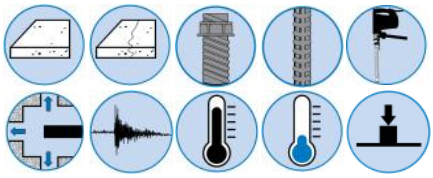
High-Strength Hybrid Anchoring Adhesive

Anchoring

ULTRABOND® HYB-2CC



ICC ES ESR- 4535

NSF

Product Description

ULTRABOND® HYB-2CC is a code compliant, two-component, 10:1 mix ratio by volume, high performance hybrid anchoring and post-installed reinforcing bar system. The system is suitable for use in cracked and uncracked concrete in accordance with ACI 355.4 and ICC-ES AC308. HYB-2CC offers an extended installation temperature range between 23 °F to 104 °F (-5 °C to 40 °C).

General Uses & Applications

- Anchoring threaded rod and reinforcing bar (rebar) into cracked or uncracked concrete
- Alternative to cast-in-place reinforcing bar connections per ACI 318 & IBC Chapter 19
- Suitable for dry, water saturated and water-filled conditions using threaded rod or rebar
- Vertical down, horizontal, upwardly inclined and overhead installations

Advantages & Features

- ICC-ES ESR-4535 evaluation report for cracked and uncracked concrete
- Building code compliant, IBC/IRC: 2018, 2015, 2012 & 2009
- Florida Building Code (FBC) Compliant: 2017
- City of Los Angeles (LABC/LARC) Code Compliant: 2017
- ICC-ES AC308 and ACI 355.4 assessed for resisting long term loading conditions (creep) up to 212 °F (100 °C) and short term loading up to 320 °F (160 °C)
- NSF Certified – Drinking Water System Components to NSF/ ANSI 61
- Multiple Anchor Types: fractional and metric threaded rod & rebar (for both anchor systems and rebar development length applications)
- Qualified for Seismic Design Categories A through F
- Designed for rapid strength concrete anchoring

STANDARDS & APPROVALS

CODE COMPLIANT:
ICC-ES ESR-4535
IBC/IRC 2018, 2015, 2012, & 2009
City of Los Angeles 2017
Florida Building Code 2017

ASTM C881-15/AASHTO M235
Type I, II, IV & V Grade 3 Class A, B & C

Drinking Water System Components NSF/ANSI 61

Availability: Adhesives Technology Corp. (ATC) products are available online and through select distributors providing all your construction needs. Please contact ATC for a distributor near you or visit www.atcepoxy.com to search for a distributor by zip code.

Color & Ratio: Part A (Resin) Light Beige: Part B (Hardener) Black, Mixed Ratio: 10:1 by volume, Mixed Color - Gray.

Storage & Shelf Life: 18 months when stored in unopened containers in dry and dark conditions. Store between 41 °F (5 °C) and 77 °F (25 °C).

Installation & Estimation: Manufacturer's Printed Installation Instructions (MPII) are available within this Technical Data Sheet (TDS). Due to occasional updates and revisions, always verify the most current MPII usage. In order to achieve maximum results, proper installation is imperative. An estimating guide for product usage may be found at www.atcepoxy.com.

Clean-Up: Clean uncured materials from tools and equipment with mild solvents. Cured material can only be removed mechanically.

Limitations & Warnings:

- Do not thin with solvents, as this will prevent cure
- For anchoring applications, concrete should be a minimum of 21 days old prior to anchor installation per ACI 355.4

Safety: Please refer to the Safety Data Sheet (SDS) for ULTRABOND HYB-2CC. Call ATC for more information at 1 -800-892-1880.

Specification: Anchoring adhesive shall be a two component, 10:1 ratio by volume, hybrid anchoring system supplied in pre-measured cartridges. Adhesive must meet the requirements of C881-15 specification for Type I, II, IV, and V, Grade 3 Class A, B & C and must have a compressive yield strength of 15,049 psi (104 MPa) at 73 °F (23 °C) after a 7 day cure. Adhesive shall be ULTRABOND HYB-2CC from Adhesives Technology Corp., Pompano Beach, Florida. Anchors shall be installed per the Manufacturer's Printed Installation Instructions (MPII) for ULTRABOND HYB-2CC anchoring system.

MATERIAL SPECIFICATION

TABLE 1: ULTRABOND HYB-2CC performance to **ASTM C881-15**[1,2,3]

Property	Cure Time	ASTM Standard	Units	Sample Conditioning Temperature		
				Class A	Class B	Class C
				32 °F (0 °C)	40 °F (4 °C)	60 °F (16 °C)
Gel Time - 60 Gram Mass[4,5]	----	C881	min	26	14	6
Consistency or Viscosity			----	Non-sag		
Compressive Yield Strength	7 day	D695	psi (MPa)	10,347 (71.3)	13,400 (92.4)	15,049 (104)
Compressive Modulus			psi (MPa)	1,407,000 (9,701)	1,573,030 (10,846)	1,676,320 (11,558)
Bond Strength[6] Hardened to Hardened Concrete	2 day	C882	psi (MPa)	2,839 (19.6)	2,824 (19.5)	2,812 (19.4)
	14 day		psi (MPa)	3,211 (22.1)	3,143 (21.7)	3,270 (22.5)
Heat Deflection Temperature[7]	7 day	D648	°F (°C)	258 (126)		
Water Absorption[7]	14 day	D570	%	0.90		
Linear Coefficient of Shrinkage[7]	----	D2566		0.000		

1. Product testing results based on representative lot(s). Average results will vary according to the tolerances of the given property.
2. Full cure time is listed above to obtain the given properties for each product characteristic.
3. Results may vary due to environmental factors such as temperature, moisture and type of substrate.
4. Per ASTM C881 Section 5.2 minimum Gel Time of 5 minutes may be specified when automatic proportioning, mixing and dispensing equipment is used for Types I and IV.
5. Properties tested at 50 °F (10° C) for Class B.
6. Property tested at 35 °F (2 °C) for class A and 73 °F (23 °C) for Class C.
7. Specimens cured at 73 °C (23 °C).

TABLE 2: ULTRABOND HYB-2CC **NSF/ANSI CERTIFICATION**

ANSI Certification	Description	Application	Water Contact Temperature	Anchor Sizes Installed in Concrete
NSF 61	Drinking Water System Components - Health Effects	Joining and Sealing Materials	Commercial Hot 180 ± 4 °F (82 ± 2 °C)	Threaded Rod and Rebar ≤ 1 1/4 in. Diameter

ULTRABOND HYB-2CC has been tested and assessed by an accredited independent testing laboratory in accordance with ICC -ES AC308, ACI 355.4 and ASTM E488 for use in cracked and uncracked normal weight and lightweight concrete, for loading conditions including seismic and wind, for structural design to ACI 318-14 Chapter 17 (ACI 318-11/08 Appendix D) and is approved per ICC-ES ESR-4535. The design process and parameters for ULTRABOND HYB-2CC are shown in Figure 1 and Tables 4 - 15 for Strength Design. Tables 16 and 17 show the determination of development length for post-installed reinforcing bar connections.

