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# PC-Concrete Pro™ Technical Data Sheet

## Product Description

PC-Concrete Pro™ is a code compliant, two component (1:1 mix ratio by volume), high performance epoxy anchoring system approved for use in cartridges and in bulk with threaded rod and reinforcing bar for cracked and uncracked concrete conditions, and internally threaded inserts in uncracked concrete, in accordance with ACI 355.4 and ICC-ES AC308. It has an extended application temperature range between 43 °F and 110 °F (6 °C and 43 °C) for structural applications per IAPMO ER-632 and between 38 °F and 125 °F (3 °C and 52 °C) for transportation infrastructure applications to AASHTO M235 & ASTM C881.

## Specification

Anchoring adhesive shall be a two component, 1:1 ratio by volume, epoxy anchoring system supplied in pre-measured cartridges or bulk. Adhesive must meet the requirements of ICC- ES AC308, ACI 355.4 and ASTM C881-15 specification for Type I, II, IV, and V, Grade 3 Class A, B & C. Adhesive must have a heat deflection temperature of 148 °F (64 °C) per ASTM D648 and have a compressive yield strength of 14,480 psi (99.8 MPa) at 75° F (24 °C) after a 7 day cure per ASTM D695. Adhesive shall be PC-Concrete Pro™ from Protective Coating Company. Anchors shall be installed per the Manufacturer's Printed Installation Instructions (MPII) for PC-Concrete Pro™ anchoring system.

## Availability

Protective Coating Co. products are available online and through select distributors providing all your construction needs. Please contact Protective Coating Co. for a distributor near you or visit www.pcepoxy.com.

## *STANDARDS AND APPROVALS*

**CODE COMPLIANT:**

**IAPMO-UES ER-632**

**IBC/IRC 2018, 2015, 2012, 2009**

**Florida Building Code (FBC) Compliant: 2017 & 2014**

**City of Los Angeles Code (LABC/LARC) Compliant: 2017**

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

**ER-632**

## General Uses & Applications

- Anchoring threaded rod and reinforcing bar (rebar) into cracked or uncracked concrete using hammer drill or threaded rod into uncracked concrete using core drill
- Suitable for dry, water saturated, & water-filled conditions using threaded rod or rebar
- Vertical down, horizontal, upwardly inclined and overhead installations

## Advantages & Features

- IAPMO ER-632 evaluation report for use in cracked and uncracked normal weight and lightweight concrete
- Code Compliant in cartridge and bulk dispensing systems, IBC/ IRC: 2018, 2015, 2012 & 2009
- ICC-ES AC308 and ACI 355.4 assessed for resisting short term loading conditions up to 205 °F (96 °C)
- Suitable for core drilled installations in dry or water saturated concrete
- Multiple anchor types: threaded rod, rebar & internally threaded inserts
- OSHA Table 1 compliant drilling/cleaning method using Milwaukee Tool hollow vacuum bit system
- Qualified for Seismic Design Categories A through F
- Florida Building Code (FBC) Compliant: 2017 & 2014
- City of Los Angeles Code (LABC/LARC) Compliant: 2017
- Made in the USA in accordance with CFR 49 section 50101

### Color & Ratio:

- Part A (Resin) White
- Part B (Hardener) Dark Gray
- Mixed Ratio: 1:1 by volume
- Mixed Color – Gray

### Storage & Shelf Life

- 24 months when stored in unopened containers in dry and dark conditions
- Store between 40 °F (4 °C) and 95 °F (35 °)

### Installation & Estimation:

Manufacturer's Printed Installation Instructions (MPII) are available in this Technical Data Sheet. Due to occasional updates and revisions, always verify that you are using the most current version of the MPII. In order to achieve maximum results, proper installation is imperative.

### Clean-Up:

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

### Limitations & Warnings:

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

### Safety:

Please refer to the Safety Data Sheet (SDS) for PC-Concrete Pro™ Call Protective Coating Co. for more information at 610-432-3543.

**TABLE 3:** PC-Concrete Pro™ **installation parameters**, brushes and piston plugs

| Threaded Rod in. | Rebar | Drill Bit Diameter in. | Maximum Installation Torque ft-lbs. (N-m) | Brush Part # | Brush Length in. | Piston Plug Part # | Color |
|---|---|---|---|---|---|---|---|
| 3/8 | ---- | 7/16 | 15 (20) | B6716 | 6 | P0716 | Black |
| ---- | #3 | 1/2 | ---- | B6012 | | | |
| 1/2 | ---- | 9/16 | 30 (41) | B6916 | | P0916 | Blue |
| ---- | #4 | 5/8 | ---- | B6058 | | P058 | Red |
| 5/8 | #5 | 3/4 | 60 (82) | B6034 | | P034 | Yellow |
| 3/4 | #6 | 7/8 | 105 (142) | B6078 | | P078 | Green |
| 7/8 | #7 | 1 | 125 (170) | B9001 | 9 | P100 | Black |
| 1 | #8 | 1 1/8 | 165 (224) | B9118 | | P118 | Orange |
| 1 1/4 | #9 | 1 3/8 | 280 (381) | B9138 | | P138 | Brown |
| ---- | #10 | 1 1/2 | ---- | B9112 | | P112 | Gray |

# MATERIAL SPECIFICATION

**TABLE 4:** PC-Concrete Pro™ performance to **ASTM C881-15**[1,2,3]

| Property | Cure Time | ASTM Standard | Units | Sample Conditioning Temperature | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Class A | Class B | Optional | Optional | Class C |
| | | | | 38 °F (3 °C) | 50 °F (10 °C) | 75 °F (24 °C) | 110 °F (43 °C) | 125 °F (52 °C) |
| Gel Time - 60 Gram Mass | ---- | C881 | min | 14 | 13 | 10 | 2[4] | 2[4] |
| Consistency or Viscosity | ---- | C881 | ---- | Non-sag | | | | |
| Compressive Yield Strength | 7 day | D695 | psi (MPa) | 12,980 (89.5) | 13,280 (91.6) | 14,480 (99.8) | 14,500 (100.0) | 13,430 (92.6) |
| Compressive Modulus | 7 day | D695 | psi (MPa) | 534,900 (3,688) | 506,100 (3,489) | 475,900 (3,281) | 599,600 (4,134) | 585,600 (4,038) |
| Bond Strength Hardened to Hardened Concrete | 2 day | C882 | psi (MPa) | 2,700 (18.6) | 2,770 (19.1) | 2,780 (19.2) | 3,150 (21.7) | 2,050 (14.1) |
| | 14 day | C882 | psi (MPa) | 2,860 (19.7) | 2,950 (20.3) | 3,110 (21.4) | 3,050 (21.0) | 2,080 (14.3) |
| Bond Strength Fresh to Hardened Concrete | 14 day | C882 | psi (MPa) | 2,730 (18.8) | | | | |
| Tensile Strength[5] | 7 day | D638 | psi (MPa) | 6,780 (46.7) | | | | |
| Tensile Elongation[5] | 7 day | D638 | % | 1.0 | | | | |
| Heat Deflection Temperature | 7 day | D648 | °F (°C) | 148 (64) | | | | |
| Water Absorption | 24 hr | D570 | % | 0.02 | | | | |
| Linear Coefficient of Shrinkage | ---- | D2566 | % | 0.0003 | | | | |

1. Product testing results based on representative lot(s). Average results will vary according to the tolerances of the given property. 2. Full cure time is listed above to obtain the given properties for each product characteristic. 3. Results may vary due to environmental factors such as temperature, moisture and type of substrate. 4. Gel time may be lower than the minimum required for ASTM C881. 5. Optional testing for ASTM C881 Grade 3.

**TABLE 5:** PC-Concrete Pro™ **CURE SCHEDULE**[1,2,3]

| Base Material Temperature °F (°C) | Working Time min | Full Cure Time hr |
|---|---|---|
| 43 (6) | 45 | 144 |
| 50 (10) | 35 | 72 |
| 75 (24) | 16 | 7 |
| 90 (32) | 12 | 4 |
| 110 (43) | 3 | 2 |

1. Working and full cure times are approximate, may be linearly interpolated between listed temperatures and are based on cartridge/nozzle system performance.
2. Application Temperature: Substrate and ambient air temperature should be between 43 - 110 °F (6 - 43 °C).
3. When ambient or base material temperature falls below 70 °F (21 °C), condition the adhesive to 70 - 75 °F (21 - 24 °C) prior to use.

