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:

SCREW-BOLT+™ ANCHORS AND HANGERMATE®+ ROD HANGER SCREW 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 Screw-Bolt+ Screw Anchors and Hangermate+ Rod Hanger Screw Anchors in cracked and uncracked concrete, described in ICC-ES evaluation report ESR-3889, 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 Screw-Bolt+ Screw Anchors and Hangermate+ Rod Hanger Screw Anchors in cracked and uncracked concrete, described in Sections 2.0 through 7.0 of the evaluation report ESR-3889, comply with LABC Chapter 19, and LARC, and are subjected to the conditions of use described in this report.

3.0 CONDITIONS OF USE

The Screw-Bolt+ and Hangermate+ anchors described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-3889.
- 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-3889.
- 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 November 2020.

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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

701 EAST JOPPA ROAD
TOWSON, MARYLAND 21286

EVALUATION SUBJECT:

SCREW-BOLT+™ SCREW ANCHORS AND HANGERMATE®+ ROD HANGER SCREW ANCHORS IN CRACKED AND UNCRACKED CONCRETE (DEWALT)

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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:

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EVALUATION SUBJECT:

SCREW-BOLT+™ SCREW ANCHORS AND HANGERMATE®+ ROD HANGER SCREW ANCHORS IN CRACKED AND UNCRACKED CONCRETE (DEWALT)

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2015, 2012 and 2009 *International Building Code®* (IBC)
- 2015, 2012 and 2009 *International Residential Code®* (IRC)

Property evaluated:

Structural

2.0 USES

The Screw-Bolt+ screw anchors and Hangermate+ rod hanger screw anchors are used to resist static, wind and seismic tension and shear loads 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).

The $^1/_4$-inch-, $^3/_8$-inch- and $^1/_2$-inch-diameter (6.4 mm, 9.5 mm and 12.7 mm) Screw-Bolt+ anchors may be installed in the topside of cracked and uncracked normal-weight or sand-lightweight concrete-filled steel deck having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

The $^1/_4$-inch-, $^3/_8$-inch-, $^1/_2$-inch-, $^5/_8$-inch, and $^3/_4$-inch-diameter (6.4 mm 9.5 mm, 12.7 mm, 15.9 mm and 19.1 mm) Screw-Bolt+ anchors may be installed in the soffit of cracked and uncracked normal-weight or sand-lightweight concrete-filled steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

The $^1/_4$-inch- and $^3/_8$-inch-diameter (6.4 mm and 9.5 mm) Hangermate+ anchors may be installed in the soffit of cracked and uncracked normal-weight or sand-lightweight concrete-filled steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

The anchors are an alternative to cast-in-place anchors described in Section 1901.3 of the 2015 IBC, Section 1908 and 1909 of the 2012 IBC, and Sections 1911 and 1912 of the 2009 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 Screw-Bolt+ Anchors:

Screw-Bolt+ screw anchors are comprised of an anchor body with hex washer head. Available diameters are $^1/_4$-inch, $^3/_8$-inch, $^1/_2$-inch, $^5/_8$-inch and $^3/_4$-inch (6.4 mm, 9.5 mm, 12.7 mm, 15.9 mm and 19.1 mm). The anchor body and hex washer head are manufactured from low-carbon steel which is case hardened and have minimum 0.0002-inch (5 µm) zinc plating in accordance with ASTM B633 or minimum 0.0021-inch (53 µm) mechanical zinc plating in accordance with ASTM B695, Class 55. The Screw-Bolt+ screw anchor is illustrated in Figures 1A and 1B.

The hex head of the anchor is formed with an integral washer and serrations on the underside. The anchor body is formed with dual lead threads and a chamfered tip. The screw anchors are installed in a predrilled hole with a powered impact wrench or torque wrench. The threads on the anchor tap into the sides of the predrilled hole and interlock with the base material during installation.

3.2 Hangermate+ Anchors:

Hangermate+ rod hanger screw anchors are comprised of a nominally $^1/_4$-inch-diameter one-piece anchor body, with a hex coupler head version containing internal threads that accepts threaded rods and bolts in $^1/_4$-inch and $^3/_8$-inch (6.4 mm and 9.5 mm) diameters or a stud head version containing external threads in $^3/_8$-inch (9.5 mm) diameter.

The anchor body and hex coupler head are manufactured from low-carbon steel which is case hardened, and have minimum 0.0002-inch (5 µm) zinc plating in accordance with ASTM B633. The Hangermate+ rod hanger screw anchor is illustrated in Figures 1A and 1B.

The hex coupler head of the anchor is formed with serrations on the underside, and with internal threads into the topside that accepts threaded rods or threaded bolt steel insert elements. The anchor body is formed with dual lead threads and a chamfered tip. The anchors are installed in a predrilled hole with a powered impact wrench or torque wrench. The threads on the anchor body tap into the sides of the predrilled concrete hole and interlock with the base material during installation.

3.3 Threaded Steel Insert Elements for Hangermate+:

Threaded steel insert elements must be threaded into the Hangermate+ anchors to form a connection. The material properties of the steel inserts must comply national or international specifications (e.g., ASTM A36; ASTM A307, ASTM F1554, Grade 36; ASTM A307, SAE J429, Grade 2, ASTM A193, Grade B7), or equivalent.

3.4 Concrete:

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

3.5 Steel Deck Panels:

Steel deck panels for anchors must comply with the configurations in Figures 5A, 5B, 6A and 6B of this report and have a minimum base-metal thickness of 0.035 inch (0.89 mm) [No. 20 gage]. Steel deck must comply with ASTM A653/A 653M SS Grade 50, and have a minimum yield strength of 50 ksi (345 MPa).

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design strength of anchors complying with the 2015 IBC, as well as Section R301.1.3 of the 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.

Design strength of anchors complying with the 2009 IBC, as well as Section R301.1.3 of the 2009 IRC, must be determined in accordance with ACI 318-08 Appendix D and this report.

A design example in accordance with the 2015 and 2012 IBC is given in Figure 7 of this report.

Design parameters provided in Tables 3, 4 and 5 of this report are based on the 2015 IBC (ACI 318-14) and the 2012 IBC (ACI 318-11) unless noted otherwise in Section 4.1.1 through 4.1.12 of this report.

The strength design of anchors must comply with ACI 318-14 17.3.1 or ACI 318-11 D.4.1, as applicable, except as required in ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Strength reduction factors, ϕ, as given in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, and noted in Tables 3, 4 and 5 of this report, must be used for load combinations calculated in accordance with Section 1605.2 of the IBC, Section 5.3 of ACI 318-14, and Section 9.2 of ACI 318-11, as applicable. Strength reduction factors, ϕ, 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 used in the calculation must be limited to a maximum of 8,000 psi (55.2 MPa), in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

4.1.2 Requirements for Static Steel Strength in Tension, N_{sa}: The nominal static steel strength of a single anchor in tension, N_{sa}, calculated in accordance with ACI 318-14 17.4.1.2 or ACI 318-11 D.5.1.2, as applicable, is given in Table 3 of this report. Strength reduction factors, ϕ, corresponding to brittle steel elements must be used.

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 a group of anchors in tension, N_{cb} or N_{cbg}, respectively, must be calculated in accordance with 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 in cracked concrete, N_b, must be calculated according to 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 Table 3 of this report. The nominal concrete breakout strength in tension in regions where analysis indicates no cracking in accordance with ACI 318-14 17.4.2.6 or ACI 318-11 D.5.2.6, as applicable, must be calculated with the value of k_{uncr} as given in Table 3 of this report and with $\psi_{c,N}$ = 1.0.

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, 6A and 6B, calculation of the concrete breakout strength in accordance with 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 or a group of anchors, in accordance with ACI 318-14 17.4.3 or ACI 318-11 D.5.3, as applicable, in cracked and uncracked concrete, $N_{p,cr}$ and $N_{p,uncr}$, respectively, is given in Table 3. In lieu of 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. The nominal pullout strength in cracked concrete may be adjusted by calculation according to Eq-1:

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

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

where f'_c is the specified concrete compressive strength and n is the factor defining the influence of concrete compressive strength on pullout strength. For the $^1/_4$-inch-diameter anchors, n is 0.3. For all other cases, n is 0.5.

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

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

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

where f'_c is the specified concrete compressive strength and n is the factor defining the influence of concrete compressive strength on pullout strength. For the $^1/_4$-inch-diameter anchors, n is 0.3. For all other cases, n is 0.5.

Where values for $N_{p,cr}$ or $N_{p,uncr}$ are not provided in Table 3 of this report, the pullout strength in tension need not be considered or evaluated.

The nominal pullout strength in tension of anchors installed in the upper and lower flute soffit of sand-lightweight or normal-weight concrete-filled steel deck floor and roof assemblies, as shown in Figures 5A, 5B, 6A and 6B, is provided in Table 5. The nominal pullout strength in cracked concrete can be adjusted by calculation according to Eq-1, whereby the value of $N_{p,deck,cr}$ must be substituted for $N_{p,cr}$ and the value of 3,000 psi (20.7 MPa) must be substituted for the value of 2,500 psi (17.2 MPa) in the denominator. The nominal pullout strength in uncracked concrete can be adjusted by calculation according to Eq-2, whereby the value of $N_{p,deck,uncr}$ must be substituted for $N_{p,uncr}$ and the value of 3,000 psi (20.7 MPa) must be substituted for the value of 2,500 psi (17.2 MPa) in the denominator.

4.1.5 Requirements for Static Steel Strength in Shear, V_{sa}: The nominal steel strength in shear, V_{sa}, of a single anchor in accordance with ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable, is given in Table 4 of this report and must be used in lieu of the values derived by calculation from ACI 318-14 Eq, 17.5.1.2b or ACI 318-11, Eq. D-29, as applicable. Strength reduction factors, ϕ, corresponding to brittle steel elements must be used.

The nominal shear strength of anchors installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, $V_{sa,deck}$, as shown in Figures 5A, 5B, 6A and 6B is given in Table 5 of this report, in lieu of the values derived by calculation from ACI 318-14 Eq. 17.5.1.2b or ACI 318-11, Eq. D-29, as applicable.