FIGURE 1 – ULTRABOND HYB-2CC FLOW CHART FOR THE ESTABLISHMENT OF DESIGN STRENGTH

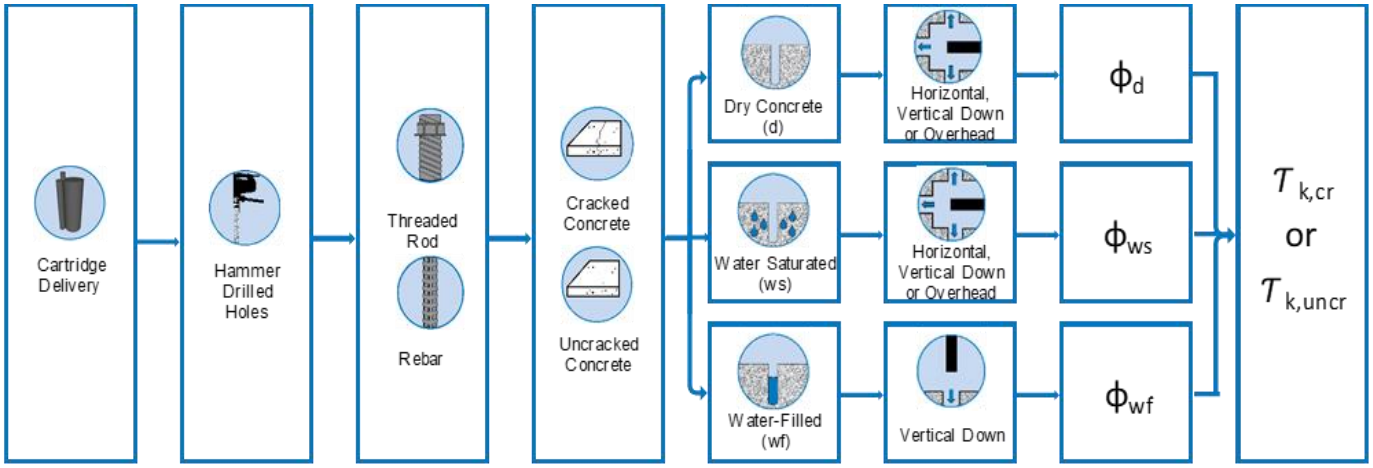


TABLE 3: DESIGN STRENGTH - TABLE REFERENCE INDEX

DESIGN STRENGTH[1] - THREADED RODS	Fractional	Metric
Steel Strength - N_{sa}, V_{sa}	Table 4	Table 7
Concrete Strength - N_{pn}, N_{sb}, N_{sbg}, N_{cb}, N_{cbg}, V_{cb}, V_{cbg}, V_{cp}, V_{cpg}	Table 5	Table 8
Bond Strength[2] - N_a, N_{ag}	Table 6	Table 9
DESIGN STRENGTH[1] - REINFORCING BAR	**Fractional**	**Metric**
Steel Strength - N_{sa}, V_{sa}	Table 10	Table 13
Concrete Strength - N_{pn}, N_{sb}, N_{sbg}, N_{cb}, N_{cbg}, V_{cb}, V_{cbg}, V_{cp}, V_{cpg}	Table 11	Table 14
Bond Strength[2] - N_a, N_{ag}	Table 12	Table 15
Determination of development length for post-installed reinforcing bar connections	Table 16	Table 17

1. Ref. ACI 318-14 17.3.1.1 or 318-11 D.4.1.1, as applicable.
2. See Section 4.1.4 of the ICC evaluation report.

TABLE 4: ULTRABOND HYB-2CC **STEEL** design information for **THREADED ROD**[1]

Design Information		Symbol	Units	Threaded Rod						
				3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Nominal Anchor Diameter		d	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.250 (31.8)
Threaded Rod Cross-Sectional Area		A_{se}	in.^{2} (mm^2)	0.078 (50)	0.142 (92)	0.226 (146)	0.335 (216)	0.462 (298)	0.606 (391)	0.969 (625)
ASTM A36 Grade 36 F1554 Grade 36	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	4,495 (20.0)	8,230 (36.6)	13,110 (58.3)	19,400 (86.3)	26,780 (119.1)	35,130 (156.3)	56,210 (250.0)
		V_{sa}	lb. (kN)	2,695 (12.0)	4,940 (22.0)	7,860 (35.0)	11,640 (51.8)	16,070 (71.5)	21,080 (93.8)	33,725 (150.0)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.60						
	Strength Reduction Factor for Tension[2]	ϕ	----	0.75						
	Strength Reduction Factor for Shear[2]	ϕ	----	0.65						
ASTM F1554 Grade 55	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	5,815 (25.9)	10,645 (47.4)	16,950 (75.4)	25,090 (111.6)	34,630 (154.0)	45,430 (202.1)	72,685 (323.3)
		V_{sa}	lb. (kN)	3,490 (15.5)	6,385 (28.4)	10,170 (45.2)	15,055 (67.0)	20,780 (92.4)	27,260 (121.3)	43,610 (194.0)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.60						
	Strength Reduction Factor for Tension[2]	ϕ	----	0.75						
	Strength Reduction Factor for Shear[2]	ϕ	----	0.65						
ASTM A193 B7 ASTM F1554 Grade 105	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	9,685 (43.1)	17,735 (78.9)	28,250 (125.7)	41,810 (186.0)	57,710 (256.7)	75,710 (336.8)	121,135 (538.8)
		V_{sa}	lb. (kN)	5,810 (25.8)	10,640 (47.3)	16,950 (75.4)	25,085 (111.6)	34,625 (154.0)	45,425 (202.1)	72,680 (323.3)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.60						
	Strength Reduction Factor for Tension[2]	ϕ	----	0.75						
	Strength Reduction Factor for Shear[2]	ϕ	----	0.65						
ASTM A449	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	9,300 (41.4)	17,030 (75.8)	27,120 (120.6)	40,140 (178.6)	55,405 (246.5)	72,685 (323.3)	101,755 (452.6)
		V_{sa}	lb. (kN)	5,580 (24.8)	10,220 (45.5)	16,270 (72.4)	24,085 (107.1)	33,240 (147.9)	43,610 (194.0)	61,055 (271.6)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.60						
	Strength Reduction Factor for Tension[2]	ϕ	----	0.75						
	Strength Reduction Factor for Shear[2]	ϕ	----	0.65						

TABLE 4 (Continued): ULTRABOND HYB-2CC **STEEL** design information for **THREADED ROD**[1]

Design Information		Symbol	Units	Threaded Rod						
				3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
ASTM F568M Class 5.8	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	5,620 (25.0)	10,290 (45.8)	16,385 (72.9)	24,250 (107.9)	33,470 (148.9)	43,910 (195.3)	70,260 (312.5)
		V_{sa}	lb. (kN)	3,370 (15.0)	6,175 (27.5)	9,830 (43.7)	14,550 (64.7)	20,085 (89.3)	26,350 (117.2)	42,155 (187.5)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.60						
	Strength Reduction Factor for Tension[2]	ϕ	----	0.65						
	Strength Reduction Factor for Shear[2]	ϕ	----	0.60						
ASTM F593 CW Stainless Types 304 & 316	Nominal Strength as Governed by Steel Strength	N_{sa}	lb (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	28,430 (126.5)	39,245 (174.6)	51,485 (229.0)	82,370 (366.4)
		V_{sa}	lb (kN)	4,650 (20.7)	8,515 (37.9)	13,560 (60.3)	17,060 (75.9)	23,545 (104.7)	30,890 (137.4)	49,425 (219.9)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.60						
	Strength Reduction Factor for Tension[2]	ϕ	----	0.65						
	Strength Reduction Factor for Shear[2]	ϕ	----	0.60						
ASTM A193/ A193M Grade B8/ B8M, Class 2B	Nominal Strength as Governed by Steel Strength	N_{sa}	lb (kN)	7,365 (32.8)	13,480 (60.0)	21,470 (95.5)	31,780 (141.4)	43,860 (195.1)	57,540 (256.0)	92,065 (409.5)
		V_{sa}	lb (kN)	4,420 (19.7)	8,090 (36.0)	12,880 (57.3)	19,070 (84.8)	26,320 (117.1)	34,525 (153.6)	55,240 (245.7)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.60						
	Strength Reduction Factor for Tension[2]	ϕ	----	0.75						
	Strength Reduction Factor for Shear[2]	ϕ	----	0.65						

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

1. 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), as applicable. Nuts and washers must comply with requirements for the rod.
2. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3., as applicable are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D4.4.

TABLE 5: ULTRABOND HYB-2CC **CONCRETE BREAKOUT** design information for **THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL and CARBIDE BIT**[1]

Design Information	Symbol	Units	Threaded Rod						
			3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Minimum Embedment Depth	$h_{ef,min}$	in. (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 1/2 (89)	4 (102)	5 (127)
Maximum Embedment Depth	$h_{ef,max}$	in. (mm)	7 1/2 (191)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	25 (635)
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	in-lb (SI)	17 (7)						
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	in-lb (SI)	24 (10)						
Minimum Spacing Distance	s_{min}	in. (mm)	1 7/8 (48)	2 1/2 (64)	3 (76)	3 3/4 (95)	4 1/4 (108)	4 3/4 (121)	5 7/8 (149)
Minimum Edge Distance	c_{min}	in. (mm)	1 5/8 (41)	1 3/4 (44)	2 (51)	2 3/8 (60)	2 1/2 (64)	2 3/4 (70)	3 1/4 (83)
					For smaller edge distances, see Section 4.1.9 of ICC-ESR 4535				
Minimum Concrete Thickness	h_{min}	in. (mm)	h_{ef} + 1.25 (h_{ef} + 30)		h_{ef} + 2d_0, where d_0 Is the hole diameter				
Critical Edge Distance (Uncracked Concrete Only)	c_{ac}	----	See section 4.1.10 of ICC-ESR 4535						
Strength Reduction Factor for Tension, Concrete Failure Mode, Condition B[2]	ϕ	----	0.65						
Strength Reduction Factor for Shear, Concrete Failure Mode, Condition B[2]	ϕ	----	0.70						

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

[1] Additional setting information is described the installation instructions.

