## GENERAL INFORMATION

# PURE220+™

Epoxy Injection Adhesive Anchoring System and Post-Installed Reinforcing Bar Connections

### PRODUCT DESCRIPTION

The Pure220+ is a two-component, ultra high strength adhesive anchoring system. The system includes injection adhesive in plastic cartridges, mixing nozzles, dispensing tools and hole cleaning equipment. Pure220+ is designed for bonding threaded rod and reinforcing bar hardware into drilled holes in concrete base materials and for post-installed reinforcing bar connections (rebar development). It can also be considered for anchor bolt repairs, filling abandoned holes and large cracks.

### GENERAL APPLICATIONS AND USES

- Bonding threaded rod and reinforcing bar into hardened concrete
- Rebar development length and lap splice connections in concrete up to 60d embedments
- Evaluated for installation and use in dry and wet holes, including water-filled and submerged
- Can be installed in a broad range of base material temperatures with excellent working times
- Cracked and uncracked concrete conditions as well as wind and seismic loading (SDC A - F)

### FEATURES AND BENEFITS

+ Suitable for use in hammer-drilled holes and core-drilled holes
+ Can be considered for oversized holes in concrete (see www.DEWALT.com)
+ Smooth paste formula allows for easier dispensing and very good flow rates
+ Standard curing system which offers excellent working times even in warm temperatures
+ Cartridge design allows for multiple uses using extra mixing nozzles
+ Mixing nozzles proportion adhesive and provide simple delivery method into drilled holes
+ Evaluated and recognized for freeze/thaw performance and sustained loading
+ Evaluated and recognized for long term and short term loading (see performance tables)
+ Outstanding bond strengths and performance data including at elevated temperatures
+ In-service temperature ratings between -40ºF (-40ºC) and 176ºF (80ºC)

### APPROVALS AND LISTINGS

- International Code Council, Evaluation Service (ICC-ES) ESR-5144 for cracked and uncracked concrete
- Code Compliant with 2024 IBC/IRC, and 2021 IBC/IRC, 2018 IBC/IRC, and 2015 IBC/IRC
- Tested in accordance with ACI 355.4/ASTM E488, and ICC-ES AC308 for use in structural concrete with design according to ACI 318 (-19 & -14) Chapter 17 and ACI 318 Appendix D
- Tested and qualified for use in post-installed reinforcing bar connections including rebar development and lap splices in accordance with ICC-ES AC308, Table 3.8 and ACI 318 Chapter 12 and Chapter 25
- Evaluated and qualified by an accredited independent testing laboratory for recognition in cracked and uncracked concrete including static, wind and seismic loading
- Tested in accordance with ICC-ES AC308 for bond strength vs temperature for post-installed reinforcing bar applications subject to fire (within ESR-5144)
- City of Los Angeles, LABC and LARC Supplement (within ESR-5144)
- Florida Building Code, FBC Supplement including HVHZ (within ESR-5144)
- Compliant with NSF/ANSI/CAN 61 for drinking water system components - health effects Also classified as lead free in accordance with NSF/ANSI/CAN 372
- Compliant to California DPH for VOC emissions and South Coast AQMD for VOC content (LEED v4.1)
- Conforms to requirements of ASTM C881 including C882 and AASHTO M235, Types I, II, IV and V, Grade 3, Classes B & C (also meets Type III except for elongation)
- Department of Transportation listings – see www.DEWALT.com or contact transportation agency

### GUIDE SPECIFICATIONS

CSI Divisions: 03 16 00 - Concrete Anchors, 04 05 19.16 Masonry Anchors and 05 05 19 Post-Installed Concrete Anchors. Adhesive anchoring system shall be Pure220+ as supplied by DEWALT, Towson, MD. Anchors shall be installed in accordance with published instructions and requirements of the Authority Having Jurisdiction.

## SECTION CONTENTS




PURE220+ ADHESIVE IN CARTRIDGE
(STANDARD THREADED ROD AND REBAR STEEL SUPPLIED BY OTHERS)

### PACKAGING (1:1 MIX RATIO)

**Coaxial Cartridge**

- 9.5 fl. oz. (280 ml or 17 in³)

**Dual Cartridge (side-by-side)**

- 20.5 fl. oz. (610 ml or 37 in³)

### STORAGE LIFE & CONDITIONS

Coaxial and dual cartridges: Two years
Store in a dry, dark environment with temperature ranging from 41°F to 95°F (5°C to 35°C)

### ANCHOR SIZE RANGE (TYPICAL)

- 3/8" to 1-1/4" diameter threaded rod
- No. 3 to No. 11 reinforcing bar (rebar)

### SUITABLE BASE MATERIALS

- Normal-weight concrete
- Lightweight concrete
- Grouted Concrete Masonry

### PERMISSIBLE INSTALLATION CONDITIONS (ADHESIVE)

- Dry concrete
- Water-saturated concrete (wet)
- Water-filled holes (flooded)
- Underwater concrete (submerged)

TENSION ZONE CRACKED CONCRETE · SEISMIC REGION QUALIFICATION · C US · POST-INSTALLED REBAR CONNECTIONS

CODE LISTED ICC-ES ESR-5144 CONCRETE

DDA DEWALT DESIGN ASSIST™ · DUSTX+™ ANCHOR INSTALLATION SYSTEM

# INSTALLATION SPECIFICATIONS

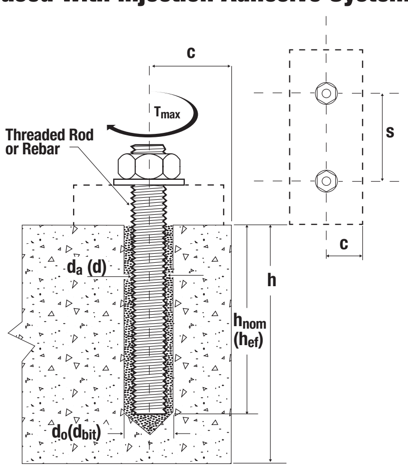
## Installation Specifications for Threaded Rod and Reinforcing Bar[6]

| Parameter | Symbol | Units | Fractional Nominal Rod Diameter (Inch) / Reinforcing Bar Size (No.) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3/8 | #3 | 1/2 | #4 | 5/8 or #5 | 3/4 or #6 | 7/8 or #7 | 1 or #8 | #9 | 1-1/4 | #10 |
| Threaded rod outside diameter | $d_a$ (d) | inch (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) | - |
| Rebar nominal outside diameter | $d_a$ (d) | inch (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 (28.7) | - | 1.250 (31.8) |
| Nominal drill bit (ANSI) / core bit diameter | $d_o$ ($d_{bit}$) | inch | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 or 3/4 | 7/8 | 1 | 1-1/8 | 1-3/8 | 1-3/8 | 1-1/2 |
| Minimum embedment[1,2] | $h_{ef,min}$ | inch (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) | 5 (127) |
| Maximum embedment[1,2] | $h_{ef,max}$ | inch (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) | 25 (635) |
| Minimum member thickness | $h_{min}$ | inch (mm) | $h_{ef}$ + 1-1/4 ($h_{ef}$ + 30) | | | | $h_{ef} + 2d_o$ | | | | | | |
| Minimum anchor spacing | $s_{min}$ | inch (mm) | 1-7/8 (48) | | 2-3/8 (60) | | 3 (77) | 3-3/4 (95) | 4-1/4 (108) | 4-3/4 (121) | 5-1/4 (135) | 5-7/8 (149) | 6-1/4 (149) |
| Minimum edge distance (up to 100% $T_{max}$) | $c_{min}$ | inch (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 (82) | 3-1/4 (82) |
| Max. torque[3] | $T_{max}$ | ft-lbs (N-m) | 20 [4] (27) | | 30 (41) | | 45 (61) | 65 (88) | 95 (129) | 145 (197) | 220 (298) | 280 (380) | 280 (380) |
| Min. edge distance, reduced[4] with up to (45% $T_{max}$) | $c_{min,red}$ | inch (mm) | - | | - | | 1-3/4 (45) | 1-3/4 (45) | 1-3/4 (45) | 1-3/4 (45) | 2-3/4 (70) | 2-3/4 (70) | 2-3/4 (70) |

For pound-inch units: 1 mm = 0.03937 inch, 1 N-m = 0.7375 ft-lbf. For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m.

1. Embedment range qualified for use with the anchoring design provisions of ACI 318 (-19 & -14) or ACI 318 Appendix D as applicable, ICC-ES AC308, Section 4.2 and ESR-5144.
2. For rebar development lengths with embedments up to 60d, see the table for Installation Parameters for Common Post-installed Reinforcing Bar Connections.
3. Torque may not be applied to the anchors until the full cure time of the adhesive has been achieved.
4. Max. torque is 11 ft-lbs (15 N-m) for ASTM A36 / F1554 Grade 36 carbon steel threaded rods and ASTM A193 Grade B8/B8M (Class 1) stainless steel threaded rods.
5. For installations below the minimum edge distance, $c_{min}$, down to the reduced minimum edge distance, $c_{min,red}$, the reduced maximum torque is $0.45*T_{max}$. The minimum anchor spacing, $s_{min}$ is $5d_a$.
6. Contact DEWALT for guidance on anchor diameters or hole sizes not included in this documentation.

## Detail of Steel Hardware Elements used with Injection Adhesive System




**Nomenclature**

$d_a$ (d) = Diameter of anchor
$d_o$ ($d_{bit}$) = Diameter of drilled hole
h = Base material thickness
$h_{nom}$ ($h_{ef}$) = Embedment depth
s = Spacing of anchors
c = Edge distance
$T_{max}$ = Maximum torque

## Threaded Rod and Deformed Reinforcing Bar Material Properties

| Steel Description (General) | Steel Specification (ASTM) | Nominal Anchor Size (inch/No.) | Minimum Yield Strength, $f_y$ (psi) | Minimum Ultimate Strength, $f_u$ (psi) |
|---|---|---|---|---|
| Carbon rod | A36 or F1554 Grade 36 | 3/8 through 1-1/4 | 36,000 | 58,000 |
| | F1554 Grade 55 | | 55,000 | 75,000 |
| | A449 | 3/8 through 1 | 92,000 | 120,000 |
| | | 1-1/4 | 81,000 | 105,000 |
| | A193, Grade B7 or F1554 Grade 105 | 3/8 through 1-1/4 | 105,000 | 125,000 |
| | F568M Class 5.8 | 3/4 through 1 | 58,000 | 72,500 |
| Stainless rod | F593 Condition CW | 3/8 through 5/8 | 65,000 | 100,000 |
| | | 3/4 through 1-1/4 | 45,000 | 85,000 |
| | A193/193M Grade B8/B8M, Class 1 | 3/8 through 1-1/4 | 30,000 | 75,000 |
| | A193/A193M Grade B8/B8M2, Class 2B | 3/8 through 1-1/4 | 75,000 | 95,000 |
| Reinforcing Bar | A615, A767, Grade 40 | #3 through #6 | 40,000 | 60,000 |
| | A615, A767, Grade 60 | #3 through #10 | 60,000 | 90,000 |
| | A706, A767, Grade 60 | | 60,000 | 80,000 |
| | A615, A767, Grade 75 | #3 through #10 | 75,000 | 100,000 |
| | A706, A767, Grade 80 | #3 through #10 | 80,000 | 100,000 |

Tabulated material properties are provided for reference; other steel hardware elements and sizes may also be considered.

# MATERIAL SPECIFICATIONS

Pure220+ is a high strength, non-sag, non-shrink, 100% solids epoxy adhesive. The formula does not contain styrene or solvents.

Pure220+ conforms to requirements of ASTM C881 and AASHTO M235, Types I, II, IV and V, Grade 3, Classes B & C (also meets Type III except for elongation).

## Properties of Cured Adhesive

| Property (Standard) | | Units | Value |
|---|---|---|---|
| Consistency (ASTM C881) | | Non-sag (Grade 3) | |
| Compressive Yield Strength @ 7 days (ASTM D695) | | psi | 11,755 |
| Compressive Modulus (ASTM C881) | | psi | 1,790,430 |
| Tensile Strength @ 7 days (ASTM D638) | | psi | 2,360 |
| Tensile Elongation @ 7 days (ASTM D639) | | % | 0.10 |
| Water Absorption, 24 hours (ASTM D570) | | % | 0.11 |
| Bond Strength (ASTM C882) | 2 days (moist cure) | psi | 2,460 |
| | 14 days (moist cure) | psi | 2,945 |
| Linear Coefficient of Shrinkage on Cure (ASTM C881) | | in./in. | .001 |
| Heat Deflection Temperature @7 days (ASTM C881) | | ºF | 138 |
| Shore D Hardness (DIN EN ISO 868) | | - | 88 |
| Gel time (ASTM C881) | @ 50ºF | minutes (minimum) | 160 |
| | @ 70ºF | | 30 |
| Electrical resistance, specific surface resistance (IEC 93) | | Ω | $2.0 \times 10^{15}$ |
| Electrical resistance, specific flow resistance (IEC 93) | | Ω cm | $1.6 \times 10^{15}$ |
| Thermal Compatibility (ASTM C884) | | Pass (no cracking or delamination) | |

*There is no requirement in ASTM C881 and AASHTO M235 for viscosity, tensile strength or tensile elongation of Grade 3 products.

Where ASTM C881 specifically referenced, the tests were also conducted in accordance with AASHTO M235.

## Gel (working) Time and Curing Table

| Temperature of base material | Maximum working time | Initial curing time[1] | Full curing time |
|---|---|---|---|
| 41°F (5°C) to 49°F (9°C) | 80 minutes | 24 hours | 48 hours |
| 50°F (10°C) to 58°F (14°C) | 60 minutes | 15 hours | 30 hours |
| 59°F (15°C) to 67°F (19°C) | 40 minutes | 10 hours | 20 hours |
| 68°F (20°C) to 76°F (24°C) | 30 minutes | 5 hours | 11 hours |
| 77°F (25°C) to 85°F (29°C) | 12 minutes | 4 hours | 9 hours |
| 86°F (30°C) to 103°F (39°C) | 8 minutes | 3 hours | 6 hours |
| 104°F (40°C) to 109°F (42°C) | 6 minutes | 2 hours | 4 hours |
| 110°F (43°C) | 5 minutes | 2 hours | 4 hours |

Cartridge temperature must be between 41ºF (5ºC) and 104ºF (40ºC).

1. Initial cure times are for post-installed rebar applications only. After the initial curing time, the installation of connecting reinforcements and formwork attachments is permitted for post-installed rebar applications.

## Chemical Resistance

| Chemical Agent | Concentration % | Resistant | Not Resistant |
|---|---|---|---|
| Accumulator acid | | | • |
| Acetic acid | 10 | | • |
| Acetic acid | 40 | | • |
| Laitance | | • | |
| Acetone | 5 | | • |
| Acetone | 10 | | • |
| Acetone | 100 | | • |
| Ammonia, aqueous solution | 5 | • | |
| Ammonia, aqueous solution | 32 | | • |
| Aniline | 100 | | • |
| Beer | 100 | • | |
| Benzyl alcohol | 100 | | • |
| Chlorine | all | • | |
| Phosphoric acid | 85 | • | |
| Boric acid, aqueous solution | | • | |
| Calcium carbonate, suspended in water | all | • | |
| Calcium chloride, suspended in water | | • | |
| Calcium hydroxide, suspended in water | | • | |
| Chlorinated lime (calcium hypochlorite) | 10 | | • |
| Carbon tetrachloride | 100 | • | |
| Caustic soda solution | 10 | • | |
| Caustic soda solution | 40 | • | |
| Citric acid | 10 | | • |
| Citric acid | 50 | | • |
| Citric acid | all | • | |
| Chlorine water, swimming pool | all | | • |
| Demineralized water | all | | • |
| Diesel oil | 100 | • | |
| Ethyl alcohol, aqueous solution | 100 | | • |
| Ethyl alcohol, aqueous solution | 50 | | • |
| Formic acid | 10 | • | |
| Formic acid | 30 | | • |
| Formic acid | 100 | | • |
| Formaldehyde, aqueous solution | 20 | • | |
| Formaldehyde, aqueous solution | 30 | • | |
| Freon | | • | |
| Fuel oil | | • | |
| Gasoline (premium grade) | 100 | • | |
| Glycol (ethylene glycol) | | • | |
| Hydraulic fluid | conc. | | • |
| Hydrochloric acid (muriatic acid) | conc. | | • |
| Hydrogen peroxide | 10 | | • |
| Hydrogen peroxide | 30 | | • |
| Isopropyi alcohol | 100 | | • |
| Kerosene (jet fuel) | 100 | • | |
| Lactic acid | 10 | | • |
| Lactic acid | all | | • |
| Linseed oil | 100 | • | |
| Lubricating oil | 100 | • | |
| Magnesium chloride, aqueous solution | all | • | |
| Methanol | 100 | | • |
| Standard benzine | | | • |
| Motor oil (SAE 20 W-50) | 100 | • | |
| Nitric acid | 10 | | • |
| Oleic acid | 100 | • | |
| Perchloroethylene | 100 | • | |
| Petroleum | 100 | • | |
| Phenol, aqueous solution | 8 | | • |
| Phosphoric acid | 10 | • | |
| Potash lye (potassium hydroxide) | 10 | • | |
| Potash lye (potassium hydroxide) | 40 | • | |
| Potassium carbonate, aqueous solution | all | • | |
| Potassium chlorite, aqueous solution | all | • | |
| Potassium nitrate, aqueous solution | all | • | |
| Sodium carbonate | all | • | |
| Sodium chloride, aqueous solution | all | • | |
| Sodium phosphate, aqueous solution | all | • | |
| Sodium silicate | all | • | |
| Sulfuric acid | 10 | | • |
| Sulfuric acid | 30 | | • |
| Sulfuric acid | 70 | | • |
| Tartaric acid | all | • | |
| Tetrachloroethylene | 100 | • | |
| Toluene | | | • |
| Trichloroethylene | 100 | | • |
| Turpentine | 100 | • | |

Results shown in the table are applicable to brief periods of chemical contact with fully cured adhesive (e.g. temporary contact with the adhesive during a spill).

