# ICC-ES Listing Report

**ELC-4027**

*Reissued July 2022*

*This listing is subject to renewal July 2023.*

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**CSI:** DIVISION: 03 00 00—CONCRETE
Section: 03 16 00—Concrete Anchors

DIVISION: 05 00 00—METALS
Section: 05 05 19—Post-Installed Concrete Anchors

**Product Certification System:**

The ICC-ES product-certification system includes evaluating reports of tests of standard manufactured product, prepared by accredited testing laboratories and provided by the listee, to verify compliance with applicable codes and standards. The system also involves factory inspections, and assessment and surveillance of the listee's quality system.

**Product:** AC200+™ Adhesive Anchor System in Cracked and Uncracked Concrete

**Listee:** DEWALT

**Compliance with the following standards:**

- Annex D, Anchorage, of CSA A23.3-14, Design of Concrete Structures, CSA Group.

**Compliance with the following codes:**

AC200+™ adhesive anchor system in cracked and uncracked concrete, as described in this listing report, are in conformance with CSA A23.3-14, Annex D, as referenced in the applicable section of the following code edition:

- *National Building Code of Canada*® 2015
  Applicable Section: Division B, Part 4, Section 4.3.3.

**Description of adhesive anchor system:**

The AC200+ adhesive anchor system comprised of AC200+ two-component adhesive filled in cartridges, static mixing nozzles, dispensing tools, hole cleaning equipment, and adhesive injection accessories. The AC200+ adhesive may be used with continuously threaded steel rods or deformed steel reinforcing bars. The primary components of the AC200+ adhesive anchor system, including the AC200+ adhesive cartridge, static mixing nozzle, and steel anchor elements, are shown in Figure 1.


**FIGURE 1—AC200+ ADHESIVE ANCHOR SYSTEM INCLUDING TYPICAL STEEL ANCHOR ELEMENTS**

AC200+ adhesive two components are kept separate by means of a labelled dual-cylinder cartridge. The two components combine and react when dispensed through a static mixing nozzle, supplied by DEWALT, which is attached to the cartridge. AC200+ is available in 9.5-ounce (280 mL) and 28-ounce (825 mL) cartridges. Each cartridge label is marked with the adhesive expiration date. The shelf life, as indicated by the expiration date, applies to an unopened cartridge stored in a dry, dark, and cool environment.

Standard hole cleaning equipment and dust extraction system equipment (i.e. suction, vacuum) are available from the report holder.

Standard hole cleaning equipment used after drilling is comprised of steel wire brushes supplied by DEWALT and compressed air nozzle (applicable for post-installed adhesive anchor system). Standard hole cleaning equipment is shown in Figure 3.

The DustX+™ extraction system automatically cleans the holes during drilling using hollow drill bits with a carbide head meeting the requirements of ANSI B212.15 and a DEWALT DWV012 / DWV902M vacuum equipped with an automatic filter cleaning system or equivalent approved by DEWALT (applicable for post-installed adhesive anchor system). After drilling with the DustX+ system, no future hole cleaning is required. See Figure 2 for an illustration of the DustX+™ extraction system.

AC200+ adhesive must be dispensed with manual dispensers, pneumatic dispensers, or electric powered dispensers supplied by DEWALT.

**Identification:**

1. AC200+ adhesive is identified by packaging labelled with the company's name (DEWALT) and address, anchor name, the lot number, the expiration date, listing report number (ELC-4027), and the ICC-ES listing mark. Threaded rods, nuts, washers, and deformed reinforcing bars are standard steel anchor elements and must conform to applicable national or international specifications as set forth in Tables 2 and 3 of this report or equivalent.
2. The report holder's contact information is the following:

   DEWALT
   701 EAST JOPPA ROAD
   TOWSON, MARYLAND 21286
   (800) 524-3244
   www.DEWALT.com
   anchors@DEWALT.com

**Installation:** The installation parameters are illustrated in Figure 4 and Table 1. Installation of the AC200+ adhesive anchor system must conform to the manufacturer's printed installation instructions (MPII) included in each unit package as described in Figure 3.

The adhesive anchor system may be used for upwardly inclined orientation applications (e.g. overhead). Upwardly included and horizontal orientation applications are to be installed using piston plugs for the $^5/_8$-inch through $1^1/_4$-inch (M16 through M30) diameter threaded steel rods and No. 5 through No. 10 (14 mm through 32 mm) steel reinforcing bars, installed in the specified hole diameter, and attached to the mixing nozzle and extension tube supplied by DEWALT as described in Figure 3 in this report. Upwardly included and horizontal orientation installation for the $^3/_8$-inch and $^1/_2$-inch (M10 and M12) diameter threaded steel rods, and No. 3 and No. 4 (10 mm and 12 mm) steel reinforcing bars may be injected directly to the end of the hole using extension tubing attached to the mixing nozzle with a hole depth $h_0 \leq 10"$ (250 mm).

Installation of anchors in horizontal or upwardly inclined orientations shall be fully restrained from movement throughout the specified curing period through the use of temporary wedges, external supports, or other methods. Where temporary restraint devices are used, their use shall not result in impairment of the anchor shear resistance.

The DEWALT drilling systems in Figure 2 collect and remove dust with a HEPA dust extractor during the hole drilling operation in dry base materials using hammer-drills (see Step 1 of the manufacturer's published installation instructions in Figure 3).

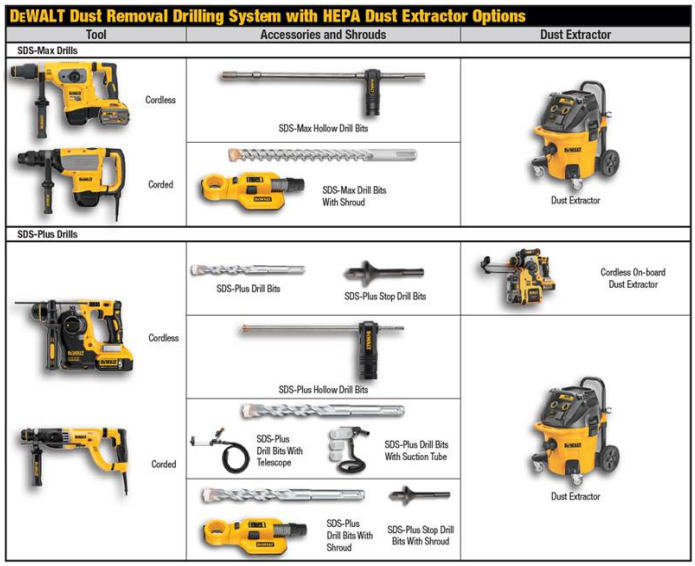


**FIGURE 2—EXAMPLES DEWALT DUST REMOVAL DRILLING SYSTEMS WITH HEPA DUST EXTACTORS FOR ILLUSTRATION**

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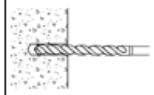
**AC200+ Instruction Card** Follow steps #1 through #10 for recommended installation

## 1. Setting instructions for Adhesive Anchors and Post-installed Rebar Connections in solid base material

### 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 (see Table III). Tolerances of carbide drill bits including hollow drill bits must meet ANSI Standard B212.15

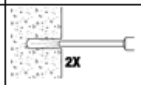
**Precaution:** Wear suitable eye and skin protection. Avoid inhalation of dusts during drilling and/or removal (*see dust extraction equipment by DEWALT to minimize dust emissions*).

**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.

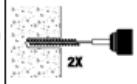
Drilling in dry concrete is recommended when using hollow drill bits (vacuum must be on).

➔ ***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.***

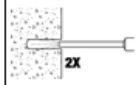
### Hole cleaning




2a. Starting from the bottom or back of the anchor hole, blow the hole clean with compressed air (min. 6 bar / 90 psi) a minimum of two times. If the back of the drilled hole is not reached an extension shall be used with the mixing nozzle.




2b. Determine brush diameter (see Table 3) for the drilled hole. 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 > 6" (150mm). The wire brush diameter must be checked periodically during use (see Table 3a or 3b as applicable). 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. If the back of the drilled hole is not reached a brush extension shall be used.

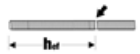



2c. Finally blow the hole clean again with compressed air (min. 6 bar / 90 psi) a minimum of two times, until return air stream is free of noticeable dust. If the back of the drilled hole is not reached an extension shall be used. When finished the hole should be clean and free of dust, debris, ice, grease, oil or other foreign material.

### Preparing

3. Check adhesive expiration date on cartridge label. Do not use expired product. Review Safety Data Sheet (SDS) before use. Cartridge adhesive temperature must be between 41°F - 104°F (5°C - 40°C) when in use; except for installations in base material temperatures between 14ºF and 23ºF (-10ºC and -5ºC) the cartridge adhesive temperature must be conditioned to 50ºF (10ºC) minimum. Review working and cure times. 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 Table 2. Attach a supplied mixing nozzle to the cartridge. 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.

