

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:

HILTI, INC.

EVALUATION SUBJECT:

**HILTI KB-VTZ CARBON STEEL ANCHORS IN
 CRACKED AND UNCRACKED CONCRETE**

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2018, 2015, 2012 and 2009 *International Building Code*® (IBC)
- 2018, 2015, 2012 and 2009 *International Residential Code*® (IRC)
- 2013 *Abu Dhabi International Building Code* (ADIBC)†

†The ADIBC is based on the 2009 IBC. 2009 IBC code sections referenced in this report are the same sections in the ADIBC.

For evaluation for compliance with codes adopted by the Los Angeles Department of Building and Safety (LADBS), see [ESR-3904 LABC and LARC Supplement](#).

Property evaluated:

Structural

2.0 USES

The Hilti KB-VTZ carbon steel anchor is 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) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

The $\frac{3}{8}$ -inch-diameter (9.5 mm) KB-VTZ carbon steel 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 5C of this report and a specified compressive strength, f_c , of 3,000 psi to 8,500 psi (20.7 MPa to 58.6 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

The $\frac{3}{8}$ -inch-, $\frac{1}{2}$ -inch-, $\frac{5}{8}$ -inch- and $\frac{3}{4}$ -inch-diameter (9.5 mm, 12.7 mm, 15.9 mm and 19.1 mm) KB-VTZ carbon

steel anchors may be installed in the soffit of cracked and uncracked normal-weight or sand-lightweight concrete over metal deck having a minimum specified compressive strength, f_c , of 3,000 psi (20.7 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

The anchoring system complies with anchors as described in Section 1901.3 of the 2018 and 2015 IBC, Section 1909 of the 2012 IBC, and Section 1912 of the 2009 IBC. The anchoring system is an alternative to cast-in-place anchors described in Section 1908 of the 2012 IBC and Section 1911 of the 2009 IBC. The anchors may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 KB-VTZ:

KB-VTZ anchors are torque-controlled, mechanical expansion anchors. KB-VTZ anchors consist of a stud (anchor body), wedge (expansion elements), nut, and washer as illustrated in Figure 1. The stud and expansion elements are manufactured from carbon steel. KB-VTZ anchors have a minimum 5 μ m (0.0002 inch) zinc plating that conforms to ASTM B633. The hex nut conforms to ASTM A563-04, Grade A.

The anchor body is composed of a high-strength rod threaded at one end and a tapered mandrel at the other end. The tapered mandrel is enclosed by a three-section expansion element which freely moves around the mandrel. The expansion element movement is restrained by the mandrel taper and by a collar. The anchor is installed in a predrilled hole with a hammer. When torque is applied to the nut of the installed anchor, the mandrel is drawn into the expansion element, which is in turn expanded against the wall of the drilled hole.

3.2 Concrete:

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

3.3 Steel Deck Panels:

Steel deck panels must be in accordance with the configuration in Figures 5A, 5B, and 5C and have a minimum base steel thickness of 0.035 inch (0.899 mm). Steel must comply with ASTM A653/A653M SS Grade 40 with a minimum published yield strength of 40,000 psi (276 MPa).

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design strength of anchors complying with

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

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

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

Design parameters provided in Tables 3, 4, 5A, 5B, and 5C of this report are based on the 2018 and 2015 IBC (ACI 318-14) and the 2012 IBC (ACI 318-11) unless noted otherwise in Sections 4.1.1 through 4.1.12. 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 Table 4 of this report, must be used for load combinations calculated in accordance with Section 1605.2 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 318-11 Appendix C. An example calculation in accordance with the 2018, 2015 and 2012 IBC is provided in Figure 6. 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 static steel strength, N_{sa} , of a single anchor in tension must be calculated in accordance with ACI 318-14 17.4.1.2 or ACI 318-11 D.5.1.2, as applicable. The resulting N_{sa} values are provided in Table 4 of this report. Strength reduction factors ϕ corresponding to ductile steel elements may be used.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension: The nominal concrete breakout strength of a single anchor or 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 in tension, 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 Tables 4 or 5C, as applicable. 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 k_{uncr} as given in Table 4 and with $\psi_{c,N} = 1.0$.

