

**DESCRIPTION**

UCAN FLO-ROK® FR5 MAX is a styrene free epoxy acrylate adhesive suitable for year-round use without preconditioning in temperature ranging from -20°C to over 30°C. This versatile two component, high strength anchoring adhesive, provides stress free fastening and is an excellent choice for anchoring & dowelling. A matching static mixing nozzle, as well as FLO-ROK's low mix ratio sensitivity, ensures thorough, 10:1 mixing of the resin and the hardener. FR5-MAX is available in 2 sizes 10 oz. for small jobs, and 28 oz. that is perfect for high volume applications such as rebar dowelling.

UCAN FLO-ROK® FR5 MAX 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® FR5 MAX adhesive anchors are designed to be used for floor (vertically down), wall (horizontal) anchoring applications.

**FEATURES**

- IAPMO ES #
- ACI 318 Category I anchor (continuous spec. inspection) for cracked & uncracked concrete
- Tested in accordance to AC 308 for long term sustained load at standard and elevated temperature.
- Seismic resistance
- Use friendly, low odour, styrene free & MMA free
- Meets LEED guidelines; low VOC
- Moisture insensitive, non sag formula
- Suitable for damp and water filled holes
- Shelf life 1 year, store cartridge at +5°C to +25°C before use
- Meets CSA A23.3-14, Annex D requirements

**TYPICAL APPLICATIONS**

- Rebar dowelling
- Highway and bridge construction
- Machine, crane and hoist installation
- Hollow wall anchoring applications
- Renovations



**LISTING AND APPROVALS**



• IAPMO ES - LISTING XXXX

- MTO MI 120
- MTQ Approved

**COMPLIANCE WITH THE FOLLOWING CODES**

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

**LEED® COMPLIANCE**



• Credit 4.1 - Low Emitting Materials

**MATERIAL SPECIFICATIONS**

**TABLE 1. ANCHOR RODS**

Properties	Symbol	Unit	Value	Test Standard
<b>Standard Threaded Rod / Carbon Steel</b>	f <sub>u</sub>	psi	72,500	ISO 898 Grade 5.8
		MPa	500	
	f <sub>y</sub>	psi	58,000	
		MPa	400	
<b>High Strength Threaded Rod / Carbon Steel</b>	f <sub>u</sub>	psi	125,000	ASTM A 193, Grade B7
		MPa	862	
	f <sub>y</sub>	psi	105,000	
		MPa	724	
<b>Stainless Steel Threaded Rod</b>	f <sub>u</sub>	psi	100,000	ASTM F 593 (AISI 304/316)
		MPa	689	
	f <sub>y</sub>	psi	65,000	
		MPa	448	
<b>Carbon Steel Nuts</b>	-	-	-	ASTM A 563
<b>Stainless Steel Nuts</b>	-	-	-	ASTM F 594
<b>Carbon and Stainless Steel Washers</b>	-	-	-	ASTM B18.22.1 Type A Plain

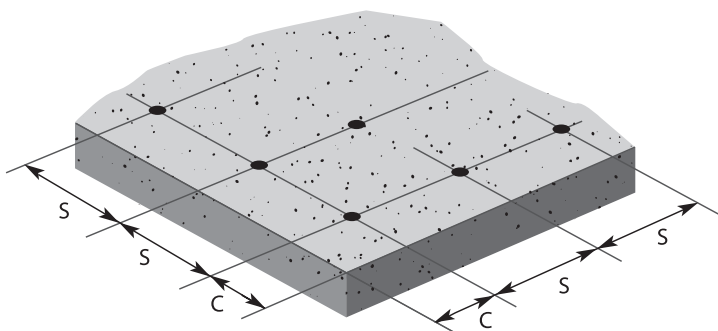
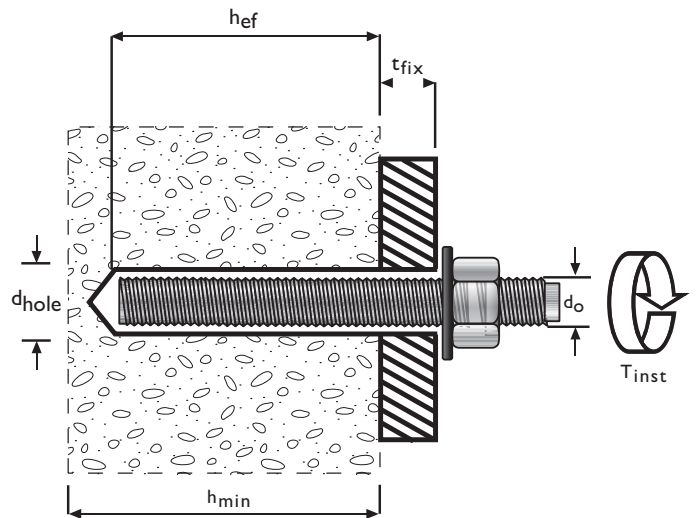
**TABLE 2 - CURED EPOXY**

Properties		Unit	Value	Test Standard
<b>Compressive Strength</b>	24 hrs.	psi	10,400	ASTM D 695 @ 20°C/72°
		MPa	72	
	7 days	psi	11,100	
		MPa	77	
<b>Tensile Strength</b>	24 hrs	psi	1,885	ASTM D 638 @ 20°C/72°
		MPa	13	
	7 days	psi	2,175	
		MPa	15	
<b>Elongation at Break</b>	24 hrs.	%	6.0	ASTM D 638 @ 20°C/72°
	7 days		7.0	
<b>Tensile Modulus</b>	24 hrs.	psi	536,000	ASTM D 638 @ 20°C/72°
		GNm <sup>-2</sup>	3.7	
	7 days	psi	551,000	
		GNm <sup>-2</sup>	3.7	
<b>Flexural Strength</b>	24 hrs	psi	4,200	ASTM D 790 @ 20°C/72°
		MPa	29	
<b>HDT (Heat Deflection Temp.)</b>	7 days	°F	169	ASTM D 648 @ 20°C/72°
		°C	76	

**TABLE 3. CURING TIMES**

Temperature	Gel Time	Full Cure
-20°C to -10°C	16 minutes	24 hours
-10°C to 0°C	16 minutes	24 hours
0°C to + 5°C	16 minutes	12 hours
+5°C to +10°C	10 minutes	145 minutes
+10°C to +15°C	8 minutes	85 minutes
+15°C to +20°C	6 minutes	75 minutes
+20°C to +25°C	5 minutes	50 minutes
+25°C to +30°C	4 minutes	40 minutes

Do not disturb stud during the curing time  
 \*Cartridge temperature +5°C (41°F)