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 318-14 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 318-14 17.5.2.2 or ACI 318-11 D.6.2.2, as applicable, using the value of ℓ_e and d_a given in Table 4 of this report.

For anchors installed in the topside of concrete-filled steel deck assemblies, 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 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, using the actual member topping thickness, $h_{min,deck}$, in the determination of A_{vc}. Minimum member topping thickness for anchors in the topside of concrete-filled steel deck assemblies is given in Tables 1 and 2 of this report, 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, 6A and 6B, calculation of the concrete breakout strength in accordance with ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, 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 group of anchors, V_{cp} or V_{cpg}, respectively, must be calculated in accordance with ACI 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable, using the value of k_{cp} provided in Table 4, and the value of N_{cb} or N_{cbg} as calculated in Section 4.1.3 of this report.

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, 6A and 6B, calculation of the concrete pryout strength in accordance with ACI 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable, 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 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Modifications to ACI 318-14 17.2.3 shall be applied under 2015 IBC Section 1905.1.8. For the 2012 IBC, Section 1905.1.9 shall be omitted. Modifications to ACI 318-08 D.3.3 shall be applied under Section 1908.1.9 of the 2009 IBC.

The nominal steel strength and nominal concrete breakout strength for anchors in tension, and the nominal concrete breakout strength and pryout strength for anchors in shear, must be calculated according to ACI 318-14 17.4 and 17.5 or ACI 318-11 D.5 and D.6, respectively, as applicable, taking into account the corresponding values in Tables 3 and 4 of this report.

The anchors comply with ACI 318-14 2.3 or ACI 318-11 D.1, as applicable, as brittle steel elements and must be designed in accordance with ACI 318-14 17.2.3.4, 17.2.3.5, 17.2.3.6, or 17.2.3.7; ACI 318-11 D.3.3.4, D.3.3.5, D.3.3.6 or D.3.3.7; or ACI 318-08 D.3.3.4, D.3.3.5 or D.3.3.6, as applicable.

The $^1/_4$-inch-diameter (6.4 mm), $^3/_8$-inch-diameter (9.5 mm), $^1/_2$-inch-diameter (12.7 mm), $^5/_8$-inch-diameter (15.9 mm) and $^3/_4$-inch-diameter (19.1 mm) Screw-Bolt+ anchors and the $^1/_4$-inch-diameter (6.4 mm) and $^3/_8$-inch-diameter (9.5 mm) Hangermate+ anchors may be installed in regions designated as IBC Seismic Design Categories 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 318-14 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 318-14 17.4.3.2 or ACI 318-11 D.5.3.2, as applicable, the appropriate value for nominal pullout strength in tension for seismic loads, $N_{p,eq}$ described in Table 3 of this report, must be used in lieu of N_p. $N_{p,eq}$ may be adjusted by calculations for concrete compressive strength in accordance with Eq-1 of this report.

Where values for $N_{p,eq}$ are not provided in Table 3, the pullout strength in tension for seismic forces need not be evaluated.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete-filled steel deck floor and roof assemblies, the nominal pullout strength in tension for seismic loads, $N_{p,deck,eq}$, is provided in Table 5 and must be used in lieu of $N_{p,cr}$. $N_{p,deck,eq}$ may be adjusted by calculations for concrete compressive strength in accordance with Eq-1 of this report where 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.

4.1.8.3 Seismic Shear: The nominal concrete breakout strength and pryout strength for anchors in shear must be calculated according to ACI 318-14 17.5.2 or 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 318-14 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, $V_{sa,eq}$ described in Table 4 of this report, must be used in lieu of V_{sa}.

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, 6A and 6B, the appropriate value for nominal steel strength in shear for seismic loads, $V_{sa,deck,eq}$, described in Table 5 must be used in lieu of V_{sa}.

4.1.9 Requirements for Interaction of Tensile and Shear Forces: The effects of combined tensile and shear forces must be determined in accordance with ACI 318-14 17.6 or ACI 318-11 D.7, as applicable.

4.1.10 Requirements for Critical Edge Distance, c_{ac}: 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 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, must be further multiplied by the factor $\psi_{cp,N}$ given by Eq-3:

$$\psi_{cp,N} = \frac{c}{c_{ac}} \quad \text{(Eq-3)}$$

whereby the factor $\psi_{cp,N}$ need not be taken less than $\frac{1.5h_{ef}}{c_{ac}}$. For all other cases, $\psi_{cp,N} = 1.0$. In lieu of using ACI 318-14 17.7.6 or ACI 318-11 D.8.6, as applicable, values of c_{ac} provided in Tables 1 and 2 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 318-14 17.7.1 and 17.7.3, or ACI 318-11 D.8.1 and D.8.3, respectively, as applicable, the values of s_{min} and c_{min} as given in Table 1 of this report must be used. In lieu of ACI 318-14 17.7.5 or ACI 318-11 D.8.5, as applicable, minimum member thicknesses, h_{min}, as given in Table 1 of this report must be used.

For anchors installed in the topside of concrete-filled steel deck assemblies, the anchors must be installed in accordance with Tables 1 and 2 and Figure 4 of this report.

For anchors installed through the soffit of steel deck assemblies, the anchors must be installed in accordance with Figures 5A, 5B, 6A, and 6B, and shall have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width.

4.1.12 Requirements for Lightweight Concrete: For the use of anchors in lightweight concrete, the modification factor λ_a equal to 0.8λ is applied to all values of $\sqrt{f_c'}$ affecting N_n and V_n.

For ACI 318-14 (2015 IBC), ACI 318-11 (2012 IBC) and ACI 318-08 (2009 IBC), λ 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: Design values for use with allowable stress design load combinations calculated in accordance with Section 1605.3 of the IBC must be established using Eq-4 and Eq-5 as follows:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \quad \text{(Eq-4)}$$

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

where:

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

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

ϕN_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318-14 Chapter 17 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Section 1908.1.9, and Section 4.1 of this report, as applicable (lbf or kN).

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318-14 Chapter 17 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Section 1908.1.9, and Section 4.1 of this report, as applicable (lbf or kN).

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

The limits on edge distance, anchor spacing and member thickness as given in Tables 1 and 2 of this report must apply. An example of Allowable Stress Design tension values for illustrative purposes is shown in Table 6 of this report.

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

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

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

For all other cases: $\frac{T}{T_{allowable}} + \frac{V}{V_{allowable}} \le 1.2$ (Eq-6)

4.3 Installation:

Installation parameters are provided in Tables 1 and 2, and Figures 1A, 2 and 3 of this report. Anchor locations must comply with this report and plans and specifications approved by the code official. The Screw-Bolt+ and Hangermate+ screw anchors must be installed according to the manufacturer's published installation instructions and this report. Recommendations for installation equipment is given in Table A. Anchors must be installed in holes drilled using carbide-tipped masonry drill bits complying with ANSI B212.15.

The Screw-Bolt+ and Hangermate+ screw anchors are permitted to be loosened by a maximum of one full turn and retightened with a torque wrench or powered impact wrench to facilitate fixture attachment or realignment. Complete removal and reinstallation of the anchor is not allowed.

For anchor installation in the topside of concrete-filled steel deck assemblies, installation must comply with Tables 1 and 2 and Figure 4, as applicable.

For installation 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 $^1/_8$ inch (3.2 mm). For member thickness and edge distance restrictions for installations into the soffit of concrete on steel deck assemblies, see Table 5 and Figures 5A, 5B, 6A, and 6B.

4.4 Special Inspection:

Periodic special inspection is required, in accordance with Section 1705.1.1 and Table 1705.3 of the 2015 IBC or 2012 IBC, as applicable; Section 1704.15 and Table 1704.4 of the 2009 IBC; or Section 1704.13 of the 2006 IBC, as applicable. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, drill bit size and type, anchor spacing, edge distances, concrete thickness, anchor embedment, maximum impact wrench power and adherence to the manufacturer's published 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 Screw-Bolt+ and Hangermate+ screw anchors described in this report comply with, or are a suitable alternative 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 published 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 to $^3/_4$-inch (6.4 mm to 19.1 mm) Screw-Bolt+ anchors and $^1/_4$-inch- and $^3/_8$-inch-diameter (6.4 mm and 9.5 mm) Hangermate+ 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).

5.4 The $^1/_4$-inch to $^1/_2$-inch (6.4 mm to 12.7 mm) Screw-Bolt+ anchors may be installed in the topside of cracked and uncracked normal-weight or sand-lightweight concrete-filled steel deck having a minimum specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

5.5 The $^1/_4$-inch to $^3/_4$-inch (6.4 mm to 19.1 mm) Screw-Bolt+ anchors and $^1/_4$-inch- and $^3/_8$-inch-inch-diameter (6.4 mm and 9.5 mm) Hangermate+ anchors must be installed in the soffit of cracked and uncracked normal-weight or sand-lightweight concrete-filled steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

5.6 The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.2 MPa).

5.7 Strength design values must be established in accordance with Section 4.1 of this report.

5.8 Allowable design values must be established in accordance with Section 4.2 of this report.

5.9 Anchor spacing(s) and edge distance(s), and minimum member thickness, must comply with Tables 1 and 2, and Figures 4, 5A, 5B, 6A, and 6B of this report.

5.10 Reported values for the Hangermate+ with an internally threaded head do not consider the steel insert element which must be verified by the design professional. Shear design values in this report for the Hangermate+ with an internally threaded head are for threaded rod or steel inserts with an ultimate strength, $F_u \geq 125$ ksi; threaded rod or steel inserts with an F_u less than 125 ksi are allowed provided the steel strength shear values are multiplied by the ratio of F_u (ksi) of the steel insert and 125 ksi.

5.11 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.

5.12 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.

5.13 The $^1/_4$-inch- to $^3/_4$-inch-diameter (6.4 mm to 19.1 mm) Screw-Bolt+ anchors and $^1/_4$-inch- and $^3/_8$-inch-diameter (6.4 mm and 9.5 mm) Hangermate+ 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.

5.14 The $^1/_4$-inch- to $^3/_4$-inch-diameter (6.4 mm to 19.1 mm) Screw-Bolt+ anchors and $^1/_4$-inch- and $^3/_8$-inch-diameter (6.4 mm and 9.5 mm) Hangermate+ anchors may be used to resist short-term loading due to wind or seismic forces (Seismic Design Categories A through F under the IBC), subject to the conditions of this report.