[2] Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 6: ULTRABOND HYB-2CC **BOND STRENGTH** design information for **THREADED ROD** in holes drilled with a **HAMMER DRILL** and **CARBIDE BIT**[1,2,3]

Design Information			Symbol	Units	Threaded Rod						
					3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Minimum Embedment Depth			$h_{ef,min}$	in. (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 1/2 (89)	4 (102)	5 (127)
Maximum Embedment Depth			$h_{ef,max}$	in. (mm)	7 1/2 (191)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	25 (635)
Maximum Long Term Temperature **122 °F** (50 °C) Maximum Short Term Temperature **176 °F** 80 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,cr}$	psi (MPa)	1,040 (7.2)	1,040 (7.2)	1,110 (7.7)	1,220 (8.4)	1,210 (8.3)	1,205 (8.3)	1,145 (7.9)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,uncr}$	psi (MPa)	2,600 (17.9)	2,415 (16.7)	2,260 (15.6)	2,140 (14.8)	2,055 (14.2)	2,000 (13.8)	1,990 (13.7)
Maximum Long Term Temperature **161 °F** (72 °C) Maximum Short Term Temperature **248 °F** (120 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,cr}$	psi (MPa)	905 (6.2)	905 (6.2)	965 (6.7)	1,060 (7.3)	1,055 (7.3)	1,050 (7.2)	995 (6.9)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,uncr}$	psi (MPa)	2,265 (15.6)	2,100 (14.5)	1,970 (13.6)	1,865 (12.9)	1,785 (12.3)	1,740 (12.0)	1,730 (11.9)
Maximum Long Term Temperature **212 °F** (100 °C) Maximum Short Term Temperature **320 °F** (160 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$T_{k,cr}$	psi (MPa)	650 (4.5)	655 (4.5)	695 (4.8)	765 (5.3)	760 (5.2)	755 (5.2)	720 (5.0)
		No Sustained Load		psi (MPa)	800 (5.5)	806 (5.6)	855 (5.9)	941 (6.5)	935 (6.4)	929 (6.4)	886 (6.1)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$T_{k,uncr}$	psi (MPa)	1,630 (11.2)	1,515 (10.4)	1,420 (9.8)	1,345 (9.3)	1,290 (8.9)	1,255 (8.7)	1,250 (8.6)
		No Sustained Load		psi (MPa)	2,005 (13.8)	1,863 (12.8)	1,747 (12.0)	1,654 (11.4)	1,587 (10.9)	1,544 (10.6)	1,538 (10.6)
Reduction Factor for Seismic Tension[5]			$\alpha_{N,seis}$	----	0.95						
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Concrete	ϕ_d	----	0.65						
		Water Saturated Concrete	ϕ_{ws}	----	0.55						
		Water-Filled Holes in Concrete	ϕ_{wf}	----	0.45						

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

[1]Characteristic bond strength values correspond to concrete compressive strength f'_c =2,500 psi (17.2 MPa). For concrete compressive strength f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.10}$. See Section 4.1.4 of ICC-ESR 4535.

[2]Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D Section D.3.6 as applicable.

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

[4]Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.

[5]For structures assigned to Seismic Design Category C, D, E or F, the bond strength values must be multiplied by αN,seis.

TABLE 7: ULTRABOND HYB-2CC **STEEL** design information for **REBAR**[1]

Design Information		Symbol	Units	Rebar Size							
				#3	#4	#5	#6	#7	#8	#9	#10
Nominal Anchor Diameter		d	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.125 (28.6)	1.250 (31.8)
Rebar Cross-Sectional Area[3]		A_{se}	in^2 (mm^2)	0.110 (71)	0.200 (129)	0.310 (200)	0.440 (284)	0.600 (387)	0.790 (510)	1.000 (645)	1.270 (819)
ASTM A615 Grade 40	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	Grade 40 reinforcing bars are only available in sizes #3 through #6 per ASTM A615			
		V_{sa}	lb. (kN)	3,960 (17.6)	7,200 (32.0)	11,160 (49.6)	15,840 (70.5)				
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.65							
	Strength Reduction Factor for Tension[2]	ϕ	----	0.65							
	Strength Reduction Factor for Shear[2]	ϕ	----	0.60							
ASTM A615 Grade 60	Nominal Strength as Governed by Steel Strength	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)	90,000 (400.3)	114,300 (508.4)
		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)	54,000 (240.2)	68,580 (305.1)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.65							
	Strength Reduction Factor for Tension[2]	ϕ	----	0.65							
	Strength Reduction Factor for Shear[2]	ϕ	----	0.60							
ASTM A706 Grade 60	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	8,800 (39.1)	16,000 (71.2)	24,800 (110.3)	35,200 (156.6)	48,000 (213.5)	63,200 (281.1)	80,000 (355.9)	101,600 (451.9)
		V_{sa}	lb. (kN)	5,280 (23.5)	9,600 (42.7)	14,880 (66.2)	21,120 (93.9)	28,800 (128.1)	37,920 (168.7)	48,000 (213.5)	60,960 (271.2)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.65							
	Strength Reduction Factor for Tension[2]	ϕ	----	0.75							
	Strength Reduction Factor for Shear[2]	ϕ	----	0.65							

For SI: 1 inch = 25.4 mm, 1lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

[1] 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), as applicable.

[2] For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D4.4.

[3] Cross-sectional area is minimum stress area applicable for either tension or shear.

TABLE 8: ULTRABOND HYB-2CC **CONCRETE BREAKOUT** design information for **REBAR** in holes drilled with a **HAMMER DRILL** and **CARBIDE BIT** [1]

Design Information	Symbol	Units	Rebar Size							
			#3	#4	#5	#6	#7	#8	#9	#10
Minimum Embedment Depth	$h_{ef,min}$	in. (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 1/2 (89)	4 (102)	4 1/2 (114)	5 (127)
Maximum Embedment Depth	$h_{ef,max}$	in. (mm)	7 1/2 (191)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	22 1/2 (572)	25 (635)
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	in-lb (SI)	17 (7)							
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	in-lb (SI)	24 (10)							
Minimum Spacing Distance	s_{min}	in. (mm)	1 7/8 (48)	2 1/2 (64)	3 (76)	3 3/4 (95)	4 1/4 (108)	4 3/4 (121)	5 1/4 (133)	5 7/8 (149)
Minimum Edge Distance	c_{min}	in. (mm)	1 5/8 (41)	1 3/4 (44)	2 (51)	2 3/8 (60)	2 1/2 (64)	2 3/4 (70)	3 (76)	3 1/4 (83)
					For smaller edge distances, see Section 4.1.9 of ICC-ESR 4535					
Minimum Concrete Thickness	h_{min}	in. (mm)	$h_{ef} + 1.25$ ($h_{ef} + 30$)		$h_{ef} + 2d_0$, where d_0 is the hole diameter					
Critical Edge Distance (Uncracked Concrete Only)	c_{ac}	----	See Section 4.1.10 of ICC-ESR 4535							
Strength Reduction Factor for Tension, Concrete Failure Mode, Condition B[2]	ϕ	----	0.65							
Strength Reduction Factor for Shear, Concrete Failure Mode, Condition B[2]	ϕ	----	0.70							

For SI: 1 inch = 25.4 mm, 1lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

[1] Additional setting information is decribed in Figure 6, installation instructions.