# MANUFACTURER'S PRINTED INSTALLATION INSTRUCTIONS

## Drilling and Cleaning

### Hammer Drilled Holes - Dry, Water Saturated (Damp), Water-Filled (Wet) Cracked and Uncracked Concrete

1. **(A) Recommended Dust Extractor System for drilling into dry and damp cracked and uncracked concrete** - Attach appropriate size drill bit to the Dust Extractor Vacuum System. The drill bit should conform to ANSI B212.15 and be the appropriate size for the anchor diameter to be installed. Drill the hole to the specified embedment depth.

   GO TO STEP 6 FOR EITHER CARTRIDGE OR BULK SYSTEMS

   **(B) Traditional Drilling Method for dry, damp and wet cracked and uncracked concrete** - Using a rotary hammer drill, and while following the manufacturer's operations manual, select appropriate size drill bit in compliance with ANSI B212.15, drill hole into the base material to the specified embedment depth. **CAUTION:** Always wear appropriate personal protection equipment (PPE) for eyes, ears & skin and avoid inhalation of dust during the drilling and cleaning process. Refer to the Safety Data Sheet (SDS) for details prior to proceeding.

   **BLOW (2X) - BRUSH (2X) - BLOW (2X)**

2. BLOW - **NOTE:** Remove any standing water from hole prior to beginning the cleaning process. Using oil free compressed air with a minimum pressure of 87 psi (6 bar), insert the air wand to the bottom of the drilled hole and blow out the debris with an up/down motion for a minimum of 2 seconds/cycles (2X).
3. BRUSH - Select the correct wire brush size for the drilled hole diameter, making sure that the brush is long enough to reach the bottom of the drilled hole. Reaching the bottom of the hole (use brush extension if required, brush in an up/down and twisting motion for 2 cycles (2X). **CAUTION:** The brush should be clean and contact the walls of the hole. If it does not, the brush is either too worn or small and should be replaced with a new brush of the correct diameter.

4. BLOW - Blow the hole out once more to remove brush debris using oil free compressed air with a minimum pressure of 87 psi (6 bar). Insert the air wand to the bottom of the drilled hole and blow out the debris with an up/down motion for a minimum of 2 seconds/cycles (2X). Visually inspect the hole to confirm it is clean. **NOTE:** If installation will be delayed for any reason, cover cleaned holes to prevent contamination.

   GO TO STEP 6 FOR EITHER CARTRIDGE OR BULK SYSTEMS

### Core Drilled Holes - Dry, Water Saturated (Damp) Uncracked Concrete

1. Using a core drill, and while following the manufacturer's operations manual, select appropriate size drill bit. Drill hole into the base material to the specified embedment depth. Remove center core and ensure that the specified embedment depth can be achieved. **CAUTION**: Always wear appropriate personal protection equipment (PPE) for eyes, ears & skin and avoid inhalation of dust during the drilling and cleaning process. Refer to the Safety Data Sheet (SDS) for details prior to proceeding.

2. FLUSH - Using pressurized water, place the tip of the water nozzle at the bottom or back of the drilled hole. Rinse the drilled hole with pressurized water until the water flows clean and free of debris.

   **BLOW (2X) - BRUSH (2X) - BLOW (2X)**

3. BLOW **- NOTE:** Remove any standing water from hole prior to beginning the cleaning process. Using oil free compressed air with a minimum pressure of 87 psi (6 bar), insert the air wand to the bottom of the drilled hole and blow out the debris with an up/down motion for a minimum of 2 seconds/cycles (2X).

4. BRUSH - Select the correct wire brush size for the drilled hole diameter, making sure that the brush is long enough to reach the bottom of the drilled hole. Reaching the bottom of the hole (use brush extension if required), brush in an up/down and twisting motion for 2 cycles (2X). **CAUTION**: The brush should be clean and contact the walls of the hole. If it does not, the brush is either too worn or small and should be replaced with a new brush of the correct diameter.

5. BLOW - Blow the hole out once more to remove brush debris using oil free compressed air with a minimum pressure of 87 psi (6 bar). Insert the air wand to the bottom of the drilled hole and blow out the debris with an up/down motion for a minimum of 2 seconds/cycles (2X). Visually inspect the hole to confirm it is clean. **NOTE:** If installation will be delayed for any reason, cover cleaned holes to prevent contamination.

   GO TO STEP 6 FOR EITHER CARTRIDGE OR BULK SYSTEMS

## Dispensing Preparation

### Cartridge Systems

6. **CAUTION:** Check the expiration date on the cartridge to ensure it is not expired. **Do not use expired product**! Remove the protective cap from the cartridge and insert the cartridge into the recommended dispensing tool. Before attaching mixing nozzle, balance the cartridge by dispensing a small amount of material until both components are flowing evenly. For a cleaner environment, hand mix the two components and let cure prior to disposal in accordance with local regulations.

7. Only after the cartridge has been balanced, screw on the proper Protective Coating Co. mixing nozzle to the cartridge. Do not modify mixing nozzle and confirm that internal mixing element is in place prior to dispensing adhesive. Take note of the air and base material temperatures and review the working/full cure time chart prior to starting the injection process.

8. Dispense an initial amount of material from the mixing nozzle onto a disposable surface until the product is a uniform gray color with no streaks, as adhesive must be properly mixed in order to perform as published. Dispose of the initial amount of adhesive according to federal, state and local regulations prior to injection into the drill hole. CAUTION: When changing cartridges, never re-use nozzles. For a new cartridge (or if working time has been exceeded), ensure that cartridge opening is clean, install a new nozzle and repeat Steps 6 & 7 above accordingly. Leave the mixing nozzle attached to the cartridge upon completion of work.

GO TO STEP 11A

### Bulk Systems

The bulk pump uses a two component delivery system whereby metering individual components and mixing of the two components are automatically controlled during dispensing through a metering manifold and disposable mixing nozzle. The bulk pump has a minimum input air pressure requirement of 80-90 psi @ 15 CFM, supplied through a regulator which reduces the pressure in order to control the rate of dispensing. The two individual adhesive components stay separate throughout the system, until they reach the specified disposable mixing nozzle via a manifold at the end of the bulk pump wand. Under normal operation, the bulk pump must be capable of dispensing the individual components at a 1:1 mix ratio by volume with a tolerance of ± 2%.

6. CAUTION: Check the expiration date on each product container to ensure it is not expired. Do not use expired product! Epoxy materials may separate. This is normal and can be expected when stored over a period of time. Part A Resin should not be remixed. Part B Hardener should

6

that e ual volumes of art A and art B are being dispensed.

9. After the proper pump dispensing ratio has been verified, place the appropriate mixing nozzle onto the bulk pump wand. Do not modify mixing nozzle.

10. Dispense the initial amount of material from the mixing nozzle onto a disposable surface until the product is a uniform gray color with no streaks, as and regulations prior to injection into the drill hole. Take note of the air and base material temperatures and review the working full cure time to starting the injection process.

## Installation and Curing (Vertical Down, Horizontal & Overhead)

11. (A) **NOTE: The engineering drawings must be followed. For any applications not covered by this document, or for any installation questions, please contact Protective Coating Co.** Insert the mixing nozzle, using an extension tube if necessary, to the bottom of the hole and fill from the bottom to the top approximately 2/3 full, being careful not to withdraw the nozzle too quickly as this may trap air in the adhesive. For internally threaded inserts only fill the hole to approximately half. NOTE: Building Code Requirements for Structural Concrete (ACI 318-11 / ACI 318-14) requires the Installer to be certified where adhesive anchors are to be installed in horizontal or overhead installations. If extension tubing is needed, it can be connected onto the outside of the tip of both the small mixing nozzle (072226) and the large mixing nozzle (076224) **NOTE:** When using a pneumatic dispensing tool, ensure that pressure is set at 90 psi (6.2 bar) maximum.

   (B) Piston plugs must be used for overhead installations and those between horizontal and overhead. Select the proper piston plug for the drill hole diameter. The piston plug fits directly onto the tip of both the small and large mixing nozzle. Extension tubing may also be used if needed in order to reach the bottom of the drill hole.

