



## ICC-ES Evaluation Report ESR-2502

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

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

### REPORT HOLDER:

DEWALT

### EVALUATION SUBJECT:

**POWER-STUD®+ SD2 CARBON STEEL ANCHORS,  
POWER-STUD®+ SD4 AND POWER-STUD®+ SD6  
STAINLESS STEEL ANCHORS IN CRACKED AND  
UNCRAKED CONCRETE (DEWALT)**

### 1.0 EVALUATION SCOPE

#### Compliance with the following codes:

- 2021, 2018, 2015, and 2012 *International Building Code*® (IBC)
- 2021, 2018, 2015, and 2012 *International Residential Code*® (IRC)

For evaluation for compliance with codes adopted by Los Angeles Department of Building and Safety (LADBS), see [ESR-2502 LABC and LARC Supplement](#).

For evaluation for compliance with the *National Building Code of Canada*® (NBCC), see listing report [ELC-2502](#).

#### Property evaluated:

Structural

### 2.0 USES

The Power-Stud+ SD2 carbon steel anchors and Power-Stud+ SD4 and SD6 stainless steel anchors are used to anchor building components to cracked and uncracked normal-weight and lightweight concrete having a specified compressive strength,  $f'_c$ , of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa) to resist static, wind and seismic tension and shear loads.

The  $\frac{3}{8}$ -inch- and  $\frac{1}{2}$ -inch diameter (9.5 mm and 12.7 mm) Power-Stud+ SD2 carbon steel anchors may be installed in the topside of cracked and uncracked normal-weight or sand-lightweight concrete over steel deck having a minimum specified compressive strength,  $f'_c$ , of 2,500 psi (17.2 MPa).

The  $\frac{3}{8}$ -inch through  $\frac{3}{4}$ -inch diameter (9.5 mm through 19.1 mm) Power-Stud+ SD2 carbon steel anchors may be

installed in the soffit of cracked and uncracked normal-weight or sand-lightweight concrete over steel deck having a minimum specified compressive strength,  $f'_c$ , of 3,000 psi (20.7 MPa).

The anchors comply with Section 1901.3 of the 2021, 2018 and 2015 IBC, and Sections 1908 and 1909 of the 2012 IBC. The anchors may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

### 3.0 DESCRIPTION

#### 3.1 General:

The anchors are torque-controlled, mechanical expansion anchors comprised of an anchor body, expansion wedge (clip), washer and hex nut.

The anchor body is comprised of a high-strength carbon or stainless steel rod threaded at one end and having a tapered mandrel at the other end. The tapered mandrel is enclosed by a three-section expansion clip which freely moves around the mandrel. The expansion clip movement is restrained by the mandrel taper and by a collar. On the stainless steel anchors, the mandrel taper has a knurling with the exception of the  $\frac{1}{4}$ -inch-diameter (6.4 mm) anchors.

The anchors are installed in a predrilled hole with a hammer. When torque is applied to the nut of the installed anchor on the threaded end of the anchor body, the mandrel at the other end of the anchor is drawn into the expansion clip, forcing it outward into the sides of the predrilled hole in the base material. Installation instructions and related information are set forth in Section 4.3, Tables 1, 2 and 6, and Figures A, 1, 3, 5A, 5B, 5C and 5D.

#### 3.2 Power-Stud+ SD2 Carbon Steel Anchors:

The anchor body is manufactured from medium carbon steel and has minimum 0.0002-inch (5  $\mu$ m) zinc plating in accordance with ASTM B633. The expansion clip is manufactured from AISI Type 316 stainless steel. The washer conforms to ASTM F844. The hex nuts conform to ASTM A563, Grade A. The Power-Stud+ SD2 anchor is illustrated in Figure 2. Installation instructions and related information are set forth in Section 4.3, Tables 1 and 2, and Figures A, 1, 3, 5A, 5B, 5C and 5D.

#### 3.3 Power-Stud+ SD4 and Power-Stud+ SD6 Stainless Steel Anchors:

The Power-Stud+ SD4 anchor body is manufactured from Type 304 stainless steel and the Power-Stud+ SD6 is manufactured from Type 316 stainless steel. The expansion

clips and hex nuts are manufactured from Type 316 stainless steel. Washers are manufactured from 300 series stainless steel for the Power-Stud+ SD4 and Type 316 stainless steel for the Power-Stud+ SD6. The Power-Stud+ SD4 and Power-Stud+ SD6 anchors are illustrated in Figure 2. Installation instructions and related information are set forth in Section 4.3, Table 6, and Figures A, 1 and 3.

### 3.4 Concrete:

Normal-weight and lightweight concrete must conform to Sections 1903 and 1905 of the IBC.

### 3.5 Steel Deck Panels (for SD2 anchors only):

Steel deck panels must comply with the configurations in Figure 5A and 5C of this report and have a minimum base-metal thickness of 0.035 inch (0.899 mm) [20 gauge]. Steel deck must comply with the requirements of ASTM A653/A653M SS Grade 33, and have a minimum yield strength of 33 ksi (228 MPa) for Figures 5A and 5C.

Steel deck panels must comply with the configurations in Figure 5B of this report and have a minimum base-metal thickness of 0.035 inch (0.899 mm) [20 gauge]. Steel deck must comply with requirements of ASTM A653/A653M SS Grade 50, and have a minimum yield strength of 50 ksi (345 MPa) for Figure 5B.

## 4.0 DESIGN AND INSTALLATION

### 4.1 Strength Design:

**4.1.1 General:** Design strength of anchors complying with the 2021 IBC, as well as Section R301.1.3 of the 2021 IRC must be determined in accordance with ACI 318-19 Chapter 17 and this report.

Design strength of anchors complying with the 2018 and 2015 IBC, as well as Section R301.1.3 of the 2018 and 2015 IRC must be determined in accordance with ACI 318-14 Chapter 17 and this report.

Design strength of anchors complying with the 2012 IBC, as well as Section R301.1.3 of the 2012 IRC, must be determined in accordance with ACI 318-11 Appendix D and this report.

A design example in accordance with the 2021, 2018, 2015 and 2012 IBC is shown in Figure 6 of this report. Design parameters are based on the 2021 (ACI 318-19), 2018 and 2015 IBC (ACI 318-14) and the 2012 IBC (ACI 318-11) unless noted otherwise in Sections 4.1.1 through 4.1.12 of this report. The strength design of anchors must comply with ACI 318-19 17.5.1.2, ACI 318-14 17.3.1 or ACI 318-11 D.4.1, as applicable, except as required in ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Strength reduction factors,  $\phi$ , as given in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, and noted in Tables 3, 4, 5, 7 and 8 of this report, must be used for load combinations calculated in accordance with Section 1605.1 of the 2021 IBC or Section 1605.2 of the 2018, 2015 and 2012 IBC, Section 5.3 of ACI 318 (-19 or -14) or Section 9.2 of ACI 318-11, as applicable. Strength reduction factors,  $\phi$ , as given in ACI 318-11 D.4.4, must be used for load combinations calculated in accordance with Appendix C of ACI 318-11. The value of  $f'_c$  must be limited to 8,000 psi (55.2 MPa), in accordance with ACI 318-19 17.3.1, ACI 318-14 17.2.7 or ACI 318-11 D.3.7.

**4.1.2 Requirements for Static Steel Strength in Tension,  $N_{sa}$ :** The nominal steel strength of a single anchor in tension,  $N_{sa}$ , is given in Tables 3 and 7 of this report. The values of  $N_{sa}$  for single anchors given in Tables 3 and 7 must be used and not be derived by calculation. For installation in

the soffit of steel deck, the steel strength in tension is not decisive and need not be calculated.

**4.1.3 Requirements for Static Concrete Breakout Strength in Tension,  $N_{cb}$  or  $N_{cbg}$ :** The nominal concrete breakout strength of a single anchor or group of anchors in tension,  $N_{cb}$  and  $N_{cbg}$ , respectively, must be calculated in accordance with ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, with modifications as described in this section. The basic concrete breakout strength of a single anchor in tension,  $N_b$ , must be calculated according to ACI 318-19 17.6.2.2, ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2, as applicable, using the values of  $h_{ef}$  and  $k_{cr}$  as given in Tables 3 and 7 of this report. The nominal concrete breakout strength in tension in regions where analysis indicates no cracking in accordance with ACI 318-19 17.6.2.5.1(a), ACI 318-14 17.4.2.6 or ACI 318-11 D.5.2.6, as applicable, must be calculated, with  $\psi_{c,N} = 1.0$  and using the value of  $K_{uncr}$  as given in Tables 3 and 7. The value of  $f'_c$  must be limited to 8,000 psi (55.2 MPa), in accordance with ACI 318-19 17.3.1, ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, as shown in Figures 5A, 5B and 5C, calculation of the concrete breakout strength in accordance with ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, is not required.

**4.1.4 Requirements for Static Pullout Strength in Tension,  $N_{pn}$ :** The nominal pullout strength of a single anchor in tension in accordance with ACI 318-19 17.6.3.1 and 17.6.3.2.1, ACI 318-14 17.4.3.1 and 17.4.3.2 or ACI 318-11 D.5.3.1 and D.5.3.2, as applicable, in cracked and uncracked concrete,  $N_{p,cr}$  and  $N_{p,uncr}$ , respectively, is given in Tables 3 and 7 of this report. In lieu of ACI 318-19 17.6.3.3, ACI 318-14 17.4.3.6 or ACI 318-11 D.5.3.6, as applicable,  $\psi_{c,P} = 1.0$  for all design cases. In accordance with ACI 318-19 17.6.3.2.1, ACI 318-14 17.4.3.2 or ACI 318-11 D.5.3.2, as applicable, the nominal pullout strength in cracked concrete must be adjusted by calculation according to Eq-1:

$$N_{pn,f'_c} = N_{p,cr} \left( \frac{f'_c}{2,500} \right)^n \quad (\text{lb, psi}) \quad (\text{Eq-1})$$

$$N_{pn,f'_c} = N_{p,cr} \left( \frac{f'_c}{17.2} \right)^n \quad (\text{N,MPa})$$

where  $f'_c$  is the specified concrete compressive strength and whereby the exponent  $n = 1/2$  for all anchor diameters with the exception of the  $3/8$ -inch-diameter (9.5 mm) Power-Stud+ SD2 anchor size, where  $n = 1/3$ .

In regions where analysis indicates no cracking in accordance with ACI 318-19 17.6.3.3, ACI 318-14 17.4.3.6 or ACI 318-11 D.5.3.6, as applicable, the nominal pullout strength in tension must be adjusted by calculation according to Eq-2:

$$N_{pn,f'_c} = N_{p,uncr} \left( \frac{f'_c}{2,500} \right)^n \quad (\text{lb, psi}) \quad (\text{Eq-2})$$

$$N_{pn,f'_c} = N_{p,uncr} \left( \frac{f'_c}{17.2} \right)^n \quad (\text{N,MPa})$$

where  $f'_c$  is the specified concrete compressive strength and whereby the exponent  $n = 1/2$  for all anchors.

Where values for  $N_{p,cr}$  or  $N_{p,uncr}$  are not provided in Tables 3 or 7, the pullout strength in tension need not be evaluated.