[2] Condition A requires supplemental reinforcement, while condition B applies where supplemental reinforcement is not provided or where pullout or pryout governes, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. The tabulated value of f' applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 Section 9.2, as applicable, as set forth in ACI 318-11 D.4.3, as applicable. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 9: ULTRABOND HYB-2CC **BOND STRENGTH** design information for **REBAR** in holes drilled with a **HAMMER DRILL**

Design Information			Symbol	Units	Rebar Size							
					#3	#4	#5	#6	#7	#8	#9	#10
Minimum Embedment Depth			$h_{ef,min}$	in. (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 1/2 (89)	4 (102)	4 1/2 (114)	5 (127)
Maximum Embedment Depth			$h_{ef,max}$	in. (mm)	7 1/2 (191)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	22 1/2 (572)	25 (635)
Maximum Long Term Temperature **122 °F** (50 °C) Maximum Short Term Temperature **176 °F** 80 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,cr}$	psi (MPa)	1,090 (7.5)	1,055 (7.3)	1,130 (7.8)	1,170 (8.1)	1,175 (8.1)	1,155 (8.0)	1,140 (7.9)	1,165 (8.0)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,uncr}$	psi (MPa)	2,200 (15.2)	2,100 (14.5)	2,030 (14.0)	1,970 (13.6)	1,920 (13.2)	1,880 (13.0)	1,845 (12.7)	1,815 (12.5)
Maximum Long Term Temperature **161 °F** (72 °C) Maximum Short Term Temperature **248 °F** (120 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,cr}$	psi (MPa)	945 (6.5)	915 (6.3)	980 (6.8)	1,015 (7.0)	1,020 (7.0)	1,005 (6.9)	995 (6.9)	1,010 (7.0)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,uncr}$	psi (MPa)	1,915 (13.2)	1,830 (12.6)	1,765 (12.2)	1,715 (11.8)	1,670 (11.5)	1,635 (11.3)	1,615 (11.1)	1,580 (10.9)
Maximum Long Term Temperature **212 °F** (100 °C) Maximum Short Term Temperature **320 °F** (160 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$T_{k,cr}$	psi (MPa)	680 (4.7)	660 (4.6)	705 (4.9)	735 (5.1)	735 (5.1)	725 (5.0)	715 (4.9)	730 (5.0)
		No Sustained Load		psi (MPa)	836 (5.8)	812 (5.6)	867 (6.0)	904 (6.2)	904 (6.2)	892 (6.1)	879 (6.1)	898 (6.2)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$T_{k,uncr}$	psi (MPa)	1,380 (9.5)	1,315 (9.1)	1,270 (8.8)	1,235 (8.5)	1,205 (8.3)	1,180 (8.1)	1,155 (8.0)	1,140 (7.9)
		No Sustained Load		psi (MPa)	1,697 (11.7)	1,617 (11.2)	1,562 (10.8)	1,519 (10.5)	1,482 (10.2)	1,451 (10.0)	1,421 (9.8)	1,402 (9.7)
Reduction Factor for Seismic Tension[5]			$\alpha_{N,seis}$	----	0.95			1.00				
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Concrete	ϕ_d	----	0.65							
		Water Saturated Concrete	ϕ_{ws}	----	0.55							
		Water-Filled Holes in Concrete	ϕ_{wf}	----	0.45							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

[1]Characteristic bond strength values correspond to concrete compressive strength f'_c =2,500 psi (17.2 MPa). For concrete compressive strength f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.10}$. See Section 4.1.4 ICC-ESR 4535.

[2]Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D Section D.3.6 as applicable.

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

[4]Characteristic bond strengths are for sustained loads (when noted) including live and dead loads.

[5]For structures assigned to Seismic Design Category C, D, E or F, the bond strength values must be multiplied by αN,seis.

TABLE 10: ULTRABOND HYB-2CC **STEEL** design information for **METRIC THREADED ROD**[1]

Design Information		Symbol	Units	Metric Threaded Rod						
				M10	M12	M16	M20	M24	M27	M30
Nominal Anchor Diameter		d	mm (in.)	10 (0.39)	12 (0.47)	16 (0.63)	20 (0.79)	24 (0.94)	27 (1.06)	30 (1.18)
Threaded Rod Cross-Sectional Area		A_{se}	mm^2 ($in.^2$)	58.0 0.090	84.3 0.131	157 0.243	245 0.380	353 0.547	459 0.711	561 0.876
ISO 898-1 Class 5.8	Nominal Strength as Governed by Steel Strength	N_{sa}	kN (lb)	29.0 (6,518)	42.2 (9,473)	78.5 (17,643)	122.5 (27,532)	176.5 (39,668)	229.5 (51,580)	280.5 (63,043)
		V_{sa}	kN (lb)	17.4 (3,911)	25.3 (5,684)	47.1 ‘10,586)	73.5 (16,519)	105.9 (23,801)	137.7 (30,948)	168.3 (37,826)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.60						
	Strength Reduction Factor for Tension[2]	ϕ	----	0.65						
	Strength Reduction Factor for Shear[2]	ϕ	----	0.60						
ISO 898-1 Class 8.8	Nominal Strength as Governed by Steel Strength	N_{sa}	kN (lb)	46.4 (10,428)	67.4 (15,157)	125.6 (28,229)	196 (44,051)	282.4 (63,470)	367.2 (82,528)	448.3 (100,868)
		V_{sa}	kN (lb)	27.8 (6,257)	40.5 (9,094)	75.4 (16,937)	117.6 (26,431)	169.4 (38,082)	220.3 (49,517)	269.3 (60,521)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.60						
	Strength Reduction Factor for Tension[2]	ϕ	----	0.65						
	Strength Reduction Factor for Shear[2]	ϕ	----	0.60						
ISO 3506-1 A4 stainless steel[3]	Nominal Strength as Governed by Steel Strength	N_{sa}	kN (lb)	40.6 (9,125)	59 (13,263)	109.9 (24,700)	171.5 (38,545)	247.1 (55,536)	229.5 (51,580)	280.5 (63,043)
		V_{sa}	kN (lb)	24.4 (5,475)	35.4 (7,958)	65.9 (14,820)	102.9 (23,127)	148.3 (33,322)	137.7 (30,948)	168.3 (37,826)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.60						
	Strength Reduction Factor for Tension[2]	ϕ	----	0.65						
	Strength Reduction Factor for Shear[2]	ϕ	----	0.60						

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

[1]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), as applicable. Nuts and washers must comply with requirements for the rod.

[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318 -14 17.3.3 or ACI 318-11 D.4.3., as applicable are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D4.4.

[3]A4-70 Stainless steel (M8-M24); A4-50 Stainless steel (M27-M30).

TABLE 11: ULTRABOND HYB-2CC **CONCRETE BREAKOUT** design information for **METRIC THREADED ROD** in holes drilled with a **HAMMER DRILL** and **CARBIDE BIT**[1]

Design Information	Symbol	Units	Metric Threaded Rod						
			M10	M12	M16	M20	M24	M27	M30
Minimum Embedment Depth	$h_{ef,min}$	in. (mm)	60 (2.4)	70 (2.8)	80 (3.1)	90 (3.5)	96 (3.8)	108 (4.3)	120 (4.7)
Maximum Embedment Depth	$h_{ef,max}$	in. (mm)	200 (7.9)	240 (9.4)	320 (12.6)	400 (15.7)	480 (18.9)	540 (21.3)	600 (23.6)
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	SI (in-lb)	7 (17)						
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	SI (in-lb)	10 (24)						
Minimum Spacing Distance	s_{min}	mm (in.)	50 (2)	60 (2 3/8)	75 (3)	95 (3 3/4)	115 (4 1/2)	125 (5)	140 (5 1/2)
Minimum Edge Distance	c_{min}	mm (in.)	40 (1 5/8)	45 (1 3/4)	50 (2)	60 (2 3/8)	65 (2 1/2)	75 (3)	80 (3 1/8)
					For smaller edge distances, see Section 4.1.9 of ICC-ESR 4535				
Minimum Concrete Thickness	h_{min}	mm (in.)	$h_{ef} + 30$ ($h_{ef} + 1.25$)		$h_{ef} + 2d_0^3$ where d_0 is the hole diameter				
Critical Edge Distance (Uncracked Concrete Only)	c_{ac}	----	See Section 4.1.10 of ICC-ESR 4535						
Strength Reduction Factor for Tension, Concrete Failure Mode, Condition B[2]	ϕ	----	0.65						
Strength Reduction Factor for Shear, Concrete Failure Mode, Condition B[2]	ϕ	----	0.70						

For SI: 1 inch = 25.4 mm, 1lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

[1] Additional setting information is decribed in Figure 6, installation instructions.