12. **(A)** Prior to inserting the threaded rod or rebar into the hole, make sure it is straight, clean and free of oil and dirt and that the necessary embedment depth is marked on the anchor element. Insert the anchor element into the hole while turning 1-2 rotations prior to the anchor reaching the bottom of the hole. Excess adhesive should be visible on all sides of the fully installed anchor. For installing the internally threaded inserts, thread a bolt into the insert and press it into the hole with a slight twisting motion. To finish, drive the insert down with sharp blows to the head of the bolt with a hammer until it is flush with the surface of the concrete. **CAUTION:** Use extra care with deep embedment or high temperature installations to ensure that the working time has not elapsed prior to the anchor being fully installed.

   (B) For overhead installations, horizontal and inclined (between horizontal and overhead), wedges should be used to support the anchor while the adhesive is curing. Take appropriate steps to protect the exposed threads of the anchor element from uncured adhesive until after the full cure time has elapsed.

   (C) Do not disturb, torque or apply any load to the installed anchor until the specified full cure time has passed. The amount of time needed to reach full cure is base material temperature dependent - refer to Table 5 for appropriate full cure time.

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## TECHNICAL DATA

PC-Concrete Pro™ has been tested and assessed by an accredited independent testing laboratory in accordance with ICC ES AC308, ACI 355.4 and ASTM E488 for use in cracked and uncracked, normal weight and lightweight concrete, for loading conditions including seismic and wind, for structural design to ACI 318-14 Chapter 17 (ACI 318-11/08 Appendix D) and is approved per IAPMO-UES ER-632. The design process and parameters for PC-Concrete Pro™ are shown in Tables 6 - 18 for Strength Design.

# STRENGTH DESIGN

## TABLE 6: PC-Concrete Pro™ DESIGN STRENGTH INDEX

| DESIGN STRENGTH | | Drilling Method | Threaded Rod | Rebar | Threaded Insert |
|---|---|---|---|---|---|
| Steel Strength | $N_{sa}$, $V_{sa}$ | ---- | 7 | 12 | 16 |
| Concrete Breakout | $N_{cb}$, $V_{cb}$, $V_{cp}$ | ---- | 8 | 13 | 17 |
| Strength Design Bond Strength (SD) | Cracked Concrete | Hammer Drilled | 9 | 14 | ---- |
| | Uncracked Concrete | | 9 | 14 | 18 |
| | Cracked Concrete | Vacuum Bit Drilled | 10 | ---- | ---- |
| | Uncracked Concrete | | 10 | ---- | ---- |
| | Uncracked Concrete | Core Drilled | 11 | 15 | ---- |

## TABLE 7: PC-Concrete Pro™ STEEL design information for THREADED ROD[1]

| Design Information | | | Symbol | Units | Threaded Rod 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/4" |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Anchor Diameter | | | *d* | in. (mm) | 0.375 (9.5) | 0.500 (12.7) | 0.625 (15.9) | 0.750 (19.1) | 0.875 (22.2) | 1.000 (25.4) | 1.250 (31.8) |
| Threaded Rod Cross-Sectional Area[4] | | | $A_{se}$ | in.$^2$ (mm$^2$) | 0.078 (50) | 0.142 (92) | 0.226 (146) | 0.335 (216) | 0.462 (298) | 0.606 (391) | 0.969 (625) |
| Carbon Steel | ASTM A36 Grade 36 F1554 Grade 36 | Nominal Strength as Governed by Steel Strength | $N_{sa}$ | lb. (kN) | 4,495 (20.0) | 8,230 (36.6) | 13,110 (58.3) | 19,370 (86.2) | 26,795 (119.2) | 35,150 (156.4) | 56,200 (250.0) |
| | | | $V_{sa}$ | lb. (kN) | 2,695 (12.0) | 4,940 (22.0) | 7,865 (35.0) | 11,625 (51.7) | 16,080 (71.5) | 21,900 (97.4) | 33,720 (150.0) |
| | | Reduction Factor for Seismic Shear | $\alpha_{V,seis}$ | ---- | 0.83 | 0.78 | 0.74 | 0.70 | 0.69 | 0.67 | 0.65 |
| | | Strength Reduction Factor for Tension[3] | $\phi$ | ---- | 0.75 | | | | | | |
| | | Strength Reduction actor for Shear[3] | $\phi$ | ---- | 0.65 | | | | | | |
| | ASTM A193 B7 ASTM F1554 Grade 105 | Nominal Strength as Governed by Steel Strength | $N_{sa}$ | lb. (kN) | 9,690 (43.1) | 17,740 (78.9) | 28,250 (125.7) | 41,750 (185.7) | 57,750 (256.9) | 75,750 (337.0) | 121,125 (538.8) |
| | | | $V_{sa}$ | lb. (kN) | 5,815 (25.9) | 10,645 (47.4) | 16,950 (75.4) | 25,050 (111.4) | 34,650 (154.1) | 45,450 (202.2) | 72,675 (323.3) |
| | | Reduction Factor for Seismic Shear | $\alpha_{V,seis}$ | ---- | 0.60 | 0.58 | 0.57 | 0.55 | 0.53 | 0.50 | 0.46 |
| | | Strength Reduction Factor for Tension[3] | $\phi$ | ---- | 0.75 | | | | | | |
| | | Strength Reduction Factor for Shear[3] | $\phi$ | ---- | 0.65 | | | | | | |
| Stainless Steel | ASTM F593 CW Stainless 316 & Type 304 | Nominal Strength as Governed by Steel Strength | $N_{sa}$ | lb (kN) | 7,750 (34.5) | 14,190 (63.1) | 22,600 (100.5) | 28,390 (126.3) | 39,270 (174.7) | 51,510 (229.1) | 82,365 (366.4) |
| | | | $V_{sa}$ | lb (kN) | 3,955 (17.6) | 7,235 (32.2) | 11,525 (51.3) | 17,035 (75.8) | 23,560 (104.8) | 30,905 (137.5) | 49,420 (219.8) |
| | | Reduction Factor for Seismic Shear | $\alpha_{V,seis}$ | ---- | 0.65 | 0.62 | 0.60 | 0.58 | 0.57 | 0.55 | 0.53 |
| | | Strength Reduction Factor for Tension[2] | $\phi$ | ---- | 0.65 | | | | | | |
| | | Strength Reduction Factor for Shear[2] | $\phi$ | ---- | 0.60 | | | | | | |

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

1. Values provided for common rod material types are based on specified strength and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable. Nuts and washers must be appropriate for the rod strength and type.
2. For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318-11 D4.4. Values correspond to a brittle steel element.
3. For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318-11 D4.4. Values correspond to a ductile steel element.
4. Cross-sectional area is minimum stress area applicable for either tension or shear.

**TABLE 8:** PC-Concrete Pro™ **CONCRETE BREAKOUT** design information for **THREADED ROD**

| Design Information | Symbol | Units | Threaded Rod | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/4" |
| Minimum Embedment Depth | $h_{ef,min}$ | in. (mm) | 2 3/8 (60) | 2 3/4 (70) | 3 1/8 (79) | 3 1/2 (89) | 3 3/4 (95) | 4 (102) | 5 (127) |
| Maximum Embedment Depth | $h_{ef,max}$ | in. (mm) | 7 1/2 (191) | 10 (254) | 12 1/2 (318) | 15 (381) | 17 1/2 (445) | 20 (508) | 25 (635) |
| Effectiveness Factor for Cracked Concrete | $k_{c,cr}$ | ---- SI | 17 (7.1) | | | | | | |
| Effectiveness Factor for Uncracked Concrete | $k_{c,uncr}$ | ---- SI | 24 (10) | | | | | | |
| Minimum Spacing Distance | $s_{min}$ | in. (mm) | $S_{min} = C_{min}$ | | | | | | |
| Minimum Edge Distance | $c_{min}$ | in. (mm) | 2 3/16 (56) | 2 13/16 (71) | 3 3/4 (95) | 4 3/8 (111) | 5 (127) | 5 5/8 (143) | 6 7/8 (175) |
| Minimum Concrete Thickness | $h_{min}$ | in. (mm) | $h_{ef}$ + 1.25 , [ ≥ 3.937 ] ($h_{ef}$ + 30 , [ ≥ 100 ]) | | $h_{ef}$ + 2$d_0$ where $d_o$ is the hole diameter | | | | |
| Critical Edge Distance (Uncracked Concrete Only) | $c_{ac}$ | in. | $C_{ac} = h_{ef} \cdot \left(\frac{\min(\tau_{k,uncr};\tau_{k,\max})}{1160}\right)^{0.4} \cdot \max\left[\left(3.1 - 0.7\frac{h}{h_{ef}}\right);1.4\right]$ | | | | | | |
| | | mm | $C_{ac} = h_{ef} \cdot \left(\frac{\min(\tau_{k,uncr};\tau_{k,\max})}{8}\right)^{0.4} \cdot \max\left[\left(3.1 - 0.7\frac{h}{h_{ef}}\right);1.4\right]$ | | | | | | |
| Strength Reduction Factor for Tension, Concrete Failure Mode, Condition B[1] | $\phi$ | ---- | 0.65 | | | | | | |
| Strength Reduction Factor for Shear, Concrete Failure Mode, Condition B[1] | $\phi$ | ---- | 0.70 | | | | | | |

