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ESR-2713

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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:

SIMPSON STRONG-TIE COMPANY INC.

5956 WEST LAS POSITAS BOULEVARD
PLEASANTON, CALIFORNIA 94588

EVALUATION SUBJECT:

TITEN HD® SCREW ANCHOR AND TITEN HD® ROD HANGER FOR CRACKED AND UNCRACKED CONCRETE

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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:

SIMPSON STRONG-TIE COMPANY INC.
5956 WEST LAS POSITAS BOULEVARD
PLEASANTON, CALIFORNIA 94588
(800) 925-5099
www.strongtie.com

EVALUATION SUBJECT:

TITEN HD® SCREW ANCHOR AND TITEN HD® ROD HANGER FOR CRACKED AND UNCRACKED CONCRETE

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 Simpson Strong-Tie® Titen HD® Screw Anchor is used to resist static, wind and seismic tension and shear loads in cracked and uncracked normal-weight concrete and lightweight concrete members having a specified compressive strength, f'_c, from 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa); and cracked and uncracked sand-lightweight or normal-weight concrete over profile steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

The $^1/_4$-inch-diameter (6.4 mm) and $^3/_8$-inch-diameter (9.5 mm) anchors may be installed in the topside of cracked and uncracked normal-weight or sand-lightweight concrete-filled steel deck having a minimum member thickness, $h_{min,deck}$, as noted in Table 5 of this report and a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

The Simpson Strong-Tie Titen HD® Rod Hanger is used to resist static, wind and seismic tension loads in cracked and uncracked normal-weight concrete and lightweight concrete members having a specified compressive strength, f'_c, from 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa); and cracked and uncracked sand-lightweight or normal-weight concrete over profile steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

The Simpson Strong-Tie® Titen HD® Screw Anchors and Rod Hangers are alternatives to anchors described in Section 1901.3 of 2015 IBC, Sections 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 Titen HD® Screw Anchor:

The Titen HD® Screw Anchor is a carbon steel threaded anchor with a hex-washer head. The screw anchor is manufactured from heat-treated steel complying with SAE J403 Grade 10B21, and has an electrodeposited coating of zinc, minimum thickness 0.0002 inch (5 µm) in accordance with ASTM B633, SC1, Type III. Titen HD® Screw Anchors are available with nominally $^1/_4$-, $^3/_8$-, $^1/_2$-, $^5/_8$-, and $^3/_4$-inch shank diameters, and various lengths in each diameter. Figure 1A illustrates a typical Titen HD® Screw Anchor.

3.2 Titen HD® Rod Hanger:

The Titen HD® Rod Hanger is a carbon steel threaded anchor with an oversized hex-washer head that is internally threaded. The rod hanger is manufactured from heat-treated steel complying with SAE J403 Grade 10B21, and has an electrodeposited coating of zinc, minimum thickness 0.0002 inch (5 µm), in accordance with ASTM B633, SC1, Type III. The Titen HD® Rod Hanger is available with a nominally $^1/_4$-inch shank diameter with $^1/_4$-inch or $^3/_8$-inch diameter (6.4 mm or 9.5 mm) internal threads, and $^3/_8$-inch shank diameter with $^3/_8$-inch (9.5 mm) and 10 mm diameter internal threads or $^1/_2$-inch-diameter (12.7 mm) internal threads. Figure 1B illustrates the Titen HD® Rod Hanger. Refer to Table 7 for catalog number information.

3.3 Concrete:

Normal-weight and lightweight concrete must comply with Sections 1903 and 1905 of the IBC.

3.4 Profile Steel Deck:

The profile steel deck must comply with the configuration in Figures 3, 4, 5 and 6 of this report and have a minimum base steel thickness of 0.035 inch (0.889 mm). Steel deck in Figures 3 and 4 must comply with ASTM A653/A653M SS Grade 33, and have a minimum yield strength of 33 ksi (228 MPa). Steel deck in Figures 5 and 6 must comply with ASTM A653/A653M 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 Section 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 2006 IRC must be in accordance with ACI 318-05 Appendix D and this report.

Design parameters provided in Tables 1 through 5 and in Figures 2 through 6 of this report are based on the 2015 IBC (ACI 318-14) and on 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. 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 and 3 of this report, must be used for load combinations calculated in accordance with Section 1605.2.1 of the IBC and Section 5.3 of ACI 318-14 or 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 ACI 318 Appendix C. The value of f'_c used in the calculations 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: The nominal steel strength of a single screw 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 2 of this report. The strength reduction factor, ϕ, corresponding to a brittle steel element must be used for all anchors, as given in Table 2.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension: The nominal concrete breakout strength of a single screw anchor or a group of screw 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 screw anchor in tension in cracked concrete, N_b, must be calculated in accordance with 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 2 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 2 of this report and with $\Psi_{c,N}$ = 1.0.

Determination of concrete breakout strength in accordance with ACI 318-14 17.4.2 or ACI 318-11 D.5.2 is not required for anchors installed in the lower flute or upper flute of the soffit of profile steel deck floor and roof assemblies with sand-lightweight or normal-weight concrete fill as shown in Figures 3, 4 or 5.

4.1.4 Requirements for Static Pullout Strength in Tension: The nominal pullout strength of a single screw anchor or a group of screw anchors in tension in accordance with ACI 318-14 17.4.3.1 and 17.4.3.2 or ACI 318-11 D.5.3.1 and D.5.3.2, as applicable, in cracked and uncracked concrete, $N_{p,cr}$ and $N_{p,uncr}$, respectively, is given in Table 2 of this report and must be used in lieu of N_p. In regions of a concrete member where analysis indicates no cracking at service level loads 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 uncracked concrete, $N_{p,uncr}$, applies. Where values for $N_{p,cr}$ or $N_{p,uncr}$ are not provided in Table 2, the pullout strength does not need to be considered in design.