5.15 Anchors are not permitted to support fire-resistance-rated construction. Where not otherwise prohibited by code, Screw-Bolt+ and Hangermate+ anchors are permitted for installation in 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.

5.16 Anchors have been evaluated for reliability against brittle failure and found to be not significantly sensitive to stress-induced hydrogen embrittlement.

5.17 Use of carbon steel anchors with zinc plating in accordance with ASTM B633 as described in Section 3.1 and 3.2 of this report is limited to dry, interior locations.

5.18 Special inspection must be provided in accordance with Section 4.4.

5.19 Screw-Bolt+ and Hangermate+ are manufactured under an approved quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated October 2015, which incorporates requirements in ACI 355.2-07 / ACI 355.2-04, for use in cracked and uncracked concrete; including Test No. 11 (AC193, Annex 1, Table 4.2) for reliability of screw anchors against brittle failure, and optional service-condition Test No. 18 and Test No. 19 (AC193, Annex 1, Table 4.2) for seismic tension and shear.

6.2 Quality control documentation.

7.0 IDENTIFICATION

The Screw-Bolt+ and Hangermate+ screw anchors are identified in the field by dimensional characteristics and packaging. A diameter and length marking is stamped on the hex head of each Screw-Bolt+ screw anchor; these are visible after installation for verification. Packages are identified with the anchor name; part number; type; anchor size and length; and the evaluation report number ESR-3889).

TABLE A—RECOMMENDED INSTALLATION EQUIPMENT MATRIX

CATALOG NUMBER								20V MAX** SDS PLUS ROTARY HAMMERS			FLEXVOLT SDS MAX	20V MAX** IMPACT WRENCHES		
								DCH273P2DH 1" L-Shape	DCH133M2 1" D-Handle	DCH293R2 1-1/8" L-Shape w/ E-Clutch	DCH481X2 1-9/16" W/ E-Clutch	DCF883L2 3/8" Impact Wrench	DCF880M2 1/2" Impact Wrench	DCF899P2 High Torque 1/2" (Speed #2)
ZINC PLATED	GALVANIZED	ANCHOR	LENGTH	HOLE SIZE	SOCKET SIZE	QTY	MASTER QTY	CARBIDE BITS				IMPACT RATED SOCKETS		
*PFM1411000	-	1/4" x 1-1/4"	1-1/4"	1/4"	7/16"	100	600	DW5517	DW5417	DW5417	–	DWMT74479B	–	–
PFM1411020	-	1/4" x 1-3/4"	1-3/4"	1/4"	7/16"	100	600	DW5517	DW5417	DW5417	–	DWMT74479B	–	–
PFM1411060	-	1/4" x 2-1/4"	2-1/4"	1/4"	7/16"	100	600	DW5517	DW5417	DW5417	–	DWMT74479B	–	–
PFM1411080	-	1/4" x 2-5/8"	2-5/8"	1/4"	7/16"	100	500	DW5517	DW5417	DW5417		DWMT74479B	–	–
PFM1411100	-	1/4" x 3"	3"	1/4"	7/16"	100	500	DW5517	DW5417	DW5417	–	DWMT74479B	–	–
*PFM1411160	-	3/8" x 1-3/4"	1-3/4"	3/8"	9/16"	50	300	DW5527	DW5427	DW5427	–	–	DWMT75122B	–
PFM1411220	-	3/8" x 2-1/2"	2-1/2"	3/8"	9/16"	50	300	DW5527	DW5427	DW5427	–	–	DWMT75122B	–
PFM1411240	PFM1461240	3/8" x 3"	3"	3/8"	9/16"	50	250	DW5527	DW5427	DW5427	–	–	DWMT75122B	–
PFM1411280	PFM1461280	3/8" x 4"	4"	3/8"	9/16"	50	250	DW5527	DW5427	DW5427		–	DWMT75122B	–
PFM1411300	PFM1461300	3/8" x 5"	5"	3/8"	9/16"	50	250	DW5529	DW5429	DW5429	–	–	DWMT75122B	–
PFM1411320	PFM1461320	3/8" x 6"	6"	3/8"	9/16"	50	150	DW5529	DW5429	DW5429			DWMT75122B	–
*PFM1411340	-	1/2" x 2"	2"	1/2"	3/4"	50	200	DW5537	DW5437	DW5437	–	–	–	DWMT75113B
PFM1411360	-	1/2" x 2-1/2"	2-1/2"	1/2"	3/4"	50	200	DW5537	DW5437	DW5437	–	–	–	DWMT75113B
PFM1411380	-	1/2" x 3"	3"	1/2"	3/4"	50	150	DW5537	DW5437	DW5437	–	–	–	DWMT75113B
PFM1411420	PFM1461420	1/2" x 4"	4"	1/2"	3/4"	50	150	DW5537	DW5437	DW5437	–	–	–	DWMT75113B
PFM1411460	PFM1461460	1/2" x 5"	5"	1/2"	3/4"	25	100	DW5538	DW5438	DW5438	–	–	–	DWMT75113B
PFM1411480	PFM1461480	1/2" x 6"	6"	1/2"	3/4"	25	75	DW5538	DW5438	DW5438	–	–	–	DWMT75113B
PFM1411520	PFM1461520	1/2" x 8"	8"	1/2"	3/4"	25	100	DW5538	DW5438	DW5438	–	–	–	DWMT75113B
*PFM1411540	-	5/8" x 3"	3"	5/8"	15/16"	25	100	DW5471	DW5446	DW5471	DW5806	–	–	DWMT75104B
PFM1411580	-	5/8" x 4"	4"	5/8"	15/16"	25	100	DW5471	DW5446	DW5471	DW5806	–	–	DWMT75104B
PFM1411600	PFM1461600	5/8" x 5"	5"	5/8"	15/16"	25	75	DW5471	DW5446	DW5471	DW5806	–	–	DWMT75104B
PFM1411640	PFM1461640	5/8" x 6"	6"	5/8"	15/16"	25	75	DW5471	DW5446	DW5471	DW5806	–	–	DWMT75104B
PFM1411680	PFM1461680	5/8" x 8"	8"	5/8"	15/16"	25	50	DW5471	DW5447	DW5471	DW5806	–	–	DWMT75104B
*PFM1411700	-	3/4" x 3"	3"	3/4"	1-1/8"	20	60	DW5474	DW5453	DW5474	DW5810	–	–	DWMT75125B
*PFM1411720	-	3/4" x 4"	4"	3/4"	1-1/8"	20	60	DW5474	DW5453	DW5474	DW5810	–	–	DWMT75125B
PFM1411760	-	3/4" x 5"	5"	3/4"	1-1/8"	20	60	DW5474	DW5453	DW5474	DW5810	–	–	DWMT75125B
PFM1411800	PFM1461800	3/4" x 6"	6"	3/4"	1-1/8"	20	60	DW5474	DW5453	DW5474	DW5810	–	–	DWMT75125B
PFM1411840	PFM1461850	3/4" x 8"	8"	3/4"	1-1/8"	10	40	DW5474	DW5455	DW5474	DW5810	–	–	DWMT75125B
PFM1411880	-	3/4" x 10"	10"	3/4"	1-1/8"	10	20	DW5475	DW5455	DW5475	DW5812	–	–	DWMT75125B

* denotes sizes which are less than the minimum standard anchor length for Strength Design. The published size length of the anchor is measured from under the head.

Maximum **Optimum** – (Not Recommended)

** Maximum initial battery voltage (measured without a workload) is 20 volts. Nominal voltage is 18.

TABLE B—INSTALLATION AND DESIGN INDEX[1]

Product Name	Installation Specifications	Tension Design Data			Shear Design Data		
		Concrete	Top of Steel Deck	Steel Deck Soffit	Concrete	Top of Steel Deck	Steel Deck Soffit
Screw-Bolt+	Tables 1, 2 and 5	Table 3	Table 3	Table 5	Table 4	Table 4	Table 5
Hangermate+	Table 1 and 5	Table 3	Table 3	Table 5	Table 4	Table 4	Table 5

Concrete Type	Concrete State	Anchor Nominal Size	Seismic Design Categories[2]
Normal-weight and lightweight	Cracked	$^1/_4$", $^3/_8$", $^1/_2$", $^5/_8$", $^3/_4$"	A through F
	Uncracked	$^1/_4$", $^3/_8$", $^1/_2$", $^5/_8$", $^3/_4$"	A through F

For **SI:** 1 inch = 25.4 mm. For **pound-inch** units: 1 mm = 0.03937 inch.

[1]Reference ACI 318-14 17.3.1.1 or ACI 318-11 D.4.1.1, as applicable. The controlling strength is decisive from all appropriate failure modes (i.e. steel, concrete breakout, pullout, pryout, as applicable) and design assumptions.

[2]See Section 4.1.8 for requirements for seismic design, where applicable.

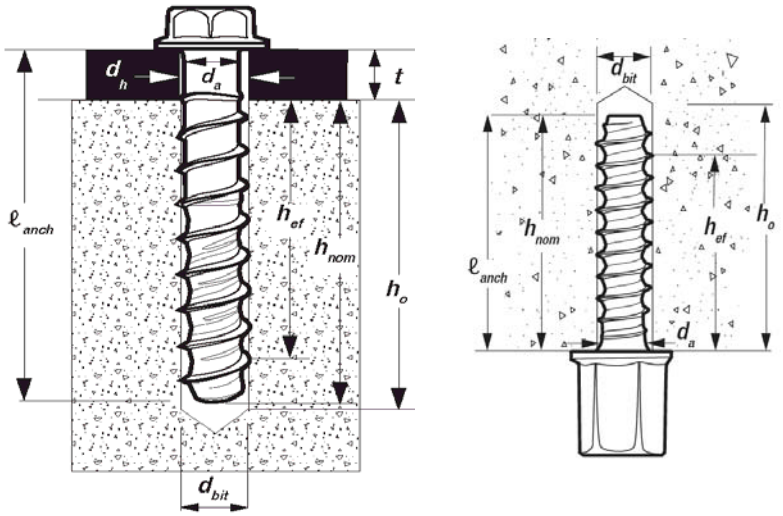
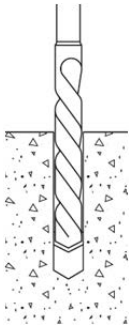
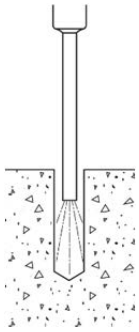


FIGURE 1A—SCREW-BOLT+ ANCHOR DETAIL (Left Picture) AND HANGERMATE+ ANCHOR DETAIL (Right Picture)

FIGURE 1B—SCREW-BOLT+ (Top Picture) AND HANGERMATE+ (Bottom Pictures – Internally Threaded Head and External Thread Head Rod Hanger Versions)



1.) Using the proper drill bit size, drill a hole into the base material to the required depth. The tolerances of the drill bit used should meet the requirements of ANSI Standard B212.15.