The nominal pullout strength in tension of the anchors installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, as

shown in Figures 5A, 5B and 5C, is provided in Table 5. In accordance with ACI 318-19 17.6.3.2.1, ACI 318-14 17.4.3.2 or ACI 318-11 D.5.3.2, as applicable, the nominal pullout strength in cracked concrete must be calculated according to Eq-1, whereby the value of  $N_{p,deck,cr}$  must be substituted for  $N_{p,cr}$  and the values of 3,000 psi or 20.7 MPa must substitute for 2,500 psi or 17.2 MPa in the denominator. In regions where analysis indicates no cracking in accordance with ACI 318-19 17.6.3.3, ACI 318-14 17.4.3.6 or ACI 318-11 D.5.3.6, as applicable, the nominal strength in uncracked concrete must be calculated according to Eq-2, whereby the value of  $N_{p,deck,uncr}$  must be substituted for  $N_{p,uncr}$  and the values of 3,000 psi or 20.7 MPa must substitute for 2,500 psi or 17.2 MPa in the denominator.

**4.1.5 Requirements for Static Steel Shear Capacity,  $V_{sa}$ :** The nominal steel strength in shear,  $V_{sa}$ , of a single anchor in accordance with ACI 318-19 17.7.1.2, ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable, is given in Tables 4 and 8 of this report and must be used in lieu of the values derived by calculation from ACI 318-19 Eq. 17.7.1.2b, ACI 318-14 Eq. 17.5.1.2b or ACI 318-11 Eq. D-29, as applicable. The shear strength  $V_{sa,deck}$  of anchors installed in the soffit of sand-lightweight or normal weight concrete filled steel deck floor and roof assemblies, as shown in Figures 5A, 5B and 5C, is given in Table 5.

**4.1.6 Requirements for Static Concrete Breakout Strength in Shear,  $V_{cb}$  or  $V_{cbg}$ :** The nominal concrete breakout strength of a single anchor or group of anchors in shear,  $V_{cb}$  or  $V_{cbg}$ , respectively, must be calculated in accordance with ACI 318-19 17.7.2, ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, with modifications as described in this section. The basic concrete breakout strength of a single anchor in shear,  $V_b$ , must be calculated in accordance with ACI 318-19 17.7.2.2.1, ACI 318-14 17.5.2.2 or ACI 318-11 D.6.2.2, as applicable, using the values of  $\ell_e$  and  $d_a$  given in Tables 4 and 8. The value of  $f'_c$  must be limited to 8,000 psi (55.2 MPa), in accordance with ACI 318-19 17.3.1, ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 5A, 5B and 5C, calculation of the concrete breakout strength in accordance with ACI 318-19 17.7.2, ACI 318-14 17.5.2 or ACI 318-11 D.6.2 is not required.

**4.1.7 Requirements for Static Concrete Pryout Strength in Shear,  $V_{cp}$  or  $V_{cpg}$ :** The nominal concrete pryout strength of a single anchor or a group of anchors in shear,  $V_{cp}$  or  $V_{cpg}$ , must be calculated in accordance with ACI 318-19 17.7.3, ACI 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable, using the value of  $k_{cp}$  provided in Tables 4 and 8 and the value of  $N_{cb}$  or  $N_{cbg}$  as calculated in accordance with Section 4.1.3 of this report.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 5A, 5B and 5C, calculation of the concrete pryout strength in accordance with ACI 318-19 17.7.3, ACI 318-14 17.5.3 or ACI 318-11 D.6.3 is not required.

#### 4.1.8 Requirements for Seismic Design:

**4.1.8.1 General:** For load combinations including seismic loads, the design must be performed in accordance with ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Modifications to ACI 318-19 17.10, ACI 318-14

17.2.3 shall be applied under Section 1905.1.8 of the 2021, 2018 and 2015 IBC. For the 2012 IBC, Section 1905.1.9 shall be omitted.

The anchors comply with ACI 318 (-19 or -14) 2.3 or ACI 318-11 D.1, as applicable, as ductile steel elements and must be designed in accordance with ACI 318-19 17.10.4, 17.10.5, 17.10.6, and 17.10.7; ACI 318-14, 17.2.3.4, 17.2.3.5, 17.2.3.6 and 17.2.3.7; ACI 318-11 D.3.3.4, D.3.3.5, D.3.3.6 and D.3.3.7, as applicable. Strength reduction factors,  $\phi$ , are given in Tables 3, 4, 5, 7 and 8. The anchors, except for the 1/4-inch-diameter (6.4 mm) stainless steel anchors, may be installed in regions designed as IBC Seismic Design Category A through F.

**4.1.8.2 Seismic Tension:** The nominal steel strength and nominal concrete breakout strength for anchors in tension must be calculated according to ACI 318-19 17.6.1 and 17.6.2, ACI 318-14 17.4.1 and 17.4.2 or ACI 318-11 D.5.1 and D.5.2, respectively, as applicable, as described in Sections 4.1.2 and 4.1.3 of this report. In accordance with ACI 318-19 17.6.3.2.1, ACI 318-14 17.4.3.2 or ACI 318-11 D.5.3.2, as applicable, the appropriate value for pullout strength in tension for seismic loads,  $N_{p,eq}$  or  $N_{p,deck,cr}$ , described in Tables 3, 5 and 7 of this report, must be used in lieu of  $N_p$ . The values of  $N_{p,eq}$  or  $N_{p,deck,cr}$  can be adjusted for concrete strength as follows:

$$N_{eq,f'_c} = N_{eq} \left( \frac{f'_c}{2,500} \right)^n \quad (\text{lb, psi}) \quad (\text{Eq-3})$$

$$N_{eq,f'_c} = N_{eq} \left( \frac{f'_c}{17.2} \right)^n \quad (\text{N,MPa})$$

where  $f'_c$  is the specified concrete compressive strength and whereby the exponent  $n = 1/2$  for all anchor diameters with the exception of the 3/8-inch-diameter (9.5 mm) Power-Stud+ SD2 anchor size where  $n = 1/3$ . In addition, for sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, the value of 3,000 psi or 20.7 MPa must be substituted for the value of 2,500 psi or 17.2 MPa in the denominator.

Where values of  $N_{p,eq}$  are not provided in Tables 3 and 7 of this report, the pullout strength in tension for seismic loads does not govern and need not be evaluated.

**4.1.8.3 Seismic Shear:** The nominal concrete breakout strength and pryout strength for anchors in shear must be calculated according to ACI 318-19 17.7.2 and 17.7.3, ACI 318-14 17.5.2 and 17.5.3 or ACI 318-11 D.6.2 and D.6.3, respectively, as applicable, as described in Sections 4.1.6 and 4.1.7 of this report. In accordance with ACI 318-19 17.7.1.2, ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable, the appropriate value for nominal steel strength in shear for seismic loads,  $V_{sa,eq}$  or  $V_{sa,deck,eq}$ , described in Tables 4, 5 and 8 of this report must be used in lieu of  $V_{sa}$ .

**4.1.9 Interaction of Tensile and Shear Forces:** For anchors or groups of anchors that are subject to the effects of combined tension and shear forces, the design must be performed in accordance with ACI 318-19 17.8, ACI 318-14 17.6 or ACI 318-11 D.7, as applicable.

**4.1.10 Requirements for Critical Edge Distance:** In applications where  $c < c_{ac}$  and supplemental reinforcement to control splitting of the concrete is not present, the concrete breakout strength in tension for uncracked concrete, calculated according to ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, must be further multiplied by the factor  $\psi_{cp,N}$  given by the following equation:

$$\psi_{cp,N} = \frac{c}{c_{ac}} \quad (\text{Eq-4})$$

whereby the factor  $\psi_{cp,N}$  need not be taken as less than  $\frac{1.5h_{ef}}{c_{ac}}$ . For all other cases  $\psi_{cp,N} = 1.0$ . In lieu of ACI 318-19 17.9.5, ACI 318-14 17.7.6 or ACI 318-11 D.8.6, as applicable, values of  $c_{ac}$  provided in Tables 1, 2 and 6 of this report must be used.

#### 4.1.11 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance:

In lieu of ACI 318-19 17.9.2, ACI 318-14 17.7.1 and 17.7.3 or ACI 318-11 D.8.1 and D.8.3, as applicable, values of  $c_{min}$  and  $s_{min}$  as given in Tables 1, 2 and 6 of this report must be used. In lieu of ACI 318-19 17.9.4, ACI 318-14 17.7.5 or ACI 318-11 D.8.5, as applicable, minimum member thicknesses,  $h_{min}$  as given in Tables 1, 2 and 6 must be used. Additional combinations for minimum edge distance,  $c_{min}$ , and spacing,  $s_{min}$ , may be derived from linear interpolation between the given boundary values as described in Figure 4.

For anchors installed through the soffit of steel deck assemblies, the anchors must be installed in accordance with Figure 5A, 5B or 5C, as applicable, and shall have an axial spacing along the flute equal to the greater of  $3h_{ef}$  or 1.5 times the flute width.

For anchors installed in the top of concrete over steel deck assemblies, the anchors must be installed in accordance with Figure 5D.

**4.1.12 Lightweight Concrete:** For the use of anchors in lightweight concrete, the modification factor  $\lambda_a$  equal to 0.8 $\lambda$  is applied to all values of  $\sqrt{f'_c}$  affecting  $N_n$  and  $V_n$ .

For ACI 318-19 (2021 IBC), ACI 318-14 (2018 or 2015 IBC), and ACI 318-11 (2012 IBC),  $\lambda$  shall be determined in accordance with the corresponding version of ACI 318.

For anchors installed in the soffit of sand-lightweight concrete-filled steel deck and floor and roof assemblies, further reduction of the pullout values provided in this report is not required.

## 4.2 Allowable Stress Design (ASD):

**4.2.1 General:** Where design values for use with allowable stress design (working stress design) load combinations in accordance with Section 1605.1 of the 2021 IBC or Section 1605.3 of the 2018, 2015 and 2012 IBC are required, these are calculated using Eq-5 and Eq-6 as follows:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \quad (\text{Eq-5})$$

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha} \quad (\text{Eq-6})$$

where:

$T_{allowable,ASD}$  = Allowable tension load (lbf or kN)

$V_{allowable,ASD}$  = Allowable shear load (lbf or kN)

$\phi N_n$  = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 (-19 or -14) Chapter 17 and 2021, 2018 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, and Section 4.1 of this report as applicable (lbf or N). For the 2012 IBC, Section 1905.1.9 shall be omitted.

$\phi V_n$  = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 (-19 or -14) Chapter 17 and 2021, 2018 and 2015

IBC Section 1905.1.8, and Section 4.1 of this report as applicable (lbf or N). For the 2012 IBC, Section 1905.1.9 shall be omitted.

$\alpha$  = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition,  $\alpha$  shall include all applicable factors to account for non-ductile failure modes and required over-strength.

The requirements for member thickness, edge distance and spacing, as described in this report, must apply. An example of allowable stress design values for illustrative purposes is shown in Table 9 and Figure 6 of this report.

**4.2.2 Interaction of Tensile and Shear Forces:** The interaction shall be calculated and consistent with ACI 318-19 17.8, ACI 318-14 17.6 or ACI 318 (-11 and -08) D.7, as applicable, as follows:

For shear loads  $V \leq 0.2V_{allowable,ASD}$ , the full allowable load in tension shall be permitted.

