

# ICC-ES Evaluation Report

**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:**

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**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:**

- 2012, 2009, and 2006 *International Building Code*® (IBC)
- \* ■ 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 sand-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 sand-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 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 3/8-inch shank diameter and either 3/8-inch- or 1/2-inch-diameter (9.5 mm or 12.7 mm) internal threads. Figure 1B illustrates the Titen HD® Rod Hanger.

### 3.3 Concrete:

Normal-weight and sand-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

\*Revised May 2015

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 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 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 D.4.1, except as required in ACI 318 D.3.3. Strength reduction factors,  $\phi$ , as given in ACI 318-11 D.4.3, 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 9.2 of ACI 318. Strength reduction factors,  $\phi$ , 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 318-11 D.3.7.

**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 D.5.1.2, is given in Table 2 of this report. The strength reduction factor,  $\phi$ , 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 D.5.2, 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 D.5.2.2 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 D.5.2.6 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 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 D.5.3.1 and D.5.3.2 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 D.5.3.6, 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 D.5.3.6, 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 D.6.1.2, is given in Table 3 of this report and must be used in lieu of the values derived by calculation from ACI 318-11 Eq. D-29. The strength reduction factor,  $\phi$ , 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 D.6.2, 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 D.6.2.2 using the values of  $l_e$  and  $d_a$  as given in Table 3 of this report. The modification factors in ACI 318 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 D.6.2, using the actual member 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 5 of this report.

Calculation of the concrete breakout strength in accordance with ACI 318 D.6.2 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  $V_{cpb}$ , respectively, must be calculated in accordance with ACI 318 D.6.3, 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 of 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 D.6.3 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 D.3.3. For the 2012 IBC, Section 1905.1.9 shall be omitted. Modifications to ACI 318 D.3.3 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 D.5 and D.6, respectively, taking into account the corresponding values in Tables 1 through 5 of this report.

The screw anchors comply with ACI 318 D.1 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 D.5.1 and D.5.2, as described in Sections 4.1.2 and 4.1.3 of this report. In accordance with ACI 318 D.5.3.2, 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 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 D.6.1.2, 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 D.7.

**4.1.10 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance:** In lieu of ACI 318 D.8.1 and D.8.3, values of  $c_{min}$  and  $s_{min}$  provided in Table 1 of this report must be used. In lieu of ACI 318 D.8.5, minimum member thickness,  $h_{min}$ , must comply with Table 1 of this report.

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 D.5.2, must be further multiplied by the factor  $\psi_{cp,N}$  given by Eq-1:

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

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 D.8.6, values of  $c_{ac}$  provided in Tables 1 and 5 of this report must be used.

#### 4.1.12 Requirements for Sand-lightweight Concrete:

For ACI 318-11 and ACI 318-08, when anchors are used in sand-lightweight concrete, the modification factor  $\lambda_a$  or  $\lambda$ , respectively, for concrete breakout strength must be taken as 0.6 in lieu of ACI 318-11 D.3.6 (2012 IBC) or ACI 318-08 D.3.4 (2009 IBC). In addition, the pullout strength  $N_{p,uncr}$ ,  $N_{p,cr}$ , and  $N_{p,eq}$  must be multiplied by 0.6, as applicable.

For ACI 318-05, the values  $N_b$ ,  $N_{p,eq}$ ,  $N_{p,uncr}$ ,  $N_{p,cr}$ , and  $V_b$  determined in accordance with this report must be multiplied by 0.60, in lieu of ACI 318 D.3.4.

For anchors installed in the lower flute or upper flute of the soffit of sand-lightweight concrete filled profile steel deck floor and roof assemblies, this reduction 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 Sections 1605.3 of the IBC must be established using the following equations:

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

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)

$\phi N_n$  = The lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 Appendix D, Section 4.1 of this report, and either 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable (lbf or N).

$\phi V_n$  = The lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 Appendix D, Section 4.1 of this report, and either 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable (lbf or N).

