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) anchoring applications.

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
- Suitable for water saturated concrete on water filled hole anchoring

TYPICAL APPLICATIONS

- Structural steel base plate anchoring
- Vibratory loading applications
- Rebar 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)

MTO MI 120

MTQ Approved

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)

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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
VOC Content		g/l	4.5	ASTM D2369

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 318-11 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 2 through 12. 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.

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)

$V_{allowable,ASD} = \varphi Vn/\alpha$ 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 13.
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 $T \leq 0.2 \; T_{allowable,ASD}$, the full allowable strength in shear, $V_{allowable,ASD}$, shall be permitted.
For shear loads $V \leq 0.2 \; V_{allowable,ASD}$, the full allowable strength in tension, $T_{allowable,ASD}$, shall be permitted.
For all other cases:

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

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 through. Strength Reduction Factors (R) and Material Resistance Factors (Φ) are provided in Table1. 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.

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DESIGN DATA

TABLE1 - RESISTANCE FACTORS FOR LIMIT STATE DESIGN IN ACCORDANCE WITH CSA A23.3-14, ANNEX D[1]

Characteristic	Symbol	Units	Nominal Anchor Diameter (in.) 3/8" (10M), 1/2", 5/8" (15M), 3/4" (20M), 7/8", 1" (25M), 1-1/4" (30M)
Concrete material resistance factor (dry concrete)	Φ_c	-	0.65
Steel material resistance factor	Φ_s	-	0.85
Strength reduction factor for tension, steel failure modes (carbon steel threaded rod)	R		0.80
Strength reduction factor for tension, steel failure modes (stainless steel threaded rod and reinforcing bar)	R		0.70
Strength reduction factor for shear, steel failure modes (carbon steel threaded rod)	R		0.75
Strength reduction factor for shear, steel failure modes (stainless steel threaded rod and 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

[1]For strength reduction factors in other than dry installation conditions please contact UCAN.

TABLE 2 - REDUCTION FACTORS FOR IN-SERVICE TEMPERATURES[1]

In-Service temperature	Reduction Factor
40°F (+5° C)	1.00
68°F (+20°C)	1.00
110°F (+43°C)	0.90
130°F (+55°C)	0.70
150°F (+65°C)	0.50
168°F (+75°C)	0.40
176°F (+80°C)	0.30

[1]Linear interpolation for intermediate temperatures is allowed.

TABLE 3 - 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	1	-	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}		ACI 318-11 D.8.6						
				CSA A23.3-14 D6.5.1						
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 3. Anchor locations must comply with this report and the plans and specifications approved by the building official. Installation of the FR6 SD adhesive anchor system must conform to the manufacturer's published installation instructions (MPII) included in each package unit and as described on page 14-15. 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 installation instructions.

TABLE 4 - GEL AND CURING TIME

Substrate Temperature (^oC)	Substrate Temperature (^oF)	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 79	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

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TABLE 5—STEEL DESIGN INFORMATION FOR FRACTIONAL CARBON STEEL AND STAINLESS STEEL THREADED ROD[1,2,3]

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

[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.

[3]For limit state design as per CSA A23.3-14, Annex D, material resistance factors (Ø) and resistance modification factors (R) in Table 1 shall be used.

TABLE 6—STEEL DESIGN INFORMATION FOR FRACTIONAL STEEL REINFORCING BAR[1,2,3]

	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 for Shear 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)

TABLE 7—STEEL DESIGN INFORMATION FOR CANADIAN METRIC REINFORCING BAR[1,2,3]

	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 for Shear 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)

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.

[3]For limit state design as per CSA A23.3-14, Annex D, material resistance factors (Ø) and resistance modification factors (R) in Table1 shall be used.

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TABLE 8—FRACTIONAL THREADED ROD AND REINFORCING BAR CONCRETE BREAKOUT STRENGTH DESIGN INFORMATION[1,2]

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}		ACI 318-11 d.8.6						
				CSA A23.3-14 D6.5.1						
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						

TABLE 9—CANADIAN METRIC REINFORCING BAR CONCRETE BREAKOUT STRENGTH DESIGN INFORMATION[1,2]

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}	mm	CSA A23.3-14, Annex D				
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.