The nominal pullout strength in cracked concrete for anchors installed in the lower flute or upper flute of the soffit of sand-lightweight or normal-weight concrete filled profile steel deck floor and roof assemblies as shown in Figures 3, 4 and 5, $N_{p,deck,cr}$, is given in Table 4. $N_{p,deck,cr}$ must be used in lieu of $N_{p,cr}$. In regions of a concrete member 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 uncracked concrete $N_{p,deck,uncr}$ applies in lieu of $N_{p,uncr}$.

The value of $\Psi_{c,p}$ equals 1.0 for all design cases.

4.1.5 Requirements for Static Steel Strength in Shear: The nominal steel strength in shear, V_{sa}, of a single screw 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 3 of this report and must be used in lieu of the values derived by calculation from ACI 318-14 Eq. 17.5.1.2a or ACI 318-11 Eq. D-29, as applicable. The strength reduction factor, ϕ, corresponding to a brittle steel element must be used for all anchors, as described in Table 3.

The nominal shear strength, $V_{sa,deck}$, of a single screw anchor installed in the lower flute or upper flute of the soffit of sand-lightweight or normal-weight concrete filled profile steel deck floor and roof assemblies, as shown in Figures 3, 4 and 5, is given in Table 4.

4.1.6 Requirements for Static Concrete Breakout Strength in Shear: The nominal concrete breakout strength in shear of a single screw anchor or group of screw anchors, 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 in shear of a single screw anchor in cracked concrete, 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 values of l_e and d_a as given in Table 3 of this report. The modification factors in ACI 318-14 17.5.2.4, 17.5.2.5, 17.5.2.6 and 17.5.2.7 ACI 318-11 D.6.2.4, D.6.2.5, D.6.2.6 and D.6.2.7 must be applied to the basic breakout strength in shear, V_b, as applicable.

For anchors installed in the topside of concrete-filled steel deck assemblies, as shown in Figures 5 and 6, 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 thickness, $h_{min,deck}$, in the determination of A_{Vc}. Minimum number topping thickness for anchors in the topside of concrete-filled steel deck assemblies is given in Table 5 of this report.

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 for screw anchors installed in the lower flute or upper flute of the soffit of sand-lightweight or normal-weight concrete filled profile steel deck floor and roof assemblies, as shown in Figures 3, 4 and 5.

4.1.7 Requirements for Static Concrete Pryout Strength in Shear: The nominal concrete pryout strength for a single screw anchor or group of screw 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 coefficient for pryout strength, k_{cp}, provided in Table 3 of this report and the value of nominal breakout strength in tension of a single screw anchor or group screw anchors, N_{cb} or N_{cbg}, as calculated in Section 4.1.3 of this report.

For anchors installed in the lower flute or upper flute of the soffit of sand-lightweight or normal-weight concrete filled profile steel deck floor and roof assemblies, as shown in Figures 3, 4 and 5, 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: When the screw anchor design includes 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 Section 1905.1.8 of the 2015 IBC. For the 2012 IBC, Section 1905.1.9 shall be omitted. Modifications to ACI 318-08 and 318-05 D.3.3, as applicable, shall be applied under Section 1908.1.9 of the 2009 IBC, Section 1908.1.16 of the 2006 IBC.

Except for use in Seismic Design Category A or B of the IBC, design strengths must be determined presuming the concrete is cracked unless it can be demonstrated that the concrete remains uncracked.

The nominal steel strength and nominal concrete breakout strength of anchors in tension, and the nominal concrete breakout strength and pryout strength of anchors in shear, must be calculated according to ACI 318-14 17.4 and 17.5 ACI 318-11 D.5 and D.6, as applicable, respectively, taking into account the corresponding values in Tables 1 through 5 of this report.

The screw 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 318-08 D.3.3.5 or D.3.3.6 or ACI 318-05 D.3.3.5, as applicable.

4.1.8.2 Seismic Tension: The nominal steel strength and concrete breakout strength in tension must be determined in accordance with 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, $N_{p,eq}$ or $N_{p,deck,cr}$, described in Tables 2 and 4 of this report, must be used in lieu of N_p.

4.1.8.3 Seismic Shear: The nominal concrete breakout and concrete pryout strength in shear must be determined in accordance with ACI 318-14 17.5.2 and 17.5.3 or ACI 318-11 D.6.2 and D.6.3, 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, $V_{sa,eq}$, or $V_{sa,deck,eq}$ described in Tables 3 and 4 of this report, must be used in lieu of V_{sa}.

4.1.9 Interaction of Tensile and Shear Forces: Screw anchors or groups of screw anchors that are subjected to combined axial (tensile) and shear loadings must be designed in accordance with ACI 318-14 17.6 or ACI 318-11 D.7, as applicable.

4.1.10 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, values of c_{min} and s_{min} provided 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, minimum member thickness, h_{min}, must comply with Table 1 of this report, as applicable.

For anchors installed in the topside of normal-weight or sand-lightweight concrete over profile steel deck floor and roof assemblies, installation parameters are provided in Table 5 and Figures 5 and 6 of this report.

For anchors installed in the lower flute or upper flute of the soffit of sand-lightweight or normal-weight concrete filled profile steel deck floor and roof assemblies, details in Figures 3, 4 and 5 must be observed. The minimum anchor spacing along the flute must be the greater of $3h_{ef}$ or 1.5 times the flute width.

4.1.11 Requirements for Critical Edge Distance: In applications where $c < c_{ac}$ and supplemental reinforcement to control splitting of the concrete is not present, the concrete breakout strength in tension for uncracked concrete, calculated according to ACI 318-14 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-1:

$$\psi_{cp,N} = \frac{c}{c_{ac}} \qquad \text{(Eq-1)}$$

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 5 of this report must be used.

4.1.12 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 $N_{p,cr}$, $N_{p,uncr}$, 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: Where design values for use with allowable stress design (working stress design) load combinations in accordance with Sections 1605.3 of the IBC are required, these are calculated using Eq-2 and Eq-3 as follows:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \quad \text{(Eq-2)}$$

and

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha} \quad \text{(Eq-3)}$$

where:

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

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

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 N).

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 N).

α = A 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.

An example calculation for the derivation of allowable stress design tension values is presented in Table 6.

The requirements for member thickness, edge distance and spacing, described in Tables 1 and 5 of this report, must apply.