For SI: 1 inch = 25.4 mm, 1lbf = 4.448 N, 1 psi = 0.006897 MPa
For pound-inch units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1MPa = 145.0 psi
1. Values provided for post-installed anchors with category as determined from ACI 355.4 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, while condition A requires supplemental reinforcement. Values are for use with the load combinations Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 Section 9.2, as applicable, as set forth in ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318-11 D.4.4.

**TABLE 9:** PC-Concrete Pro™ **BOND STRENGTH** design information for **THREADED ROD IN HAMMER DRILLED HOLES**[1,2,3,4]

| Design Information | | | Symbol | Units | Threaded Rod | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/4" |
| Minimum Embedment Depth | | | $h_{ef,min}$ | in. (mm) | 2 3/8 (60) | 2 3/4 (70) | 3 1/8 (79) | 3 1/2 (89) | 3 3/4 (95) | 4 (102) | 5 (127) |
| Maximum Embedment Depth | | | $h_{ef,max}$ | in. (mm) | 7 1/2 (191) | 10 (254) | 12 1/2 (318) | 15 (381) | 17 1/2 (445) | 20 (508) | 25 (635) |
| Maximum Service Temperature<br>Short Term **150 °F** (66 °C)<br>Long Term **110** °F (43 °C) | Cracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,cr}$ | psi (MPa) | 1,231 (8.5) | 1,088 (7.5) | 1,231 (8.5) | 979 (6.7) | 1,044 (7.2) | 1,153 (7.9) | 1,109 (7.6) |
| | | No Sustained Load | | psi (MPa) | 1,414 (9.7) | 1,248 (8.6) | 1,414 (9.7) | 1,127 (7.8) | 1,201 (8.3) | 1,327 (9.1) | 1,275 (8.8) |
| | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 2,171 (15.0) | 2,084 (14.4) | 2,001 (13.8) | 1,914 (13.2) | 1,831 (12.6) | 1,744 (12.0) | 1,575 (10.9) |
| | | No Sustained Load | | psi (MPa) | 2,497 (17.2) | 2,397 (16.5) | 2,301 (15.9) | 2,201 (15.2) | 2,105 (14.5) | 2,005 (13.8) | 1,810 (12.5) |
| Maximum Service Temperature<br>Short Term **180 °F** (82 °C)<br>Long Term **110 °F** (43 °C) | Cracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,cr}$ | psi (MPa) | 1,083 (7.5) | 957 (6.6) | 1,083 (7.5) | 861 (5.9) | 918 (6.3) | 1,018 (7.0) | 974 (6.7) |
| | | No Sustained Load | | psi (MPa) | 1,244 (8.6) | 1,101 (7.6) | 1,244 (8.6) | 992 (6.8) | 1,057 (7.3) | 1,170 (8.1) | 1,118 (7.7) |
| | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 1,910 (13.2) | 1,836 (12.7) | 1,762 (12.1) | 1,683 (11.6) | 1,610 (11.1) | 1,536 (10.6) | 1,388 (9.6) |
| | | No Sustained Load | | psi (MPa) | 2,197 (15.1) | 2,110 (14.5) | 2,027 (14.0) | 1,936 (13.3) | 1,849 (12.7) | 1,766 (12.2) | 1,596 (11.0) |
| Maximum Service Temperature<br>Short Term **205 °F** (96 °C)<br>Long Term **110 °F** (43 °C) | Cracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,cr}$ | psi (MPa) | 493 (3.4) | 437 (3.0) | 493 (3.4) | 391 (2.7) | 419 (2.9) | 465 (3.2) | 446 (3.1) |
| | | No Sustained Load | | psi (MPa) | 567 (3.9) | 502 (3.5) | 567 (3.9) | 451 (3.1) | 479 (3.3) | 535 (3.7) | 512 (3.5) |
| | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 870 (6.0) | 837 (5.8) | 800 (5.5) | 767 (5.3) | 735 (5.1) | 698 (4.8) | 632 (4.4) |
| | | No Sustained Load | | psi (MPa) | 1,000 (6.9) | 963 (6.6) | 921 (6.3) | 884 (6.1) | 846 (5.8) | 800 (5.5) | 725 (5.0) |
| Reduction Factor for Seismic Tension[5] | | | $\alpha_{N,seis}$ | ---- | 1.00 | | | 0.77 | 1.00 | 0.97 | 0.96 |
| Continuous Inspection | Strength Reduction Factors for Permissible Installation Conditions[6,7,8] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.65 | | 0.55 | | | | |
| | | Water-Filled Holes in Concrete | $\phi_{wf}$ | ---- | 0.55 | | | | | 0.45 | |
| | | | $K_{wf}$ | ---- | 1.00 | | | | | 0.98 | 0.88 |
| Periodic Inspection | Strength Reduction Factors for Permissible Installation Conditions[6,7,8] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.55 | | 0.45 | | | | |
| | | Water-Filled Holes in Concrete | $\phi_{wf}$ | ---- | 0.45 | | | | | | |
| | | | $K_{wf}$ | ---- | 1.00 | | | | | 0.92 | 0.75 |

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

1. Characteristic bond strength values correspond to concrete compressive strength $f'_c$ =2,500 psi (17.2 MPa). For uncracked concrete compressive strength $f'_c$ between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.1}$ (for SI: $(f'_c/17.2)^{0.1}$). For cracked concrete, no increase in bond strength is permitted.
2. Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D section D3.6 as applicable.
3. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a results of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
4. Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.
5. For structures in regions assigned to Seismic Design Category C, D, E, or F, the bond strength values shall be multiplied by $\alpha_{n,seis}$.
6. The tabulated value of $\phi$ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ shall be determined in accordance with ACI 318 D.4.4.
7. The values of $\phi$ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of $\phi$ shall be determined.
8. The values of $\phi$ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The $\phi$ factor of 0.65 represents a Category 1, 0.55 a Category 2 and 0.45 a Category 3.

**TABLE 10:** PC-Concrete Pro™ **BOND STRENGTH** design information for
**THREADED ROD in MILWAUKEE VACUUM BIT DRILLED HOLES**[1,2,3,4]