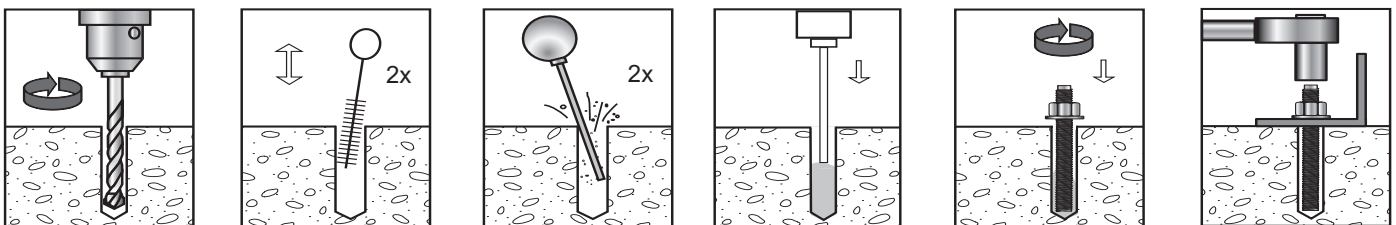
**INSTALLATION**

**TABLE 4 - ANCHOR SYSTEM INSTALLATION INFORMATION**

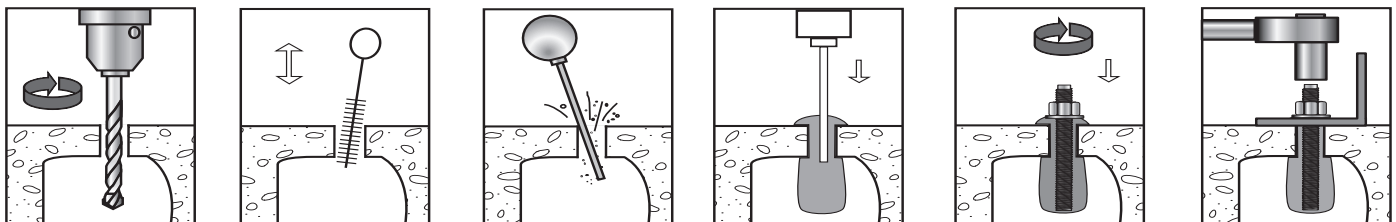
Characteristics		Symbol	Unit	Nominal Anchor Element Diameter						
<b>UNC Threaded Bar</b>	Size	$d_o$	inch	3/8	1/2	5/8	3/4	7/8	1	1-1/4
	Drill Size	$d_{hole}$	inch	1/2	9/16	3/4	7/8	1	1-1/8	1-3/8
<b>US Re-bar</b>	Size	$d_o$	inch	#3	#4	#5	#6	#7	#8	#10
	Drill Size	$d_{hole}$	inch	9/16	5/8	3/4	7/8	1	1-1/8	1-3/8
<b>Metric Threaded Rod</b>	Size	$d_o$	mm	M10	M12	M16	M20	-	M24	M30
	Drill Size	$d_{hole}$	mm	1	14	18	22	-	26	35
<b>Metric Re-bar (CAN)</b>	Size	M	-	10M	-	15M	20M	-	25M	30M
	Drill Size	$d_{hole}$	inch	9/16	-	3/4	7/8	-	1-1/4	1-1/2
<b>Maximum Tightening Torque</b>		$T_{inst}$	ft.-lb	15	30	60	100	125	150	200
<b>Embedment Depth Range</b>		$h_{ef,min}$	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
<b>Minimum Concrete Thickness</b>		$h_{min}$	inch	$2.0 \cdot h_{ef}$						
<b>Critical Edge Distance</b>		$C_{ac}$	inch	See Section 3.1.10. (IAPMO ES Report # xxxx)						
<b>Minimum Edge Distance</b>		$C_{min}$	inch	$0.5 \cdot h_{ef}$						
<b>Minimum Anchor Spacing</b>		$S_{min}$	inch	$0.5 \cdot h_{ef}$						

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

**SOLID CONCRETE/MASONRY APPLICATIONS**



**HOLLOW CONCRETE BLOCK/MASONRY APPLICATIONS**



**NOTE:**

- Clean hole thoroughly by using nylon brush and blow-out bulb or compressed air (65 - 80 psi)
- Always dispense about 1 oz. FLO - ROK to the side, prior to injecting it into the clean hole, to assure uniform mixing indicated by a consistent dark grey colour.
- At a minimum, half fill the hole starting from the bottom up by slowly withdrawing the nozzle. (solid installation)  
Fill the screen fully starting from the bottom by slowly withdrawing the nozzle. (hollow installation)
- Mark embedment depth on the threaded rod (rebar) prior to installation, and insert the rod (rebar) turning it slowly until it reaches the bottom of the hole ( depth mark is flush with the surface).
- Observe curing time. The installed anchor must not be disturbed or loaded before the specified curing time has elapsed.

**STRENGTH DESIGN**

**General:** The design strength of anchors shall be determined in accordance with ACI 318-14 chapter 17 or ACI 318-11 Appendix D and the IAPMO ES # xxxxreport.

The strength design of anchors must comply with ACI 318-14 and Section 3.2.2 of IAPMO ES # xxxx report.

Design parameters, including strength reduction factors,  $\phi$ , corresponding to each limit state, are provided in Tables 6 through 12. Strength reduction factors,  $\phi$  Applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 Section 5.3 (ACI 318-11 Section 9.2), are used in accordance with ACI 318-14 Section 17.3.3 (ACI 318-11 Section D.4.3). If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  shall be determined in accordance with ACI 318 D.4.4.

**Interaction of Tensile and Shear Forces:** For designs that include combined tension and shear forces, the interaction of the tension and shear loads must be calculated in accordance with ACI 318-14 Section 17.5.3.1 (ACI 318-11 Section D.4.3)

**LIMIT STATE DESIGN (CSA A23.3-14, ANNEX D)**

The design strength of anchors in Limit State Design (Canada) shall comply with CSA A23.3-14, Annex D.

Design parameters are provided in Tables 6 through 12. Strength Reduction Factors (R) and Material Resistance Factors ( $\Phi$ ) are provided in Table 5. The requirements for member thickness edge distance and spacing shown in Table must apply. For designs that include tension and shear forces, the interaction of the loads must be calculated in accordance with CSA A23.3-14, Annex D.8

**TABLE 5 - RESISTANCE FACTORS FOR LIMIT STATE DESIGN IN ACCORDANCE WITH  
 CSA A23.3-14, ANNEX D**

Characteristic	Symbol	Units	Nominal Anchor Diameter (in.)						
			3/8"	1/2"	5/8"	3/4"	7/8"	1"	1-1/4"
			10M	15M	20M	25M	30M		
Concrete material resistance factor (dry concrete)	$\Phi_c$	-	0.65						
Steel material resistance factor	$\Phi_s$	-	0.85						
Strength reduction factor for tension, steel failure modes (carbon and stainless steel threaded rod)	R		0.80						
Strength reduction factor for tension, steel failure modes (reinforcing bar)	R		0.70						
Strength reduction factor for shear, steel failure modes (carbon and stainless steel threaded rod)	R		0.75						
Strength reduction factor for shear, steel failure modes (reinforcing bar)	R		0.65						
Strength reduction factor for tension, concrete failure modes	R	Cond. A	1.15						
		Cond. B	1.00						
Strength reduction factor for Shear, concrete failure modes	R	Cond. A	1.15						
		Cond. B	1.00						
Coefficient for factored concrete breakout in tension, cracked concrete	k	-	7						
Modification factor concrete resistance to account uncracked concrete	$\psi_{c,N}$	-	1.4						

TABLE 6—STEEL DESIGN INFORMATION FOR FRACTIONAL CARBON STEEL AND STAINLESS STEEL THREADED ROD<sup>1,2,3,4</sup>

Characteristic		Symbol	Units	Nominal Rod Diameter, d <sub>o</sub>						
Nominal Size		do	inch	3/8	1/2	5/8	3/4	7/8	1	1-1/4
Stress Area <sup>1</sup>		Ase	in. <sup>2</sup>	0.0775	0.1419	0.226	0.334	0.462	0.606	0.969
Carbon Steel Threaded Rod	Reduction Factor for Tension Steel Failure <sup>3,4</sup>	∅	-	0.75						
	Strength Reduction Factor for Shear Steel Failure <sup>3,4</sup>	∅	-	0.65						
	Tension Resistance of Carbon Steel ISO 898-1 Class 5.8	N <sub>sa</sub>	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	N <sub>sa</sub>	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	V <sub>sa</sub>	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	V <sub>sa</sub>	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 <sup>3,4</sup>	∅	-	0.75						
	Strength Reduction Factor for Shear Steel Failure <sup>3,4</sup>	∅	-	0.65						
	Tension Resistance of Stainless Steel ASTM F593 CW1	N <sub>sa</sub>	lb (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	--	--	--	--
	Tension Resistance of Stainless Steel ASTM F593 CW2	N <sub>sa</sub>	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	N <sub>sa</sub>	lb (kN)	8,915 (39.7)	16,320 (72.6)	25,990 (115.6)	--	--	--	--
	Tension Resistance of Stainless Steel ASTM F593 SH2	N <sub>sa</sub>	lb (kN)	--	--	--	35,070 (156.0)	48,510 (215.8)	63,630 (283.0)	--
	Tension Resistance of Stainless Steel ASTM F593 SH3	N <sub>sa</sub>	lb (kN)	--	--	--	--	--	--	92,055 (409.5)
	Shear Resistance of Stainless Steel ASTM F593 CW1	V <sub>sa</sub>	lb (kN)	3,875 (17.2)	7,095 (31.6)	11,300 (50.3)	--	--	--	--
	Shear Resistance of Stainless Steel ASTM F593 CW2	V <sub>sa</sub>	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	V <sub>sa</sub>	lb (kN)	4,455 (19.8)	9,790 (43.5)	15,595 (69.4)	--	--	--	--
	Shear Resistance of Stainless Steel ASTM F593 SH2	V <sub>sa</sub>	lb (kN)	--	--	--	17,535 (78.0)	24,255 (107.9)	31,815 (141.5)	--
	Shear Resistance of Stainless Steel ASTM F593 SH3	V <sub>sa</sub>	lb (kN)	--	--	--	--	--	--	46,030 (204.8)

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

<sup>1</sup>Values provided for common rod material types are based on specified strength and calculated in accordance with ACI 318-14 Eq. (17.4.1.2) and Eq. (17.5.1.2b) or ACI 318-11 Eq. (D-2) and Eq. (D-29). Nuts and washers shall be appropriate for the rod as set forth in Table I of this report.