For KB-VTZ anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 5A and 5B, calculation of the concrete breakout strength is not required.

4.1.4 Requirements for Static Pullout Strength in Tension: The nominal pullout strength of a single anchor 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, respectively, as applicable, in cracked and uncracked concrete, $N_{p,cr}$ and $N_{p,uncr}$, respectively, is given in Table 4. For all design cases $\psi_{c,P} = 1.0$. In accordance with ACI 318-14 17.4.3 or ACI 318-11 D.5.3, as applicable, the nominal pullout strength in cracked concrete may be calculated in accordance with the following equation:

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

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

In regions where analysis indicates no cracking in accordance with ACI 318-14 17.4.3.6 or ACI 318-11 D.5.3.6, as applicable, the nominal pullout strength in tension may be calculated in accordance with the following equation:

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

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

Where values for $N_{p,cr}$ and $N_{p,uncr}$ are not provided in Table 4, the pullout strength in tension need not be evaluated.

The nominal pullout strength in cracked concrete of the KB-VTZ installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 5A and 5B, are given in Tables 5A and 5B, respectively. In accordance with ACI 318-14 17.4.3.2 or ACI 318-11 D.5.3.2, as applicable, the nominal pullout strength in cracked concrete must be calculated in accordance with 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, the nominal strength in uncracked concrete must be calculated according to Eq-2, whereby the value of $N_{p,deck,uncr}$ must be substituted for $N_{p,uncr}$ and the value of 3,000 psi (20.7 MPa) must be substituted for the value of 2,500 psi (17.2 MPa) in the denominator.

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

4.1.6 Requirements for Static Concrete Breakout Strength in Shear: The nominal concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg} , respectively, must be calculated in accordance with ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, with modifications as described in this section. The basic concrete breakout strength, 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, based on the values provided in Table 4. The value of l_e used in ACI 318-14 Eq. 17.5.2.2a or ACI 318-11 Eq. D-33 must be taken as no greater than the lesser of h_{ef} or $8d_a$.

For carbon steel KB-VTZ anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 5A and 5B, calculation of the concrete breakout strength in shear is not required.

4.1.7 Requirements for Static Concrete Pryout Strength in Shear: The nominal concrete pryout strength

of a single anchor or group of anchors, V_{cp} or V_{cpg} , respectively, must be calculated in accordance with ACI 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable, modified by using the value of K_{cp} provided in Table 4 of this report and the value of N_{cb} or N_{cbg} as calculated in Section 4.1.3 of this report.

For KB-VTZ anchors installed in the soffit of sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, as shown in Figures 5A and 5B, calculation of the concrete pry-out strength in accordance with ACI 318-14 17.5.3 or ACI 318-11 D.6.3 is not required.

4.1.8 Requirements for Seismic Design:

4.1.8.1 General: For load combinations including seismic, 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 2018 and 2015 IBC. For the 2012 IBC, Section 1905.1.9 shall be omitted. Modifications to ACI 318-08 D.3.3 shall be applied under Section 1908.1.9 of the 2009 IBC, as applicable.

The anchors comply with ACI 318-14 2.3 or ACI 318-11 D.1, as applicable, as ductile 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; or ACI 318-11 D.3.3.4, D.3.3.5, D.3.3.6 or D.3.3.7; ACI 318-08 D.3.3.4, D.3.3.5 or D.3.3.6, as applicable. Strength reduction factors, ϕ , are given in Table 4 of this report. The anchors may be installed in Seismic Design Categories A through F of the IBC.

4.1.8.2 Seismic Tension: The nominal steel strength and nominal concrete breakout strength for anchors in tension must be calculated 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 pullout strength in tension for seismic loads, $N_{p,eq}$, described in Table 4 or $N_{p,deck,cr}$ described in Tables 5A and 5B must be used in lieu of N_p , as applicable. The value of $N_{p,eq}$ or $N_{p,deck,cr}$ may be adjusted by calculation for concrete strength in accordance with Eq-1 and Section 4.1.4 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. If no values for $N_{p,eq}$ are given in Table 4, the static design strength values govern.

