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RESEARCH REPORT: RR 25808
(CSI # 03151)

BASED UPON ICC ES EVALUATION SERVICE
REPORT NO. ESR-2526

REEVALUATION DUE

DATE: August 1, 2018
Issued Date: August 1, 2016
Code: 2014 LABC

GENERAL APPROVAL – Reevaluation -Powers Wedge Bolt® + Screw Anchors and Vertigo®+ Rod Hanger Screw Anchors in Cracked and Uncracked Concrete

DETAILS

The above assemblies and/or products are approved when in compliance with the use, description, design, installation, conditions of use, and identification of ICC Evaluation Services Report No. ESR-2526 reissued, June of 2016, of the ICC Evaluation Service, Incorporated. The report in its entirety is attached and made part of this general approval.

The parts of Report No. ESR-2526 which are excluded on the attached copy have been removed by the City of Los Angeles Building and Safety Department as not being included in this approval.

The approval is subject to the following conditions:

1. The allowable and strength design values listed in the attached report and tables are for the fasteners only and do not include supporting members. The supporting members shall be checked separately for structural adequacy.
2. The anchors shall be identified by labels on the packaging indicating the manufacturer's name and product designation.

RR 25808
Page 1 of 3

ICC-ES Evaluation Report

ESR-2526

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DIVISION: 05 00 00—METALS
Section: 05 05 19—Post-Installed Concrete Anchors
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EVALUATION SUBJECT:
**WEDGE-BOLT+ SCREW ANCHORS AND VERTIGO®+
 ROD HANGER SCREW ANCHORS IN CRACKED AND
 UNCRACKED CONCRETE (DEWALT / POWERS)**

1.0 EVALUATION SCOPE

Compliance with the following codes:

- * ■ ~~2015~~, 2012, 2009, and 2006 *International Building Code*® (IBC)
- * ■ ~~2015~~, 2012, 2009, and 2006 *International Residential Code*® (IRC)

Property evaluated:

Structural

2.0 USES

The Wedge-Bolt+ screw anchors and Vertigo+ 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) Wedge-Bolt+ anchors may be installed in the topside of cracked and uncracked [¹/₄-inch (6.4 mm) uncracked only] normal-weight or sand-lightweight concrete-filled steel deck having a specified
- ** compressive strength, f'_c , of 3,000 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

The 3/8-inch-, 1/2-inch-, and 5/8-inch-diameter (9.5 mm, 12.7mm, and 15.9 mm) Wedge-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-, 3/8-inch- and 1/2-inch-diameter (6.4 mm, 9.5 mm and 12.7 mm) Vertigo+ 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 and 2006 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 Wedge-Bolt+ Anchors:

Wedge-Bolt+ screw anchors are comprised of an anchor body with hex washer head. Product names corresponding to report holder and additional listees are presented in Table A of this report. 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 Wedge-Bolt+ screw anchor is illustrated in Figure 2.

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. The threads on the anchor tap into the sides of the predrilled hole and interlock with the base material during installation.

3.2 Vertigo+ Anchors:

Vertigo+ rod hanger screw anchors are comprised of a nominally $\frac{3}{8}$ -inch-diameter one-piece anchor body, with a hex coupler head containing internal threads that accepts threaded rods and bolts in $\frac{1}{4}$ -inch, $\frac{3}{8}$ -inch, and $\frac{1}{2}$ -inch (6.4 mm, 9.5 mm, and 12.7 mm) diameters. Product names corresponding to report holder and additional listees are presented in Table A of this report.

The anchor body and hex coupler head are manufactured from low-carbon steel which is case hardened, and have minimum 0.0002-inch (5 μ m) zinc plating in accordance with ASTM B633, Type II. The Vertigo+ rod hanger screw anchor is illustrated in Figure 7.

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 and bolts. 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. 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 Vertigo+:

Threaded steel insert elements must be threaded into the Vertigo+ anchors to form a connection. The material properties of the steel insert elements must comply with the minimum specifications as given in Table 5 of this report (e.g., ASTM A36; ASTM F1554, Grade 36; SAE J429, Grade 2), or equivalent.

3.4 Concrete:

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

3.5 Steel Deck Panels:

Steel deck panels for Wedge-Bolt+ anchors must comply with the configurations in Figure 4 and Figure 5 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 36, and have a minimum yield strength of 36 ksi (248 MPa).

Steel deck panels for Vertigo+ anchors must comply with the configurations in Figures 9A and 9B and have a minimum base-metal thickness of 0.035 inch (0.89 mm) [No. 20 gage]. For Figure 9A, steel must comply with ASTM A653/A653M SS Grade 36, and have a minimum yield strength of 36 ksi (248 MPa). For Figure 9B, steel must comply with ASTM A653/A653M SS Grade 33, and have a minimum yield strength of 33 ksi (228 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.

- * ~~Design strength of anchors complying with the 2006 IBC and Section R301.1.3 of the 2006 IRC must be in accordance with ACI 318-05 Appendix D and this report.~~

A design example in accordance with the 2015 and 2012 IBC is given in Figure 10 of this report.

- * Design parameters provided in Tables 1 through 6 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 2, 3, 5 and 6 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 Tables 2 and 5 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 Tables 2 and 5 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 Tables 2 and 5 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 5, 9A, and 9B, 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 Tables 2 and 5. 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:

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

$$N_{pn,fc} = N_{p,cr} \sqrt{\frac{f'_c}{17.2}} \quad (\text{N, MPa})$$

where f'_c is the specified concrete compressive strength.

Where values for $N_{p,cr}$ or $N_{p,uncr}$ are not provided in Tables 2 or 5 of this report, the pullout strength in tension need not be 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 5, 9A, and 9B, is provided in Tables 2 and 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.

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, in the upper and lower flute soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, the nominal pullout strength in tension of the anchors can be adjusted by calculation according to Eq-2:

$$N_{pn,fc} = N_{p,deck,uncr} \sqrt{\frac{f'_c}{3,000}} \quad (\text{lb, psi}) \quad (\text{Eq-2})$$

$$N_{pn,fc} = N_{p,deck,uncr} \sqrt{\frac{f'_c}{20.7}} \quad (\text{N, MPa})$$

where f'_c is the specified concrete compressive strength.

4.1.5 Requirements for Static Steel Strength in Shear Shear Capacity, 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 Tables 3 and 6 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 Figure 5 is given in Table 3 of this report for the Wedge-Bolt+ anchors; and as shown in Figures 9A and 9B is given in Table 6 for the Vertigo+ anchors, 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} , 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 Tables 3 and 6 of this report.

For Wedge-Bolt+ 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} , 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 Table 1 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 5, 9A, and 9B, calculation of the concrete breakout strength in accordance with ACI 318-14 17.5.2 or ACI 318 D.6.2, as applicable, is not required.

4.1.7 Requirements for Static Concrete Pryout Strength in Shear, V_{cp} or V_{cpq} : The nominal concrete pryout strength of a single anchor or group of anchors, V_{cp} or V_{cpq} , 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 Tables 3 and 6, 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 5, 9A, and 9B, 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 and ACI 318-05 D.3.3 shall be applied under Section 1908.1.9 of the 2009 IBC, or Section 1908.1.16 of the 2006 IBC, respectively, as applicable.

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 2, 3, 5 and Table 6 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; ACI 318-08 D.3.3.5 or D.3.3.6; or ACI 318-05 D.3.3.5, as applicable.

The $1/4$ -inch-diameter (6.4 mm) Wedge-Bolt+ anchors must be limited to installation in regions designated as IBC Seismic Design Categories A and B only. The $3/8$ -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) Wedge-Bolt+ anchors and the $1/4$ -inch-diameter (6.4 mm), $3/8$ -inch-diameter (9.5 mm) and $1/2$ -inch-diameter (12.7 mm) Vertigo+ 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, 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 Tables 2 and 5 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 Tables 2 and 5, 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 Tables 2 and 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, 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 Tables 3 and 6 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 5, 9A and 9B, the appropriate value for nominal steel strength in shear for seismic loads, $V_{sa,deck,eq}$, described in Tables 3 and 6 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.