$\alpha$  = A conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition,  $\alpha$  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 D.7, as follows:

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

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

For all other cases:

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

### 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) and 3/8-inch (9.5 mm) Titen HD® Screw Anchors and 3/8-inch (9.5 mm) Rod Hangers, the hole is drilled to the specified nominal embedment depth plus 1/8 inch (3.2 mm) and 1/4 inch (6.4 mm) respectively. 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 (12.7mm). 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 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 sand-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 3/8-inch-diameter (9.5 mm) and 1/2-inch-diameter (12.7 mm) 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) and the 1/2-inch-diameter (12.7 mm) Titen HD® Screw Anchors, the 3/8-inch-diameter (9.5 mm) and the 1/2-inch-diameter (12.7 mm) Titen HD® Rod Hanger and in Figure 5 for the 1/4 inch-diameter (6.4 mm) Titen HD® Screw Anchors.

The  $\frac{1}{4}$ -inch-diameter (6.4 mm), the  $\frac{3}{8}$ -inch-diameter (9.5 mm) and the  $\frac{1}{2}$ -inch-diameter (12.7 mm) Titen HD® Screw Anchors 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  $\frac{1}{4}$ -inch-diameter (6.4 mm) and in Figure 4 for the  $\frac{3}{8}$ -inch-diameter (9.5 mm) and the  $\frac{1}{2}$ -inch-diameter (12.7 mm).

- 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 March 2012, 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<sup>1</sup>

Characteristic	Symbol	Units	Nominal Anchor Diameter / Threaded Coupler Diameter (inch)													
			1/4		3/8		1/2		5/8		3/4		3/8 Rod Hanger		1/2 Rod Hanger	
<b>Installation Information</b>																
Nominal Diameter	$d_a (d_o)$ <sup>5</sup>	in.	1/4		3/8		1/2		5/8		3/4		3/8		3/8	
Drill Bit Diameter	$d_{bit}$	in.	1/4		3/8		1/2		5/8		3/4		3/8		3/8	
Minimum Baseplate Clearance Hole Diameter <sup>2</sup>	$d_c$	in.	3/8		1/2		5/8		3/4		7/8		N/A <sup>3</sup>		N/A <sup>3</sup>	
Maximum Installation Torque <sup>4</sup>	$T_{inst,max}$	ft-lbf	24		50		65		100		150		50		50	
Maximum Impact Wrench Torque Rating	$T_{impact,max}$	ft-lbf	125		150		340		340		385		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	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	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	1.77	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	2 11/16	2 11/16		
Minimum Edge Distance	$c_{min}$	in.	1 1/2	1 1/2	1 3/4											
Minimum Spacing	$s_{min}$	in.	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	4	4 1/4		
<b>Anchor Data</b>																
Yield Strength	$f_{ya}$	psi	100,000			97,000										
Tensile Strength	$f_{uta}$	psi	125,000			110,000										
Minimum Tensile & Shear Stress Area	$A_{se}$ <sup>6</sup>	in <sup>2</sup>	0.042			0.099	0.183	0.276	0.414	0.099	0.099					
Axial Stiffness in Service Load Range - Uncracked Concrete	$\beta_{uncr}$	lb/in.	202,000			715,000										
Axial Stiffness in Service Load Range - Cracked Concrete	$\beta_{cr}$	lb/in.	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<sup>2</sup> = 645 mm<sup>2</sup>, 1 lb/in = 0.175 N/mm.

<sup>1</sup>The information presented in this table is to be used in conjunction with the design criteria of ACI 318 Appendix D.

<sup>2</sup>The clearance must comply with applicable code requirements for the connected element.

<sup>3</sup>The Titen HD® Rod Hanger version is driven directly to the supporting member surface.

<sup>4</sup> $T_{inst,max}$  applies to installations using a calibrated torque wrench.