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

4.1.9 Requirements for Interaction of Tensile and Shear Forces: For anchors or groups of anchors that are subject to the effects of combined tension and shear forces, the design must be performed in accordance with ACI 318-14 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, respectively, as applicable, values of s_{min} and c_{min} as given in Table 3 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 3 of this report must be used. Additional combinations for minimum edge distance, c_{min} , and spacing, s_{min} , may be derived by linear interpolation between the given boundary values as described in Figures 3 and 4.

For KB-VTZ anchors installed on the top of normal-weight or sand-lightweight concrete over profile steel deck floor and roof assemblies, the anchor must be installed in accordance with Table 5C and Figure 5C.

For KB-VTZ anchors installed in the soffit of sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, the anchors must be installed in accordance with Figures 5A and 5B and shall have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width.

4.1.11 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 in accordance with ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, must be further multiplied by the factor $\Psi_{cp,N}$ as given by Eq-3:

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

whereby the factor $\Psi_{cp,N}$ need not be taken as 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} must comply with Table 3 and values of $c_{ac,deck,top}$ must comply with Table 5C.

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

For ACI 318-14 (2018 and 2015 IBC), ACI 318-11 (2012 IBC) and ACI 318-08 (2009 IBC), λ shall be determined in accordance with the corresponding version of ACI 318.

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

4.2 Allowable Stress Design (ASD):

4.2.1 General: Design values for use with allowable stress design (working stress design) load combinations calculated in accordance with Section 1605.3 of the IBC, must be established as follows:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha}$$

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha}$$

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 2018 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Section 1908.1.9, and Section 4.1 of this report, as applicable (lbf or kN).

- ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318-14 Chapter 17 and 2018 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Section 1908.1.9, and Section 4.1 of this report, as applicable (lbf or kN).
- α = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, α must include all applicable factors to account for nonductile failure modes and required over-strength.

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

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 $V_{applied} \leq 0.2V_{allowable,ASD}$, the full allowable load in tension must be permitted.

For tension loads $T_{applied} \leq 0.2T_{allowable,ASD}$, the full allowable load in shear must 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 5C and Figures 2, 5A, 5B, and 5C. Anchor locations must comply with this report and plans and specifications approved by the code official. The Hilti KB-VTZ must be installed in accordance with manufacturer's published installation instructions and this report. In case of conflict, this report governs. Anchors must be installed in holes drilled into the concrete using carbide-tipped masonry drill bits complying with ANSI B212.15-1994. The minimum drilled hole depth is given in Table 1. Prior to installation, dust and debris must be removed from the drilled hole to enable installation to the stated embedment depth. The anchor must be hammered into the predrilled hole until h_{nom} is achieved. The nut must be tightened against the washer until the torque values specified in Table 1 are achieved. For installation in the soffit of concrete on steel deck assemblies, the hole diameter in the steel deck not exceed the diameter of the hole in the concrete by more than $1/8$ inch (3.2 mm). For member thickness and edge distance restrictions for installations into the soffit of concrete on steel deck assemblies, see Figures 5A and 5B.

4.4 Special Inspection:

Periodic special inspection is required in accordance with Section 1705.1.1 and Table 1705.3 of the 2018, 2015 and 2012 IBC; Section 1704.15 and Table 1704.4 of the 2009 IBC, as applicable. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, anchor spacing, edge distances, concrete member thickness, tightening torque, hole dimensions, anchor embedment 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."

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

5.0 CONDITIONS OF USE

The Hilti KB-VTZ anchors described in this report comply with the codes listed in Section 1.0 of this report, subject to the following conditions:

- 5.1 Anchor sizes, dimensions, minimum embedment depths and other installation parameters are as set forth in this report.
- 5.2 The anchors must be installed in accordance with the manufacturer's published instructions and this report. In case of conflict, this report governs.
- 5.3 Anchors must be limited to use 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) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1], and cracked and uncracked normal-weight or sand-lightweight concrete over metal deck having a minimum specified compressive strength, f'_c , of 3,000 psi (20.7 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].
- 5.4 The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.1 MPa).
- 5.5 Strength design values must be established in accordance with Section 4.1 of this report.
- 5.6 Allowable design values are established in accordance with Section 4.2.
- 5.7 Anchor spacing and edge distance as well as minimum member thickness must comply with Tables 3, 4 and 5C and Figures 2, 3, 4, 5A, 5B, and 5C.
- 5.8 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.
- 5.9 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of expansion 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.
- 5.10 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.
- 5.11 Anchors may be used to resist short-term loading due to wind or seismic forces in locations designated as Seismic Design Categories A through F of the IBC, subject to the conditions of this report.
- 5.12 Where not otherwise prohibited in the code, KB-VTZ anchors are permitted for use with fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:
 - Anchors are used to resist wind or seismic forces only.
 - Anchors that support a fire-resistance-rated envelope or a fire-resistance-rated membrane are

protected by approved fire-resistance-rated materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.