For tension loads  $T \leq 0.2T_{allowable,ASD}$ , the full allowable load in shear shall be permitted.

$$\text{For all other cases: } \frac{T}{T_{allowable}} + \frac{V}{V_{allowable}} \leq 1.2 \quad (\text{Eq-7})$$

## 4.3 Installation:

Installation parameters are provided in Tables 1, 2 and 6, and Figures A, 1, 3, 5A, 5B, 5C and 5D. Anchor locations must comply with this report and the plans and specifications approved by the code official. The Power-Stud+ SD2 carbon steel anchors and Power-Stud+ SD4 and Power-Stud+ SD6 stainless steel anchors must be installed according to manufacturer's printed installation instructions and this report. Anchors must be installed in holes drilled into the concrete using carbide-tipped masonry drill bits complying with ANSI B212.15-1994. The nominal drill bit diameter must be equal to that of the anchor size. The minimum drilled hole depths are given in Tables 1, 2 and 6. Remove dust and debris from the hole during drilling (e.g. dust extractor, hollow bit) or following drilling (e.g. suction, forced air) to extract loose particles created by drilling (see Figures A and 3). The anchor must be hammered into the predrilled hole until the proper nominal embedment depth is achieved. The nut must be tightened against the washer until the torque values specified in Tables 1, 2 and 6 are achieved.

For installation of SD2 anchors in the soffit of concrete on steel deck assemblies, the hole diameter in the steel deck must not exceed the diameter of the hole in the concrete by more than  $\frac{1}{8}$  inch (3.2 mm). For member thickness and edge distance requirements for installations into the soffit of concrete on steel deck assemblies, see Figure 5A, 5B and 5C.

## 4.4 Special Inspection:

Periodic special inspection is required, in accordance with Section 1705.1.1 and Table 1705.3 of the 2021, 2018, 2015 and 2012 IBC. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, hole cleaning procedure, anchor spacing, edge distances, concrete member thickness, anchor embedment, tightening torque and adherence to the manufacturer's installation instructions. The special inspector must be present as often as required in accordance with the "statement of special inspection".

## 5.0 CONDITIONS OF USE

The anchors described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

- 5.1 The anchors must be installed in accordance with the manufacturer's printed installation instructions and this report. In case of a conflict, this report governs.
- 5.2 Anchor sizes, dimensions, and minimum embedment depths are as set forth in this report.
- 5.3 The 1/4-inch-diameter (6.4 mm) anchors must be installed in uncracked normal-weight or lightweight concrete; 3/8-inch- to 3/4-inch-diameter (9.5 mm to 19.1 mm) anchors must be installed in cracked and uncracked normal-weight concrete and lightweight concrete having a specified compressive strength,  $f'_c$ , of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa); and installed in the soffit or in the top of cracked and uncracked normal weight or sand-lightweight concrete over steel deck profiles having a minimum specified compressive strength,  $f'_c$ , of 3,000 psi (20.7 MPa).
- 5.4 The values of  $f'_c$  used for calculation purposes must not exceed 8,000 psi (55.2 MPa).
- 5.5 The concrete shall have attained its minimum design strength prior to installation of the anchors.
- 5.6 Strength Design values must be established in accordance with Section 4.1 of this report.
- 5.7 Allowable Stress Design values must be established in accordance with Section 4.2 of this report.
- 5.8 Anchor spacing(s) and edge distance(s), as well as minimum member thickness, must comply with Tables 1, 2 and 6, and Figures 5A, 5B, 5C and 5D.
- 5.9 Prior to installation, calculations and details demonstrating compliance with this report must be submitted to the code official. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.
- 5.10 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of anchors subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under such conditions is beyond the scope of this report.
- 5.11 Anchors may be installed in regions of concrete where cracking has occurred or where analysis indicates cracking may occur ( $f_t > f_r$ ), subject to the conditions of this report.
- 5.12 The 3/8-inch-diameter to 3/4-inch-diameter (9.5 mm to 19.1 mm) anchors may be used to resist short-term loading due to wind or seismic forces in locations designated as Seismic Design Categories A through F under the IBC, subject to the conditions of this report. The 1/4-inch-diameter (6.4 mm) anchors may be used to resist short-term loading due to wind forces, and for seismic load combinations limited to structures assigned to Seismic Design Categories A and B under the IBC, subject to the conditions of this report.
- 5.13 Where not otherwise prohibited in the code, the anchors are permitted for use with fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:
  - Anchors are used to resist wind or seismic forces only.
  - 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.
  - Anchors are used to support nonstructural elements.

5.14 Use of zinc-coated carbon steel anchors is limited to dry, interior locations.

5.15 Use of anchors made of stainless steel as specified in this report are permitted for exterior exposure or damp environments.

5.16 Use of anchors made of stainless steel as specified in this report are permitted for contact with preservative-treated and fire-retardant-treated wood.

5.17 Special inspection must be provided in accordance with Section 4.4 of this report.

5.18 Anchors are manufactured under an approved quality-control program with inspections by ICC-ES.

## 6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated October 2017 (editorially revised December 2020), which incorporates requirements in ACI 355.2 (-19 and -07), for use in cracked and uncracked concrete; including optional service-condition Test No. 18 and Test No. 19 (AC193, Annex 1, Table 4.2) for seismic tension and shear, respectively; and quality control documentation.

## 7.0 IDENTIFICATION

7.1 The anchors are identified by dimensional characteristics and packaging. A length letter code marking is stamped on each anchor on the exposed threaded stud end which is visible after installation. Table D shows the length code identification system. For the Power-Stud+ SD2 anchors, a plus sign "+" and the number "2" are also visible after installation. For the Power-Stud+ SD4 and Power-Stud+ SD6 anchors, a plus sign "+" is also marked with a number on all anchors with the exception of the 1/4-inch-diameter (6.4 mm) anchors. The number "4" designates the Power-Stud+ SD4 and the number "6" designates the Power-Stud+ SD6. Packages are identified with the anchor name, type and size, the company name as set forth in Table A, and the evaluation report number (ESR-2502).

7.2 The report holder's contact information is the following:

**DEWALT**  
**701 EAST JOPPA ROAD**  
**TOWSON, MARYLAND 21286**  
**(800) 524-3244**  
[www.DEWALT.com](http://www.DEWALT.com)  
[anchors@DEWALT.com](mailto:anchors@DEWALT.com)

TABLE A—PRODUCT AND DESIGN INDEX

Product Name	Installation Specifications	Tension Design Data			Shear Design Data		
		Concrete	Top of Concrete Over Steel Deck	Steel Deck Soffit	Concrete	Top of Concrete Over Steel Deck	Steel Deck Soffit
Power-Stud+ SD2	Tables 1 and 2	Table 3	Table 3	Table 5	Table 4	Table 4	Table 5
Power-Stud+ SD4 and Power-Stud+ SD6	Table 6	Table 7	Table 7	Not applicable	Table 8	Table 8	Not applicable

TABLE B—POWER-STUD+ SD2, POWER-STUD+ SD4 AND POWER-STUD+ SD6 ANCHOR LENGTH CODE IDENTIFICATION SYSTEM

Length ID marking on threaded stud head		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Overall anchor length, $\ell_{anch}$ , (inches)	From	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10
	Up to but not including	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11

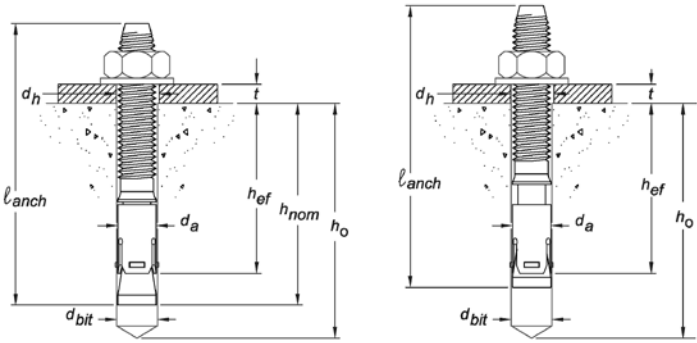


FIGURE 1—POWER-STUD+ SD2, POWER-STUD+ SD4 AND POWER-STUD+ SD6 ANCHOR DETAIL Before (Left Picture) and After (Right Picture) Application of Installation Torque

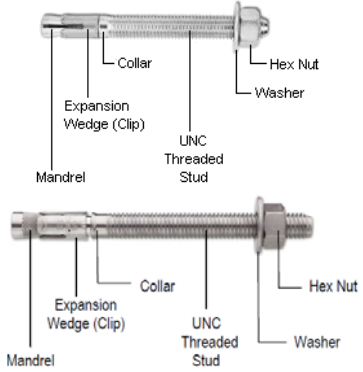


FIGURE 2—POWER-STUD+ SD2 (Top Picture), POWER-STUD+ SD4 AND POWER-STUD+ SD6 (Bottom Picture), ANCHOR ASSEMBLY

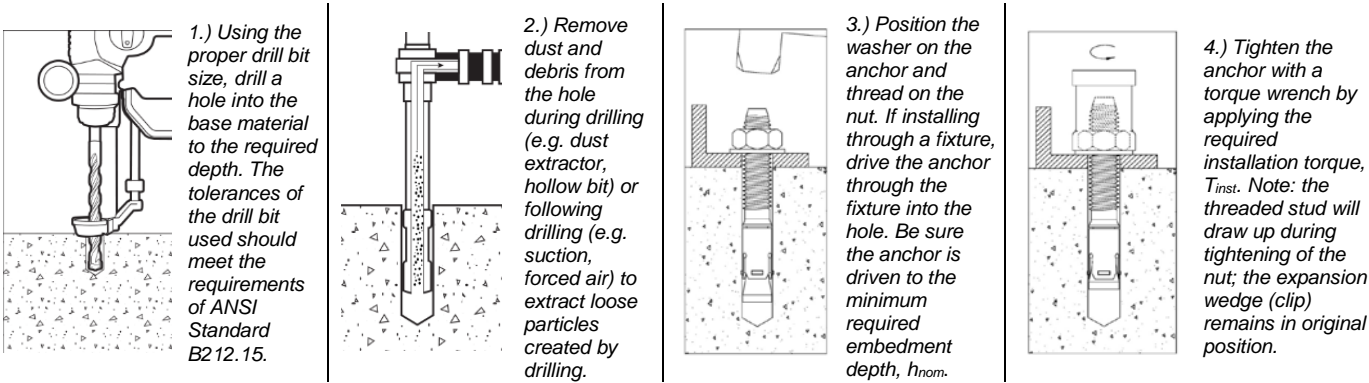
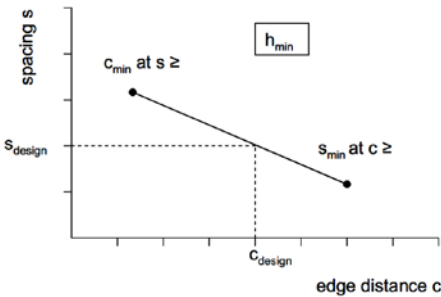


FIGURE 3— POWER-STUD+ SD2, POWER-STUD+ SD4 AND POWER-STUD+ SD6 INSTALLATION INSTRUCTIONS



<sup>1</sup>This interpolation applies to the cases when two sets of minimum edge distances,  $c_{min}$ , and minimum spacing distances,  $s_{min}$ , are given in Tables 1, 2, and 6 for a given anchor diameter under the same effective embedment depth,  $h_{ef}$ , and corresponding minimum member thickness,  $h_{min}$ .