## STRENGTH DESIGN INFORMATION

### Steel Tension and Shear Design Information for Threaded Rods

CODE LISTED ICC-ES ESR-5144

| Design Information | | Symbol | Units | Nominal Rod Diameter[1] (inch) 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 |
|---|---|---|---|---|---|---|---|---|---|---|
| Threaded rod nominal outside diameter | | $d_a$ | inch (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 effective cross-sectional area | | $A_{se}$ | inch² (mm²) | 0.0775 (50) | 0.1419 (92) | 0.2260 (146) | 0.3345 (216) | 0.4617 (298) | 0.6057 (391) | 0.9691 (625) |
| ASTM A36 and ASTM F1554 Grade 36 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | lbf (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) |
| | | $V_{sa}$ | lbf (kN) | 2,695 (12.0) | 4,940 (22.0) | 7,860 (35.0) | 11,640 (51.8) | 16,070 (71.4) | 21,080 (93.8) | 33,725 (150.0) |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| | Strength reduction factor for tension[2] | $\phi$ | - | 0.75 | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 0.65 | | | | | | |
| ASTM F1554 Grade 55 | Nominal strength as governed by steel strength(for a single anchor) | $N_{sa}$ | lbf (kN) | 5,810 (25.9) | 10,640 (47.3) | 16,950 (75.4) | 25,085 (111.6) | 34,625 (154.0) | 45,425 (202.0) | 72,680 (323.3) |
| | | $V_{sa}$ | lbf (kN) | 3,485 (15.5) | 6,385 (28.4) | 10,170 (45.2) | 15,050 (67.0) | 20,775 (92.4) | 27,255 (121.2) | 43,610 (194.0) |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| | Strength reduction factor for tension[2] | $\phi$ | - | 0.75 | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 0.65 | | | | | | |
| ASTM A193 Grade B7 and ASTM F1554 Grade 105 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | lbf (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) |
| | | $V_{sa}$ | lbf (kN) | 5,815 (25.9) | 10,640 (7.3) | 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 | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| | Strength reduction factor for tension[2] | $\phi$ | - | 0.75 | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 0.65 | | | | | | |
| ASTM A449 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | lbf (kN) | 9,300 (41.4) | 17,025 (75.7) | 27,120 (120.6) | 40,140 (178.5) | 55,905 (248.7) | 72,685 (323.3) | 101,755 (452.6) |
| | | $V_{sa}$ | lbf (kN) | 5,580 (24.8) | 10,215 (45.4) | 16,270 (72.4) | 24,085 (107.1) | 33,540 (149.2) | 43,610 (194.0) | 61,050 (271.6) |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| | Strength reduction factor for tension[2] | $\phi$ | - | 0.75 | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 0.65 | | | | | | |
| ISO 898-1 Class 5.8 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | lbf (kN) | 5,620 (25.0) | 10,290 (45.8) | 16,385 (72.9) | 24,250 (107.9) | 33,475 (148.9) | 43,915 (195.4) | -[5] |
| | | $V_{sa}$ | lbf (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) | -[5] |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | -[5] |
| | Strength reduction factor for tension[3] | $\phi$ | - | 0.65 | | | | | | |
| | Strength reduction factor for shear[3] | $\phi$ | - | 0.60 | | | | | | |
| ASTM F593 CW Stainless (Types 304 and 316) | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | lbf (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) |
| | | $V_{sa}$ | lbf (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 (219.8) |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| | Strength reduction factor for tension[3] | $\phi$ | - | 0.65 | | | | | | |
| | Strength reduction factor for shear[3] | $\phi$ | - | 0.60 | | | | | | |
| ASTM A193 Grade B8/B8M, Class 1 Stainless (Types 304 and 316) | Nominal strength as governed by steel strength (for a single anchor)[4] | $N_{sa}$ | lbf (kN) | 4,420 (19.7) | 8,090 (36.0) | 12,880 (57.3) | 19,065 (84.8) | 26,315 (117.1) | 34,525 (153.6) | 55,240 (245.7) |
| | | $V_{sa}$ | lbf (kN) | 2,650 (11.8) | 4,855 (21.6) | 7,730 (34.4) | 11,440 (50.9) | 15,790 (70.2) | 20,715 (92.1) | 33,145 (147.4) |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| | Strength reduction factor for tension[2] | $\phi$ | - | 0.75 | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 0.65 | | | | | | |
| ASTM A193 Grade B8/ B8M2, Class 2B Stainless (Types 304 and 316) | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | lbf (kN) | 7,365 (32.8) | 13,480 (60.0) | 21,470 (95.5) | 31,775 (141.3) | 43,860 (195.1) | 57,545 (256.0) | 92,065 (409.5) |
| | | $V_{sa}$ | lbf (kN) | 4,420 (19.7) | 8,085 (36.0) | 12,880 (57.3) | 19,065 (84.8) | 26,315 (117.1) | 34,525 (153.6) | 55,240 (245.7) |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | | | | | | |
| | Strength reduction factor for tension[2] | $\phi$ | - | 0.75 | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 0.65 | | | | | | |

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

1. Values provided for steel element material types are based on minimum specified strengths and calculated in accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2(b) or 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, except where noted. Nuts and washers must be appropriate for the rod. Nuts must have specified proof load stresses equal to or greater than the minimum tensile strength of the specified threaded rod.
2. The tabulated value of $\phi$ applies when the load combinations of Section 1605.2 of the IBC, ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-19 Section 17.5.3, 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 $\phi$ must be determined in accordance with ACI 318 D.4.4. Values correspond to ductile steel elements.
3. The tabulated value of $\phi$ applies when the load combinations of Section 1605.2 of the IBC, ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-19 Section 17.5.3, 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 $\phi$ must be determined in accordance with ACI 318 D.4.4. Values correspond to brittle steel elements
4. In accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2(b), ACI 318-14 17.4.1.2 and 17.5.1.2 or ACI 318-11 D.5.1.2 and D.6.1.2, as applicable, the calculated values for nominal tension and shear strength for ASTM A193 Grade B8/B8M Class 1 stainless steel threaded rods are based on limiting the specified tensile strength of the anchor steel to $1.9f_y$ or 57,000 psi (393 MPa).
5. The referenced standard includes rod diameters up to and including 1-inch (24 mm).

## Steel Tension and Shear Design Information for Reinforcing Bars

CODE LISTED
ICC-ES ESR-5144

STRENGTH DESIGN TABLES

| Design Information | | Symbol | Units | Nominal Reinforcing Bar Size (Rebar)[1] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | No. 3 | No. 4 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 |
| Rebar nominal outside diameter | | $d_a$ | inch (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 (28.7) | 1.250 (32.3) |
| Rebar effective cross-sectional area | | $A_{se}$ | inch² (mm²) | 0.110 (71.0) | 0.200 (129.0) | 0.310 (200.0) | 0.440 (283.9) | 0.600 (387.1) | 0.790 (509.7) | 1.000 (645.2) | 1.270 (819.4) |
| ASTM A615 Grade 75 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | lbf (kN) | 11,000 (48.9) | 20,000 (89.0) | 31,000 (137.9) | 44,000 (195.7) | 60,000 (266.9) | 79,000 (351.4) | 100,000 (444.8) | 127,000 (564.9) |
| | | $V_{sa}$ | lbf (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) | 60,000 (266.9) | 76,200 (338.9) |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| | Strength reduction factor for tension[3] | $\phi$ | - | 0.65 | | | | | | | |
| | Strength reduction factor for shear[3] | $\phi$ | - | 0.60 | | | | | | | |
| ASTM A615 Grade 60 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | lbf (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) |
| | | $V_{sa}$ | lbf (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 (305.0) |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| | Strength reduction factor for tension[3] | $\phi$ | - | 0.65 | | | | | | | |
| | Strength reduction factor for shear[3] | $\phi$ | - | 0.60 | | | | | | | |
| ASTM A706 Grade 60 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | lbf (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 (452.0) |
| | | $V_{sa}$ | lbf (kN) | 5,280 (23.5) | 9,600 (42.7) | 14,880 (66.2) | 21,120 (94.0) | 28,800 (128.1) | 37,920 (168.7) | 48,000 (213.5) | 60,960 (271.2) |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| | Strength reduction factor for tension[2] | $\phi$ | - | 0.75 | | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 0.65 | | | | | | | |
| ASTM A615 Grade 40 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | lbf (kN) | 6,600 (29.4) | 12,000 (53.4) | 18,600 (82.7) | 26,400 (117.4) | In accordance with ASTM A615, Grade 40 bars are furnished only in sizes No. 3 through No. 6 | | | |
| | | $V_{sa}$ | lbf (kN) | 3,960 (17.6) | 7,200 (32.0) | 11,160 (49.6) | 15,840 (70.5) | | | | |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | | | | |
| | Strength reduction factor for tension[3] | $\phi$ | - | 0.65 | | | | | | | |
| | Strength reduction factor for shear[3] | $\phi$ | - | 0.60 | | | | | | | |

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

1. Values provided for reinforcing bar material types based on minimum specified strengths and calculated in accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2(b), 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. The tabulated value of $\phi$ applies when the load combinations of Section 1605.2 of the IBC, ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-19 Section 17.5.3, 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 $\phi$ must be determined in accordance with ACI 318 D.4.4. Values correspond to ductile steel elements. In accordance with ACI 318-14 17.2.3.4.3(a)(vi) or ACI 318-11 D.3.3.4.3(a)6, as applicable, deformed reinforcing bars meeting this specification used as ductile steel elements to resist earthquake effects shall be limited to reinforcing bars satisfying the requirements of ACI 318-14 20.2.2.4 and 20.2.2.5 or ACI 318-11 21.1.5.2 (a) and (b), as applicable.
3. The tabulated value of $\phi$ applies when the load combinations of Section 1605.2 of the IBC, ACI 318 (-19 or -14) 5.3, or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-19 Section 17.5.3, 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 $\phi$ must be determined in accordance with ACI 318 D.4.4. Values correspond to brittle steel elements.

## Concrete Breakout Design Information for Threaded Rod and Reinforcing Bars

CODE LISTED
ICC-ES ESR-5144

| Design Information | Symbol | Units | Nominal Rod Diameter (inch) / Reinforcing Bar Size | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3/8 or #3 | 1/2 or #4 | 5/8 or #5 | 3/4 or #6 | 7/8 or #7 | 1 or #8 | #9 | 1-1/4 | #10 |
| Effectiveness factor for cracked concrete | $k_{c,cr}$ | - (SI) | 17 (7.1) | | | | | | | | |
| Effectiveness factor for uncracked concrete | $k_{c,uncr}$ | - (SI) | 24 (10.0) | | | | | | | | |
| Minimum embedment | $h_{ef,min}$ | inch (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) | 5 (127) |
| Maximum embedment | $h_{ef,max}$ | inch (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) | 25 (635) |
| Minimum anchor spacing | $s_{min}$ | inch (mm) | 1-7/8 (48) | 2-3/8 (60) | 3 (77) | 3-3/4 (95) | 4-1/4 (108) | 4-3/4 (121) | 5-1/4 (135) | 5-7/8 (149) | 6-1/4 (149) |
| Minimum edge distance[2] | $c_{min}$ | inch (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 (82) | 3-1/4 (82) |
| Minimum edge distance, reduced[2] (45% $T_{max}$) | $c_{min,red}$ | inch (mm) | - | - | 1-3/4 (45) | 1-3/4 (45) | 1-3/4 (45) | 1-3/4 (45) | 2-3/4 (70) | 2-3/4 (70) | 2-3/4 (70) |
| Minimum member thickness | $h_{min}$ | inch (mm) | $h_{ef}$ + 1-1/4 ($h_{ef}$ + 30) | | $h_{ef} + 2d_o$ where $d_o$ is hole diameter; | | | | | | |
| Critical edge distance—splitting (for uncracked concrete only)[3] | $c_{ac}$ | inch | $c_{ac} = h_{ef} \cdot \left(\frac{\tau_{uncr}}{1160}\right)^{0.4} \cdot \left[3.1-0.7\frac{h}{h_{ef}}\right]$ | | | | | | | | |
| | | (mm) | $c_{ac} = h_{ef} \cdot \left(\frac{\tau_{uncr}}{8}\right)^{0.4} \cdot \left[3.1-0.7\frac{h}{h_{ef}}\right]$ | | | | | | | | |
| Strength reduction factor for tension, concrete failure modes, Condition B[4] | $\phi$ | - | 0.65 | | | | | | | | |
| Strength reduction factor for shear, concrete failure modes, Condition B[4] | $\phi$ | - | 0.70 | | | | | | | | |

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

1. Additional setting information is described in the installation instructions.
2. For installation between the minimum edge distance, $c_{min}$, and the reduced minimum edge distance, $c_{min,red}$, the maximum torque applied must be reduced (multiplied) by a factor of 0.45.
3. $\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr} \cdot \sqrt{h_{ef} \cdot f'_c}}{\pi \cdot d}$ and $\frac{h}{h_{ef}}$ need not be taken as larger than 2.4.
4. Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pryout governs, as set forth in ACI 318-19 Section 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. The tabulated value of $\phi$ applies when the load combinations of Section 1605.2 of the IBC, ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-19 Section 17.5.3, 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 $\phi$ must be determined in accordance with ACI 318 D.4.4.

## Bond Strength Design Information for Threaded Rods and Reinforcing Bars in Holes Drilled with a Hammer-Drill and Carbide Bit (Including Hollow Bits in Dry Concrete)[1,2]

CODE LISTED
ICC-ES ESR-5144

STRENGTH DESIGN TABLES

| Design Information | | Symbol | Units | Nominal Rod Diameter (inch) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 |
| Minimum embedment | | $h_{ef,min}$ | inch (mm) | 2-3/8 (60.3) | 2-3/4 (69.9) | 3-1/8 (79.4) | 3-1/2 (88.9) | 3-1/2 (88.9) | 4 (101.6) | 5 (127.0) |
| Maximum embedment | | $h_{ef,max}$ | inch (mm) | 7-1/2 | 10 | 12-1/2 | 15 | 17-1/2 (445) | 20 (508) | 25 (635) |
| 110°F (43°C) Maximum Long-Term Service Temperature; 140°F (60°C) Maximum Short-Term Service Temperature[3,5] | Characteristic bond strength in uncracked concrete[6,8] | $\tau_{k,uncr}$ | psi (N/mm²) | 2,200 (15.1) | 2,135 (14.7) | 2,075 (14.3) | 2,010 (13.8) | 1,950 (13.4) | 1,885 (13.0) | 1,760 (12.1) |
| | Characteristic bond strength in cracked concrete[6,9] | $\tau_{k,cr}$ | psi (N/mm²) | 1,525 (10.5) | 1,535 (10.6) | 1,375 (9.4) | 1,555 (10.7) | 1,530 (10.5) | 1,495 (10.3) | 1,445 (9.9) |
| 110°F (43°C) Maximum Long-Term Service Temperature; 176°F (80°C) Maximum Short-Term Service Temperature[4,5] | Characteristic bond strength in uncracked concrete[6,8] | $\tau_{k,uncr}$ | psi (N/mm²) | 1,720 (11.8) | 1,675 (11.5) | 1,625 (11.2) | 1,575 (10.8) | 1,525 (10.5) | 1,480 (10.1) | 1,380 (9.5) |
| | Characteristic bond strength in cracked concrete[6,9] | $\tau_{k,cr}$ | psi (N/mm²) | 1,195 (8.2) | 1,205 (8.3) | 1,080 (7.4) | 1,215 (8.3) | 1,200 (8.2) | 1,170 (8.0) | 1,135 (7.8) |
| Reduction factor for seismic tension[9] | | $\alpha_{N,seis}$ | - | 1.0 | 1.0 | 0.90 | 1.0 | 0.95 | 1.0 | 1.0 |

| Design Information | | Symbol | Units | Nominal Bar Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 |
| Minimum embedment | | $h_{ef,min}$ | inch (mm) | 2-3/8 | 2-3/4 | 3-1/8 | 3-1/2 | 3-1/2 | 4 | 4-1/2 | 5 |
| Maximum embedment | | $h_{ef,max}$ | inch (mm) | 7-1/2 | 10 | 12-1/2 | 15 | 17-1/2 | 20 | 22-1/2 | 25 |
| 110°F (43°C) Maximum Long-Term Service Temperature; 140°F (60°C) Maximum Short-Term Service Temperature[3,5] | Characteristic bond strength in uncracked concrete[6,8] | $\tau_{k,uncr}$ | psi (N/mm²) | 1,945 (13.4) | 1,910 (13.1) | 1,875 (12.9) | 1,845 (12.7) | 1,810 (12.4) | 1,775 (12.2) | 1,705 (11.7) | 1,705 (11.7) |
| | Characteristic bond strength in cracked concrete[6,9] | $\tau_{k,cr}$ | psi (N/mm²) | 1,460 (10.0) | 1,460 (10.0) | 1,315 (9.0) | 1,460 (10.0) | 1,460 (10.0) | 1,460 (10.0) | 1,430 (9.8) | 1,430 (9.8) |
| 110°F (43°C) Maximum Long-Term Service Temperature; 176°F (80°C) Maximum Short-Term Service Temperature[4,5] | Characteristic bond strength in uncracked concrete[6,8] | $\tau_{k,uncr}$ | psi (N/mm²) | 1,525 (10.5) | 1,495 (10.3) | 1,470 (10.1) | 1,445 (9.9) | 1,420 (9.7) | 1,390 (9.5) | 1,330 (9.1) | 1,335 (9.2) |
| | Characteristic bond strength in cracked concrete[6,9] | $\tau_{k,cr}$ | psi (N/mm²) | 1,145 (7.8) | 1,145 (7.8) | 1,030 (7.1) | 1,145 (7.8) | 1,145 (7.8) | 1,145 (7.8) | 1,120 (7.7) | 1,120 (7.7) |
| Reduction factor for seismic tension[9] | | $\alpha_{N,seis}$ | - | 1.0 | | | | | | | |

| | | | Symbol | Units | Value |
|---|---|---|---|---|---|
| Permissible installation conditions[7] | Dry concrete | Anchor Category | - | - | 1 |
| | | Strength reduction factor | $\phi_d$ | - | 0.65 |
| | Water-saturated concrete | Anchor Category | - | - | 2 |
| | | Strength reduction factor | $\phi_{ws}$ | - | 0.55 |
| | Water-filled hole (flooded) | Anchor Category | - | - | 3 |
| | | Strength reduction factor | $\phi_{wf}$ | - | 0.45 |
| | | Modified factor for water-filled holes | $K_{wf}$ | - | 0.85 |
| | Underwater (submerged) | Anchor Category | - | - | 2 |
| | | Strength reduction factor | $\phi_{wu}$ | - | 0.55 |

For SI: 1 inch = 25.4 mm, 1 psi = 0.006894 MPa. For pound-inch units: 1 mm = 0.03937 inch, 1 MPa = 145.0 psi.

1. 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 and 8,000 psi (17.2 MPa and 55.2 MPa), the tabulated characteristic bond strength for threaded rod may be increased by a factor of $(f'c / 2,500)^{0.21}$ for uncracked concrete, and $(f'c / 2500)^{0.14}$ for cracked concrete [For SI: $(f'c / 17.2)^{0.21}$ for uncracked concrete, and $(f'c / 17.2)^{0.14}$ for cracked concrete], the tabulated characteristic bond strength for reinforcing bar may be increased by a factor of $(f'c / 2,500)^{0.18}$ for uncracked concrete [For SI: $(f'c / 17.2)^{0.18}$ for uncracked concrete.]
2. The modification factor for bond strength of adhesive anchors in lightweight concrete shall be taken as given in ACI 318-19 17.2.4.1, ACI 318-14 17.2.6 or ACI 318-11 D.3.6, as applicable, where applicable.
3. The maximum short-term service temperature may be increased to 162°F (72°C) provided characteristic bond strengths are reduced by 3 percent. Long-term and short-term temperatures meet the requirements of Section 8.5 of ACI 355.4 and Table 8.1, Temperature Category B.
4. Long-term and short-term temperatures meet the requirements of Section 8.5 of ACI 355.4 and Table 8.1, Temperature Category A.
5. Short-term base material service temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling. Long-term elevated concrete base material service temperatures are roughly constant over significant periods of time.
6. Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short-term loads only such as wind and seismic, bond strengths may be increased by 17 percent.
7. Permissible installation conditions include dry concrete, water-saturated concrete, water-filled holes and underwater (submerged) applications. Water-filled holes include applications in dry or water-saturated concrete where the drilled holes contain standing water at the time of anchor installation.
8. Bond strength values for uncracked concrete are applicable for structures assigned to Seismic Design Categories A and B only.
9. For structures assigned to Seismic Design Categories C, D, E or F, the tabulated bond strength values for cracked concrete may require an additional reduction factor applied for seismic tension, where seismic design is applicable.