For limit state design as per CSA A23.3-14, Annex D, material resistance factors (Ø) and resistance modification factors (R) in Table 1 shall be used.

TABLE 10—FRACTIONAL THREADED ROD BOND STRENGTH DESIGN INFORMATION[1,9]

Design Information		Symbol	Units	Nominal Threaded Rod Diameter						
				3/8"	1/2"	5/8"	3/4"	7/8"	1"	1-1/4"
Minimum Effective Installation Depth		$h_{ef,min}$	in.	2-3/8	2-3/4	3-1/8	3-1/2	4	4	5
			mm	60	70	79	89	102	102	127
Maximum Effective Installation Depth		$h_{ef,max}$	in.	7-1/2	10	12-1/2	15	17-1/2	20	25
			mm	191	254	318	381	445	508	635
Temperature Category A[2,5]	**Characteristic Bond Strength in Non-cracked Concrete**	$t_{k,uncr}$	psi	725						
			N/mm^2	5.0						
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	620	585	550	520	485	450	385
			N/mm^2	4.3	4.0	3.8	3.6	3.3	3.1	2.7
Temperature Category B, Range 1[3,5]	**Characteristic Bond Strength in Non-cracked Concrete**	$t_{k,uncr}$	psi	1,350						
			N/mm^2	9.3						
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	1,150	1,090	1,025	965	900	840	715
			N/mm^2	7.9	7.5	7.0	6.7	6.2	5.8	4.9
Temperature Category B, Range 2[4,5]	**Characteristic Bond Strength in Non-cracked Concrete**	$t_{k,uncr}$	psi	1,350						
			N/mm^2	7.1						
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	875	830	780	735	685	640	545
			N/mm^2	6.1	5.7	5.4	5.1	4.7	4.4	3.8
Anchor Category, Dry Concrete		-	-	1	1	1	1	1	1	1
Strength Reduction factor[6,8]		$Ø_d$	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65

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

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

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

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

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

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

[6]The tabulated value of 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.4.3. 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.4.4.

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

[8]For limit state design as per CSA A23.3-14, Annex D, material resistance factors (Ø) and resistance modification factors (R) in Table 1 shall be used.

[9]Tabulated values are for dry concrete installation with periodic special inspection only. For other installation conditions, please see ICC-ES ESR - 3584.

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TABLE 11 - FRACTIONAL REINFORCING BAR BOND STRENGTH DESIGN INFORMATION[1,9]

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	$t_{k,uncr}$	psi	725						
			N/mm^2	5.0						
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	620	585	550	520	485	450	385
			N/mm^2	4.3	4.0	3.8	3.6	3.3	3.1	2.7
Temperature Category B, Range 1[3,5]	Characteristic Bond Strength in Non-cracked Concrete	$t_{k,uncr}$	psi	1,350						
			N/mm^2	9.3						
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	1,150	1,090	1,025	965	900	840	715
			N/mm^2	7.9	7.5	7.0	6.7	6.2	5.8	4.9
Temperature Category B, Range 2[4,5]	Characteristic Bond Strength in Non-cracked Concrete	$t_{k,uncr}$	psi	1,350						
			N/mm^2	7.1						
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	875	830	780	735	685	640	545
			N/mm^2	6.1	5.7	5.4	5.1	4.7	4.4	3.8
Anchor Category, Dry Concrete		-	-	1	1	1	1	1	1	1
Strength Reduction factor[6,8]		$Ø_d$	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65

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

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

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

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

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

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

[6]The tabulated value of 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.4.3. 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.4.4.

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

[8]For limit state design as per CSA A23.3-14, Annex D, material resistance factors (Ø) and resistance modification factors (R) in Table 1 shall be used.

[9]Tabulated values are for dry concrete installation with periodic special inspection only. For other installation conditions, please see ICC-ES ESR - 3584.