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

If $T_{applied} \le 0.2T_{allowable,ASD}$, then the full allowable strength in shear, $V_{allowable,ASD}$, shall be permitted.

If $V_{applied} \le 0.2V_{allowable,ASD}$, then the full allowable strength in tension, $T_{allowable,ASD}$, shall be permitted.

For all other cases:

$$\frac{T_{applied}}{T_{allowable,ASD}} + \frac{V_{applied}}{V_{allowable,ASD}} \le 1.2 \quad \text{(Eq-4)}$$

4.3 Installation:

Installation parameters are provided in Tables 1 and 5, and Figures 2, 3, 4, 5, and 6. Anchor locations must comply with this report and the plans and specifications approved by the code official. The Titen HD® Screw Anchors and Rod Hangers must be installed in accordance with the manufacturer's published instructions and this report. Anchors must be installed by drilling a pilot hole into the concrete using a handheld electro-pneumatic rotary hammer drill with a carbide-tipped drill bit conforming to ANSI B212.15-1994. The pilot hole must have the same nominal diameter as the nominal diameter of the anchor. For the $^1/_4$-inch (6.4 mm) Titen HD® Screw Anchors and $^1/_4$-inch (6.4mm) shank diameter Rod Hangers, the hole is drilled to the specified nominal embedment depth plus $^1/_8$ inch (3.2 mm). For the $^3/_8$-inch (9.5 mm) Titen HD® Screw Anchors and $^3/_8$-inch (9.5 mm) shank diameter Rod Hangers, the hole is drilled to the specified nominal embedment depth plus ¼ inch (6.4 mm). For $^1/_2$-, $^5/_8$- and $^3/_4$-inch (12.7, 15.9 and 19.1 mm) Titen HD® Screw Anchors, the hole is drilled to the specified nominal embedment depth plus $^1/_2$ inch (12.7 mm). Dust and debris in the hole must be removed by using oil-free compressed air. The Titen HD® Screw Anchors and Rod Hangers must be installed into the hole to the specified embedment depth using a socket wrench or powered impact wrench. The maximum installation torque and maximum impact wrench torque rating requirements for the Titen HD® Screw Anchor and Rod Hangers are detailed in Table 1. Titen HD® Screw Anchors and Rod Hangers may be loosened by a maximum one turn and reinstalled with a socket wrench or powered impact wrench to facilitate fixture attachment or realignment.

For anchors installed in the topside of normal-weight or sand-lightweight concrete over profile steel deck floor and roof assemblies, installation parameters are provided in Table 5 and Figures 5 and 6 of this report.

For anchors installed in the lower flute or upper flute of the soffit of sand-lightweight or normal-weight concrete over profile steel deck floor and roof 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).

4.4 Special Inspection:

Periodic special inspection is required in accordance with Section 1705.1.1 and Table 1705.3 of the 2015 or 2012 IBC or Section 1704.15 of the 2009 IBC or Section 1704.13 of the 2006 IBC. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, hole cleaning procedure, embedment depth, concrete type, concrete compressive strength, concrete member thickness, hole dimensions, anchor spacing, edge distance, installation torque, maximum impact wrench torque rating, 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."

Under the IBC, additional requirements as set forth in Section 1705, 1706 or 1707 must be observed, where applicable.

5.0 CONDITIONS OF USE

The Simpson Strong-Tie® Titen HD® Screw Anchors and Rod Hangers described in this report 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 conflict, this report governs.

5.2 Anchor sizes, dimensions and minimum embedment depths are set forth in the tables of this report.

5.3 The anchor must be installed in accordance with Section 4.3 of this report in cracked and uncracked normal-weight and lightweight concrete having a compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa); and cracked and uncracked sand-lightweight or normal-weight concrete over profile steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

5.4 The $^1/_4$-inch-diameter (6.4 mm) and $^3/_8$-inch-diameter (9.5 mm) 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 value of f'_c used for calculation purposes must not exceed 8,000 psi (55.2 MPa).

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

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

5.8 Anchor spacing(s) and edge distance(s), as well as minimum member thickness, must comply with Tables 1, 4 and 5, and Figures 3, 4, 5 and 6 of this report.

5.9 Reported values for the Titen HD® Rod Hanger do not consider the steel insert element which must be verified by the design professional.

5.10 The $^1/_4$-inch-diameter (6.4 mm) and $^3/_8$-inch-diameter (9.5 mm) Titen HD® Screw Anchors may be installed in the topside of cracked and uncracked normal-weight or sand-lightweight concrete-filled steel deck in accordance with Table 5 and as shown in Figure 6 for the $^1/_4$-inch-diameter (6.4 mm) and in Figure 5 for the $^3/_8$-inch-diameter (9.5 mm).

The $^1/_4$-inch-diameter (6.4 mm), $^3/_8$-inch-diameter (9.5 mm), and $^1/_2$-inch-diameter (12.7 mm) Titen HD® Screw Anchors, and the $^1/_4$-inch (6.4 mm) and $^3/_8$-inch (9.5 mm) shank diameter Titen HD® Rod Hanger may be installed in cracked and uncracked sand-lightweight or normal-weight concrete in the lower flute over profile steel deck in accordance with Table 4 and as shown in Figure 3 for the $^3/_8$-inch-diameter (9.5 mm), $^1/_2$-inch-diameter (12.7 mm) Titen HD® Screw Anchors, and the $^3/_8$-inch (9.5 mm) shank diameter Titen HD® Rod Hanger; and in Figure 5 for the $^1/_4$ inch-diameter (6.4 mm) Titen HD® Screw Anchors and $^1/_4$-inch (6.4 mm) shank diameter Titen HD® Rod Hanger.