[2] Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 12: ULTRABOND HYB-2CC **BOND STRENGTH** design information for **METRIC THREADED ROD** in holes drilled with a **HAMMER DRILL** and **CARBIDE BIT**[1,2]

Design Information			Symbol	Units	Metric Threaded Rod						
					M10	M12	M16	M20	M24	M27	M30
Minimum Embedment Depth			$h_{ef,min}$	mm (in.)	60 (2.4)	70 (2.8)	80 (3.1)	90 (3.5)	96 (3.8)	108 (4.3)	120 (4.7)
Maximum Embedment Depth			$h_{ef,max}$	mm (in.)	200 (7.9)	240 (9.4)	320 (12.6)	400 (15.7)	480 (18.9)	540 (21.3)	600 (23.6)
Maximum Long Term Temperature **122 °F** (50 °C) Maximum Short Term Temperature **176 °F** 80 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,cr}$	MPa (psi)	7.2 (1,039)	7.2 (1,043)	7.7 (1,110)	8.4 (1,217)	8.3 (1,209)	8.3 (1,204)	7.9 (1,149)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,uncr}$	MPa (psi)	17.7 (2,571)	16.9 (2,453)	15.6 (2,256)	14.6 (2,112)	13.9 (2,020)	13.7 (1,985)	13.7 (1,980)
Maximum Long Term Temperature **161 °F** (72 °C) Maximum Short Term Temperature **248 °F** (120 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,cr}$	MPa (psi)	6.2 (904)	6.3 (908)	6.7 (966)	7.3 (1,058)	7.2 (1,052)	7.2 (1,047)	6.9 (999)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,uncr}$	MPa (psi)	15.4 (2,237)	14.7 (2,134)	13.5 (1,963)	12.7 (1,837)	12.1 (1,757)	11.9 (1,727)	11.9 (1,723)
Maximum Long Term Temperature **212 °F** (100 °C) Maximum Short Term Temperature **320 °F** (160 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$T_{k,cr}$	MPa (psi)	4.5 (651)	4.5 (654)	4.8 (696)	5.3 (763)	5.2 (758)	5.2 (755)	5.0 (720)
		No Sustained Load		MPa (psi)	5.5 (803)	5.5 (803)	5.9 (856)	6.5 (945)	6.4 (927)	6.4 (927)	6.2 (892)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$T_{k,uncr}$	MPa (psi)	11.1 (1,612)	10.6 (1,538)	9.8 (1,415)	9.1 (1,324)	8.7 (1,266)	8.6 (1,245)	8.6 (1,241)
		No Sustained Load		MPa (psi)	13.7 (1,980)	13.0 (1,891)	12.1 (1,748)	11.2 (1,623)	10.7 (1,552)	10.6 (1,534)	10.6 (1,534)
Reduction Factor for Seismic Tension[5]			$\alpha_{N,seis}$	----	0.95						
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Concrete	ϕ_d	----	0.65						
		Water Saturated Concrete	ϕ_{ws}	----	0.55						
		Water-Filled Holes in Concrete	ϕ_{wf}	----	0.45						

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

[1]Characteristic bond strength values correspond to concrete compressive strength f'_c =2,500 psi (17.2 MPa). For concrete compressive strength f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.10}$. See Section 4.1.4 of ICC-ESR 4535.

[2]Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D Section D.3.6 as applicable.

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

[4]Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.

[5]For structures assigned to Seismic Design Category C, D, E or F, the bond strength values must be multiplied by αN,seis.

TABLE 13: ULTRABOND HYB-2CC **STEEL** design information for **METRIC REBAR**[1]

Design Information		Symbol	Units	Metric Rebar Size							
				Ø 10	**ø 12**	**ø 14**	**ø 16**	**ø 20**	**ø 25**	**ø 28**	**ø 32**
Nominal Anchor Diameter		d	mm (in.)	10 (0.315)	12 (0.394)	14 (0.472)	16 (0.551)	20 (0.630)	25 (0.787)	28 1.102	32 1.260
Rebar Cross-Sectional Area		A_{se}	mm^2 ($in.^2$)	78.5 (0.112)	113.1 (0.175)	153.9 (0.239)	201.1 (0.312)	314.2 (0.487)	490.9 (0.761)	615.8 (0.954)	804.2 (1.247)
DIN 488 BSt 500	Nominal Strength as Governed by Steel Strength	N_{sa}	kN (lb)	43.2 (9,739)	62.2 (14,024)	84.7 (19,088)	110.6 (24,932)	172.8 (38,956)	270 (60,868)	338.7 (76,353)	442.3 (99,727)
		V_{sa}	kN (lb)	25.9 (5,843)	37.3 (8,414)	50.8 (11,453)	66.4 (14,959)	103.7 (23,373)	162 (36,521)	203.2 (45,812)	265.4 (59,836)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.65							
	Strength Reduction Factor for Tension[2]	ϕ	----	0.65							
	Strength Reduction Factor for Shear[2]	ϕ	----	0.60							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

[1]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), as applicable. Nuts and washers must comply with requirements for the rod.

[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318 -14 17.3.3 or ACI 318-11 D.4.3., as applicable are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D4.4.

TABLE 14: ULTRABOND HYB-2CC **CONCRETE BREAKOUT** design information for **METRIC REBAR** in holes with a **HAMMER DRILL** and **CARBIDE BIT**[1]

Design Information	Symbol	Units	Metric Rebar Size							
			ø 10	**ø 12**	**ø 14**	**ø 16**	**ø 20**	**ø 25**	**ø 28**	**ø 32**
Minimum Embedment Depth	$h_{ef,min}$	in. (mm)	60 (2.4)	70 (2.8)	75 (3.0)	80 (3.1)	90 (3.5)	100 (3.9)	112 (4.4)	128 (5.0)
Maximum Embedment Depth	$h_{ef,max}$	in. (mm)	200 (7.9)	240 (9.4)	280 (9.4)	320 (12.6)	400 (15.7)	500 (19.7)	560 (22)	640 25.2
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	SI (in-lb)	7 (17)							
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	SI (in-lb)	10 (24)							
Minimum Spacing Distance	s_{min}	mm (in.)	50 (2)	60 (2 3/8)	70 (2 3/4)	75 (3)	95 (3 3/4)	120 (4 5/8)	130 (5 1/4)	150 (5 7/8)
Minimum Edge Distance	c_{min}	mm (in.)	40 (1 5/8)	45 (1 3/4)	50 (2)	50 (2)	60 (2 3/8)	70 (2 3/4)	75 (3)	85 (3 1/8)
					For smaller edge distances, see Section 4.1.9 of ICC-ESR 4535					
Minimum Concrete Thickness	h_{min}	mm (in.)	h_{ef} + 30 (h_{ef} + 1.25)		$h_{ef} + 2d_0$[3] where d_0 is the hole diameter					
Critical Edge Distance (Uncracked Concrete Only)	c_{ac}	----	See Section 4.1.10 of ICC-ESR 4535							
Strength Reduction Factor for Tension, Concrete Failure Mode, Condition B[2]	ϕ	----	0.65							
Strength Reduction Factor for Shear, Concrete Failure Mode, Condition B[2]	ϕ	----	0.70							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

[1] Additional setting information is described in Figure 6, installation instructions.