FIGURE 4—INTERPOLATION OF MINIMUM EDGE DISTANCE AND MINIMUM ANCHOR SPACING<sup>1</sup>

TABLE 1—POWER-STUD+ SD2 ANCHOR INSTALLATION SPECIFICATIONS

ANCHOR PROPERTY / SETTING INFORMATION	NOTATION	UNITS	NOMINAL ANCHOR SIZE (inch)							
			$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
Outside diameter of anchor	$d_a$	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)				
Minimum diameter of hole clearance in fixture	$d_h$	in. (mm)	$\frac{7}{16}$ (11.1)	$\frac{9}{16}$ (14.3)	$\frac{11}{16}$ (17.5)	$\frac{13}{16}$ (20.6)				
Nominal drill bit diameter (ANSI)	$d_{bit}$	in.	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
Minimum nominal embedment depth <sup>1</sup>	$h_{nom}$	in. (mm)	$2\frac{3}{8}$ (60)	$2\frac{1}{2}$ (64)	$3\frac{3}{4}$ (83)	$3\frac{7}{8}$ (98)	$4\frac{7}{8}$ (124)	$4\frac{1}{2}$ (114)	$5\frac{3}{4}$ (146)	
Effective embedment	$h_{ef}$	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)	5.00 (127)	
Minimum concrete member thickness <sup>2,3</sup>	$h_{min}$	in. (mm)	4 (102)	$4\frac{1}{2}$ (114)	6 (152)	$5\frac{3}{4}$ (146)	$5\frac{3}{4}$ (146)	$5\frac{3}{4}$ (146)	$6\frac{1}{2}$ (165)	8 (203)
Critical edge distance <sup>3</sup> (uncracked concrete)	$c_{ac}$	in. (mm)	$6\frac{1}{2}$ (165)	8 (203)	10 (254)	8 (203)	$15\frac{3}{4}$ (400)	10 (254)	12 (305)	12 (305)
Minimum edge distance <sup>3,4</sup>	$c_{min}$	in. (mm)	$2\frac{1}{2}$ (64)	4 (102)	$2\frac{3}{4}$ (70)	4 (102)	$2\frac{3}{4}$ (70)	$4\frac{1}{4}$ (108)	$4\frac{1}{4}$ (108)	5 (127)
Minimum spacing distance <sup>3,4</sup>	$s_{min}$	in. (mm)	$3\frac{1}{2}$ (89)	6 (152)	6 (152)	4 (102)	6 (152)	$4\frac{1}{4}$ (108)	$4\frac{1}{4}$ (108)	6 (152)
Minimum hole depth <sup>3</sup>	$h_o$	in. (mm)	$2\frac{5}{8}$ (67)	$2\frac{3}{4}$ (70)	4 (102)	$4\frac{1}{4}$ (108)	$5\frac{1}{4}$ (133)	5 (127)	$6\frac{1}{4}$ (159)	
Minimum overall anchor length <sup>5</sup>	$\ell_{anch}$	in.	3	$3\frac{3}{4}$	$4\frac{1}{2}$	$4\frac{3}{4}$	6	$5\frac{1}{2}$	7	
Installation torque	$T_{inst}$	ft.-lb. (N-m)	20 (27)	40 (54)	60 (81)	110 (149)				
Torque wrench / socket size	-	in.	$\frac{9}{16}$	$\frac{3}{4}$	$\frac{15}{16}$	$\frac{1}{8}$				
Hex nut height	-	in.	$\frac{21}{64}$	$\frac{7}{16}$	$\frac{35}{64}$	$\frac{41}{64}$				

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

<sup>1</sup>The embedment depth,  $h_{nom}$ , is measured from the outside surface of the concrete member to the embedded end of the anchor prior to tightening.

<sup>2</sup>The anchors may be installed in the topside of concrete-filled steel deck floor and roof assemblies in accordance with Section 4.3 of this report, provided the concrete thickness above the upper flute meets the minimum thicknesses as specified in Table 2 and Figure 5D of this report.

<sup>3</sup>For installations through the soffit of steel deck into concrete see the installation details in Figures 5A, 5B and 5C of this report. In addition, anchors shall have an axial spacing along the flute soffit equal to the greater of  $3h_{ef}$  or 1.5 times the flute width.

<sup>4</sup>Additional combinations for minimum edge distance,  $c_{min}$ , and minimum spacing distance,  $s_{min}$ , may be derived by linear interpolation between the given boundary values for the anchors. See Figure 4.

<sup>5</sup>The listed minimum overall anchor length is based on anchor sizes commercially available at the time of publication compared with the requirements to achieve the minimum nominal embedment depth and possible fixture attachment, as applicable.

TABLE 2—POWER-STUD+ SD2 ANCHORS SETTING INFORMATION FOR INSTALLATION ON THE TOP OF CONCRETE-FILLED STEEL DECK ASSEMBLIES (ACCORDING TO FIGURE 5D)

ANCHOR PROPERTY / SETTING INFORMATION	NOTATION	UNITS	NOMINAL ANCHOR SIZE (inch)			
			$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$
Nominal drill bit diameter (ANSI)	$d_{bit}$	in.	$\frac{3}{8}$	$\frac{1}{2}$		
Minimum nominal embedment depth <sup>1</sup>	$h_{nom}$	in. (mm)	$2\frac{3}{8}$ (60)	$2\frac{1}{2}$ (64)		
Effective embedment	$h_{ef}$	in. (mm)	2.00 (51)	2.00 (51)		
Minimum concrete member thickness <sup>2,3</sup>	$h_{min,deck}$	in. (mm)	$2\frac{1}{2}$ (64)	$2\frac{1}{2}$ (64)		
Critical edge distance for topside of concrete-filled steel decks with minimum topping thickness (uncracked concrete) <sup>3</sup>	$c_{ac,deck,top}$	in. (mm)	8 (203)	9 (229)		
Minimum edge distance <sup>3,4</sup>	$c_{min,deck,top}$	in. (mm)	4 (102)	$2\frac{3}{4}$ (70)	4 (102)	8 (203)
Minimum spacing distance <sup>3,4</sup>	$s_{min,deck,top}$	in. (mm)	$3\frac{1}{2}$ (89)	6 (152)	8 (203)	4 (102)
Minimum hole depth	$h_o$	in. (mm)	$2\frac{1}{2}$ (64)	$2\frac{1}{2}$ (64)		
Minimum overall anchor length <sup>5</sup>	$\ell_{anch}$	in.	3	$3\frac{3}{4}$		
Installation torque	$T_{inst}$	ft.-lb. (N-m)	20 (27)	40 (54)		
Torque wrench / socket size	-	in.	$\frac{9}{16}$	$\frac{3}{4}$		
Hex nut height	-	in.	$\frac{21}{64}$	$\frac{7}{16}$		

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

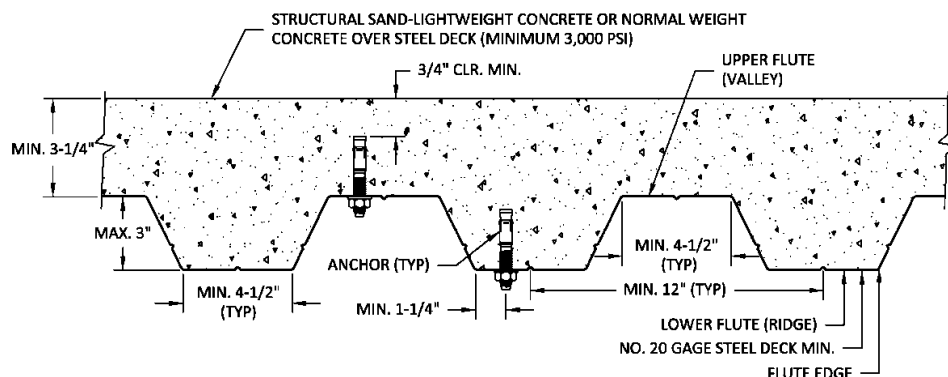
<sup>1</sup>The embedment depth,  $h_{nom}$ , is measured from the outside surface of the concrete member to the embedded end of the anchor prior to tightening.

<sup>2</sup>The anchors may be installed in the topside of concrete-filled steel deck floor and roof assemblies in accordance with Section 4.3 of this report provided the concrete thickness above the upper flute meets the minimum thicknesses specified in this table. Minimum concrete member thickness refers to the concrete thickness above the upper flute (topping thickness). See Figure 5D of this report.

<sup>3</sup>For all other anchor diameters and embedment depths, refer to Table 1 for applicable values of  $h_{min}$ ,  $c_{min}$  and  $s_{min}$ .

<sup>4</sup>Additional combinations for minimum design distance,  $c_{min}$ , and minimum spacing distance,  $s_{min}$ , may be derived by linear interpolation between the given boundary values for the anchors. See Figure 4.

<sup>5</sup>The listed minimum overall anchor length is based on anchor sizes commercially available at the time of publication compared with the requirements to achieve the minimum nominal embedment depth and possible fixture attachment, as applicable.

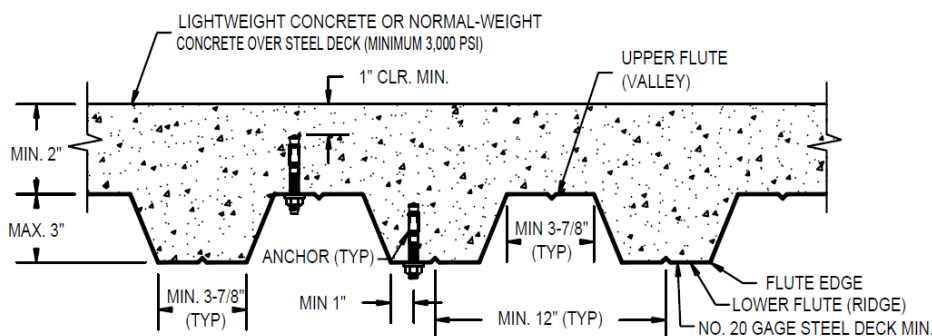


**FIGURE 5A—POWER-STUD+ SD2 INSTALLATION DETAIL FOR ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)<sup>1,2</sup>**

<sup>1</sup> SD2 anchors may be placed in the upper flute or lower flute of the steel deck profiles in accordance with Figure 5A provided the minimum hole clearance is satisfied.

Anchors in the lower flute of Figure 5A profiles may be installed with a maximum 1-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

<sup>2</sup> See Table 5 of this report for design data.

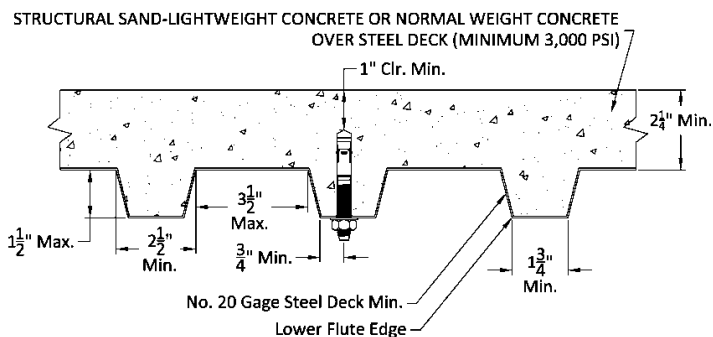


**FIGURE 5B—POWER-STUD+ SD2 INSTALLATION DETAIL FOR ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)<sup>1,2</sup>**

<sup>1</sup> SD2 anchors may be placed in the upper flute or lower flute of the steel deck profiles in accordance with Figure 5B provided the minimum hole clearance is satisfied.