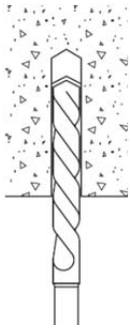


2.) Remove dust and debris from hole using a hand pump, compressed air or a vacuum to remove loose particles left from drilling.

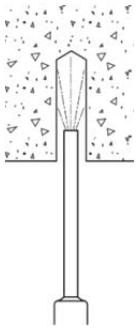
3.) Select a powered impact wrench or torque wrench and do not exceed the maximum torque, $T_{impact,max}$ or $T_{inst,max}$, respectively, for the selected anchor diameter and embedment (See Table 1). Attach an appropriate sized hex socket to the wrench. Mount the screw anchor head into the socket.

4.) Drive the anchor with an impact wrench or torque wrench through the fixture and into the hole until the head of the anchor comes into contact with the fixture. The anchor must be snug after installation. Do not spin the hex socket off the anchor to disengage.

FIGURE 2—SCREW-BOLT+ INSTALLATION INSTRUCTIONS

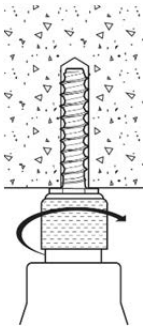


1.) Using the proper drill bit size, drill a hole into the base material to the required depth. The tolerances of the drill bit used should meet the requirements of ANSI Standard B212.15.



2.) Remove dust and debris from hole using a hand pump, compressed air or a vacuum to remove loose particles left from drilling.

3.) Select a powered impact wrench or torque wrench and do not exceed the maximum torque, $T_{impact,max}$ or $T_{inst,max}$, respectively, for the selected anchor diameter and embedment (See Table 1). Attach an appropriate sized hex socket to the wrench. Mount the screw anchor head into the socket.



4.) Drive the anchor with an impact wrench or torque wrench through the fixture and into the hole until the head of the anchor comes into contact with the member surface. Do not spin the hex socket off the anchor to disengage. Insert threaded rod or threaded bolt element into Hangermate+.

FIGURE 3—HANGERMATE+ INSTALLATION INSTRUCTIONS (Internally Threaded Rod Hanger Version Illustrated)

TABLE 1—SCREW-BOLT+ AND HANGERMATE+ ANCHOR INSTALLATION AND SUPPLEMENTAL INFORMATION[1,2,4]

Anchor Property / Setting Information		Notation	Units	Nominal Anchor Size (inch)													
				1/4 Hangermate+		1/4 Screw-Bolt+		3/8 Screw-Bolt+			1/2 Screw-Bolt+			5/8 Screw-Bolt+			3/4 Screw-Bolt+
Head style		-	-	Threaded		Hex Head		Hex Head			Hex Head			Hex Head			Hex Head
Nominal anchor diameter		d_a	in. (mm)	0.250 (6.4)		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)	N/A		3/8 (9.5)		1/2 (12.7)			5/8 (15.9)			3/4 (19.1)			7/8 (22.2)
Nominal drill bit diameter		d_{bit}	in.	1/4 ANSI		1/4 ANSI		3/8 ANSI			1/2 ANSI			5/8 ANSI			3/4 ANSI
Minimum nominal embedment depth[5]		h_{nom}	in. (mm)	1 5/8 (41)	2 1/2 (64)	1 5/8 (41)	2 1/2 (64)	2 (51)	2 1/2 (64)	3 1/4 (83)	2 1/2 (64)	3 (76)	4 1/4 (108)	3 1/4 (83)	4 (102)	5 (127)	4 1/4 (108)
Effective embedment		h_{ef}	in. (mm)	1.20 (30)	1.94 (49)	1.20 (30)	1.94 (49)	1.33 (33)	1.75 (44)	2.39 (60)	1.75 (44)	2.17 (55)	3.23 (82)	2.24 (56)	2.88 (73)	3.73 (94)	3.08 (78)
Minimum hole depth		h_o	in. mm	2 (51)	2 7/8 (73)	2 (51)	2 7/8 (73)	2 3/8 (60)	2 7/8 (73)	3 5/8 (92)	2 7/8 (73)	3 3/8 (86)	4 5/8 (117)	3 5/8 (86)	4 3/8 (111)	5 3/8 (137)	4 5/8 (117)
Minimum concrete member thickness		h_{min}	in. (mm)	3 1/4 (83)	4 (102)	3 1/4 (83)	4 (102)	3 1/2 (89)	4 (102)	5 (127)	4 1/2 (114)	5 1/4 (133)	6 3/4 (171)	5 (127)	6 (152)	7 (178)	6 (152)
Minimum edge distance[6]		c_{min}	in. (mm)	1 1/2 (38)		1 1/2 (38)		c_{min} = 1 1/2 (38) for $s_{min} \geq$ 3 (76);			1 3/4 (44)			1 3/4 (44)			1 3/4 (44)
Minimum spacing distance[6]		s_{min}	in. (mm)	1 1/2 (38)		1 1/2 (38)		s_{min} = 2 (51) for $c_{min} \geq$ 2 (51)			2 3/4 (70)			2 3/4 (70)			3 (76)
Critical edge distance		c_{ac}	in. (mm)	4.3 (110)	6.1 (156)	4.3 (110)	6.1 (156)	5.0 (127)	6.3 (160)	7.8 (198)	3.3 (83)	5.9 (150)	8.1 (205)	6.3 (159)	7.9 (201)	10.1 (255)	10.9 (277)
Minimum nominal anchor length[7]		ℓ_{anch}	in. (mm)	1 5/8 (41)	2 1/2 (64)	1 3/4 (44)	3 (76)	2 1/2 (64)	3 (76)	4 (102)	3 (76)	4 (102)	5 (127)	4 (102)	5 (127)	6 (152)	6 (152)
Maximum impact wrench power (torque)		$T_{impact,max}$	ft.-lb. (N-m)	150 (203)		150 (203)		300 (407)			300 (407)			700 (949)			700 (949)
Max. installation torque		$T_{inst,max}$	ft.-lb. (N-m)	19 [3] (26)	25 (34)	19 [3] (26)	25 (34)	25 (34)		40 (54)	45 (61)		60 (81)	60 (81)			70 (81)
Internally Threaded Head	Wrench socket size	1/4" thread	in.	3/8													
		3/8" thread		1/2													
	Max. head height	1/4" thread	in.	33/64		N/A		N/A			N/A			N/A			N/A
		3/8" thread		43/64													
	Max. washer dia.	1/4" thread	in.	1/2													
		3/8" thread		21/32													
External Thread Head	Wrench socket size	3/8" thread	in.	1/2		N/A		N/A			N/A			N/A			N/A
	Max. head height (including thread)			1 3/16													
	Max. washer dia.			21/32													
Hex Head	Wrench socket size	-	in.	N/A		7/16		9/16			3/4			15/16			1 1/8
	Max. head height	-	in.			21/64		3/8			31/64			37/64			43/64
	Max. washer dia.	-	in.			37/64		3/4			1 1/16			1 1/8			1 13/32
Effective tensile stress area (screw anchor body)		A_{se}	in.^{2} (mm^2)	0.045 (28.8)		0.045 (28.8)		0.094 (60.7)			0.176 (113.9)			0.274 (177.0)			0.399 (257.2)
Minimum specified ultimate strength		f_{uta}	psi (N/mm^2)	100,000 (690)		100,000 (690)		92,500 (638)			115,000 (793)			95,000 (658)			95,000 (658)
Minimum specified yield strength		f_{ya}	psi (N/mm^2)	80,000 (552)		80,000 (552)		74,000 (510)			92,000 (634)			76,000 (524)			76,000 (524)
Mean axial stiffness[8]	Uncracked concrete	β_{uncr}	lbf/in. (kN/mm)	1,381,000 (232)		1,252,000 (211)		1,157,000 (195)			1,014,000 (171)			919,000 (155)			1,028,000 (173)
	Cracked concrete	β_{cr}	lbf/in. (kN/mm)	318,000 (54)		355,000 (60)		330,000 (56)			349,000 (59)			378,000 (64)			419,000 (71)

For **SI:** 1 inch = 25.4 mm, 1 ft-lb = 1.356 N-m, 1 psi = 0.0069 N/mm^2 (MPa).

N/A = Not Applicable.

[1]The information presented in this table is to be used in conjunction with the design criteria of ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable.

[2]For installations in the topside of concrete-filled steel deck assemblies with minimum concrete member thickness, $h_{min,deck}$, of 2.5 inches above the upper flute (topping thickness). See Table 2 and the installation detail in Figure 4 of this report.

[3]For installations in the topside of concrete-filled steel deck assemblies with sand-lightweight concrete fill, the maximum installation torque, $T_{inst,max}$, is 18 ft.-lb.

[4]For installations through the soffit of steel deck assemblies into concrete, see Table 5 and the installation detail in Figures 5A, 5B, 6A and 6B of this report. Tabulated minimum spacing values are based on anchors installed along the flute with axial spacing equal to the greater of $3h_{ef}$ or 1.5 times the flute width.

[5]The embedment depth, h_{nom}, is measured from the outside surface of the concrete member to the embedded end of the anchor.

[6]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 3/8-inch-diameter anchors.

[7]The listed minimum anchor length is based on the anchor sizes commercially available at the time of publication compared with the requirements to achieve the minimum nominal embedment depth, including consideration of a fixture attachment for hex head anchors. The minimum nominal anchor length is measured from under the head to the tip of the anchor.