### Bond Strength Design Information for U.S. Customary Unit Threaded Rod in Holes Drilled with a Diamond Core Bit[1,2]

| Design Information | | | Symbol | Units | Nominal Rod Diameter (inch) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 |
| Minimum embedment | | | $h_{ef,min}$ | in. (mm) | 2-3/8 (60) | 2-3/4 (70) | 3-1/8 (80) | 3-1/2 (89) | 3-1/2 (89) | 4 (102) | 5 (127) |
| Maximum embedment | | | $h_{ef,max}$ | in. (mm) | 7-1/2 (191) | 10 (254) | 12-1/2 (318) | 15 (381) | 17-1/2 (445) | 20 (508) | 25 (635) |
| 110°F (43°C) Maximum Long-Term Service Temperature; 140°F (60°C) Maximum Short-Term Service Temperature[3] | Characteristic bond strength in uncracked concrete[4,6] | | $\tau_{k,uncr}$ | psi (N/mm²) | 1,655 (11.4) | 1,550 (10.7) | 1,495 (10.3) | 1,435 (9.9) | 1,390 (9.6) | 1,350 (9.3) | 1,290 (8.9) |
| | Characteristic bond strength in cracked concrete[4,7] | | $\tau_{k,cr}$ | psi (N/mm²) | 1,205 (8.3) | 1,116 (7.7) | 1,045 (7.2) | 1,000 (6.9) | 970 (6.7) | 945 (6.5) | 945 (6.5) |
| 110°F (43°C) Maximum Long-Term Service Temperature; 176°F (80°C) Maximum Short-Term Service Temperature[3] | Characteristic bond strength in uncracked concrete[4,6] | | $\tau_{k,uncr}$ | psi (N/mm²) | 1,350 (9.3) | 1,275 (8.8) | 1,220 (8.4) | 1,160 (8.0) | 1,130 (7.8) | 1,100 (7.6) | 1,045 (7.2) |
| | Characteristic bond strength in cracked concrete[4,7] | | $\tau_{k,cr}$ | psi (N/mm²) | 970 (6.7) | 915 (6.3) | 855 (5.9) | 810 (5.6) | 800 (5.5) | 770 (5.3) | 770 (5.3) |
| Permissible installation conditions[5] | Dry concrete | Anchor Category | - | - | 1 | | | | | | |
| | | Strength reduction factor | $\phi_d$ | - | 0.65 | | | | | | |
| | Water-saturated concrete | Anchor Category | - | - | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| | | Strength reduction factor | $\phi_{ws}$ | - | 0.65 | 0.55 | 0.55 | 0.55 | 0.45 | 0.45 | 0.45 |
| Reduction factor for seismic tension | | | $\alpha_{N,seis}$ | - | 1.00 | 1.00 | 1.00 | 0.98 | 0.99 | 0.98 | 1.00 |

For SI: 1 inch = 25.4 mm, 1 psi = 0.006894 MPa. For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1. Bond strength values correspond to concrete compressive strength f'c = 2,500 psi (17.2 N/mm²). For concrete compressive strength, f'c between 2,500 psi (17.2 N/mm²) and 8,000 psi (55.2 N/mm²), the tabulated characteristic bond strength may be increased by a factor of $(f'c / 2500)^{0.24}$ [For SI: $(f'c / 17.2)^{0.24}$] for uncracked concrete, and $(f'c / 2500)^{0.20}$ [For SI: $(f'c / 17.2)^{0.20}$] for cracked concrete.
2. The modification factor for bond strength of adhesive anchors in lightweight concrete shall be taken as given in ACI 318-19 17.2.4.1, ACI 318-14 17.2.6 or ACI 318-11 D.3.6, as applicable, where applicable.
3. Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
4. Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short-term loads only such as wind or seismic, bond strengths may be increased by 20 percent.
5. Permissible installation conditions include dry concrete, and water-saturated concrete applications.
6. Bond strength values for uncracked concrete are applicable for structures assigned to Seismic Design Categories A and B only.
7. For structures assigned to Seismic Design Categories C, D, E or F, the tabulated bond strength values for cracked concrete may require an additional reduction factor applied for seismic tension, where seismic design is applicable.

### Bond Strength Design Information for U.S. Customary Unit Reinforcing Bars in Holes Drilled with a Diamond Core Bit[1,2]

| Design Information | | | Symbol | Units | Nominal Bar Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 |
| Minimum embedment | | | $h_{ef,min}$ | inch (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 | | | $h_{ef,max}$ | inch (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) |
| 110°F (43°C) Maximum Long-Term Service Temperature; 140°F (60°C) Maximum Short-Term Service Temperature[3] | Characteristic bond strength in uncracked concrete[4,6] | | $\tau_{k,uncr}$ | psi (N/mm²) | 1,480 (10.2) | 1,465 (10.1) | 1,350 (9.3) | 1,350 (9.3) | 1,350 (9.3) | 1,350 (9.3) | 1,350 (9.3) | 1,350 (9.3) |
| 110°F (43°C) Maximum Long-Term Service Temperature; 176°F (80°C) Maximum Short-Term Service Temperature[3] | Characteristic bond strength in uncracked concrete[4,6] | | $\tau_{k,uncr}$ | psi (N/mm²) | 1,205 (8.3) | 1,205 (8.3) | 1,100 (7.6) | 1,100 (7.6) | 1,100 (7.6) | 1,100 (7.6) | 1,100 (7.6) | 1,100 (7.6) |
| Permissible installation conditions[5] | Dry concrete | Anchor Category | - | - | 1 | | | | | | | |
| | | Strength reduction factor | $\phi_d$ | - | 0.65 | | | | | | | |
| | Water-saturated concrete | Anchor Category | - | - | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| | | Strength reduction factor | $\phi_{ws}$ | - | 0.65 | 0.55 | 0.55 | 0.55 | 0.45 | 0.45 | 0.45 | 0.45 |

For SI: 1 inch = 25.4 mm, 1 psi = 0.006894 MPa. For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1. Bond strength values correspond to concrete compressive strength f'c = 2,500 psi (17.2 N/mm²). For compressive strength, f'c between 2,500 psi (17.2 N/mm²) and 8,000 psi (55.2 N/mm²), the tabulated characteristic bond strength may be increased by a factor of $(f'c / 2500)^{0.35}$ [For SI: $(f'c / 17.2)^{0.35}$].
2. The modification factor for bond strength of adhesive anchors in lightweight concrete shall be taken as given in ACI 318-19 17.2.4.1, ACI 318-14 17.2.6 or ACI 318-11 D.3.6, as applicable, where applicable.
3. Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
4. Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short-term loads only such as wind or seismic, bond strengths may be increased by 20 percent.
5. Permissible installation conditions include dry concrete, and water-saturated concrete.
6. Bond strength values for uncracked concrete are applicable for structures assigned to Seismic Design Categories A and B only.

# DESIGN STRENGTH TABLES (SD)

### Tension and Shear Design Strength for Threaded Rod Installed in Uncracked Concrete (Bond or Concrete Strength) Drilled with a Hammer-Drill and Carbide Bit in a Dry Hole Condition 110°F (43°C) Maximum Long-Term Service Temperature; 140°F (60°C) Maximum Short-Term Service Temperature[1,2,3,4,5,6,7,8,9,10,11]

| Nominal Rod/Rebar Size (in.) | Embed. Depth $h_{ef}$ (in.) | Minimum Concrete Compressive Strength | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | f'c = 2,500 (psi) | | f'c = 3,000 (psi) | | f'c = 4,000 (psi) | | f'c = 6,000 (psi) | | f'c = 8,000 (psi) | |
| | | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) |
| 3/8 | 2-3/8 | 2,855 | 2,570 | 3,125 | 2,920 | 3,610 | 3,575 | 4,425 | 4,745 | 5,105 | 5,500 |
| | 3 | 4,055 | 4,010 | 4,440 | 4,555 | 5,125 | 5,570 | 6,075 | 7,300 | 6,450 | 8,635 |
| | 4-1/2 | 7,445 | 7,935 | 7,875 | 8,890 | 8,365 | 10,515 | 9,110 | 13,325 | 9,680 | 15,765 |
| | 7-1/2 | 12,635 | 17,010 | 13,130 | 18,920 | 13,945 | 22,385 | 15,185 | 28,365 | 16,130 | 33,550 |
| 1/2 | 2-3/4 | 3,555 | 3,305 | 3,895 | 3,755 | 4,500 | 4,590 | 5,510 | 6,095 | 6,365 | 7,455 |
| | 4 | 6,240 | 6,700 | 6,835 | 7,610 | 7,895 | 9,310 | 9,665 | 12,365 | 11,130 | 15,105 |
| | 6 | 11,465 | 13,235 | 12,560 | 15,035 | 14,435 | 18,360 | 15,720 | 23,265 | 16,700 | 27,520 |
| | 10 | 21,800 | 29,715 | 22,650 | 33,055 | 24,060 | 39,100 | 26,200 | 49,550 | 27,830 | 58,615 |
| 5/8 | 3-1/8 | 4,310 | 4,115 | 4,720 | 4,675 | 5,450 | 5,715 | 6,675 | 7,595 | 7,710 | 9,290 |
| | 5 | 8,720 | 9,965 | 9,555 | 11,325 | 11,030 | 13,850 | 13,510 | 18,395 | 15,600 | 22,495 |
| | 7-1/2 | 16,020 | 19,685 | 17,550 | 22,365 | 20,265 | 27,355 | 23,870 | 35,770 | 25,355 | 42,315 |
| | 12-1/2 | 33,105 | 45,735 | 34,395 | 50,875 | 36,535 | 60,180 | 39,785 | 76,260 | 42,260 | 90,210 |
| 3/4 | 3-1/2 | 5,105 | 5,015 | 5,595 | 5,700 | 6,460 | 6,970 | 7,910 | 9,255 | 9,135 | 11,320 |
| | 6 | 11,465 | 13,595 | 12,560 | 15,445 | 14,500 | 18,895 | 17,760 | 25,095 | 20,505 | 30,695 |
| | 9 | 21,060 | 26,855 | 23,070 | 30,510 | 26,640 | 37,320 | 32,625 | 49,565 | 35,370 | 59,115 |
| | 15 | 45,315 | 63,370 | 47,980 | 71,025 | 50,965 | 84,015 | 55,495 | 106,465 | 58,950 | 125,940 |
| 7/8 | 3-1/2 | 5,105 | 4,930 | 5,595 | 5,605 | 6,460 | 6,855 | 7,910 | 9,100 | 9,135 | 11,130 |
| | 7 | 14,445 | 16,605 | 15,825 | 18,865 | 18,275 | 23,075 | 22,380 | 30,650 | 25,840 | 37,485 |
| | 10-1/2 | 26,540 | 32,800 | 29,070 | 37,265 | 33,570 | 45,580 | 41,115 | 60,540 | 46,705 | 73,565 |
| | 17-1/2 | 57,100 | 77,405 | 62,550 | 87,940 | 67,300 | 104,560 | 73,280 | 132,500 | 77,845 | 156,740 |
| 1 | 4 | 6,240 | 6,115 | 6,835 | 6,945 | 7,895 | 8,495 | 9,665 | 11,280 | 11,160 | 13,800 |
| | 8 | 17,650 | 19,750 | 19,335 | 22,435 | 22,325 | 27,440 | 27,340 | 36,450 | 31,570 | 44,580 |
| | 12 | 32,425 | 39,005 | 35,520 | 44,315 | 41,015 | 54,200 | 50,230 | 71,990 | 58,000 | 88,050 |
| | 20 | 69,765 | 92,055 | 76,425 | 104,585 | 84,970 | 125,995 | 92,525 | 159,660 | 98,285 | 188,870 |
| 1-1/4 | 5 | 8,720 | 8,170 | 9,555 | 9,285 | 11,030 | 11,355 | 13,510 | 15,085 | 15,600 | 18,450 |
| | 10 | 24,665 | 26,380 | 27,020 | 29,975 | 31,200 | 36,660 | 38,210 | 48,690 | 44,125 | 59,555 |
| | 15 | 45,315 | 52,110 | 49,640 | 59,200 | 57,320 | 72,410 | 70,200 | 96,175 | 81,060 | 117,630 |
| | 25 | 97,500 | 122,990 | 106,805 | 139,730 | 123,330 | 170,905 | 134,980 | 217,010 | 143,385 | 256,710 |

☐ - Concrete Breakout Strength ☐ - Bond Strength/Pryout Strength

1. Tabular values are provided for illustration and are applicable for single anchors installed in uncracked normal-weight concrete with minimum slab thickness, $h_a = h_{min}$, and with the following conditions:
   - $c_{a1}$ is greater than or equal to the critical edge distance, $c_{ac}$
   - $c_{a2}$ is greater than or equal to 1.5 times $c_{a1}$.
2. Calculations were performed according to ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308. The load level corresponding to the failure mode listed [Concrete breakout strength, bond strength/pryout strength] must be checked against the tabulated steel strength of the corresponding threaded rod or rebar size and type, the lowest load level controls.
3. Strength reduction factors ($\phi$) for concrete breakout strength are based on ACI 318 (-19 or -14) Section 5.3 for load combinations. Condition B was assumed.
4. Strength reduction factors ($\phi$) for bond strength are determined from reliability testing and qualification in accordance with ICC-ES AC308 and are tabulated in this product information and in ESR-5144.
5. Tabular values are permitted for static loads only, seismic loading is not considered with these tables. Periodic special inspection must be performed where required by code, see ESR-5144 for applicable information.
6. For anchors subjected to tension resulting from sustained loading a supplemental check must be performed according to ACI 318 -19 17.5.2.2, or ACI 318-14 17.3.1.2.
7. For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 (-19 or -14) Ch. 17.
8. Interpolation is not permitted to be used with the tabular values. For intermediate base material compressive strengths, please see ACI 318 (-19 or -14) Ch. 17, ICC-ES AC308 and information included in this product supplement. For other design conditions including seismic considerations please see ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308 and ESR-5144.
9. Long term concrete temperatures are roughly constant over significant periods of time. Short-term elevated temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling.
10. The tabulated design strengths may be converted to allowable stress design values. Divide by conversion factor calculated as a weighted average of the load factors for the controlling load combination.
11. For other installation conditions such as water-saturated concrete, water-filled holes or underwater applications, see the associated strength reduction factors ($\phi$) for bond strength in the determination of controlling design strength values, as applicable.

## Tension and Shear Design Strength for Threaded Rod Installed in Cracked Concrete (Bond or Concrete Strength) Drilled with a Hammer-Drill and Carbide Bit in a Dry Hole Condition 110°F (43°C) Maximum Long-Term Service Temperature; 140°F (60°C) Maximum Short-Term Service Temperature[1,2,3,4,5,6,7,8,9,10,11,12]

| Nominal Rod/Rebar Size (in. or #) | Embed. Depth $h_{ef}$ (in.) | Minimum Concrete Compressive Strength | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | f'c = 2,500 (psi) | | f'c = 3,000 (psi) | | f'c = 4,000 (psi) | | f'c = 6,000 (psi) | | f'c = 8,000 (psi) | |
| | | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) |
| 3/8 | 2-3/8 | 2,020 | 1,835 | 2,215 | 2,085 | 2,560 | 2,555 | 3,135 | 3,375 | 3,265 | 3,515 |
| | 3 | 2,870 | 2,865 | 3,145 | 3,255 | 3,630 | 3,980 | 3,960 | 5,215 | 4,125 | 6,170 |
| | 4-1/2 | 5,255 | 5,665 | 5,390 | 6,350 | 5,610 | 7,510 | 5,940 | 9,520 | 6,185 | 11,260 |
| | 7-1/2 | 8,760 | 12,150 | 8,985 | 13,515 | 9,355 | 15,990 | 9,900 | 20,260 | 10,305 | 22,200 |
| 1/2 | 2-3/4 | 2,520 | 2,360 | 2,760 | 2,680 | 3,185 | 3,280 | 3,905 | 4,355 | 4,505 | 5,325 |
| | 4 | 4,420 | 4,785 | 4,840 | 5,435 | 5,590 | 6,650 | 6,845 | 8,830 | 7,380 | 10,790 |
| | 6 | 8,120 | 9,455 | 8,895 | 10,740 | 10,045 | 13,115 | 10,630 | 16,615 | 11,065 | 19,655 |
| | 10 | 15,675 | 21,225 | 16,080 | 23,610 | 16,740 | 27,930 | 17,715 | 35,390 | 18,445 | 39,725 |
| 5/8 | 3-1/8 | 3,050 | 2,940 | 3,345 | 3,340 | 3,860 | 4,085 | 4,730 | 5,425 | 5,460 | 6,635 |
| | 5 | 6,175 | 7,120 | 6,765 | 8,090 | 7,815 | 9,890 | 9,570 | 13,140 | 10,325 | 16,070 |
| | 7-1/2 | 11,350 | 14,060 | 12,430 | 15,975 | 14,055 | 19,540 | 14,880 | 25,550 | 15,490 | 30,225 |
| | 12-1/2 | 21,935 | 32,670 | 22,505 | 36,340 | 23,430 | 42,985 | 24,795 | 53,405 | 25,815 | 55,600 |
| 3/4 | 3-1/2 | 3,620 | 3,580 | 3,965 | 4,070 | 4,575 | 4,980 | 5,605 | 6,610 | 6,470 | 8,085 |
| | 6 | 8,120 | 9,710 | 8,895 | 11,035 | 10,270 | 13,495 | 12,580 | 17,925 | 14,525 | 21,925 |
| | 9 | 14,920 | 19,185 | 16,340 | 21,795 | 18,870 | 26,655 | 23,110 | 35,405 | 25,225 | 42,225 |
| | 15 | 32,095 | 45,265 | 35,160 | 50,730 | 38,150 | 60,010 | 40,380 | 76,045 | 42,040 | 89,960 |
| 7/8 | 3-1/2 | 3,620 | 3,525 | 3,965 | 4,000 | 4,575 | 4,895 | 5,605 | 6,500 | 6,470 | 7,950 |
| | 7 | 10,230 | 11,860 | 11,210 | 13,475 | 12,945 | 16,485 | 15,850 | 21,895 | 18,305 | 26,775 |
| | 10-1/2 | 18,800 | 23,430 | 20,590 | 26,620 | 23,780 | 32,555 | 29,120 | 43,240 | 33,625 | 52,545 |
| | 17-1/2 | 40,445 | 55,290 | 44,310 | 62,815 | 51,095 | 74,685 | 54,080 | 94,640 | 56,300 | 111,955 |
| 1 | 4 | 4,420 | 4,365 | 4,840 | 4,960 | 5,590 | 6,065 | 6,845 | 8,060 | 7,905 | 9,855 |
| | 8 | 12,500 | 14,105 | 13,695 | 16,025 | 15,815 | 19,600 | 19,365 | 26,035 | 22,365 | 31,845 |
| | 12 | 22,965 | 27,860 | 25,160 | 31,655 | 29,050 | 38,715 | 35,580 | 51,425 | 41,085 | 62,895 |
| | 20 | 49,415 | 65,755 | 54,135 | 74,705 | 62,510 | 89,995 | 69,020 | 114,040 | 71,855 | 134,905 |
| 1-1/4 | 5 | 6,175 | 5,835 | 6,765 | 6,630 | 7,815 | 8,110 | 9,570 | 10,775 | 11,050 | 13,175 |
| | 10 | 17,470 | 18,845 | 19,140 | 21,410 | 22,100 | 26,185 | 27,065 | 34,780 | 31,255 | 42,540 |
| | 15 | 32,095 | 37,220 | 35,160 | 42,285 | 40,600 | 51,720 | 49,725 | 68,695 | 57,415 | 84,020 |
| | 25 | 69,060 | 87,850 | 75,655 | 99,810 | 87,360 | 122,075 | 104,235 | 155,005 | 108,520 | 183,365 |

☐ - Concrete Breakout Strength ☐ - Bond Strength/Pryout Strength

1. Tabular values are provided for illustration and are applicable for single anchors installed in cracked normal-weight concrete with minimum slab thickness, $h_a = h_{min}$, and with the following conditions:
   - $c_{a1}$ is greater than or equal to the critical edge distance, $c_{ac}$
   - $c_{a2}$ is greater than or equal to 1.5 times $c_{a1}$.
2. Calculations were performed according to ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308. The load level corresponding to the failure mode listed [Concrete breakout strength, bond strength/pryout strength] must be checked against the tabulated steel strength of the corresponding threaded rod or rebar size and type, the lowest load level controls.
3. Strength reduction factors ($\phi$) for concrete breakout strength are based on ACI 318 (-19 or -14) 5.3 for load combinations. Condition B was assumed.
4. Strength reduction factors ($\phi$) for bond strength are determined from reliability testing and qualification in accordance with ICC-ES AC308 and are tabulated in this product information and in ESR-5144.
5. Tabular values are permitted for static loads only, seismic loading is not considered with these tables. Periodic special inspection must be performed where required by code, see ESR-5144 for applicable information.
6. For anchors subjected to tension resulting from sustained loading a supplemental check must be performed according to ACI 318 -19 17.5.2.2, ACI 318-14 17.3.1.2.
7. For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 (-19 or -14) Ch. 17.
8. Interpolation is not permitted to be used with the tabular values. For intermediate base material compressive strengths, please see ACI 318 (-19 or -14) Ch. 17, ICC-ES AC308 and information included in this product supplement. For other design conditions including seismic considerations please see ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308 and ESR-5144.
9. Long term concrete temperatures are roughly constant over significant periods of time. Short-term elevated temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling.
10. The tabulated design strengths may be converted to allowable stress design values. Divide by conversion factor calculated as a weighted average of the load factors for the controlling load combination.
11. For seismic design in accordance with ACI 318, the tabulated tension design strengths in cracked concrete for structures assigned to Seismic Design Categories C, D, E or F, the concrete breakout and bond strength must be multiplied by a factor of 0.75. In the determination of the tension design strength values in cracked concrete, the bond strength may require an additional reduction factor applied for seismic tension, where seismic design is applicable.
12. For other installation conditions such as water-saturated concrete, water-filled holes or underwater applications, see the associated strength reduction factors ($\phi$) for bond strength in the determination of controlling design strength values, as applicable.