TABLE 12 - CANDIAN METRIC REINFORCING BAR BOND STRENGTH DESIGN INFORMATION[1,9]

Design Information		Symbol	Units	Reinforcing Bar Size				
				10M	15M	20M	25M	30M
Minimum Effective Installation Depth		$h_{ef,min}$	in.	2-3/8	3-1/8	3-1/8	4	5
			mm	60	79	89	102	127
Maximum Effective Installation Depth		$h_{ef,max}$	in.	7-1/2	12-1/2	15	20	25
			mm	191	318	381	508	635
Temperature Category A[2,5]	**Characteristic Bond Strength in Non-cracked Concrete**	$t_{k,uncr}$	psi	725				
			N/mm^2	5.0				
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	615	550	520	450	385
			N/mm^2	4.2	3.8	3.6	3.1	2.7
Temperature Category B, Range 1[3,5]	**Characteristic Bond Strength in Non-cracked Concrete**	$t_{k,uncr}$	psi	1,350				
			N/mm^2	9.3				
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	1,150	1,025	965	840	715
			N/mm^2	7.9	7.0	6.7	5.8	4.9
Temperature Category B, Range 2[4,5]	**Characteristic Bond Strength in Non-cracked Concrete**	$t_{k,uncr}$	psi	1,030				
			N/mm^2	7.1				
	Characteristic Bond Strength in Cracked Concrete	$t_{k,cr}$	psi	875	780	735	640	545
			N/mm^2	6.1	5.4	5.1	4.4	3.8
Anchor Category, Dry Concrete		-	-	1	1	1	1	1
Strength Reduction factor[6,8]		$Ø_d$	-	0.65	0.65	0.65	0.65	0.65

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

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

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

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

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

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

[6]The tabulated value of 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.4.3. 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.4.4.

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

[8]For limit state design as per CSA A23.3-14, Annex D, material resistance factors (Ø) and resistance modification factors (R) in Table 1 shall be used.

[9]Tabulated values are for dry concrete installation with periodic special inspection only. For other installation conditions, please see ICC-ES ESR - 3584.

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TABLE 13—EXAMPLE OF ALOWABLE STRESS DESIGN (ASD) TENSION VALUES FOR ILLUSTRATIVE PURPOSES

Calculated Allowable Tension Load 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	1,350	1,658	Bond Strength
	7.500	1,350	5,239	Bond Strength
1/2"	2.750	1,350	2,403	Breakout Strength
	10.00	1,350	9,313	Bond Strength
5/8"	3.125	1,350	2,911	Breakout Strength
	12.50	1,350	14,552	Bond Strength
3/4"	3.50	1,350	3,451	Breakout Strength
	15.00	1,350	20,955	Bond Strength
7/8"	4.000	1,350	4,216	Breakout Strength
	17.50	1,350	24,448	Bond Strength
1"	4.000	1,350	4,216	Breakout Strength
	20.00	1,350	37,253	Bond Strength
1-1/4"	4.000	1,350	4,216	Breakout Strength
	25.00	1,350	58,208	Bond 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 category B1
5. Dry condition (carbide drilled hole).
6. Embedment (h_{ef}) = min / max for each diameter.
7. Concrete determined to remain uncracked for life of anchor.
8. Load combinations from ACI 318 Section 9.2 (no seismic loading).
9. 30% dead load and 70% live load. Controlling load combination 1.2D + 1.6L
10. Calculation of weighted average for $\alpha = 1.2(0.3) + 1.6(0.7) = 1.48$
11. f'_c = 2,500 psi (normal weight concrete)
12. $c_{ac1} = c_{ac2} \geq c_{ac}$
13. $h \geq h_{min}$

ILLUSTRATIVE PROCEDURE TO CALCULATE ALLOWABLE STRESS DESIGN TENSION VALUE

Anchor 1/2" Diameter, using an enbedment of 2.75", with the design assumptions given in table 13

	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.	$\varphi N_{sa} = \varphi N_{sa}$ $= 0.65 \times 17740$ **= 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 x (2500)^0.5 x 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 x 1 x 1 x 1 x 1 x 5472 **= 3557**
Step 3:	Calculate bond strength of a single anchor in tension per Eq D-16a and Table 7 of this report.	$N_{ao} = \tau_{k,uncr} \pi\ dh_{ef}$ = 1350 x 3.141 x 0.5 x 2.75 = 5830 $\varphi N_{ao} = (A_{na} / A_{na0})\ \Psi_{ed,Na} \Psi_{c,Na} N_{ao}$ = 0.65 x 5830 **= 3790**
Step 4:	Determine controlling resistance strength in tension per ACI 318 D 4. 1. 1. and D 4. 1. 2.	**3557** lbs = controlling resistance (concrete breakout)
Step 5:	Calculate Allowable Stress Design conversion factor for loading condition per ACI 318 Section 9. 2.	α = 1.2DL + 1.6LL = 1.2*0.3 + 1.6*0.7 **= 1.48**
Step 6:	Calculate Allowable Stress Design value per Section 4. 2 of this report.	$T_{allowable,ASD}$ = 3557 / 1.48 **= 2403 lbs**