[8]Mean values shown, actual stiffness varies considerably depending on concrete strength, loading and geometry of application.

TABLE 2—ANCHOR SETTING INFORMATION FOR INSTALLATION ON THE TOP OF CONCRETE-FILLED STEEL DECK ASSEMBLIES WITH MINIMUM TOPPING THICKNESS[1,2,3,4]

Anchor Property / Setting Information	Notation	Units	Nominal Anchor Size (inch)			
			$^1/_4$ Screw-Bolt+		$^3/_8$ Screw-Bolt+	$^1/_2$ Screw-Bolt+
Head style	-	-	Hex Head		Hex Head	Hex Head
Nominal anchor diameter	d_a	in. (mm)	0.250 (6.4)		0.375 (9.5)	0.500 (12.7)
Minimum diameter of hole clearance in fixture	d_h	in. (mm)	$^3/_8$ (9.5)		$^1/_2$ (12.7)	$^5/_8$ (15.9)
Nominal drill bit diameter	d_{bit}	in.	$^1/_4$ ANSI		$^3/_8$ ANSI	$^1/_2$ ANSI
Minimum nominal embedment depth[5]	h_{nom}	in. (mm)	$1^5/_8$ (41)	$2^1/_2$ (64)	2 (51)	$2^1/_2$ (64)
Effective embedment	h_{ef}	in. (mm)	1.20 (30)	1.94 (49)	1.33 (33)	1.75 (44)
Minimum hole depth	h_o	in. mm	2 (51)	$2^1/_2$ (64)	$2^3/_8$ (60)	$2^1/_2$ (64)
Minimum concrete member thickness (topping thickness)	$h_{min,deck}$	in. (mm)	$2^1/_2$ (64)	$2^1/_2$ (64)	$2^1/_2$ (64)	$2^1/_2$ (64)
Minimum edge distance	$c_{min,deck,top}$	in. (mm)	$1^1/_2$ (38)		2 (51)	$2^1/_2$ (64)
Minimum spacing distance	$s_{min,deck,top}$	in. (mm)	$1^1/_2$ (38)		2 (51)	$2^1/_2$ (64)
Critical edge distance	$c_{ac,deck,top}$	in. (mm)	3.0 (76)	4.0 (102)	3.5 (89)	6.0 (152)
Minimum nominal anchor length[6]	ℓ_{anch}	in. (mm)	$1^3/_4$ (44)	3 (76)	$2^1/_2$ (64)	3 (76)
Maximum impact wrench power (torque)	$T_{impact,max}$	ft.-lb. (N-m)	150 (203)		300 (407)	300 (407)
Max. installation torque	$T_{inst,max}$	ft.-lb. (N-m)	18(26)	25 (34)	25 (34)	45 (61)
Wrench socket size	-	in.	$^7/_{16}$		$^9/_{16}$	$^3/_4$
Max. head height	-	in.	$^{21}/_{64}$		$^3/_8$	$^{31}/_{64}$
Max. washer diameter	-	in.	$^{37}/_{64}$		$^3/_4$	$1^1/_{16}$

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

[1]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, $h_{min,deck}$, refers to the concrete thickness above the upper flute (topping thickness). See Figure 4 of this report.

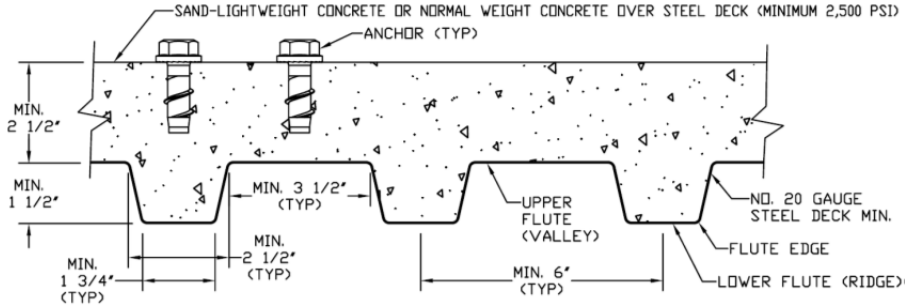
[2]Applicable to the following conditions:
For $^1/_4$-inch-diameter anchors with $1^5/_8$-inch nominal embedment, $2^1/_2$-inch ≤ $h_{min,deck}$ < $3^1/_4$-inch.
For $^1/_4$-inch-diameter anchors with $2^1/_2$-inch nominal embedment, $2^1/_2$-inch ≤ $h_{min,deck}$ < 4-inch.
For $^3/_8$-inch-diameter anchors with 2-inch nominal embedment, $2^1/_2$-inch ≤ $h_{min,deck}$ < $3^1/_2$-inch.
For $^1/_2$-inch-diameter anchors with $2^1/_2$-inch nominal embedment, $2^1/_2$-inch ≤ $h_{min,deck}$ < $4^1/_2$-inch.

[3]For all other anchor diameters and embedment depths, refer to Table 1 for applicable values of h_{min}, c_{min} and s_{min}, which can be substituted for $h_{min,deck}$, $c_{min,deck,top}$ and $s_{min,deck,top}$, respectively.

[4]Design capacities shall be based on calculations according to values in Tables 3 and 4 of this report.

[5]The embedment depth, h_{nom}, is measured from the outside surface of the concrete member to the embedded end of the anchor.

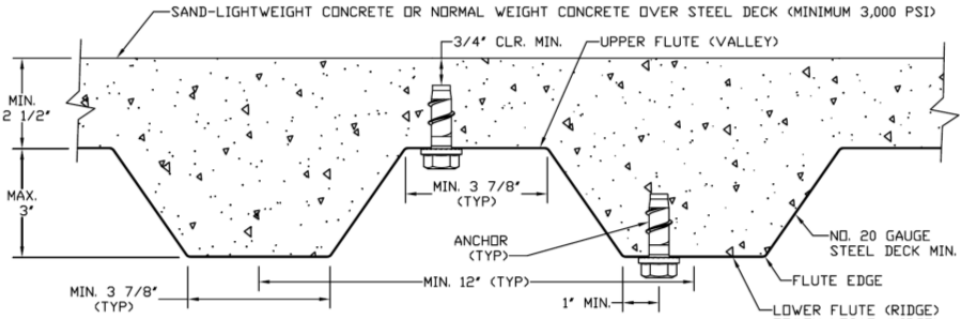
[6]The listed minimum overall anchor length is based on the anchor sizes commercially available at the time of publication compared with the requirements to achieve the minimum nominal embedment depth, including consideration of a fixture attachment for hex head anchors. The minimum nominal anchor length is measured from under the head to the tip of the anchor.



[1]Anchors may be placed in the top side of concrete over steel deck profiles in accordance with Figure 4 provided the minimum concrete thickness above the upper flute (topping thickness), minimum spacing distance and minimum edge distances are satisfied as given in Table 2 of this report.

[2]For all other anchor diameters and embedment depths installed in the top of concrete over steel deck profiles with topping thickness greater than or equal to the minimum concrete member thicknesses given in Table 1, the minimum spacing distances and minimum edge distances must be used from Table 1, as applicable.

FIGURE 4—INSTALLATION DETAIL FOR ANCHORS IN THE TOP OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES WITH MINIMUM TOPPING THICKNESS (SEE DIMENSIONAL PROFILE REQUIREMENTS)[1,2]

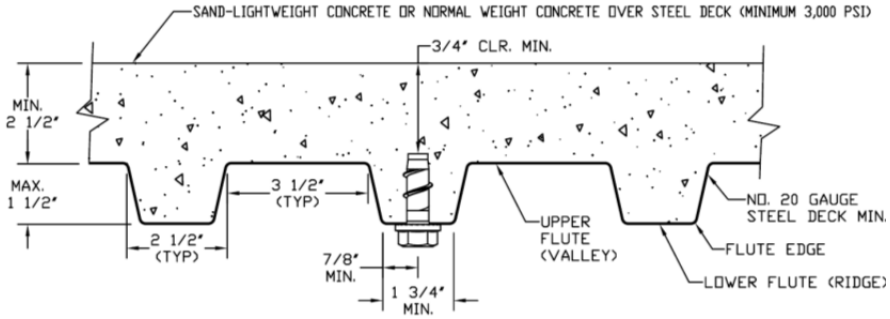


[1]Anchors may be placed in the upper flute or lower flute of concrete-filled steel deck profiles in accordance with Figure 5A provided the minimum hole clearance of $^3/_4$-inch is satisfied for the selected anchor. See Table 5.

[2]Anchors in the lower flute of Figure 5A profiles may be installed with a maximum $^{15}/_{16}$-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 (e.g. $1^1/_4$-inch offset for $4^1/_2$-inch wide flute).

[3]See Table 5 of this report for design data.

FIGURE 5A—SCREW-BOLT+ INSTALLATION DETAIL FOR ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)[1,2,3]

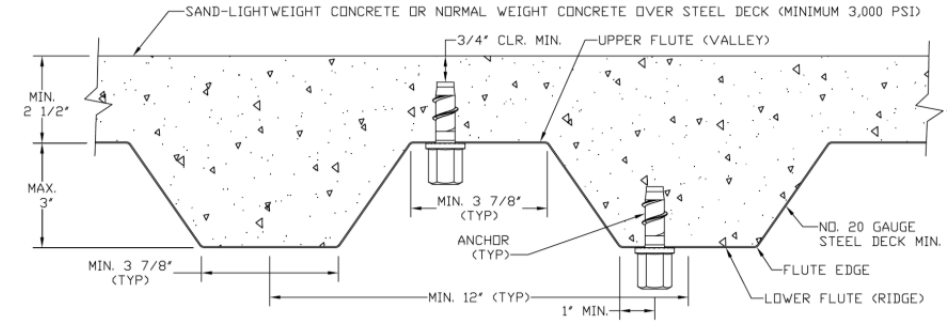


[1]Anchors may be placed in the upper flute or lower flute of the concrete-filled steel deck profiles in accordance with Figure 5B provided the minimum hole clearance of $^3/_4$-inch is satisfied for the selected anchor. See Table 5.

[2]Anchors in the lower flute of Figure 5B profiles may be installed in the center of the flute. An offset distance may be given proportionally for profiles with flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

[3]See Table 5 of this report for design data.