The $^1/_4$-inch-diameter (6.4 mm), the $^3/_8$-inch-diameter (9.5 mm) and the $^1/_2$-inch-diameter (12.7 mm) Titen HD® Screw Anchors and $^1/_4$-inch (6.4 mm) shank diameter Titen HD® Rod Hanger may be installed in cracked and uncracked sand-lightweight or normal-weight concrete in the upper flute over profile steel deck in accordance with Table 4 and as shown in Figure 5 for the $^1/_4$-inch-diameter (6.4 mm) Titen HD® Screw Anchor and $^1/_4$-inch (6.4 mm) shank diameter Titen HD® Rod Hanger; and in Figure 4 for the $^3/_8$-inch-diameter (9.5 mm) and the $^1/_2$-inch-diameter (12.7 mm) Titen HD® Screw Anchor.

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 screw 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 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 Anchors may be used to resist short-term loading due to wind or seismic forces, subject to the conditions of this report.

5.15 Anchors are not permitted to support fire-resistance-rated construction. Where not otherwise prohibited by the code, Titen HD® Screw Anchors and Rod Hangers 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 gravity load–bearing structural elements are within 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 anchors is limited to dry, interior locations.

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

5.19 The anchors are manufactured by Simpson Strong-Tie® Company, Inc., under a quality-control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated October 2015, including an optional suitability test for seismic tension and shear; profile steel deck soffit tests; mechanical properties tests; calculations; and quality-control documentation.

7.0 IDENTIFICATION

The Titen HD® Screw Anchor and Rod Hanger packaging is marked with the Simpson Strong-Tie® Company name; product name (Titen HD®); anchor diameter and length; catalog number corresponding to Table 7 of this report; and the evaluation report number (ESR-2713). In addition, the ≠ symbol and the anchor length (in inches) are stamped on the head of each screw anchor.

TABLE 1—TITEN HD® SCREW ANCHORS AND ROD HANGERS INSTALLATION INFORMATION[1]

Characteristic	Symbol	Units	Titen HD Screw Anchor Nominal Anchor Diameter (inch)										Titen HD Rod Hanger Model No.		
			1/4		3/8		1/2		5/8		3/4		THDB25158RH THDB37158RH	THD37212RH THD10212RH	THD50234RH
Installation Information															
Nominal Diameter	d_a (d_o)[5]	in.	1/4		3/8		1/2		5/8		3/4		1/4	3/8	3/8
Drill Bit Diameter	d_{bit}	in.	1/4		3/8		1/2		5/8		3/4		1/4	3/8	3/8
Rod Hanger Diameter	d_{rh}	-	N/A		N/A		N/A		N/A		N/A		¼-inch or 3/8-inch	3/8-inch or 10mm	½-inch
Minimum Baseplate Clearance Hole Diameter[2]	d_c	in.	3/8		1/2		5/8		3/4		7/8		N/A[3]	N/A[3]	N/A[3]
Maximum Installation Torque[4]	$T_{inst,max}$	ft-lbf	24		50		65		100		150		24	50	50
Maximum Impact Wrench Torque Rating	$T_{impact,max}$	ft-lbf	125		150		340		340		385		125	150	150
Minimum Hole Depth	h_{hole}	in.	1 3/4	2 5/8	2 3/4	3 1/2	3 3/4	4 1/2	4 1/2	6	6	6 3/4	1 3/4	2 3/4	3
Nominal Embedment Depth	h_{nom}	in.	1 5/8	2 1/2	2 1/2	3 1/4	3 1/4	4	4	5 1/2	5 1/2	6 1/4	1 5/8	2 1/2	2 1/2
Effective Embedment Depth	h_{ef}	in.	1.19	1.94	1.77	2.40	2.35	2.99	2.97	4.24	4.22	4.86	1.19	1.77	1.77
Critical Edge Distance	c_{ac}	in.	3	6	2 11/16	3 5/8	3 9/16	4 1/2	4 1/2	6 3/8	6 3/8	7 5/16	3	2 11/16	2 11/16
Minimum Edge Distance	c_{min}	in.	1 1/2	1 1/2	1 3/4								1 1/2	1 3/4	
Minimum Spacing	s_{min}	in.	1 1/2	1 1/2	3								1 1/2	3	
Minimum Concrete Thickness	h_{min}	in.	3 1/4	3 1/2	4	5	5	6 1/4	6	8 1/2	8 3/4	10	3 1/4	4	4 1/4
Anchor Data															
Yield Strength	f_{ya}	psi	100,000		97,000								100,000	97,000	
Tensile Strength	f_{uta}	psi	125,000		110,000								125,000	110,000	
Minimum Tensile & Shear Stress Area	A_{se}[6]	in^2	0.042		0.099		0.183		0.276		0.414		0.042	0.099	0.099
Axial Stiffness in Service Load Range - Uncracked Concrete	β_{uncr}	lb/in.	202,000		715,000								202,000	715,000	
Axial Stiffness in Service Load Range - Cracked Concrete	β_{cr}	lb/in.	173,000		345,000								173,000	345,000	

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 kPa, 1 in^2 = 645 mm^2, 1 lb/in = 0.175 N/mm.

[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]The clearance must comply with applicable code requirements for the connected element.
[3]The Titen HD® Rod Hanger version is driven directly to the supporting member surface.
[4]$T_{inst,max}$ applies to installations using a calibrated torque wrench.
[5]For the 2006 IBC d_o replaces d_a
[6]$A_{se,N} = A_{se,V} = A_{se}$

TABLE 2—TITEN HD® SCREW ANCHOR AND ROD HANGER CHARACTERISTIC TENSION STRENGTH DESIGN VALUES[1]