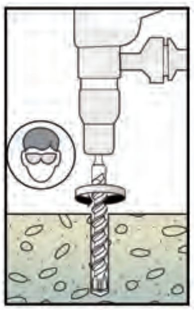
FLO-ROK FR6-SD INJECTION ADHESIVE ANCHOR

UCAN FLO-ROK® FR6-SD INSTALLATION DETAILS

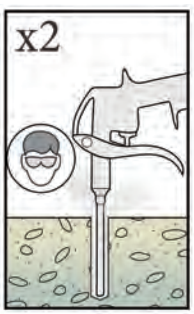
Before beginning installation ensure the worker is equipped with appropriate personal protection equipment, rotary hammer drill, compressed air nozzle, hole cleaning brush, good quality dispensing tool – either manual or power operated, chemical cartridge with mixing nozzle and extension tube, if needed. Refer to technical data "Installation information" (table 1) 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

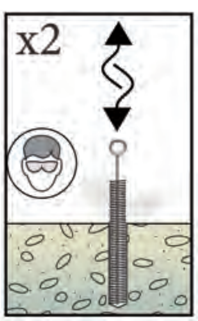


1. Drill the hole to the specied hole diameter and depth using rotary hammer drill in hammer "ON" mode with a UCAN carbide tipped drill bit, conforming to ANSI B212.15-1994 of the appropriate size.



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.

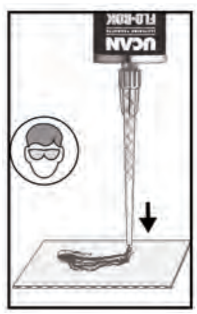
Perform the brushing operation twice.

4. Repeat 2
5. Repeat3
6. Repeat 2

Injection Cartridge preparation

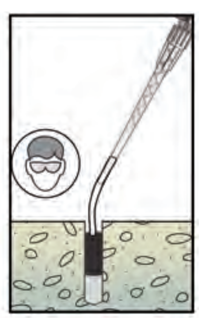
7. Select the appropriate static mixer nozzle, checking that the mixing elements are present and correct (do not modify the mixer). Remoe port closure and attach mixer nozzle to the cartridge. Check the dispensing tool is in good working order. Place the cartridge into the dispensing tool.

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 (Table 2)



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

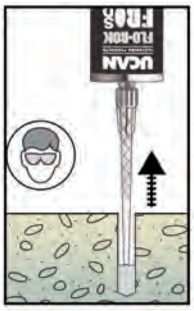
Floor and Wall Anchoring



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.

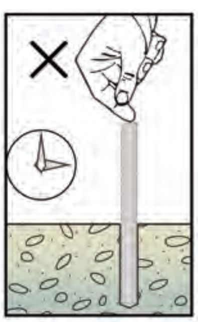
Floor and Wall Anchoring - Continued



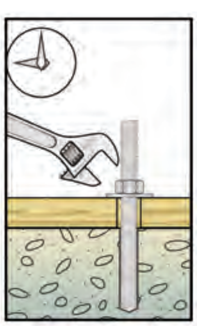
10. Insert the mixing nozzle or extension tube with resin stopper (see figure 9) to the bottom of the hole. Dispense the resin and slowly withdraw the nozzle from the hole. Ensure no air voids are created as the nozzle is withdrawn. Inject resin until the hole is approximately 1/2 - 2/3 full and remove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

FLO-ROK FR6-SD INJECTION ADHESIVE ANCHOR

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

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

✓ = Resistant to 75°C with at least 80% of physical properties retained.
C = Contact only to a maximun of 25°C.
✗ = Not Resistant.

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)