FIGURE 5B— SCREW-BOLT+ INSTALLATION DETAIL FOR ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)[1,2,3]

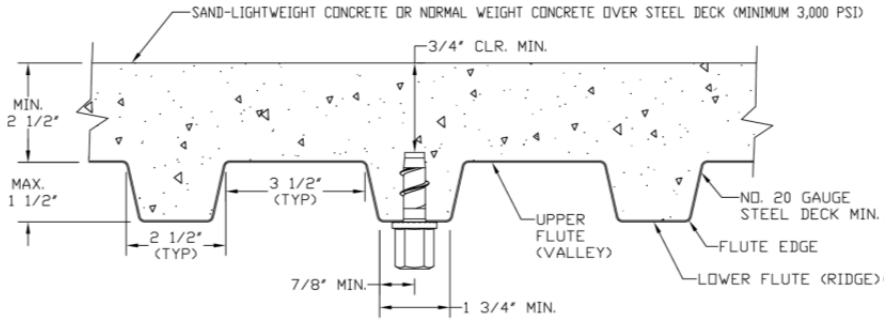


[1]Anchors may be placed in the upper flute or lower flute of the concrete-filled steel deck profiles in accordance with Figure 6A provided the minimum hole clearance of $^3/_4$-inch is satisfied for the selected anchor. See Table 5.

[2]Anchors in the lower flute of Figure 6A profiles may be installed with a maximum $^{15}/_{16}$-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 (e.g. $1^1/_4$-inch offset for $4^1/_2$-inch wide flute).

[3]See Table 5 of this report for design data.

FIGURE 6A—HANGERMATE+ INSTALLATION DETAIL FOR SCREW ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)[1,2,3]



[1]Anchors may be placed in the upper flute or lower flute of the concrete-filled steel deck profiles in accordance with Figure 6B provided the minimum hole clearance of $^3/_4$-inch is satisfied for the selected anchor. See Table 5.

[2]Anchors in the lower flute of Figure 6B profiles may be installed in the center of the flute. An offset distance may be given proportionally for profiles with flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

[3]See Table 5 of this report for design data.

FIGURE 6B—HANGERMATE+ INSTALLATION DETAIL FOR SCREW ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQURIEMENTS)[1,2,3]

TABLE 3—TENSION DESIGN INFORMATION FOR SCREW-BOLT+ AND HANGERMATE+ SCREW ANCHORS IN CONCRETE[1,2,9]

Anchor Property / Setting Information	Notation	Units	Nominal Anchor Size (inch)													
			1/4 Hangermate+		1/4 Screw-Bolt+		3/8 Screw-Bolt+			1/2 Screw-Bolt+			5/8 Screw-Bolt+			3/4 Screw-Bolt+
Anchor category	1, 2 or 3	-	1		1		1			1			1			1
Head style	-	-	Threaded		Hex Head		Hex Head			Hex Head			Hex Head			Hex Head
Minimum nominal embedment depth	h_{nom}	in. (mm)	1 5/8 (41)	2 1/2 (64)	1 5/8 (41)	2 1/2 (64)	2 (51)	2 1/2 (64)	3 1/4 (83)	2 1/2 (64)	3 (76)	4 1/4 (108)	3 1/4 (83)	4 (102)	5 (127)	4 1/4 (108)
STEEL STRENGTH IN TENSION (ACI 318-14 17.4.1 or ACI 318-11 D.5.1)																
Steel strength in tension	N_{sa}	lb (kN)	4,535 (20.2)		4,535 (20.2)		8,730 (38.8)			20,475 (91.1)			26,260 (116.8)			38,165 (169.8)
Reduction factor, steel strength[3,4]	ϕ	-	0.65		0.65		0.65			0.65			0.65			0.65
CONCRETE BREAKOUT STRENGTH IN TENSION (ACI 318-14 17.4.2 or ACI 318-11 D.5.2)																
Effective embedment	h_{ef}	in. (mm)	1.20 (30)	1.94 (49)	1.20 (30)	1.94 (49)	1.33 (33)	1.75 (44)	2.39 (60)	1.75 (44)	2.17 (55)	3.23 (82)	2.24 (56)	2.88 (73)	3.73 (94)	3.08 (78)
Critical edge distance	c_{ac}	in. (mm)	4.3 (110)	6.1 (156)	4.3 (110)	6.1 (156)	5.0 (127)	6.3 (160)	7.8 (298)	3.3 (83)	5.9 (150)	8.1 (205)	6.3 (159)	7.9 (201)	10.1 (255)	10.9 (277)
Critical edge distance, topside of concrete-filled steel decks with minimum topping thickness[9]	$c_{ac,deck,top}$	in. (mm)	- [11]	- [11]	3.0 (76)	4.0 (102)	3.5 (89)	- [11]	- [11]	6.0 (152)	- [11]	- [11]	- [11]	- [11]	- [11]	- [11]
Effectiveness factor for uncracked concrete	k_{uncr}	-	27	24	27	24	30	24		30	24		30	24		27
Effectiveness factor for cracked concrete	k_{cr}	-	17		17		17			17			21			17
Modification factor, cracked and uncracked concrete[5]	$\psi_{c,N}$	-	1.0		1.0		1.0			1.0			1.0			1.0
Reduction factor, concrete breakout strength[3]	ϕ	-	0.65		0.65		0.65			0.65			0.65			0.65
PULLOUT STRENGTH IN TENSION (ACI 318-14 17.4.3 or ACI 318-11 D.5.3)																
Pullout strength, uncracked concrete (2,500 psi)[6,10]	$N_{p,uncr}$	lb (kN)	See note 7		See note 7		See note 7			See note 7			See note 7			See note 7
Pullout strength, cracked concrete (2,500 psi)[6,10]	$N_{p,cr}$	lb (kN)	765 (3.4)	1,415 (6.3)	765 (3.4)	1,415 (6.3)	See note 7			1,645 (7.3)	2,515 (11.2)	4,700 (20.9)	3,080 (13.7	4,720 (21.0)	6,900 (30.7)	See note 7
Reduction factor, pullout strength[3]	ϕ	-	0.65		0.65		0.65			0.65			0.65			0.65
PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS (ACI 318-14 17.2.3.3 or ACI 318-11 D.3.3.3)																
Pullout strength, seismic (2,500 psi)[6,8,10]	$N_{p,eq}$	lb (kN)	360 (1.6)	1,170 (5.2)	360 (1.6)	1,170 (5.2)	900 (4.0)	1,645 (7.3)	2,765 (12.3)	1,645 (7.3)	2,515 (11.2)	4,700 (20.9)	1,910 (8.5)	2,445 (10.9)	3,370 (15.0)	4,085 (18.2)
Reduction factor, pullout strength, seismic[3]	ϕ	-	0.65		0.65		0.65			0.65			0.65			0.65

For **SI:** 1 inch = 25.4 mm, 1 ft-lb = 1.356 N-m, 1 psi = 0.0069 N/mm^2 (MPa).

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

[2]Installation must comply with manufacturer's published installation instructions and details.

[3]All values of ϕ were determined from the load combinations of IBC Section 1605.2, ACI 318-14 Section 5.3, or ACI 318-11 Section 9.2. If the load combinations of ACI 318-11 Appendix C are used, then the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4. For reinforcement that complies with ACI 318-14 Chapter 17 or ACI 318-11 Appendix D requirements for Condition A, see ACI 318-14 17.3.3(c) or ACI 318-11 Section D.4.3(c), as applicable for the appropriate ϕ factor when the load combinations of IBC Section 1605.2, ACI 318-14 Section 5.3 or ACI 318-11 Section 9.2 are used.

[4]The anchors are considered a brittle steel elements as defined by ACI 318-14 2.3 or ACI 318-11 D.1, as applicable.

[5]Select the appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}) and use $\psi_{c,N}$ = 1.0.

[6]For calculation of N_{pn} see Section 4.1.4 of this report. The characteristic pullout strength for concrete compressive strengths greater than 2,500 psi for 1/4-inch-diameter anchors may be increased by multiplying the value in the table by $(f'_c / 2{,}500)^{0.3}$ for psi or $(f'_c / 17.2)^{0.3}$ for MPa. The characteristic pullout strength for concrete compressive strengths greater than 2,500 psi for 3/8-inch- to 3/4-inch-diameter anchors may be increased by multiplying the value in the table by $(f'_c / 2{,}500)^{0.5}$ for psi or $(f'_c / 17.2)^{0.5}$ for MPa.

[7]Pullout strength does not control design of indicated anchors and does not need to be calculated for indicated anchor size and embedment.

[8]Reported values for characteristic pullout strength in tension for seismic applications are based on test results per ACI 355.2, Section 9.5.

[9]Anchors are permitted in the topside of concrete-filled steel deck assemblies in accordance with Figure 4 of this report.

[10]Anchors are permitted to be used in lightweight concrete in accordance with Section 4.1.12 of this report.