- Anchors are used to support nonstructural elements.

5.13 Use of zinc-coated anchors is limited to dry, interior locations.

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

5.15 Anchors are manufactured for Hilti, Inc. 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 2017 (editorially revised April 2018), which incorporates requirements in ACI 355.2-07 / ACI 355.2-04 for use in cracked and uncracked concrete.

6.2 Quality-control documentation.

7.0 IDENTIFICATION

7.1 The anchors are identified by packaging labeled with the report holder's name (Hilti, Inc.) and contact information, anchor name, anchor size, and evaluation report number (ESR-3904). The anchors have the letters KB-VTZ embossed on the anchor stud and a length identification marking according to Figure 1 and Table 2.

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

HILTI, INC.

7250 DALLAS PARKWAY, SUITE 1000

PLANO, TEXAS 75024

(800) 879-8000

www.us.hilti.com

HiltiTechEng@us.hilti.com

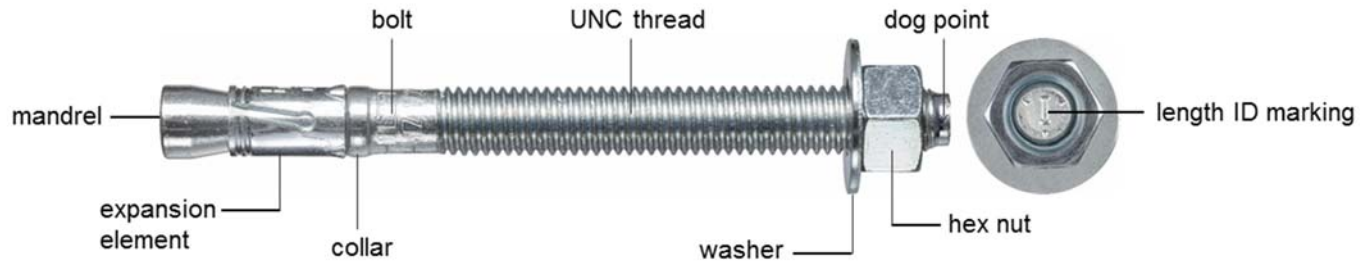


FIGURE 1—HILTI KB-VTZ COMPONENTS

TABLE 1—KB-VTZ SETTING INFORMATION

| SETTING INFORMATION | Symbol | Units | Nominal anchor diameter (in.) | | | | | | | | | |
|------------------------------------|------------|-----------------|-------------------------------|----------------|----------------|---------------|------------------|-----------------|------------------|------------------|----------------|------------|
| | | | 3/8 | | 1/2 | | 5/8 | | 3/4 | | | |
| Anchor O.D. | d_a | in. (mm) | 3/8 (10) | | 1/2 (13) | | 5/8 (16) | | 3/4 (19) | | | |
| Nominal bit diameter | d_{bit} | in. | 3/8 | | 1/2 | | 5/8 | | 3/4 | | | |
| Effective min. embedment | h_{ef} | in. (mm) | 1 1/2 (38) | 2 (51) | 2 (51) | 3 1/4 (83) | 2 3/4 (70) | 4 (102) | 3 1/8 (79) | 4 3/4 (121) | | |
| Nominal embedment | h_{nom} | in. (mm) | 1 13/16 (46) | 2 5/16 (59) | 2 1/2 (64) | 3 3/4 (95) | 3 5/16 (84) | 4 9/16 (116) | 3 3/4 (95) | 5 3/8 (137) | | |
| Min. hole depth | h_o | in. (mm) | 2 (51) | 2 1/2 (64) | 2 3/4 (70) | 4 (102) | 3 5/8 (92) | 4 7/8 (124) | 4 1/16 (103) | 5 11/16 (144) | | |
| Installation torque | T_{inst} | ft.-lb (N-m) | 20 (27) | | 40 (54) | | 60 (81) | | 110 (149) | | | |
| Min. dia. of hole in fastened part | d_h | in. (mm) | 7/16 (11.1) | | 9/16 (14.3) | | 1 1/16 (17.5) | | 1 3/16 (20.6) | | | |
| Standard anchor lengths | l_{anch} | in. (mm) | 3 (76) | 3 3/4 (95) | 5 (127) | 3 3/4 (95) | 4 1/2 (114) | 5 1/2 (140) | 4 3/4 (121) | 6 (152) | 5 1/2 (140) | 7 (178) |