Characteristic	Symbol	Units	Titen HD Screw Anchor Nominal Anchor Diameter (inch)										Titen HD Rod Hanger Model No.		
			1/4		3/8		1/2		5/8		3/4		THDB25158RH THDB37158RH	THD37212RH THD10212RH	THD50234RH
Anchor Category	1, 2 or 3	-	1												
Nominal Embedment Depth	h_{nom}	in.	$1^5/_8$	$2^1/_2$	$2^1/_2$	$3^1/_4$	$3^1/_4$	4	4	$5^1/_2$	$5^1/_2$	$6^1/_4$	$1^5/_8$	$2^1/_2$	$2^1/_2$
Steel Strength in Tension (ACI 318-14 17.4.1 or ACI 318-11 Section D.5.1)															
Tension Resistance of Steel	N_{sa}	lbf	5,195		10,890		20,130		30,360		45,540		5,195	10,890	10,890
Strength Reduction Factor - Steel Failure[2]	ϕ_{sa}	-	0.65												
Concrete Breakout Strength in Tension (ACI 318-14 17.4.2 or ACI 318 Section D.5.2)															
Effective Embedment Depth	h_{ef}	in.	1.19	1.94	1.77	2.40	2.35	2.99	2.97	4.24	4.22	4.86	1.19	1.77	1.77
Critical Edge Distance	c_{ac}	in.	3	6	$2^{11}/_{16}$	$3^5/_8$	$3^9/_{16}$	$4^1/_2$	$4^1/_2$	$6^3/_8$	$6^3/_8$	$7^5/_{16}$	3	$2^{11}/_{16}$	$2^{11}/_{16}$
Effectiveness Factor - Uncracked Concrete	k_{uncr}	-	30	24									30	24	
Effectiveness Factor - Cracked Concrete	k_{cr}	-	17												
Modification factor	$\Psi_{c,N}$	-	1.0												
Strength Reduction Factor - Concrete Breakout Failure[3]	ϕ_{cb}	-	0.65												
Pullout Strength in Tension (ACI 318-14 17.4.3 or ACI 318-11 Section D.5.3)															
Pullout Resistance Uncracked Concrete (f'_c=2,500 psi)	$N_{p,uncr}$	lbf	N/A[4]	N/A[4]	2,700[5]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	9,810[5]	N/A[4]	N/A[4]	N/A[4]	2,025[5]	2,025[5]
Pullout Resistance Cracked Concrete (f'_c=2,500 psi)	$N_{p,cr}$	lbf	N/A[4]	1,905[5]	1,235[5]	2,700[5]	N/A[4]	N/A[4]	3,040[5]	5,570[5]	6,070[5]	7,195[5]	N/A[4]	1,235[5]	1,235[5]
Strength Reduction Factor - Pullout Failure[6]	ϕ_p	-	0.65												
Tension Strength for Seismic Applications (ACI 318-14 17.2.3.3 or ACI 318-11 Section D.3.3.3)															
Nominal Pullout Strength for Seismic Loads (f'_c=2,500 psi)	$N_{p,eq}$	lbf	N/A[4]	1905[5]	1,235[5]	2,700[5]	N/A[4]	N/A[4]	3,040[5]	5,570[5]	6,070[5]	7,195[5]	N/A[4]	1,235[5]	1,235[5]
Strength Reduction Factor for Pullout Failure[6]	ϕ_{eq}	-	0.65												

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 kPa, 1 in^2 = 645 mm^2, 1 lb/in = 0.175 N/mm.

[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]The tabulated value of ϕ_{sa} applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 Section 5.3 or ACI 318-11 Section 9.2 are used, as applicable. 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 D.4.4(b), as applicable.

[3]The tabulated values of ϕ_{cb} applies when both the load combinations of Section 1605.2 of the IBC, ACI 318-14 Section 5.3 or ACI 318-11 Section 9.2, as applicable, are used and the requirements of ACI 318-11 D.4.3(c) for Condition B are met. Condition B applies where supplementary reinforcement is not provided in concrete. For installations were complying reinforcement can be verified, the ϕ_{cb} factors described in ACI 318-14 17.3.3(c) or ACI 318-11 D.4.3(c), as applicable, may be used for Condition A. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4(c) for Condition B.

[4]As described in this report, N/A denotes that pullout resistance does not govern and does not need to be considered.

[5]The characteristic pullout resistance for greater compressive strengths may be increased by multiplying the tabular value by $(f'_c/2{,}500)^{0.5}$.

[6]The tabulated values of ϕ_p or ϕ_{eq} applies when both the load combinations of ACI 318-14 Section 5.3 or ACI 318-11 Section 9.2, as applicable, are used and the requirements of ACI 318-11 D.4.3(c) for Condition B are met. Condition B applies where supplementary reinforcement is not provided in concrete. For installations were complying reinforcement can be verified, the ϕ_p or ϕ_{eq} factors described in ACI 318-14 17.3.3(c) or ACI 318-11 D.4.3(c), as applicable, may be used for Condition A. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4(c) for Condition B.

TABLE 3—TITEN HD® SCREW ANCHOR CHARACTERISTIC SHEAR STRENGTH DESIGN VALUES[1]

Characteristic	Symbol	Units	Nominal Anchor Diameter (inch)									
			1/4		3/8		1/2		5/8		3/4	
Anchor Category	1, 2 or 3	-	1									
Nominal Embedment Depth	h_{nom}	in.	1 5/8	2 1/2	2 1/2	3 1/4	3 1/4	4	4	5 1/2	5 1/2	6 1/4
	Steel Strength in Shear (ACI 318-14 17.5.1 or ACI 318-11 Section D.6.1)											
Shear Resistance of Steel	V_{sa}	Lbf	2,020		4,460		7,455		10,000		16,840	
Strength Reduction Factor - Steel Failure[2]	ϕ_{sa}	-	0.60									
	Concrete Breakout Strength in Shear (ACI 318-14 17.5.2 or ACI 318-11 Section D.6.2)											
Nominal Diameter	d_a (d_o)[4]	in.	0.25		0.375		0.500		0.625		0.750	
Load Bearing Length of Anchor in Shear	l_e	in.	1.19	1.94	1.77	2.40	2.35	2.99	2.97	4.24	4.22	4.86
Strength Reduction Factor - Concrete Breakout Failure[3]	ϕ_{cb}	-	0.70									
	Concrete Pryout Strength in Shear (ACI 318-14 17.5.3 or ACI 318-11 Section D.6.3)											
Coefficient for Pryout Strength	k_{cp}	-	1.0					2.0				
Strength Reduction Factor - Concrete Pryout Failure[3]	ϕ_{cp}	-	0.70									
	Shear Strength for Seismic Applications (ACI 318-14 17.2.3.3 or ACI 318-11 Section D.3.3.3)											
Shear Resistance of Single Anchor for Seismic Loads (f'_c=2,500 psi)	$V_{sa,eq}$	Lbf	1,695		2,855		4,790		8,000		9,350	
Strength Reduction Factor - Steel Failure[2]	ϕ_{eq}	-	0.60									

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N.