[11]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 SCREW-BOLT+ AND HANGERMATE+ SCREW ANCHORS IN CONCRETE[1,2,7,8,9]

Anchor Property / Setting Information	Notation	Units	Nominal Anchor Size (inch)																
			1/4 Hangermate+				1/4 Screw-Bolt+		3/8 Screw-Bolt+			1/2 Screw-Bolt+			5/8 Screw-Bolt+			3/4 Screw-Bolt+	
Anchor category	1, 2 or 3	-	1				1		1			1			1			1	
Head style	-	-	Threaded				Hex Head		Hex Head			Hex Head			Hex Head			Hex Head	
Threaded diameter	-	in.	1/4		3/8		N/A		N/A			N/A			N/A			N/A	
Minimum nominal embedment depth	h_{nom}	in. (mm)	1 5/8 (41)	2 1/2 (64)	1 5/8 (41)	2 1/2 (64)	1 5/8 (41)	2 1/2 (64)	2 (51)	2 1/2 (64)	3 1/4 (83)	2 1/2 (64)	3 (76)	4 1/4 (108)	3 1/4 (83)	4 (102)	5 (127)	4 1/4 (108)	
STEEL STRENGTH IN SHEAR (ACI 318-14 17.5.1 or ACI 318-11 D.6.1)																			
Steel strength in shear[5]	V_{sa}	lb (kN)	860 (3.8)		1,545 (6.9)		1,635 (7.3)	2,040 (9.1)	3,465 (15.4)		4,345 (19.3)	8,860 (39.4)		11,175 (49.7)	12,310 (54.8)		15,585 (69.3)	19,260 (85.7)	
Reduction factor, steel strength[3,4]	ϕ	-	0.60				0.60		0.60			0.60			0.60			0.60	
STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS (ACI 318-14 17.2.3.3 or ACI 318-11 D.3.3.3)																			
Steel strength in shear, seismic[6]	$V_{sa,eq}$	lb (kN)	600 (2.7)		1,390 (6.2)		1,360 (6.1)	1,700 (7.6)	2,415 (10.8)		3,030 (13.5)	7,090 (31.5)		8,940 (39.8)	9,845 (43.8)		12,465 (55.5)	15,405 (68.5)	
Reduction factor, steel strength, seismic[3]	ϕ	-	0.60				0.60		0.60			0.60			0.60			0.60	
CONCRETE BREAKOUT STRENGTH IN SHEAR (ACI 318-14 17.5.2 or ACI 318-11 D.6.2)																			
Nominal anchor diameter	d_a	in. (mm)	0.250 (6.4)				0.250 (6.4)		0.375 (9.5)			0.500 (12.7)			0.625 (15.9)			0.750 (19.1)	
Load bearing length of anchor	ℓ_e	in. (mm)	1.20 (30)	1.94 (49)	1.20 (30)	1.94 (49)	1.20 (30)	1.94 (49)	1.33 (33)	1.75 (44)	2.39 (60)	1.75 (44)	2.17 (55)	3.23 (82)	2.24 (56)	2.88 (73)	3.73 (94)	3.08 (78)	
Reduction factor, concrete breakout strength[3]	ϕ	-	0.70				0.70		0.70			0.70			0.70			0.70	
PRYOUT STRENGTH IN SHEAR (ACI 318-14 17.5.3 or ACI 318-11 D.6.3)																			
Coefficient for pryout strength	k_{cp}	-	1		1		1		1			1		2	1	2		2	
Effective embedment depth	h_{ef}	in. (mm)	1.20 (30)	1.94 (49)	1.20 (30)	1.94 (49)	1.20 (30)	1.94 (49)	1.33 (33)	1.75 (44)	2.39 (60)	1.75 (44)	2.17 (55)	3.23 (82)	2.24 (56)	2.88 (73)	3.73 (94)	3.08 (78)	
Reduction factor, pryout strength[3]	ϕ	-	0.70				0.70		0.70			0.70			0.70			0.70	

For **SI:** 1 inch = 25.4 mm, 1 ft-lb = 1.356 N-m, 1 psi = 0.0069 N/mm^2 (MPa).

N/A = Not Applicable.

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

[2]Installation must comply with manufacturer's published installation instructions and details.

[3]All values of ϕ were determined from the load combinations of IBC Section 1605.2, ACI 318-14 Section 5.3, or ACI 318-11 Section 9.2. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 Section D.4.4. For reinforcement that complies with ACI 318-14 Chapter 17 or ACI 318-11 Appendix D requirements for Condition A, see ACI 318-14 17.3.3(c) or ACI 318-11 D.4.3(c), as applicable, for the appropriate ϕ factor when the load combinations of IBC Section 1605.2, ACI 318-14 Section 5.3, or ACI 318-11 Section 9.2 are used.

[4]The anchors are considered a brittle steel elements as defined by ACI 318-14 2.3 or ACI 318-11 D.1.

[5]Reported values for steel strength in shear are based on test results per ACI 355.2, Section 9.4 and must be used for design in lieu of the calculated results using equation 17.5.1.2b of ACI 318-14 or equation D-29 in ACI 318-11 D.6.1.2.

[6]Reported values for steel strength in shear are for seismic applications and based on test results in accordance with ACI 355.2, Section 9.6 and must be used for design.

[7]Anchors are permitted in the topside of concrete-filled steel deck assemblies in accordance with Figure 4 of this report.

[8]Anchors are permitted to be used in lightweight concrete in accordance with Section 4.1.12 of this report.

[9]Hangermate+ shear values are for threaded rod or steel inserts with and ultimate strength, $F_u \geq 125$ ksi; threaded rod or steel inserts with an F_u less than 125 ksi are allowed provided the steel strength shear values are multiplied by the ratio of F_u (ksi) of the steel insert and 125 ksi.

TABLE 5—TENSION AND SHEAR DESIGN INFORMATION FOR SCREW-BOLT+ AND HANGERMATE+ SCREW ANCHORS IN THE SOFFIT (THROUGH THE UNDERSIDE) OF CONCRETE-FILLED STEEL DECK ASSEMBLIES[1,2,3,4,5,6,7]

Anchor Property / Setting Information	Notation	Units	Nominal Anchor Size (inch)														
			1/4 Hangermate+				1/4 Screw-Bolt+		3/8 Screw-Bolt+			1/2 Screw-Bolt+			5/8 Screw-Bolt+			3/4 Screw-Bolt+
Anchor category	1, 2 or 3	-	1				1		1			1			1			1
Head style	-	-	Threaded				Hex Head		Hex Head			Hex Head			Hex Head			Hex Head
Threaded diameter	-	in.	1/4		3/8		N/A		N/A			N/A			N/A			N/A
Minimum nominal embedment depth	h_{nom}	in. (mm)	1 5/8 (41)	2 1/2 (64)	1 5/8 (41)	2 1/2 (64)	1 5/8 (41)	2 1/2 (64)	2 (51)	2 1/2 (64)	3 1/4 (83)	2 1/2 (64)	3 (76)	4 1/4 (108)	3 1/4 (83)	4 (102)	5 (127)	4 1/4 (108)
Effective embedment	h_{ef}	in. (mm)	1.20 (30)	1.94 (49)	1.20 (30)	1.94 (49)	1.20 (30)	1.94 (49)	1.33 (33)	1.75 (44)	2.39 (60)	1.75 (44)	2.17 (55)	3.23 (82)	2.24 (56)	2.88 (73)	3.73 (94)	3.08 (78)
Minimum hole depth	h_o	in. (mm)	1 3/4 (44)	2 5/8 (67)	1 3/4 (44)	2 5/8 (67)	1 3/4 (44)	2 5/8 (67)	2 1/8 (54)	2 5/8 (67)	3 3/8 (86)	2 5/8 (67)	3 1/8 (79)	4 3/8 (111)	3 3/8 (86)	4 1/8 (105)	5 1/8 (130)	4 3/8 (111)
See Figure 5A for Screw-Bolt+ and Figure 6A for Hangermate+ (Minimum 3 7/8-inch-wide deck flute)																		
Minimum concrete member thickness[8]	$h_{min,deck,total}$	in. (mm)	5 1/2 (140)		5 1/2 (140)		5 1/2 (140)		5 1/2 (140)			5 1/2 (140)			5 1/2 (140)		6 1/4 (159)	6 1/4 (159)
Pullout strength, uncracked concrete (3,000 psi)	$N_{p,deck,uncr}$	lb (kN)	1,430 (6.4)		1,430 (6.4)		1,430 (6.4)	2,555 (11.4)	2,275 (10.1)	2,655 (11.8)	3,235 (14.4)	2,600 (11.6)	3,555 (15.8)	5,975 (26.6)	2,610 (11.6)	4,150 (18.5)	6,195 (27.6)	6,085 (27.1)
Pullout strength, cracked concrete (3,000 psi)	$N_{p,deck,cr}$	lb (kN)	615 (2.7)		615 (2.7)		615 (2.7)	1,115 (5.0)	1,290 (5.1)	1,880 (8.4)	2,290 (10.2)	1,230 (5.5)	2,330 (10.4)	4,030 (17.9)	1,600 (7.1)	3,340 (14.9)	4,945 (22.0)	3,835 (17.1)
Pullout strength, seismic (3,000 psi)	$N_{p,deck,eq}$	lb (kN)	290 (1.3)		290 (1.3)		290 (1.3)	920 (4.1)	890 (4.0)	1,570 (7.0)	2,015 (9.0)	1,230 (5.5)	2,330 (10.4)	4,030 (17.9)	990 (4.4)	1,730 (7.7)	2,415 (10.8)	3,410 (15.2)
Reduction factor, pullout strength[9]	ϕ	-	0.65				0.65		0.65			0.65			0.65			0.65
Steel strength in shear	$V_{sa,deck}$	lb (kN)	1,485 (6.6)		2,740 (12.2)		1,155 (5.1)	2,595 (11.6)	2,540 (11.3)	2,540 (11.3)	3,225 (14.4)	2,435 (10.8)	2,435 (10.8)	5,845 (26.0)	2,650 (11.8)	2,650 (11.8)	6,325 (28.1)	5,175 (23.0)
Steel strength in shear, seismic	$V_{sa,deck,eq}$	lb (kN)	1,040 (4.6)		2,465 (11.0)		960 (4.3)	2165 (9.6)	1,775 (7.9)	1,950 (8.7)	2,250 (10.0)	1,950 (8.7)	2,095 (9.3)	4,675 (20.8)	2,120 (9.4)	2,325 (10.3)	5,060 (22.5)	4,140 (18.4)
Reduction factor, steel strength in shear[9]	ϕ	-	0.60				0.60		0.60			0.60			0.60			0.60
See Figure 5B for Screw-Bolt+ and Figure 6B for Hangermate+ (Minimum 1 3/4-inch-wide deck flute)																		
Minimum concrete member thickness[8]	$h_{min,deck,total}$	in. (mm)	4 (102)		4 (102)		4 (102)		4 (102)			4 (102)	N/A		N/A			N/A
Pullout strength, uncracked concrete (3,000 psi)	$N_{p,deck,uncr}$	lb (kN)	1,760 (7.8)		1,760 (7.8)		1,760 (7.8)	2,075 (9.2)	1,440 (6.4)	2,135 (9.5)	3,190 (14.2)	1,720 (7.6)	N/A		N/A			N/A
Pullout strength, cracked concrete (3,000 psi)	$N_{p,deck,cr}$	lb (kN)	760 (3.4)		770 (3.4)		760 (3.4)	910 (4.0)	815 (3.6)	1,510 (6.7)	2,260 (10.0)	1280 (5.7)						
Pullout strength, seismic (3,000 psi)	$N_{p,deck,eq}$	lb (kN)	355 (1.6)		635 (2.8)		355 (1.6)	750 (3.3)	565 (2.5)	1,260 (5.6)	1,985 (8.8)	1280 (5.7)						
Reduction factor, pullout strength[9]	ϕ	-	0.65				0.65		0.65			0.65						
Steel strength in shear	$V_{sa,deck}$	lb (kN)	1,680 (7.5)		2,180 (9.7)		1,880 (8.4)	2,315 (10.3)	2,115 (9.4)	2,115 (9.4)	2,820 (12.5)	2,095 (9.3)	N/A		N/A			N/A
Steel strength in shear, seismic	$V_{sa,deck,eq}$	lb (kN)	1,175 (5.2)		1,960 (8.7)		1,565 (7.0)	1,930 (8.6)	1,475 (6.6)	1,260 (5.6)	1,965 (8.7)	1,675 (7.5)						
Reduction factor, steel strength in shear[9]	ϕ	-	0.60				0.60		0.60			0.60						

For **SI:** 1 inch = 25.4 mm, 1 ft-lb = 1.356 N-m, 1 psi = 0.0069 N/mm^2 (MPa).