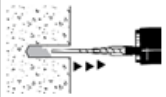
**Note:** Always use a new mixing nozzle with new cartridges of adhesive and also for all work interruptions exceeding the published gel (working) time of the adhesive.




4. Prior to inserting the anchor rod or 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.

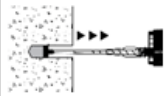

5. Adhesive must be properly mixed to achieve published properties. Prior to dispensing adhesive into the drilled hole, separately dispense at least three full strokes of adhesive through the mixing nozzle until the adhesive is a consistent gray color. Review and note the published working and cure times (see Table 2) prior to injection of the mixed adhesive into the cleaned anchor hole. Consideration should be given to the reduced gel (working) time of the adhesive in warm temperatures.

### Installation



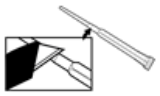
6. Fill the cleaned hole approximately two-thirds full with mixed adhesive starting from the bottom or back of the anchor hole. Slowly withdraw the mixing nozzle as the hole fills to avoid creating air pockets or voids. For embedment depths greater than 7-1/2" an extension tube supplied by DEWALT must be used with the mixing nozzle if the bottom or back of the hole is not reached with the mixing nozzle only.

*with piston plug:*

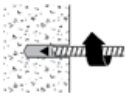


Piston plugs (see Table 3a or 3b) must be used with and attached to mixing nozzle and extension tube for:
- overhead installations and installations between horizontal and overhead (upwardly inclined)
- all installations with drill hole depth $d_o$ >10" (250mm) with anchor rod 5/8" to 1-1/4" (M16 to M30) diameter and rebar sizes #5 to #10 (Ø14 to Ø32)

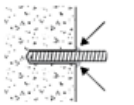
Insert piston plug to the back of the drilled hole and inject as described in the method above. During installation the piston plug will be naturally extruded from the drilled hole by the adhesive pressure.
- In the case that flexible tubing is used (Cat. #PFC1640600), the mixing nozzle may be trimmed at the perforation on the front port before attachment of the tubing.



**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.

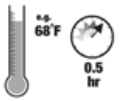


7. The anchor should be free of dirt, grease, oil or other foreign material. Push clean threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. Observe the gel (working) time.



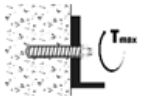
8. Be sure that the anchor is fully seated at the bottom of the hole and that some adhesive has flowed from the hole and all around the top of the anchor. Following installation of the anchor, remove excess adhesive. For overhead applications and applications between horizontal and overhead the anchor must be secured from moving/falling during the cure time (e.g. wedges). Minor adjustments to the anchor may be performed during the gel time but the anchor shall not be moved after placement and during cure.

### Curing and fixture




9. Allow the adhesive anchor to cure to the specified full curing time prior to applying any load (see Table 2).

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 (shown in Table 4) by using a calibrated torque wrench.

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

## 2. Gel (working) times and curing times

| Temperature of base material | | | | Gel (working) time | Full curing time |
|---|---|---|---|---|---|
| 14 °F | (-10 °C) to | 22 °F | (-6 °C) | 60 mins | 24 hrs |
| 23 °F | (-5 °C) to | 31 °F | (-1 °C) | 50 mins | 5 hrs |
| 32 °F | (0 °C) to | 40 °F | (+4 °C) | 25 mins | 3.5 hrs |
| 41 °F | (+5 °C) to | 49 °F | (+9 °C) | 15 mins | 2 hrs |
| 50 °F | (+10 °C) to | 58 °F | (+14 °C) | 10 mins | 1 hrs |
| 59 °F | (+15 °C) to | 67 °F | (+19 °C) | 6 mins | 40 mins |
| 68 °F | (+20 °C) to | 85 °F | (+29 °C) | 3 mins | 30 mins |
| 86 °F | (+30 °C) to | 104 °F | (+40 °C) | 2 mins | 30 mins |

FIGURE 3—MANUFACTURER'S PRINTED INSTALLATION INSTRUCTIONS (MPII)

## 3a. Standard hole cleaning / piston plug info (fractional sizes)[1]

| Threaded Rod [inch] | Rebar [inch] | $d_b$, Drill bit - Ø [inch] | $d_b$, Brush - Ø [mm] | $d_b$, Brush - Ø [inch] | Cat. # | Piston plug (size) | Cat. # Standard | Cat. # Premium |
|---|---|---|---|---|---|---|---|---|
| 3/8" | - | 7/16 | 13.5 | 0.528 | PFC1671050 | Piston plugs not required | | |
| - | #3 | 1/2 | 14.3 | 0.562 | PFC1671100 | | | |
| 1/2" | - | 9/16 | 16.3 | 0.654 | PFC1671150 | | | |
| - | #4 | 5/8 | 18.3 | 0.720 | PFC1671200 | | | |
| 5/8" | - | 11/16 | 20.0 | 0.787 | PFC1671225 | 11/16" | 08258-PWR | - |
| - | #5 | 3/4 | 21.5 | 0.846 | PFC1671250 | 3/4" | 08259-PWR | PFC1691520 |
| 3/4" | #6 | 7/8 | 24.8 | 0.976 | PFC1671300 | 7/8" | 08300-PWR | PFC1691530 |
| 7/8" | #7 | 1 | 28.5 | 1.122 | PFC1671350 | 1" | 08301-PWR | PFC1691540 |
| 1" | #8 | 1 1/8 | 31.8 | 1.252 | PFC1671400 | 1-1/8" | 08303-PWR | PFC1691550 |
| 1-1/4" | #9 | 1 3/8 | 38.2 | 1.504 | PFC1671450 | 1-3/8" | 08305-PWR | PFC1691560 |
| - | #10 | 1 1/2 | 41.4 | 1.630 | PFC1671500 | 1-1/2" | 08309-PWR | PFC1691570 |

[1]Note for Tables 3a and 3b: 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.

## 3b. Standard hole cleaning / piston plug info (EU metric and CA metric sizes)[1]

| Threaded Rod [mm] | Rebar EU \| CA [mm] | $d_b$, Drill bit - Ø EU \| CA [mm] | $d_b$, Drill bit - Ø EU \| CA [inch] | $d_b$, Brush - Ø [mm] | $d_b$, Brush - Ø [inch] | Cat. # EU | Cat. # CA | Piston plug (size) | Cat. # EU | Cat. # CA |
|---|---|---|---|---|---|---|---|---|---|---|
| M10 | - | 12 | - | 13.5 | 0.53 | DFC1670120 | - | Piston plugs not required | | |
| M12 | 10 \| 10M | 14 | 9/16 | 15.5 | 0.61 | DFC1670140 | PFC1671150 | | | |
| - | 12 | 16 | - | 17.5 | 0.69 | DFC1670160 | - | | | |
| - | 15M | - | 3/4 | 19 | 0.75 | PFC1671250 | - | 3/4" | - | 08259-PWR |
| M16 | 14 | 18 | - | 20 | 0.79 | DFC1670180 | - | 18mm | DFC1690100 | - |
| - | 16 | 20 | - | 22 | 0.87 | DFC1670190 | - | 20mm | DFC1690150 | - |
| M20 | - | 22 | - | 24 | 0.94 | DFC1670220 | - | 22mm | DFC1690180 | - |
| - | 20 \| 20M | 25 | 1 | 27 | 1.06 | DFC1670240 | PFC1671350 | 25mm \| 1" | DFC1690250 | 08301-PWR |
| M24 | - | 28 | - | 30 | 1.18 | DFC1670280 | - | 28mm | DFC1690300 | - |
| M27 | - | 30 | - | 31.8 | 1.25 | DFC1670310 | - | 30mm | DFC1690310 | - |
| - | 25 \| 25M | 32 | 1 1/4 | 34 | 1.34 | DFC1670320 | PFC1671425 | 32mm \| 1 1/4" | DFC1690350 | 08290-PWR |
| M30 | 28 | 35 | - | 37 | 1.46 | DFC1670330 | - | 35mm | DFC1690400 | - |
| - | 30M | - | 1 1/2 | - | 1.50 | PFC1691570 | - | 1 1/2" | - | 08291-PWR |
| - | 32 | 40 | - | 43.5 | 1.71 | DFC1670340 | - | 40mm | DFC1690420 | - |