<sup>2</sup>Stress area is minimum stress area applicable for either tension or shear.

<sup>3</sup>Tabulate value of  $\phi$  complies with ACI 318-14 Section 17.3.3 (ACI 318-11 Section D.4.3) and applies when the load combinations of Section 1605.1 of the IBC or ACI318-14 Section 5.3 (ACI 318-11 Section 9.2) are used. When the load combinations in ACI 318 Appendix C are used, the appropriate value of  $\phi$  shall be determined in accordance with ACI 318-11 D.4.4.

<sup>4</sup>For limit state design as per CSA A23.3-14, Annex D, Material resistance factors ( $\phi$ ) and resistance modification factors (R) in table shall be used.

**TABLE 7a—STEEL DESIGN INFORMATION FOR FRACTIONAL STEEL US REINFORCING BAR<sup>1,2,3</sup>**

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. <sup>2</sup>	0.11	0.20	0.31	0.44	0.60	0.79	1.27	
	Strength Reduction Factor for Tension Steel Failure	$\phi$		0.75							
	Strength Reduction Shear for Tension Steel Failure	$\phi$		0.65							
	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.<sup>2</sup> = 645.16 mm<sup>2</sup>, 1 lb = 0.004448 kN

<sup>1</sup>Values provided for common rod material types are based on specified strength and calculated in accordance with ACI 318-14 Eq. (17.4.1.2) and Eq. (17.5.1.2b) or ACI 318-11 Eq. (D-2) and Eq. (D-29). Nuts and washers shall be appropriate for the rod as set forth in Table 3 of this report.

<sup>2</sup>Stress area is minimum stress area applicable for either tension or shear.

<sup>3</sup>Tabulate value of  $\phi$  complies with ACI 318-14 Section 17.3.3 (ACI 318-11 Section D.4.3) and applies when the load combinations of Section 1605.1 of the IBC or ACI 318-14 Section 5.3 (ACI 318-11 Section 9.2) are used. When the load combinations in ACI 318 Appendix C are used, the appropriate value of  $\phi$  shall be determined in accordance with ACI 318-11 D.4.4.

**TABLE 7b—STEEL DESIGN STRENGTH FOR CAN GRADE 400 REINFORCING BAR<sup>1,2</sup>**

Rebar size	Area(mm <sup>2</sup> )	$f_{uta}$ (MPa)	$f_{ya}$ (MPa)	Tension $N_{sar}$	Shear $V_{sar}$	Seismic Shear $V_{sar}$
10M	100	540	400	36.72 kN 8,255 lb	17.44 kN 3,921 lb	12.73 kN 2,863 lb
15M	200	540	400	73.44 kN 16,511 lb	34.88 kN 7,843 lb	23.37 kN 5,255 lb
20M	300	540	400	110.16 kN 24,766 lb	52.33 kN 11,764 lb	35.06 kN 7,882 lb
25M	500	540	400	183.60 kN 41,277 lb	87.21 kN 19,607 lb	53.20 kN 11,960 lb
30M	700	540	400	257.04 kN 57,788 lb	122.09 kN 27,449 lb	56.16 kN 12,627 lb

<sup>1</sup>Tabulated value are calculated in accordance with CSA A23.3-14 Annex D (Factored Resistance Loads)

<sup>2</sup>CSA G30.18 Grade 400 reinforcing bar are considered ductile steel elements.

**TABLE 8 - FRACTIONAL THREADED ROD AND REINFORCING BAR CONCRETE BREAKOUT STRENGTH DESIGN INFORMATION<sup>1,2</sup>**

Characteristic		Symbol	Units	Nominal Anchor Element Diameter						
				3/8	1/2	5/8	3/4	7/8	1	1-1/4
<b>US Threaded Rod</b>	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
<b>US Re-bar</b>	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	1	1	1-1/4	1-5/8
<b>Embedment Depth Range</b>		$h_{ef,min}$	inch	2-3/8	2-3/4	3-1/8	3-1/2	4	4	5
		$h_{ef,max}$	inch	7-1/2	10	12-1/2	15	17-1/2	20	25
<b>Minimum Anchor Spacing</b>		$s_{min}$	inch	$0.5 \cdot h_{ef}$						
<b>Minimum Edge Distance</b>		$c_{min}$	inch	$0.5 \cdot h_{ef}$						
<b>Minimum Concrete Thickness</b>		$h_{min}$	inch	$2.0 \cdot h_{ef}$						
<b>Critical Edge Distance</b>		$c_{ac}$	-	See ACI 318 D.8.6						
<b>Effectiveness Factor for Uncracked Concrete, Breakout</b>		$k_{c,uncr}$	--	24						
			(SI)	(10)						
<b>Effectiveness Factor for Cracked Concrete, Breakout</b>		$k_{c,cr}$	--	17						
			(SI)	(7.1)						
	$k_{c,uncr} / k_{c,cr}$	--	--	1.41						
<b>Strength Reduction Factor for Tension, Concrete Failure Modes, Condition B<sup>2</sup></b>		$\phi$	--	0.65						
<b>Strength Reduction Factor for Shear, Concrete Failure Modes, Condition B<sup>2</sup></b>		$\phi$	--	0.70						

**TABLE 9—CANADIAN METRIC REINFORCING BAR CONCRETE BREAKOUT STRENGTH DESIGN INFORMATION<sup>1,2,3</sup>**

Characteristic	Symbol	Units	Bar size					
			10M	15 M	20M	25M	30M	
<b>Embedment Depth Range</b>		$h_{ef,min}$	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
<b>Minimum Anchor Spacing</b>		$s_{min}$	inch	$0.5 \cdot h_{ef}$				
<b>Minimum Edge Distance</b>		$c_{min}$	inch	$0.5 \cdot h_{ef}$				
<b>Minimum Concrete Thickness</b>		$h_{min}$	inch	$2.0 \cdot h_{ef}$				
<b>Critical Edge Distance</b>		$c_{ac}$		See Section 3.1.10 (IAPMO ES Report # xxxx)				
<b>Effectiveness Factor for Uncracked Concrete, Breakout</b>		$k_{c,uncr}$	--	24				
			(SI)	(10)				
<b>Effectiveness Factor for Cracked Concrete, Breakout</b>		$k_{c,cr}$	--	17				
			(SI)	(7.1)				
	$k_{c,uncr} / k_{c,cr}$	--	--	1.41				
<b>Strength Reduction Factor for Tension, Concrete Failure Modes, Condition B<sup>3</sup></b>		$\phi$	--	0.65				
<b>Strength Reduction Factor for Shear, Concrete Failure Modes, Condition B<sup>3</sup></b>		$\phi$	--	0.70				

For SI: 1 inch = 25.4 mm, 1 in.<sup>2</sup> = 645.16 mm<sup>2</sup>, 1 lb = 0.004448 kN

<sup>1</sup>The tabulated value of  $\phi$  applies when the load combinations of Section 1605.2 of the IBC, or ACI 318-14 Section 5.3 (ACI 318 Section 9.2), are used in accordance with ACI 318-14 Section 17.3.3 (ACI 318-11 Section D.4.3). If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  shall be determined in accordance with ACI 318 D.4.4.

<sup>2</sup>The values of  $\phi$  correspond to Condition B as described in Section 17.3.3 of ACI 318-14 (Section D.4.3 of ACI 318-11) for post-installation anchors designed using the load combination of IBC Section 1605.2. If the load combinations of ACI 318-11 Appendix C are used, the corresponding value of  $\phi$  shall be determined.