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 D.5.2, as applicable, must be further multiplied by the factor $\psi_{cp,N}$ given by Eq-3:

$$\psi_{cp,N} = \frac{c}{c_{ac}} \tag{Eq-3}$$

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 4 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, as applicable, the values of s_{min} and c_{min} as given in Tables 1 and 4 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 Table 1 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 5, 9A, and 9B, 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 ACI 318-05 (2006 IBC), λ shall be taken as 0.75 for all lightweight concrete and 0.85 for sand-lightweight concrete. Linear interpolation shall be permitted if partial sand replacement is used. In addition, the pullout strengths $N_{p,cr}$ and N_{eq} shall be multiplied by the modification factor, λ_a , as applicable.

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 the following equations:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \tag{Eq-4}$$

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha} \tag{Eq-5}$$

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, ACI 318-05 Appendix D and 2006 IBC Section 1908.1.16, 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, ACI 318-05 Appendix D and 2006 IBC Section 1908.1.16, 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 nonductile failure modes and required over-strength.

Limits on edge distance, anchor spacing and member thickness as given in Tables 1 and 4 of this report must apply. An example of Allowable Stress Design tension values for illustrative purposes is shown in Table 7 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 D.7, as applicable, as follows:

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

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

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

4.3 Installation:

Installation parameters are provided in Tables 1 and 4, and Figures 1, 3, 6, and 8 of this report. Anchor locations must comply with this report and plans and specifications approved by the code official. The Wedge-Bolt+ and Vertigo+ screw anchors must be installed according to manufacturer's published installation instructions and this report. Anchors must be installed in holes drilled using carbide-tipped masonry drill bits (Wedge-bits) supplied by Fasteners, and complying with the tolerances given in Tables 1 and 4, Figure 4 and Figure 5. The nominal Wedge-bit diameter must be equal to the nominal anchor size.

Anchors are permitted to be loosened and retightened to facilitate attachment, realignment, etc. The Wedge-Bolt+ and Vertigo+ screw anchors may 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 Wedge-Bolt+ installation in the topside of concrete-filled steel deck assemblies, installation must comply with Figure 4.

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 $\frac{1}{8}$ inch (3.2 mm). For member thickness and edge distance restrictions for installations into the soffit of concrete on steel deck assemblies, see Figures 5, 9A, and 9B.

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 printed 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 Wedge-Bolt+ and Vertigo+ screw 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 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 $\frac{1}{4}$ -inch (6.4 mm) Wedge-Bolt+ anchors must be installed in uncracked concrete and lightweight concrete; $\frac{3}{8}$ -inch to $\frac{3}{4}$ -inch (9.5 mm to 19.1 mm)

Wedge-Bolt+ anchors and $\frac{1}{4}$ -inch- $\frac{3}{8}$ -inch- and $\frac{1}{2}$ -inch-diameter (6.4 mm, 9.5 mm and 12.7 mm) Vertigo+ 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 $\frac{3}{8}$ -inch to $\frac{1}{2}$ -inch (9.5 mm to 12.7 mm) Wedge-Bolt+ anchors must 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 ~~3,000~~ *** 3,000** psi to 8,500 psi (17.2 MPa to 58.6 MPa).
- 5.5 The $\frac{3}{8}$ -inch to $\frac{5}{8}$ -inch (9.5 mm to 15.9 mm) Wedge-Bolt+ anchors and $\frac{1}{4}$ -inch- $\frac{3}{8}$ -inch- and $\frac{1}{2}$ -inch-diameter (6.4 mm, 9.5 mm and 12.7 mm) Vertigo+ 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 4, and Figures 4, 5, 9A, and 9B of this report.
- 5.10 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.
- 5.11 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.
- 5.12 The $\frac{3}{8}$ -inch- to $\frac{3}{4}$ -inch-diameter (9.5 mm to 19.1 mm) Wedge-Bolt+ anchors and $\frac{1}{4}$ -inch- $\frac{3}{8}$ -inch- and $\frac{1}{2}$ -inch-diameter (6.4 mm, 9.5 mm and 12.7 mm) Vertigo+ 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.
- 5.13 The $\frac{1}{4}$ -inch-diameter (6.4 mm) Wedge-Bolt+ anchors may be used to resist short-term loading due to wind forces and for seismic load combinations limited to locations designated as Seismic Design Categories A and B under the IBC, subject to the conditions of this report. The $\frac{3}{8}$ -inch- to $\frac{3}{4}$ -inch-diameter (9.5 mm to 19.1 mm) Wedge-Bolt+ anchors and $\frac{1}{4}$ -inch- $\frac{3}{8}$ -inch- and $\frac{1}{2}$ -inch-diameter (6.4 mm, 9.5 mm and 12.7 mm) Vertigo+ 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.
- 5.14 Anchors are not permitted to support fire-resistance-rated construction. Where not otherwise prohibited by code, Wedge-Bolt+ and Vertigo+ anchors are permitted for installation in fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:

- The 1/4-inch (6.4 mm) Wedge-Bolt+ anchors are used to resist wind forces or seismic forces in regions as set forth in Section 5.11 of this report only.
- The 3/8-inch to 3/4-inch (9.5 mm to 19.1 mm) Wedge-Bolt+ anchors and 1/4-inch- 3/8-inch- and 1/2-inch-diameter (6.4 mm, 9.5 mm and 12.7 mm) Vertigo+ 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.

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

5.16 Use of Wedge-Bolt+ and Vertigo+ 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. Use of anchors in an interior damp environment must have mechanical zinc plating in accordance with ASTM B695, Class 55.

5.17 Steel anchoring materials in contact with preservative-treated and fire-retardant-treated wood must be zinc-coated. Minimum coating weights for zinc-coated steel anchors must comply with ASTM B695, Class

55 as described in Section 3.1. Exception: Anchors with a diameter of 1/2 inch (12.7 mm) or greater under the IRC.

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

5.19 Anchors 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 355.207 / ACI 355.2-04, for use in cracked and uncracked concrete; including Test No. 11, Methods A and B (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 Wedge-Bolt+ and Vertigo+ 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 Wedge-Bolt+ screw anchor, along with a plus sign; these are visible after installation. Packages are identified with the anchor name; part number; type; anchor size and length; quantity; the company name as set forth in Table A of this report; and the evaluation report number (ICC-ES ESR-2526).

TABLE A—PRODUCT NAMES BY COMPANY

COMPANY NAME	PRODUCT NAME
DEWALT	Wedge-Bolt+ and Vertigo+
Powers Fasteners	Wedge-Bolt+ and Vertigo+
L. H. Dottie Co.	Dottie Wedge-Bolt+ and Dottie Vertigo+
The Hillman Group	Hillman Wedge-Bolt+ and Hillman Vertigo+

TABLE B—MEAN AXIAL STIFFNESS VALUES, β, FOR WEDGE-BOLT+ AND VERTIGO+ SCREW ANCHORS IN NORMAL-WEIGHT CONCRETE¹

CONCRETE STATE	UNITS	Wedge-Bolt+ Nominal Anchor Diameter / Vertigo+ Threaded Coupler Diameter								
		1/4 inch		3/8 inch		1/2 inch		5/8 inch		3/4 inch
		Wedge-Bolt+	Vertigo+	Wedge-Bolt+	Vertigo+	Wedge-Bolt+	Vertigo+	Wedge-Bolt+	Wedge-Bolt+	
Uncracked concrete	10 ³ lbf/in. (kN/mm)	400 (70)	14,200 (736)	8200 (1435)	14,200 (736)	7700 (1347)	14,200 (736)	9900 (1732)	10000 (1750)	
Cracked concrete	10 ³ lbf/in. (kN/mm)	Not Applicable	2,200 (385)	2200 (385)	2,200 (385)	2500 (437)	2,200 (385)	4100 (717)	3900 (682)	

¹Mean values shown, actual stiffness varies considerably depending on concrete strength, loading and geometry of application.