| Design Information | | | Symbol | Units | Threaded Rod 5/8" | 3/4" | 7/8" | 1" | 1 1/4" |
|---|---|---|---|---|---|---|---|---|---|
| Minimum Embedment Depth | | | $h_{ef,min}$ | in. (mm) | 3 1/8 (79) | 4 (89) | 3 3/4 (95) | 4 (102) | 5 (127) |
| Maximum Embedment Depth | | | $h_{ef,max}$ | in. (mm) | 12 1/2 (318) | 15 (381) | 17 1/2 (445) | 20 (508) | 25 (635) |
| Maximum Service Temperature<br>Short Term **150 °F** (66 °C)<br>Long Term **110** °F (43 °C) | Cracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,cr}$ | psi (MPa) | 1,022 (7.0) | 874 (6.0) | 900 (6.2) | 1,031 (7.1) | 992 (6.8) |
| | | No Sustained Load | | psi (MPa) | 1,175 (8.1) | 1,005 (6.9) | 1,031 (7.1) | 1,183 (8.2) | 1,140 (7.9) |
| | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 1,831 (12.6) | 1,766 (12.2) | 1,701 (11.7) | 1,636 (11.3) | 1,505 (10.4) |
| | | No Sustained Load | | psi (MPa) | 2,101 (14.5) | 2,027 (14.0) | 1,953 (13.5) | 1,879 (13.0) | 1,727 (11.9) |
| Maximum Service Temperature<br>Short Term **180 °F** (82 °C)<br>Long Term **110 °F** (43 °C) | Cracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,cr}$ | psi (MPa) | 900 (6.2) | 770 (5.3) | 792 (5.5) | 909 (6.3) | 874 (6.0) |
| | | No Sustained Load | | psi (MPa) | 1,035 (7.1) | 883 (6.1) | 909 (6.3) | 1,044 (7.2) | 1,005 (6.9) |
| | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 1,610 (11.1) | 1,553 (10.7) | 1,496 (10.3) | 1,440 (9.9) | 1,327 (9.1) |
| | | No Sustained Load | | psi (MPa) | 1,849 (12.7) | 1,784 (12.3) | 1,718 (11.8) | 1,653 (11.4) | 1,523 (10.5) |
| Maximum Service Temperature<br>Short Term **205 °F** (96 °C)<br>Long Term **110 °F** (43 °C) | Cracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,cr}$ | psi (MPa) | 409 (2.8) | 349 (2.4) | 358 (2.5) | 414 (2.9) | 400 (2.8) |
| | | No Sustained Load | | psi (MPa) | 470 (3.2) | 405 (2.8) | 414 (2.9) | 474 (3.3) | 456 (3.1) |
| | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 735 (5.1) | 707 (4.9) | 684 (4.7) | 656 (4.5) | 605 (4.2) |
| | | No Sustained Load | | psi (MPa) | 842 (5.8) | 814 (5.6) | 781 (5.4) | 753 (5.2) | 693 (4.8) |
| Reduction Factor for Seismic Tension[5] | | | $\alpha_{N,seis}$ | ---- | 1.00 | 0.77 | 1.00 | 0.97 | 0.96 |
| Continuous Inspection | Strength Reduction Factors for Permissible Installation Conditions[6,7,8] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.45 | | 0.55 | | 0.65 |
| | | | $\kappa_{ws}$ | ---- | 1.0 | | | | |
| Periodic Inspection | Strength Reduction Factors for Permissible Installation Conditions[6,7,8] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.45 | | | | 0.55 |
| | | | $\kappa_{ws}$ | ---- | 0.89 | 0.96 | 1.0 | | |

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

1. Characteristic bond strength values correspond to concrete compressive strength $f'_c$ =2,500 psi (17.2 MPa). For uncracked concrete compressive strength $f'_c$ between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.1}$ (for SI: $(f'_c/17.2)^{0.1}$). For cracked concrete, no increase in bond strength is permitted.
2. Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D section D3.6 as applicable.
3. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a results of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
4. Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.
5. For structures in regions assigned to Seismic Design Category C, D, E, or F, the bond strength values shall be multiplied by $\alpha_{n,seis}$.
6. The tabulated value of $\phi$ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ shall be determined in accordance with ACI 318 D.4.4.
7. The values of $\phi$ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of $\phi$ shall be determined.
8. The values of $\phi$ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The $\phi$ factor of 0.65 represents a Category 1, 0.55 a Category 2 and 0.45 a Category 3.

**TABLE 11:** PC-Concrete Pro™ **BOND STRENGTH** design information for **THREADED ROD IN CORE DRILLED HOLES**[1,2,3,4,5]

| Design Information | | | Symbol | Units | Threaded Rod 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/4" |
|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Embedment Depth | | | $h_{ef,min}$ | in. (mm) | 2 3/4 (70) | 3 1/8 (79) | 4 (89) | 3 3/4 (95) | 4 (102) | 5 (127) |
| Maximum Embedment Depth | | | $h_{ef,max}$ | in. (mm) | 10 (254) | 12 1/2 (318) | 15 (381) | 17 1/2 (445) | 20 (508) | 25 (635) |
| Maximum Service Temperature<br>Short Term **150 °F** (66 °C)<br>Long Term **110** °F (43 °C) | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 866 (6.0) | 866 (6.0) | 866 (6.0) | 866 (6.0) | 866 (6.0) | 866 (6.0) |
| | | No Sustained Load | | psi (MPa) | 996 (6.9) | 996 (6.9) | 996 (6.9) | 996 (6.9) | 996 (6.9) | 996 (6.9) |
| Maximum Service Temperature<br>Short Term **180 °F** (82 °C)<br>Long Term **110 °F** (43 °C) | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 766 (5.3) | 766 (5.3) | 766 (5.3) | 766 (5.3) | 766 (5.3) | 766 (5.3) |
| | | No Sustained Load | | psi (MPa) | 879 (6.1) | 879 (6.1) | 879 (6.1) | 879 (6.1) | 879 (6.1) | 879 (6.1) |
| Maximum Service Temperature<br>Short Term **205 °F** (96 °C)<br>Long Term **110 °F** (43 °C) | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 349 (2.4) | 349 (2.4) | 349 (2.4) | 349 (2.4) | 349 (2.4) | 349 (2.4) |
| | | No Sustained Load | | psi (MPa) | 400 (2.8) | 400 (2.8) | 400 (2.8) | 400 (2.8) | 400 (2.8) | 400 (2.8) |
| Continuous Inspection | Strength Reduction Factors for Permissible Installation Conditions[6,7,8] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.65 | | | | | |
| Periodic Inspection | Strength Reduction Factors for Permissible Installation Conditions[6,7,8] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.55 | | | | | |

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

1. Characteristic bond strength values correspond to concrete compressive strength $f'_c$ =2,500 psi (17.2 MPa). For uncracked concrete compressive strength $f'_c$ between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.1}$ (for SI: $(f'_c/17.2)^{0.1}$). For cracked concrete, no increase in bond strength is permitted.
2. Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D section D3.6 as applicable.
3. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a results of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
4. Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.
5. *K* factor not listed for conditions where *K* = 1.0.
6. The tabulated value of $\phi$ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ shall be determined in accordance with ACI 318 D.4.4.
7. The values of $\phi$ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of $\phi$ shall be determined.
8. The values of $\phi$ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The $\phi$ factor of 0.65 represents a Category 1, 0.55 a Category 2 and 0.45 a Category 3.