## 4. Adhesive Anchor property / setting information (fractional and metric sizes)

| | Nominal threaded rod (fractional) Units: inch, ft.-lb. | | | | | | | Nominal threaded rod (metric) Units: mm, N-m | | | | | | | Reinforcing bar (fractional) Units: inch, ft.-lb. | | | | | | | | Reinforcing bar (metric) Units: mm, N-m | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nominal Anchor Size** | 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1-1/4" | M10 | M12 | M16 | M20 | M24 | M27 | M30 | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 | Ø10 | 10M | Ø12 | Ø14 | 15M | Ø16 | 20M | Ø20 | Ø25 | 25M | Ø28 | 30M | Ø32 | | |
| $d_a$ = Nominal anchor diameter | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.00 | 1.250 | 10 | 12 | 16 | 20 | 24 | 27 | 30 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/8 | 1-1/4 | 10 | | 12 | 14 | 15 | 16 | 20 | | 25 | | 28 | 30 | 32 | | |
| $d_o$ ($d_{bit}$) = Nominal ANSI drill bit size | 7/16 | 9/16 | 11/16 | 7/8 | 1 | 1-1/8 | 1-3/8 | 12 | 14 | 18 | 22 | 28 | 30 | 35 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/8 | 1-3/8 | 1-1/2 | 14 | 9/16" | 16 | 18 | 3/4" | 20 | 1" | 25 | 32 | 1 1/4" | 35 | 1 1/2" | 40 | | |
| $T_{max}$ = Maximum torque | 15[1] | 30 | 44 | 66 | 96 | 147 | 221 | 20 | 40 | 80 | 120 | 170 | 250 | 300 | 15[1] | 30 | 44 | 66 | 96 | 147 | 185 | 221 | 20 | | 40 | 45 | 80 | 80 | 120 | | 175 | | 250 | 275 | 300 | | |
| $h_{ef,min}$ = Minimum embedment | 2-3/8 | 2-3/4 | 3-1/8 | 3-1/2 | 3-1/2 | 4 | 5 | 60 | 70 | 80 | 90 | 96 | 108 | 120 | 2-3/8 | 2-3/4 | 3-1/8 | 3-1/2 | 3-1/2 | 4 | 4-1/2 | 5 | 60 | 70 | 70 | 75 | 80 | 80 | 90 | 90 | 100 | 100 | 112 | 120 | 128 | | |
| $h_{ef,max}$ = Maximum embedment | 7-1/2 | 10 | 12-1/2 | 15 | 17-1/2 | 20 | 25 | 200 | 240 | 320 | 400 | 480 | 540 | 600 | 7-1/2 | 10 | 12-1/2 | 15 | 17-1/2 | 20 | 22-1/2 | 25 | 200 | 225 | 240 | 280 | 320 | 320 | 390 | 400 | 500 | 505 | 560 | 600 | 640 | | |
| $s_{min}$ = Min. spacing | 1-7/8 | 2-1/2 | 3 | 3-5/8 | 4-1/4 | 4-3/4 | 5-7/8 | 50 | 60 | 80 | 100 | 120 | 135 | 150 | 1-7/8 | 2-1/2 | 3 | 3-5/8 | 4-1/4 | 4-3/4 | 5-1/4 | 5-7/8 | 50 | | 60 | 70 | 80 | 80 | 100 | | 125 | | 140 | 150 | 160 | | |
| $c_{min}$ = Min. edge distance w/100% $T_{max}$ | 1-5/8 | 1-3/4 | 2 | 2-3/8 | 2-1/2 | 2-3/4 | 3-1/4 | 45 | 45 | 55 | 60 | 70 | 75 | 80 | 1-5/8 | 1-3/4 | 2 | 2-3/8 | 2-1/2 | 2-3/4 | 3 | 3-1/4 | 45 | | 45 | 50 | 55 | | 60 | | 70 | | 75 | 70 | 85 | | |
| $c_{min}$ = Min. edge distance w/45% $T_{max}$ | - | | 1-3/4 | | | | 2-3/4 | - | | 45 | | | 70 | | - | | 1-3/4 | | | | 2-3/4 | | - | | 45 | | | | | | | | 70 | | | | |
| $h_{min}$ = Minimum member thickness | $h_{ef}$ + 1-1/4 | | $h_{ef}$ + $2d_o$ | | | | | $h_{ef}$ + 30 | | $h_{ef}$ + $2d_o$ | | | | | $h_{ef}$ + 1-1/4 | | $h_{ef}$ + $2d_o$ | | | | | | $h_{ef}$ + 30 | | $h_{ef}$ + $2d_o$ | | | | | | | | | | | | |
| **Nominal Post-installed Rebar Size** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $h_{ef,max}$ = Maximum embedment for Post-installed Rebar Connections | | | | | | | | | | | | | | | 22-1/2 | 30 | 37-1/2 | 45 | 52-1/2 | 60 | 67-1/2 | 75 | 600 | 680 | 720 | 840 | 960 | 960 | 1170 | 1200 | 1500 | 1510 | 1680 | 1795 | 1920 | | |

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

## 5. Adhesive Anchor and Post-installed Rebar Connection systems and accessories

| Dispensing tools | | Cartridge | Extra mixing nozzles | Piston plugs | Compressed air nozzle (min. 90 psi) | SDS connector for brush | Brush extension with wood handle |
|---|---|---|---|---|---|---|---|
| 10 fl. oz. manual and powered caulking guns | Cat. #08437-PWR – Standard metal<br>Cat. #08479-PWR - High performance<br>Cat. #DCE560D1 – Cordless battery | AC200+ 9.5 fl. oz. Quik-Shot w/nozzle<br>Cat. #PFC1271050 | AC200+ mixing nozzle<br>Cat. #PFC1641600 |  <br>See Table 3a or 3b for sizes and Cat. # |  <br>Note: if the back of the drilled hole is not reached an extension to the nozzle shall be used. |  <br>Cat. #PFC1671830 |  <br>Cat. #PFC1671000 |
| 28 fl. oz. manual and powered dispensers | Cat. #08495-PWR – Standard metal<br>Cat. #08496-PWR - High performance<br>Cat. #DCE595D1 – Cordless battery<br>Cat. #08496 - Pneumatic | AC200+ 28 fl. oz. Dual cart. w/nozzle<br>Cat. #PFC1271150 | AC200+ mixing nozzle<br>Cat. #PFC1641600 | | | **Extension tubes for nozzles**<br><br>Cat. #08281 or #08297<br>(Cat. #PFC1640600 for flex tubing) | **Brush extension**<br>  <br>Cat. #PFC1671820 |



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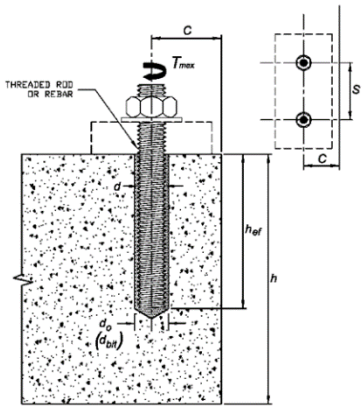
FIGURE 3—MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII) (Continued)

**Anchor setting information:**




**THREADED ROD**

**REINFORCING BAR**

**FIGURE 4—INSTALLATION PARAMETERS FOR THREADED RODS AND REINFORCING BARS**

**TABLE 1—INSTALLATION TORQUE SUBJECT TO EDGE DISTANCE**

For anchors that will be torqued during installation, the maximum torque, $T_{max}$, must be reduced for edge distances less than the values given in Tables 5, 8, 11 and 14, as applicable. $T_{max}$ is subject to the edge distance, $c_{min}$, and anchor spacing, $s_{min}$, and shall comply with the following requirements:

| INSTALLATION TORQUE SUBJECT TO EDGE DISTANCE | | | |
|---|---|---|---|
| **NOMINAL ANCHOR SIZE, *d*** | **MINIMUM EDGE DISTANCE, $c_{min}$** | **MINIMUM ANCHOR SPACING, $s_{min}$** | **MAXIMUM TORQUE, $T_{max}$** |
| #5 to #8<br>M16 to M24<br>ø14to ø25<br>($^5/_8$ in. to 1 in.)<br>15M to 25M | 44.5 mm<br>(1.75 in.) | 5*d* | 0.45·$T_{max}$ |
| #9 to #10<br>M27 to M30<br>ø28 to ø32<br>($1^1/_4$ in.)<br>30M | 70 mm<br>(2.75 in.) | | |

For values of $T_{max}$, see Figure 2 of this report.

**Ultimate Limit States Design:**

Design resistance of anchors for compliance with the 2015 NBCC must be determined in accordance with CSA A23.3-14 Annex D, and this listing report.

Design parameters are provided in Table 2 through 15 of this listing report are based on the 2015 NBCC (CSA A23.3-14). The limit states design of anchors must comply with CSA A23.3-14 D.5.1, except as required in CSA A23.3-14 D.4.3.1.

Material resistance factors must be $\phi_c$ = 0.65 *and* $\phi_s$ = 0.85 in accordance with CSA A23.3-14 Sections 8.4.2 and 8.4.3*,* and resistance modification factor, *R,* as given in CSA A23.3-14 Section D.5.3, and noted in Tables 4, 5, 7, 8, 10, 11, 13 and 14 of this listing report, must be used for load combinations calculated in accordance with Division B, Part 4, Section 4.1.3 of the 2015 NBCC, or Annex C of CSA A23.3-14. The nominal strength, $N_{sa}$ or $V_{sa}$, in Tables 4, 7, and 10 of this listing report must be multiplied by $\phi_s$ and *R* to determine the factored resistance, $N_{sar}$ or $V_{sar}$.