TABLE C—DESIGN INDEX

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
Wedge-Bolt+	Table 1	Table 2	Table 2	Table 2	Table 3	Table 3	Table 3
Vertigo+	Table 4	Table 5	Not applicable	Table 5	Table 6	Not applicable	Table 6

TABLE 1—WEDGE-BOLT+ SCREW ANCHOR INSTALLATION SPECIFICATIONS¹

Anchor Property / Setting Information	Notation	Units	Nominal Anchor Size (inch)							
			1/4	3/8	1/2	5/8		3/4		
Nominal anchor diameter	$d_a [d_o]$ ⁵	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	d_{bit}	in.	1/4 Wedge-bit	3/8 Wedge-bit	1/2 Wedge-bit	5/8 Wedge-bit		3/4 Wedge-bit		
Wedge-bit tolerance range	-	in.	0.255 to 0.259	0.385 to 0.389	0.490 to 0.495	0.600 to 0.605		0.720 to 0.725		
Minimum nominal embedment depth	h_{nom}	in. (mm)	1 3/4 (44)	2 1/8 (54)	2 1/2 (64)	3 1/2 (89)	3 1/4 (83)	4 3/8 (111)	4 1/4 (108)	
Effective embedment	h_{ef}	in. (mm)	1.100 (28)	1.425 (36)	1.650 (42)	2.500 (64)	2.145 (55)	3.100 (79)	2.910 (74)	
Minimum hole depth	h_o	in. (mm)	2 (51)	2 1/4 (57)	2 3/4 (70)	4 (102)	4 (101)	5 (127)	5 (127)	
Minimum overall anchor length ²	ℓ_{anch}	in. (mm)	2 (51)	2 1/2 (64)	3 (76)	4 (102)	4 (102)	5 (127)	5 (127)	
Maximum impact wrench power (torque)	T_{screw}	ft.-lb. (N-m)	115 (156)	245 (332)	300 (407)	350 (475)		400 (542)		
Impact wrench / socket size	-	in.	7/16	9/16	3/4	15/16		1 1/8		
Head height	-	in.	7/32	21/64	7/16	1/2		19/32		
Anchors Installed in Concrete Construction										
Minimum concrete member thickness	h_{min}	in. (mm)	3 1/4 (83)	3 1/2 (89)	4 (102)	4 (102)	6 (152)	6 (152)	7 (178)	7 (178)
Minimum edge distance	c_{min}	in. (mm)	1 1/2 (38)	1 1/2 (38)	1 3/4 (44)	1 3/4 (44)	1 3/4 (44)	1 3/4 (44)	1 3/4 (44)	1 3/4 (44)
Minimum spacing distance	s_{min}	in. (mm)	2 (51)	2 1/2 (64)	2 1/2 (64)	3 1/2 (89)	2 1/2 (64)	3 3/4 (95)	3 (76)	4 1/2 (114)
Critical edge distance	c_{cac}	in. (mm)	2 1/2 (64)	4 (102)	2 3/4 (70)	4 (102)	4 1/2 (114)	5 (127)	5 (127)	6 (152)
Anchors Installed in the Topside of Concrete-filled Steel Deck Assemblies³										
Minimum member topping thickness	$h_{min,deck}$	in. (mm)	3 1/4 (83)	3 1/4 (83)	3 1/4 (83)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	
Minimum edge distance	$c_{min,deck,top}$	in. (mm)	1 1/2 (38)	1 1/2 (38)	1 3/4 (44)					
Minimum spacing distance	$s_{min,deck,top}$	in. (mm)	2 (51)	2 1/2 (64)	3 (76)					
Critical edge distance	$c_{cac,deck,top}$	in. (mm)	2 1/2 (64)	2 3/4 (70)	3 1/2 (89)					
Anchors Installed Through the Soffit of Steel Deck Assemblies into Concrete⁴										
Minimum member thickness	$h_{min,deck}$	in. (mm)	Not Applicable	3 1/4 (83)	3 1/4 (83)	3 1/4 (83)	3 1/4 (83)	3 1/4 (83)	Not Applicable	
Minimum edge distance	c_{min}	in. (mm)		1 1/4 (32)	1 1/4 (32)	1 1/4 (32)	1 1/4 (32)	1 1/4 (32)		
Minimum spacing distance	s_{min}	in. (mm)		6 3/4 (171)	6 3/4 (171)	7 1/2 (191)	6 3/4 (171)	9 3/8 (238)		

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

¹The 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.

²The 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 and consideration of a fixture attachment.

³For installations in the topside of concrete-filled steel deck assemblies, see the installation detail in Figure 4.

⁴For installations through the soffit of steel deck assemblies into concrete, see the installation detail in Figure 5. 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.

⁵The notation in brackets is for the 2006 IBC.