## Tension and Shear Design Strength for Threaded Rod Installed in Uncracked Concrete (Bond or Concrete Strength) Drilled with a Diamond Core Bit in a Dry Hole Condition 110°F (43°C) Maximum Long-Term ServiceTemperature; 140°F (60°C) Maximum Short-Term Service Temperature[1,2,3,4,5,6,7,8,9,10,11]

STRENGTH DESIGN SD TABLES

| Nominal Rod/Rebar Size (in.) | Embed. Depth $h_{ef}$ (in.) | Minimum Concrete Compressive Strength | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | f'c = 2,500 (psi) | | f'c = 3,000 (psi) | | f'c = 4,000 (psi) | | f'c = 6,000 (psi) | | f'c = 8,000 (psi) | |
| | | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) |
| 3/8 | 2-3/8 | 2,855 | 2,570 | 3,125 | 2,920 | 3,370 | 3,475 | 3,715 | 4,000 | 3,980 | 4,285 |
| | 3 | 3,800 | 3,905 | 3,970 | 4,355 | 4,255 | 5,170 | 4,690 | 6,585 | 5,025 | 7,815 |
| | 4-1/2 | 5,705 | 7,130 | 5,960 | 7,950 | 6,385 | 9,435 | 7,035 | 12,015 | 7,540 | 14,265 |
| | 7-1/2 | 9,505 | 15,180 | 9,930 | 16,920 | 10,640 | 20,085 | 11,725 | 25,260 | 12,565 | 27,065 |
| 1/2 | 2-3/4 | 3,555 | 3,305 | 3,895 | 3,755 | 4,500 | 4,590 | 5,370 | 6,035 | 5,755 | 7,160 |
| | 4 | 6,240 | 6,700 | 6,615 | 7,510 | 7,085 | 8,915 | 7,810 | 11,355 | 8,370 | 13,480 |
| | 6 | 9,495 | 12,275 | 9,920 | 13,685 | 10,630 | 16,245 | 11,715 | 20,685 | 12,555 | 24,550 |
| | 10 | 15,825 | 26,145 | 16,535 | 29,145 | 17,715 | 34,595 | 19,525 | 42,055 | 20,920 | 45,065 |
| 5/8 | 3-1/8 | 4,310 | 4,115 | 4,720 | 4,675 | 5,450 | 5,715 | 6,675 | 7,595 | 7,695 | 9,290 |
| | 5 | 8,720 | 9,965 | 9,555 | 11,325 | 10,680 | 13,670 | 11,770 | 17,405 | 12,610 | 20,665 |
| | 7-1/2 | 14,310 | 18,815 | 14,950 | 20,975 | 16,020 | 24,900 | 17,655 | 31,705 | 18,920 | 37,635 |
| | 12-1/2 | 23,850 | 40,115 | 24,915 | 44,720 | 26,700 | 53,085 | 29,425 | 63,380 | 31,530 | 67,910 |
| 3/4 | 3-1/2 | 5,105 | 5,015 | 5,595 | 5,700 | 6,460 | 6,970 | 7,910 | 9,255 | 8,980 | 11,320 |
| | 6 | 11,465 | 13,595 | 12,560 | 15,445 | 14,500 | 18,895 | 16,270 | 24,230 | 17,435 | 28,760 |
| | 9 | 19,780 | 26,190 | 20,665 | 29,195 | 22,140 | 34,660 | 24,405 | 44,130 | 26,150 | 52,385 |
| | 15 | 32,965 | 55,800 | 34,440 | 62,205 | 36,905 | 73,840 | 40,675 | 87,605 | 43,580 | 93,870 |
| 7/8 | 3-1/2 | 5,105 | 4,930 | 5,595 | 5,605 | 6,460 | 6,855 | 7,910 | 9,100 | 8,715 | 11,130 |
| | 7 | 14,445 | 16,605 | 15,825 | 18,865 | 18,275 | 23,075 | 21,450 | 30,135 | 22,985 | 35,770 |
| | 10-1/2 | 26,080 | 32,570 | 27,245 | 36,310 | 29,190 | 43,105 | 32,175 | 54,885 | 34,475 | 65,150 |
| | 17-1/2 | 43,465 | 69,400 | 45,410 | 77,365 | 48,655 | 91,835 | 53,625 | 115,500 | 57,460 | 123,760 |
| 1 | 4 | 6,240 | 6,115 | 6,835 | 6,945 | 7,895 | 8,495 | 9,665 | 11,280 | 10,995 | 13,800 |
| | 8 | 17,650 | 19,750 | 19,335 | 22,435 | 22,325 | 27,440 | 27,210 | 36,380 | 29,155 | 43,180 |
| | 12 | 32,425 | 39,005 | 34,560 | 43,835 | 37,030 | 52,030 | 40,815 | 66,255 | 43,735 | 78,650 |
| | 20 | 55,135 | 83,785 | 57,600 | 93,400 | 61,720 | 110,870 | 68,025 | 141,180 | 72,890 | 156,990 |
| 1-1/4 | 5 | 8,720 | 8,170 | 9,555 | 9,285 | 11,030 | 11,355 | 13,510 | 15,085 | 15,600 | 18,450 |
| | 10 | 24,665 | 26,380 | 27,020 | 29,975 | 31,200 | 36,660 | 38,210 | 48,690 | 43,530 | 59,235 |
| | 15 | 45,315 | 52,110 | 49,640 | 59,200 | 55,290 | 71,375 | 60,940 | 90,885 | 65,295 | 107,880 |
| | 25 | 82,320 | 114,940 | 86,000 | 128,130 | 92,150 | 152,095 | 101,565 | 193,675 | 108,830 | 229,900 |

□ - Concrete Breakout Strength □ - Bond Strength/Pryout Strength

1. Tabular values are provided for illustration and are applicable for single anchors installed in uncracked normal-weight concrete with minimum slab thickness, $h_a = h_{min}$, and with the following conditions:
   - $c_{a1}$ is greater than or equal to the critical edge distance, $c_{ac}$
   - $c_{a2}$ is greater than or equal to 1.5 times $c_{a1}$.
2. Calculations were performed according to ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308. The load level corresponding to the failure mode listed [Concrete breakout strength, bond strength/pryout strength] must be checked against the tabulated steel strength of the corresponding threaded rod or rebar size and type, the lowest load level controls.
3. Strength reduction factors ($\phi$) for concrete breakout strength are based on ACI 318 (-19 or -14) Section 5.3 for load combinations. Condition B was assumed.
4. Strength reduction factors ($\phi$) for bond strength are determined from reliability testing and qualification in accordance with ICC-ES AC308 and are tabulated in this product information and in ESR-5144.
5. Tabular values are permitted for static loads only, seismic loading is not considered with these tables. Periodic special inspection must be performed where required by code, see ESR-5144 for applicable information.
6. For anchors subjected to tension resulting from sustained loading a supplemental check must be performed according to ACI 318 -19 17.5.2.2, or ACI 318-14 17.3.1.2.
7. For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 (-19 or -14) Ch. 17.
8. Interpolation is not permitted to be used with the tabular values. For intermediate base material compressive strengths, please see ACI 318 (-19 or -14) Ch. 17, ICC-ES AC308 and information included in this product supplement. For other design conditions including seismic considerations please see ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308 and ESR-5144.
9. Long term concrete temperatures are roughly constant over significant periods of time. Short-term elevated temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling.
10. The tabulated design strengths may be converted to allowable stress design values. Divide by conversion factor calculated as a weighted average of the load factors for the controlling load combination.
11. For other installation conditions such as water-saturated concrete, water-filled holes or underwater applications, see the associated strength reduction factors ($\phi$) for bond strength in the determination of controlling design strength values, as applicable.

## Tension and Shear Design Strength for Threaded Rod Installed in Cracked Concrete (Bond or Concrete Strength) Drilled with a Diamond Core Bit in a Dry Hole Condition 110°F (43°C) Maximum Long-Term ServiceTemperature; 140°F (60°C) Maximum Short-Term Service Temperature[1,2,3,4,5,6,7,8,9,10,11,12]

| Nominal Rod/Rebar Size (in. or #) | Embed. Depth $h_{ef}$ (in.) | Minimum Concrete Compressive Strength | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | f'c = 2,500 (psi) | | f'c = 3,000 (psi) | | f'c = 4,000 (psi) | | f'c = 6,000 (psi) | | f'c = 8,000 (psi) | |
| | | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) |
| 3/8 | 2-3/8 | 2,020 | 1,835 | 2,215 | 2,085 | 2,410 | 2,485 | 2,610 | 2,810 | 2,765 | 2,980 |
| | 3 | 2,770 | 2,790 | 2,870 | 3,110 | 3,040 | 3,695 | 3,300 | 4,705 | 3,495 | 5,580 |
| | 4-1/2 | 4,150 | 5,095 | 4,305 | 5,680 | 4,560 | 6,740 | 4,945 | 8,585 | 5,240 | 10,190 |
| | 7-1/2 | 6,920 | 10,840 | 7,180 | 12,085 | 7,605 | 14,350 | 8,245 | 17,760 | 8,735 | 18,810 |
| 1/2 | 2-3/4 | 2,520 | 2,360 | 2,760 | 2,680 | 3,185 | 3,280 | 3,735 | 4,310 | 3,955 | 5,115 |
| | 4 | 4,420 | 4,785 | 4,725 | 5,365 | 5,005 | 6,370 | 5,430 | 8,110 | 5,750 | 9,625 |
| | 6 | 6,835 | 8,770 | 7,090 | 9,775 | 7,510 | 11,600 | 8,145 | 14,775 | 8,625 | 17,535 |
| | 10 | 11,395 | 18,675 | 11,820 | 20,815 | 12,520 | 24,710 | 13,575 | 29,240 | 14,380 | 30,970 |
| 5/8 | 3-1/8 | 3,050 | 2,940 | 3,345 | 3,340 | 3,860 | 4,085 | 4,730 | 5,425 | 5,135 | 6,635 |
| | 5 | 6,175 | 7,120 | 6,765 | 8,090 | 7,325 | 9,765 | 7,945 | 12,435 | 8,415 | 14,760 |
| | 7-1/2 | 10,005 | 13,440 | 10,375 | 14,980 | 10,990 | 17,785 | 11,915 | 22,645 | 12,625 | 26,880 |
| | 12-1/2 | 16,670 | 28,655 | 17,290 | 31,940 | 18,315 | 37,915 | 19,860 | 42,780 | 21,040 | 45,310 |
| 3/4 | 3-1/2 | 3,620 | 3,580 | 3,965 | 4,070 | 4,575 | 4,980 | 5,545 | 6,610 | 5,975 | 8,085 |
| | 6 | 8,120 | 9,710 | 8,895 | 11,035 | 10,095 | 13,495 | 10,950 | 17,305 | 11,595 | 20,545 |
| | 9 | 13,785 | 18,710 | 14,295 | 20,855 | 15,140 | 24,755 | 16,420 | 31,525 | 17,395 | 37,420 |
| | 15 | 22,975 | 39,855 | 23,825 | 44,430 | 25,235 | 52,740 | 27,370 | 58,950 | 28,990 | 62,440 |
| 7/8 | 3-1/2 | 3,620 | 3,525 | 3,965 | 4,000 | 4,575 | 4,895 | 5,405 | 6,500 | 5,805 | 7,950 |
| | 7 | 10,230 | 11,860 | 11,210 | 13,475 | 12,945 | 16,485 | 14,455 | 21,525 | 15,310 | 25,550 |
| | 10-1/2 | 18,200 | 23,265 | 18,875 | 25,935 | 19,990 | 30,790 | 21,680 | 39,205 | 22,965 | 46,535 |
| | 17-1/2 | 30,330 | 49,570 | 31,455 | 55,260 | 33,320 | 65,595 | 36,135 | 77,830 | 38,275 | 82,440 |
| 1 | 4 | 4,420 | 4,365 | 4,840 | 4,960 | 5,590 | 6,065 | 6,835 | 8,060 | 7,345 | 9,855 |
| | 8 | 12,500 | 14,105 | 13,695 | 16,025 | 15,815 | 19,600 | 18,390 | 25,985 | 19,480 | 30,845 |
| | 12 | 22,965 | 27,860 | 24,015 | 31,310 | 25,440 | 37,165 | 27,590 | 47,325 | 29,220 | 56,175 |
| | 20 | 38,595 | 59,845 | 40,030 | 66,715 | 42,400 | 79,195 | 45,980 | 99,035 | 48,705 | 104,900 |
| 1-1/4 | 5 | 6,175 | 5,835 | 6,765 | 6,630 | 7,815 | 8,110 | 9,570 | 10,775 | 11,050 | 13,175 |
| | 10 | 17,470 | 18,845 | 19,140 | 21,410 | 22,100 | 26,185 | 27,065 | 34,780 | 30,440 | 42,310 |
| | 15 | 32,095 | 37,220 | 35,160 | 42,285 | 39,750 | 50,980 | 43,105 | 64,915 | 45,660 | 77,060 |
| | 25 | 60,305 | 82,100 | 62,545 | 91,525 | 66,245 | 108,640 | 71,845 | 138,340 | 76,100 | 163,905 |

☐ - Concrete Breakout Strength ☐ - Bond Strength/Pryout Strength

1. Tabular values are provided for illustration and are applicable for single anchors installed in cracked normal-weight concrete with minimum slab thickness, $h_a = h_{min}$, and with the following conditions:
   - $c_{a1}$ is greater than or equal to the critical edge distance, $c_{ac}$
   - $c_{a2}$ is greater than or equal to 1.5 times $c_{a1}$.
2. Calculations were performed according to ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308. The load level corresponding to the failure mode listed [Concrete breakout strength, bond strength/pryout strength] must be checked against the tabulated steel strength of the corresponding threaded rod or rebar size and type, the lowest load level controls.
3. Strength reduction factors ($\phi$) for concrete breakout strength are based on ACI 318 (-19 or -14) 5.3 for load combinations. Condition B was assumed.
4. Strength reduction factors ($\phi$) for bond strength are determined from reliability testing and qualification in accordance with ICC-ES AC308 and are tabulated in this product information and in ESR-5144.
5. Tabular values are permitted for static loads only, seismic loading is not considered with these tables. Periodic special inspection must be performed where required by code, see ESR-5144 for applicable information.
6. For anchors subjected to tension resulting from sustained loading a supplemental check must be performed according to ACI 318 -19 17.5.2.2, ACI 318-14 17.3.1.2.
7. For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 (-19 or -14) Ch. 17.
8. Interpolation is not permitted to be used with the tabular values. For intermediate base material compressive strengths, please see ACI 318 (-19 or -14) Ch. 17, ICC-ES AC308 and information included in this product supplement. For other design conditions including seismic considerations please see ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308 and ESR-5144.
9. Long term concrete temperatures are roughly constant over significant periods of time. Short-term elevated temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling.
10. The tabulated design strengths may be converted to allowable stress design values. Divide by conversion factor calculated as a weighted average of the load factors for the controlling load combination.
11. For seismic design in accordance with ACI 318, the tabulated tension design strengths in cracked concrete for structures assigned to Seismic Design Categories C, D, E or F, the concrete breakout and bond strength must be multiplied by a factor of 0.75. In the determination of the tension design strength values in cracked concrete, the bond strength may require an additional reduction factor applied for seismic tension, where seismic design is applicable.
12. For other installation conditions such as water-saturated concrete, water-filled holes or underwater applications, see the associated strength reduction factors ($\phi$) for bond strength in the determination of controlling design strength values, as applicable.