[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]The tabulated value of ϕ_{sa} and ϕ_{eq} applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 Section 5.3 or ACI 318-11 Section 9.2, as applicable, are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4(b).

[3]The tabulated values of ϕ_{cb} and ϕ_{cp} applies when both the load combinations of Section 1605.2 of the IBC ACI 318-14 Section 5.3 or ACI 318-11 Section 9.2 are used and the requirements of ACI 318-11 D.4.4(c) for Condition B are met. Condition B applies were supplementary reinforcement is not provided in concrete. For installations where complying reinforcement can be verified, the ϕ_{cb} and ϕ_{cp} factors described in ACI 318-14 17.3.3(c) or ACI 318-11 D.4.3(c), as applicable, can be used for Condition A. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ_{cb} must be determined in accordance with ACI 318 D.4.5(c) for Condition B.

[4]The notation in parenthesis is for the 2006 IBC.

TABLE 4—TITEN HD® SCREW ANCHOR AND ROD HANGER CHARACTERISTIC TENSION AND SHEAR DESIGN VALUES FOR THE SOFFIT OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES[1,5,6]

Characteristic	Symbol	Units	Titen HD Screw Anchor Nominal Anchor Diameter (inch) / Titen HD Rod Hanger Model No.													
			Lower Flute									Upper Flute				
			Figure 5			Figure 3						Figure 5			Figure 4	
			1/4		THDB25158RH THDB37158RH	3/8		1/2		THD37212RH THD10212RH	THD50234RH	1/4		THDB25158RH THDB37158RH	3/8	1/2
Minimum Hole Depth	h_{hole}	in.	1 3/4	2 5/8	1 3/4	2 1/8	2 3/4	2 1/2	4	2 3/4	3	1 3/4	2 5/8	1 3/4	2 1/8	2 1/2
Nominal Embedment Depth	h_{nom}	in.	1 5/8	2 1/2	1 5/8	1 7/8	2 1/2	2	3 1/2	2 1/2	2 1/2	1 5/8	2 1/2	1 5/8	1 7/8	2
Effective Embedment Depth	h_{ef}	in.	1.19	1.94	1.19	1.23	1.77	1.29	2.56	1.77	1.77	1.19	1.94	1.19	1.23	1.29
Pullout Resistance, Cracked Concrete[2,7]	$N_{p,deck,cr}$	lbf	420	535	420	375	870	905	2040	870	870	655	1195	655	500	1700
Pullout Resistance, Uncracked Concrete[3,7]	$N_{p,deck,uncr}$	lbf	995	1275	995	825	1905	1295	2910	1430	1430	1555	2850	1555	1095	2430
Steel Strength in Shear[4]	$V_{sa,deck}$	lbf	1335	1745	N/A	2240	2395	2435	4430	N/A	N/A	2010	2420	N/A	4180	7145
Steel Strength in Shear, Seismic[4]	$V_{sa,deck,eq}$	lbf	870	1135	N/A	1434	1533	1565	2846	N/A	N/A	1305	1575	N/A	2676	4591

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N.

[1]Installation must comply with Sections 3.4, 4.1.9.1, 4.3, 5.4, and 5.10, and Figures 3, 4 and 5 of this report.
[2]The values listed must be used in accordance with Section 4.1.4 and 4.1.8.2 of this report.
[3]The values listed must be used in accordance with Section 4.1.4 of this report.
[4]The values listed must be used in accordance with Section 4.1.5 and 4.1.8.3 of this report.
[5]The values for ϕ_p (reduction factor for pullout strength) can be found in Table 2 and the value for ϕ_{sa} (reduction factor for steel strength in shear) can be found in Table 3.
[6]The minimum anchor spacing along the flute must be the greater of $3h_{ef}$ or 1.5 times the flute width in accordance with Section 4.1.9.1 of this report.
[7]The characteristic pull-out resistance for greater concrete compressive strengths shall be increased by multiplying the tabular value by $(f'_c / 3{,}000\ psi)^{0.5}$.

TABLE 5—TITEN HD® SCREW ANCHOR INSTALLATION INFORMATION IN THE TOPSIDE OF CONCRETE-FILLED PROFILE STEEL DECK FLOOR AND ROOF ASSEMBLIES[1,2,3,4]

Design Information	Symbol	Units	Nominal Anchor Diameter (inch)	
			1/4	3/8
			Figure 6	Figure 5
Effective Embedment Depth	h_{ef}	in.	1.19	1.77
Minimum Concrete Thickness[5]	$h_{min,deck}$	in.	2 1/2	3 1/4
Critical Edge Distance	$c_{ac,deck,top}$	in.	3 3/4	7 1/4
Minimum Edge Distance	$c_{min,deck,top}$	in.	3 1/2	3
Minimum Spacing	$s_{min,deck,top}$	in.	3 1/2	3

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N.

[1]Installation must comply with Sections 3.4, 4.1.9.1, 4.3, 5.4, and 5.10, and Figures 5 and 6 of this report.
[2]Design capacity shall be based on calculations according to values in Tables 2 and 3 of this report.
[3]Minimum flute depth (distance from top of flute to bottom of flute) is 1½-inch, see Figures 5 and 6.
[4]Steel deck thickness shall be minimum 20 gauge.
[5]Minimum concrete thickness ($h_{min,deck}$) refers to concrete thickness above upper flute, see Figures 5 and 6.