The bond strength must be adjusted by the permissible installation condition factors for dry concrete, $R_d$, water-saturated concrete, $R_{ws}$, and water-filled holes, $R_{wf}$, for the corresponding installation conditions as given in Tables 6, 9, 12 and 15.

For anchors to be installed in seismic regions described in NBCC 2015. The factored resistance in shear, $V_{sar}$, must be adjusted by $\alpha_{V,seis}$ as given in tables 4, 7, and 10 for the corresponding anchor steel. The nominal bond strength $\tau_{k,cr}$ must be adjusted by $\alpha_{N,seis}$ a as given in Tables 6, 9, 12 and 15 for threaded rods.

**TABLE 2—SPECIFICATIONS AND PHYSICAL PROPERTIES OF COMMON CARBON AND STAINLESS STEEL ROD MATERIALS[1]**

| | THREADED ROD SPECIFICATION | | MINIMUM SPECIFIED ULTIMATE STRENGTH, $f_{uta}$ | MINIMUM SPECIFIED YIELD STRENGTH 0.2 PERCENT OFFSET, $f_{ya}$ | $f_{uta}/f_{ya}$ | ELONGATION, MIN. PERCENT[11] | REDUCTION OF AREA, MIN. PERCENT | SPECIFICATION FOR NUTS[12] |
|---|---|---|---|---|---|---|---|---|
| CARBON STEEL | ASTM A193[2] Grade B7 | MPa | 860 | 720 | 1.19 | 16 | 50 | ASTM A194 / A563 Grade DH |
| | ASTM A36[3] / F1554[4], Grade 36 | MPa | 400 | 250 | 1.61 | 23 | 40 | ASTM A194 / A563 Grade A |
| | ASTM F1554[4] Grade 55 | MPa | 515 | 380 | 1.36 | 23 | 40 | |
| | ASTM F1554[4] Grade 105 | MPa | 860 | 725 | 1.19 | 15 | 45 | ASTM A194 / A563 Grade DH |
| | ASTM A449[5] (3/8" to1" dia.) | MPa | 830 | 635 | 1.30 | 14 | 35 | |
| | ASTM A449[5] (1-1/4" dia.) | MPa | 720 | 560 | 1.30 | 14 | 35 | |
| | ASTM F568M[6] Class 5.8 (equivalent to ISO 898-1) | MPa | 500 | 400 | 1.25 | 10 | 35 | A563 Grade DH DIN 934 (8-A2K)[13] |
| | ISO 898-1[7] Class 5.8 | MPa | 500 | 400 | 1.25 | 22 | - | EN ISO 4032 Grade 6 |
| | ISO 898-1[7] Class 8.8 | MPa | 800 | 640 | 1.25 | 12 | 52 | EN ISO 4032 Grade 8 |
| STAINLESS STEEL | ASTM F593[8] CW1 $^3/_8$ to $^5/_8$ in. | MPa | 690 | 450 | 1.54 | 20 | - | ASTM F594 Alloy Group 1, 2 or 3 |
| | ASTM F593[8] CW2 $^3/_4$ to $1^1/_4$ in. | MPa | 590 | 310 | 1.89 | 25 | - | |
| | ASTM A193/A193M[9] Grade B8/B8M2, Class 2B | MPa | 655 | 515 | 1.27 | 25 | 40 | ASTM A194/A194M |
| | ISO 3506-1[10] A4-70 M10-M24 | MPa | 700 | 450 | 1.56 | 40 | - | EN ISO 4032 |
| | ISO 3506-1[10] A4-50 M27-M30 | MPa | 500 | 210 | 2.38 | 40 | - | EN ISO 4032 |

[1]Adhesive must be used with continuously threaded carbon or stainless steel rod (all-thread) having thread characteristics complying with ANSI B1.1 UNC Coarse Thread Series.
[2]Standard Specification for Alloy-Steel and Stainless steel Bolting Materials for High temperature of High Pressure service and Other Special Purpose Applications.
[3]Standard Specification for Carbon Structural steel
[4]Standard Specification for Anchor Bolts, Steel 36, 55 and 105-ksi Yield Strength
[5]Standard Specification for Hex Cap Screws, Bolts and Studs, Heat Treated, 827/724/345 MPa Minimum Tensile Strength, General Use.
[6]Standard Specification for Carbon and Alloy Steel external Threaded Metric Fasteners
[7]Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel - Part 1: Bolts, Screws and Studs
[8]Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
[9]Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
[10]Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, Screws and Studs
[11]Based on 2-in. (50 mm) gauge length except for ASTM A193, which is based on a gauge length of 4d.
[12]Nuts and washers of other grades and style having specified proof load stress greater than the specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than the minimum tensile strength of the specified threaded rod.
[13]Nuts for metric rods.
[14]Minimum percent reduction of area not reported in the referenced standard.

**TABLE 3—SPECIFICATIONS AND PHYSICAL PROPERTIES OF COMMON STEEL REINFORCING BARS[1]**

| REINFORCING SPECIFICATION | UNITS | MINIMUM SPECIFIED ULTIMATE STRENGTH, $f_{uta}$ | MINIMUM SPECIFIED YIELD STRENGTH, $f_{ya}$ |
|---|---|---|---|
| ASTM A615[1], A767[3], A996[4] Grade 60 | MPa | 620 | 414 |
| ASTM A706[2], A767[3] Grade 60 | MPa | 550 | 414 |
| ASTM A615[1], Grade 40 | MPa | 415 | 275 |
| DIN 488[5], BSt 500 | MPa | 550 | 500 |
| CAN/CSA-G30.18[6], Grade 400 | MPa | 540 | 400 |

[1]Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
[2]Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
[3]Standard Specification for Zinc-Coated (Galvanized) steel Bars for Concrete Reinforcement.
[4]Standard Specification for Rail-Steel and Axle-steel Deformed bars for Concrete Reinforcement.
[5]Reinforcing steel, reinforcing steel bars; dimensions and masses.
[6]Billet-Steel Bars for Concrete Reinforcement.

**TABLE 4—STEEL DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD[1]**

| DESIGN INFORMATION | | Symbol | Units | Nominal Rod Diameter (inch) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1 1/4 |
| Threaded rod O.D. | | *d* | mm (inch) | 9.5 (0.375) | 12.7 (0.500) | 15.9 (0.625) | 19.1 (0.750) | 22.2 (0.875) | 25.4 (1.000) | 31.8 (1.250) |
| Threaded rod effective cross-sectional area | | $A_{se}$ | mm² (inch²) | 50 (0.0775) | 92 (0.1419) | 146 (0.2260) | 216 (0.3345) | 298 (0.4617) | 391 (0.6057) | 625 (0.9691) |
| ASTM A36/F1554, Grade 36 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 20.0 | 36.6 | 58.3 | 86.3 | 119.1 | 156.3 | 250.0 |
| | | $V_{sa}$ | kN | 12.0 | 22.0 | 35.0 | 51.8 | 71.4 | 93.8 | 150.0 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.60 | | | | | | |
| | Resistance modification factor for tension[2] | *R* | - | 0.80 | | | | | | |
| | Resistance modification factor for shear[2] | *R* | - | 0.75 | | | | | | |
| ASTM F1554 Grade 55 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 25.9 | 47.6 | 75.5 | 111.7 | 154.1 | 202.1 | 323.1 |
| | | $V_{sa}$ | kN | 15.5 | 28.6 | 45.3 | 67 | 92.5 | 121.3 | 193.9 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.60 | | | | | | |
| | Resistance modification factor for tension[2] | *R* | - | 0.80 | | | | | | |
| | Resistance modification factor for shear[2] | *R* | - | 0.75 | | | | | | |
| ASTM A193 Grade B7 ASTM F1554 Grade 105 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 43.1 | 78.9 | 125.7 | 186.0 | 256.7 | 336.8 | 538.8 |
| | | $V_{sa}$ | kN | 25.9 | 47.3 | 75.4 | 111.6 | 154.0 | 202.1 | 323.3 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.60 | | | | | | |
| | Resistance modification factor for tension[2] | *R* | - | 0.80 | | | | | | |
| | Resistance modification factor for shear[2] | *R* | - | 0.75 | | | | | | |
| ASTM A449 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 41.4 | 76.2 | 120.9 | 178.8 | 246.7 | 323.7 | 450.0 |
| | | $V_{sa}$ | kN | 24.8 | 45.7 | 72.5 | 107.3 | 148 | 194.2 | 270.0 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.60 | | | | | | |
| | Resistance modification factor for tension[2] | *R* | - | 0.80 | | | | | | |
| | Resistance modification factor for shear[2] | *R* | - | 0.75 | | | | | | |
| ASTM F568M Class 5.8 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 25 | 46 | 73 | 108 | 149 | 195.5 | 312.5 |
| | | $V_{sa}$ | kN | 15 | 27.6 | 43.8 | 64.8 | 89.4 | 117.3 | 187.5 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.60 | | | | | | |
| | Resistance modification factor for tension[3] | *R* | - | 0.70 | | | | | | |
| | Resistance modification factor for shear[3] | *R* | - | 0.65 | | | | | | |
| ASTM F593 CW Stainless | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 34.5 | 63.1 | 100.5 | 126.5 | 174.6 | 229.0 | 366.4 |
| | | $V_{sa}$ | kN | 20.7 | 37.9 | 60.3 | 75.9 | 104.7 | 137.4 | 219.8 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.60 | | | | | | |
| | Resistance modification factor for tension[3] | *R* | - | 0.70 | | | | | | |
| | Resistance modification factor for shear[3] | *R* | - | 0.65 | | | | | | |
| ASTM A193/A193M Grade B8/B8M2, Class 2B | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 32.8 | 60.3 | 95.6 | 141.5 | 195.2 | 256.1 | 409.4 |
| | | $V_{sa}$ | kN | 19.7 | 36.2 | 57.4 | 84.9 | 117.1 | 153.7 | 245.6 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.60 | | | | | | |
| | Resistance modification factor for tension[2] | *R* | - | 0.80 | | | | | | |
| | Resistance modification factor for shear[2] | *R* | - | 0.75 | | | | | | |