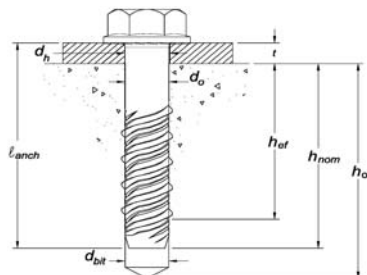


FIGURE 1—WEDGE-BOLT+ ANCHOR DETAIL

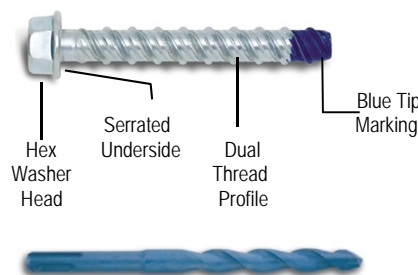


FIGURE 2—WEDGE-BOLT+ ANCHOR (ZINC PLATED OR MECHANICALLY GALVANIZED) AND WEDGE-BIT

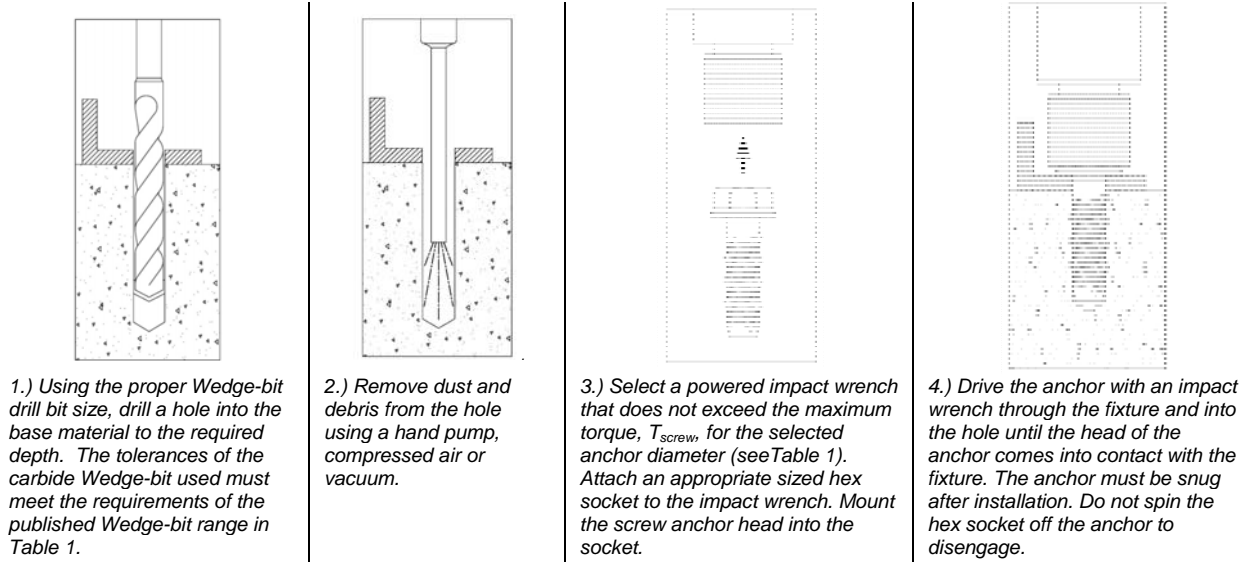


FIGURE 3—WEDGE-BOLT+ INSTALLATION INSTRUCTIONS

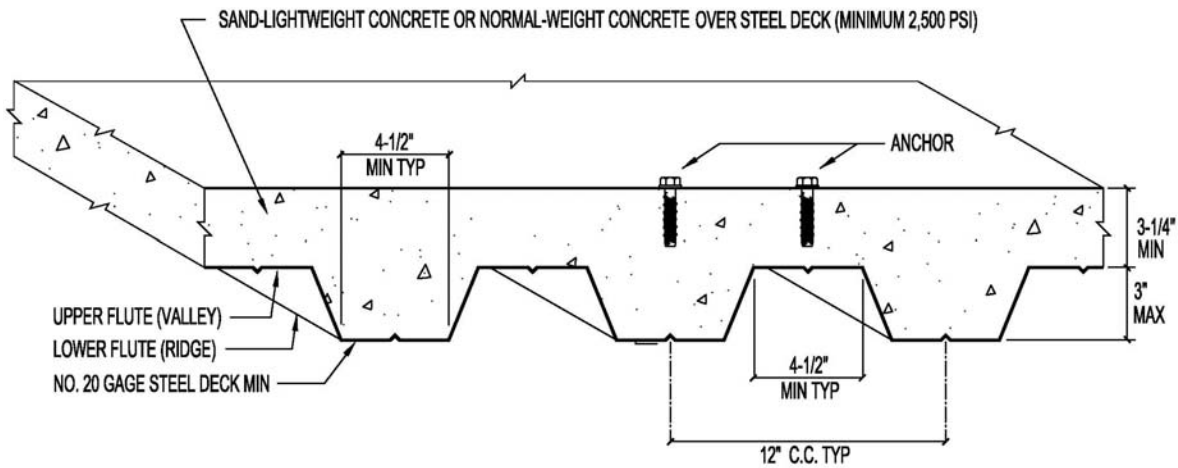


FIGURE 4—WEDGE-BOLT+ INSTALLATION DETAIL FOR SCREW ANCHORS IN THE TOPSIDE OF CONCRETE-FILLED STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)¹

¹Anchors may be placed in the topside of steel deck profiles in accordance with Figure 4 provided the minimum member topping thickness, minimum spacing distance and minimum edge distance are satisfied as given in Table 1 of this report.

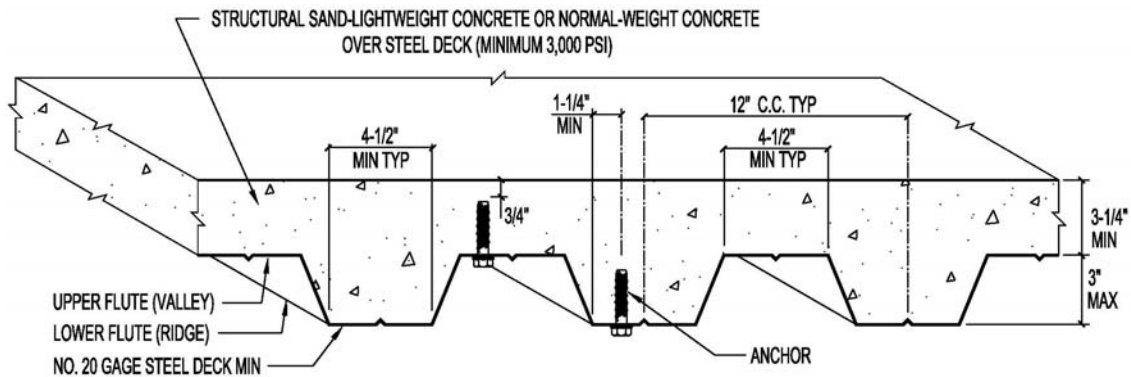


FIGURE 5—WEDGE-BOLT+ INSTALLATION DETAIL FOR SCREW ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)¹

¹Anchors may be placed in the upper or lower flute of the steel deck profile in accordance with Figure 5 provided the minimum hole clearance is satisfied. The minimum spacing distance is given in Table 1 of this report.

²Anchors in the lower flute of Figure 5 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.

TABLE 2—TENSION DESIGN INFORMATION FOR WEDGE-BOLT+ SCREW ANCHORS IN CONCRETE^{1,2}

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	1	
Minimum nominal embedment depth	h_{nom}	in.	¹ / ₄	² / ₈	² / ₂	³ / ₂	³ / ₄	⁴ / ₈	⁴ / ₄
STEEL STRENGTH IN TENSION⁴									
Minimum specified ultimate strength	f_{uta}	ksi (N/mm ²)	100 (689)	100 (689)	100 (689)	100 (689)	100 (689)	100 (689)	
Effective tensile stress area	$A_{se,N}$ [A_{se}] ¹²	in ² (mm ²)	0.044 (28.4)	0.103 (66.5)	0.168 (108.4)	0.249 (160.6)	0.249 (160.6)	0.371 (239.4)	
Steel strength in tension	N_{sa}	lb (kN)	4,400 (19.6)	10,300 (45.8)	16,800 (74.7)	24,900 (110.7)	24,900 (110.7)	37,100 (164.9)	
Reduction factor for steel strength ³	ϕ	-	0.65						
CONCRETE BREAKOUT STRENGTH IN TENSION⁹									
Effective embedment depth	h_{ef}	in. (mm)	1.100 (28)	1.425 (36)	1.650 (42)	2.500 (64)	2.145 (55)	3.100 (79)	2.910 (74)
Effectiveness factor for uncracked concrete	k_{uncr}	-	24	24	24	24	24	24	
Effectiveness factor for cracked concrete	k_{cr}	-	Not Applicable	17	17	17	17	17	
Modification factor for cracked and uncracked concrete ⁵	$\psi_{c,N}$	-	Not Applicable	1.0	1.0	1.0	1.0	1.0	
Critical edge distance	c_{ac}	in. (mm)	See Table 1						
Reduction factor for concrete breakout strength ³	ϕ	-	0.65 (Condition B)						
PULLOUT STRENGTH IN TENSION (NON-SEISMIC APPLICATIONS)^{9,10}									
Characteristic pullout strength, uncracked concrete (2,500 psi) ¹⁰	$N_{p,uncr}$	lb (kN)	See note 7	See note 7	See note 7	See note 7	See note 7	See note 7	See note 7
Characteristic pullout strength, cracked concrete (2,500 psi) ^{6,10}	$N_{p,cr}$	lb (kN)	Not Applicable	See note 7	See note 7	2,965 (13.2)	3,085 (13.7)	4,290 (19.1)	See note 7
Reduction factor for pullout strength ³	ϕ	-	0.65 (Condition B)						
PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS^{9,10}									
Characteristic pullout strength, seismic (2,500 psi) ^{6,8}	$N_{p,eq}$	lb (kN)	Not Applicable	1,085 (4.8)	1,350 (6.0)	2,520 (11.2)	3,085 (13.7)	4,290 (19.1)	4,270 (19.0)
Reduction factor for pullout strength ³	ϕ	-	0.65 (Condition B)						
PULLOUT STRENGTH IN TENSION FOR SAND-LIGHTWEIGHT AND NORMAL-WEIGHT CONCRETE OVER STEEL DECK (see Figure 5)									
Characteristic pullout strength, uncracked concrete over steel deck ^{6,11}	$N_{p,deck,uncr}$	lb (kN)	Not Applicable	2,010 (8.9)	2,480 (11.0)	3,760 (16.7)	4,095 (18.2)	4,095 (18.2)	Not Applicable
Characteristic pullout strength, cracked concrete over steel deck ^{6,11}	$N_{p,deck,cr}$	lb (kN)	Not Applicable	1,425 (6.3)	1,755 (7.8)	3,045 (13.5)	2,665 (11.9)	2,665 (11.9)	Not Applicable
Characteristic pullout strength, cracked concrete over steel deck, seismic ^{6,10}	$N_{p,deck,eq}$	lb (kN)	Not Applicable	1,065 (4.8)	1,310 (5.8)	3,045 (13.5)	2,665 (11.9)	2,665 (11.9)	Not Applicable
Reduction factor for pullout strength, concrete over steel deck ³	ϕ	-	0.65 (Condition B)						

For SI: 1 inch = 25.4 mm, 1 ksi = 6.894 N/mm², 1 lbf = 0.0044 kN.