N/A = Not Applicable.

[1]Installation must comply with manufacturer's published installation instructions and details.

[2]Values for $N_{p,deck}$ and $N_{p,deck,cr}$ 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 318-14 17.4.2 or ACI 318 D.5.2, as applicable, is not required for anchors installed in the deck soffit (through underside).

[3]Values for $N_{p,deck,eq}$ are applicable for seismic loading; see Section 4.1.8.2 of this report.

[4]For the calculation of N_{pn}, see Section 4.1.4 of this report; for all design cases $\Psi_{c,P}$ = 1.0. The characteristic pullout strength for concrete compressive strengths greater than 3,000 psi for 1/4-inch-diameter anchors may be increased by multiplying the value in the table by $(f'_c / 3{,}000)^{0.3}$ for psi or $(f'_c / 17.2)^{0.3}$ for MPa. The characteristic pullout strength for concrete compressive strengths greater than 3,000 psi for 3/8-inch- to 3/4-inch-diameter anchors may be increased by multiplying the value in the table by $(f'_c / 3{,}000)^{0.5}$ for psi or $(f'_c / 17.2)^{0.5}$ for MPa.

[5]Shear loads for anchors installed through steel deck into concrete may be applied in any direction.

[6]Values of $V_{sa,deck}$ and $V_{sa,deck,eq}$ are for sand-lightweight concrete and additional lightweight concrete reduction factors need not be applied. In addition, evaluation for the concrete breakout capacity in accordance with ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, and the pryout capacity in accordance with ACI 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable, are not required for anchors installed in the soffit (through underside).

[7]Hangermate+ shear values are for threaded rod or steel inserts with and ultimate strength, $F_u \geq$ 125 ksi; threaded rod or steel inserts with an F_u less than 125 ksi are allowed provided the steel strength shear values are multiplied by the ratio of F_u (ksi) of the steel insert and 125 ksi.

[8]The minimum concrete member thickness, $h_{min,deck,total}$, is the minimum overall thickness of the concrete-filled steel deck (depth and topping thickness).

[9]All values of ϕ were determined from the load combinations of IBC Section 1605.2, ACI 318-14 Section 5.3 or ACI 318 Section 9.2. If the load combinations of ACI 318 Appendix C are used, then the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08).

TABLE 6—EXAMPLE ALLOWABLE STRESS DESIGN VALUES FOR ILLUSTRATIVE PURPOSES[1,2,3,4,5,6,7,8,9]

Anchor	Nominal Anchor Diameter (in.)	Nominal Embedment Depth (in.)	Effective Embedment (in.)	Allowable Tension Load (lbs)
Screw-Bolt+	1/4	1 5/8	1.20	780
		2 1/2	1.94	1,425
	3/8	2	1.33	1,010
		2 1/2	1.75	1,220
		3 1/4	2.39	1,950
	1/2	2 1/2	1.75	1,525
		3	2.17	1,685
		4 1/4	3.23	3,060
	5/8	3 1/4	2.24	2,210
		4	2.88	2,575
		5	3.73	3,795
	3/4	4 1/4	3.08	3,205
Hangermate+	1/4	1 5/8	1.20	780
		2 1/2	1.94	1,425
	3/8	1 5/8	1.20	780
		2 1/2	1.94	1,425

For **SI:** 1 inch = 25.4 mm; 1 lbf = 0.0044 kN.

Illustrative Allowable Stress Design Values in Table 7 are applicable only when the following design assumptions are followed:
[1]Single anchor with static tension load only.
[2]Concrete determined to remain uncracked for the life of the anchorage.
[3]Load combinations from ACI 318-14 Section 5.3 or ACI 318-11 Section 9.2, as applicable, (no seismic loading).
[4]30% dead load and 70% live load, controlling load combination: 1.2*D* + 1.6*L*.
[5]Calculated of weighted average for α = 1.2(0.3) + 1.6(0.7) = 1.48.
[6] f'_c = 2,500 psi (normal weight concrete).
[7] $c_{a1} = c_{a2} \geq c_{ac}$.
[8] $h \geq h_{min}$.
[9]Values are for Condition B; supplementary reinforcement in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3 is not provided, as applicable.

Given: Calculate the factored strength design resistance in tension, $\boldsymbol{\phi N_n}$, and the allowable stress design value, $\boldsymbol{T_{allowable,ASD}}$, for a 1/2-inch diameter Screw-Bolt+ screw anchor with 3-inch nominal embedment assuming the given conditions in Table 6.

Calculation in accordance with ACI 318-14 Chapter 17 or ACI 318-11 Appendix D and this report:	Code Ref.	Report Ref.
Step 1. Calculate steel strength of a single anchor in tension:	D.5.1.2 (318-11) 17.4.1.2 (318-14)	Table 3 §4.1.2
$\boldsymbol{\phi N_{sa}} = (0.65)(20{,}475) = 13{,}309\ lbs.$		
Step 2. Calculate concrete breakout strength of a single anchor in tension:	D.5.2.1 (318-11) 17.4.2.1 (318-14)	Table 3 §4.1.3
$\phi N_{cb} = \phi \frac{A_{Nc}}{A_{Nc0}} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$		
$N_b = k_c \lambda_a \sqrt{f'_c} (h_{ef})^{1.5}$	D.5.2.2 (318-11) 17.4.2.2 (318-14)	Table 3
$N_b = (24)(1.0)\sqrt{2{,}500}(2.17)^{1.5} = 3{,}836\ lbs.$		
$\boldsymbol{\phi N_{cb}} = (0.65)\frac{(42.4)}{(42.4)}(1.0)(1.0)(1.0)(3{,}836) = 2{,}493\ lbs.$		
Step 3. Calculate pullout strength:	D.5.3.2 (318-11) 17.4.3.2 (318-14)	Table 3 §4.1.4
$\phi N_{pn} = \phi N_{p,uncr} \psi_{c,P}$		
$\boldsymbol{\phi N_{pn}}$ = n/a (pullout strength does not control per reported design values)		
Step 4. Determine controlling resistance strength in tension:	D.4.1.1 (318-11) 17.3.1.1 (318-14)	
$\boldsymbol{\phi N_n} = \min\lvert\phi N_{sa}, \phi N_{cb}, \phi N_{pn}\rvert = \phi N_{cb} = 2{,}493\ lbs.$		
Step 5. Calculate allowable stress design conversion factor for loading condition:	9.2 (ACI 318-11) 5.2 (ACI 318-14)	
Controlling load combination: 1.2*D* + 1.6*L*		
$\boldsymbol{\alpha}$ = 1.2(30%) + 1.6(70%) = 1.48		
Step 6. Calculate allowable stress design value		§4.2
$\boldsymbol{T_{allowable,ASD}} = \frac{\boldsymbol{\phi N_n}}{\boldsymbol{\alpha}} = \frac{\mathbf{2{,}493}}{\mathbf{1.48}} = \mathbf{1{,}685\ lbs.}$		

FIGURE 7—EXAMPLE STRENGTH DESIGN CALCULATION INCLUDING ASD CONVERSION, FOR ILLUSTRATIVE PURPOSES

ICC-ES Evaluation Report

ESR-3889 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

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EVALUATION SUBJECT:

SCREW-BOLT+™ SCREW ANCHORS AND HANGERMATE®+ ROD HANGER SCREW 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 Screw-Bolt+ Screw Anchors and Hangermate+ Rod Hanger Screw Anchors in Cracked and Uncracked Concrete, recognized in ICC-ES master evaluation report ESR-3889, have also been evaluated for compliance with the codes noted below:

Compliance with the following codes:

- 2014 *Florida Building Code—Building*
- 2014 *Florida Building Code—Residential*

2.0 CONCLUSIONS

The Screw-Bolt+ Screw Anchors and Hangermate+ Rod Hanger Screw Anchors in Cracked and Uncracked Concrete described in Sections 2.0 through 7.0 of the master evaluation report ESR-3889 comply with the 2014 *Florida Building Code—Building* and the 2014 *Florida Building Code—Residential*, provided the design and installation are in accordance with the 2012 *International Building Code®* (IBC) provisions noted in the master evaluation report and the following conditions are met:

- Design wind loads must be based on Section 1609 of the 2014 *Florida Building Code—Building* or Section R301.2.1.1 of the 2014 *Florida Building Code—Residential*, as applicable.
- Load combinations must be in accordance with Section 1605.2 or Section 1605.3 of the 2014 *Florida Building Code—Building*, as applicable.

Use of the Screw-Bolt+ Screw Anchors and Hangermate+ Rod Hanger Screw Anchors in cracked and uncracked concrete as described in the master evaluation report for compliance with the High-Velocity Hurricane Zone provisions of the 2014 *Florida Building Code—Building* and the 2014 *Florida Building Code—Residential* has not been evaluated, and is outside the scope of this supplement.

For products falling under Florida Rule 9N-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 master report, issued November 2016.