[1]Values provided for common rod material types based on specified strengths and calculated in accordance with CSA A23.3-14 Eq. D.2 and Eq. D.31, as applicable. Nuts and washers must comply with requirements for the rod.

[2]The tabulated value of material resistance factors $\phi_c$ and $\phi_s$, and resistance modification factor, *R*, applies when the load combinations of Division B, Part 4, Section 4.1.3 of the 2015 NBCC or Annex C of CSA A23.3-14 are used. Values correspond to ductile steel elements.

[3]The tabulated value of material resistance factors $\phi_c$ and $\phi_s$, and resistance modification factor, *R*, applies when the load combinations of Division B, Part 4, Section 4.1.3 of the 2015 NBCC or Annex C of CSA A23.3-14 are used. Values correspond to brittle steel elements.

**TABLE 5—CONCRETE BREAKOUT DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]**

| DESIGN INFORMATION | Symbol | Units | Nominal Rod Diameter (inch) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1 1/4 |
| Effectiveness factor for cracked concrete | $k_{c,cr}$ | SI (in-lb) | 7 (17) | | | | | | |
| Effectiveness factor for uncracked concrete | $k_{c,uncr}$ | SI (in-lb) | 10 (24) | | | | | | |
| Min. anchor spacing | $s_{min}$ | Mm (inch) | 48 (1 7/8) | 64 (2 1/2) | 76 (3) | 95 (3 3/4) | 108 (4 1/4) | 121 (4 3/4) | 149 (5 7/8) |
| Min. edge distance | $c_{min}$ | mm (inch) | 41 (1 5/8) | 45 (1 3/4) | 51 (2) | 60 (2 3/8) | 64 (2 1/2) | 70 (2 3/4) | 82 (3 1/4) |
| | | | | | For edge distances to 44 mm (1 3/4-inch) see Table 1 of this report. | | | | For edge distances to 70 mm (2 3/4-inch), see Table 1 of this report. |
| Min. member thickness | $h_{min}$ | mm (inch) | $h_{ef}$ + 30 ($h_{ef}$ + 1 1/4) | | $h_{ef}$ + 2$d_o$ [3] | | | | |
| Critical edge distance - splitting (for uncracked concrete only)[2] | $c_{ac}$ | - | 2$h_{ef}$ | | | | | | |
| Resistance modification factor for tension, concrete failure modes, Condition B[2] | $R$ | - | 1.00 | | | | | | |
| Resistance modification factor for shear, concrete failure modes, Condition B[2] | $R$ | - | 1.00 | | | | | | |

[1]Additional setting information is described in Figure 3, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in CSA A23.3-14 D.5. The tabulated value of the material resistance factors $\phi_c$ and $\phi_s$, and resistance modification factor, $R$, applies when the load combinations of Division B, Part 4, Section 4.1.3 of the 2015 NBCC or Annex C of CSA A23.3-14 are used.
[3] $d_o$ = hole diameter.

**TABLE 6—BOND STRENGTH DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]**

| DESIGN INFORMATION | | Symbol | Units | Nominal Rod Diameter (inch) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1 1/4 |
| Minimum embedment | | $h_{ef,min}$ | mm (inch) | 60 (2 3/8) | 70 (2 3/4) | 79 (3 1/8) | 89 (3 1/2) | 89 (3 1/2) | 102 (4) | 127 (5) |
| Maximum embedment | | $h_{ef,max}$ | mm (inch) | 191 (7 1/2) | 254 (10) | 318 (12 1/2) | 381 (15) | 445 (17 1/2) | 508 (20) | 635 (25) |
| **Temperature range A[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 17.9 | 16.6 | 15.6 | 14.8 | 14.2 | 13.8 | 13.7 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 7.2 | 7.2 | 7.7 | 8.4 | 8.4 | 8.3 | 7.9 |
| **Temperature range B[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 15.6 | 14.5 | 13.6 | 12.8 | 12.3 | 12.0 | 11.9 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 6.2 | 6.2 | 6.7 | 7.3 | 7.3 | 7.2 | 6.9 |
| **Temperature range C[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 11.2 | 10.4 | 9.8 | 9.3 | 8.9 | 8.6 | 8.6 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 4.5 | 4.5 | 4.8 | 5.3 | 5.2 | 5.2 | 5.0 |
| Dry Concrete | Anchor category | – | - | 1 | | | | | | |
| | Permissible installation condition factor | $R_d$ | - | 1.00 | | | | | | |
| Water-saturated concrete | Anchor category | – | - | 2 | | | | | | |
| | Permissible installation condition factor | $R_{ws}$ | - | 0.85 | | | | | | |
| Water-filled holes | Anchor category | - | - | 3 | | | | | | |
| | Permissible installation condition factor | $R_{wf}$ | - | 0.75 | | | | | | |
| Reduction factor for seismic tension | | $\alpha_{N,seis}$ | - | 0.95 | | | | | | |

[1]Bond strength values correspond to concrete compressive strength $f'_c$ = 2,500 psi. For concrete compressive strength, $f'_c$ between 2,500 psi and 8,000 psi, the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2500)^{0.10}$.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C); Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C); Temperature range C: Maximum short term temperature = 320°F (160°C), maximum long term temperature = 212°F (100°C).
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.
[3]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 23 percent for temperature range C.

**TABLE 7—STEEL DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING BARS [1]**

| DESIGN INFORMATION | | Symbol | Units | Nominal Bar Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | No. 3 | No. 4 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 |
| Reinforcing bar O.D. | | $d$ | mm (inch) | 9.5 (0.375) | 12.7 (0.500) | 15.9 (0.625) | 19.1 (0.750) | 22.2 (0.875) | 25.4 (1.000) | 28.6 (1.125) | 31.8 (1.250) |
| Reinforcing bar effective cross-sectional area | | $A_{se}$ | mm² (inch²) | 71 (0.110) | 129 (0.200) | 200 (0.310) | 284 (0.440) | 387 (0.600) | 510 (0.790) | 645 (1.000) | 819 (1.270) |
| ASTM A615, A767, A996 Grade 60 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 44.0 | 80.1 | 124.1 | 176.0 | 240.0 | 316.0 | 400.0 | 508.0 |
| | | $V_{sa}$ | kN | 26.4 | 48.0 | 74.5 | 105.7 | 144.1 | 189.8 | 240.2 | 305.0 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.65 | | | | | | | |
| | Resistance modification factor for tension[3] | $R$ | - | 0.70 | | | | | | | |
| | Resistance modification factor for shear[3] | $R$ | - | 0.65 | | | | | | | |
| ASTM A706 Grade 60 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 39.1 | 71.2 | 110.3 | 156.6 | 213.5 | 281.1 | 355.9 | 452.0 |
| | | $V_{sa}$ | kN | 23.5 | 42.7 | 66.2 | 93.9 | 128.1 | 168.7 | 213.5 | 271.2 |
| | Reduction for seismic shear | $\alpha_{V,seis}$ | ---- | 0.65 | | | | | | | |
| | Resistance modification factor $\phi$ for tension[2] | $R$ | ---- | 0.80 | | | | | | | |
| | Resistance modification factor $\phi$ for shear[2] | $R$ | ---- | 0.75 | | | | | | | |
| ASTM A615 Grade 40 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 29.4 | 53.4 | 82.7 | 117.4 | In accordance with ASTM A615, Grade 40 bars are furnished only in sizes No. 3 through No. 6 | | | |
| | | $V_{sa}$ | kN | 17.6 | 32.0 | 49.6 | 70.5 | | | | |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.65 | | | | | | | |
| | Resistance modification factor for tension[3] | $R$ | - | 0.70 | | | | | | | |
| | Resistance modification factor for shear[3] | $R$ | - | 0.65 | | | | | | | |

[1]Values provided for common bar material types based on specified strengths and calculated in accordance with CSA A23.3-14 Eq. D.2 and Eq. D.3.
[2]The tabulated value of the material resistance factors $\phi_c$ and $\phi_s$, and resistance modification factor, *R,* applies when the load combinations of Division B, Part 4, Section 4.1.3 of the 2015 NBCC or Annex C of CSA A23.3-14 are used. Values correspond to ductile steel elements
[3]The tabulated value of material resistance factors $\phi_c$ and $\phi_s$, and resistance modification factor, *R*, applies when the load combinations of Division B, Part 4, Section 4.1.3 of the 2015 NBCC or Annex C of CSA A23.3-14 are used. Values correspond to brittle steel elements.