¹The 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.

²Installation must comply with published instructions and details.

³All 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.

⁴The Wedge-Bolt+ is considered a brittle steel element as defined by ACI 318-14 2.3 or ACI 318-11 D.1, as applicable.

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

⁶For calculation of N_{pn} see Section 4.1.4 of this report.

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

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

⁹The ³/₈-inch-diameter with 1.425-inch effective embedment and ¹/₂-inch-diameter anchors with 1.650-inch effective embedment are permitted in the top side of concrete-filled steel deck assemblies in accordance with Figure 4 of this report.

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

¹¹Values 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 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, is not required for anchors installed in the flute (soffit).

¹²The notation in bracket is for the 2006 IBC.

TABLE 3—SHEAR DESIGN INFORMATION FOR WEDGE-BOLT+ SCREW ANCHORS IN CONCRETE^{1,2}

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	1	1
Minimum nominal embedment depth	h_{nom}	in.	1 3/4	2 1/8	2 1/2	3 1/2	3 1/4	4 3/8	4 1/4
STEEL STRENGTH IN SHEAR⁴									
Steel strength in shear ⁵	V_{sa}	lb (kN)	2,475 (11.0)	4,825 (21.5)	7,980 (35.5)		11,990 (53.3)		19,350 (86.1)
Reduction factor for steel strength ³	ϕ	-	0.60						
CONCRETE BREAKOUT STRENGTH IN SHEAR^{7,8}									
Load bearing length of anchor (h_{ef} or $8d_o$, whichever is less)	ℓ_e	in. (mm)	1.100 (28)	1.425 (36)	1.650 (42)	2.500 (64)	2.145 (55)	3.100 (79)	2.910 (74)
Nominal anchor diameter	$d_a [d_o]$ ¹¹	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 ³	ϕ	-	0.70 (Condition B)						
PRYOUT STRENGTH IN SHEAR^{7,8}									
Coefficient for pryout strength (1.0 for $h_{ef} < 2.5$ in, 2.0 for $h_{ef} \geq 2.5$ in)	k_{cp}	-	1.0	1.0	1.0	2.0	1.0	2.0	2.0
Effective embedment depth	h_{ef}	in. (mm)	1.100 (28)	1.425 (36)	1.650 (42)	2.500 (64)	2.145 (55)	3.100 (79)	2.910 (74)
Reduction factor for pryout strength ³	ϕ	-	0.70 (Condition B)						
STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS									
Steel strength in shear, seismic ⁶	$V_{sa,eq}$	lb (kN)	Not Applicable	3,670 (16.3)	7,980 (35.5)		11,990 (53.3)		12,970 (57.7)
Reduction factor for steel strength in shear for seismic ³	ϕ	-	0.60						
STEEL STRENGTH IN SHEAR FOR SAND-LIGHTWEIGHT AND NORMAL-WEIGHT CONCRETE OVER STEEL DECK(see Figure 5)⁹									
Steel strength in shear, concrete over steel deck ⁹	$V_{sa,deck}$	lb (kN)	Not Applicable	1,640 (7.3)	3,090 (13.7)		3,140 (14.0)	3,305 (14.7)	Not Applicable
Steel strength in shear, concrete over steel deck, seismic ⁹	$V_{sa,deck,eq}$	Lb (kN)	Not Applicable	1,250 (5.6)	3,090 (13.7)		3,140 (14.0)	3,305 (14.7)	Not Applicable
Reduction factor for steel strength in shear for concrete over steel deck ³	ϕ	-	0.60						

For SI: 1 inch = 25.4 mm; 1 ksi = 6.894 N/mm²; 1 lbf = 0.0044 kN.

¹The 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.

²Installation must comply with published instructions and details.

³All 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.

⁴The Wedge-Bolt+ is considered a brittle steel element as defined by ACI 318-14 2.3 or ACI 318-11 D.1.

⁵Reported 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.

⁶Reported 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.

⁷The 3/8-inch-diameter with 1.425-inch effective embedment and 1/2-inch-diameter anchors with 1.650-inch effective embedment are permitted in the top side of concrete-filled steel deck assemblies in accordance with Figure 4.

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

⁹Values of $V_{sa,deck}$ 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 318-14 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 flute (soffit).

¹⁰Shear loads for anchors installed through steel deck into concrete may be applied in any direction.

¹¹The notation in brackets is for the 2006 IBC.

TABLE 4—VERTIGO+ SCREW ANCHOR INSTALLATION SPECIFICATIONS¹

Anchor Property / Setting Information	Symbol	Units	Nominal Anchor Size / Threaded Coupler Diameter					
			1/4 inch		3/8 inch		1/2 inch	
Nominal anchor diameter	$d_a [d_o]^3$	in. (mm)	0.375 (9.5)		0.375 (9.5)		0.375 (9.5)	
Nominal drill bit diameter	d_{bit}	in.	3/8 Wedge-bit		3/8 Wedge-bit		3/8 Wedge-bit	
Wedge-bit tolerance range	-	in.	0.385 to 0.389		0.385 to 0.389		0.385 to 0.389	
Nominal embedment depth	h_{nom}	in. (mm)	2 1/8 (50.8)		2 1/8 (50.8)		2 1/8 (50.8)	
Effective embedment	h_{ef}	in. (mm)	1.425 (36)		1.425 (36)		1.425 (36)	
Minimum member thickness ²	h_{min}	in. (mm)	3 1/2 (89)	4 (102)	3 1/2 (89)	4 (102)	3 1/2 (89)	4 (102)
Critical edge distance ²	c_{ac}	in. (mm)	4 (102)	2 3/4 (70)	4 (102)	2 3/4 (70)	4 (102)	2 3/4 (70)
Minimum edge distance ²	c_{min}	in. (mm)	1 1/2 (38)	1 3/4 (44)	1 1/2 (38)	1 3/4 (44)	1 1/2 (38)	1 3/4 (44)
Minimum spacing distance ²	s_{min}	in. (mm)	2 1/2 (64)	2 1/2 (64)	2 1/2 (64)	2 1/2 (64)	2 1/2 (64)	2 1/2 (64)
Minimum hole depth	h_o	in. (mm)	2 1/2 (64)		2 1/2 (64)		2 1/2 (64)	
Overall anchor length	l_{anch}	in. (mm)	3 (76)		3 (76)		3 (76)	
Maximum impact wrench power/torque (values not applicable for hand wrench)	T_{screw}	ft.-lb. (N-m)	185 (250)		185 (250)		185 (250)	
Impact wrench / socket size	d_h	in.	1 1/16		1 1/16		1 1/16	
Head Height	-	in.	3/4		3/4		3/4	

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

¹The 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.

²For installations through the soffit of steel deck into concrete see the installation detail in Figures 9A and 9B of this report. Anchors shall have an axial spacing along the flute equal to the greater of 3 h_{ef} or 1.5 times the flute width.

³The notation in brackets is for the 2006 IBC.