**TABLE 12:** PC-Concrete Pro™ **STEEL** design information for **REBAR**[1]

| Design Information | | Symbol | Units | Rebar Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 |
| Nominal Anchor Diameter | | $d_a$ | in. (mm) | 0.375 (9.5) | 0.500 (12.7) | 0.625 (15.9) | 0.750 (19.1) | 0.875 (22.2) | 1.000 (25.4) | 1.127 (28.6) | 1.270 (32.3) |
| Rebar Cross-Sectional Area[4] | | $A_{se}$ | in.$^2$ (mm$^2$) | 0.110 (71) | 0.200 (129) | 0.310 (200) | 0.440 (284) | 0.600 (387) | 0.790 (510) | 1.000 (645) | 1.270 (819) |
| ASTM A615 Grade 40 | Nominal Strength as Governed by Steel Strength | $N_{sa}$ | lb. (kN) | 6,600 (29.4) | 12,000 (53.4) | 18,600 (82.7) | 26,400 (117.4) | Grade 40 reinforcing bars are only available in sizes #3 through #6 per ASTM A615 | | | |
| | | $V_{sa}$ | lb. (kN) | 3,960 (17.6) | 7,200 (32.0) | 11,160 (49.6) | 15,840 (70.5) | | | | |
| | Reduction Factor for Seismic Shear | $\alpha_{V,seis}$ | ---- | 0.70 | 0.74 | 0.78 | 0.82 | | | | |
| | Strength Reduction Factor for Tension[3] | $\phi$ | ---- | 0.75 | | | | | | | |
| | Strength Reduction Factor for Shear[3] | $\phi$ | ---- | 0.65 | | | | | | | |
| ASTM A706 Grade 60 | Nominal Strength as Governed by Steel Strength | $N_{sa}$ | lb. (kN) | 8,800 (39.1) | 16,000 (71.2) | 24,800 (110.3) | 35,200 (156.6) | 48,000 (213.5) | 63,200 (281.1) | 80,000 (355.9) | 101,600 (451.9) |
| | | $V_{sa}$ | lb. (kN) | 5,280 (23.5) | 9,600 (42.7) | 14,880 (66.2) | 21,120 (93.9) | 28,800 (128.1) | 37,920 (168.7) | 48,000 (213.5) | 60,960 (271.2) |
| | Reduction Factor for Seismic Shear | $\alpha_{V,seis}$ | ---- | 0.70 | 0.74 | 0.78 | 0.82 | 0.73 | 0.63 | 0.53 | 0.42 |
| | Strength Reduction Factor for Tension[3] | $\phi$ | ---- | 0.75 | | | | | | | |
| | Strength Reduction Factor for Shear[3] | $\phi$ | ---- | 0.65 | | | | | | | |
| ASTM A615 Grade 60 | Nominal Strength as Governed by Steel Strength | $N_{sa}$ | lb. (kN) | 9,900 (44.0) | 18,000 (80.1) | 27,900 (124.1) | 39,600 (176.1) | 54,000 (240.2) | 71,100 (316.3) | 90,000 (400.3) | 114,300 (508.4) |
| | | $V_{sa}$ | lb. (kN) | 5,940 (26.4) | 10,800 (48.0) | 16,740 (74.5) | 23,760 (105.7) | 32,400 (144.1) | 42,660 (189.8) | 54,000 (240.2) | 68,580 (305.1) |
| | Reduction Factor for Seismic Shear | $\alpha_{V,seis}$ | ---- | 0.70 | 0.74 | 0.78 | 0.82 | 0.73 | 0.63 | 0.53 | 0.42 |
| | Strength Reduction Factor for Tension[3] | $\phi$ | ---- | 0.75 | | | | | | | |
| | Strength Reduction Factor for Shear[3] | $\phi$ | ---- | 0.65 | | | | | | | |
| ASTM A615 Grade 75 | Nominal Strength as Governed by Steel Strength | $N_{sa}$ | lb. (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) |
| | | $V_{sa}$ | lb. (kN) | 6,600 (29.4) | 12,000 (53.4) | 18,600 (82.7) | 26,400 (117.4) | 36,000 (160.1) | 47,400 (210.8) | 60,000 (266.9) | 76,200 (339.0) |
| | Reduction Factor for Seismic Shear | $\alpha_{V,seis}$ | ---- | 0.70 | 0.74 | 0.78 | 0.82 | 0.73 | 0.63 | 0.53 | 0.42 |
| | Strength Reduction Factor for Tension[2] | $\phi$ | ---- | 0.65 | | | | | | | |
| | Strength Reduction Factor for Shear[2] | $\phi$ | ---- | 0.60 | | | | | | | |

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

1. Values provided for common rod material types are based on specified strength and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable. Nuts and washers must be appropriate for the rod strength and type.
2. For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D4.4. Values correspond to a brittle steel element.
3. For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318-11 D4.4. Values correspond to a ductile steel element.
4. Cross-sectional area is minimum stress area applicable for either tension or shear.

**TABLE 13:** PC-Concrete Pro™ **CONCRETE BREAKOUT** design information for **REBAR**[1]

| Design Information | Symbol | Units | Rebar Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 |
| Minimum Embedment Depth | $h_{ef,min}$ | in. (mm) | 2 3/8 (60) | 2 3/4 (70) | 3 1/8 (79) | 3 1/2 (89) | 3 3/4 (95) | 4 (102) | 4 1/2 (114) | 5 (127) |
| Maximum Embedment Depth | $h_{ef,max}$ | in. (mm) | 7 1/2 (191) | 10 (254) | 12 1/2 (318) | 15 (381) | 17 1/2 (445) | 20 (508) | 22 1/2 (572) | 25 (635) |
| Effectiveness Factor Cracked Concrete | $k_{c,cr}$ | ---- SI | 17 (7.1) | | | | | | | |
| Effectiveness Factor Uncracked Concrete | $k_{c,uncr}$ | ---- SI | 24 (10) | | | | | | | |
| Minimum Spacing Distance | $s_{min}$ | in. (mm) | $S_{min} = C_{min}$ | | | | | | | |
| Minimum Edge Distance | $c_{min}$ | in. (mm) | 2 3/16 (56) | 2 13/16 (71) | 3 3/4 (95) | 4 3/8 (111) | 5 (127) | 5 5/8 (143) | 6 1/4 (159) | 6 7/8 (175) |
| Minimum Concrete Thickness | $h_{min}$ | in. (mm) | $h_{ef}$ + 1.25 , [ ≥ 3.937 ] ($h_{ef}$ + 30 , [ ≥ 100 ]) | | $h_{ef}$ + 2$d_0$ where $d_o$ is the hole diameter | | | | | |
| Critical Edge Distance (Uncracked Concrete Only) | $c_{ac}$ | in. | $C_{ac} = h_{ef} \cdot \left(\frac{\min(\tau_{k,uncr};\tau_{k,\max})}{1160}\right)^{0.4} \cdot \max\left[\left(3.1 - 0.7\frac{h}{h_{ef}}\right);1.4\right]$ | | | | | | | |
| | | mm | $C_{ac} = h_{ef} \cdot \left(\frac{\min(\tau_{k,uncr};\tau_{k,\max})}{8}\right)^{0.4} \cdot \max\left[\left(3.1 - 0.7\frac{h}{h_{ef}}\right);1.4\right]$ | | | | | | | |
| Strength Reduction Factor for Tension, Concrete Failure Mode, Condition B[1] | $\phi$ | ---- | 0.65 | | | | | | | |
| Strength Reduction Factor for Shear, Concrete Failure Mode, Condition B[1] | $\phi$ | ---- | 0.70 | | | | | | | |

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

1. Values provided for post-installed anchors with category as determined from ACI 355.4 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, while condition A requires supplemental reinforcement. Values are for use with the load combinations Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 Section 9.2, as applicable, as set forth in ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318-11 D.4.4.