For SI: 1 inch = 25.4 mm, 1 lb = 4.45 N, 1 psi = 0.00689 MPa. For pound-inch units: 1 mm = 0.0394 inches.

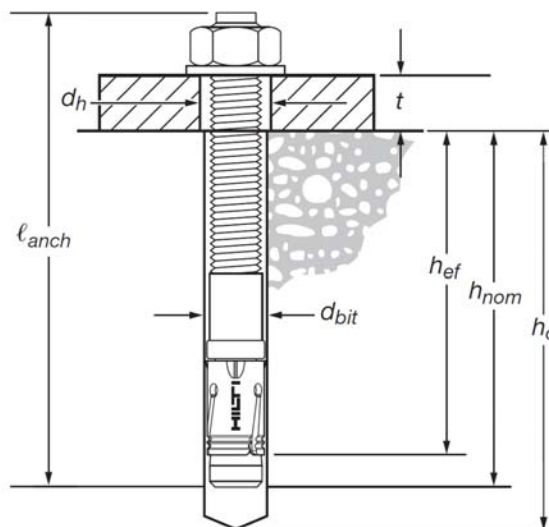


FIGURE 2—KB-VTZ INSTALLATION DIMENSIONS

TABLE 2—KB-VTZ LENGTH IDENTIFICATION SYSTEM

| Length ID marking on bolt head | | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W |
|---------------------------------------|-------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|----|----|----|----|----|----|
| Length of anchor, l_{anch} (inches) | From | 1 1/2 | 2 | 2 1/2 | 3 | 3 1/2 | 4 | 4 1/2 | 5 | 5 1/2 | 6 | 6 1/2 | 7 | 7 1/2 | 8 | 8 1/2 | 9 | 9 1/2 | 10 | 11 | 12 | 13 | 14 | 15 |
| | Up to but not including | 2 | 2 1/2 | 3 | 3 1/2 | 4 | 4 1/2 | 5 | 5 1/2 | 6 | 6 1/2 | 7 | 7 1/2 | 8 | 8 1/2 | 9 | 9 1/2 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |

TABLE 3—KB-VTZ DIMENSIONAL DESIGN INFORMATION FOR INSTALLATION IN CONCRETE

| DESIGN INFORMATION | Symbol | Units | Nominal anchor diameter | | | | | | | |
|---------------------------------------|--------------|-------------|-------------------------|------------|---------------|------------|---------------|------------|---------------|-------------|
| | | | $\frac{3}{8}$ | | $\frac{1}{2}$ | | $\frac{5}{8}$ | | $\frac{3}{4}$ | |
| Anchor O.D. | d_a | in. (mm) | 0.375 (10) | | 0.5 (13) | | 0.625 (16) | | 0.75 (19) | |
| Effective min. embedment ¹ | h_{ef} | in. (mm) | 1½ (38) | 2 (51) | 2 (51) | ¾ (83) | ¾ (70) | 4 (102) | ¾ (79) | ¾ (121) |
| Min. member thickness ² | h_{min} | in. (mm) | ¾ (83) | 4 (102) | 4 (102) | 6 (152) | 6 (152) | 7 (178) | 6 (152) | 10 (254) |
| Critical edge distance | c_{ac} | in. (mm) | 6 (152) | 8 (203) | 8 (203) | 5 (127) | 6 (152) | 9 (229) | 11 (279) | 16 (406) |
| Min. edge distance | c_{min} | in. (mm) | ¾ (70) | ¼ (57) | ¾ (83) | ¾ (70) | ½ (140) | ¼ (108) | 5 (127) | 6 (152) |
| | for $s \geq$ | in. (mm) | 9 (229) | ¾ (95) | 10 (254) | 6 (152) | 11 (279) | ¼ (108) | 6 (152) | ½ (165) |
| Min. anchor spacing | s_{min} | in. (mm) | ½ (89) | ¼ (83) | ½ (114) | 4 (102) | ½ (165) | ¼ (108) | 5 (127) | 6 (152) |
| | for $c \geq$ | in. (mm) | 6 (152) | ¼ (133) | 6 (152) | 5 (127) | ½ (165) | ¼ (108) | 6 (152) | ½ (165) |