## Tension and Shear Design Strength for Reinforcing Bar Installed in Uncracked Concrete (Bond or Concrete Strength) Drilled with a Hammer-Drill and Carbide Bit in a Dry Hole Condition 110°F (43°C) Maximum Long-Term Service Temperature; 140°F (60°C) Maximum Short-Term Service Temperature[1,2,3,4,5,6,7,8,9,10,11]

| Nominal Rod/Rebar Size (#) | Embed. Depth $h_{ef}$ (in.) | Minimum Concrete Compressive Strength | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | f'c = 2,500 (psi) | | f'c = 3,000 (psi) | | f'c = 4,000 (psi) | | f'c = 6,000 (psi) | | f'c = 8,000 (psi) | |
| | | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) |
| #3 | 2-3/8 | 2,855 | 2,570 | 3,125 | 2,920 | 3,610 | 3,575 | 4,140 | 4,460 | 4,360 | 4,695 |
| | 3 | 4,055 | 4,010 | 4,440 | 4,555 | 4,865 | 5,455 | 5,230 | 6,875 | 5,510 | 8,105 |
| | 4-1/2 | 6,700 | 7,605 | 6,925 | 8,445 | 7,295 | 9,955 | 7,845 | 12,550 | 8,265 | 14,795 |
| | 7-1/2 | 11,170 | 16,190 | 11,545 | 17,970 | 12,155 | 21,185 | 13,075 | 26,715 | 13,770 | 29,665 |
| #4 | 2-3/4 | 3,555 | 3,305 | 3,895 | 3,755 | 4,500 | 4,590 | 5,510 | 6,095 | 6,365 | 7,455 |
| | 4 | 6,240 | 6,700 | 6,835 | 7,610 | 7,895 | 9,310 | 9,130 | 12,085 | 9,615 | 14,250 |
| | 6 | 11,465 | 13,235 | 12,090 | 14,810 | 12,735 | 17,460 | 13,700 | 22,020 | 14,425 | 25,955 |
| | 10 | 19,500 | 28,420 | 20,150 | 31,545 | 21,225 | 37,185 | 22,830 | 46,895 | 24,045 | 51,785 |
| #5 | 3-1/8 | 4,310 | 4,120 | 4,720 | 4,680 | 5,450 | 5,725 | 6,675 | 7,600 | 7,710 | 9,295 |
| | 5 | 8,720 | 10,005 | 9,555 | 11,365 | 11,030 | 13,900 | 13,510 | 18,465 | 14,750 | 22,080 |
| | 7-1/2 | 16,020 | 19,760 | 17,550 | 22,450 | 19,530 | 27,055 | 21,010 | 34,120 | 22,130 | 40,220 |
| | 12-1/2 | 29,915 | 44,050 | 30,910 | 48,890 | 32,555 | 57,635 | 35,020 | 72,680 | 36,880 | 79,430 |
| #6 | 3-1/2 | 5,105 | 5,015 | 5,595 | 5,700 | 6,460 | 6,970 | 7,910 | 9,255 | 9,135 | 11,320 |
| | 6 | 11,465 | 13,595 | 12,560 | 15,445 | 14,500 | 18,895 | 17,760 | 25,095 | 20,505 | 30,695 |
| | 9 | 21,060 | 26,855 | 23,070 | 30,510 | 26,640 | 37,320 | 29,770 | 47,785 | 31,355 | 56,330 |
| | 15 | 42,385 | 61,700 | 43,800 | 68,480 | 46,125 | 80,730 | 49,620 | 101,805 | 52,255 | 112,550 |
| #7 | 3-1/2 | 5,105 | 4,930 | 5,595 | 5,605 | 6,460 | 6,855 | 7,910 | 9,100 | 9,135 | 11,130 |
| | 7 | 14,445 | 16,605 | 15,825 | 18,865 | 18,275 | 23,075 | 22,380 | 30,650 | 25,840 | 37,485 |
| | 10-1/2 | 26,540 | 32,800 | 29,070 | 37,265 | 33,570 | 45,580 | 39,755 | 59,730 | 41,865 | 70,415 |
| | 17-1/2 | 56,595 | 77,130 | 58,485 | 85,610 | 61,595 | 100,920 | 66,255 | 127,265 | 69,775 | 150,025 |
| #8 | 4 | 6,240 | 6,115 | 6,835 | 6,945 | 7,895 | 8,495 | 9,665 | 11,280 | 11,160 | 13,800 |
| | 8 | 17,650 | 19,750 | 19,335 | 22,435 | 22,325 | 27,440 | 27,340 | 36,450 | 31,570 | 44,580 |
| | 12 | 32,425 | 39,005 | 35,520 | 44,315 | 41,015 | 54,200 | 50,230 | 71,990 | 53,625 | 85,330 |
| | 20 | 69,765 | 92,055 | 74,910 | 103,750 | 78,890 | 122,310 | 84,865 | 154,235 | 89,375 | 181,825 |
| #9 | 4-1/2 | 7,445 | 7,105 | 8,155 | 8,070 | 9,420 | 9,870 | 11,535 | 13,110 | 13,320 | 16,035 |
| | 9 | 21,060 | 23,030 | 23,070 | 26,165 | 26,640 | 32,000 | 32,625 | 42,505 | 37,675 | 51,985 |
| | 13-1/2 | 38,690 | 45,490 | 42,380 | 51,685 | 48,940 | 63,215 | 59,940 | 83,960 | 65,365 | 100,375 |
| | 22-1/2 | 83,245 | 107,325 | 91,190 | 121,935 | 96,165 | 143,820 | 103,445 | 181,360 | 108,945 | 213,800 |
| #10 | 5 | 8,720 | 8,105 | 9,555 | 9,210 | 11,030 | 11,265 | 13,510 | 14,965 | 15,600 | 18,300 |
| | 10 | 24,665 | 26,260 | 27,020 | 29,835 | 31,200 | 36,490 | 38,210 | 48,470 | 44,125 | 59,280 |
| | 15 | 45,315 | 51,875 | 49,640 | 58,935 | 57,320 | 72,085 | 70,200 | 95,740 | 81,060 | 117,100 |
| | 25 | 97,500 | 122,390 | 106,805 | 139,050 | 120,300 | 168,390 | 129,410 | 212,345 | 136,290 | 250,325 |

☐ - Concrete Breakout Strength ☐ - Bond Strength/Pryout Strength

1. Tabular values are provided for illustration and are applicable for single anchors installed in uncracked normal-weight concrete with minimum slab thickness, $h_a = h_{min}$, and with the following conditions:
   - $c_{a1}$ is greater than or equal to the critical edge distance, $c_{ac}$
   - $c_{a2}$ is greater than or equal to 1.5 times $c_{a1}$.
2. Calculations were performed according to ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308. The load level corresponding to the failure mode listed [Concrete breakout strength, bond strength/pryout strength] must be checked against the tabulated steel strength of the corresponding threaded rod or rebar size and type, the lowest load level controls.
3. Strength reduction factors ($\phi$) for concrete breakout strength are based on ACI 318 (-19 or -14) 5.3 for load combinations. Condition B was assumed.
4. Strength reduction factors ($\phi$) for bond strength are determined from reliability testing and qualification in accordance with ICC-ES AC308 and are tabulated in this product information and in ESR-5144.
5. Tabular values are permitted for static loads only, seismic loading is not considered with these tables. Periodic special inspection must be performed where required by code, see ESR-5144 for applicable information.
6. For anchors subjected to tension resulting from sustained loading a supplemental check must be performed according to ACI 318 -19 17.5.2.2, ACI 318-14 17.3.1.2.
7. For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 (-19 or -14) Ch. 17.
8. Interpolation is not permitted to be used with the tabular values. For intermediate base material compressive strengths, please see ACI 318 (-19 or -14) Ch. 17, ICC-ES AC308 and information included in this product supplement. For other design conditions including seismic considerations please see ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308 and ESR-5144.
9. Long term concrete temperatures are roughly constant over significant periods of time. Short-term elevated temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling.
10. The tabulated design strengths may be converted to allowable stress design values. Divide by conversion factor calculated as a weighted average of the load factors for the controlling load combination.
11. For other installation conditions such as water-saturated concrete, water-filled holes or underwater applications, see the associated strength reduction factors ($\phi$) for bond strength in the determination of controlling design strength values, as applicable.

## Tension and Shear Design Strength for Reinforcing Bar Installed in Cracked Concrete (Bond or Concrete Strength) Drilled with a Hammer-Drill and Carbide Bit in a Dry Hole Condition 110°F (43°C) Maximum Long-Term Service Temperature; 140°F (60°C) Maximum Short-Term Service Temperature[1,2,3,4,5,6,7,8,9,10,11,12]

| Nominal Rod/Rebar Size (#) | Embed. Depth $h_{ef}$ (in.) | Minimum Concrete Compressive Strength | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | f'c = 2,500 (psi) | | f'c = 3,000 (psi) | | f'c = 4,000 (psi) | | f'c = 6,000 (psi) | | f'c = 8,000 (psi) | |
| | | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) |
| #3 | 2-3/8 | 2,020 | 1,835 | 2,215 | 2,085 | 2,560 | 2,555 | 2,655 | 2,860 | 2,655 | 2,860 |
| | 3 | 2,870 | 2,865 | 3,145 | 3,255 | 3,355 | 3,895 | 3,355 | 4,910 | 3,355 | 5,790 |
| | 4-1/2 | 5,030 | 5,435 | 5,030 | 6,030 | 5,030 | 7,110 | 5,030 | 8,965 | 5,030 | 10,570 |
| | 7-1/2 | 8,385 | 11,565 | 8,385 | 12,835 | 8,385 | 15,135 | 8,385 | 18,060 | 8,385 | 18,060 |
| #4 | 2-3/4 | 2,520 | 2,360 | 2,760 | 2,680 | 3,185 | 3,280 | 3,905 | 4,355 | 4,100 | 5,325 |
| | 4 | 4,420 | 4,785 | 4,840 | 5,435 | 5,590 | 6,650 | 5,965 | 8,635 | 5,965 | 10,180 |
| | 6 | 8,120 | 9,455 | 8,895 | 10,580 | 8,945 | 12,470 | 8,945 | 15,725 | 8,945 | 18,540 |
| | 10 | 14,905 | 20,300 | 14,905 | 22,530 | 14,905 | 26,560 | 14,905 | 32,105 | 14,905 | 32,105 |
| #5 | 3-1/8 | 3,050 | 2,940 | 3,345 | 3,340 | 3,860 | 4,090 | 4,615 | 5,430 | 4,725 | 6,640 |
| | 5 | 6,175 | 7,145 | 6,765 | 8,120 | 7,815 | 9,930 | 8,390 | 13,190 | 8,390 | 15,775 |
| | 7-1/2 | 11,350 | 14,115 | 12,430 | 16,035 | 12,585 | 19,325 | 12,585 | 24,370 | 12,585 | 27,110 |
| | 12-1/2 | 20,980 | 31,465 | 20,980 | 34,920 | 20,980 | 41,170 | 20,980 | 45,185 | 20,980 | 45,185 |
| #6 | 3-1/2 | 3,620 | 3,580 | 3,965 | 4,070 | 4,575 | 4,980 | 5,605 | 6,610 | 6,470 | 8,085 |
| | 6 | 8,120 | 9,710 | 8,895 | 11,035 | 10,270 | 13,495 | 12,580 | 17,925 | 13,415 | 21,925 |
| | 9 | 14,920 | 19,185 | 16,340 | 21,795 | 18,870 | 26,655 | 20,125 | 34,130 | 20,125 | 40,235 |
| | 15 | 32,095 | 44,070 | 33,540 | 48,915 | 33,540 | 57,665 | 33,540 | 72,240 | 33,540 | 72,240 |
| #7 | 3-1/2 | 3,620 | 3,525 | 3,965 | 4,000 | 4,575 | 4,895 | 5,605 | 6,500 | 6,470 | 7,950 |
| | 7 | 10,230 | 11,860 | 11,210 | 13,475 | 12,945 | 16,485 | 15,850 | 21,895 | 18,260 | 26,775 |
| | 10-1/2 | 18,800 | 23,430 | 20,590 | 26,620 | 23,780 | 32,555 | 27,390 | 42,665 | 27,390 | 50,295 |
| | 17-1/2 | 40,445 | 55,095 | 44,310 | 61,150 | 45,650 | 72,085 | 45,650 | 90,905 | 45,650 | 98,330 |
| #8 | 4 | 4,420 | 4,365 | 4,840 | 4,960 | 5,590 | 6,065 | 6,845 | 8,060 | 7,905 | 9,855 |
| | 8 | 12,500 | 14,105 | 13,695 | 16,025 | 15,815 | 19,600 | 19,365 | 26,035 | 22,365 | 31,845 |
| | 12 | 22,965 | 27,860 | 25,160 | 31,655 | 29,050 | 38,715 | 35,580 | 51,425 | 35,775 | 60,950 |
| | 20 | 49,415 | 65,755 | 54,135 | 74,110 | 59,625 | 87,365 | 59,625 | 110,170 | 59,625 | 128,430 |
| #9 | 4-1/2 | 5,275 | 5,075 | 5,780 | 5,765 | 6,670 | 7,050 | 8,170 | 9,365 | 9,435 | 11,455 |
| | 9 | 14,920 | 16,450 | 16,340 | 18,690 | 18,870 | 22,860 | 23,110 | 30,360 | 26,685 | 37,135 |
| | 13-1/2 | 27,405 | 32,495 | 30,020 | 36,920 | 34,665 | 45,155 | 42,455 | 59,975 | 44,465 | 71,695 |
| | 22-1/2 | 58,965 | 76,660 | 64,595 | 87,095 | 74,110 | 102,730 | 74,110 | 129,545 | 74,110 | 152,715 |
| #10 | 5 | 6,175 | 5,790 | 6,765 | 6,580 | 7,815 | 8,045 | 9,570 | 10,690 | 11,050 | 13,070 |
| | 10 | 17,470 | 18,760 | 19,140 | 21,310 | 22,100 | 26,065 | 27,065 | 34,620 | 31,255 | 42,345 |
| | 15 | 32,095 | 37,055 | 35,160 | 42,095 | 40,600 | 51,490 | 49,725 | 68,385 | 55,630 | 83,645 |
| | 25 | 69,060 | 87,420 | 75,655 | 99,320 | 87,360 | 120,280 | 92,715 | 151,675 | 92,715 | 178,805 |

■ - Concrete Breakout Strength ■ - Bond Strength/Pryout Strength

1. Tabular values are provided for illustration and are applicable for single anchors installed in cracked normal-weight concrete with minimum slab thickness, $h_a = h_{min}$, and with the following conditions:
   - $c_{a1}$ is greater than or equal to the critical edge distance, $c_{ac}$
   - $c_{a2}$ is greater than or equal to 1.5 times $c_{a1}$.
2. Calculations were performed according to ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308. The load level corresponding to the failure mode listed [Concrete breakout strength, bond strength/pryout strength] must be checked against the tabulated steel strength of the corresponding threaded rod or rebar size and type, the lowest load level controls.
3. Strength reduction factors ($\phi$) for concrete breakout strength are based on ACI 318 (-19 or -14) 5.3 for load combinations. Condition B was assumed.
4. Strength reduction factors ($\phi$) for bond strength are determined from reliability testing and qualification in accordance with ICC-ES AC308 and are tabulated in this product information and in ESR-5144.
5. Tabular values are permitted for static loads only, seismic loading is not considered with these tables. Periodic special inspection must be performed where required by code, see ESR-5144 for applicable information.
6. For anchors subjected to tension resulting from sustained loading a supplemental check must be performed according to ACI 318 -19 17.5.2.2, ACI 318-14 17.3.1.2.
7. For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 (-19 or -14) Ch. 17.
8. Interpolation is not permitted to be used with the tabular values. For intermediate base material compressive strengths, please see ACI 318 (-19 or -14) Ch. 17, ICC-ES AC308 and information included in this product supplement. For other design conditions including seismic considerations please see ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308 and ESR-5144.
9. Long term concrete temperatures are roughly constant over significant periods of time. Short-term elevated temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling.
10. The tabulated design strengths may be converted to allowable stress design values. Divide by conversion factor calculated as a weighted average of the load factors for the controlling load combination.
11. For seismic design in accordance with ACI 318, the tabulated tension design strengths in cracked concrete for structures assigned to Seismic Design Categories C, D, E or F, the breakout and bond strength must be multiplied by a factor of 0.75. In the determination of the tension design strength values in cracked concrete, the bond strength may require an additional reduction factor applied for seismic tension, where seismic design is applicable.
12. For other installation conditions such as water-saturated concrete, water-filled holes or underwater applications, see the associated strength reduction factors ($\phi$) for bond strength in the determination of controlling design strength values, as applicable.

## Tension and Shear Design Strength for Reinforcing Bar Installed in Uncracked Concrete (Bond or Concrete Strength) Drilled with a Diamond Core Bit in a Dry Hole Condition 110°F (43°C) Maximum Long-Term ServiceTemperature; 140°F (60°C) Maximum Short-Term Service Temperature[1,2,3,4,5,6,7,8,9,10,11]

| Nominal Rod/Rebar Size (#) | Embed. Depth $h_{ef}$ (in.) | Minimum Concrete Compressive Strength | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | f'c = 2,500 (psi) | | f'c = 3,000 (psi) | | f'c = 4,000 (psi) | | f'c = 6,000 (psi) | | f'c = 8,000 (psi) | |
| | | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) | $\phi N_{cb}$ or $\phi N_a$ Tension (lbs.) | $\phi V_{cb}$ or $\phi V_{cp}$ Shear (lbs.) |
| #3 | 2-3/8 | 2,690 | 2,510 | 2,870 | 2,825 | 3,175 | 3,395 | 3,655 | 3,940 | 4,045 | 4,355 |
| | 3 | 3,400 | 3,735 | 3,625 | 4,200 | 4,010 | 5,050 | 4,620 | 6,545 | 5,110 | 7,865 |
| | 4-1/2 | 5,100 | 6,820 | 5,435 | 7,665 | 6,010 | 9,215 | 6,930 | 11,945 | 7,665 | 14,355 |
| | 7-1/2 | 8,500 | 14,515 | 9,060 | 16,310 | 10,020 | 19,610 | 11,550 | 24,870 | 12,770 | 27,505 |
| #4 | 2-3/4 | 3,555 | 3,305 | 3,895 | 3,755 | 4,500 | 4,590 | 5,510 | 6,095 | 6,180 | 7,370 |
| | 4 | 5,985 | 6,590 | 6,375 | 7,405 | 7,055 | 8,900 | 8,130 | 11,535 | 8,990 | 13,870 |
| | 6 | 8,975 | 12,000 | 9,565 | 13,485 | 10,580 | 16,210 | 12,195 | 21,015 | 13,485 | 25,265 |
| | 10 | 14,960 | 25,560 | 15,945 | 28,725 | 17,630 | 34,530 | 20,320 | 43,770 | 22,475 | 48,405 |
| #5 | 3-1/8 | 4,310 | 4,115 | 4,720 | 4,675 | 5,450 | 5,715 | 6,675 | 7,595 | 7,710 | 9,290 |
| | 5 | 8,615 | 9,915 | 9,180 | 11,145 | 10,155 | 13,400 | 11,705 | 17,365 | 12,945 | 20,880 |
| | 7-1/2 | 12,920 | 18,065 | 13,775 | 20,300 | 15,235 | 24,400 | 17,555 | 31,630 | 19,415 | 38,025 |
| | 12-1/2 | 21,535 | 38,510 | 22,955 | 43,275 | 25,390 | 52,025 | 29,260 | 63,020 | 32,360 | 69,695 |
| #6 | 3-1/2 | 5,105 | 5,015 | 5,595 | 5,700 | 6,460 | 6,970 | 7,910 | 9,255 | 9,135 | 11,320 |
| | 6 | 11,465 | 13,595 | 12,560 | 15,445 | 14,500 | 18,895 | 16,855 | 24,575 | 18,640 | 29,540 |
| | 9 | 18,610 | 25,560 | 19,835 | 28,720 | 21,935 | 34,530 | 25,280 | 44,760 | 27,960 | 53,805 |
| | 15 | 31,015 | 54,450 | 33,055 | 61,190 | 36,560 | 73,560 | 42,135 | 90,750 | 46,595 | 100,360 |
| #7 | 3-1/2 | 5,105 | 4,930 | 5,595 | 5,605 | 6,460 | 6,855 | 7,910 | 9,100 | 9,135 | 11,130 |
| | 7 | 14,445 | 16,605 | 15,825 | 18,865 | 18,275 | 23,075 | 22,380 | 30,650 | 25,370 | 37,210 |
| | 10-1/2 | 25,330 | 32,195 | 26,995 | 36,180 | 29,855 | 43,490 | 34,410 | 56,380 | 38,055 | 67,775 |
| | 17-1/2 | 42,215 | 68,595 | 44,995 | 77,085 | 49,760 | 92,665 | 57,350 | 120,120 | 63,425 | 136,605 |
| #8 | 4 | 6,240 | 6,115 | 6,835 | 6,945 | 7,895 | 8,495 | 9,665 | 11,280 | 11,160 | 13,800 |
| | 8 | 17,650 | 19,750 | 19,335 | 22,435 | 22,325 | 27,440 | 27,340 | 36,450 | 31,570 | 44,580 |
| | 12 | 32,425 | 39,005 | 35,260 | 44,185 | 38,995 | 53,120 | 44,940 | 68,860 | 49,705 | 82,780 |
| | 20 | 55,135 | 83,785 | 58,770 | 94,155 | 64,995 | 113,185 | 74,905 | 146,720 | 82,840 | 176,385 |
| #9 | 4-1/2 | 7,445 | 6,810 | 8,155 | 7,735 | 9,420 | 9,465 | 11,535 | 12,570 | 13,320 | 15,375 |
| | 9 | 21,060 | 22,125 | 23,070 | 25,140 | 26,640 | 30,745 | 32,625 | 40,840 | 37,675 | 49,950 |
| | 13-1/2 | 38,690 | 44,085 | 42,380 | 50,085 | 48,940 | 61,260 | 57,030 | 79,760 | 63,075 | 95,885 |
| | 22-1/2 | 69,965 | 98,000 | 74,575 | 110,130 | 82,475 | 132,395 | 95,050 | 171,620 | 105,120 | 206,310 |
| #10 | 5 | 8,720 | 7,770 | 9,555 | 8,825 | 11,030 | 10,795 | 13,510 | 14,340 | 15,600 | 17,535 |
| | 10 | 24,665 | 25,240 | 27,020 | 28,675 | 31,200 | 35,075 | 38,210 | 46,585 | 44,125 | 56,980 |
| | 15 | 45,315 | 50,290 | 49,640 | 57,135 | 57,320 | 69,880 | 70,200 | 92,815 | 78,905 | 112,300 |
| | 25 | 87,525 | 114,780 | 93,295 | 128,985 | 103,175 | 155,060 | 118,910 | 201,000 | 131,505 | 241,635 |

☐ - Concrete Breakout Strength ☐ - Bond Strength/Pryout Strength

1. Tabular values are provided for illustration and are applicable for single anchors installed in uncracked normal-weight concrete with minimum slab thickness, $h_a = h_{min}$, and with the following conditions:
   - $c_{a1}$ is greater than or equal to the critical edge distance, $c_{ac}$
   - $c_{a2}$ is greater than or equal to 1.5 times $c_{a1}$.
2. Calculations were performed according to ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308. The load level corresponding to the failure mode listed [Concrete breakout strength, bond strength/pryout strength] must be checked against the tabulated steel strength of the corresponding threaded rod or rebar size and type, the lowest load level controls.
3. Strength reduction factors ($\phi$) for concrete breakout strength are based on ACI 318 (-19 or -14) 5.3 for load combinations. Condition B was assumed.
4. Strength reduction factors ($\phi$) for bond strength are determined from reliability testing and qualification in accordance with ICC-ES AC308 and are tabulated in this product information and in ESR-5144.
5. Tabular values are permitted for static loads only, seismic loading is not considered with these tables. Periodic special inspection must be performed where required by code, see ESR-5144 for applicable information.
6. For anchors subjected to tension resulting from sustained loading a supplemental check must be performed according to ACI 318 -19 17.5.2.2, ACI 318-14 17.3.1.2.
7. For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 (-19 or -14) Ch. 17.
8. Interpolation is not permitted to be used with the tabular values. For intermediate base material compressive strengths, please see ACI 318 (-19 or -14) Ch. 17, ICC-ES AC308 and information included in this product supplement. For other design conditions including seismic considerations please see ACI 318 (-19 or -14) Ch. 17 and ICC-ES AC308 and ESR-5144.
9. Long term concrete temperatures are roughly constant over significant periods of time. Short-term elevated temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling.
10. The tabulated design strengths may be converted to allowable stress design values. Divide by conversion factor calculated as a weighted average of the load factors for the controlling load combination.
11. For other installation conditions such as water-saturated concrete, water-filled holes or underwater applications, see the associated strength reduction factors ($\phi$) for bond strength in the determination of controlling design strength values, as applicable.