**TABLE 14:** PC-Concrete Pro™ **BOND STRENGTH** design information for **REBAR IN HAMMER DRILLED HOLES**[1,2,3,4]

| Design Information | | | Symbol | Units | Rebar Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 |
| Minimum Embedment Depth | | | $h_{ef,min}$ | in. (mm) | 2 3/8 (60) | 2 3/4 (70) | 3 1/8 (79) | 3 1/2 (89) | 3 3/4 (95) | 4 (102) | 4 1/2 (114) | 5 (127) |
| Maximum Embedment Depth | | | $h_{ef,max}$ | in. (mm) | 7 1/2 (191) | 10 (254) | 12 1/2 (318) | 15 (381) | 17 1/2 (445) | 20 (508) | 22 1/2 (572) | 25 (635) |
| Maximum Service Temperature Short Term **150 °F** (66 °C) Long Term **110** °F (43 °C) | Cracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,cr}$ | psi (MPa) | 1,262 (8.7) | 1,235 (8.5) | 1,214 (8.4) | 1,188 (8.2) | 1,127 (7.8) | 1,066 (7.3) | 1,005 (6.9) | 940 (6.5) |
| | | No Sustained Load | | psi (MPa) | 1,449 (10.0) | 1,422 (9.8) | 1,396 (9.6) | 1,366 (9.4) | 1,296 (8.9) | 1,227 (8.5) | 1,157 (8.0) | 1,079 (7.4) |
| | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 1,897 (13.1) | 1,823 (12.6) | 1,749 (12.1) | 1,675 (11.5) | 1,605 (11.1) | 1,531 (10.6) | 1,457 (10.0) | 1,370 (9.4) |
| | | No Sustained Load | | psi (MPa) | 2,179 (15.0) | 2,097 (14.5) | 2,010 (13.9) | 1,927 (13.3) | 1,844 (12.7) | 1,762 (12.1) | 1,675 (11.5) | 1,575 (10.9) |
| Maximum Service Temperature Short Term **180 °F** (82 °C) Long Term **110 °F** (43 °C) | Cracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,cr}$ | psi (MPa) | 1,109 (7.6) | 1,088 (7.5) | 1,070 (7.4) | 1,044 (7.2) | 992 (6.8) | 940 (6.5) | 887 (6.1) | 827 (5.7) |
| | | No Sustained Load | | psi (MPa) | 1,275 (8.8) | 1,248 (8.6) | 1,231 (8.5) | 1,201 (8.3) | 1,140 (7.9) | 1,079 (7.4) | 1,018 (7.0) | 948 (6.5) |
| | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 1,666 (11.5) | 1,601 (11.0) | 1,540 (10.6) | 1,475 (10.2) | 1,409 (9.7) | 1,344 (9.3) | 1,279 (8.8) | 1,209 (8.3) |
| | | No Sustained Load | | psi (MPa) | 1,914 (13.2) | 1,840 (12.7) | 1,770 (12.2) | 1,697 (11.7) | 1,618 (11.2) | 1,544 (10.6) | 1,470 (10.1) | 1,392 (9.6) |
| Maximum Service Temperature Short Term **205 °F** (96 °C) Long Term **110 °F** (43 °C) | Cracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,cr}$ | psi (MPa) | 507 (3.5) | 498 (3.4) | 488 (3.4) | 474 (3.3) | 451 (3.1) | 428 (2.9) | 405 (2.8) | 377 (2.6) |
| | | No Sustained Load | | psi (MPa) | 581 (4.0) | 572 (3.9) | 563 (3.9) | 544 (3.8) | 516 (3.6) | 493 (3.4) | 465 (3.2) | 432 (3.0) |
| | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 758 (5.2) | 730 (5.0) | 702 (4.8) | 670 (4.6) | 650 (4.5) | 650 (4.5) | Not Applicable | |
| | | No Sustained Load | | psi (MPa) | 870 (6.0) | 837 (5.8) | 809 (5.6) | 772 (5.3) | 739 (5.1) | 707 (4.9) | 670 (4.6) | 632 (4.4) |
| Reduction Factor - Seismic Tension[5] | | | $\alpha_{N,seis}$ | ---- | 1.00 | | | | | 0.97 | 0.97 | 0.96 |
| Continuous Inspection | Strength Reduction Factors for Permissible Installation Conditions[6,7,8] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.65 | | 0.55 | | | | | |
| | | Water-Filled Holes in Concrete | $\phi_{wf}$ | ---- | 0.55 | | | | | 0.45 | | |
| | | | $K_{wf}$ | ---- | 1.00 | | | | | 0.96 | 0.92 | 0.88 |
| Periodic Inspection | Strength Reduction Factors for Permissible Installation Conditions[6,7,8] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.55 | | 0.45 | | | | | |
| | | Water-Filled Holes in Concrete | $\phi_{wf}$ | ---- | 0.45 | | | | | | | |
| | | | $K_{wf}$ | ---- | 1.00 | | | | | 0.92 | 0.83 | 0.75 |

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

1. Characteristic bond strength values correspond to concrete compressive strength $f'_c$ =2,500 psi (17.2 MPa). For uncracked concrete compressive strength $f'_c$ between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.1}$ (for SI: $(f'_c/17.2)^{0.1}$). For cracked concrete, no increase in bond strength is permitted.
2. Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D section D3.6 as applicable.
3. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a results of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
4. Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.
5. For structures in regions assigned to Seismic Design Category C, D, E, or F, the bond strength values shall be multiplied by $\alpha_{n,seis}$.
6. The tabulated value of $\phi$ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ shall be determined in accordance with ACI 318 D.4.4.
7. The values of $\phi$ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of $\phi$ shall be determined.
8. The values of $\phi$ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The $\phi$ factor of 0.65 represents a Category 1, 0.55 a Category 2 and 0.45 a Category 3.

**TABLE 15:** PC-Concrete Pro™ **BOND STRENGTH** design information for **REBAR** in **CORE DRILLED HOLES**[1,2,3,4,5]

| Design Information | | | Symbol | Units | Rebar Size | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | #4 | # 5 | #6 | #7 | #8 | #9 | #10 |
| Minimum Embedment Depth | | | $h_{ef,min}$ | in. (mm) | 2 3/4 (70) | 3 1/8 (79) | 3 1/2 (89) | 3 3/4 (95) | 4 (102) | 4 1/2 (114) | 5 (127) |
| Maximum Embedment Depth | | | $h_{ef,max}$ | in. (mm) | 10 (254) | 12 1/2 (318) | 15 (381) | 17 1/2 (445) | 20 (508) | 22 1/2 (572) | 25 (635) |
| Maximum Service Temperature<br>Short Term **150 °F** (66 °C)<br>Long Term **110** °F (43 °C) | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,cr}$ | psi (MPa) | 1,335 (9.2) | 1,300 (9.0) | 1,200 (8.3) | 1,105 (7.6) | 1,010 (7.0) | 910 (6.3) | 800 (5.5) |
| | | No Sustained Load | | psi (MPa) | 1,530 (10.5) | 1,490 (10.3) | 1,380 (9.5) | 1,270 (8.8) | 1,155 (8.0) | 1,045 (7.2) | 920 (6.3) |
| Maximum Service Temperature<br>Short Term **180 °F** (82 °C)<br>Long Term **110** °F (43 °C) | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,cr}$ | psi (MPa) | 1,175 (8.1) | 1,145 (7.9) | 1,055 (7.3) | 975 (6.7) | 885 (6.1) | 800 (5.5) | 705 (4.9) |
| | | No Sustained Load | | psi (MPa) | 1,350 (9.3) | 1,315 (9.1) | 1,215 (8.4) | 1,120 (7.7) | 1,020 (7.0) | 920 (6.3) | 810 (5.6) |
| Continuous Inspection | Strength Reduction Factors for Permissible Installation Conditions[6,7,8] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.65 | | | | | | |
| Periotic Inspection | Strength Reduction Factors for Permissible Installation Conditions[6,7,8] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.55 | | | | | | |

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

1. Characteristic bond strength values correspond to concrete compressive strength f´c =2,500 psi (17.2 MPa). For uncracked concrete compressive strength f´c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of (f´c /2,500)0.1 (for SI: (f´c /17.2)0.1). For cracked concrete, no increase in bond strength is permitted.
2. Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D section D3.6 as applicable.
3. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a results of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
4. Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.
5. *K* factor not listed for conditions where *K* = 1.0.
6. The tabulated value of $\phi$ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ shall be determined in accordance with ACI 318 D.4.4.
7. The values of $\phi$ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of $\phi$ shall be determined.
8. The values of $\phi$ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The $\phi$ factor of 0.65 represents a Category 1, 0.55 a Category 2 and 0.45 a Category 3.

**TABLE 16:** PC-Concrete Pro™ **STEEL** design information for **POWER-SERT INTERNALLY THREADED INSERT**[1]

| Design Information | | Symbol | Units | PS2-38 | PS2-12 | PS2-58 | PS2-34 | PS2-1 |
|---|---|---|---|---|---|---|---|---|
| Nominal Anchor Diameter | | $d$ | in. (mm) | 0.484 (12.3) | 0.591 (15.0) | 0.819 (20.8) | 0.898 (22.8) | 1.450 (36.8) |
| Cross-Sectional Area[2] | | $A_{se}$ | in.$^2$ (mm$^2$) | 0.102 (66) | 0.135 (87) | 0.302 (195) | 0.385 (248) | 0.785 (506) |
| Specified Tensile Strength | | $F_{uta}$ | psi | 64,000 | | | | |
| SAE - AISI 1020 Carbon Steel | Nominal Strength as Governed by Steel Strength | $N_{sa}$ | lb. (kN) | 6,625 (29.5) | 8,805 (39.2) | 19,625 (87.3) | 25,015 (111.3) | 51,050 (227.1) |
| | | $V_{sa}$ | lb. (kN) | 3,975 (17.7) | 5,285 (23.5) | 11,775 (52.4) | 15,010 (66.8) | 30,630 (136.2) |
| | Strength Reduction Factor for Tension[3] | $\phi$ | ---- | 0.75 | | | | |
| | Strength Reduction Factor for Shear[3] | $\phi$ | ---- | 0.65 | | | | |
| **Design Information** | | **Symbol** | **Units** | **PS6-38** | **PS6-12** | **PS6-58** | **PS6-34** | **PS6-1** |
| Nominal Anchor Diameter | | $d$ | in. (mm) | 0.484 (12.3) | 0.591 (15.0) | 0.819 (20.8) | 0.898 (22.8) | 1.450 (36.8) |
| Cross-Sectional Area[2] | | $A_{se}$ | in.$^2$ (mm$^2$) | 0.102 (66) | 0.135 (87) | 0.302 (195) | 0.385 (248) | 0.785 (506) |
| Specified Tensile Strength | | $F_{uta}$ | psi | 100,000 | | 85,000 | | |
| Type 316 Stainless Steel | Nominal Strength as Governed by Steel Strength | $N_{sa}$ | lb. (kN) | 10,195 (45.3) | 13,550 (60.3) | 30,190 (134.3) | 32,710 (145.5) | 66,760 (297.0) |
| | | $V_{sa}$ | lb. (kN) | 6,115 (27.2) | 8,130 (36.2) | 18,115 (80.6) | 19,625 (87.3) | 40,055 (178.2) |
| | Strength Reduction Factor for Tension[4] | $\phi$ | ---- | 0.65 | | | | |
| | Strength Reduction Factor for Shear[4] | $\phi$ | ---- | 0.60 | | | | |