For SI: 1 inch = 25.4 mm, 1 lb = 4.45 N, 1 psi = 0.00689 MPa. For pound-inch units: 1 mm = 0.0394 inches.

¹ See Fig. 2.

² For sand-lightweight or normal-weight concrete over metal deck, see Figures 5A, 5B, and 5C and Tables 5A, 5B, and 5C.

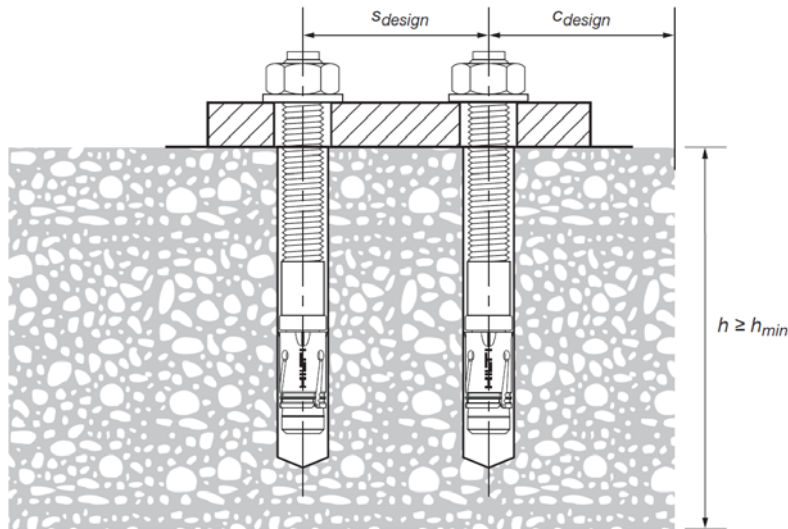


FIGURE 3—DESIGN DIMENSIONS FOR INTERPOLATION OF MINIMUM EDGE DISTANCE AND ANCHOR SPACING

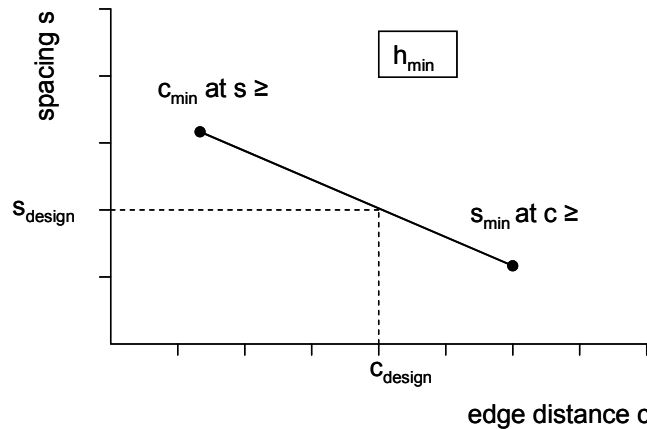


FIGURE 4—INTERPOLATION OF MINIMUM EDGE DISTANCE AND ANCHOR SPACING

TABLE 4—KB-VTZ STRENGTH DESIGN INFORMATION FOR INSTALLATION IN CONCRETE²

| DESIGN INFORMATION | Symbol | Units | Nominal anchor diameter | | | | | | | |
|--|----------------|---|---------------------------------------|-------------------|-----------------------------|---------------------------------------|---------------------------------------|-------------------|---------------------------------------|--|
| | | | ³ / ₈ | | ¹ / ₂ | | ⁵ / ₈ | | ³ / ₄ | |
| Anchor O.D. | d_a | in. (mm) | 0.375 (10) | | 0.5 (13) | | 0.625 (16) | | 0.75 (19) | |
| Effective min. embedment ¹ | h_{ef} | in. (mm) | 1 ¹ / ₂ (38) | 2 (51) | 2 (51) | 3 ¹ / ₄ (83) | 2 ³ / ₄ (70) | 4 (102) | 3 ¹ / ₈ (79) | 4 ³ / ₄ (121) |
| Strength in tension, steel failure modes | | | | | | | | | | |
| Min. specified yield stress | f_y | lb/in. ² (N/mm ²) | 89,500 (616) | | 83,500 (576) | | 83,500 (576) | | 75,500 (520) | |
| Min. specified ult. stress | f_{uta} | lb/in. ² (N/mm ²) | 111,500 (770) | | 104,500 (720) | | 104,500 (720) | | 94,500 (650) | |
| Effective tensile stress area | $A_{se,N}$ | in. ² (mm ²) | 0.0538 (34.7) | | 0.1030 (66.5) | | 0.1582 (102) | | 0.2386 (154) | |
| Steel strength in tension | N_{sa} | lb (kN) | 6,000 (26.7) | | 10,770 (47.9) | | 16,530 (73.5) | | 22,550 (100.3) | |
| Strength reduction factor ϕ for tension, steel failure modes ⁸ | | | 0.75 | | | | | | | |
| Strength in tension, concrete failure modes | | | | | | | | | | |