## Tension Design Strength of Steel Elements (Steel Strength)[1,2]

| Steel Elements - Threaded Rod and Reinforcing Bar | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Rod/Rebar Size (in. or No.) | ASTM A36 and ASTM F1554 Grade 36 | ASTM F1554 Grade 55 | ASTM A193 Grade B7 and ASTM F1554 Grade 105 | ASTM A449 | ASTM F568M Class 5.8 and ISO 898-1 Class 5.8 | ASTM F593 CW Stainless (Types 304 and 316) | ASTM A193 Grade B8/B8M, Class 1 Stainless (Types 304 and 316) | ASTM A193 Grade B8/ B8M2, Class 2B Stainless (Types 304 and 316) | ASTM A615 Grade 75 Rebar | ASTM A615 Grade 60 Rebar | ASTM A706 Grade 60 Rebar | ASTM A615 Grade 40 Rebar |
| | $\phi N_{sa}$ Tension (lbs.) | $\phi N_{sa}$ Tension (lbs.) | $\phi N_{sa}$ Tension (lbs.) | $\phi N_{sa}$ Tension (lbs.) | $\phi N_{sa}$ Tension (lbs.) | $\phi N_{sa}$ Tension (lbs.) | $\phi N_{sa}$ Tension (lbs.) | $\phi N_{sa}$ Tension (lbs.) | $\phi N_{sa}$ Tension (lbs.) | $\phi N_{sa}$ Tension (lbs.) | $\phi N_{sa}$ Tension (lbs.) | $\phi N_{sa}$ Tension (lbs.) |
| 3/8 or #3 | 3,370 | 4,360 | 7,265 | 6,975 | 3,655 | 5,040 | 3,315 | 5,525 | 7,150 | 6,435 | 6,600 | 4,290 |
| 1/2 or #4 | 6,175 | 7,980 | 13,300 | 12,770 | 6,690 | 9,225 | 6,070 | 10,110 | 13,000 | 11,700 | 12,000 | 7,800 |
| 5/8 or #5 | 9,835 | 12,715 | 21,190 | 20,340 | 10,650 | 14,690 | 9,660 | 16,105 | 20,150 | 18,135 | 18,600 | 12,090 |
| 3/4 or #6 | 14,550 | 18,815 | 31,360 | 30,105 | 15,765 | 18,480 | 14,300 | 23,830 | 28,600 | 25,740 | 26,400 | 17,160 |
| 7/8 or #7 | 20,085 | 25,970 | 43,285 | 41,930 | 21,760 | 25,510 | 19,735 | 32,895 | 39,000 | 35,100 | 36,000 | - |
| 1 or #8 | 26,350 | 34,070 | 56,785 | 54,515 | 28,545 | 33,465 | 25,895 | 43,160 | 51,350 | 46,215 | 47,400 | - |
| #9 | - | - | - | - | - | - | - | - | 65,000 | 58,500 | 60,000 | - |
| 1-1/4 | 42,160 | 54,510 | 90,850 | 76,315 | 45,670 | 53,540 | 41,430 | 69,050 | - | - | - | - |
| #10 | - | - | - | - | - | - | - | - | 82,550 | 74,295 | 76,200 | - |

■ - Steel Strength

1. Steel tensile design strength according to ACI 318 (-19 or -14) Ch. 17 and ACI 318 Appendix D, $\phi N_{sa} = \phi \bullet A_{se,N} \bullet f_{uta}$.
2. The tabulated steel design strength in tension must be checked against the bond strength/concrete capacity design strength to determine the controlling failure mode, the lowest load level controls.

## Shear Design Strength of Steel Elements (Steel Strength)[1,2,3]

| Steel Elements - Threaded Rod and Reinforcing Bar | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Rod/Rebar Size (in. or No.) | ASTM A36 and ASTM F1554 Grade 36 | ASTM F1554 Grade 55 | ASTM A193 Grade B7 and ASTM F1554 Grade 105 | ASTM A449 | ASTM F568M Class 5.8 and ISO 898-1 Class 5.8 | ASTM F593 CW Stainless (Types 304 and 316) | ASTM A193 Grade B8/B8M, Class 1 Stainless (Types 304 and 316) | ASTM A193 Grade B8/ B8M2, Class 2B Stainless (Types 304 and 316) | ASTM A615 Grade 75 Rebar | ASTM A615 Grade 60 Rebar | ASTM A706 Grade 60 Rebar | ASTM A615 Grade 40 Rebar |
| | $\phi V_{sa}$ Shear (lbs.) | $\phi V_{sa}$ Shear (lbs.) | $\phi V_{sa}$ Shear (lbs.) | $\phi V_{sa}$ Shear (lbs.) | $\phi V_{sa}$ Shear (lbs.) | $\phi V_{sa}$ Shear (lbs.) | $\phi V_{sa}$ Shear (lbs.) | $\phi V_{sa}$ Shear (lbs.) | $\phi V_{sa}$ Shear (lbs.) | $\phi V_{sa}$ Shear (lbs.) | $\phi V_{sa}$ Shear (lbs.) | $\phi V_{sa}$ Shear (lbs.) |
| 3/8 or #3 | 1,750 | 2,265 | 3,775 | 3,625 | 2,020 | 2,790 | 1,725 | 2,875 | 3,960 | 3,565 | 3,430 | 2,375 |
| 1/2 or #4 | 3,210 | 4,150 | 6,915 | 6,640 | 3,705 | 5,110 | 3,155 | 5,260 | 7,200 | 6,480 | 6,240 | 4,320 |
| 5/8 or #5 | 5,110 | 6,610 | 11,020 | 10,575 | 5,900 | 8,135 | 5,025 | 8,370 | 11,160 | 10,045 | 9,670 | 6,695 |
| 3/4 or #6 | 7,565 | 9,785 | 16,305 | 15,655 | 8,730 | 10,235 | 7,435 | 12,390 | 15,840 | 14,255 | 13,730 | 9,505 |
| 7/8 or #7 | 10,445 | 13,505 | 22,505 | 21,805 | 12,050 | 14,125 | 10,265 | 17,105 | 21,600 | 19,440 | 18,720 | - |
| 1 or #8 | 13,700 | 17,715 | 29,525 | 28,345 | 15,810 | 18,535 | 13,465 | 22,440 | 28,440 | 25,595 | 24,650 | - |
| #9 | - | - | - | - | - | - | - | - | 36,000 | 32,400 | 31,200 | - |
| 1-1/4 | 21,920 | 28,345 | 47,240 | 39,685 | 25,295 | 29,650 | 21,545 | 35,905 | - | - | - | - |
| #10 | - | - | - | - | - | - | - | - | 45,720 | 41,150 | 39,625 | - |

■ - Steel Strength

1. Steel shear design strength according to ACI 318 (-19 or -14) Ch. 17 and ACI 318 Appendix D, $\phi V_{sa} = \phi \bullet 0.60 \bullet A_{se,V} \bullet f_{uta}$.
2. The tabulated steel design strength in shear must be checked against the bond strength/concrete capacity design strength to determine the controlling failure mode, the lowest load level controls.
3. In the determination of the shear design strength values in cracked concrete for structures assigned to Seismic Design Categories C, D, E or F, the steel strength requires an additional reduction factor applied for seismic shear ($\alpha_{V,seis}$), where seismic design is applicable.

# POST-INSTALLED REBAR CONNECTION DEVELOPMENT LENGTH TABLES

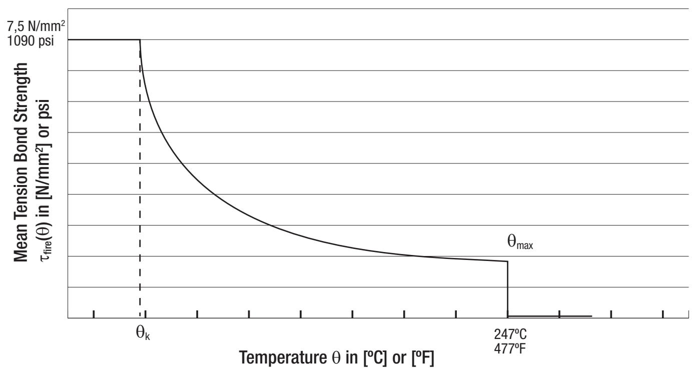
## Development Lengths for Common Reinforcing Bar Connections[1,2,3,6,7]

| Design Information | Symbol | Reference Standard | Units | Nominal Rebar Size (Us) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 | #11 |
| Nominal rebar diameter | $d_b$ | - | in. (mm) | 0.375 (10) | 0.5 (13) | 0.625 (16) | 0.75 (19) | 0.875 (22) | 1 (25) | 1.128 (29) | 1.27 (32) | 1.41 (36) |
| Nominal rebar area | $A_b$ | | in² (mm²) | 0.11 (71) | 0.2 (127) | 0.31 (198) | 0.44 (285) | 0.6 (388) | 0.79 (507) | 1 (645) | 1.27 (817) | 1.56 (1006) |
| **ASTM A615/A706, Grade 60 ($f_y$ = 60 ksi)** | | | | | | | | | | | | |
| Development length in f'c = 2,500 psi concrete[4,5] | $l_d$ | ACI 318-19 25.4.2.4 or ACI 318-14 25.4.2.3 or ACI 318-11 12.2.3 | in. (mm) | 12 (305) | 14.4 (366) | 18 (457) | 21.6 (549) | 31.5 (800) | 36 (914) | 40.6 (1031) | 45.7 (1161) | 50.8 (1290) |
| Development length in f'c = 3,000 psi concrete[4,5] | | | in. (mm) | 12 (305) | 13.1 (334) | 16.4 (417) | 19.7 (501) | 28.8 (730) | 32.9 (835) | 37.1 (942) | 41.7 (1060) | 46.3 (1177) |
| Development length in f'c = 4,000 psi concrete[4,5] | | | in. (mm) | 12 (305) | 12 (305) | 14.2 (361) | 17.1 (434) | 24.9 (633) | 28.5 (723) | 32.1 (815) | 36.2 (920) | 40.1 (1019) |
| Development length in f'c = 6,000 psi concrete[4,5] | | | in. (mm) | 12 (305) | 12 (305) | 12 (305) | 13.9 (354) | 20.3 (516) | 23.2 (590) | 26.2 (666) | 29.5 (750) | 32.8 (832) |
| Development length in f'c = 8,000 psi concrete[4,5] | | | in. (mm) | 12 (305) | 12 (305) | 12 (305) | 12.1 (307) | 17.6 (443) | 20.1 (511) | 22.7 (577) | 25.6 (649) | 28.4 (721) |
| **ASTM A615, Grade 75 ($f_y$ = 75 ksi)** | | | | | | | | | | | | |
| Development length in f'c = 2,500 psi concrete[4,5] | $l_d$ | ACI 318-19 25.4.2.4 or ACI 318-14 25.4.2.3 or ACI 318-11 12.2.3 | in. (mm) | 15 (381) | 20 (508) | 25 (635) | 30 (762) | 43.8 (1113) | 50 (1270) | 56.4 (1433) | 63.5 (1613) | 70.5 (1791) |
| Development length in f'c = 3,000 psi concrete[4,5] | | | in. (mm) | 13.7 (348) | 18.2 (462) | 22.8 (579) | 27.4 (696) | 39.9 (1013) | 45.7 (1161) | 51.5 (1308) | 58 (1473) | 64.4 (1636) |
| Development length in f'c = 4,000 psi concrete[4,5] | | | in. (mm) | 12 (305) | 15.8 (401) | 19.7 (500) | 23.7 (602) | 34.6 (879) | 39.5 (1003) | 44.6 (1133) | 50.2 (1275) | 55.8 (1417) |
| Development length in f'c = 6,000 psi concrete[4,5] | | | in. (mm) | 12 (305) | 12.9 (328) | 16.1 (409) | 19.3 (490) | 28.2 (716) | 32.3 (820) | 36.4 (925) | 41 (1041) | 45.5 (1156) |
| Development length in f'c = 8,000 psi concrete[4,5] | | | in. (mm) | 12 (305) | 12 (305) | 13.9 (353) | 16.7 (424) | 24.4 (620) | 27.9 (709) | 31.5 (800) | 35.5 (902) | 39.4 (1001) |

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 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1. Calculated development lengths in accordance with ACI 318-19 25.4.2.4, ACI 318-14 25.4.2.3 or ACI 318-11 12.2.3, as applicable, for reinforcing bars are valid for static, wind, and earthquake loads (Seismic Design Category A and B).
2. Calculated development lengths in Seismic Design Category C through F must comply with ACI 318 (-19 or -14) Chapter 18 or ACI 318-11 Chapter 21, as applicable.
3. For Class B splices, minimum length of lap for tension lap splices is 1.3ld in accordance with ACI 318 (-19 or -14) 25.5.2 and ACI 318-11 12.15.1, as applicable.
4. For lightweight concrete, $\lambda$ = 0.75; therefore multiply development lengths by 1.33 (increase development length by 33 percent), unless the provisions of ACI 318-19 25.4.2.5, ACI 318-14 25.4.2.4 or ACI 318-11 12.2.4 (d), as applicable, are met to permit alternate values of $\lambda$ (e.g for sand-lightweight concrete, $\lambda$ = 0.85; therefore multiply development lengths by 1.18). Refer to ACI 318 (-19 or -14) 19.2.4 or ACI 318-11 8.6.1, as applicable.
5. $\left(\frac{c_b + K_{tr}}{d_b}\right) = 2.5$, $\psi_t$=1.0, $\psi_e$=1.0, $\psi_s$=0.8 for $d_b \le$ #6,1.0 for $d_b >$ #6. Refer to ACI 318-19 25.4.2.5, ACI 318-14 25.4.2.4 or ACI 318-11 12.2.4, as applicable.
6. Calculations may be performed for other steel grades and concrete compressive strengths per ACI 318 (-19 or -14) Chapter 25 or ACI 318-11 Chapter 12, as applicable.
7. To determine development lengths for ASTM A615 Grade 40 reinforcing bar, multiply the ASTM A615 Grade 60 development lengths by a factor of 0.67. The minimum development length is 12" (305 mm) in accordance with ACI 318-19 25.4.2.1.

## Bond Strength vs Temperature for Post-Installed Reinforcing Bar Applications Subject to Elevated Temperature / Fire[1,2,3,4]

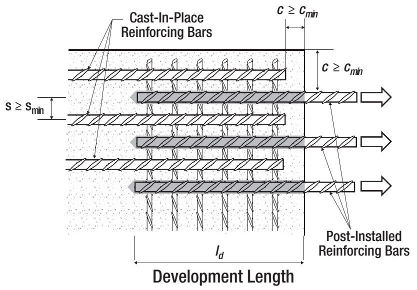



The mean tension bond strength $\tau_{fire}$ (θ) under fire conditions shall be determined in accordance with the following equations:

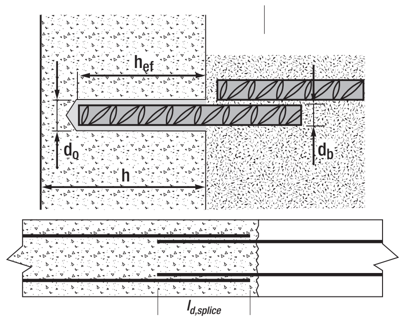
| For hammer drill and carbide bit (or DEWALT hollow carbide bit): | For diamond core bit: |
|---|---|
| $\tau_{fire}$ (θ) = 1955671 • $\theta^{-1.585}$ ≤ 1090 psi with θ in ºF<br>$\tau_{fire}$ (θ) = 1277 • $\theta^{-1.341}$ ·≤ 7.5 [N/mm²] with θ in ºC<br>where $\theta_k$ = 113ºF (46ºC) | $\tau_{fire}$ (θ) = 1814842 • $\theta^{-1.585}$ ≤ 1090 psi with θ in ºF<br>$\tau_{fire}$ (θ) = 1185 • $\theta^{-1.341}$ ·≤ 7.5 [N/mm²] with θ in ºC<br>where $\theta_k$ = 108ºF (44ºC) |

1. Post-installed reinforcing bar connections in holes drilled with hammer drill and carbide bit (or DEWALT hollow carbide drill bit) or diamond core bit.
2. With $\theta_{max}$ = 247°C (477°F). For temperatures larger than $\theta_{max}$ the bond strength $\tau_{fire}$ (θ) = 0.
3. For application with rebar #11 (36mm) or larger in an overhead installation, the bond strengths must be decreased by 11 percent.
4. Bond strengths under fire are for short-term loads such as wind and seismic; and for long-term / sustained loads including dead and live loads.