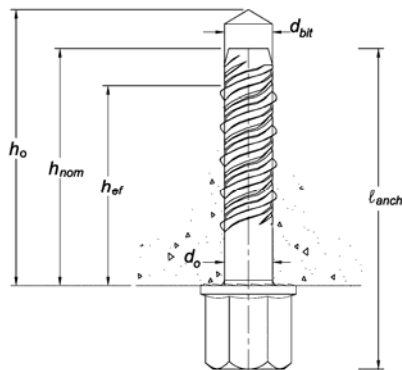


FIGURE 6—VERTIGO+ ANCHOR DETAIL

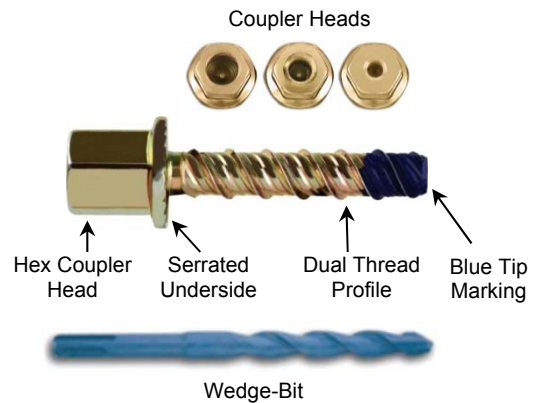
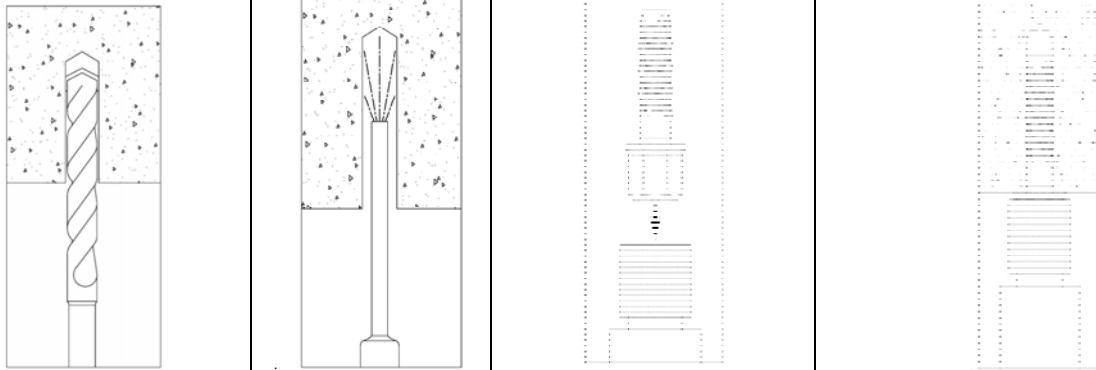


FIGURE 7—VERTIGO+ ANCHOR AND WEDGE-BIT



1.) Using the proper Wedge-bit drill bit size, drill a hole into the base material to the required depth. The tolerances of the carbide Wedge-bit used must meet the requirements of the published Wedge-bit range in Table 1.

2.) Remove dust and debris from the hole using a hand pump, compressed air or vacuum.

3.) Select a powered impact wrench that does not exceed the maximum torque, T_{screw} for the selected anchor diameter. Attach an appropriate sized hex socket/driver to the impact wrench. Mount the screw anchor head into the socket.

4.) Drive the anchor into the hole until the head of the anchor comes into contact with the member surface. The anchor should be snug against the member after installation. Do not spin the hex socket off the anchor to disengage. Insert threaded rod or bolt element into Vertigo+. Minimum thread engagement must be one threaded rod / bolt diameter.

FIGURE 8—VERTIGO+ ANCHOR INSTALLATION INSTRUCTIONS

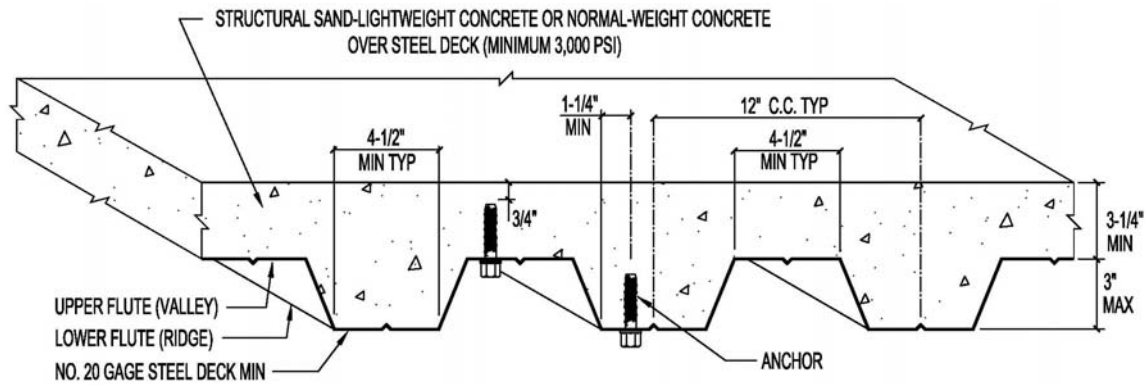


FIGURE 9A—VERTIGO+ INSTALLATION DETAIL FOR ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)¹

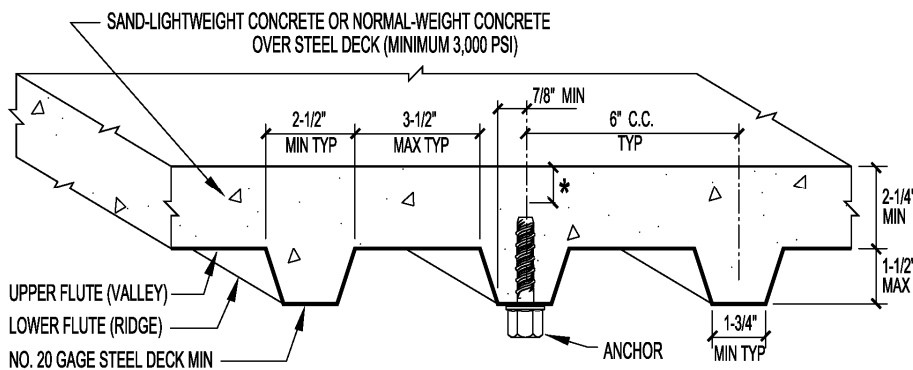


FIGURE 9B—VERTIGO+ INSTALLATION DETAIL FOR ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES (SEE DIMENSIONAL PROFILE REQUIREMENTS)^{2,3}

¹ Anchors may be placed in the upper or lower flute of the steel deck profile in accordance with Figure 9A provided the minimum hole clearance is satisfied. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from the centerline 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.

² Anchors may be placed in the lower flute of the steel deck profile in accordance with Figure 9B provided the minimum hole clearance is satisfied. Anchors in the lower flute must be installed in the center of the flute based on the minimum dimensions given in the detail. An offset distance is allowed for profiles with lower flute widths greater than those shown, provided the offset distance is increased proportionally with the lower flute width and provided the minimum lower flute edge distance is also satisfied.

³ Anchors may be placed in the upper flute of the steel deck profile in accordance with Figure 9B provided the concrete thickness above the upper flute is a minimum of 3 1/4 inches and a minimum hole clearance of 3/4-inch is satisfied.