<sup>5</sup>For the 2006 IBC  $d_o$  replaces  $d_a$

<sup>6</sup> $A_{se,N} = A_{se,V} = A_{se}$

TABLE 2—TITEN HD® SCREW ANCHOR AND ROD HANGER CHARACTERISTIC TENSION STRENGTH DESIGN VALUES<sup>1</sup>

Characteristic	Symbol	Units	Nominal Anchor Diameter / Threaded Coupler Diameter (inch)											
			1/4	3/8		1/2		5/8		3/4	3/8 Rod Hanger		1/2 Rod Hanger	
Anchor Category	1, 2 or 3	-	1											
Nominal Embedment Depth	$h_{nom}$	in.	1 <sup>5/8</sup>	2 <sup>1/2</sup>	2 <sup>1/2</sup>	3 <sup>1/4</sup>	3 <sup>1/4</sup>	4	4	5 <sup>1/2</sup>	5 <sup>1/2</sup>	6 <sup>1/4</sup>	2 <sup>1/2</sup>	2 <sup>1/2</sup>
<b>Steel Strength in Tension (ACI 318 Section D.5.1)</b>														
Tension Resistance of Steel	$N_{sa}$	lbf	5195	10,890		20,130		30,360		45,540		10,890	10,890	
Strength Reduction Factor - Steel Failure <sup>2</sup>	$\phi_{sa}$	-	0.65											
<b>Concrete Breakout Strength in Tension (ACI 318 Section D.5.2)</b>														
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	1.77	1.77
Critical Edge Distance	$c_{ac}$	in.	3	6	2 <sup>11/16</sup>	3 <sup>5/8</sup>	3 <sup>9/16</sup>	4 <sup>1/2</sup>	4 <sup>1/2</sup>	6 <sup>3/8</sup>	6 <sup>3/8</sup>	7 <sup>5/16</sup>	2 <sup>11/16</sup>	2 <sup>11/16</sup>
Effectiveness Factor - Uncracked Concrete	$k_{uncr}$	-	30	24										
Effectiveness Factor - Cracked Concrete	$k_{cr}$	-	17											
Modification factor	$\psi_{c,N}$	-	1.0											
Strength Reduction Factor - Concrete Breakout Failure <sup>3</sup>	$\phi_{cb}$	-	0.65											
<b>Pullout Strength in Tension (ACI 318 Section D.5.3)</b>														
Pullout Resistance Uncracked Concrete ( $f'_c=2,500$ psi)	$N_{p,uncr}$	lbf	N/A <sup>4</sup>	4,555 <sup>6</sup>	2,700 <sup>5</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>	9,810 <sup>5</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>	2,025 <sup>5</sup>	2,025 <sup>5</sup>
Pullout Resistance Cracked Concrete ( $f'_c=2,500$ psi)	$N_{p,cr}$	lbf	N/A <sup>4</sup>	1,905 <sup>5</sup>	1,235 <sup>5</sup>	2,700 <sup>5</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>	3,040 <sup>5</sup>	5,570 <sup>5</sup>	6,070 <sup>5</sup>	7,195 <sup>5</sup>	1,235 <sup>5</sup>	1,235 <sup>5</sup>
Strength Reduction Factor - Pullout Failure <sup>7</sup>	$\phi_p$	-	0.65											
<b>Tension Strength for Seismic Applications (ACI 318 Section D.3.3.3)</b>														
Nominal Pullout Strength for Seismic Loads ( $f'_c=2,500$ psi)	$N_{p,eq}$	lbf	N/A <sup>4</sup>	1905 <sup>5</sup>	1,235 <sup>5</sup>	2,700 <sup>5</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>	3,040 <sup>5</sup>	5,570 <sup>5</sup>	6,070 <sup>5</sup>	7,195 <sup>5</sup>	1,235 <sup>5</sup>	1,235 <sup>5</sup>
Strength Reduction Factor for Pullout Failure <sup>7</sup>	$\phi_{eq}$	-	0.65											

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

<sup>1</sup>The information presented in this table is to be used in conjunction with the design criteria of ACI 318 Appendix D.

<sup>2</sup>The tabulated value of  $\phi_{sa}$  applies when the load combinations of Section 1605.2.1 of the IBC, or ACI 318 Section 9.2 are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  must be determined in accordance with ACI 318 D.4.5(b).

<sup>3</sup>The tabulated values of  $\phi_{cb}$  applies when both the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  must be determined in accordance with ACI 318 D.4.5(c) for Condition B.

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

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

<sup>6</sup>The characteristic pullout resistance for greater compressive strengths may be increased by multiplying the tabular value by  $(f'_c/2,500)^{0.2}$ .

<sup>7</sup>The tabulated values of  $\phi_p$  or  $\phi_{eq}$  applies when both the load combinations of ACI 318 Section 9.2

are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  must be determined in accordance with ACI 318 D.4.5(c) for Condition B.

