach an extension tube with resin stopper to the end of the mixing nozzle with a push fit. (The extension tubes may be pushed into the resin stoppers and are held in place with a coarse internal thread).

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 with drawn. Inject resin until the hole is approximately 1/2 - 2/3 full and remove the nozzle from the hole.

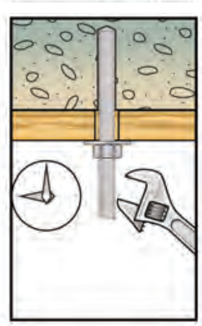


10. **Select the appropriate theaded rod** or rebar ensuring it is free from oil or other contaminants, and mark with the required embedment depth. Insert the threaded rod or rebar into the hole using a back and forth twisting motion, to ensure complete cover, until it reaches the bottom of the hole. 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.

EPOXY USAGE ESTIMATING TABLE

Holes per FR6-20 SD

Rod dia.	Hole dia.	Embedment (inch) 1	2	3	4	5	6	7	8	9	10	15	20
3/8	7/16	399.4	199.7	133.1	99.8	79.9	66.6	57.1	49.9	44.4	39.9	26.6	20.0
	1/2	256.4	128.2	85.5	64.1	51.3	42.7	36.6	32.1	28.5	25.6	17.1	12.8
1/2	5/8	185.5	92.8	61.8	46.4	37.1	30.9	26.5	23.2	20.6	18.6	12.4	9.3
5/8	3/4	144.4	72.2	48.1	36.1	28.9	24.1	20.6	18.0	16.0	14.4	9.6	7.2
3/4	7/8	119.4	59.7	39.8	29.9	23.9	19.6	17.1	14.9	13.3	11.9	8.0	6.0
7/8	1	97.5	48.8	32.5	24.4	19.5	16.3	13.9	12.2	10.8	9.8	6.5	4.9
1	1-1/8	80.2	40.1	26.7	20.1	16.0	13.4	11.5	10.0	8.9	8.0	5.3	4.0
1-1/4	1-3/8	62.1	31.1	20.7	15.5	12.4	10.4	8.9	7.8	6.9	6.2	4.1	3.1
	1-1/2	40.8	20.4	13.6	10.2	8.2	6.8	5.8	5.1	4.5	4.1	2.7	2.0

Rebar size	Hole dia.	Embedment (inch) 1	2	3	4	5	6	7	8	9	10	15	20
10M	9/16	290.5	145.3	96.8	72.6	58.1	48.4	41.5	36.3	32.3	29.1	19.4	14.5
15M	3/4	199.1	99.6	66.4	48.8	39.8	33.2	28.4	24.9	22.1	19.9	13.3	10.0
20M	61/64	128.9	64.5	43.0	32.2	25.8	21.5	18.4	16.1	14.3	12.9	8.6	6.4
25M	1-1/4	62.8	31.4	20.9	15.7	12.6	10.5	9.0	7.9	7.0	6.3	4.2	3.1
30M	1-1/2	43.6	21.8	14.5	10.9	8.7	7.3	6.2	5.4	4.8	4.4	2.9	2.2
35M	1-3/4	35.9	17.9	12.0	9.0	7.2	6.0	5.1	4.5	4.0	3.6	2.4	1.8

Epoxy usage contains no waste and is based on the following usable cartridge volume: 20.3 oz. (600 ml)
For correct expoxy usage use, add 20% installation waste (multiply the tabulated number by 0.8)