<sup>3</sup>For limit state design as per CSA A23.3-14, Annex D, material resistance factors ( $\phi$ ) and resistance modification factors (R) in table shall be used. Condition B applies where supplemental reinforcement is not provided as per CAS A23.3-14, Clause D.5.3



**TABLE 10 - BOND STRENGTH DESIGN INFORMATION FOR FRACTIONAL STEEL THREADED RODS IN HAMMER DRILLED HOLES<sup>1,2,3,4,5,6</sup>**

Design Information		Symbol	Units	Nominal Anchor Element Diameter					
				3/8"	1/2"	5/8"	3/4"	1"	1-1/4"
Minimum Embedment Depth		$h_{ef,min}$	inch	2-3/8	2-3/4	3-1/4	3-1/2	4	5
Maximum Embedment Depth		$h_{ef,max}$	inch	7-1/2	10	12-1/2	15	20	25
Characteristic Bond Strength in Uncracked Concrete for Sustained Tension loading <sup>2,3</sup>		$t_{k,sust,uncr}$	psi (N/mm <sup>2</sup> )	1,320 (9.10)	1,237 (8.53)	1,154 (7.95)	1,070 (7.38)	-	-
Characteristic Bond Strength in Uncracked Concrete for Short Term Loads <sup>2,3</sup>		$t_{k,uncr}$	psi (N/mm <sup>2</sup> )	1,230 (9.10)	1,237 (8.53)	1,154 (7.95)	1,070 (7.38)	-	-
Characteristic Bond Strength in Cracked Concrete for Sustained Tension Loading <sup>2,3</sup>		$t_{k,sust,cr}$	psi (N/mm <sup>2</sup> )	598 (4.13)	817 (5.63)	769 (5.30)	720 (4.96)	623 (4.29)	518 (3.57)
Characteristic Bond Strength in Cracked Concrete for Short Term Loads <sup>2,3</sup>		$t_{k,cr}$	psi (N/mm <sup>2</sup> )	598 (4.13)	817 (5.63)	769 (5.30)	720 (4.96)	623 (4.29)	518 (3.57)
Permissible Installation Conditions, Periodic Special Inspection	Dry Concrete	Anchor Category	-	2	2	2	2	2	3
		$\phi_d$	-	0.55	0.55	0.55	0.55	0.55	0.45
	Water-saturated Concrete	Anchor Category	-	1	2	2	2	2	3
		$\phi_{ws}$	-	0.65	0.55	0.55	0.55	0.55	0.55
	Water-filled Holes	Anchor Category	-	3	3	3	3	3	3
		$\phi_{wf}$	-	0.45	0.45	0.45	0.45	0.45	0.45
Permissible Installation Conditions, Continuous Special Inspection	Dry Concrete	Anchor Category	-	1	1	1	1	1	1
		$\phi_d$	-	0.65	0.65	0.65	0.65	0.65	0.65
	Water-saturated Concrete	Anchor Category	-	1	1	1	1	1	3
		$\phi_{ws}$	-	0.65	0.65	0.65	0.65	0.65	0.65
	Water-filled Holes	Anchor Category	-	1	1	1	1	1	1
		$\phi_{wf}$	-	0.65	0.65	0.65	0.65	0.65	0.65
Reduction for Seismic Tension		$\alpha_{N,seis}$	-	1.00	0.41	0.54	1.00	0.50	0.96

For SI: 1 inch = 25.4 mm, 1 in.<sup>2</sup> = 645.16 mm<sup>2</sup>, 1 lb = 0.004448 kN

<sup>1</sup>Bond strength values correspond to concrete compressive strength,  $f'_c = 2,500$  psi

<sup>2</sup>Maximum long term temperature: 122°F (+50°C); maximum short term temperature: 176°F (+80°C)

<sup>3</sup>Short term elevated concrete temperatures are those that occur over brief intervals, e.g. transient or part of a regular cycle of heating and cooling, such as day-night temperature rise and fall. Long term elevated concrete temperatures are roughly constant over significant periods of time.

<sup>4</sup>The tabulated value of  $\phi$  applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 Section 5.3 (ACI 318-11 Section 9.2), are used in accordance with ACI 318-14 Section 17.3.3 (ACI 318-11 Section D.4.3). If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  shall be determined in accordance with ACI 318 D.4.4.

<sup>5</sup>The value of  $\phi$  correspond to Condition B as described in Section 17.3.3 of ACI 318-14 (Section D.4.3 of ACI 318-11) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value  $\phi$  shall be determined.

<sup>6</sup>For limit state design as per CSA A23.3-14, Annex D, material resistance factors ( $\phi$ ) and resistance modification factors (R) in table shall be used. Condition B applies where supplemental reinforcement is not provided as per CAS A23.3-14, Clause D.5.3

**TABLE 11 - BOND STRENGTH DESIGN INFORMATION FOR US REINFORCING BARS IN HAMMER DRILLED HOLES USED AS ANCHOR ELEMENTS<sup>1,2,3,4,5</sup>**

Design Information		Symbol	Units	Nominal Anchor Element Diameter			
				#3	#4	#5	#6
Minimum Embedment Depth		$h_{ef,min}$	inch	2-3/8	2-3/4	3-1/4	3-1/2
Maximum Embedment Depth		$h_{ef,max}$	inch	7-1/2	10	12-1/2	15
Characteristic Bond Strength in Uncracked Concrete for Sustained Tension loading <sup>2,3</sup>		$t_{k,sust,uncr}$	psi (N/mm <sup>2</sup> )	1,262 (8.70)	1,174 (8.10)	1,087 (7.49)	1,000 (6.89)
Characteristic Bond Strength in Uncracked Concrete for Short Term Loads <sup>2,3</sup>		$t_{k,uncr}$	psi (N/mm <sup>2</sup> )	1,262 (8.70)	1,174 (8.10)	1,087 (7.49)	1,000 (6.89)
Permissible Installation Conditions, Periodic Special Inspection	Dry Concrete	Anchor Category	-	2	2	2	2
		$\phi_d$	-	0.55	0.55	0.55	0.55
	Water-saturated Concrete	Anchor Category	-	1	2	2	2
		$\phi_{ws}$	-	0.65	0.55	0.55	0.55
	Water-filled Holes	Anchor Category	-	3	3	3	3
		$\phi_{wf}$	-	0.45	0.45	0.45	0.45
Permissible Installation Conditions, Continuous Special Inspection	Dry Concrete	Anchor Category	-	1	1	1	1
		$\phi_d$	-	0.65	0.65	0.65	0.65
	Water-saturated Concrete	Anchor Category	-	1	1	1	1
		$\phi_{ws}$	-	0.65	0.65	0.65	0.65
	Water-filled Holes	Anchor Category	-	1	1	1	1
		$\phi_{wf}$	-	0.65	0.65	0.65	0.65

For **SI**: 1 inch = 25.4 mm, 1 in.<sup>2</sup> = 645.16 mm<sup>2</sup>, 1 lb = 0.004448 kN

<sup>1</sup>Bond strength values correspond to concrete compressive strengths ranging from 2,500 psi to 8,000 psi.

<sup>2</sup>Maximum long term temperature: 122°F (+50°C); maximum short term temperature: 176°F (+80°C)

<sup>3</sup>Short term elevated concrete temperatures are those that occur over brief intervals, e.g. transient or part of a regular cycle of heating and cooling, such as day-night temperature rise and fall. Long term elevated concrete temperatures are roughly constant over significant periods of time.

<sup>4</sup>The tabulated value of  $\phi$  applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 Section 5.3 (ACI 318-11 Section 9.2), are used in accordance with ACI 318-14 Section 17.3.3 (ACI 318-11 Section D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of  $\phi$  shall be determined in accordance with ACI 318 D.4.4.

<sup>5</sup>The value of  $\phi$  correspond to Condition B as described in Section 17.3.3 of ACI 318-14 (Section D.4.3 of ACI 318-11) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value  $\phi$  shall be determined.