TABLE 3—TITEN HD® SCREW ANCHOR CHARACTERISTIC SHEAR STRENGTH DESIGN VALUES<sup>1</sup>

Characteristic	Symbol	Units	Nominal Anchor Diameter (inch)									
			$1/4$	$3/8$	$1/2$	$5/8$	$3/4$	4		$5 1/2$	$6 1/4$	
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	$5 1/2$	$5 1/2$	$6 1/4$
<b>Steel Strength in Shear (ACI Section D.6.1)</b>												
Shear Resistance of Steel	$V_{sa}$	Lbf	2,020	4,460	7,455	10,000	16,840					
Strength Reduction Factor - Steel Failure <sup>2</sup>	$\phi_{sa}$	-	0.60									
<b>Concrete Breakout Strength in Shear (ACI 318 Section D.6.2)</b>												
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 <sup>3</sup>	$\phi_{cb}$	-	0.70									
<b>Concrete Pryout Strength in Shear (ACI 318 Section D.6.3)</b>												
Coefficient for Pryout Strength	$k_{cp}$	-	1.0					2.0				
Strength Reduction Factor - Concrete Pryout Failure <sup>3</sup>	$\phi_{cp}$	-	0.70									
<b>Shear Strength for Seismic Applications (ACI 318 Section D.3.3.3)</b>												
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 <sup>2</sup>	$\phi_{eq}$	-	0.60									

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

<sup>1</sup>The information presented in this table is to be used in conjunction with the design criteria of ACI 318 Appendix D.

<sup>2</sup>The tabulated value of  $\phi_{sa}$  and  $\phi_{eq}$  applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  must be determined in accordance with ACI 318 D.4.5(b).

<sup>3</sup>The tabulated values of  $\phi_{cb}$  and  $\phi_{cp}$  applies when both the load combinations of Section 1605.2.1 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\phi$  must be determined in accordance with ACI 318 D.4.5(c) for Condition B.

<sup>4</sup>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<sup>1,5,6</sup>**

Characteristic	Symbol	Units	Nominal Anchor Diameter / Threaded Coupler Diameter (inch)											
			Lower Flute								Upper Flute			
			Figure 5		Figure 3						Figure 5		Figure 4	
			1/4	3/8	1/2	3/8 Rod Hanger	1/2 Rod Hanger	1/4	3/8	1/2				
Minimum Hole Depth	$h_{hole}$	in.	1 <sup>3</sup> / <sub>4</sub>	2 <sup>5</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>8</sub>	2 <sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>2</sub>	4	2 <sup>3</sup> / <sub>4</sub>	3	1 <sup>3</sup> / <sub>4</sub>	2 <sup>5</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>2</sub>
Nominal Embedment Depth	$h_{nom}$	in.	1 <sup>5</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>2</sub>	1 <sup>7</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>2</sub>	2	3 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>2</sub>	1 <sup>5</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>2</sub>	1 <sup>7</sup> / <sub>8</sub>	2
Effective Embedment Depth	$h_{ef}$	in.	1.19	1.94	1.23	1.77	1.29	2.56	1.77	1.77	1.19	1.94	1.23	1.29
Pullout Resistance, Cracked Concrete <sup>2,7</sup>	$N_{p,deck,cr}$	lbf	420	535	375	870	905	2040	870	870	655	1195	500	1700
Pullout Resistance, Uncracked Concrete <sup>3,7</sup>	$N_{p,deck,uncl}$	lbf	995	1275	825	1905	1295	2910	1430	1430	1555	2850	1095	2430
Steel Strength in Shear <sup>4</sup>	$V_{sa,deck}$	lbf	1335	1745	2240	2395	2435	4430	N/A	N/A	2010	2420	4180	7145
Steel Strength in Shear, Seismic <sup>4</sup>	$V_{sa,deck,eq}$	lbf	870	1135	1434	1533	1565	2846	N/A	N/A	1305	1575	2676	4591

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

<sup>1</sup>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.

<sup>2</sup>The values listed must be used in accordance with Section 4.1.4 and 4.1.8.2 of this report.

<sup>3</sup>The values listed must be used in accordance with Section 4.1.4 of this report.