## Installation Detail for Post-Installed Reinforcing Bar Connection

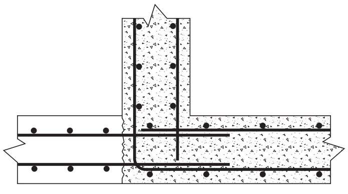



c = edge distance
s = spacing

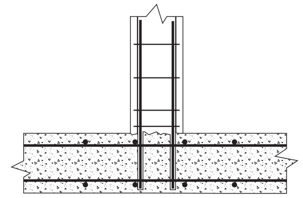



$d_b$ = nominal bar diameter
$d_o$ = nominal hole diameter
$h_{ef}$ = effective embedment
h = member thickness

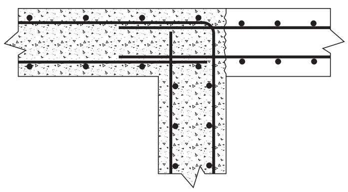
## Examples of Development Length Application Details for Post-Installed Reinforcing Bar Connections Provided for Illustration



Tension Lap Splice with Existing Reinforcement for Footing and Foundation Extensions



Tension Development of Column, Cap or Wall Dowels



Tension Lap Splice with Existing Flexural Reinforcement For Slab and Beam Extensions

## Installation Parameters for Common Post-Installed Reinforcing Bar Connections[2,3]

| Parameter | Symbol | Units | Nominal Rebar Size (US) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 | #11 |
| Nominal hole diameter[1] | $d_o$ | in. | 7/16 | 5/8 | 3/4 | 7/8 | 1 | 1-1/8 | 1-3/8 | 1-1/2 | 1-3/4 |
| Effective embedment | $h_{ef}$ | in. | Up to 7-1/2 | Up to 10 | Up to 12-1/2 | Up to 15 | Up to 17-1/2 | Up to 20 | Up to 22-1/2 | Up to 25 | Up to 27-1/2 |
| Nominal hole diameter[1] | $d_o$ | in. | 1/2 | 5/8 | 3/4 | 1 | 1-1/8 | 1-1/4 | 1-3/8 | 1-1/2 | 1-3/4 |
| Effective embedment | $h_{ef}$ | in. | Up to 22-1/2 | Up to 30 | Up to 37-1/2 | Up to 45 | Up to 52-1/2 | Up to 60 | Up to 67-1/2 | Up to 75 | Up to 82-1/2 |

For SI: 1 inch = 25.4 mm,; for pound-inch units: 1 mm = 0.03937 inches.

1. For any case, it must be possible for the reinforcing bar (rebar) to be inserted into the cleaned hole without resistance.
2. Consideration should be given regarding the commercial availability of carbide drill bits (including hollow drill bits) and diamond core bits, as applicable, with lengths necessary to achieve effective embedments for post-installed reinforcing bar connections.
3. For fractional reinforcing bars where the effective embedment is listed for two nominal hole diameters, either nominal hole diameter may be used.

## Hole Cleaning Tools and Accessories for Post-Installed Rebar Connections[1,2,3,4,5,6,7]

| Rebar Size (No.) | Nominal Hole / Bit Size (inch) | Brush Size (inch) | Brush Length (inches) | Wire Brush (Cat. No.) | Plug Size (inch) | Piston Plug (Cat. No.) |
|---|---|---|---|---|---|---|
| 3 | 1/2 | 1/2 | 6 | PFC1671010 | - | - |
| 4 | 5/8 | 5/8 | 6 | PFC1671200 | - | - |
| 5 | 3/4 | 3/4 | 6 | PFC1671250 | 3/4 | PFC1691520 |
| 6 | 7/8 | 7/8 | 6 | PFC1671300 | 7/8 | PFC1691530 |
| | 1 | 1 | 6 | PFC1671350 | 1 | PFC1691540 |
| 7 | 1 | 1 | 6 | PFC1671350 | 1 | PFC1691540 |
| | 1-1/8 | 1-1/8 | 6 | PFC1671400 | 1-1/8 | PFC1691550 |
| 8 | 1-1/8 | 1-1/8 | 6 | PFC1671400 | 1-1/8 | PFC1691550 |
| | 1-1/4 | 1-1/4 | 6 | PFC1671450 | 1-1/4 | PFC1691555 |
| 9 | 1-3/8 | 1-3/8 | 6 | PFC1671450 | 1-3/8 | PFC1691560 |
| 10 | 1-1/2 | 1-1/2 | 6 | PFC1671500 | 1-1/2 | PFC1691570 |
| 11 | 1-3/4 | 1-3/4 | 6 | 08299-PWR* | 1-3/4 | PFC1691580 |

1. If the DEWALT DustX+ extraction system is used to automatically clean the holes during drilling, standard hole cleaning (brushing and blowing following drilling) is not required.
2. Holes may be drilled with hammer-drill, i.e. rotary impact drills or rock drills with a carbide drill bit (including hollow bits) or core-drill, i.e. core drill with a diamond core drill bit.
3. For any case, it must be possible for the reinforcing bar to be inserted into the cleaned hole without resistance.
4. A brush extension (Cat. #PFC1671820) must be used with a steel wire brush for holes drilled deeper than the listed brush length.
5. Brush adaptors for power tool connections are available for SDS (Cat. #PFC1671830).
6. A extension tube (Cat.#08297-PWR) or flexible extension hose (Cat.#PFC1640600) or equivalent approved by DEWALT must be used if the bottom or back of the anchor hole is not reached with the mixing nozzle only.
7. All overhead (i.e upwardly inclined) installations require the use of piston plugs during where one is tabulated together with the anchor size (see table). All horizontal installations require the use of piston plugs where the embedment depth is greater than 10 inches and the drill bit size is larger than 5/8-inch. A flexible extension tube (Cat.#08297-PWR) or flexible extension hose (Cat.#PFC1640600) or equivalent approved by DEWALT must be used with piston plugs.

*This brush size is a standard wire brush at the time of publication (see ordering information).

Wire Brush

Brush Extension

SDS Adapter

Premium Piston Plug

Compressed Air Nozzle

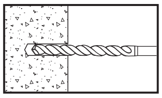
DustX+™ System
(hollow bits with HEPA dust extraction)

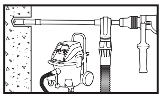
DUST X+™
ANCHOR INSTALLATION SYSTEM

# INSTALLATION INSTRUCTIONS FOR ADHESIVE ANCHORS

## HAMMER DRILLING

### DRILLING





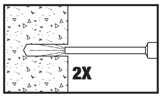
**1-** Drill a hole into the base material with rotary hammer drill (i.e. percussion drill) and a carbide drill bit to the size and embedment required by the selected steel hardware element (reference installation specifications for threaded rod and reinforcing bar). The tolerances of the carbide drill bits, including hollow bits, must meet ANSI Standard B212.15.

- Precaution: Use suitable eye and skin protection. Avoid inhalation of dust during drilling and/or removal.
- Note! In case of standing water in the drilled hole (flooded hole condition), all the water has to be removed from the hole (e.g. vacuum, compressed air, etc.) prior to cleaning.

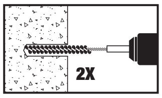
Drilling in dry base materials is recommended when using hollow drill bits (vacuum must be on).

**GO TO STEP 3 FOR HOLES DRILLED WITH DUSTX+™ EXTRACTION SYSTEM (NO FURTHER HOLE CLEANING IS REQUIRED).**
**OTHERWISE GO TO STEP 2A FOR HOLE CLEANING INSTRUCTIONS. IN THE CASE OF AN UNDERWATER (SUBMERGED) CONDITION GO TO STEP 2A-UW.**

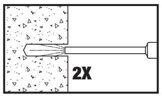
### HOLE CLEANING DRY OR WET/WATER-SATURATED HOLES (BLOW 2X, BRUSH 2X, BLOW 2X)




**2a-** Starting from the bottom or back of the drilled anchor hole, blow the hole clean a minimum of two times (2x).
- Use a compressed air nozzle (min. 90 psi) for all sizes of anchor rod and reinforcing bar (rebar).




**2b-** Determine wire brush diameter (see hole cleaning equipment selection table) for the drilled hole and brush the hole manually or attach the brush with adaptor to a rotary drill tool. Brush the hole with the selected wire brush a minimum of two times (2x).
A brush extension (supplied by DEWALT) must be used for holes drilled deeper than the listed brush length.
- The wire brush diameter must be checked periodically during use. The brush should resist insertion into the drilled hole, if not, the brush is too small and must be replaced with proper brush diameter (i.e. new wire brush).

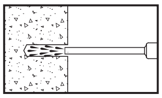



**2c-** Repeat Step 2a again by blowing the hole clean a minimum of two times (2x).

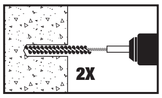
- When finished the hole should be clean and free of dust, debris, ice, grease, oil or other foreign material.

**NEXT GO TO STEP 3.**

### HOLE CLEANING UNDERWATER INSTALLATION (FLUSH, BRUSH 2X, FLUSH)



**2a-uw-** Starting from the bottom or back of the drilled anchor hole, rinse/flush the hole clean with air/water (air/water line pressure) until clear water comes out.



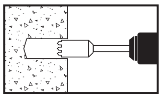

**2b-uw-** Determine brush diameter (see hole cleaning equipment selection table) for the drilled hole and brush the hole manually or attach the brush with adaptor to a rotary drill tool. Brush the hole with the selected wire brush a minimum of two times (2x). A brush extension (supplied by DEWALT) must be used for holes drilled deeper than the listed brush length.
- The wire brush diameter must be checked periodically during use. The brush should resist insertion into the drilled hole, if not, the brush is too small and must be replaced with proper brush diameter (i.e. new wire brush).

**2c-uw-** Repeat Step 2a-uw again by rinse/flushing the hole clean with air/water.
- When finished the hole should be clean and free of dust, debris, ice, grease, oil or other foreign material.

**NEXT GO TO STEP 3.**

## CORE DRILLING

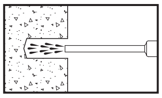
### DRILLING



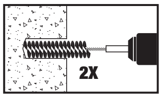
**1-** Drill a hole into the base material with a core drill tool to the size and embedment required by the selected steel hardware element

Precaution: Use suitable eye and skin protection. Avoid inhalation of dust during drilling and/or removal.

### HOLE CLEANING (RINSE, BRUSH 2X, RINSE, BLOW 2X)

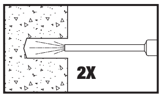


**2a-** Starting from the bottom or back of the drilled hole, rinse/flush the hole clean with air/water (air/water line pressure) until clear water comes out.




**2b-** Determine brush diameter (see hole cleaning accessories for post-installed rebar selection table) for drilled hole and brush manually or attach the brush with adaptor to a rotary drill tool. Brush the hole with the selected wire brush a minimum of two times (2x).
- A brush extension (supplied by DEWALT) must be used for holes drilled deeper than the listed brush length. The wire brush diameter must be checked periodically during use The brush should resist insertion into the drilled hole, if not the brush is small and must be replaced with the proper brush diameter (i.e. new wire brush).

**2c-** Repeat Step 2a by rinse/flush the hole clean with water.




**2d-** Starting from the bottom or back of the drilled anchor hole, blow the hole clean a minimum if two times (2x).
Use a compressed air nozzle (min. 90 psi) for all sizes of anchor rod and reinforcing bar (rebar)

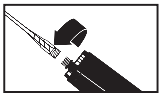
When finished the hole should be clean and free of water, debris, oil or other foreign material.

**2e-** Repeat Step 2b again by brushing the hole with a wire brush a minimum if two times (2x).

**2f-** Repeat Step 2d again by blowing the hole clean a minimum if two times (2x).

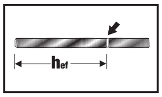
When finished the hole should be clean and free of water, debris, oil or other foreign material.
**NEXT GO TO STEP 3.**

## PREPARING

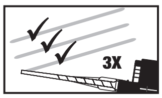


**3-** Check adhesive expiration date on cartridge label. Do not use expired product. Review Safety Data Sheet (SDS) before use. Cartridge temperature must be between 41°F - 104°F (5°C - 40°C) when in use. Review published gel (working) and cure times. Consideration should be given to the reduced gel (working) time of the adhesive in warm temperatures. For permitted range of the base material temperature, see published gel and curing times.

- Attach a supplied mixing nozzle to the cartridge. Unless otherwise noted do not modify the mixer in any way and make sure the mixing element is inside the nozzle. Load the cartridge into the correct dispensing tool.
- Note: Unless otherwise noted, use a new mixing nozzle with new cartridge of adhesive and also for all work interruptions exceeding the published gel (working) time of the adhesive.



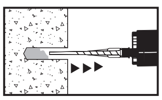

**4-** Prior to inserting the anchor rod or rebar into the drilled hole, the position of the embedment depth has to be marked on the anchor. Verify anchor element is straight and free of surface damage.



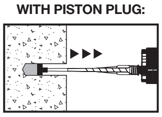

**5-** Adhesives must be properly mixed to achieve published properties. For new cartridges and nozzles, prior to dispensing adhesive into the drilled hole, separately dispense at least three full strokes of adhesive through the mixing nozzle until the adhesive is a consistent **RED** color.

- Review and note the published gel (working) and cure times (reference gel time and curing time table) prior to injection of the mixed adhesive into the cleaned anchor hole.

## INSTALLATION



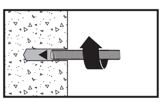
WITH PISTON PLUG:



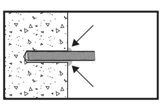
**6-** Fill the cleaned hole approximately two-thirds full with mixed adhesive starting from the bottom or back of the anchor hole. Slowly withdraw the mixing nozzle as the hole fills to avoid creating air pockets or voids. A plastic extension tube (Cat# 08281-PWR or 08297-PWR) or equivalent approved by DEWALT must be used with the mixing nozzle if the bottom or back of the anchor hole is not reached with the mixing nozzle only.

- Note: Piston plugs (see installation specifications) must be used with and attached to the mixing nozzle and extension tube for overhead (i.e. upwardly inclined) installations and horizontal installations in concrete where the embedment depth is greater than 10 inches and the drill bit size is larger than 5/8-inch. Insert piston plug to the back of the drilled hole and inject as described in the method above. During injection of the adhesive the piston plug will be naturally extruded from the drilled hole by the adhesive pressure.
- The use of piston plugs is also recommended for all underwater installations where the drill bit size is larger than 5/8-inch.

Attention! Do not install anchors overhead or upwardly inclined without installation hardware supplied by the DEWALT and also receiving proper training and/or certification. Contact DEWALT for details prior to use, as applicable.

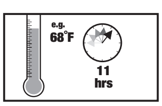


**7-** The anchor should be free of dirt, grease, oil or other foreign material. Push clean threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. Observe the gel (working) time.



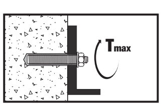
**8-** Ensure that the anchor element is installed to the specific embedment depth. Adhesive must completely fill the annular gap at the concrete surface. Following installation of the anchor element, remove excess adhesive. Protect the anchor element threads from fouling with adhesive. For all installations the anchor element must be restrained from movement throughout the specified curing period, (as necessary) through the use of temporary wedges, external supports, or other methods. Minor adjustment to the position of the anchor element may be performed during the gel (working) time only.

## CURING AND LOADING




**9-** Allow the adhesive anchor to cure to the specified full curing time prior to applying any load (reference gel time and curing time table).

- Do not disturb, torque or load the anchor until it is fully cured.



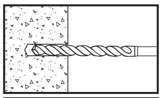

**10-** After full curing of the adhesive anchor, a fixture can be installed to the anchor and tightened up to the maximum torque (reference gel time and curing table) by using a calibrated torque wrench.

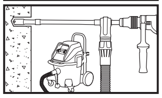
- Note! Take care not to exceed the maximum torque for the selected anchor.

# INSTALLATION INSTRUCTIONS FOR POST-INSTALLED REBAR CONNECTIONS

## HAMMER DRILLING

### DRILLING





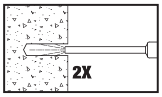
**1-** Drill a hole into the base material with rotary hammer drill (i.e. percussion drill) and a carbide drill bit to the size and embedment required by the selected steel hardware element (reference installation specifications for threaded rod and reinforcing bar). The tolerances of the carbide drill bits, including hollow bits, must meet ANSI Standard B212.15.

- Precaution: Use suitable eye and skin protection. Avoid inhalation of dust during drilling and/or removal.
- Note! In case of standing water in the drilled hole (flooded hole condition), all the water has to be removed from the hole (e.g. vacuum, compressed air, etc.) prior to cleaning.

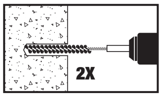
Drilling in dry base materials is recommended when using hollow drill bits (vacuum must be on).

**GO TO STEP 3 FOR HOLES DRILLED WITH DUSTX+™ EXTRACTION SYSTEM (NO FURTHER HOLE CLEANING IS REQUIRED). OTHERWISE GO TO STEP 2A FOR HOLE CLEANING INSTRUCTIONS.**

### HOLE CLEANING DRY OR WET HOLES (BLOW 2X, BRUSH 2X, BLOW 2X)

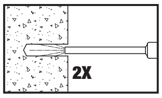



**2a-** Starting from the bottom or back of the drilled hole, blow the hole clean a minimum of two times (2x). Use a compressed air nozzle (min. 90 psi) for all sizes of reinforcing bar (rebar).




**2b-** Determine brush diameter (see hole cleaning accessories for post-installed rebar selection table) for the drilled hole and brush the hole manually or attach the brush with adaptor to a rotary drill tool. Brush the hole with the selected wire brush a minimum of two times (2x).

- A brush extension (supplied by DEWALT) must be used for drill hole depth than the listed brush length. The wire brush diameter must be checked periodically during use; the brush should resist insertion into the drilled hole, if not the brush is too small and must be replaced with the proper brush diameter (i.e. new wire brush).



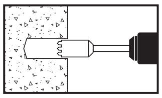

**2c-** Repeat Step 2a again by blowing the hole clean a minimum of two times (2x).

When finished the hole should be clean and free of dust, debris, oil or other foreign material.

**NEXT GO TO STEP 3.**

## CORE DRILLING

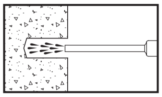
### DRILLING



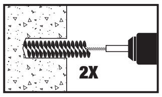
**1-** Drill a hole into the base material with a core drill tool to the size and embedment required by the selected steel hardware element

Precaution: Use suitable eye and skin protection. Avoid inhalation of dust during drilling and/or removal.

### HOLE CLEANING (RINSE, BRUSH 2X, RINSE, BLOW 2X)

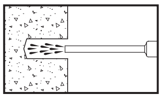


**2a-** Starting from the bottom or back of the drilled hole, rinse/flush the hole clean with air/water (air/water line pressure) until clear water comes out.

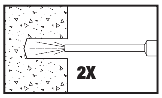



**2b-** Determine brush diameter (see hole cleaning accessories for post-installed rebar selection table) for drilled hole and brush manually or attach the brush with adaptor to a rotary drill tool. Brush the hole with the selected wire brush a minimum of two times (2x).

- A brush extension (supplied by DEWALT) must be used for holes drilled deeper than the listed brush length. The wire brush diameter must be checked periodically during use The brush should resist insertion into the drilled hole, if not the brush is small and must be replaced with the proper brush diameter (i.e. new wire brush).

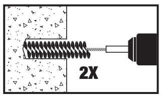


**2c-** Repeat Step 2a by rinse/flush the hole clean with water.

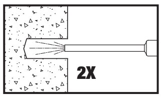



**2d-** Starting from the bottom or back of the drilled anchor hole, blow the hole clean a minimum if two times (2x). Use a compressed air nozzle (min. 90 psi) for all sizes of anchor rod and reinforcing bar (rebar)

When finished the hole should be clean and free of water, debris, oil or other foreign material.




**2e-** Repeat Step 2b again by brushing the hole with a wire brush a minimum if two times (2x).

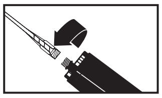



**2f-** Repeat Step 2d again by blowing the hole clean a minimum if two times (2x).

When finished the hole should be clean and free of water, debris, oil or other foreign material.