[2] Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 15: ULTRABOND HYB-2CC **BOND STRENGTH** design information for **METRIC REBAR**[1,2]

Design Information			Symbol	Units	Metric Rebar Size							
					ø 10	ø 12	ø 14	ø 16	ø 20	ø 25	ø 28	ø 32
Minimum Embedment Depth			$h_{ef,min}$	mm (in.)	60 (2.4)	70 (2.8)	80 (3.0)	90 (3.1)	96 (3.5)	100 (3.9)	112 (4.4)	128 (5.0)
Maximum Embedment Depth			$h_{ef,max}$	mm (in.)	200 (7.9)	240 (9.4)	320 (11.0)	400 (12.6)	480 (15.7)	400 (19.7)	560 (22.0)	640 (25.2)
Maximum Long Term Temperature **122 °F** (50 °C) Maximum Short Term Temperature **176 °F** 80 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,cr}$	MPa (psi)	7.5 (1,082)	7.3 (1,060)	7.9 (1,144)	8.2 (1,193)	8.2 (1,188)	8.0 (1,158)	7.9 (1,144)	8.0 (1,163)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,uncr}$	MPa (psi)	15.1 (2,183)	14.6 (2,121)	14.0 (2,025)	14.0 (2,025)	13.5 (1,954)	13.0 (1,886)	12.8 (1,852)	12.5 (1,813)
Maximum Long Term Temperature **161 °F** (72 °C) Maximum Short Term Temperature **248 °F** (120 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,cr}$	MPa (psi)	6.5 (942)	6.4 (922)	6.9 (996)	7.2 (1,038)	7.1 (1,034)	6.9 (1,008)	6.9 (995)	7.0 (1,012)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load or No sustained Load[4]	$T_{k,uncr}$	MPa (psi)	13.1 (1,899)	12.7 (1,845)	12.1 (1,762)	12.1 (1,762)	11.7 (1,700)	11.3 (1,640)	11.1 (1,611)	10.9 (1,577)
Maximum Long Term Temperature **212 °F** (100 °C) Maximum Short Term Temperature **320 °F** (160 °C)[3]	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$T_{k,cr}$	MPa (psi)	4.5 (678)	4.6 (665)	4.9 (718)	5.2 (748)	5.1 (745)	5.0 (726)	4.9 (717)	5.0 (729)
		No Sustained Load		MPa (psi)	5.5 (803)	5.7 (820)	6.0 (874)	6.4 (927)	6.3 (910)	6.2 (892)	6.0 (874)	6.2 (892)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$T_{k,uncr}$	MPa (psi)	9.4 (1,369)	9.2 (1,329)	8.8 (1,270)	8.8 (1,270)	8.4 (1,225)	8.2 (1,182)	8.0 (1,161)	7.8 (1,136)
		No Sustained Load		MPa (psi)	11.6 (1,676)	11.3 (1,641)	10.8 (1,569)	10.8 (1,569)	10.3 (1,498)	10.1 (1,462)	9.8 (1,427)	9.6 (1,391)
Reduction Factor for Seismic Tension[5]			$\alpha_{N,seis}$	----	0.95		1.00					
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Concrete	ϕ_d	----	0.65							
		Water Saturated Concrete	ϕ_{ws}	----	0.55							
		Water-Filled Holes in Concrete	ϕ_{wf}	----	0.45							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi

[1]Characteristic bond strength values correspond to concrete compressive strength f'_c =2,500 psi (17.2 MPa). For concrete compressive strength f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.10}$. See Section 4.1.4 of ICC-ESR 4535.

[2]Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D Section D.3.6 as applicable.

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

[4]Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.

[5]For structures assigned to Seismic Design Category C, D, E or F, the bond strength values must be multiplied by αN,seis.

TABLE 16: ULTRABOND HYB-2CC Development Length for **FRACTIONAL REBAR** in holes drilled with a **HAMMER DRILL** and **CARBIDE BIT**[1,2,4]

Design Information	Symbol	Criteria Section of Reference Standard	Units	Rebar Size							
				No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No.10
Nominal reinforcing bar diameter	d_b	ASTM A615/A706	in.	0.375	0.500	0.625	0.750	0.875	1.000	1.125	1.250
			(mm)	(10)	(13)	(16)	(19)	(22)	(25)	(29)	(32)
Nominal bar area	A_b	ASTM A615/A706	in^2	0.11	0.20	0.31	0.44	0.60	0.79	1.00	1.27
			(mm^2)	(71)	(127)	(198)	(285)	(388)	(507)	(645)	(817)
Development length for f_y = 60 ksi and f'_c = 2,500 psi (normal weight concrete)[3]	l_d	ACI 318-14 25.4.2.3 or ACI 318-11 12.2.3	in.	12.0	14.4	18.0	21.6	31.5	36.0	40.5	45.0
			(mm)	(305)	(366)	(457)	(549)	(800)	(914)	(1,029)	(1,143)
Development length for f_y = 60 ksi and f'_c = 4,000 psi (normal weight concrete)[3]	l_d	ACI 318-14 25.4.2.3 or ACI 318-11 12.2.3	in.	12.0	12.0	14.2	17.1	24.9	28.5	32.0	35.6
			(mm)	(305)	(305)	(361)	(434)	(633)	(723)	(813)	(904)

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi
[1]Development lengths valid for static, wind, and earthquake loads (SDC A and B).
[2]Development lengths in SDC C through F must comply with ACI 318-14 Chapter 18 or ACI 318-11 Chapter 21 and Section 4.2.4 of ICC-ESR 4535.
[3]fy and f'c used in this table are for example purposes only. For sand-lightweight concrete, increase development length by 33%, unless the provisions of ACI 318-14 25.4.2.4 or ACI 318-11 12.2.4 (d) are met to permit l > 0.75.
[4]

$$\left(\frac{c_b + K_{tr}}{d_b}\right) = 2.5$$, Ψt = 1.0, Ψe = 1.0, Ψs = 0.8 for db ≤ #6, 1.0 for db > #6

TABLE 17: ULTRABOND HYB-2CC Development Length for **METRIC REBAR** in holes drilled with a **HAMMER DRILL** and **CARBIDE BIT**[1,2,4]

Design Information	Symbol	Criteria Section of Reference Standard	Units	Rebar Size						
				ø 8	ø 10	ø 12	ø 16	ø 20	ø 25	ø 32
Nominal reinforcing bar diameter	d_b	BS 4449: 2005	mm	8	10	12	16	20	25	32
			(in.)	(0.315)	(0.394)	(0.472)	(0.630)	(0.787)	(0.984)	(1.260)
Nominal bar area	A_b	BS 4449: 2005	mm^2	50.3	78.5	113.1	210.1	314.2	490.9	804.2
			($in.^2$)	(0.08)	(0.12)	(0.18)	(0.31)	(0.49)	(0.76)	(1.25)
Development length for f_y = 72.5 ksi and f'_c = 2,500 psi (normal weight concrete)[3]	l_d	ACI 318-14 25.4.2.3 or ACI 318-11 12.2.3	(mm)	305	348	417	556	871	1,087	1,392
			(in.)	(12.0)	(13.7)	(16.4)	(21.9)	(34.3)	(42.8)	(54.8)
Development length for f_y = 72.5 ksi and f'_c = 4,000 psi (normal weight concrete)[3]	l_d	ACI 318-14 25.4.2.3 or ACI 318-11 12.2.3	mm	305	305	330	439	688	859	1,100
			(in.)	(12.0)	(12.0)	(13.0)	(17.3)	(27.1)	(33.8)	(43.3)

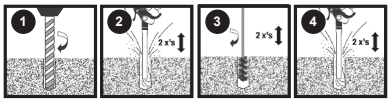
For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi
[1]Development lengths valid for static, wind, and earthquake loads (SDC A and B).
[2]Development lengths in SDC C through F must comply with ACI 318-14 Chapter 18 or ACI 318-11 Chapter 21 and Section 4.2.4 of ICC-ESR 4535.
[3]fy and f'c used in this table are for example purposes only. For sand-lightweight concrete, increase development length by 33%, unless the provisions of ACI 318-14 25.4.2.4 or ACI 318-11 12.2.4 (d) are met to permit l > 0.75.
[4]

$$\left(\frac{c_b + K_{tr}}{d_b}\right) = 2.5$$, Ψt = 1.0, Ψe = 1.0, Ψs = 0.8 for db ≤ 20mm, 1.0 for db > 20mm

ULTRABOND® HYB-2CC Adhesive Anchor Installation Instructions

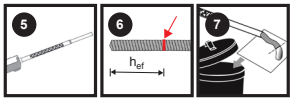
Installation Instructions

Drilling and Cleaning - Hammer Drilled Holes



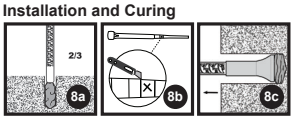
1. Using a rotary hammer drill and standard carbide bit, drill hole to specified diameter and depth required by the anchor rod or rebar. In case of standing water in drilled hole, all water must be removed from hole prior to cleaning.
2. Starting at the bottom of the anchor hole, blow out hole 2 cycles (2X) using oil free compressed air (minimum pressure of 87 psi (6 bar).
3. Select the correct wire brush for the hole diameter. Brush for 2 cycles (2X) in up/down twisting motion.
4. Repeat step 2, then confirm that hole is clean and free of dust.