<sup>4</sup>The values listed must be used in accordance with Section 4.1.5 and 4.1.8.3 of this report.

<sup>5</sup>The values for  $\phi_p$  (reduction factor for pullout strength) can be found in Table 2 and the value for  $\phi_{sa}$  (reduction factor for steel strength in shear) can be found in Table 3.

<sup>6</sup>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.

<sup>7</sup>The characteristic pull-out resistance for greater concrete compressive strengths shall be increased by multiplying the tabular value by  $(f_c / 3,000 \text{ psi})^{0.5}$ .

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

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 <sup>5</sup>	$h_{min,deck}$	in.	2 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>4</sub>
Critical Edge Distance	$C_{ac,deck,top}$	in.	3 <sup>3</sup> / <sub>4</sub>	7 <sup>1</sup> / <sub>4</sub>
Minimum Edge Distance	$C_{min,deck,top}$	in.	3 <sup>1</sup> / <sub>2</sub>	3
Minimum Spacing	$S_{min,deck,top}$	in.	3 <sup>1</sup> / <sub>2</sub>	3

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

<sup>1</sup>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.

<sup>2</sup>Design capacity shall be based on calculations according to values in Tables 2 and 3 of this report.

<sup>3</sup>Minimum flute depth (distance from top of flute to bottom of flute) is 1 1/2-inch, see Figures 5 and 6.

<sup>4</sup>Steel deck thickness shall be minimum 20 gauge.

<sup>5</sup>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<sup>1,2,3,4,5,6,7,8,9,10</sup>**

Nominal Anchor Diameter, $d_o$ (inches)	Nominal Embedment Depth, $h_{nom}$ (inches)	Effective Embedment Depth, $h_{ef}$ (inches)	Allowable Tension Load, $\phi N_r/\alpha$ (lbs)
1/4	1 <sup>5</sup> / <sub>8</sub>	1.19	855
	2 <sup>1</sup> / <sub>2</sub>	1.94	1,424
3/8	2 <sup>1</sup> / <sub>2</sub>	1.77	1,185**
	3 <sup>1</sup> / <sub>4</sub>	2.40	1,960
1/2	3 <sup>1</sup> / <sub>4</sub>	2.35	1,900
	4	2.99	2,725
5/8	4	2.97	2,695
	5 <sup>1</sup> / <sub>2</sub>	4.24	4,580
3/4	5 <sup>1</sup> / <sub>2</sub>	4.22	4,570
	6 <sup>1</sup> / <sub>4</sub>	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 Section 9.2 (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  $\alpha$  based on weighted average:  $\alpha = 1.2D + 1.6L = 1.2(0.3) + 1.6(0.7) = 1.48$
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 318-11 D.4.3 is not provided).

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

<sup>3</sup>/<sub>8</sub>" Titen HD with an Effective Embedment,  $h_{ef} = 1.77"$

Step 1: Calculate Static Steel Strength in Tension per ACI 318 Section D.5.1;  $\phi_{sa}N_{sa} = 0.65 \times 10,890 = 7,078$  lbs.

Step 2: Calculate Static Concrete Breakout Strength in Tension per ACI 318 Section D.5.2;  $\phi_{cb}N_{cb} = 0.65 \times 2,826 = 1,837$  lbs.

Step 3: Calculate Static Pullout Strength in Tension per ACI 318 Section D.5.3;  $\phi_p N_{p,unscr} = 0.65 \times 2,700 = 1,755$  lbs.

Step 4: The controlling value (from Steps 1, 2 and 3 above) per ACI 318 Section D.4.1';  $\phi N_n = 1,755$  lbs.