**TABLE 12 - BOND STRENGTH DESIGN INFORMATION FOR METRIC REINFORCING BARS IN HAMMER DRILLED HOLES USED AS ANCHOR ELEMENTS<sup>1,2,3,4,5,6</sup>**

Design Information		Symbol	Units	Nominal Anchor Element Diameter			
				M10	M12	M16	M20
Minimum Embedment Depth		$h_{ef,min}$	inch	2-3/8	2-3/4	3-1/4	3-1/2
Maximum Embedment Depth		$h_{ef,max}$	inch	7-1/2	10	12-1/2	15
Characteristic Bond Strength in Uncracked Concrete for Sustained Tension loading <sup>2,3</sup>		$t_{k,sust,uncr}$	psi (N/mm <sup>2</sup> )	1,262 (8.70)	1,174 (8.10)	1,087 (7.49)	1,000 (6.89)
Characteristic Bond Strength in Uncracked Concrete for Short Term Loads <sup>2,3</sup>		$t_{k,uncr}$	psi (N/mm <sup>2</sup> )	1,262 (8.70)	1,174 (8.10)	1,087 (7.49)	1,000 (6.89)
Permissible Installation Conditions, Periodic Special Inspection	Dry Concrete	Anchor Category	-	2	2	2	2
		$\phi_d$	-	0.55	0.55	0.55	0.55
	Water-saturated Concrete	Anchor Category	-	1	2	2	2
		$\phi_{ws}$	-	0.65	0.55	0.55	0.55
	Water-filled Holes	Anchor Category	-	3	3	3	3
		$\phi_{wf}$	-	0.45	0.45	0.45	0.45
Permissible Installation Conditions, Continuous Special Inspection	Dry Concrete	Anchor Category	-	1	1	1	1
		$\phi_d$	-	0.65	0.65	0.65	0.65
	Water-saturated Concrete	Anchor Category	-	1	1	1	1
		$\phi_{ws}$	-	0.65	0.65	0.65	0.65
	Water-filled Holes	Anchor Category	-	1	1	1	1
		$\phi_{wf}$	-	0.65	0.65	0.65	0.65

For SI: 1 inch = 25.4 mm, 1 in.<sup>2</sup> = 645.16 mm<sup>2</sup>, 1 lb = 0.004448 kN

<sup>1</sup>Bond strength values correspond to concrete compressive strengths ranging from 2,500 psi to 8,000 psi.

<sup>2</sup>Maximum long term temperature: 122°F (+50°C); maximum short term temperature: 176°F (+80°C)

<sup>3</sup>Short term elevated concrete temperatures are those that occur over brief intervals, e.g. transient or part of a regular cycle of heating and cooling, such as day-night temperature rise and fall. Long term elevated concrete temperatures are roughly constant over significant periods of time.

<sup>4</sup>The tabulated value of  $\phi$  applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 Section 5.3 (ACI 318-11 Section 9.2), are used in accordance with ACI 318-14 Section 17.3.3 (ACI 318-11 Section D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of  $\phi$  shall be determined in accordance with ACI 318 D.4.4.

<sup>5</sup>The value of  $\phi$  correspond to Condition B as described in Section 17.3.3 of ACI 318-14 (Section D.4.3 of ACI 318-11) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value  $\phi$  shall be determined.

<sup>6</sup>For limit state design as per CSA A23.3-14, Annex D, material resistance factors ( $\phi$ ) and resistance modification factors (R) in table shall be used. Condition B applies where supplemental reinforcement is not provided as per CAS A23.3-14, Clause D.5.3

**STRENGTH DESIGN DATA TABLES AT SELECTED EMBEDMENT AND CONCRETE STRENGTH**

**TABLE 13 - DESIGN STRENGTH FOR FRACTIONAL THREADED RODS IN UNCRACKED CONCRETE<sup>1,2,3,4,5,6,7,8,9,10</sup>**

Anchor Size	Embedment Depth	Sustained Tension Design Strength - $\phi N_n$			Shear Design Strength - $\phi V_n$		
		3,000 psi (20.7 MPa)	4,000 psi (27.8 MPa)	6,000 psi (41.4 MPa)	3,000 psi (20.7 MPa)	4,000 psi (27.8 MPa)	6,000 psi (41.4 MPa)
3/8"	60 mm 2-3/8 inch	10.62 kN 2,388 lb	10.62 kN 2,388 lb	10.62 kN 2,388 lb	17.49 kN 3,932 lb	20.27 kN 4,557 lb	24.73 kN 5,561 lb
	86 mm 3-3/8 inch	15.22 kN 3,422 lb	15.22 kN 3,422 lb	15.22 kN 3,422 lb	32.25 kN 7,251 lb	37.78 kN 8,403 lb	45.61 kN 10,255 lb
	191 mm 7-1/2 inch	33.81 kN 7,600 lb	33.81 kN 7,600 lb	33.81 kN 7,600 lb	125.22 kN 28,153 lb	145.12 kN 32,626 lb	177.09 kN 39,814 lb
1/2"	114 mm 4-1/2 inch	25.22 kN 5,670 lb	25.22 kN 5,670 lb	25.22 kN 5,670 lb	56.77 kN 12,764 lb	65.78 kN 14,792 lb	80.29 kN 18,051 lb
	152 mm 6 inch	33.62 kN 7,650 lb	33.62 kN 7,560 lb	33.62 kN 7,560 lb	92.59 kN 20,815 lb	107.30 kN 24,122 lb	130.94 kN 29,437 lb
	254 mm 10 inch	56.19 kN 12,632 lb	56.19 kN 12,632 lb	56.19 kN 12,632 lb	221.63 kN 49,827 lb	256.84 kN 57,744 lb	313.43 kN 70,466 lb
5/8"	143 mm 5-5/8 inch	36.85 kN 8,285 lb	36.85 kN 8,285 lb	36.85 kN 8,285 lb	89.24 kN 20,063 lb	103.42 kN 23,250 lb	126.20 kN 28,373 lb
	191 mm 7-1/2 inch	49.10 kN 11,038 lb	49.10 kN 11,038 lb	49.10 kN 11,038 lb	145.31 kN 32,670 lb	168.40 kN 37,860 lb	205.51 kN 46,202 lb
	318 mm 12-1/2 inch	81.83 kN 18,396 lb	81.83 kN 18,396 lb	81.83 kN 18,396 lb	346.30 kN 77,670 lb	401.32 kN 90,224 lb	489.74 kN 110,104 lb
3/4"	171 mm 6-3/4 inch	49.09 kN 11,137 lb	49.09 kN 11,137 lb	49.09 kN 11,137 lb	127.74 kN 28,719 lb	148.04 kN 33,282 lb	180.66 kN 40,615 lb
	229 mm 9 inch	65.63 kN 14,755 lb	65.63 kN 14,755 lb	65.63 kN 14,755 lb	209.25 kN 47,044 lb	242.50 kN 54,518 lb	295.93 kN 66,531 lb
	381 mm 15 inch	109.38 kN 24,591 lb	109.38 kN 24,591 lb	109.38 kN 24,591 lb	498.67 kN 112,111 lb	577.90 kN 129,923 lb	705.23 kN 158,549 lb
1"	229 mm 9 inch	87.66 kN 19,707 lb	87.66 kN 19,707 lb	87.66 kN 19,707 lb	228.79 kN 51,437 lb	265.14 kN 59,610 lb	323.56 kN 72,743 lb
	305 mm 12 inch	116.67 kN 26,230 lb	116.67 kN 26,230 lb	116.67 kN 26,230 lb	372.01 kN 83,634 lb	431.11 kN 96,922 lb	526.09 kN 118,277 lb
	508 mm 20 inch	194.45 kN 43,717 lb	194.45 kN 43,717 lb	194.45 kN 43,717 lb	886.53 kN 199,309 lb	1027.37 kN 230,975 lb	1253.74 kN 281,865 lb
1-1/4"	286 mm 11-1/4 inch	136.85 kN 30,766 lb	136.85 kN 30,766 lb	136.85 kN 30,766 lb	356.96 kN 80,252 lb	103.42 kN 93,002 lb	126.20 kN 113,493 lb
	381 mm 15 inch	182.30 kN 40,985 lb	182.30 kN 40,985 lb	182.30 kN 40,985 lb	581.26 kN 130,678 lb	673.61 kN 151,440 lb	822.02 kN 184,807 lb
	635 mm 25 inch	303.83 kN 68,308 lb	303.83 kN 68,308 lb	303.83 kN 68,308 lb	1385.20 kN 311,420 lb	1605.27 kN 360,898 lb	1958.97 kN 440,415 lb

<sup>1</sup>Tabulated values are calculated in accordance with ACI 318-14

<sup>2</sup>Tabulated values are only valid for single anchors without close edge or anchor spacing considerations

<sup>3</sup>Tabulated values are only valid for anchors installed in dry / water-saturated concrete

<sup>4</sup>Tabulated values are based on bond/concrete failure

<sup>5</sup>Apply anchor spacing, edge distance and concrete structure thickness factors to the above values and compare to the steel values in table 13

<sup>6</sup>The lesser of concrete/bond and steel values are to be used in design calculations.