Dispensing Preparation - Cartridge Systems

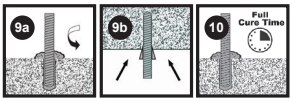


5. Check the expiration date on the cartridge to ensure it is not expired. **Do not use expired product!** Cartridge temperature must be between 41 °F - 104 °F (5 °C - 40 °C) when in use. Remove protective cap. Screw on proper, non-modified ATC mixing nozzle to cartridge. Ensure mixing element is inside the nozzle. Load cartridge into the correct dispensing tool.
6. Prior to inserting the anchor rod or rebar into the filled drilled hole, mark the embedment depth position on the anchor. Verify the anchor is straight and free of surface damage.
7. Dispense and waste 3 full strokes material to ensure uniform gray color before injecting into hole. Review and note the published working and cure times prior to injection of the mixed adhesive into the clean anchor hole.

Installation and Curing



8a. Fill hole 2/3 full with mixed adhesive starting at the bottom and slowly withdraw as hole fills using an extension tube as needed.
8b. If extension tube (Part # T16EXTL) is required, first cut the tip of the mixer nozzle at position "X."
8c. Use piston plugs for overhead and vertically inclined installations, all installations with drill hole depth > 10" (250 mm), with anchor rod 5/8" to 1-1/4" (M16 to M30) diameter and rebar sizes #5 to #10 (Ø14 to Ø32). Insert piston plug to the back of the drilled hole and inject as described above.



9a. Fully insert clean threaded rod or rebar with slow turning motion to the bottom of the hole. Observe gel (working) time.
9b. Ensure the anchor is fully seated at the bottom of the hole and that some adhesive has flowed from the hole and all around the top of the anchor. If not, the installation must be repeated. For horizontal, inclined or overhead installations, use wedges to support the anchor while curing.
10. Do not disturb, torque or apply load until full cure time has passed.

Reference Commentary

Drilling and Cleaning - Hammer Drilled Holes

Read and follow manufacturer's operations manual for the selected rotary drill.
R1. Drill bit should conform to ANSI B212.15. Refer to the installation tables for ULTRABOND HYB-2CC applicable hole diameters and embedment depth ranges. **CAUTION:** Always wear appropriate personal protection equipment (PPE) for eyes, ears and skin to help avoid inhalation of dust during the drilling and cleaning process. Refer to the Safety Data Sheet (SDS) for details prior to proceeding.
R2. **BLOW (2X) – BRUSH (2X) – BLOW (2X)**. The compressed air wand should be inserted to the bottom of the hole, have a minimum pressure of 87 psi (6 bar) and be moved in an up/down motion to remove debris.
R3. Refer to the installation tables for ULTRABOND HYB-2CC for wire brush selection. **CAUTION:** The brush should be clean and contact the walls of the hole. If it does not, the brush is either too worn or small and should be replaced with a new brush of the correct diameter. A brush extension must be used for drill hole depth > 6 inches (150 mm). The wire brush diameter must be checked periodically during use.
R4. After final blow step is completed, visually inspect the hole to confirm it is clean and free of dust, debris, ice, grease, oil or other foreign material. **NOTE:** If installation will be delayed for any reason, cover cleaned holes to prevent contamination.

Dispensing Preparation - Cartridge Systems

R5. Review Safety Data Sheet (SDS) before use. Review working and cure times. Consideration should be given to the reduced gel (working) time of the adhesive in warm temperatures. For permitted range of base matierial see the Cure Schedule. Always use a new mixing nozzle with new cartridges of adhesive and also for all work interruptions exceeding the published gel (working) time of the adhesive. Never re-use nozzles and do not attempt to force adhesive out of a hardened mixing nozzle. Shelf life of ULTRABOND HYB-2CC is 18 months when stored at temperatures between 41 °F (5 °C) and 77 °F (25 °C). **Optional**: Before attaching mixing nozzle, balance the cartridge by dispensing a small amount of material until both components are flowing evenly. For a cleaner environment, hand mix the two components and let cure prior to disposal in accordance with local regulations.
R6. Refer to the installation tables for ULTRABOND HYB-2CC applicable embedment depth ranges.
R7. Test bead of mixed adhesive must be uniform in color and free of streaks, as adhesive must be properly mixed in order to perform as published. Dispose of the test bead according to federal, state and local regulations. **CAUTION:** When changing cartridges, never re-use nozzles and do not attempt to force adhesive out of a hardened mixing nozzle. Leave the mixing nozzle attached to the cartridge upon completion of work.

Installation and Curing

NOTE: Building Code Requirements for Structural Concrete (ACI 318-14 and later) requires the Installer to be certified where adhesive anchors are to be installed in horizontal to vertically inclined (overhead) installations. The engineering drawings must be followed. For all applications not covered by this document, or for all installation questions, please contact Adhesives Technology Corp.
R8a. Be careful not to withdraw the mixing nozzle too quickly as this may trap air in the adhesive. Extension tubing (Part #'s T16EXT or T16EXTL) can be connected as needed onto the outside tip of the mixing nozzle. **NOTE:** When using a pneumatic dispensing tool, ensure that pressure is set at 90 psi (6.2 bar) maximum.
R8b. This step is not necessary if using extension tube (Part # T16EXT).
R8c. Refer to the installation tables for ULTRABOND HYB-2CC for piston plug selection. During installation the piston plug will be naturally extruded from the drilled hole by the adhesive pressure. **CAUTION:** In addition to the installer being certified, do not install adhesive anchors overhead or vertically inclined without installation hardware supplied by ATC.

R9a. Prior to inserting the threaded rod or rebar into the hole, make sure it is straight, clean and free of oil/dirt and that the necessary embedment depth is marked on the anchor element. Insert the anchor elements into the hole while turning 1 - 2 rotations prior to the anchor reaching the bottom of the hole. Excess adhesive should be visible on all sides of the fully installed rod or rebar. Reinforcing bars must not be bent after installation except as set forth in ACI 318-14 Section 26.6.3.1 (b) or ACI 318-11 Section 7.3.2, as applicable, with the additional condition that the bars must be bent cold, and heating of reinforcing bars to facilitate field bending is not permitted. **CAUTION:** Use extra care with deep embedment or high temperature installations to ensure that he working time has not elapsed prior to the anchor being fully installed. Adjustments to the anchor alignment may only performed during the published working time for a given temperature.
R9b. For overhead, horizontal and inclined (between horizontal and overhead), wedges should be used to support the anchor while the adhesive is curing. Take appropriate steps to protect the exposed threads of the anchor element from uncured adhesive until after the full cure time has elapsed.
R10. The amount of time needed to reach full cure is base material dependent. Refer to the chart for appropriate full cure time for a given temperature. Refer to the installation tables for ULTRABOND HYB-2CC to ensure proper torque is used. Take care not to exceed the maximum torque for the selected anchor. After full cure time has passed, a fixture can be installed to the anchor and tightened up to the maximum torque.

ULTRABOND® HYB-2CC Adhesive Anchor Installation Instructions

INSTALLATION PARAMETERS FOR FRACTIONAL THREADED ROD AND REBAR

	Characteristic		Symbol	Units	Fractional Threaded Rod (inch)							
					3/8	1/2	5/8	3/4	7/8	1	N/A	1 1/4
					Fractional Rebar Size							
					#3	#4	#5	#6	#7	#8	#9	#10
Threaded Rod	Nominal Anchor Diameter		d_a	in.	0.375	0.500	0.625	0.750	0.875	1.000		1.250
	Drill Size		d_o	in.	7/16	9/16	11/16	7/8	1	1 1/8		1 3/8
	Brush Part #		----	----	BP716	BP916	BP1116	BP78	BP100	BP118		BP138
	Piston Plug Part #		----	----	Not Required		PA1116-5PK	PA78-5PK	PA100-5PK	PA118-5PK	N/A	PA138-5PK
	Brush Diameter		----	in.	0.528	0.654	0.787	0.976	1.122	1.252		1.504
	Maximum Tightening Torque	A36/A307 Carbon Steel	$T_{inst,max}$	Ft-lb (N-m)	15 [1] (20)	30 (41)	44 (60)	66 (89)	96 (130)	147 (199)		221 (300)
Rebar	Nominal Anchor Diameter		d_a	in.	0.375	0.500	0.625	0.750	0.875	1.000	1.125	1.250
	Drill Size		d_o	in.	1/2	5/8	3/4	7/8	1	1 1/8	1 3/8	1 1/2
	Brush Part #		----	----	BP12	BP58	BP34	BP78	BP100	BP118	BP138	BP112
	Piston Plug Part #		----	----	Not Required		PA34-5PK	PA78-5PK	PA100-5PK	PA118-5PK	PA138-5PK	PA112-5PK
	Brush Diameter		----	in.	0.528	0.720	0.846	0.976	1.122	1.252	1.504	1.630

[1]for ASTM 36 and F1554 Grade 36, T_{max} = 11 ft.-lb.