Step 5: Divide the controlling value by the conversion factor  $\alpha$  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
<sup>3</sup> / <sub>8</sub> " Rod Hanger	THD37212RH
1/2" Rod Hanger	THD50234RH



FIGURE 1A—TITEN HD® SCREW ANCHOR



FIGURE 1B—TITEN HD® ROD HANGER

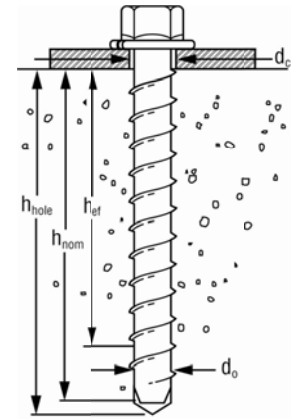


FIGURE 2—TITEN HD® SCREW ANCHOR INSTALLATION

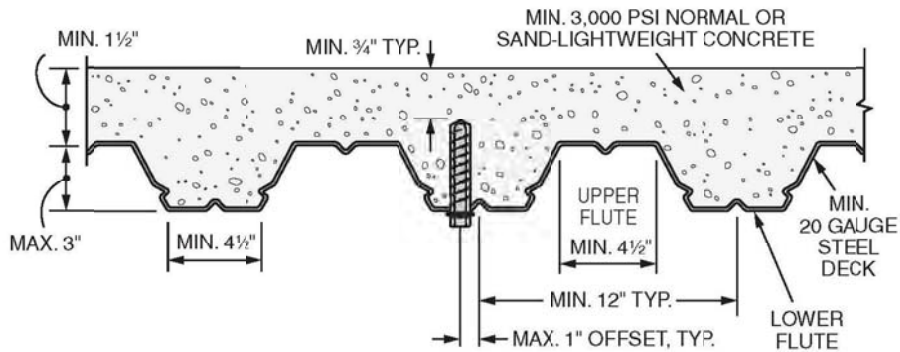


FIGURE 3—INSTALLATION OF  $\frac{3}{8}$ -INCH AND  $\frac{1}{2}$ -INCH DIAMETER ANCHORS IN THE SOFFIT OF CONCRETE-FILLED PROFILE STEEL DECK FLOOR AND ROOF ASSEMBLIES (LOWER FLUTE)  
(1 in = 25.4 mm)