| Concrete breakout calculation effectiveness factor k_{uncr} , uncracked concrete | | | 24 | | | | | | | |
| Pullout strength, uncracked concrete ⁴ | $N_{p,uncr}$ | lb (kN) | 2,120 (9.4) | 2,490 (11.1) | 3,050 (13.6) | 5,460 (24.3) | 4,830 (21.5) | 6,310 (28.1) | NA | 10,570 (47.0) |
| Mean axial stiffness, uncracked concrete ¹⁰ | β_{uncr} | lb/in. (kN/m) | 199,000 34,800 | 157,000 27,500 | 183,000 32,100 | 88,500 15,500 | 229,000 40,100 | 234,500 41,100 | 170,000 29,800 | 218,500 38,300 |
| Concrete breakout calculation effectiveness factor k_{cr} , cracked concrete ^{6,7} | | | 17 | | | | | | 21 | 17 |
| Pullout strength, cracked concrete ⁴ | $N_{p,cr}$ | lb (kN) | 1,190 (5.3) | 2,040 (9.1) | NA | 3,260 (14.5) | NA | 4,900 (21.8) | NA | |
| Mean axial stiffness, cracked concrete | β_{cr} | lb/in. (kN/m) | 85,500 15,000 | 59,000 10,400 | 84,000 14,700 | 63,000 11,100 | 78,000 13,700 | 109,000 19,100 | 97,000 17,000 | 74,500 13,100 |
| Pullout strength, seismic ⁴ | $N_{p,eq}$ | lb (kN) | 1,190 (5.3) | 2,040 (9.1) | NA | 3,260 (14.5) | NA | 4,900 (21.8) | NA | |
| Anchor category ⁵ | | | 1 | | | | | | | |
| Strength reduction ϕ factor for tension, concrete failure modes, Condition B ⁹ | | | 0.65 | | | | | | | |
| Strength in shear, steel failure modes | | | | | | | | | | |
| Steel strength in shear | V_{sa} | lb (kN) | 1,930 (8.6) | 2,730 (12.2) | 4,620 (20.5) | | 8,860 (39.4) | | 10,330 (46.0) | 10,620 (47.2) |
| Steel strength in shear, seismic ³ | $V_{sa,eq}$ | lb (kN) | 1,930 (8.6) | 2,480 (11.0) | 4,620 (20.5) | | 6,040 (26.8) | | 9,010 (40.1) | 10,310 (45.8) |
| Strength reduction factor ϕ for shear, steel failure modes ⁹ | | | 0.65 | | | | | | | |
| Strength in shear, concrete failure modes | | | | | | | | | | |
| Coefficient for prout strength, k_{cp} | | | 1.0 | | | | 2.0 | | | |
| Strength reduction ϕ factor for shear, concrete failure modes, Condition B ⁹ | | | 0.70 | | | | | | | |

For SI: 1 inch = 25.4 mm, 1 lb = 4.45 N, 1 psi = 0.00689 MPa. For pound-inch units: 1 mm = 0.0394 inches.