Anchors in the lower flute of Figure 5B profiles may be installed with a maximum  $\frac{15}{16}$ -inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

<sup>2</sup> See Table 5 of this report for design data.



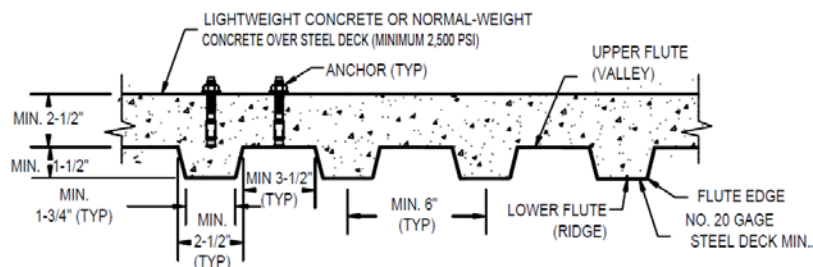
**FIGURE 5C—POWER-STUD+ SD2 INSTALLATION DETAIL FOR ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)<sup>1,2,3</sup>**

<sup>1</sup> SD2 anchors may be placed in the lower flute of the steel deck profiles in accordance with Figure 5C provided the minimum hole clearance is satisfied.

Anchors in the lower flute of Figure 5C profiles may be installed with a maximum  $\frac{1}{8}$ -inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

<sup>2</sup> Anchors may be placed in the upper flute of the steel deck profiles in accordance with Figure 5C provided the concrete thickness above the upper flute is minimum  $\frac{3}{4}$ -inch and a minimum hole clearance of  $\frac{3}{4}$ -inch is satisfied.

<sup>3</sup> See Table 5 of this report for design data.



**FIGURE 5D—INSTALLATION DETAIL FOR ANCHORS IN THE TOP OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)<sup>1,2</sup>**

<sup>1</sup> Anchors may be placed in the top side of concrete over steel deck profiles in accordance with Figure 5D provided the minimum concrete thickness above the upper flute (topping thickness) is as illustrated the and minimum spacing distance and minimum edge distances are satisfied as given in Table 2 of this report.

<sup>2</sup> For anchors installed in the top of concrete over steel deck profiles with concrete thickness above the upper flute (topping thickness) greater than or equal to the minimum concrete member thicknesses specified in Table 1 the minimum spacing distance and minimum edge distances may be used from those tables, as applicable.

<sup>3</sup> See Tables 3 and 4 of this report for design data.

TABLE 3—TENSION DESIGN INFORMATION FOR POWER-STUD+ SD2 ANCHORS IN CONCRETE<sup>1,2,12</sup>

Design Characteristic		Notation	Units	Nominal Anchor Size (inch)						
				<sup>3</sup> / <sub>8</sub>	<sup>1</sup> / <sub>2</sub>		<sup>5</sup> / <sub>8</sub>		<sup>3</sup> / <sub>4</sub>	
Anchor category		1, 2 or 3	-	1	1		1		1	
Effective embedment		<i>h<sub>ef</sub></i>	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)	5.00 (127)
STEEL STRENGTH IN TENSION (ACI 318-19 17.6.1, ACI 318-14 17.4.1 or ACI 318-11 D.5.1) <sup>4</sup>										
Minimum specified yield strength (neck)		<i>f<sub>y</sub></i>	ksi (N/mm <sup>2</sup> )	96.0 (662)	85.0 (586)		85.0 (586)		70.0 (483)	
Minimum specified ultimate strength (neck)		<i>f<sub>uta</sub></i>	ksi (N/mm <sup>2</sup> )	120.0 (827)	106.0 (731)		106.0 (731)		90.0 (620)	
Effective tensile stress area (neck)		<i>A<sub>se,N</sub></i>	in <sup>2</sup> (mm <sup>2</sup> )	0.0552 (35.6)	0.1007 (65.0)		0.1619 (104.5)		0.2359 (153.2)	
Steel strength in tension <sup>5</sup>		<i>N<sub>sa</sub></i>	lbf (kN)	6,625 (29.5)	10,445 (46.5)		13,080 (58.2)		21,230 (94.4)	
Reduction factor for steel strength <sup>3</sup>		<i>φ</i>	-	0.75						
CONCRETE BREAKOUT STRENGTH IN TENSION (ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 D.5.2) <sup>9</sup>										
Effectiveness factor for uncracked concrete		<i>k<sub>uncr</sub></i>	-	24	24		24		24	
Effectiveness factor for cracked concrete		<i>k<sub>cr</sub></i>	-	17	17		17		17	
Modification factor for cracked and uncracked concrete <sup>6</sup>		<i>ψ<sub>c,N</sub></i>	-	1.0 See note 6	1.0 See note 6		1.0 See note 6		1.0 See note 6	
Critical edge distance (uncracked concrete)		<i>c<sub>ac</sub></i>	in. (mm)	See Table 1						
Critical edge distance for topside of concrete-filled steel decks with minimum topping thickness (uncracked concrete) <sup>13</sup>		<i>c<sub>ac,deck,top</sub></i>	in. (mm)	See Table 2						
Reduction factor for concrete breakout strength in tension <sup>3</sup>		<i>φ</i>	-	0.65 (Condition B, supplementary reinforcement not present)						
PULLOUT STRENGTH IN TENSION ((ACI 318-19 17.6.3, ACI 318-14 17.4.3 or ACI 318-11 D.5.3) <sup>9</sup>										
Characteristic pullout strength, uncracked concrete (2,500 psi) <sup>7</sup>		<i>N<sub>p,uncr</sub></i>	lbf (kN)	2,775 (12.3)	See note 8	6,615 (29.4)	See note 8	See note 8	See note 8	See note 8
Characteristic pullout strength, cracked concrete (2,500 psi) <sup>7</sup>		<i>N<sub>p,cr</sub></i>	lbf (kN)	2,165 (9.6)	See note 8	4,375 (19.5)	See note 8	See note 8	See note 8	7,795 (35.1)
Reduction factor for pullout strength <sup>3</sup>		<i>φ</i>	-	0.65 (Condition B, supplementary reinforcement not present)						
PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS (ACI 318-19 17.10.3, ACI 318-14 17.2.3.3 or ACI 318-11 D.3.3.3) <sup>9</sup>										
Characteristic pullout strength, seismic (2,500 psi) <sup>7,10</sup>		<i>N<sub>p,eq</sub></i>	lbf (kN)	2,165 (9.6)	See note 8	4,375 (19.5)	See note 8	See Note 8	See note 8	7,795 (35.1)
Reduction factor for pullout strength <sup>3</sup>		<i>φ</i>	-	0.65 (Condition B, supplementary reinforcement not present)						
Mean axial stiffness values service load range <sup>11</sup>	Uncracked concrete	<i>β<sub>uncr</sub></i>	lbf/in. (kN/mm)	865,000 (1517)		717,000 (1258)		569,000 (998)		420,000 (747)
	Cracked concrete	<i>β<sub>cr</sub></i>	lbf/in. (kN/mm)	49,500 (87)		57,000 (100)		64,500 (113)		72,000 (126)

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of ACI 318 (-19 or -14) Chapter 17 or ACI 318-11 Appendix D, as applicable; for anchors resisting seismic load combinations the additional requirements of ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable, shall apply.

<sup>2</sup>Installation must comply with printed instructions and details.

<sup>3</sup>The strength reduction factor applies when the load combinations from the IBC or ACI 318 are used and the requirements of ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate strength reduction factor must be determined in accordance with ACI 318-11 D.4.4.

<sup>4</sup>The Power-Stud+ SD2 is considered a ductile steel element in tension as defined by ACI 318 (-19 or -14) 2.3 or ACI 318-11 D.1, as applicable.

<sup>5</sup>Tabulated values for steel strength in tension are based on test results per ACI 355.2 and must be used for design in lieu of calculation.

<sup>6</sup>For all design cases  $\psi_{c,N}=1.0$ . The appropriate effectiveness factor for cracked concrete ( $k_{cr}$ ) or uncracked concrete ( $k_{uncr}$ ) must be used.

<sup>7</sup>For all design cases  $\psi_{c,P}=1.0$ . For the calculation of  $N_{pn}$ , including adjustment for specified concrete compressive strength, see Section 4.1.4 of this report.

<sup>8</sup>Pullout strength does not control design of indicated anchors. Do not calculate pullout strength for indicated anchor size and embedment.

<sup>9</sup>Anchors are permitted to be used in lightweight concrete in accordance with Section 4.1.12 of this report.

<sup>10</sup>Tabulated values for characteristic pullout strength in tension are for seismic applications are based on test results per ACI 355.2, Section 9.5.

<sup>11</sup>Actual stiffness of the mean value varies considerably depending on concrete strength, loading and geometry of application.

<sup>12</sup>Anchors are permitted for use in concrete-filled steel deck floor and roof assemblies, see Section 4.1 and Figures 5A, 5B, 5C and 5D of this report.

<sup>13</sup>Tabulated critical edge distance values,  $c_{ac,deck,top}$ , are for anchors installed in the top of concrete over steel deck profiles with a minimum concrete thickness,  $h_{min,deck}$ , of 2.5 inches above the upper flute (topping thickness). For minimum topping thickness greater than or equal to the minimum concrete member thicknesses,  $h_{min}$ , given in Table 1, the associated critical edge distance,  $c_{ac}$ , for indicated anchor diameters and embedment depths may be used in the calculation of  $\psi_{cp,N}$  in accordance with Section 4.1.10 of this report, as applicable.

TABLE 4—SHEAR DESIGN INFORMATION FOR POWER-STUD+ SD2 ANCHORS IN CONCRETE<sup>1,2,8</sup>

Design Characteristic	Notation	Units	Nominal Anchor Diameter (inch)						
			3/8	1/2		5/8		3/4	
Anchor category	1, 2 or 3	-	1	1		1		1	
Effective embedment	$h_{ef}$	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)	5.00 (127)
STEEL STRENGTH IN SHEAR (ACI 318-19 17.7.1, ACI 318-14 17.5.1 or ACI 318-11 D.6.1) <sup>4</sup>									
Minimum specified yield strength (threads)	$f_y$	ksi (N/mm <sup>2</sup> )	76.8 (530)	68.0 (469)		68.0 (469)		56.0 (386)	
Minimum specified ultimate strength (threads)	$f_{uta}$	ksi (N/mm <sup>2</sup> )	100.0 (690)	88.0 (607)		88.0 (607)		80.0 (551)	
Effective tensile stress area (threads)	$A_{se,V}$	in <sup>2</sup> (mm <sup>2</sup> )	0.0775 (50.0)	0.1419 (91.6)		0.2260 (145.8)		0.3345 (215.8)	
Steel strength in shear <sup>5</sup>	$V_{sa}$	lbf (kN)	3,115 (13.9)	4,815 (21.4)		10,170 (45.2)		12,610 (56.1)	
Reduction factor for steel strength <sup>3</sup>	$\phi$	-	0.65						
STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS (ACI 318-19 17.10.3, ACI 318-14 17.2.3.3 or ACI 318-11 D.3.3.3)									
Steel strength in shear, seismic <sup>7</sup>	$V_{sa,eq}$	lbf (kN)	2,460 (11.0)	4,815 (21.4)		6,770 (30.1)		8,060 (35.9)	
Reduction factor for steel strength in shear, seismic <sup>3</sup>	$\phi$	-	0.65						
CONCRETE BREAKOUT STRENGTH IN SHEAR (ACI 318-19 17.7.2, ACI 318-14 17.5.2 or ACI 318-11 D.6.2) <sup>6</sup>									
Load-bearing length of anchor	$\ell_e$	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)	5.00 (127)
Nominal anchor diameter	$d_a$	in. (mm)	0.375 (9.5)	0.500 (12.7)		0.625 (15.9)		0.750 (19.1)	
Reduction factor for concrete breakout strength in shear <sup>3</sup>	$\phi$	-	0.70 (Condition B, supplementary reinforcement not present)						
PRYOUT STRENGTH IN SHEAR (ACI 318-19 17.7.3, ACI 318-14 17.5.3 or ACI 318-11 D.6.3) <sup>6</sup>									
Coefficient for prout strength	$k_{cp}$	-	1.0	1.0	2.0	2.0	2.0	2.0	2.0
Reduction factor for prout strength <sup>3</sup>	$\phi$	-	0.70 (Condition B, supplementary reinforcement not present)						

For **SI**: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of ACI 318 (-19 or -14) Chapter 17 or ACI 318-11 Appendix D, as applicable; for anchors resisting seismic load combinations the additional requirements of ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable, shall apply.