TABLE 5—TENSION DESIGN INFORMATION FOR VERTIGO+ ANCHORS IN CONCRETE^{1,2}

Design Characteristic	Notation	Units	Nominal Anchor Size / Threaded Coupler Diameter			
			¹ / ₄ inch	³ / ₈ inch	¹ / ₂ inch	
Anchor category	1, 2 or 3	-	1	1	1	
Nominal embedment depth	h_{nom}	in. (mm)	2 ¹ / ₈ (50.8)	2 ¹ / ₈ (50.8)	2 ¹ / ₈ (50.8)	
STEEL STRENGTH IN TENSION⁴						
Minimum specified yield strength of steel insert element (threaded rod or bolt)	f_y	ksi (N/mm ²)	36.0 (248.0)	36.0 (248.0)	36.0 (248.0)	
Minimum specified ultimate strength of steel insert element (threaded rod or bolt)	f_{uta}	ksi (N/mm ²)	58.0 (400.0)	58.0 (400.0)	58.0 (400.0)	
Effective tensile stress area of steel insert element (threaded rod or bolt)	$A_{se,N}$ [A_{se}] ¹¹	in ² (mm ²)	0.0318 (20.5)	0.0775 (50.0)	0.1419 (91.6)	
Steel strength in tension	N_{sa}	lb (kN)	1,845 (8.2)	4,495 (20.0)	8,230 (36.6)	
Reduction factor for steel strength ³	ϕ	-	0.65			
CONCRETE BREAKOUT STRENGTH IN TENSION⁸						
Effective embedment	h_{ef}	in. (mm)	1.425 (36)	1.425 (36)	1.425 (36)	
Effectiveness factor for uncracked concrete	k_{uncr}	-	24	24	24	
Effectiveness factor for cracked concrete	k_{cr}	-	17	17	17	
Modification factor for cracked and uncracked concrete ⁵	$\psi_{c,N}$	-	1.0	1.0	1.0	
Critical edge distance	c_{ac}	in. (mm)	See Table 4			
Reduction factor for concrete breakout strength ³	ϕ	-	0.65 (Condition B)			
PULLOUT STRENGTH IN TENSION (NON-SEISMIC APPLICATIONS)⁸						
Characteristic pullout strength, uncracked concrete (2,500 psi) ⁶	$N_{p,uncr}$	lb (kN)	See note 7	See note 7	See note 7	
Characteristic pullout strength, cracked concrete (2,500 psi) ⁶	$N_{p,cr}$	lb (kN)	See note 7	See note 7	See note 7	
Reduction factor for pullout strength ³	ϕ	-	0.65 (Condition B)			
PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS⁸						
Characteristic pullout strength, seismic (2,500 psi) ^{6,9}	$N_{p,eq}$	lb (kN)	1,085 (4.8)	1,085 (4.8)	1,085 (4.8)	
Reduction factor for pullout strength, seismic ³	ϕ	-	0.65 (Condition B)			
PULLOUT STRENGTH IN TENSION FOR SAND-LIGHTWEIGHT AND NORMAL WEIGHT CONCRETE OVER STEEL DECK						
According to Figure 9A Minimum 4 ¹ / ₂ -inch-wide deck flute (minimum)	Characteristic pullout strength, uncracked concrete over steel deck ^{6,10}	$N_{p,deck,uncr}$	lb (kN)	1,990 (8.9)	1,990 (8.9)	1,990 (8.9)
	Characteristic pullout strength, cracked concrete over steel deck ^{6,10}	$N_{p,deck,cr}$	lb (kN)	1,410 (6.3)	1,410 (6.3)	1,410 (6.3)
	Characteristic pullout strength, cracked concrete over steel deck, seismic ^{6,10}	$N_{p,deck,eq}$	lb (kN)	1,015 (4.5)	1,060 (4.7)	1,060 (4.7)
According to Figure 9B 1 ³ / ₄ -inch-wide deck flute (minimum)	Characteristic pullout strength, uncracked concrete over steel deck ^{6,10}	$N_{p,deck,uncr}$	lb (kN)	1,905 (8.5)	1,990 (8.9)	1,990 (8.9)
	Characteristic pullout strength, cracked concrete over steel deck ^{6,10}	$N_{p,deck,cr}$	lb (kN)	1,350 (6.0)	1,410 (6.3)	1,410 (6.3)
	Characteristic pullout strength, cracked concrete over steel deck, seismic ^{6,10}	$N_{p,deck,eq}$	lb (kN)	1,015 (4.5)	1,060 (4.7)	1,060 (4.7)
Reduction factor for pullout strength, concrete over steel deck ³	ϕ	-	0.65 (Condition B)			

For **SI**: 1 inch = 25.4 mm, 1 ksi = 6.894 N/mm²; 1 lbf = 0.0044 kN.

¹The 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, must apply.

²Installation must comply with this report, along with the manufacturer's published instructions and details.

³All 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.

⁴It is assumed that the threaded rod or bolt used with the Vertigo+ anchor is a steel element with minimum specified properties as listed in the table. The Vertigo+ anchor is considered a brittle steel element as defined by ACI 318-14 2.3 and ACI 318-11 D.1.

⁵For all design cases use $\psi_{c,N} = 1.0$. The appropriate effectiveness factor for cracked concrete (k_{cr}) and uncracked concrete (k_{uncr}) must be used.

⁶For all design cases use $\psi_{c,p} = 1.0$. For calculation of N_{pn} , see Section 4.1.5 of this report.

⁷Pullout strength does not control design of indicated anchors. Do not calculate pullout strength for indicated anchor size and embedment.

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

⁹Tabulated values for characteristic pullout strength in tension are for seismic applications and based on test results in accordance with ACI 355.2, Section 9.5.

¹⁰Values 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 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, is not required for anchors installed in the deck soffit (flute).

¹¹The notation in brackets is for the 2006 IBC.

TABLE 6—SHEAR DESIGN INFORMATION FOR VERTIGO+ ANCHORS IN CONCRETE^{1,2}

Design Characteristic	Notation	Units	Nominal Anchor Size / Threaded Coupler Diameter			
			¹ / ₄ inch	³ / ₈ inch	¹ / ₂ inch	
Anchor category	1, 2 or 3	-	1	1	1	
Nominal embedment depth	h_{nom}	in. (mm)	2 ¹ / ₈ (50.8)	2 ¹ / ₈ (50.8)	2 ¹ / ₈ (50.8)	
STEEL STRENGTH IN SHEAR⁴						
Steel strength in shear ⁵	V_{sa}	lb (kN)	1,105 (4.9)	2,695 (12.0)	3,075 (13.7)	
Reduction factor for steel strength ³	ϕ	-	0.60			
CONCRETE BREAKOUT STRENGTH IN SHEAR⁶						
Load bearing length of anchor (h_{ef} or $8d_a$, whichever is less)	ℓ_e ¹⁰	in. (mm)	1.425 (36)	1.425 (36)	1.425 (36)	
Nominal anchor diameter	d_a (d_o) ¹⁰	in. (mm)	0.375 (9.5)	0.375 (9.5)	0.375 (9.5)	
Reduction factor for concrete breakout strength ³	ϕ	-	0.70 (Condition B)			
PRYOUT STRENGTH IN SHEAR⁶						
Coefficient for prout strength (1.0 for $h_{ef} < 2.5$ in, 2.0 for $h_{ef} \geq 2.5$ in)	k_{cp}	-	1.0	1.0	1.0	
Effective embedment	h_{ef}	in. (mm)	1.425 (36)	1.425 (36)	1.425 (36)	
Reduction factor for prout strength ³	ϕ	-	0.70 (Condition B)			
STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS						
Steel strength in shear, seismic ⁷	$V_{sa,eq}$	lb (kN)	1,105 (4.9)	2,000 (8.9)	2,000 (8.9)	
Reduction factor for steel strength in shear, seismic ³	ϕ	-	0.60	0.60	0.60	
STEEL STRENGTH IN SHEAR FOR SAND-LIGHTWEIGHT AND NORMAL WEIGHT CONCRETE OVER STEEL DECK⁹						
According to Figure 9A 4 ¹ / ₂ -inch-wide deck flute (minimum)	Steel strength in shear, concrete over steel deck ⁸	$V_{sa,deck}$	lb (kN)	1,105 (4.9)	1,975 (8.8)	2,495 (11.1)
	Steel strength in shear, concrete over steel deck, seismic ⁸	$V_{sa,deck,eq}$	lb (kN)	1,105 (4.9)	1,480 (6.6)	1,620 (7.2)
According to Figure 9B 1 ³ / ₄ -inch-wide deck flute (minimum)	Steel strength in shear, concrete over steel deck ⁸	$V_{sa,deck}$	lb (kN)	965 (4.3)		
	Steel strength in shear, concrete over steel deck, seismic ⁸	$V_{sa,deck,eq}$	lb (kN)	965 (4.3)		
Reduction factor for steel strength in shear, concrete over steel deck ³	ϕ	-	0.60			

For SI: 1 inch = 25.4 mm, 1 ksi = 6.894 N/mm²; 1 lbf = 0.0044 kN.