**TABLE 8—CONCRETE BREAKOUT DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]**

| DESIGN INFORMATION | Symbol | Units | Nominal Bar Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. 3 | No. 4 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No.10 |
| Effectiveness factor for cracked concrete | $k_{c,cr}$ | SI (in-lb) | 7 (17) | | | | | | | |
| Effectiveness factor for uncracked concrete | $k_{c,uncr}$ | SI (in-lb) | 10 (24) | | | | | | | |
| Min. anchor spacing | $s_{min}$ | mm (inch) | 48 ($1^7/_8$) | 64 ($2^1/_2$) | 76 (3) | 95 ($3^3/_4$) | 108 ($4^1/_4$) | 121 ($4^3/_4$) | 133 ($5^1/_4$) | 149 ($5^7/_8$) |
| Min. edge spacing | $c_{min}$ | mm (inch) | 41 ($1^5/_8$) | 44 ($1^3/_4$) | 51 (2) | 60 ($2^3/_8$) | 64 ($2^1/_2$) | 70 ($2^3/_4$) | 76 (3) | 82 ($3^1/_4$) |
| | | | | | For edge distances to 45 mm (1¾-inch), see Table 1 of this report. | | | | | For edge distances to 70 mm (2¾-inch), see Table 1 of this report. |
| Min. member thickness | $h_{min}$ | mm (inch) | $h_{ef}$ + 30 ($h_{ef}$ + $1^1/_4$) | | $h_{ef}$ + $2d_0$ [3] | | | | | |
| Critical edge spacing – splitting (for uncracked concrete) | $c_{ac}$ | - | $2h_{ef}$ | | | | | | | |
| Resistance modification factor for tension, concrete failure modes, Condition B[2] | $R$ | - | 1.00 | | | | | | | |
| Resistance modification factor for shear, concrete failure modes, Condition B[2] | $R$ | - | 1.00 | | | | | | | |

[1]Additional setting information is described in Figure 3, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in CSA A23.3-14 D.5.3. The tabulated value of the material resistance factors $\phi_c$ and $\phi_s$, and resistance modification factor, *R,* applies when the load combinations of Division B, Part 4, Section 4.1.3 of the 2015 NBCC or Annex C of CSA A23.3-14 are used.
[3] $d_0$ = hole diameter.

**TABLE 9—BOND STRENGTH DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]**

| DESIGN INFORMATION | | Symbol | Units | Nominal Bar Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | No.3 | No. 4 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No.10 |
| Minimum embedment | | $h_{ef,min}$ | mm (inch) | 60 ($2^3/_8$) | 70 ($2^3/_4$) | 79 ($3^1/_8$) | 89 ($3^1/_2$) | 89 ($3^1/_2$) | 102 (4) | 114 ($4^1/_2$) | 127 (5) |
| Maximum embedment | | $h_{ef,max}$ | mm (inch) | 191 ($7^1/_2$) | 254 (10) | 318 ($12^1/_2$) | 381 (15) | 445 ($17^1/_2$) | 508 (20) | 572 ($22^1/_2$) | 635 (25) |
| **Temperature range A[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 15.2 | 14.5 | 14.0 | 13.6 | 13.2 | 13.0 | 12.7 | 12.5 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 7.5 | 7.3 | 7.8 | 8.1 | 8.1 | 8.0 | 7.9 | 8.0 |
| **Temperature range B[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 13.2 | 12.6 | 12.2 | 11.8 | 11.5 | 11.3 | 11.1 | 10.9 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 6.5 | 6.3 | 6.8 | 7.0 | 7.0 | 6.9 | 6.8 | 7.0 |
| **Temperature range C[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 9.5 | 9.1 | 8.8 | 8.5 | 8.3 | 8.1 | 8.0 | 7.8 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 4.7 | 4.6 | 4.9 | 5.1 | 5.1 | 5.0 | 4.9 | 5.0 |
| Dry concrete | Anchor category | – | - | 1 | | | | | | | |
| | Permissible installation condition factor | $R_d$ | - | 1.00 | | | | | | | |
| Water-saturated concrete | Anchor category | – | - | 2 | | | | | | | |
| | Permissible installation condition factor | $R_{ws}$ | - | 0.85 | | | | | | | |
| Water-filled holes | Anchor category | – | - | 3 | | | | | | | |
| | Permissible installation condition factor | $R_{wf}$ | - | 0.75 | | | | | | | |
| Reduction factor for seismic tension | | $\alpha_{N,seis}$ | - | 0.95 | 1.00 | | | | | | |

[1]Bond strength values correspond to concrete compressive strength $f'_c$ = 2,500 psi. For concrete compressive strength $f'_c$ between 2,500 psi and 8,000 psi, tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.10}$.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C); Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C); Temperature range C: Maximum short term temperature = 320°F (160°C), maximum long term temperature = 212°F (100°C). 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.
[3]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 23 percent for temperature range C.

**TABLE 10—STEEL DESIGN INFORMATION FOR METRIC THREADED ROD[1]**

| DESIGN INFORMATION | | Symbol | Units | Nominal Rod Diameter (mm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
| Threaded rod O.D. | | $d$ | mm ( inch) | 10 (0.39) | 12 (0.47) | 16 (0.63) | 20 (0.79) | 24 (0.94) | 27 (1.06) | 30 (1.18) |
| Threaded rod effective cross-sectional area | | $A_{se}$ | mm² ( inch²) | 58.0 (0.090) | 84.3 (0.131) | 157 (0.243) | 245 (0.380) | 353 (0.547) | 459 (0.711) | 561 (0.870) |
| ISO 898-1 Class 5.8 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 29.0 | 42.2 | 78.5 | 122.5 | 176.5 | 229.5 | 280.5 |
| | | $V_{sa}$ | kN | 17.4 | 25.3 | 47.1 | 73.5 | 105.9 | 137.7 | 168.3 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.60 | | | | | | |
| | Resistance modification factor for tension[2] | $R$ | - | 0.70 | | | | | | |
| | Resistance modification factor for shear[2] | $R$ | - | 0.65 | | | | | | |
| ISO 898-1 Class 8.8 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 46.4 | 67.4 | 125.6 | 196 | 282.4 | 367.2 | 448.8 |
| | | $V_{sa}$ | kN | 27.8 | 40.5 | 75.4 | 117.6 | 169.4 | 220.3 | 269.3 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.60 | | | | | | |
| | Resistance modification factor for tension[2] | $R$ | - | 0.70 | | | | | | |
| | Resistance modification factor for shear[2] | $R$ | - | 0.65 | | | | | | |
| ISO 3506-1, A4 stainless steel[3] | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 40.6 | 59 | 109.9 | 171.5 | 247.1 | 229.5 | 280.5 |
| | | $V_{sa}$ | kN | 24.4 | 35.4 | 65.9 | 102.9 | 148.3 | 137.7 | 168.3 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.60 | | | | | | |
| | Resistance modification factor for tension[2] | $R$ | - | 0.70 | | | | | | |
| | Resistance modification factor for shear[2] | $R$ | - | 0.65 | | | | | | |

[1]Values provided for common rod material types based on specified strengths and calculated in accordance with CSA A23.3-14 Eq. D.2 and Eq. D.3. Nuts and washers must comply with requirements for the rod.
[2]The tabulated value of the material resistance factors $\phi_c$ and $\phi_s$, and resistance modification factor, *R,* applies when the load combinations of Division B, Part 4, Section 4.1.3 of the 2015 NBCC or Annex C of CSA A23.3-14 are used. Values correspond to brittle steel elements
[3]A4-70 Stainless steel (M8-M24); A4-50 Stainless steel (M27-M30)