<sup>2</sup>Installation must comply with printed instructions and details.

<sup>3</sup>The strength reduction factor applies when the load combinations from the IBC or ACI 318 are used and the requirements of ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate strength reduction factor must be determined in accordance with ACI 318-11 D.4.4

<sup>4</sup>The Power-Stud+ SD2 is considered a ductile steel element as defined by ACI 318 (-19 or -14) 2.3 or ACI 318-11 D.1, as applicable.

<sup>5</sup>Tabulated values for steel strength in shear are based on test results per ACI 355.2, Section 9.4 and must be used for design.

<sup>6</sup>Anchor is permitted to be used in lightweight concrete in accordance with Section 4.1.12 of this report.

<sup>7</sup>Tabulated values for steel strength in shear are for seismic applications are based on test results per ACI 355.2, Section 9.6.

<sup>8</sup>Anchor is permitted for use in concrete-filled steel deck floor and roof assemblies, see Section 4.1 and Figures 5A, 5B, 5C and 5D of this report.

**TABLE 5—TENSION AND SHEAR DESIGN DATA FOR POWER-STUD+ SD2 ANCHORS IN THE SOFFIT OF CONCRETE-FILLED STEEL DECK ASSEMBLIES<sup>1,2,7,8</sup>**

Design Characteristic		Notation	Units	Nominal Anchor Size (inch)					
				<sup>3</sup> / <sub>8</sub>	<sup>1</sup> / <sub>2</sub>	<sup>5</sup> / <sub>8</sub>		<sup>3</sup> / <sub>4</sub>	
Anchor category		1, 2 or 3	-	1	1	1		1	
Effective embedment		$h_{ef}$	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)
Minimum nominal embedment depth		$h_{nom}$	in. (mm)	2 <sup>3</sup> / <sub>8</sub> (60)	2 <sup>1</sup> / <sub>2</sub> (64)	3 <sup>3</sup> / <sub>4</sub> (83)	3 <sup>7</sup> / <sub>8</sub> (98)	4 <sup>7</sup> / <sub>8</sub> (124)	4 <sup>1</sup> / <sub>2</sub> (114)
Minimum hole depth		$h_o$	in. (mm)	2 <sup>5</sup> / <sub>8</sub> (67)	2 <sup>3</sup> / <sub>4</sub> (70)	4 (102)	4 <sup>1</sup> / <sub>4</sub> (108)	5 <sup>1</sup> / <sub>4</sub> (133)	5 (127)
PULLOUT STRENGTH IN TENSION FOR ANCHORS IN SOFFIT OF SAND-LIGHTWEIGHT AND NORMAL-WEIGHT CONCRETE OVER STEEL DECK <sup>1</sup>									
According to Figure 5A 4 <sup>1</sup> / <sub>2</sub> -inch-wide deck flute	Characteristic pullout strength, uncracked concrete over steel deck <sup>2</sup>	$N_{p,deck,uncr}$	lbf (kN)	1,855 (8.3)	2,065 (9.2)	3,930 (17.5)	4,665 (20.8)	7,365 (32.8)	4,900 (21.8)
	Characteristic pullout strength, cracked concrete over steel deck <sup>2,3</sup>	$N_{p,deck,cr}$ ( $N_{p,deck,eq}$ )	lbf (kN)	1,445 (6.4)	1,465 (6.5)	2,600 (11.6)	3,305 (14.7)	5,215 (23.2)	3,470 (15.4)
According to Figure 5B 3 <sup>7</sup> / <sub>8</sub> -inch-wide deck flute	Characteristic pullout strength, uncracked concrete over steel deck <sup>2</sup>	$N_{p,deck,uncr}$	lbf (kN)	2,235 (9.9)	2,785 (12.4)	5,600 (24.9)	4,480 (19.9)	7,265 (32.3)	Not Applicable
	Characteristic pullout strength, cracked concrete over steel deck <sup>2,3</sup>	$N_{p,deck,cr}$ ( $N_{p,deck,eq}$ )	lbf (kN)	1,745 (7.8)	1,975 (8.8)	3,695 (16.4)	3,175 (14.1)	5,145 (22.9)	
According to Figure 5C 1 <sup>3</sup> / <sub>4</sub> -inch-wide deck flute	Characteristic pullout strength, uncracked concrete over steel deck <sup>2</sup>	$N_{p,deck,uncr}$	lbf (kN)	1,600 (7.1)	2,025 (9.0)	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Characteristic pullout strength, cracked concrete over steel deck <sup>2,3</sup>	$N_{p,deck,cr}$ ( $N_{p,deck,eq}$ )	lbf (kN)	1,250 (5.6)	1,435 (6.4)				
Reduction factor for pullout strength <sup>6</sup>		$\phi$	-	0.65 (Condition B)					
STEEL STRENGTH IN SHEAR FOR ANCHORS IN SOFFIT OF SAND-LIGHTWEIGHT AND NORMAL-WEIGHT CONCRETE OVER STEEL DECK <sup>4</sup>									
According to Figure 5A 4 <sup>1</sup> / <sub>2</sub> -inch-wide deck flute	Steel strength in shear, concrete over steel deck <sup>5</sup>	$V_{sa,deck}$	lbf (kN)	2,170 (9.7)	3,815 (17.0)	5,040 (22.4)	4,015 (17.9)	6,670 (29.7)	4,325 (19.2)
	Steel strength in shear, seismic, concrete over steel deck <sup>5</sup>	$V_{sa,deck,eq}$	lbf (kN)	1,715 (7.6)	3,815 (17.0)	5,040 (22.4)	2,675 (11.9)	4,445 (19.8)	2,820 (12.5)
According to Figure 5B 3 <sup>7</sup> / <sub>8</sub> -inch-wide deck flute	Steel strength in shear, concrete over steel deck <sup>5</sup>	$V_{sa,deck}$	lbf (kN)	3,040 (13.5)	2,675 (11.9)	4,930 (21.9)	5,370 (23.9)	6,070 (27.0)	Not Applicable
	Steel strength in shear, seismic, concrete over steel deck <sup>5</sup>	$V_{sa,deck,eq}$	lbf (kN)	2,400 (10.6)	2,675 (11.9)	4,930 (21.9)	3,580 (15.9)	4,045 (18.0)	
According to Figure 5C 1 <sup>3</sup> / <sub>4</sub> -inch-wide deck flute	Steel strength in shear, concrete over steel deck <sup>5</sup>	$V_{sa,deck}$	lbf (kN)	2,170 (9.7)	2,880 (12.8)	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Steel strength in shear, seismic, concrete over steel deck <sup>5</sup>	$V_{sa,deck,eq}$	lbf (kN)	1,715 (7.6)	2,880 (12.8)				
Reduction factor for steel strength in shear, concrete over steel deck <sup>6</sup>		$\phi$	-	0.65					

For **SI**: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>For all design cases  $\Psi_{c,P} = 1.0$ . For the calculation of  $N_{pn}$ , including adjustment for specified concrete compressive strength, see Section 4.1.4 of this report. see Section 4.1.4 of this report.

<sup>2</sup>Values for  $N_{p,deck}$  are for sand-lightweight concrete ( $f'_{c,min} = 3,000$  psi) and additional lightweight concrete reduction factors need not be applied. In addition, evaluation for the concrete breakout capacity in accordance with ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, is not required for anchors installed in the deck soffit (flute).

<sup>3</sup>Values for  $N_{p,deck,cr}$  are applicable for seismic loading; see Section 4.1.8.2 of this report.
















<sup>4</sup>Shear loads for anchors installed through steel deck into concrete may be applied in any direction.

<sup>5</sup>Values for  $V_{sa,deck}$  and  $V_{sa,deck,eq}$  are for sand-lightweight concrete ( $f'_{c,min} = 3,000$  psi) and additional lightweight concrete reduction factors need not be applied. In addition, evaluation for the concrete breakout capacity in accordance with ACI 318-19 17.7.2, ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable and the pryout capacity in accordance with ACI 318-19 17.7.3, ACI 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable, is not required for anchors installed in the deck soffit (flute).

<sup>6</sup>The strength reduction factor applies when the load combinations from the IBC or ACI 318 are used and the requirements of ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate strength reduction factor must be determined in accordance with ACI 318-11 D.4.4.

<sup>7</sup>Installations must comply with Sections 4.1.11 and 4.3 and Figures 5A, 5B and 5C of this report.

<sup>8</sup>Anchors shall have an axial spacing along the flute soffit equal to the greater of  $3h_{ef}$  or 1.5 times the flute width.

DeWALT Dust Removal Drilling System with HEPA Dust Extractor Options				
Tool		Accessories and Shrouds		Dust Extractor
SDS-Max Drills				
	Cordless	 SDS-Max Hollow Drill Bits		 Dust Extractor
	Corded	 SDS-Max Drill Bits With Shroud		
SDS-Plus Drills				
	Cordless	 SDS-Plus Drill Bits	 SDS-Plus Stop Drill Bits	 Cordless On-board Dust Extractor
		Corded	 SDS-Plus Hollow Drill Bits	
 SDS-Plus Drill Bits With Telescope		 SDS-Plus Drill Bits With Suction Tube	 SDS-Plus Drill Bits With Shroud	
				 SDS-Plus Stop Drill Bits With Shroud

The DEWALT drilling systems shown collect and remove dust with a HEPA dust extractor during the hole drilling operation in dry base materials using hammer-drills (see manufacturer's printed installation instructions).