TABLE 6—EXAMPLE TITEN HD® SCREW ANCHOR AND ROD HANGER ALLOWABLE STRESS DESIGN TENSION VALUES FOR ILLUSTRATIVE PURPOSES[1,2,3,4,5,6,7,8,9,10]

Nominal Anchor Diameter, d_o (inches)	Nominal Embedment Depth, h_{nom} (inches)	Effective Embedment Depth, h_{ef} (inches)	Allowable Tension Load, $\phi N_n/\alpha$ (lbs)
¼	1 5/8	1.19	855
	2 1/2	1.94	1,424
3/8	2 1/2	1.77	1,185**
	3 1/4	2.40	1,960
½	3 1/4	2.35	1,900
	4	2.99	2,725
5/8	4	2.97	2,695
	5 1/2	4.24	4,580
¾	5 1/2	4.22	4,570
	6 1/4	4.86	5,645

Design Assumptions:
1. Single Anchor.
2. Tension load only.
3. Concrete determined to remain uncracked for the life of the anchorage.
4. Load combinations from ACI 318-14 Section 5.3 or ACI 318-11 Section 9.2, as applicable (no seismic loading).
5. 30% Dead Load (D) and 70% Live Load (L); Controlling load combination is 1.2 D + 1.6L
6. Calculation of α based on weighted average: α = 1.2D + 1.6L = 1.2(0.3) + 1.6(0.7) = 1.48
7. Normal weight concrete: f'_c = 2500 psi
8. $c_{a1} = c_{a2} \geq c_{ac}$
9. $h \geq h_{min}$
10. Values are for Condition B (Supplementary reinforcement in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, is not provided).

**** Illustrative Procedure (reference Table 2 of this report):**

3/8" Titen HD with an Effective Embedment, h_{ef} = 1.77"

Step 1: Calculate Static Steel Strength in Tension per ACI 318-14 17.4.1 or ACI 318-11 Section D.5.1, as applicable; $\phi_{sa}N_{sa}$ = 0.65 x 10,890 = 7,078 lbs.

Step 2: Calculate Static Concrete Breakout Strength in Tension per ACI 318-14 17.4.2 or ACI 318-11 Section D.5.2, as applicable; $\phi_{cb}N_{cb}$ = 0.65 x 2,826 = 1,837 lbs.

Step 3: Calculate Static Pullout Strength in Tension per ACI 318-14 17.4.3 or ACI 318-11 Section D.5.3, as applicable; $\phi_p N_{p,uncr}$ = 0.65 x 2,700 = 1,755 lbs.

Step 4: The controlling value (from Steps 1, 2 and 3 above) per ACI 318-14 Section 17.3.1 or ACI 318 Section D.4.1, as applicable; ϕN_n = 1,755 lbs.

Step 5: Divide the controlling value by the conversion factor α per section 4.2.1 of this report:

$T_{allowable,ASD} = \phi N_n/\alpha$ = 1,755 / 1.48 = 1,185 lbs.

TABLE 7—TITEN HD® SCREW ANCHOR AND ROD HANGER IDENTIFICATION INFORMATION

Anchor Size	Catalog Number
1/4"	THDB25xxxxH
3/8"	THD37xxxxH
1/2"	THD50xxxxH
5/8"	THDB62xxxxH
3/4"	THD75xxxxH
¼" shank diameter / ¼" Rod Hanger	THDB25158RH
¼" shank diameter / 3/8" Rod Hanger	THDB37158RH
3/8" shank diameter / 3/8" Rod Hanger	THD37212RH
3/8" shank diameter / 1/2" Rod Hanger	THD50234RH
3/8" shank diameter / 10 mm Rod Hanger	THD10212RH

FIGURE 1A—TITEN HD® SCREW ANCHOR

FIGURE 1B—TITEN HD® ROD HANGER

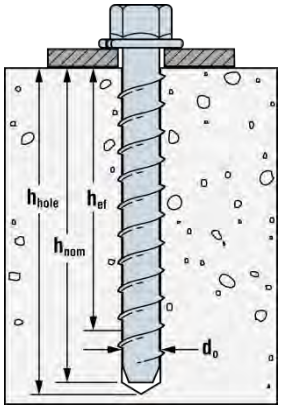

FIGURE 2—TITEN HD® SCREW ANCHOR INSTALLATION

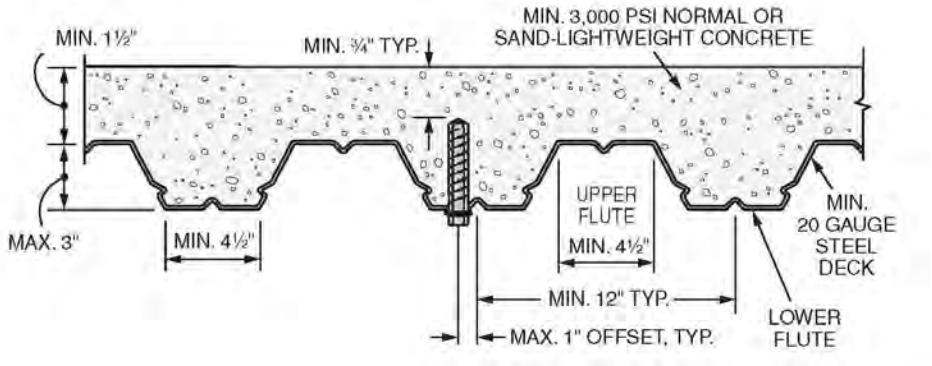

FIGURE 3—INSTALLATION OF $^3/_8$-INCH AND $^1/_2$-INCH SHANK DIAMETER ANCHORS IN THE SOFFIT OF CONCRETE-FILLED PROFILE STEEL DECK FLOOR AND ROOF ASSEMBLIES (LOWER FLUTE)
(1 in = 25.4 mm)