<sup>7</sup>Shear values are based on the critical edge distance as per IAPMO ES # , Section 3.1.10

<sup>8</sup>Linear interpolation is not permitted

<sup>9</sup>Extrapolation is not permitted

<sup>10</sup>Tabulated values are for static loading only. Seismic design is not permitted in un-cracked concrete.

**TABLE 14 - DESIGN STRENGTH FOR FRACTIONAL THREADED RODS IN CRACKED CONCRETE<sup>1,2,3,4,5,6,7,8,9</sup>**

Anchor Size	Embedment Depth	Sustained Tension Design Strength - $\phi N_n$			Shear Design Strength - $\phi V_n$		
		3,000 psi (20.7 MPa)	4,000 psi (27.8 MPa)	6,000 psi (41.4 MPa)	3,000 psi (20.7 MPa)	4,000 psi (27.8 MPa)	6,000 psi (41.4 MPa)
3/8"	60 mm 2-3/8 inch	4.82 kN 1,084 lb	4.82 kN 1,084 lb	4.82 kN 1,084 lb	13.35 kN 3,002 lb	15.48 kN 3,470 lb	18.89 kN 4,246 lb
	86 mm 3-3/8 inch	6.91 kN 1,553 lb	6.91 kN 1,553 lb	6.91 kN 1,553 lb	24.63 kN 5,537 lb	28.54 kN 6,416 lb	34.83 kN 7,830 lb
	191 mm 7-1/2 inch	15.34 kN 3,449 lb	15.34 kN 3,449 lb	15.34 kN 3,449 lb	95.61 kN 21,496 lb	110.80 kN 24,911 lb	135.22 kN 30,400 lb
1/2"	114 mm 4-1/2 inch	16.64 kN 3,742 lb	16.64 kN 3,742 lb	16.64 kN 3,742 lb	43.35 kN 9,746 lb	65.78 kN 11,294 lb	80.29 kN 13,783 lb
	152 mm 6 inch	22.19 kN 4,989 lb	22.19 kN 4,989 lb	22.19 kN 4,989 lb	70.69 kN 15,893 lb	81.92 kN 18,418 lb	99.98 kN 22,476 lb
	254 mm 10 inch	37.09 kN 8,338 lb	37.09 kN 8,338 lb	37.09 kN 8,338 lb	169.22 kN 38,045 lb	196.11 kN 44,089 lb	239.32 kN 53,804 lb
5/8"	143 mm 5-5/8 inch	24.57 kN 5,524 lb	24.57 kN 5,524 lb	24.57 kN 5,524 lb	68.14 kN 15,319 lb	78.96 kN 17,753 lb	96.36 kN 21,664 lb
	191 mm 7-1/2 inch	32.73 kN 7,358 lb	32.73 kN 7,358 lb	32.73 kN 7,358 lb	110.95 kN 24,944 lb	128.58 kN 28,908 lb	156.91 kN 35,277 lb
	318 mm 12-1/2 inch	54.55 kN 12,264 lb	54.55 kN 12,264 lb	54.55 kN 12,264 lb	264.41 kN 59,445 lb	306.42 kN 68,890 lb	373.94 kN 84,068 lb
3/4"	171 mm 6-3/4 inch	32.99 kN 7,418 lb	32.99 kN 7,418 lb	32.99 kN 7,418 lb	97.54 kN 21,928 lb	113.03 kN 25,412 lb	137.94 kN 31,011 lb
	229 mm 9 inch	44.11 kN 9,916 lb	44.11 kN 9,916 lb	44.11 kN 9,916 lb	159.77 kN 35,920 lb	185.16 kN 41,617 lb	225.95 kN 50,799 lb
	381 mm 15 inch	73.51 kN 16,527 lb	73.51 kN 16,527 lb	73.51 kN 16,527 lb	380.75 kN 85,601 lb	441.25 kN 99,201 lb	538.47 kN 121,058 lb
1"	229 mm 9 inch	50.96 kN 11,456 lb	50.96 kN 11,456 lb	50.96 kN 11,456 lb	174.69 kN 39,274 lb	202.45 kN 45,514 lb	247.05 kN 55,542 lb
	305 mm 12 inch	67.82 kN 15,248 lb	67.82 kN 15,248 lb	67.82 kN 15,248 lb	284.04 kN 63,858 lb	329.17 kN 74,003 lb	401.69 kN 90,309 lb
	508 mm 20 inch	113.04 kN 25,413 lb	113.04 kN 25,413 lb	113.04 kN 25,413 lb	676.90 kN 152,180 lb	784.44 kN 176,357 lb	957.27 kN 215,215 lb
1-1/4"	286 mm 11-1/4 inch	66.20 kN 14,886 lb	66.20 kN 14,886 lb	66.20 kN 14,886 lb	272.55 kN 61,275 lb	315.85 kN 71,010 lb	385.45 kN 86,656 lb
	381 mm 15 inch	88.19 kN 19,826 lb	88.19 kN 19,826 lb	88.19 kN 19,826 lb	443.81 kN 99,778 lb	514.32 kN 115,630 lb	627.64 kN 141,107 lb
	635 mm 25 inch	146.98 kN 33,043 lb	146.98 kN 33,043 lb	146.98 kN 33,043 lb	1057.65 kN 237,781 lb	1225.68 kN 275,559 lb	1495.74 kN 336,273 lb

<sup>1</sup> Tabulated values are calculated in accordance with ACI 318-14

<sup>2</sup> Tabulated values are only valid for single anchors without close edge or anchor spacing considerations

<sup>3</sup> Tabulated values are only valid for anchors installed in dry / water-saturated concrete

<sup>4</sup> Tabulated values are based on bod/concrete failure

<sup>5</sup> Apply anchor spacing, edge distance and concrete structure thickness factors to the above values and compare to the steel values in table 14

<sup>6</sup> The lesser of concrete/bond and steel values are to be used in design calculations.

<sup>7</sup> Shear values are based on the critical edge distance as per IAPMO ES # , Section 3.1.10