**TABLE 11—CONCRETE BREAKOUT DESIGN INFORMATION FOR METRIC THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]**

| DESIGN INFORMATION | Symbol | Units | Nominal Rod Diameter (mm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
| Effectiveness factor for cracked concrete | $k_{c,cr}$ | SI (in-lb) | 7 (17) | | | | | | |
| Effectiveness factor for uncracked concrete | $k_{c,uncr}$ | SI (in-lb) | 10 (24) | | | | | | |
| Min. anchor spacing | $s_{min}$ | mm ( inch) | 50 (2) | 60 ($2^3/_8$) | 75 (3) | 95 ($3^3/_4$) | 115 ($4^1/_2$) | 125 (5) | 140 ($5^1/_2$) |
| Min. edge distance | $c_{min}$ | mm (inch) | 40 ($1^5/_8$) . | 45 ($1^3/_4$) | 50 (2) | 60 ($2^3/_8$) | 65 ($2^1/_2$) | 75 (3) | 80 ($3^1/_8$) |
| | | | | | For edge distances to 45 mm ($1^3/_4$-inch), see Table 1 of this report. | | | | For edge distances to 70 mm ($2^3/_4$-inch), see Table 1 of this report. |
| Min. member thickness | $h_{min}$ | mm (inch) | $h_{ef}$ + 30 ($h_{ef}$ + $1^1/_4$) | | $h_{ef}$ + $2d_0$ [3] | | | | |
| Critical edge distance - splitting (for uncracked concrete only) | $c_{ac}$ | - | $2h_{ef}$ | | | | | | |
| Resistance modification factor for tension, concrete failure modes, Condition B[2] | $R$ | - | 1.00 | | | | | | |
| Resistance modification factor for shear, concrete failure modes, Condition B[2] | $R$ | - | 1.00 | | | | | | |

[1]Additional setting information is described in Figure 3, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in CSA A23.3 D.5.3. The tabulated value of the material resistance factors $\phi_c$ and $\phi_s$, and resistance modification factor, *R,* applies when the load combinations of Division B, Part 4, Section 4.1.3 of the 2015 NBCC or Annex C of CSA A23.3-14 are used.
[3] $d_0$ = hole diameter.

**TABLE 12—BOND STRENGTH DESIGN INFORMATION FOR METRIC THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]**

| DESIGN INFORMATION | | Symbol | Units | Nominal Rod Diameter (inch) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
| Minimum embedment | | $h_{ef,min}$ | mm (inch) | 60 (2.4) | 70 (2.8) | 80 (3.1) | 90 (3.5) | 96 (3.8) | 108 (4.3) | 120 (4.7) |
| Maximum embedment | | $h_{ef,max}$ | mm (inch) | 200 (7.9) | 240 (9.4) | 320 (12.6) | 400 (15.7) | 480 (18.9) | 540 (21.3) | 600 (23.6) |
| **Temperature range A[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 17.7 | 16.9 | 15.6 | 14.6 | 13.9 | 13.7 | 13.7 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 7.2 | 7.2 | 7.7 | 8.4 | 8.3 | 8.3 | 7.9 |
| **Temperature range B[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 15.4 | 14.7 | 13.5 | 12.7 | 12.1 | 11.9 | 11.9 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 6.2 | 6.3 | 6.7 | 7.3 | 7.2 | 7.2 | 6.9 |
| **Temperature range C[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 11.1 | 10.6 | 9.8 | 9.1 | 8.7 | 8.6 | 8.6 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 4.5 | 4.5 | 4.8 | 5.3 | 5.2 | 5.2 | 5.0 |
| Dry concrete | Anchor category | – | - | 1 | | | | | | |
| | Permissible installation condition factor | $R_d$ | - | 1.00 | | | | | | |
| Water-saturated concrete | Anchor category | – | - | 2 | | | | | | |
| | Permissible installation condition factor | $R_{ws}$ | - | 0.85 | | | | | | |
| Water-filled holes | Anchor category | – | - | 3 | | | | | | |
| | Permissible installation condition factor | $R_{wf}$ | - | 0.75 | | | | | | |
| Reduction factor for seismic tension | | $\alpha_{N,seis}$ | - | 0.95 | | | | | | |

[1]Bond strength values correspond to concrete compressive strength $f'_c$ = 2,500 psi. For concrete compressive strength, $f'_c$ between 2,500 psi and 8,000 psi, the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2500)^{0.10}$.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C ), maximum long term temperature = 122°F (50°C); Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C); Temperature range C: Maximum short term temperature = 320°F (160°C), maximum long term temperature = 212°F (100°C).
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.
[3]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 23 percent for temperature range C.

**TABLE 13—STEEL DESIGN INFORMATION FOR COMMON METRIC EU AND METRIC CANADIAN REINFORCING BARS [1]**

| DESIGN INFORMATION | | Symbol | Units | Nominal Bar Size (EU) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
| Reinforcing bar O.D. | | $d$ | mm (inch) | 10 (0.315) | 12 (0.394) | 14 (0.472) | 16 (0.551) | 20 (0.630) | 25 (0.787) | 28 (1.102) | 32 (1.260) |
| Reinforcing bar effective cross-sectional area | | $A_{se}$ | mm² (inch²) | 78.5 (0.112) | 113.1 (0.175) | 153.9 (0.239) | 201.1 (0.312) | 314.2 (0.487) | 490.9 (0.761) | 615.8 (0.954) | 804.2 (1.247) |
| DIN 488 BSt 500 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 43.2 | 62.2 | 84.7 | 110.6 | 172.8 | 270.0 | 338.7 | 442.3 |
| | | $V_{sa}$ | kN | 25.9 | 37.3 | 50.8 | 66.4 | 103.7 | 162.0 | 203.2 | 265.4 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.65 | | | | | | | |
| | Resistance modification factor for tension[2] | $R$ | - | 1.00 | | | | | | | |
| | Resistance modification factor for shear[2] | $R$ | - | 1.00 | | | | | | | |

| DESIGN INFORMATION | | Symbol | Units | Nominal Bar Size (CA) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 10 M | 15 M | 20 M | 25 M | 30 M |
| Reinforcing bar O.D. | | $d$ | mm (inch) | 11.3 (0.445) | 16 (0.630) | 19.5 (0.768) | 25.2 (0.992) | 29.9 (1.177) |
| Reinforcing bar effective cross-sectional area | | $A_{se}$ | mm² (inch²) | 100.3 (0.155) | 201.1 (0.312) | 298.6 (0.463) | 498.8 (0.773) | 702.2 (1.088) |
| CAN/CSA-G30.18 Grade 400 | Nominal strength as governed by steel strength (for a single anchor) | $N_{sa}$ | kN | 54.0 | 108.5 | 161.5 | 270.0 | 380.0 |
| | | $V_{sa}$ | kN | 32.5 | 65.0 | 97.0 | 161.5 | 227.5 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.65 | | | | |
| | Resistance modification factor for tension[2] | $R$ | - | 1.00 | | | | |
| | Resistance modification factor for shear[2] | $R$ | - | 1.00 | | | | |

[1]Values provided for common bar material types based on specified strengths and calculated in accordance with CSA A23.3-14 Eq. D.2 and Eq. D.3.
[2]The tabulated value of the material resistance factors $\phi_c$ and $\phi_s$, and resistance modification factor, *R,* applies when the load combinations of Division B, Part 4, Section 4.1.3 of the 2015 NBCC or Annex C of CSA A23.3-14.

**TABLE 14—CONCRETE BREAKOUT DESIGN INFORMATION COMMON EU METRIC AND CANADIAN METRIC REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]**

| DESIGN INFORMATION | Symbol | Units | Nominal Bar Size | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ø 10 | 10 M | Ø 12 | Ø 14 | 15 M | Ø 16 | Ø 20 | 20 M | Ø 25 | 25 M | Ø 28 | 30 M | Ø 32 |
| Effectiveness factor for cracked concrete | $k_{c,cr}$ | SI (in-lb) | 7 (17) | | | | | | | | | | | | |
| Effectiveness factor for uncracked concrete | $k_{c,uncr}$ | SI (in-lb) | 10 (24) | | | | | | | | | | | | |
| Min. anchor spacing | $s_{min}$ | mm ( inch) | 50 (2) | 55 (2 1/8) | 60 (2 3/8) | 70 (2 3/4) | 80 (3 1/8) | 75 (3) | 95 (3 3/4) | 100 (3 7/8) | 120 (4 5/8) | 125 (5.0) | 130 (5 1/4) | 150 (5 7/8) | |
| Min. edge spacing | $c_{min}$ | mm ( inch) | 40 (1 5/8) | 40 (1 3/4) | 45 (1 3/4) | 50 (2) | | | 60 (2 3/8) | 60 (2 3/8) | 70 (2 3/4) | 75 (3) | | 85 (3 1/8) | |
| | | | For edge distances to 45 mm (1 3/4-inch), see Table 1 of this report. | | | | | | | | | | | For edge distances to 70 mm (2 3/4-inch), see Table 1 of this report. | |
| Min. member thickness | $h_{min}$ | mm (inch) | $h_{ef}$ + 30 ($h_{ef}$ + 1 1/4) | | | $h_{ef}$ + $2d_0$ [3] | | | | | | | | | |
| Critical edge spacing – splitting (for uncracked concrete only) | $c_{ac}$ | - | $2h_{ef}$ | | | | | | | | | | | | |
| Resistance modification factor for tension, concrete failure modes, Condition B[2] | $R$ | - | 1.00 | | | | | | | | | | | | |
| Resistance modification factor for shear, concrete failure modes, Condition B[2] | $R$ | - | 1.00 | | | | | | | | | | | | |

[1]Additional setting information is described in Figure 3, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in CSA A23.3-14 D.5.3. The tabulated value of the material resistance factors $\phi_c$ and $\phi_s$, and resistance modification factor, *R,* applies when the load combinations of Division B, Part 4, Section 4.1.3 of the 2015 NBCC or Annex C of CSA A23.3-14.
[3] $d_0$ = hole diameter.