INSTALLATION PARAMETERS FOR METRIC THREADED ROD AND REBAR

Characteristic		Symbol	Units	Metric Threaded Rod							Metric Rebar Size							
				M10	M12	M16	M20	M24	M27	M30	10	12	14	16	20	25	28	32
Nominal Anchor Diameter		d_a	mm	10	12	16	20	24	27	30	10	12	14	16	20	25	28	32
Drill Size		d_o	mm	12	14	18	22	28	30	35	14	16	18	20	25	32	35	40
Brush Part #		----	----	BP716	BPM14	BP1116	BPM24	BPM28	BP118	BPM35	BPM14	BPM16	BP1116	BPM20	BPM25	BPM32	BPM35	BPM40
Piston Plug Part #		----	----	Not Required		PAM18-5PK	PA78-5PK	PA118-5PK	PAM30-5PK	PAM138-5PK	Not Required		PAM18-5PK	PAM20-5PK	PAM100-5PK	PAM32-5PK	PA138-5PK	PAM40-5PK
Brush Diameter		----	mm	13.5	15.5	20	24	30	32	37	15.5	17.5	20	22	27	34	37	43.5
Maximum Tightening Torque	A36/A307 Carbon Steel	$T_{inst,max}$	N-m (Ft-lb)	20 (15)	40 (30)	80 (59)	120 (89)	170 (125)	250 (184)	300 (221)	20 (15)	40 (30)	45 (33)	80 (59)	120 (89)	175 (129)	250 (184)	300 (221)

CONCRETE BREAKOUT DESIGN INFORMATION FOR FRACTIONAL THREADED ROD AND REBAR

Design Information	Symbol	Units	Fractional Threaded Rod Diameter (inch)							
			3/8	1/2	5/8	3/4	7/8	1	N/A	1 1/4
			Fractional Rebar Size							
			#3	#4	#5	#6	#7	#8	#9	#10
Minimum Embedment Depth	$h_{ef,min}$	in. (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 1/2 (89)	4 (102)	4 1/2 (114)	5 (127)
Maximum Embedment Depth	$h_{ef,max}$	in. (mm)	7 1/2 (191)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	22 1/2 (572)	25 (635)
Maximum Embedment Depth (PIR)	$h_{ef,max}$	in. (mm)	22 1/2 (572)	30 (762)	37 1/2 (953)	45 (1143)	52 1/2 (1334)	60 (1524)	67 1/2 (1715)	75 (1905)
Minimum Spacing Distance	s_{min}	in. (mm)	1 7/8 (48)	2 1/2 (64)	3 (76)	3 5/8 (92)	4 1/4 (108)	4 3/4 (121)	5 1/4 (133)	5 7/8 (149)
Minimum Edge Distance with 100% T_{max}	c_{min}	in. (mm)	1 5/8 (41)	1 3/4 (44)	2 (51)	2 3/8 (60)	2 1/2 (64)	2 3/4 (70)	3 (76)	3 1/4 (83)
Minimum Edge Distance with 45% T_{max}	c_{min}	in. (mm)	----		1 3/4 (44)				2 3/4 (70)	
Minimum Concrete Thickness	h_{min}	in. (mm)	h_{ef} + 1.25 (h_{ef} + 30)		h_{ef} + 2d_o where d_o is the hold diameter					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 006894 MPa. For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

CONCRETE BREAKOUT DESIGN INFORMATION FOR METRIC THREADED ROD AND REBAR

Design Information	Symbol	Units	Metric Threaded Rod							Metric Rebar Size							
			M10	M12	M16	M20	M24	M27	M30	10	12	14	16	20	25	28	32
Minimum Embedment Depth	$h_{ef,min}$	mm (in.)	60 (2.4)	70 (2.8)	80 (3.1)	90 (3.5)	96 (3.8)	108 (4.3)	120 (4.7)	60 (2.4)	70 (2.8)	75 (3.0)	80 (3.1)	90 (3.5)	100 (3.9)	112 (4.4)	128 (5.0)
Maximum Embedment Depth	$h_{ef,max}$	mm (in.)	200 (7.9)	240 (9.4)	320 (12.6)	400 (15.7)	480 (18.9)	540 (21.3)	600 (23.6)	200 (7.9)	240 (9.4)	280 (11.0)	320 (12.6)	400 (15.7)	500 (19.7)	560 (22.0)	640 (25.2)
Maximum Embedment Depth (PIR)	$h_{ef,max}$	mm (in.)	----	----	----	----	----	----	----	600 (23.6)	720 (28.3)	840 (33.1)	960 (37.8)	1200 (47.2)	1500 (59.1)	1680 (66.1)	1920 (75.6)
Minimum Spacing Distance	s_{min}	mm (in.)	50 (2.0)	60 (2.4)	80 (3.1)	100 (3.9)	120 (4.7)	135 (5.3)	150 (5.9)	50 (2.0)	60 (2.4)	70 (2.8)	80 (3.1)	100 (3.9)	125 (4.9)	140 (5.5)	160 (6.3)
Minimum Edge Distance with 100% T_{max}	c_{min}	mm (in.)	45 (1.8)	45 (1.8)	55 (2.2)	60 (2.4)	70 (2.8)	75 (3.0)	80 (3.1)	45 (1.8)	45 (1.8)	50 (2.0)	55 (2.2)	60 (2.4)	70 (2.8)	75 (3.0)	85 (3.3)
Minimum Edge Distance with 45% T_{max}	c_{min}	mm (in.)	----		45 (1.8)				70 (2.8)	----		45 (1.8)				70 (2.8)	
Minimum Concrete Thickness	h_{min}	mm (in.)	h_{ef} + 30 (h_{ef} + 1.25)		h_{ef} + 2d_o where d_o is the hold diameter					h_{ef} + 30 (h_{ef} + 1.25)		h_{ef} + 2d_o where d_o is the hold diameter					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 006894 MPa. For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

CURE SCHEDULE[1]

Base Material Tempature °F	(°C)	Working Time	Full Cure Time
23 to 31	(-5 to -1)	50 min	5 hr
32 to 40	(0 to 4)	25 min	3.5 hr
41 to 49	(5 to 9)	15 min	2 hr
50 to 58	(10 to 14)	10 min	1 hr
59 to 67	(15 to 19)	6 min	40 min
68 to 85	(20 to 29)	3 min	30 min
86 to 104	(30 to 40)	2 min	30 min

Condition (warm) cartridge to 41 °F to 104 °F for installations from 23 °F to 40 °F.

ADHESIVE DISPENSING TOOLS AND MIXING NOZZLES

Accessory	9.5 fl. oz. (280 ml) Cartridge	27.9 fl. oz. (825 ml) Cartridge
Part #	A10-HYB2CC	A28-HYB2CC
Manual Dispensing Tool	TM10-HYB	TM28HD
Pneumatic Dispensing Tool	----	TA28-HYB
Recommended Mixing Nozzle	T16-3PK	
Brush Extension	BP-EXT	
Brush Extension with Handle	BP-EXTH	
Nozzle Extension Tubing	T16EXT	T16EXTL
Retention Wedge	WEDGE	

POST-INSTALLED REBAR hef ≥ 20d

Cartridge Size fl. oz.	Injection Tools	d_s	h_{ef}	Extension Tube
9.5	Manual Tool	≤ #5 ≤ 16 (mm)	≤ 27-1/2 (inch) ≤ 700 (mm)	T16EXT
28	Pneumatic Tool	≤ #5 ≤ 16 (mm)	≤ 39-1/2 (inch) ≤ 1,000 (mm)	
		≤ #8 ≤ 25 (mm)	≤ 27-1/2 (inch) ≤ 700 (mm)	
		≤ #10 ≤ 32 (mm)	≤ 75 (inch) ≤ 1,920 (mm)	T16EXTL

450 East Copans Rd. | Pompano Beach, FL 33064 | 1(800) 892-1880 | www.atcepoxy.com

ADHESIVES TECHNOLOGY® CORP.

Rev 022620T1.0