FIGURE A—EXAMPLES OF DEWALT DUST REMOVAL DRILLING SYSTEMS WITH HEPA DUST EXTRACTORS FOR ILLUSTRATION

TABLE 6—POWER-STUD+ SD4 AND POWER-STUD+ SD6 STAINLESS STEEL ANCHOR INSTALLATION SPECIFICATIONS

ANCHOR PROPERTY / SETTING INFORMATION	NOTATION	UNITS	NOMINAL ANCHOR SIZE (inch)							
			1/4	3/8	1/2	5/8	3/4			
Outside diameter of anchor	$d_a$	in. (mm)	0.250 (6.4)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)			
Minimum diameter of hole clearance in fixture	$d_h$	in. (mm)	5/16 (7.9)	7/16 (11.1)	9/16 (14.3)	11/16 (17.5)	13/16 (20.6)			
Nominal drill bit diameter (ANSI)	$d_{bit}$	in.	1/4	3/8	1/2	5/8	3/4			
Minimum nominal embedment depth <sup>1</sup>	$h_{nom}$	in. (mm)	1 3/4 (44)	1 7/8 (48)	2 1/2 (64)	3 1/4 (83)	4 1/2 (114)			
Effective embedment	$h_{ef}$	in. (mm)	1.50 (38)	1.50 (38)	2.00 (51)	2.75 (70)	3.75 (95)			
Minimum concrete member thickness <sup>2</sup>	$h_{min}$	in. (mm)	3 1/4 (83)	3 1/4 (83)	4 (102)	5 (127)	6 (152)			
Critical edge distance (uncracked concrete)	$c_{ac}$	in. (mm)	5 (127)	5 (127)	7 1/2 (191)	9 1/2 (241)	9 (229)			
Minimum edge distance <sup>3</sup>	$c_{min}$	in. (mm)	1 3/4 (45)	3 (76)	3 1/2 (89)	6 (152)	8 1/2 (216)	5 (127)	9 (229)	
Minimum spacing distance <sup>3</sup>	$s_{min}$	in. (mm)	2 (51)	5 1/2 (140)	3 (76)	3 (76)	6 (152)	5 (127)	9 (229)	5 (127)
Minimum hole depth	$h_o$	in. (mm)	1 7/8 (48)	2 (51)	2 5/8 (67)	3 1/2 (89)	4 3/4 (121)			
Minimum overall anchor length <sup>4</sup>	$\ell_{anch}$	in.	2 1/4	2 3/4	3 3/4	4 1/2	5 1/2			
Installation torque	$T_{inst}$	ft.-lb. (N-m)	6 (8)	25 (34)	40 (54)	60 (81)	110 (149)			
Torque wrench / socket size	-	in.	7/16	9/16	3/4	15/16	1 1/8			
Nut height	-	In.	7/32	21/64	7/16	35/64	41/64			

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

<sup>1</sup>The embedment depth,  $h_{nom}$ , is measured from the outside surface of the concrete member to the embedded end of the anchor prior to tightening.

<sup>2</sup>The anchors may be installed in the top of concrete-filled steel deck floor and roof assemblies in accordance with Section 4.3 of this report provided the concrete thickness above the upper flute meets the minimum thickness specified in this table.

<sup>3</sup>Additional combinations for minimum edge distance,  $c_{min}$ , and minimum spacing distance,  $s_{min}$ , may be derived by linear interpolation between the given boundary values for the anchors. See Figure 4.

<sup>4</sup>The listed minimum overall anchor length is based on anchor sizes commercially available at the time of publication compared with the requirements to achieve the minimum nominal embedment depth and possible fixture attachment, as applicable.

**TABLE 7—TENSION DESIGN INFORMATION FOR POWER-STUD+ SD4 AND POWER-STUD+ SD6  
STAINLESS STEEL ANCHORS IN CONCRETE<sup>1,7</sup>**

Design Characteristic		Notation	Units	Nominal Anchor Size (inch)				
				1/4	3/8	1/2	5/8	3/4
Anchor category		1, 2 or 3	-	1	1	1	1	1
Effective embedment		$h_{ef}$	in. (mm)	1.50 (38)	1.50 (38)	2.00 (51)	2.75 (70)	3.75 (95)
STEEL STRENGTH IN TENSION (ACI 318-19 17.6.1, ACI 318-14 17.4.1 or ACI 318-11 D.5.1)								
Minimum specified yield strength (neck)		$f_y$	ksi (N/mm <sup>2</sup> )	60.0 (414)	60.0 (414)	60.0 (414)	60.0 (414)	60.0 (414)
Minimum specified ultimate strength (neck)		$f_{uta}$	ksi (N/mm <sup>2</sup> )	90.0 (621)	90.0 (621)	90.0 (621)	90.0 (621)	90.0 (621)
Effective tensile stress area (neck)		$A_{se,N}$	in <sup>2</sup> (mm <sup>2</sup> )	0.0249 (16.1)	0.0530 (34.2)	0.1020 (65.8)	0.1630 (105.2)	0.238 (151)
Steel strength in tension		$N_{sa}$	lbf (kN)	2,240 (10.0)	4,780 (21.3)	9,160 (40.8)	14,635 (65.1)	21,380 (95.1)
Reduction factor for steel strength <sup>2,3</sup>		$\phi$	-	0.75				
CONCRETE BREAKOUT STRENGTH IN TENSION (ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 D.5.2) <sup>6</sup>								
Effectiveness factor for uncracked concrete		$k_{uncr}$	-	24	24	24	24	24
Effectiveness factor for cracked concrete		$k_{cr}$	-	Not applicable	17	21	21	21
Modification factor for cracked and uncracked concrete		$\psi_{c,N}$	-	1.0 See note 4	1.0 See note 4	1.0 See note 4	1.0 See note 4	1.0 See note 4
Critical edge distance (uncracked concrete)		$c_{ac}$	in. (mm)	See Table 6				
Reduction factor for concrete breakout strength in tension <sup>2</sup>		$\phi$	-	0.65 (Condition B, supplementary reinforcement not present)				
PULLOUT STRENGTH IN TENSION (ACI 318-19 17.6.3, ACI 318-14 17.4.3 or ACI 318-11 D.5.3) <sup>7</sup>								
Characteristic pullout strength, uncracked concrete (2,500 psi) <sup>5</sup>		$N_{p,uncr}$	lbf (kN)	1,510 (6.7)	See note 6	See note 6	See note 6	8,520 (37.8)
Characteristic pullout strength, cracked concrete (2,500 psi) <sup>5</sup>		$N_{p,cr}$	lbf (kN)	Not applicable	1,645 (7.3)	See note 6	See note 6	See note 6
Reduction factor for pullout strength <sup>2</sup>		$\phi$	-	0.65 (Condition B, supplementary reinforcement not present)				
PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS (ACI 318-19 17.10.3, ACI 318-14 17.2.3.3 or ACI 318-11 D.3.3.3) <sup>7</sup>								
Characteristic pullout strength, seismic (2,500 psi) <sup>5,8</sup>		$N_{p,eq}$	lbf (kN)	Not applicable	1,645 (7.3)	See note 6	See note 6	See note 6
Reduction factor for pullout strength <sup>2</sup>		$\phi$	-	0.65 (Condition B, supplementary reinforcement not present)				
Mean axial stiffness values for service load range <sup>9</sup>	Uncracked concrete	$\beta$	lbf/in (kN/mm)	171,400 (30,060)	490,000 (86,000)	459,000 (80,500)	234,000 (41,000)	395,000 (69,300)
	Cracked concrete	$\beta$	lbf/in (kN/mm)	Not applicable	228,000 (40,000)	392,000 (68,800)	193,000 (33,800)	76,600 (13,400)

For **SI**: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of ACI 318 (-19 or -14) Chapter 17 or ACI 318-11 Appendix D, as applicable; for anchors resisting seismic load combinations the additional requirements of ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable, shall apply.

<sup>2</sup> The strength reduction factor applies when the load combinations from the IBC or ACI 318 are used and the requirements of ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate strength reduction factor must be determined in accordance with ACI 318-11 D.4.4.

<sup>3</sup>The anchors are ductile steel elements as defined in ACI 318 (-19 or -14) 2.3 or ACI 318-11 D.1, as applicable.

<sup>4</sup>For all design cases  $\psi_{c,N}=1.0$ . The appropriate effectiveness factor for cracked concrete ( $k_{cr}$ ) or uncracked concrete ( $k_{uncr}$ ) must be used.

<sup>5</sup>For all design cases  $\psi_{c,P}=1.0$ . For the calculation of  $N_{pn}$ , including adjustment for specified concrete compressive strength, see Section 4.1.4 of this report.

<sup>6</sup>Pullout strength does not control design of indicated anchors. Do not calculate pullout strength for indicated anchor size and embedment.

<sup>7</sup>Anchors are permitted to be used in lightweight concrete in accordance with Section 4.1.12 of this report.

<sup>8</sup>Tabulated values for characteristic pullout strength in tension are for seismic applications are based on test results per ACI 355.2, Section 9.5.

<sup>9</sup>Actual stiffness of the mean value varies depending on concrete strength, loading and geometry of application.

**TABLE 8—SHEAR DESIGN INFORMATION FOR POWER-STUD+ SD4 AND POWER-STUD+ SD6 STAINLESS STEEL ANCHORS IN CONCRETE<sup>1,5</sup>**

Design Characteristic	Notation	Units	Nominal Anchor Diameter				
			1/4	3/8	1/2	5/8	3/4
Anchor category	1, 2 or 3	-	1	1	1	1	1
Effective embedment	$h_{ef}$	in. (mm)	1.50 (38)	1.50 (38)	2.00 (51)	2.75 (70)	3 <sup>3</sup> /4 (95)
STEEL STRENGTH IN SHEAR (ACI 318-19 17.7.1, ACI 318-14 17.5.1 or ACI 318-11 D.6.1) <sup>2</sup>							
Minimum specified yield strength (threads)	$f_y$	ksi (N/mm <sup>2</sup> )	60.0 (414)	60.0 (414)	60.0 (414)	60.0 (414)	60.0 (414)
Minimum specified ultimate strength (threads)	$f_{uta}$	ksi (N/mm <sup>2</sup> )	90.0 (621)	90.0 (621)	90.0 (621)	90.0 (621)	90.0 (621)
Effective shear stress area (threads)	$A_{se,V}$	in <sup>2</sup> (mm <sup>2</sup> )	0.0318 (20.5)	0.0780 (50.3)	0.142 (91.6)	0.226 (145.8)	0.334 (212)
Steel strength in shear <sup>4</sup>	$V_{sa}$	lbf (kN)	1,115 (5.0)	1,470 (6.6)	3,170 (14.1)	7,455 (33.2)	11,955 (53.2)
Reduction factor for steel strength <sup>2,3</sup>	$\phi$	-	0.65				
STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS (ACI 318-19 17.10.3, ACI 318-14 17.2.3.3 or ACI 318-11 D.3.3.3)							
Steel strength in shear, seismic <sup>6</sup>	$V_{sa,eq}$	lbf (kN)	Not applicable	1,305 (5.8)	2,765 (12.3)	5,240 (23.3)	7,745 (34.45)
Reduction factor for steel strength in shear, seismic <sup>2</sup>	$\phi$	-	0.65				
CONCRETE BREAKOUT STRENGTH IN SHEAR (ACI 318-19 17.7.2, ACI 318-14 17.5.2 or ACI 318-11 D.6.2) <sup>5</sup>							
Load-bearing length of anchor	$\ell_e$	in. (mm)	1.50 (38)	1.50 (38)	2.00 (51)	2.75 (70)	3.75 (95)
Nominal anchor diameter	$d_a$	in. (mm)	0.250 (6.4)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)
Reduction factor for concrete breakout strength in shear <sup>2</sup>	$\phi$	-	0.70 (Condition B, supplementary reinforcement not present)				
PRYOUT STRENGTH IN SHEAR (ACI 318-19 17.7.3, ACI 318-14 17.5.3 or ACI 318-11 D.6.3) <sup>5</sup>							
Coefficient for prout strength	$k_{cp}$	-	1.0	1.0	1.0	2.0	2.0
Reduction factor for prout strength <sup>2</sup>	$\phi$	-	0.70 (Condition B, supplementary reinforcement not present)				

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of ACI 318 (-19 or -14) Chapter or ACI 318-11 Appendix D, as applicable; for anchors resisting seismic load combinations the additional requirements of ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable, shall apply.