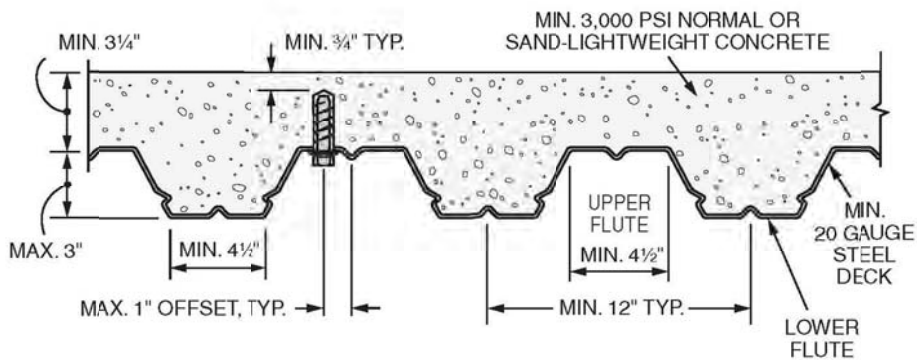
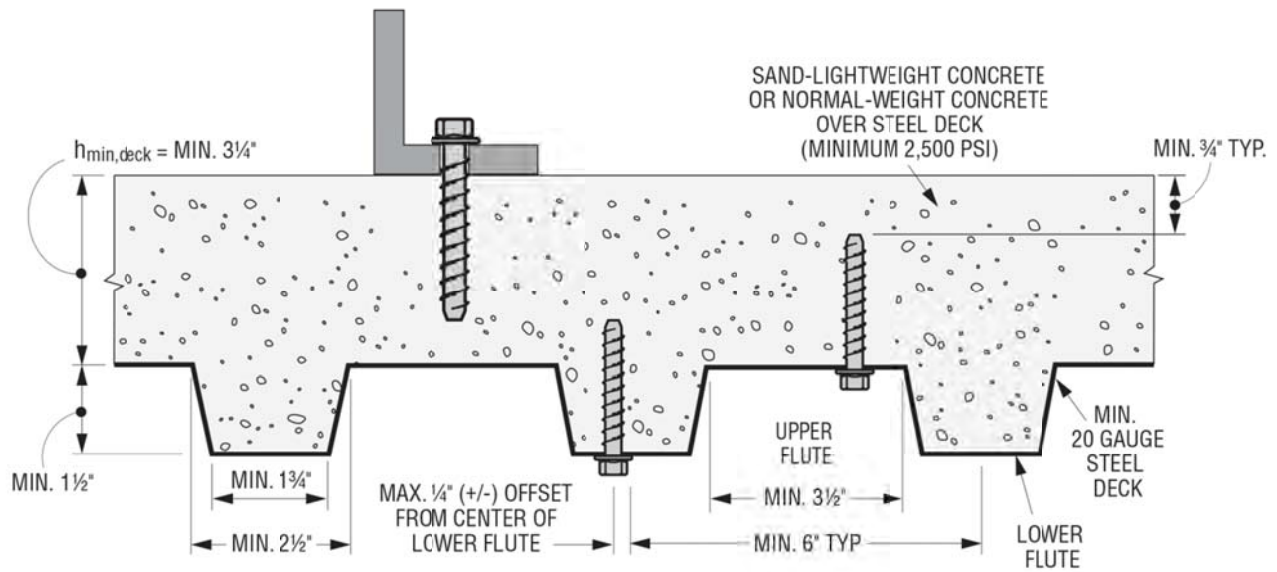
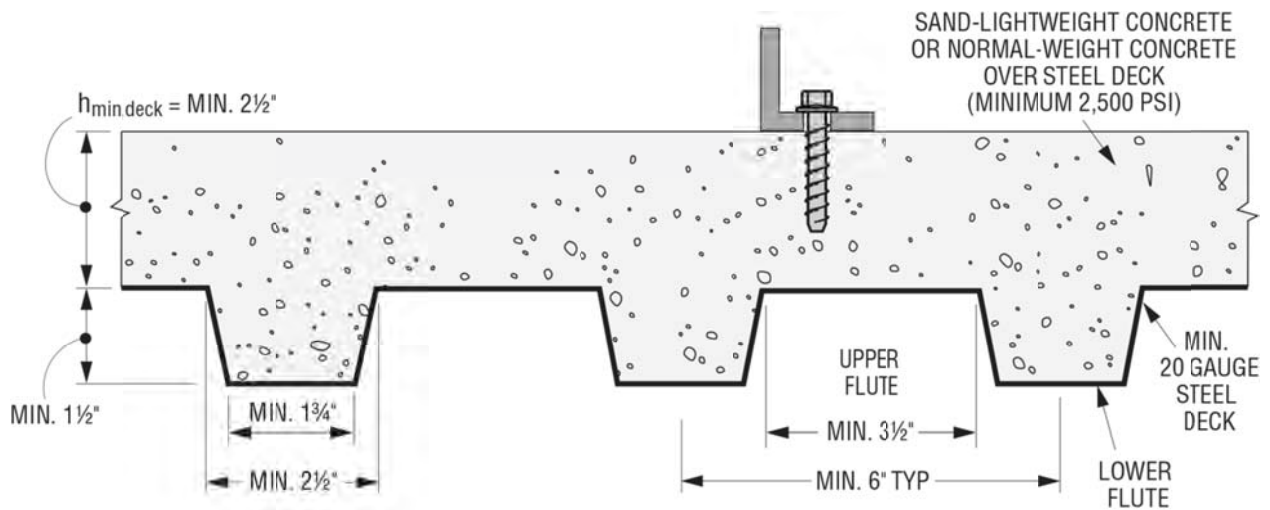


FIGURE 4—INSTALLATION OF  $\frac{3}{8}$ -INCH AND  $\frac{1}{2}$ -INCH DIAMETER ANCHORS IN THE SOFFIT OF CONCRETE-FILLED PROFILE STEEL DECK FLOOR AND ROOF ASSEMBLIES (UPPER FLUTE)  
(1 in = 25.4 mm)



**FIGURE 5—INSTALLATION OF 3/8-INCH DIAMETER ANCHORS IN THE TOPSIDE, AND 1/4-INCH DIAMETER ANCHORS IN THE SOFFIT OF CONCRETE-FILLED PROFILE STEEL DECK FLOOR AND ROOF ASSEMBLIES**

(1 in = 25.4 mm)



**FIGURE 6—INSTALLATION OF 1/4-INCH DIAMETER ANCHORS IN THE TOPSIDE OF CONCRETE-FILLED PROFILE STEEL DECK FLOOR AND ROOF ASSEMBLIES**

(1 in = 25.4 mm)