**NEXT GO TO STEP 3.**

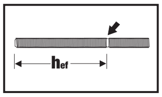
## PREPARING



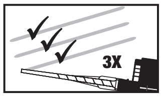
**3-** Check adhesive expiration date on cartridge label. Do not use expired product. Review Safety Data Sheet (SDS) before use. Review published gel (working) and cure times. Cartridge adhesive temperature must be between 41°F - 104°F (5°C - 40°C) when in use. Consideration should be given to the reduced gel (working) time of the adhesive in warm temperatures. For the permitted range of the base material temperature see published gel and cure times.

Attach a supplied mixing nozzle to the cartridge. Unless otherwise noted do not modify the mixer in any way and make sure the mixing element is inside the nozzle. Load the cartridge into the correct dispensing tool.

- Note: Unless otherwise noted, use a new mixing nozzle with new cartridge of adhesive and also for all work interruptions exceeding the published gel (working) time of the adhesive.



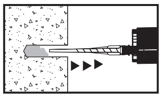

**4-** Prior to inserting the rebar into the filled drilled hole, the position of the embedment depth has to be marked on the anchor. Verify anchor element is straight and free of surface damage.



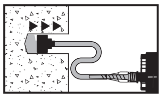

**5-** Adhesive must be properly mixed to achieve published properties. Prior to dispensing adhesive into the drilled hole, separately dispense at least three full strokes of adhesive through the mixing nozzle until the adhesive is a consistent **RED** color.

Review and note the published gel (working) and cure times prior to injection of the mixed adhesive into the cleaned anchor hole.

## INSTALLATION



WITH PISTON PLUG:

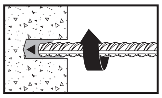


**6-** Fill the cleaned hole approximately two-thirds full with mixed adhesive starting from the bottom or back of the anchor hole. Slowly withdraw the mixing nozzle as the hole fills to avoid creating air pockets or voids. A flexible extension tube (Cat.# 08297-PWR) or flexible extension hose (Cat.# PFC1640600) or equivalent approved by DEWALT must be used with the mixing nozzle if the bottom or back of the anchor hole is not reached with the mixing nozzle only (see hole cleaning tools and accessories for post-installed rebar table).

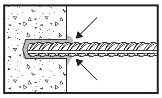
- Note! Piston plugs must be used with and attached to mixing nozzle and extension tube for overhead (i.e. upwardly inclined) installations and horizontal installations with rebar sizes where the embedment depth is greater than 10 inches and the drill bit size is larger than 5/8-inch.

Insert piston plug to the back of the drilled hole and inject as described in the method above. During injection of the adhesive the piston plug will be naturally extruded from the drilled hole by the adhesive pressure.

- Attention! Do not install anchors overhead or upwardly inclined without installation hardware supplied by DEWALT and also receiving proper training and/or certification. Contact DEWALT for details prior to use, as applicable.

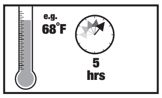


**7-** The reinforcing bar should be free of dirt, grease, oil or other foreign material. Push clean rebar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. Observe the gel (working) time.



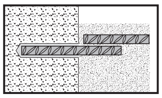
**8-** Ensure that the reinforcing bar is installed to the specified embedment depth. Adhesive must completely fill the annular gap at the concrete surface. Following installation of the rebar, remove excess adhesive. For all installations the rebar must be restrained from movement throughout the specified curing period, (as necessary) through the use of temporary wedges, external supports, or other methods. Minor adjustments to the position of the rebar may be performed during the gel (working) time only.

## CURING AND LOADING




**9-** Allow the adhesive anchor to cure to the specified full curing time prior to applying any load (reference gel time and curing time table).

- Note! After the initial curing time, the installation of connecting reinforcements and formwork attachments is permitted. Do not torque or load the anchor until it is fully cured.



**10-** After full curing of the rebar connection, new concrete can be poured (placed) to the installed rebar connection.

# ANCHOR ACCESSORY SELECTION

## Wire Brush Selection Table for Pure220+ Adhesive Anchors[1,2,3]

| Nominal Wire Brush Size (inch) | Nominal Hole / Bit Size (inch) | Brush Length (inches) | Steel Wire Brush[1,2] (Cat. #) | Blowout Tool |
|---|---|---|---|---|
| 7/16 | 7/16 | 6 | PFC1671050 | Compressed air nozzle, Cat #08292-PWR (min. 90 psi) |
| 1/2 | 1/2 | 6 | PFC1671100 | |
| 9/16 | 9/16 | 6 | PFC1671150 | |
| 5/8 | 5/8 | 6 | PFC1671200 | |
| 11/16 | 11/16 | 6 | PFC1671225 | |
| 3/4 | 3/4 | 6 | PFC1671250 | |
| 7/8 | 7/8 | 6 | PFC1671300 | |
| 1 | 1 | 6 | PFC1671350 | |
| 1-1/8 | 1-1/8 | 6 | PFC1671400 | |
| 1-1/4 | 1-1/4 | 6 | PFC1671450 | |
| 1-3/8 | 1-3/8 | 6 | PFC1671450 | |
| 1-1/2 | 1-1/2 | 6 | PFC1671500 | |

1. An SDS-plus adaptor (Cat. #PFC1671830) is required to attach a steel wire brush to hammer drill. For hand brushing, attach manual brush handle (Cat. #PFC1671000) to the steel brush.
2. A brush extension (Cat. #PFC1671820) must be used with a steel wire brush for holes drilled deeper than the listed brush length.
3. If the DEWALT DustX+ extraction system is used to automatically clean holes during drilling, standard hole cleaning (i.e. brushing and removing dust/debris following drilling) is not required.

## Piston Plug Selection Table for Adhesive Anchors[1,2,3,4]

| Plug Size (inch) | Nominal Hole / Bit Size (inch) | Piston Plug (Cat. #) | Premium Piston Plug (Cat. #) |
|---|---|---|---|
| 11/16 | 11/16 | 08258-PWR | PFC1691515 |
| 3/4 | 3/4 | 08259-PWR | PFC1691520 |
| 7/8 | 7/8 | 08300-PWR | PFC1691530 |
| 1 | 1 | 08301-PWR | PFC1691540 |
| 1-1/8 | 1-1/8 | 08303-PWR | PFC1691550 |
| 1-1/4 | 1-1/4 | 08307-PWR | PFC1691555 |
| 1-3/8 | 1-3/8 | 08305-PWR | PFC1691560 |
| 1-1/2 | 1-1/2 | 08309-PWR | PFC1691570 |
| 1-3/4 | 1-3/4 | - | PFC1691580 |
| 2 | 2 | - | PFC1691590 |
| 2-3/16 | 2-3/16 | - | PFC1691600 |

1. All overhead or upwardly inclined installations require the use of piston plugs where one is tabulated together with the anchor size.
2. Installations require the use of piston plugs for horizontal and overhead applications where the embedment depth is greater than 10 inches and drill bit size is larger than 5/8-inch.
3. The use of piston plugs is also recommended for all underwater installations where one is tabulated together with the anchor size.
4. A plastic extension tube (Cat. #08281-PWR or #08297-PWR) or equivalent approved by DEWALT must be used with piston plugs. Flexible extension hose (Cat. #PFC1640600) is suggested for use with premium piston plugs, where applicable.

## ORDERING INFORMATION

### Pure220+ Cartridges (1:1 mix ratio)

| Cat. No. | Description | Pack Qty. | Pallet Qty. |
|---|---|---|---|
| DFC114110 | Pure220+ 9.5 fl. oz. Quick-Shot cartridge | 12 | 846 |
| DFC114121 | Pure220+ 20.5 fl. oz. dual cartridge | 12 | 720 |
| A mixing nozzle is packaged with each cartridge.<br>Pure220+ mixing nozzles must be used to ensure complete and proper mixing of the adhesive. | | | |

### Cartridge System Mixing Nozzles and Nozzle Extensions

| Cat. No. | Description | Pack Qty. | Carton Qty. |
|---|---|---|---|
| PFC1641600 | Mixing nozzle (with 8" extension) | 2 | 24 |
| 08609-PWR | High flow mixing nozzle (with 8" extension) | 2 | 24 |
| 08281-PWR | Mixing nozzle extension, 8" long | 2 | 24 |
| 08297-PWR | Mixing nozzle extension, 20" long | 1 | 12 |
| PFC1640600 | Flexible Extension Hose, 25 ft. (5/8" O.D.) | 1 | 12 |

### Dispensing Tools for Injection Adhesive

| Cat. No. | Description | Pack Qty. | Carton Qty. |
|---|---|---|---|
| 08437-PWR | Manual caulking gun for Quick-Shot cartridge | 1 | 12 |
| DCE560D1 | Cordless 20v Battery powered dispensing tool for Quick-Shot | 1 | - |
| 08409-PWR | 20.5 fl. oz. Standard metal manual tool | 1 | 10 |
| DCE591B | 20.5 fl. oz. cordless 20v Battery powered dispensing tool (bare) | 1 | - |
| DCE591D1 | 20.5 fl. oz. cordless 20v Battery powered dispensing tool (kit) | 1 | - |
| 08459-PWR | 20.5 fl. oz. Pneumatic tool | 1 | - |

### Hole Cleaning Tools and Accessories

| Cat No. | Description | Pack Qty. |
|---|---|---|
| PFC1671050 | Premium Wire brush for 7/16" ANSI hole, 6" length | 1 |
| PFC1671100 | Premium Wire brush for 1/2" ANSI hole, 6" length | 1 |
| PFC1671150 | Premium Wire brush for 9/16" ANSI hole, 6" length | 1 |
| PFC1671200 | Premium Wire brush for 5/8" ANSI hole, 6" length | 1 |
| PFC1671225 | Premium Wire brush for 11/16" ANSI hole, 6" length | 1 |
| PFC1671250 | Premium Wire brush for 3/4" ANSI hole, 6" length | 1 |
| PFC1671300 | Premium Wire brush for 7/8" ANSI hole, 6" length | 1 |
| PFC1671350 | Premium Wire brush for 1" ANSI hole, 6" length | 1 |
| PFC1671400 | Premium Wire brush for 1-1/8" ANSI hole, 6" length | 1 |
| PFC1671450 | Premium Wire brush for 1-1/4" and 1-3/8" ANSI hole, 6" length | 1 |
| PFC1671500 | Premium Wire brush for 1-1/2" ANSI hole, 6" length | 1 |
| PFC1671830 | SDS-plus adapter for premium steel brushes | 1 |
| PFC1671000 | Premium manual brush wood handle | 1 |
| PFC1671820 | Premium steel brush extension, 12" length | 1 |
| 08292-PWR | Air compressor nozzle with extension, 18" length | 1 |
| **Std. Wire Brushes for Large Diameter Holes** | | |
| 08299-PWR | Std. Wire brush for 1-3/4" ANSI hole, 11" length | 1 |
| 08271-PWR | Std. Wire brush for 2" ANSI hole, 11" length | 1 |
| 08272-PWR | Std. Wire brush for 2-3/16" ANSI hole, 11" length | 1 |
| 08282-PWR | Std. steel brush extension, 12" length | 1 |
| 08283-PWR | SDS-Plus adaptor for Std. steel brushes | 1 |

### Piston Plugs for Adhesive Anchors

| Cat No. | Description | ANSI Drill Bit Dia. | Pack Qty. |
|---|---|---|---|
| 08258-PWR | 11/16" Plug | 11/16" | 10 |
| 08259-PWR | 3/4" Plug | 3/4" | 10 |
| 08300-PWR | 7/8" Plug | 7/8" | 10 |
| 08301-PWR | 1" Plug | 1" | 10 |
| 08303-PWR | 1-1/8" Plug | 1-1/8" | 10 |
| 08307-PWR | 1-1/4" Plug | 1-1/4 | 10 |
| 08305-PWR | 1-3/8" Plug | 1-3/8" | 10 |
| 08309-PWR | 1-1/2" Plug | 1-1/2" | 10 |

### Piston Plugs for Post-Installed Rebar Connections

| Cat. No. | Description | ANSI Drill Bit Dia. | Pack Qty. |
|---|---|---|---|
| PFC1691510 | 5/8" Plug | 5/8" | 1 |
| PFC1691515 | 11/16" Plug | 11/16" | 1 |
| PFC1691520 | 3/4" Plug | 3/4" | 1 |
| PFC1691530 | 7/8" Plug | 7/8" | 1 |
| PFC1691540 | 1" Plug | 1" | 1 |
| PFC1691550 | 1-1/8" Plug | 1-1/8" | 1 |
| PFC1691555 | 1-1/4" Plug | 1-1/4" | 1 |
| PFC1691560 | 1-3/8" Plug | 1-3/8" | 1 |
| PFC1691570 | 1-1/2" Plug | 1-1/2" | 1 |
| PFC1691580 | 1-3/4" Plug | 1-3/4" | 1 |
| PFC1691590 | 2" Plug | 2" | 1 |
| PFC1691600 | 2-3/16" Plug | 2-3/16" | 1 |

## SDS+ Carbide Drill Bits

| Cat. No. | Diameter | Usable Length | Overall Length |
|---|---|---|---|
| DW5433 | 7/16" | 4" | 6" |
| DW5435 | 7/16" | 10" | 12" |
| DW5436 | 7/16" | 16" | 18" |
| DW5437 | 1/2" | 4" | 6" |
| DW5438 | 1/2" | 8" | 10" |
| DW5439 | 1/2" | 10" | 12" |
| DW5440 | 1/2" | 16" | 18" |
| DW5441 | 1/2" | 22" | 24" |
| DW5442 | 9/16" | 4" | 6" |
| DW5443 | 9/16" | 10" | 12" |
| DW5444 | 9/16" | 16" | 18" |
| DW5446 | 5/8" | 6" | 8" |
| DW5447 | 5/8" | 10" | 12" |
| DW5448 | 5/8" | 16" | 18" |
| DW5449 | 5/8" | 22" | 24" |
| DW5450 | 11/16" | 6" | 8" |
| DW5453 | 3/4" | 6" | 8" |
| DW5455 | 3/4" | 10" | 12" |
| DW5456 | 3/4" | 16" | 18" |
| DW5457 | 3/4" | 22" | 24" |

## Diamond Core Bits

| Cat. No. | Diameter | Usable Length |
|---|---|---|
| DW55000 | 1/2" | 14" |
| DW55001 | 9/16" | 14" |
| DW55002 | 5/8" | 14" |
| DW55003 | 11/16" | 14" |
| DW55004 | 3/4" | 14" |
| DW55005 | 7/8" | 14" |
| DW55006 | 1" | 14" |
| DW55007 | 1-1/8" | 14" |
| DW55008 | 1-1/4" | 14" |
| DW55009 | 1-3/8" | 14" |
| DW55010 | 1-1/2" | 14" |
| DW55011 | 1-3/4" | 14" |
| DW55012 | 2" | 14" |
| DW55013 | 2-1/4" | 14" |
| DW55014 | 2-1/2" | 14" |

## SDS Max 4-Cutter Carbide Drill Bits

| Cat. No. | Diameter | Usable Length | Overall Length |
|---|---|---|---|
| DW5806 | 5/8" | 8" | 13-1/2" |
| DW5809 | 5/8" | 16" | 21-1/2" |
| DW5807 | 5/8" | 31" | 36" |
| DW5808 | 11/16" | 16" | 21-1/2" |
| DW5810 | 3/4" | 8" | 13-1/2" |
| DW5812 | 3/4" | 16" | 21-1/2" |
| DW5813 | 3/4" | 31" | 36" |
| DW5814 | 13/16" | 16" | 21-1/2" |
| DW5815 | 7/8" | 8" | 13-1/2" |
| DW5816 | 7/8" | 16" | 21-1/2" |
| DW5851 | 7/8" | 31" | 36" |
| DW5817 | 27/32" | 16" | 21-1/2" |
| DW5818 | 1" | 8" | 13-1/2" |
| DW5819 | 1" | 16" | 22-1/2" |
| DW5852 | 1" | 24" | 29" |
| DW5820 | 1" | 31" | 36" |
| DW5821 | 1-1/8" | 10" | 15" |
| DW5822 | 1-1/8" | 18" | 22-1/2" |
| DW5853 | 1-1/8" | 24" | 29" |
| DW5854 | 1-1/8" | 31" | 36" |
| DW5824 | 1-1/4" | 10" | 15" |
| DW5825 | 1-1/4" | 18" | 22-1/2" |
| DW5855 | 1-1/4" | 24" | 29" |
| DW5826 | 1-1/4" | 31" | 36" |
| DW5827 | 1-3/8" | 18" | 22-1/2" |
| DW5856 | 1-3/8" | 24" | 29" |
| DW5857 | 1-3/8" | 31" | 36" |
| DW5828 | 1-1/2" | 18" | 22-1/2" |
| DW5858 | 1-1/2" | 24" | 29" |
| DW5859 | 1-1/2" | 31" | 36" |
| DW5830 | 1-3/4" | 18" | 22-1/2" |
| DW5831 | 2" | 18" | 22-1/2" |

## Dust Extraction

| Cat. No. | Description |
|---|---|
| DWV015 | 10 Gallon Wet/Dry HEPA/RRP Dust Extractor<br>DWV9402 Fleece bag for DEWALT dust extractors<br>DWV9336 Replacement Anti-Static Hose<br>DWV9330 Replacement HEPA Filter Set |
| DWH050K | Dust Extraction with two interchangeable drilling heads |
| DCB1800B | 1800 Watt Portable Power Station &<br>Parallel Battery Charger Bare Unit |

## Hollow Drill Bits

| Shank | Cat. No. | Diameter | Overall Length | Usable Length | Recommended Hammer |
|---|---|---|---|---|---|
| SDS+ | DWA54012 | 1/2" | 14-1/2" | 9-3/4" | DCH133 / DCH273 / DCH293 |
| | DWA54916 | 9/16" | 14-1/2" | 9-3/4" | DCH133 / DCH273 / DCH293 |
| | DWA54058 | 5/8" | 14-1/2" | 9-3/4" | DCH133 / DCH273 / DCH293 |
| | DWA54034 | 3/4" | 14-1/2" | 9-3/4" | DCH133 / DCH273 / DCH293 |
| SDS Max | DWA58058 | 5/8" | 23-5/8" | 15-3/4" | DCH481 / D25603K |
| | DWA58958 | 5/8" | 47-1/4" | 39-3/8" | DCH481 / D25603K |
| | DWA58116 | 11/16" | 24-3/4" | 15-3/4" | DCH481 / D25603K |
| | DWA58034 | 3/4" | 23-5/8" | 15-3/4" | DCH481 / D25603K |
| | DWA58934 | 3/4" | 47-1/4" | 39-3/8" | DCH481 / D25603K |
| | DWA58078 | 7/8" | 23-5/8" | 15-3/4" | DCH481 / D25603K |
| | DWA58001 | 1" | 23-5/8" | 15-3/4" | DCH481 / D25603K |
| | DWA58901 | 1" | 47-1/4" | 39-3/8" | DCH481 / D25603K |
| | DWA58118 | 1-1/8" | 23-5/8" | 15-3/4" | DCH481 / D25603K |
| | DWA58918 | 1-1/8" | 47-1/4" | 39-3/8" | DCH481 / D25603K |
| | DWA58115 | 1-1/4" | 23-5/8" | 15-3/4" | DCH481 / D25603K |
| | DWA58114 | 1-1/4" | 47-1/4" | 39-3/8" | DCH481 / D25603K |
| | DWA58138 | 1-3/8" | 47-1/4" | 39-3/8" | DCH481 / D25603K |
| | DWA58112 | 1-1/2" | 47-1/4" | 39-3/8" | DCH481 / D25603K |

DUSTX+ ANCHOR INSTALLATION SYSTEM