<sup>2</sup> The strength reduction factor applies when the load combinations from the IBC or ACI 318 are used and the requirements of ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate strength reduction factor must be determined in accordance with ACI 318-11 D.4.4.

<sup>3</sup>The anchors are ductile steel elements as defined in ACI 318-14 2.3 or ACI 318-11 D.1, as applicable.

<sup>4</sup>Tabulated values for steel strength in shear are based on test results per ACI 355.2, Section 9.4 and must be used for design.

<sup>5</sup>Anchors are permitted to be used in lightweight concrete in accordance with Section 4.1.12 of this report.

<sup>6</sup>Tabulated values for steel strength in shear are for seismic applications are based on test results per ACI 355.2, Section 9.6.

TABLE 9—EXAMPLE ALLOWABLE STRESS DESIGN VALUES FOR ILLUSTRATIVE PURPOSES<sup>1,2,3,4,5,6,7,8,9</sup>

Nominal Anchor Diameter (in.)	Product	Nominal Embedment Depth (in.)	Effective Embedment (in.)	Allowable Tension Load (pounds)
1/4	Power-Stud+ SD4 and Power-Stud+ SD6	1 3/4	1.50	665
3/8	Power-Stud+ SD2	2 3/8	2.00	1,220
	Power-Stud+ SD4 and Power-Stud+ SD6	1 7/8	1.50	970
1/2	Power-Stud+ SD2	2 1/2	2.00	1,490
	Power-Stud+ SD4 and Power-Stud+ SD6	2 1/2	2.00	1,865
	Power-Stud+ SD2	3 3/4	3.25	2,905
5/8	Power-Stud+ SD4 and Power-Stud+ SD6	3 1/4	2.75	2,405
	Power-Stud+ SD2	3 7/8	3.25	3,090
		4 7/8	4.25	4,615
3/4	Power-Stud+ SD4 and Power-Stud+ SD6	4 1/2	3.75	3,740
	Power-Stud+ SD2	4 1/2	3.75	3,825
		5 3/4	5.00	5,890

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

<sup>1</sup>Single anchor with static tension load only.

<sup>2</sup>Concrete determined to remain uncracked for the life of the anchorage.

<sup>3</sup>Load combinations from ACI 318 (-19 or -14) Section 5.3 or ACI 318-11 Section 9.2, as applicable (no seismic loading considered).

<sup>4</sup>30% dead load and 70% live load, controlling load combination 1.2D + 1.6L.

<sup>5</sup>Calculation of weighted average for  $\alpha = 1.2(0.3) + 1.6(0.7) = 1.48$ .

<sup>6</sup> $f'_c = 2,500$  psi (normal weight concrete).

<sup>7</sup> $C_{a1} = C_{a2} \geq C_{ac}$ .

<sup>8</sup> $h \geq h_{min}$ .

<sup>9</sup>Values are for Condition B where supplementary reinforcement in accordance with ACI 318 (-19 or -14) 17.3.3 or ACI 318-11 D.4.3, as applicable, is not provided.

**Given:** Calculate the factored strength design resistance in tension,  $\phi N_n$ , and the allowable stress design value,  $T_{allowable, ASD}$ , for a 3/8-inch diameter Power-Stud+ SD2 anchor assuming the given conditions in Table 7.

Calculation in accordance with ACI 318 (-19 or -14) Chapter 17, ACI 318-11 Appendix D and this report:	ACI 318-19 Ref.	ACI 318-14 Ref.	ACI 318-11 Ref.	Report Ref.
Step 1. Calculate steel strength of a single anchor in tension: $\phi N_{sa} = (0.75)(6,625) = 4,969 \text{ lbs.}$	17.6.1.2	17.4.1.2	D.5.1.2	Table 3
Step 2. Calculate concrete breakout strength of a single anchor in tension: $\phi N_{cb} = \phi \frac{A_{Nc}}{A_{Nco}} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$ $N_b = k_c \lambda_a \sqrt{f'_c} (h_{ef})^{1.5}$ $N_b = (24)(1.0) \sqrt{2,500} (2.0)^{1.5} = 3,394 \text{ lbs.}$ $\phi N_{cb} = (0.65) \left( \frac{36.0}{36.0} \right) (1.0)(1.0)(1.0)(3,394) = 2,206 \text{ lbs.}$	17.6.2.1	17.4.2.1	D.5.2.1	Table 3
Step 3. Calculate pullout strength of a single anchor: $\phi N_{pn} = \phi N_{p,uncr} \psi_{c,P} \left( \frac{f'_c}{2,500} \right)^n$ $\phi N_{pn} = (0.65)(2,775)(1.0)(1.0)^{0.5} = 1,804 \text{ lbs.}$	17.6.2.2	17.4.2.2	D.5.2.2	Table 3
Step 4. Determine controlling factored resistance strength in tension: $\phi N_n = \min[\phi N_{sa}, \phi N_{cb}, \phi N_{pn}] = \phi N_{pn} = 1,804 \text{ lbs.}$	17.5.1.3	17.3.1.1	D.4.1.1	-
Step 5. Calculate allowable stress design conversion factor for loading condition: Controlling load combination: 1.2D + 1.6L $\alpha = 1.2(30\%) + 1.6(70\%) = 1.48$	5.3	5.3	9.2	-
Step 6. Calculate allowable stress design value: $T_{allowable, ASD} = \frac{\phi N_n}{\alpha} = \frac{1,804}{1.48} = 1,220 \text{ lbs.}$	-	-	-	§ 4.2

FIGURE 6—EXAMPLE STRENGTH DESIGN CALCULATION INCLUDING ASD CONVERSION FOR ILLUSTRATIVE PURPOSES

# ICC-ES Evaluation Report

# ESR-2502 LABC and LARC Supplement

Reissued May 2022

*This report is subject to renewal May 2023.*

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**DIVISION: 03 00 00—CONCRETE**

**Section: 03 16 00—Concrete Anchors**

**DIVISION: 05 00 00—METALS**

**Section: 05 05 19—Post-installed Concrete Anchors**

**REPORT HOLDER:**

**DEWALT**

**EVALUATION SUBJECT:**

**POWER-STUD®+ SD2 CARBON STEEL ANCHORS, POWER-STUD®+ SD4 STAINLESS STEEL ANCHORS AND POWER-STUD®+ SD6 STAINLESS STEEL ANCHORS IN CRACKED AND UNCRACKED CONCRETE (DEWALT)**

## 1.0 REPORT PURPOSE AND SCOPE

### Purpose:

The purpose of this evaluation report supplement is to indicate that Power-Stud®+ SD2 carbon steel anchors, Power-Stud®+ SD4 stainless steel anchors and Power-Stud®+ SD6 stainless steel anchors in cracked and uncracked concrete, described in ICC-ES evaluation report [ESR-2502](#), have also been evaluated for compliance with the codes noted below as adopted by Los Angeles Department of Building and Safety (LADBS).

### Applicable code editions:

- 2020 *City of Los Angeles Building Code* (LABC)
- 2020 *City of Los Angeles Residential Code* (LARC)

## 2.0 CONCLUSIONS

The Power-Stud®+ SD2 carbon steel anchors, Power-Stud®+ SD4 stainless steel anchors and Power-Stud®+ SD6 stainless steel anchors in cracked and uncracked concrete, described in Sections 2.0 through 7.0 of the evaluation report [ESR-2502](#), comply with LABC Chapter 19, and LARC, and are subject to the conditions of use described in this report.

## 3.0 CONDITIONS OF USE

The Power-Stud®+ SD2 carbon steel anchors, Power-Stud®+ SD4 stainless steel anchors and Power-Stud®+ SD6 stainless steel anchors described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report [ESR-2502](#).
- The design, installation, conditions of use and labeling of the anchors are in accordance with the 2018 *International Building Code*® (IBC) provisions noted in the evaluation report [ESR-2502](#).
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.
- Under the LARC, an engineered design in accordance with LARC Section R301.1.3 must be submitted.
- The allowable and strength design values listed in the evaluation report and tables, are for the connection of the anchors to the concrete. The connection between the anchors and the connected members shall be checked for capacity (which may govern).
- For use in wall anchorage assemblies to flexible diaphragm applications, anchors shall be designed per the requirements of City of Los Angeles Information Bulletin P/BC 2020-071.

This supplement expires concurrently with the evaluation report, reissued May 2022.

# ICC-ES Evaluation Report

# ESR-2502 FBC Supplement

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**DIVISION: 03 00 00—CONCRETE**

**Section: 03 16 00—Concrete Anchors**

**DIVISION: 05 00 00—METALS**

**Section: 05 05 19—Post-Installed Concrete Anchors**

## REPORT HOLDER:

**DEWALT**

## EVALUATION SUBJECT:

**POWER-STUD®+ SD2 CARBON STEEL ANCHORS, POWER-STUD®+ SD4 STAINLESS STEEL ANCHORS AND POWER-STUD®+ SD6 STAINLESS STEEL ANCHORS IN CRACKED AND UNCRACKED CONCRETE (DEWALT)**

## 1.0 REPORT PURPOSE AND SCOPE

### Purpose:

The purpose of this evaluation report supplement is to indicate that Power-Stud+ SD2 Carbon Steel Anchors, Power-Stud+ SD4 Stainless Steel Anchors and Power-Stud+ SD6 Stainless Steel Anchors in Cracked and Uncracked Concrete, described in ICC-ES evaluation report ESR-2502, have also been evaluated for compliance with the codes noted below:

### Compliance with the following codes:

- 2020 *Florida Building Code—Building*
- 2020 *Florida Building Code—Residential*

## 2.0 PURPOSE OF THIS SUPPLEMENT

The Power-Stud+ SD2 Carbon Steel Anchors, Power-Stud+ SD4 Stainless Steel Anchors and Power-Stud+ SD6 Stainless Steel Anchors in Cracked and Uncracked Concrete, described in Sections 2.0 through 7.0 of the evaluation report ESR-2502, comply with the *Florida Building Code—Building* and the *Florida Building Code—Residential*, provided the design requirements are in accordance with the *Florida Building Code—Building* or the *Florida Building Code—Residential*, as applicable. The installation noted in ICC-ES evaluation report ESR-2502 for the 2018 *International Building Code*® meet the requirements of the *Florida Building Code—Building* or the *Florida Building Code—Residential*.

Use of the Power-Stud+ SD2 Carbon Steel Anchors, Power-Stud+ SD4 Stainless Steel Anchors and Power-Stud+ SD6 Stainless Steel Anchors in cracked and uncracked concrete has also been found to be in compliance with the High-Velocity Hurricane Zone provisions of the *Florida Building Code—Building* and the *Florida Building Code—Residential* with the following condition:

- a) For anchorage to wood members, the connection subject to uplift, must be designed for no less than 700 pounds (3114 N).

For products falling under Florida Rule 61G20-3, verification that the report holder's quality assurance program is audited by a quality assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official, when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the evaluation report, reissued May 2022.