**TABLE 15—BOND STRENGTH DESIGN INFORMATION COMMON EU METRIC REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]**

| DESIGN INFORMATION | | Symbol | Units | Nominal Bar Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ø 10 | ø 12 | ø 14 | ø 16 | ø 20 | ø 25 | ø 28 | ø 32 |
| Minimum embedment | | $h_{ef,min}$ | mm ( inch) | 60 (2.4) | 70 (2.8) | 75 (3.0) | 80 (3.1) | 90 (3.5) | 100 (3.9) | 112 (4.4) | 128 (5.0) |
| Maximum embedment | | $h_{ef,max}$ | mm ( inch) | 200 (7.9) | 240 (9.4) | 280 (11.0) | 320 (12.6) | 400 (15.7) | 500 (19.7) | 560 (22.0) | 640 (25.2) |
| **Temperature range A[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 15.1 | 14.6 | 14.0 | 14.0 | 13.5 | 13.0 | 12.8 | 12.5 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 7.5 | 7.3 | 7.9 | 8.2 | 8.2 | 8.0 | 7.9 | 8.0 |
| **Temperature range B[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 13.1 | 12.7 | 12.1 | 12.1 | 11.7 | 11.3 | 11.1 | 10.9 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 6.5 | 6.4 | 6.9 | 7.2 | 7.1 | 6.9 | 6.9 | 7.0 |
| **Temperature range C[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² | 9.4 | 9.2 | 8.8 | 8.8 | 8.4 | 8.2 | 8.0 | 7.8 |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² | 4.7 | 4.6 | 4.9 | 5.2 | 5.1 | 5.0 | 4.9 | 5.0 |
| Dry concrete | Anchor category | – | - | 1 | | | | | | | |
| | Permissible installation condition factor | $R_d$ | - | 1.00 | | | | | | | |
| Water-saturated concrete | Anchor category | – | - | 2 | | | | | | | |
| | Permissible installation condition factor | $R_{ws}$ | - | 0.85 | | | | | | | |
| Water-filled holes | Anchor category | – | - | 3 | | | | | | | |
| | Permissible installation condition factor | $R_{wf}$ | - | 0.75 | | | | | | | |
| Reduction factor for seismic tension | | $\alpha_{N,seis}$ | - | 0.95 | | 1.00 | | | | | |

[1]Bond strength values correspond to concrete compressive strength $f'_c$ = 2,500 psi. For concrete compressive strength $f'_c$ between 2,500 psi and 8,000 psi, tabulated characteristic bond strength may not be increased.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C); Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C); Temperature range C: Maximum short term temperature = 320°F (160°C), maximum long term temperature = 212°F (100°C). 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.
[3]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 23 percent for temperature range C.

**TABLE 16—BOND STRENGTH DESIGN INFORMATION COMMON CANADIAN METRIC REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]**

| DESIGN INFORMATION | | Symbol | Units | Nominal Bar Size (CA) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 10 M | 15 M | 20 M | 25 M | 30 M |
| Minimum embedment | | $h_{ef,min}$ | mm ( in.) | 70 (2.8) | 80 (3.1) | 90 (3.5) | 100 (3.9) | 120 (4.7) |
| Maximum embedment | | $h_{ef,max}$ | mm ( in.) | 225 (8.9) | 320 (12.6) | 390 (15.4) | 505 (19.8) | 600 (23.5) |
| **Temperature range A[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² (psi) | 14.5 (2,110) | 13.2 (1,916) | 12.5 (1,814) | 11.7 (1,690) | 11.1 (1,612) |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² (psi) | 7.2 (1,041) | 7.5 (1,087) | 7.2 (1,045) | 6.7 (965) | 6.3 (915) |
| **Temperature range B[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² (psi) | 12.7 (1,836) | 11.5 (1,667) | 10.9 (1,578) | 10.1 (1,470) | 9.7 (1,402) |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² (psi) | 6.2 (906) | 6.5 (946) | 6.3 (909) | 5.8 (840) | 5.5 (796) |
| **Temperature range C[2,3]:** | Characteristic bond strength in uncracked concrete | $\tau_{k,uncr}$ | N/mm² (psi) | 9.1 (1,633) | 8.3 (1,201) | 7.8 (1,137) | 7.3 (1,059) | 7.0 (1,010) |
| | Characteristic bond strength in cracked concrete | $\tau_{k,cr}$ | N/mm² (psi) | 5.6 (806) | 5.8 (841) | 5.6 (809) | 5.2 (747) | 4.9 (708) |
| Dry concrete | Anchor category | – | - | 1 | | | | |
| | Permissible installation condition factor | $R_d$ | - | 1.00 | | | | |
| Water-saturated concrete | Anchor category | – | - | 2 | | | | |
| | Permissible installation condition factor | $R_{ws}$ | - | 0.85 | | | | |
| Water-filled holes | Anchor category | – | - | 3 | | | | |
| | Permissible installation condition factor | $R_{wf}$ | - | 0.75 | | | | |
| Reduction factor for seismic tension | | $\alpha_{N,seis}$ | - | 0.95 | | 1.00 | | |

[1]Bond strength values correspond to concrete compressive strength $f'_c$ = 2,500 psi. For concrete compressive strength $f'_c$ between 2,500 psi and 8,000 psi, tabulated characteristic bond strength may not be increased. See Section 4.1.4 of this report.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C); Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C); Temperature range C: Maximum short term temperature = 320°F (160°C), maximum long term temperature = 212°F (100°C). 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.
[3]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 23 percent for temperature range C.

**Conditions of listing:**

1. The listing report addresses only conformance with the standards and code sections noted above.
2. Approval of the product's use is the sole responsibility of the local code official.
3. The listing report applies only to the materials tested and as submitted for review by ICC-ES.
4. Anchor sizes, dimensions, minimum embedment depths and other installation parameters are as set forth in this listing report.
5. Anchors must be limited to use in cracked and uncracked normal-weight concrete and lightweight concrete having a specified compressive strength, $f'_c$, of 2,500 psi (17.2 MPa) to 8,500 psi (58.6 MPa).
6. The values of $f'_c$, used for calculation purposes must not exceed 55 MPa. The values of $f'_c$, used for calculation of tension resistance must be lmited to 17.2 MPa maximum for EU metric reinforcing bars used as anchorage in cracked concrete only.
7. Limit states design values must be established in accordance with this listing report.
8. The use of fatigue or shock loading for these anchors under such conditions is beyond the scope of this listing report.
9. Anchors may be used to resist short-term loading due to wind or seismic forces in locations designed according to NBCC 2015.
10. Where not otherwise prohibited in the code as referenced in CSA A23.3-14, the DEWALT AC200+ adhesive anchor system is permitted for use with fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:
    a. Anchors are used to resist wind or seismic forces only.
    b. Anchors that support a fire-resistance-rated envelope or a fire- resistance-rated membrane are protected by approved fire-resistance- rated materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
    c. Anchors are used to support nonstructural elements.
11. Use of zinc-coated carbon steel anchors is limited to dry, interior locations.
12. Use of hot-dipped galvanized carbon steel and stainless steel rods as specified in this report are permitted for exterior exposure and damp environments.
13. Steel anchoring materials in contact with preservative-treated wood and fire-retardant-treated wood must be of zinc-coated carbon steel or stainless steel. The minimum coating weights for zinc-coated steel must comply with ASTM A153.
14. Installation of anchors in horizontal or upwardly inclined orientations to resist sustained tension loads shall be performed by personnel certified by an applicable certification program, and the certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchor Installer Certification program, or equivalent in accordance with CSA A23.3-14 D.10.2.3. The installation shall be continuously inspected during installation by an inspector specially approved for that purpose. The special inspector shall furnish a report to the licensed design professional and building official that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the approved contract documents and the MPII in accordance with CSA A23.3-14 D.10.2.4.
15. AC200+ Adhesive Anchors may be used to resist tension and shear forces in wall (horizontal) and for overhead (upwardly inclined) installations into concrete with a temperature between -5°C and 40°C; and between -10°C and 40°C for floor (downward) installations.
16. Anchors shall not be used for installations where the concrete temperature can vary from 5°C or less, to 27°C or higher within a 12-hour period. Such applications may include but are not limited to anchorage of building facade system and other applications to direct sun exposure.
17. Periodic special inspection must be provided in accordance with CSA A23.3-14 Section D.10.2.2.