<sup>8</sup> Linear interpolation is not permitted

<sup>9</sup> Extrapolation is not permitted

TABLE 15 - DESIGN STRENGTH FOR GRADE 400 CAN REINFORCING BARS IN UNCRACKED CONCRETE<sup>1,2,3,4,5,6,7,8,9,10</sup>

Anchor Size	Embedment Depth	Sustained Tension Design Strength - N <sub>r</sub>			Shear Design Strength - V <sub>r</sub>		
		3,625 psi (25 Mpa)	4,350 psi (30 Mpa)	5,800 psi (40 Mpa)	3,625 psi (25 Mpa)	4,350 psi (30 Mpa)	5,800 psi (40 Mpa)
10M	115 mm 4-1/2 inch	24.52 kN 5,512 lb	24.52 kN 5,512 lb	24.52 kN 5,512 lb	57.81 kN 12,997 lb	63.33 kN 14,238 lb	73.13 kN 16,440 lb
	180 mm 7-1/8 inch	38.37 kN 3,422 lb	38.37 kN 3,422 lb	38.37 kN 3,422 lb	123.82 kN 27,837 lb	135.64 kN 30,494 lb	156.62 kN 35,212 lb
	226 mm 8-7/8 inch	48.18 kN 10,832 lb	48.18 kN 10,832 lb	48.18 kN 10,832 lb	182.31 kN 40,987 lb	199.71 kN 44,899 lb	230.61 kN 51,845 lb
15M	145 mm 5-1/2 inch	35.48 kN 7,978 lb	35.48 kN 7,978 lb	35.48 kN 7,978 lb	93.46 kN 21,012 lb	102.38 kN 23,018 lb	118.22 kN 26,578 lb
	250 mm 9-7/8 inch	61.18 kN 13,754 lb	61.18 kN 13,754 lb	61.18 kN 13,754 lb	235.94 kN 53,045 lb	258.46 kN 58,108 lb	298.45 kN 67,097 lb
	320 mm 12-5/8 inch	78.31 kN 17,606 lb	78.31 kN 17,606 lb	78.31 kN 17,606 lb	358.98 kN 80,705 lb	393.24 kN 88,408 lb	454.07 kN 102,084 lb
20M	200 mm 7-7/8 inch	56.28 kN 12,653 lb	56.28 kN 12,653 lb	56.28 kN 12,653 lb	172.64 kN 38,812 lb	189.11 kN 42,517 lb	218.37 kN 49,094 lb
	355 mm 14 inch	99.89 kN 22,458 lb	99.89 kN 22,458 lb	99.89 kN 22,458 lb	457.90 kN 102,945 lb	501.60 kN 112,771 lb	579.20 kN 130,216 lb
	390 mm 15-3/8 inch	109.74 kN 24,672 lb	109.74 kN 24,672 lb	109.74 kN 24,672 lb	537.27 kN 120,789 lb	588.55 kN 132,318 lb	678.50 kN 152,787 lb
25M	230 mm 9 inch	84.14 kN 18,916 lb	84.14 kN 18,916 lb	84.14 kN 18,916 lb	236.87 kN 53,252 lb	259.47 kN 58,335 lb	299.61 kN 67,359 lb
	405 mm 16 inch	148.63 kN 33,308 lb	160.65 kN 36,117 lb	160.65 kN 36,117 lb	619.78 kN 139,339 lb	678.94 kN 152,639 lb	783.97 kN 176,252 lb
	504 mm 19-7/8 inch	184.37 kN 41,450 lb	184.37 kN 41,450 lb	184.37 kN 41,450 lb	898.87 kN 202,084 lb	984.66 kN 221,372 lb	1136.99 kN 255,619 lb
30M	260 mm 10 inch	109.74 kN 24,672 lb	109.74 kN 24,672 lb	109.74 kN 24,672 lb	304.55 kN 68,470 lb	333.62 kN 75,005 lb	385.23 kN 86,608 lb
	455 mm 12 inch	192.05 kN 43,117 lb	192.05 kN 43,117 lb	192.05 kN 43,117 lb	788.55 kN 177,282 lb	863.81 kN 194,203 lb	997.45 kN 224,246 lb
	600 mm 23-5/8 inch	253.25 kN 56,936 lb	253.25 kN 56,936 lb	253.25 kN 56,936 lb	1262.02 kN 283,728 lb	1382.48 kN 310,808 lb	1596.35 kN 358,891 lb

<sup>1</sup>Tabulated N<sub>r</sub> and V<sub>r</sub> (factored resistance) values are calculated in accordance with CSA A23.3-14 Annex D

<sup>2</sup>Tabulated values are only valid for single anchors without close edge or anchor spacing considerations

<sup>3</sup>Tabulated values are only valid for anchors installed in dry / water-saturated concrete

<sup>4</sup>Tabulated values are based on bond/concrete failure

<sup>5</sup>Apply anchor spacing, edge distance and concrete structure thickness factors to the above values and compare to the steel values in table 7b

<sup>6</sup>The lesser of concrete/bond and steel values are to be used in design calculations.

<sup>7</sup>CSA G30.18 Grade 400 reinforcing bar are considered ductile steel elements

<sup>8</sup>Linear interpolation is not permitted

<sup>9</sup>Extrapolation is not permitted

<sup>10</sup>Tabulated values are for static loading only. Seismic design is not permitted in un-cracked concrete.

**TABLE 16 - DESIGN STRENGTH FOR GRADE 400 CAN REINFORCING BARS IN CRACKED CONCRETE<sup>1,2,3,4,5,6,7,8,9</sup>**

Anchor Size	Embedment Depth	Sustained Tension Design Strength - $N_r$			Shear Design Strength - $V_r$		
		3,625 psi (25 Mpa)	4,350 psi (30 Mpa)	5,800 psi (40 Mpa)	3,625 psi (25 Mpa)	4,350 psi (30 Mpa)	5,800 psi (40 Mpa)
10M	115 mm 4-1/2 inch	11.64 kN 2,617 lb	11.64 kN 2,617 lb	11.64 kN 2,617 lb	41.29 kN 9,284 lb	45.24 kN 10,173 lb	52.23 kN 11,743 lb
	180 mm 7-1/8 inch	18.22 kN 4,095 lb	18.22 kN 4,095 lb	18.22 kN 4,095 lb	88.44 kN 19,884 lb	96.88 kN 21,782 lb	156.62 kN 25,151 lb
	226 mm 8-7/8 inch	22.87 kN 5,142 lb	22.87 kN 5,142 lb	22.87 kN 5,142 lb	130.22 kN 29,277 lb	142.65 kN 32,071 lb	164.72 kN 37,032 lb
	145 mm 5-1/2 inch	25.11 kN 5,645 lb	25.11 kN 5,645 lb	25.11 kN 5,645 lb	66.76 kN 15,009 lb	73.13 kN 16,441 lb	84.44 kN 18,985 lb
15M	250 mm 9-7/8 inch	43.29 kN 9,733 lb	43.29 kN 9,733 lb	43.29 kN 9,733 lb	168.53 kN 37,889 lb	184.62 kN 41,505 lb	213.18 kN 47,926 lb
	320 mm 12-5/8 inch	55.41 kN 12,458 lb	55.41 kN 12,458 lb	55.41 kN 12,458 lb	256.41 kN 57,646 lb	280.88 kN 63,148 lb	324.34 kN 72,917 lb
	200 mm 7-7/8 inch	40.68 kN 9,145 lb	40.68 kN 9,145 lb	40.68 kN 9,145 lb	123.31 kN 27,723 lb	135.08 kN 30,369 lb	155.98 kN 35,067 lb
	355 mm 14 inch	71.91 kN 16,167 lb	71.91 kN 16,167 lb	71.91 kN 16,167 lb	327.07 kN 73,532 lb	358.29 kN 80,551 lb	413.72 kN 93,012 lb
20M	390 mm 15-3/8 inch	79.00 kN 17,761 lb	79.00 kN 17,761 lb	79.00 kN 17,761 lb	383.76 kN 86,278 lb	420.39 kN 94,513 lb	485.43 kN 109,134 lb
	230 mm 9 inch	52.39 kN 11,778 lb	52.39 kN 11,778 lb	52.39 kN 11,778 lb	169.19 kN 38,037 lb	185.34 kN 41,668 lb	214.01 kN 48,114 lb
	405 mm 16 inch	92.25 kN 20,739 lb	92.25 kN 20,739 lb	92.25 kN 20,739 lb	442.70 kN 99,528 lb	484.96 kN 109,028 lb	559.98 kN 125,894 lb
	504 mm 19-7/8 inch	114.80 kN 25,808 lb	114.80 kN 25,808 lb	114.80 kN 25,808 lb	642.05 kN 144,346 lb	703.33 kN 158,123 lb	812.14 kN 182,585 lb
25M	260 mm 10 inch	56.86 kN 12,784 lb	56.86 kN 12,784 lb	56.86 kN 12,784 lb	217.54 kN 48,907 lb	238.30 kN 53,575 lb	275.17 kN 61,863 lb
	455 mm 12 inch	99.51 kN 22,372 lb	99.51 kN 22,372 lb	99.51 kN 22,372 lb	563.25 kN 126,630 lb	617.01 kN 38,716 lb	712.46 kN 160,176 lb
	600 mm 23-5/8 inch	131.22 kN 29,501 lb	131.22 kN 29,501 lb	131.22 kN 29,501 lb	901.44 kN 202,663 lb	987.48 kN 222,006 lb	1140.25 kN 256,350 lb
	30M						

<sup>1</sup> Tabulated  $N_r$  and  $V_r$  (factored resistance) values are calculated in accordance with CSA A23.3-14 Annex D

<sup>2</sup> Tabulated values are only valid for single anchors without close edge or anchor spacing considerations

<sup>3</sup> Tabulated values are only valid for anchors installed in dry / water-saturated concrete

<sup>4</sup> Tabulated values are based on bod/concrete failure

<sup>5</sup> Apply anchor spacing, edge distance and concrete structure thickness factors to the above values and compare to the steel values in table 7b

<sup>6</sup> The lesser of concrete/bond and steel values are to be used in design calculations.