¹The 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.

²Installation comply with this report, along with the manufacturer’s published instructions and details.

³All 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 or ACI 318-11 Section D.4.3, 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.

⁴The Vertigo+ anchor is considered a brittle steel element as defined by ACI 318-14 2.3 and ACI 318-11 D.1.

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

⁶Anchors are permitted to be used in lightweight concrete in accordance with Section 4.1.12 of this report.

⁷Tabulated values for steel strength in shear are for seismic applications and based on test results in accordance with ACI 355.2 Section 9.6.

⁸Tabulated values for $V_{sa,deck}$ 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 318-14 17.5.2 or ACI 318 D.6.2, as applicable, and the prout capacity in accordance with ACI 318-14 17.5.3 or ACI 318 D.6.3, as applicable, are not required for anchors installed in the deck soffit (flute).

⁹Shear loads for anchors installed through steel deck into concrete may be applied in any direction.

¹⁰The notation in brackets is for the 2006 IBC.

TABLE 7—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)
Wedge-Bolt+	1/4	1 3/4	1.100	610
	3/8	2 1/8	1.425	895
	1/2	2 1/2	1.650	1,115
		3 1/2	2.500	2,085
	5/8	3 1/4	2.145	1,655
		4 3/8	3.100	2,875
	3/4	4 1/4	2.910	2,615
Vertigo+	1/4	2 1/8	1.425	810
	3/8	2 1/8	1.425	895
	1/2	2 1/8	1.425	895

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

¹Single anchor with static tension load only.

²Concrete determined to remain uncracked for the life of the anchorage.

³Load combinations from ACI 318-14 Section 5.3 or ACI 318-11 Section 9.2, as applicable, (no seismic loading).

⁴30% dead load and 70% live load, controlling load combination: 1.2D + 1.6L.

⁵Calculated of weighted average for $\alpha = 1.2(0.3) + 1.6(0.7) = 1.48$.

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

⁷ $C_{a1} = C_{a2} \geq C_{ac}$.

⁸ $h \geq h_{min}$.

⁹Values 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, ϕN_n , and the allowable stress design value, $T_{allowable,ASD}$, for a 3/8-inch diameter Wedge-Bolt+ screw anchor assuming the given conditions in Table 7.		
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: $\phi N_{sa} = (0.65)(10,300) = 6,695 \text{ lbs.}$	D.5.1.2 (318-11), 17.4.1.2 (318-14)	Table 2 §4.1.2
Step 2. Calculate concrete breakout strength of a single anchor in tension: $\phi N_{cb} = \phi \frac{A_{Nc}}{A_{Nc0}} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$ $N_b = k_c \lambda_a \sqrt{f'_c} (h_{ef})^{1.5}$ $N_b = (24)(1.0) \sqrt{2,500} (1.425)^{1.5} = 2,041 \text{ lbs.}$ $\phi N_{cb} = (0.65) \frac{(18.3)}{(18.3)} (1.0)(1.0)(1.0)(2,041) = 1,326 \text{ lbs.}$	D.5.2.1 (318-11) 17.4.2.1 (318-14) D.5.2.2 (318-11) 17.4.2.2 (318-14)	Table 2 §4.1.3 Table 2
Step 3. Calculate pullout strength: $\phi N_{pn} = \phi N_{p,uncr} \psi_{c,P}$ $\phi N_{pn} = \text{n/a (pullout strength does not control, see Table 2, footnote 7)}$	D.5.3.2 (318-11) 17.4.3.2 (318-14)	Table 2 §4.1.4
Step 4. Determine controlling resistance strength in tension: $\phi N_n = \min[\phi N_{sa}, \phi N_{cb}, \phi N_{pn}] = \phi N_{cb} = 1,326 \text{ lbs.}$	D.4.1.1 17.3.1.1 (ACI 318-14)	
Step 5. Calculate allowable stress design conversion factor for loading condition: Controlling load combination: 1.2D + 1.6L $\alpha = 1.2(30\%) + 1.6(70\%) = 1.48$	9.2 (ACI 318-11) 5.3 (ACI 318-14)	
Step 6. Calculate allowable stress design value: $T_{allowable,ASD} = \frac{\phi N_n}{\alpha} = \frac{1,326}{1.48} = 897 \text{ lbs.}$		§4.2

FIGURE 10—EXAMPLE STRENGTH DESIGN CALCULATION INCLUDING ASD CONVERSION, FOR ILLUSTRATIVE PURPOSES

Powers Fasteners, Inc.

Re: Powers Wedge Bolt® + Screw Anchors and Vertigo®+ Rod Hanger Screw Anchors in Cracked and Uncracked Concrete

3. The anchors shall be installed in accordance with the manufacturer's published installation instructions. Copies of the installation instructions shall be available at each job site.
4. Design values for tension and shear designs shall be per Tables 2, 3, 5 and 6 in ICC ES Report No. ESR-2526.
5. The 1/4-inch-diameter (6.4 mm) anchors shall not be used to resist short-term loading due to seismic forces since it is limited to locations designated as Seismic Design Categories A and B which are not applicable in the City of Los Angeles.
6. The 3/8-inch to 1/2-inch (9.5 mm to 12.7 mm) Wedge-Bolt+ anchors must 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 3,000 psi to 8,500 psi.
7. The concrete shall have attained its minimum design strength prior to installation of the anchors.
8. Special inspection in accordance with Section 1705 of the 2014 City of Los Angeles Building Code shall be provided for anchor installations.
9. The use of anchors is limited to dry interior locations.
10. The anchors are not approved for masonry application.
11. Calculations demonstrating that the applied loads or factored loads are less than the allowable load values or design strength level values respectively, described in this report shall be submitted to the plan check Engineer at the time of permit application. The calculations shall be prepared by a Civil or Structural Engineer registered in the State of California.

EXCEPTION: Anchors used for the installation of mechanical, plumbing and electrical equipment may be designed and detailed on a plan prepared by an engineer licensed by the state of California.

DISCUSSION

The report is in compliance with the 2014 City of Los Angeles Building Code.

The approval is based on tests in accordance with ICC ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC 193), dated June 2012, which incorporate requirements in ACI 355.2-04, for use in cracked and uncracked concrete; including optional suitability Test 12 and 13 (AC 193, Table 4.2) for seismic tension and shear; and quality control documentation.

Powers Fasteners, Inc.

Re: Powers Wedge Bolt® + Screw Anchors and Vertigo®+ Rod Hanger Screw Anchors in Cracked and Uncracked Concrete

This general approval will remain effective provided the Evaluation Report is maintained valid and unrevised with the issuing organization. Any revision to the report must be submitted to this Department for review with appropriate fee to continue the approval of the revised report.

Addressee to whom this Research Report is issued is responsible for providing copies of it, complete with any attachments indicated, to architects, engineers and builders using items approved herein in design or construction which must be approved by Department of Building and Safety Engineers and Inspectors.

This general approval of an equivalent alternate to the Code is only valid where an engineer and/or inspector of this Department has determined that all conditions of this Approval have been met in the project in which it is to be used.

QUAN NGHIEM, Chief
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