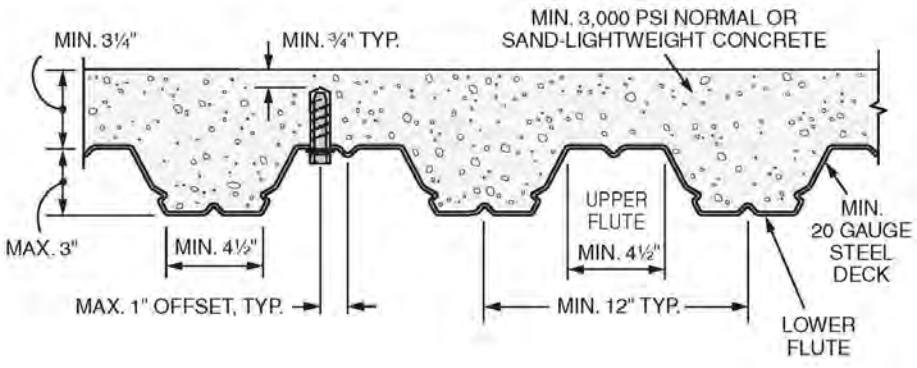

FIGURE 4—INSTALLATION OF $^3/_8$-INCH AND $^1/_2$-INCH SHANK DIAMETER ANCHORS IN THE SOFFIT OF CONCRETE-FILLED PROFILE STEEL DECK FLOOR AND ROOF ASSEMBLIES (UPPER FLUTE)
(1 in = 25.4 mm)

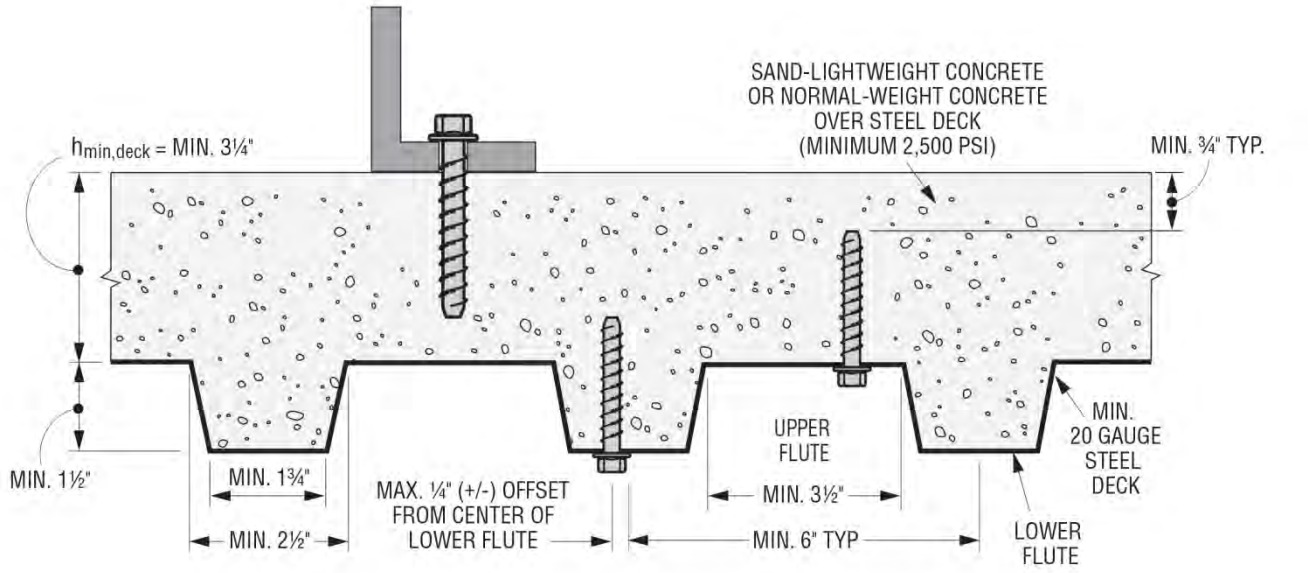

FIGURE 5—INSTALLATION OF $^3/_8$-INCH SHANK DIAMETER ANCHORS IN THE TOPSIDE, AND ¼-INCH SHANK DIAMETER ANCHORS IN THE SOFFIT OF CONCRETE-FILLED PROFILE STEEL DECK FLOOR AND ROOF ASSEMBLIES
(1 in = 25.4 mm)

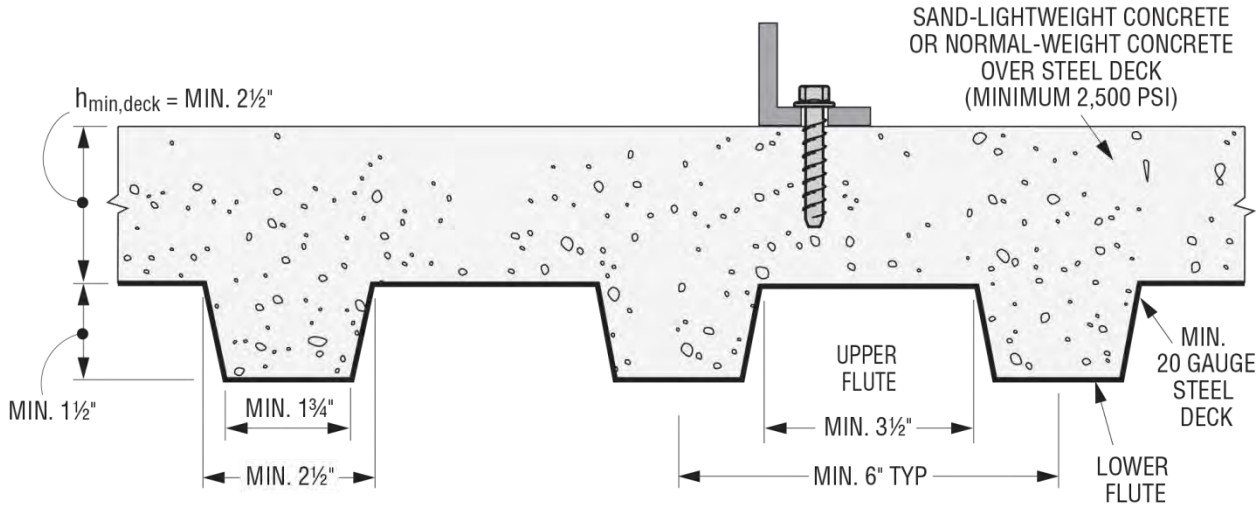

FIGURE 6—INSTALLATION OF ¼-INCH SHANK DIAMETER ANCHORS IN THE TOPSIDE OF CONCRETE-FILLED PROFILE STEEL DECK FLOOR AND ROOF ASSEMBLIES
(1 in = 25.4 mm)