1. Values provided for common rod material types are based on specified strength and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable. Nuts and washers shall be appropriate for the rod strength and type.
2. Cross-sectional area is minimum stress area applicable for either tension or shear.
3. For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ shall be determined in accordance with ACI 318-11 D4.4. Values correspond to a ductile steel element.
4. For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ shall be determined in accordance with ACI 318-11 D4.4. Values correspond to a brittle steel element.

**TABLE 17:** PC-Concrete Pro™ **CONCRETE BREAKOUT** design information for **POWER-SERT INTERNALLY THREADED INSERT**[1]

| Design Information | Symbol | Units | PS2-38<br>PS6-38 | PS2-12<br>PS6-12 | PS2-58<br>PS6-58 | PS2-34<br>PS6-34 | PS2-1<br>PS6-1 |
|---|---|---|---|---|---|---|---|
| Minimum Embedment Depth | $h_a$ | in.<br>(mm) | 2 3/4<br>(70) | 3 11/16<br>(94) | 5 3/4<br>(146) | 6 1/2<br>(165) | 8 1/2<br>(216) |
| Effective Embedment Depth for Concrete Breakout Design | $h_{ef,cb}$ | in.<br>(mm) | 2.5<br>(63.5) | 3.5<br>(89) | 5.5<br>(140) | 6.2<br>(157.5) | 8.2<br>(208) |
| Maximum Embedment Depth | $h_{ef,max}$ | in.<br>(mm) | Not Applicable | | | | |
| Effectiveness Factor for Uncracked Concrete | $k_{c,uncr}$ | ----<br>SI | 24<br>(10) | | | | |
| Minimum Spacing Distance | $s_{min}$ | in.<br>(mm) | $S_{min} = C_{min}$ | | | | |
| Minimum Edge Distance | $c_{min}$ | in.<br>(mm) | 2 1/2<br>(64) | 3 1/8<br>(79) | 4 3/8<br>(111) | 5<br>(127) | 7 1/2<br>(191) |
| Minimum Concrete Thickness | $h_{min}$ | in.<br>(mm) | 4 1/2<br>(114) | 5 3/8<br>(137) | 8<br>(203) | 10<br>(241) | 12 1/2<br>(318) |
| Critical Edge Distance (Uncracked Concrete Only) | $c_{ac}$ | in. | $C_{ac} = h_{ef} \cdot \left( \frac{\min(\tau_{k,uncr}; \tau_{k,\max})}{1160} \right)^{0.4} \cdot \max\left[ \left( 3.1 - 0.7 \frac{h}{h_{ef}} \right); 1.4 \right]$ | | | | |
| | | mm | $C_{ac} = h_{ef} \cdot \left( \frac{\min(\tau_{k,uncr}; \tau_{k,\max})}{8} \right)^{0.4} \cdot \max\left[ \left( 3.1 - 0.7 \frac{h}{h_{ef}} \right); 1.4 \right]$ | | | | |
| Strength Reduction Factor for Tension, Concrete Failure Mode, Condition B[1] | $\phi$ | ---- | 0.65 | | | | |
| Strength Reduction Factor for Shear, Concrete Failure Mode, Condition B[1] | $\phi$ | ---- | 0.70 | | | | |

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

1. Values provided for post-installed anchors with category as determined from ACI 355.4 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, while condition A requires supplemental reinforcement. Values are for use with the load combinations Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 Section 9.2, as applicable, as set forth in ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318-11 D.4.4.

**TABLE 18:** PC-Concrete Pro™ **BOND STRENGTH** design information for
**POWER-SERT INTERNALLY THREADED INSERT IN HAMMER DRILLED HOLES**[1,2,3,4]

| Design Information | | | Symbol | Units | PS2-38 PS6-38 | PS2-12 PS6-12 | PS2-58 PS6-58 | PS2-34 PS6-34 | PS2-1 PS6-1 |
|---|---|---|---|---|---|---|---|---|---|
| Internal Thread Diameter | | | $d_t$ | in.-TPI | 3/8 - 16 | 1/2 - 13 | 5/8 - 11 | 3/4 - 10 | 1 - 8 |
| Drill Bit Diameter | | | $d_o$ | in. | 1/2 | 5/8 | 7/8 | 1 | 1 1/2 |
| Recommended Drill Depth | | | $h_{drill}$ | in. (mm) | 3 1/4 (83) | 4 1/8 (105) | 6 1/4 (159) | 7 1/2 (191) | 9 1/2 (241) |
| Overall Anchor Length | | | $h_a$ | in. (mm) | 2 3/4 (70) | 3 11/16 (94) | 5 3/4 (146) | 6 1/2 (165) | 8 1/2 (216) |
| Effective Embedment Depth | | | $h_{ef,bond}$ | in. (mm) | 1.550 (39) | 2.488 (63) | 3.750 (95) | 3.744 (95) | 5.000 (127) |
| Maximum Service Temperature Short Term **150 °F** (66 °C) Long Term **110** °F (43 °C) | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 1,905 (13.1) | 1,814 (12.5) | 1,627 (11.2) | 1,562 (10.8) | 1,096 (7.6) |
| | | No Sustained Load | | psi (MPa) | 2,184 (15.1) | 2,084 (14.4) | 1,866 (12.9) | 1,792 (12.4) | 1,257 (8.7) |
| Maximum Service Temperature Short Term **180 °F** (82 °C) Long Term **110 °F** (43 °C) | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 1,675 (11.5) | 1,596 (11.0) | 1,431 (9.9) | 1,375 (9.5) | 966 (6.7) |
| | | No Sustained Load | | psi (MPa) | 1,923 (13.3) | 1,831 (12.6) | 1,644 (11.3) | 1,575 (10.9) | 1,109 (7.6) |
| Maximum Service Temperature Short Term **205 °F** (96 °C) Long Term **110 °F** (43 °C) | Uncracked Concrete Characteristic Bond Strength | With Sustained Load | $\tau_{k,uncr}$ | psi (MPa) | 820 (5.7) | 780 (5.4) | 700 (4.8) | 670 (4.6) | Not Applicable |
| | | No Sustained Load | | psi (MPa) | 874 (6.0) | 837 (5.8) | 749 (5.2) | 716 (4.9) | |
| Continuous Inspection | Strength Reduction Factors for Permissible Installation Conditions[6,7,8] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.65 | 0.55 | | | |
| Periodic Inspection | Strength Reduction Factors for Permissible Installation Conditions[5,6,7] | Dry Concrete | $\phi_d$ | ---- | 0.65 | | | | |
| | | Water Saturated Concrete | $\phi_{ws}$ | ---- | 0.55 | 0.45 | | | |

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

1. Characteristic bond strength values correspond to concrete compressive strength $f'_c$ =2,500 psi (17.2 MPa). For uncracked concrete compressive strength $f'_c$ between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.1}$ (for SI: $(f'_c/17.2)^{0.1}$).
2. Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D section D3.6 as applicable.
3. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a results of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
4. Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.
5. The tabulated value of $\phi$ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ shall be determined in accordance with ACI 318 D.4.4
6. The values of $\phi$ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of $\phi$ shall be determined.
7. The values of $\phi$ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The $\phi$ factor of 0.65 represents a Category 1, 0.55 a Category 2 and 0.45 a Category 3.