<sup>7</sup> CSA G30.18 Grade 400 reinforcing bar are considered ductile steel elements

<sup>8</sup> Linear interpolation is not permitted

<sup>9</sup> Extrapolation is not permitted

## ALLOWABLE STRESS DESIGN (ASD)

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:

$$T_{\text{allowable, ASD}} = \varphi N_n / a$$
$$V_{\text{allowable, ASD}} = \varphi V_n / a \quad \text{where}$$

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

$\varphi N_n$  = The lowest design strength for an anchor or anchor group in tension as determined in accordance with ACI 318 Appendix D as amended in the IAPMO ES # report and 2009 IBC Sections 1908.1.9 and 1908.1.10 or 2006 IBC Section 1908.1.16, as applicable.

$\varphi V_n$  = The lowest design strength for an anchor or anchor group in shear as determined in accordance with ACI 318 Appendix D as amended in the IAPMO ES # report and 2009 IBC Sections 1908.1.9 and 1908.1.10 or 2006 IBC Section 1908.1.16, as applicable.

$a$  = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition,  $a$  must include all applicable factors to account for non-ductile failure modes and required over-strength.

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

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

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

For all other cases:

$$\frac{T}{T_{\text{allowable, ASD}}} + \frac{V}{V_{\text{allowable, ASD}}} \leq 1.2$$



## CHEMICAL RESISTANCE

The chemical mortar has undergone extensive chemical resistance testing. The results are summarised in the table below.

Chemical Environment	Concentration	Result
Aqueous Solution Acetic Acid	10%	✓
Acetone	100%	X
Aqueous Solution Aluminium Chloride	Saturated	✓
Aqueous Solution Aluminium Nitrate	10%	✓
Ammonia Solution	5%	✓
Jet Fuel	100%	✓
Benzene	100%	X
Benzoic Acid	Saturated	✓
Benzyl Alcohol	100%	X
Sodium Hypochlorite Solution	5 - 15%	C
Butyl Alcohol	100%	C
Calcium Sulphate Aqueous Solution	Saturated	✓
Carbon Monoxide	Gas	✓
Carbon Tetrachloride	100%	✓
Chlorine Water	Saturated	✓
Chloro Benzene	100%	X
Citric Acid Aqueous Solution	Saturated	✓
Cyclohexanol	100%	✓
Diesel Fuel	100%	✓
Diethylene Glycol	100%	✓
Ethanol	95%	C
Ethanol Aqueous Solution	20%	C
Heptane	100%	✓

Chemical Environment	Concentration	Result
Hexane	100%	C
Hydrochloric Acid	10%	✓
	15%	✓
	25%	C
Hydrogen Sulphide Gas	100%	✓
Isoproyl Alcohol	100%	C
Linseed Oil	100%	✓
Lubricating Oil	100%	✓
Mineral Oil	100%	✓
Paraffin / Kerosene (Domestic)	100%	✓
Phenol Aqueous Solution	1%	X
Phosphoric Acid	50%	✓
Potassium Hydroxide	10% / pH13	C
Sea Water	100%	✓
Styrene	100%	X
Sulphur Dioxide Solution	10%	✓
Sulphur Dioxide (40°C)	5%	✓
	10%	✓
	50%	✓
Turpentine	100%	C
White Spirit	100%	✓
Xylene	100%	X

✓ = Resistant to 75°C with at least 80% of physical properties retained.

C = Contact only to a maximum of 25°C.

X = Not Resistant.

**EPOXY USAGE ESTIMATING TABLES<sup>1</sup>**

**TABLE 17 - Holes per FR5MAX-10**

Rod dia.	Hole dia.	Embedment (inch)											
		1	2	3	4	5	6	7	8	9	10	15	20
1/4	5/16	302.1	151.1	100.7	75.5	60.4	50.4	43.2	37.8	33.6	30.2	20.1	15.1
	3/8	178.8	89.4	59.6	44.7	35.8	29.8	25.5	22.4	19.9	17.9	11.9	8.9
3/8	7/16	182.4	91.2	60.8	45.6	36.5	30.4	26.1	22.8	20.3	18.2	12.2	9.1
	1/2	117.1	58.5	39.0	29.3	23.4	19.5	16.7	14.6	13.0	11.7	7.8	5.9
1/2	9/16	131.6	65.8	43.9	32.9	26.3	21.9	18.8	16.5	14.6	13.2	8.8	6.6
	5/8	84.7	42.4	28.2	21.2	16.9	14.1	12.1	10.6	9.4	8.5	5.6	4.2
5/8	1 1/16	96.2	48.1	32.1	24.1	19.2	16.0	13.7	12.0	10.7	9.6	6.4	4.8
	3/4	65.9	33.0	22.0	16.5	13.2	11.0	9.4	8.2	7.3	6.6	4.4	3.3
3/4	1 3/16	77.2	38.6	25.7	19.3	15.4	12.9	11.0	9.7	8.6	7.7	5.1	3.9
	7/8	54.5	27.3	18.2	13.6	10.9	9.1	7.8	6.8	6.1	5.5	3.6	2.7
7/8	1 1/4	67.1	33.5	22.4	16.8	13.4	11.2	9.6	8.4	7.5	6.7	4.5	3.4
	1	44.5	22.3	14.8	11.1	8.9	7.4	6.4	5.6	4.9	4.5	3.0	2.2

**TABLE 18 - Holes per FR5MAX-28**

Rod dia.	Hole dia.	Embedment (inch)											
		1	2	3	4	5	6	7	8	9	10	15	20
1/4	5/16	891.9	446.0	297.3	223.0	178.4	148.7	127.4	111.5	99.1	89.2	59.5	44.6
	3/8	27.9	264.0	176.0	132.0	105.6	88.0	75.4	66.0	58.7	52.8	35.2	26.4
3/8	7/16	538.3	269.2	179.4	134.6	107.7	89.7	76.9	67.3	59.8	53.8	35.9	26.9
	1/2	345.6	172.8	115.2	86.4	69.1	57.6	49.4	43.2	38.4	34.6	23.0	17.3
1/2	9/16	388.5	194.3	129.5	97.1	77.7	64.8	55.5	48.6	43.2	38.9	25.9	19.4
	5/8	250.1	125.0	83.4	62.5	50.0	41.7	35.7	31.3	27.8	25.0	16.7	12.5
5/8	1 1/16	284.0	142.0	94.7	71.0	56.8	47.3	40.6	35.5	31.6	28.4	18.9	14.2
	3/4	194.6	97.3	64.9	48.7	38.9	32.4	27.8	24.3	21.6	19.5	13.0	9.7
3/4	1 3/16	228.0	114.0	76.0	57.0	45.6	38.0	32.6	28.5	25.3	22.8	15.2	11.4
	7/8	161.0	80.5	53.7	40.2	32.2	26.8	23.0	20.1	17.9	16.1	10.7	8.0
7/8	1 1/4	198.0	99.0	66.0	49.5	39.6	33.0	28.3	24.7	22.0	19.8	13.2	9.9
	1	131.5	65.7	43.8	32.9	26.3	21.9	18.8	16.4	14.6	13.1	8.8	6.6
1	1 1/16	143.9	72.0	48.0	36.0	28.8	24.0	20.6	18.0	16.0	14.4	9.6	7.2
	1 1/8	108.1	54.1	36.0	27.0	21.6	18.0	15.4	13.5	12.0	10.8	7.2	5.4
1 1/4	1 3/8	83.7	41.9	27.9	20.9	16.7	14.0	12.0	10.5	9.3	8.4	5.6	4.2
	1 1/2	55.0	27.5	18.3	13.8	11.0	9.2	7.9	6.9	6.1	5.5	3.7	2.8
Rebar size													
10M	9/16	391.6	195.8	130.5	97.9	78.3	65.3	55.9	49.0	43.5	39.2	26.1	19.6
15M	3/4	268.4	134.2	89.5	67.1	53.7	44.7	38.3	33.6	29.8	26.8	17.9	13.4
20M	61/64	173.8	86.9	57.9	43.4	34.8	29.0	24.8	21.7	19.3	17.4	11.6	8.7
25M	1 1/4	84.7	42.3	28.2	21.2	16.9	14.1	12.1	10.6	9.4	8.5	5.6	4.2
30M	1 1/2	58.8	29.4	19.6	14.7	11.8	9.8	8.4	7.3	6.5	5.9	3.9	2.9
35M	1 3/4	48.3	24.2	16.1	12.1	9.7	8.1	6.9	6.0	5.4	4.8	3.2	2.4

<sup>1</sup>For correct epoxy usage, add 20% waste (multiply the tabulated number by 0.80)