¹ See Fig. 2.

² For sand-lightweight or normal-weight concrete over metal deck, see Figures 5A, 5B, and 5C and Tables 5A, 5B, and 5C.

³ See Section 4.1.8 of this report.

⁴ For all design cases $\Psi_{c,p}=1.0$. NA (not applicable) denotes that this value does not control for design. See Section 4.1.4 of this report.

⁵ See ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable.

⁶ See ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2, as applicable.

⁷ For all design cases $\Psi_{c,N}=1.0$. The appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}) must be used.

⁸ The KB-VTZ is a ductile steel element as defined by ACI 318-14 2.3 or ACI 318-11 D.1, as applicable.

⁹ For use with the load combinations of ACI 318-14 Section 5.3 or ACI 318-11 Section 9.2, as applicable. Condition B applies where supplementary reinforcement in conformance with ACI 318-14 17.3.3(c) or ACI 318-11 D.4.3(c), as applicable, is not provided, or where pullout or prout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.

¹⁰ Mean values shown, actual stiffness may vary considerably depending on concrete strength, loading and geometry of application.

TABLE 5A—KB-VTZ TENSION AND SHEAR DESIGN DATA FOR INSTALLATION IN THE SOFFIT OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES ACCORDING TO FIGURE 5A^{1,2,3,4}

| DESIGN INFORMATION | Symbol | Units | Anchor Diameter | | | | | | | |
|---|--------------------------------|-------------|-----------------------------|----------------|-----------------|-----------------|-----------------------------|-----------------|-----------------------------|------------------|
| | | | ³ / ₈ | | 1/2 | | ⁵ / ₈ | | ³ / ₄ | |
| Effective Embedment Depth | <i>h_{ef}</i> | in. (mm) | 1 1/2 (38) | 2 (51) | 2 (51) | 3 1/4 (83) | 2 3/4 (70) | 4 (102) | 3 1/8 (79) | 4 3/4 (121) |
| Minimum Hole Depth | <i>h_o</i> | in. (mm) | 2 (51) | 2 1/2 (64) | 2 3/4 (70) | 4 (102) | 3 5/8 (92) | 4 7/8 (124) | 4 1/16 (103) | 5 11/16 (144) |
| Strength in tension | | | | | | | | | | |
| Pullout Resistance, uncracked concrete ⁵ | <i>N_{p,deck,uncr}</i> | lb (kN) | 1,160 (5.2) | 2,010 (8.9) | 1,700 (7.6) | 3,180 (14.1) | 2,410 (10.7) | 2,410 (10.7) | 3,550 (15.8) | 3,550 (15.8) |
| Pullout Resistance, cracked concrete ⁶ | <i>N_{p,deck,cr}</i> | lb (kN) | 650 (2.9) | 1,650 (7.3) | 1,340 (6.0) | 1,900 (8.5) | 1,930 (8.6) | 1,870 (8.3) | 3,110 (13.8) | 2,960 (13.2) |
| Pullout Resistance, seismic ⁶ | <i>N_{p,deck,eq}</i> | lb (kN) | 650 (2.9) | 1,650 (7.3) | 1,340 (6.0) | 1,900 (8.5) | 1,930 (8.6) | 1,870 (8.3) | 3,110 (13.8) | 2,960 (13.2) |
| Strength in shear | | | | | | | | | | |
| Steel Strength in Shear ⁷ | <i>V_{sa,deck}</i> | lb (kN) | 1,530 (6.8) | 1,810 (8.1) | 2,500 (11.1) | 4,220 (18.8) | 3,680 (16.4) | 3,680 (16.4) | 3,010 (13.4) | 3,010 (13.4) |
| Steel Strength in Shear, Seismic ⁸ | <i>V_{sa,deck,eq}</i> | lb (kN) | 1,390 (6.2) | 1,730 (7.7) | 2,500 (11.1) | 4,220 (18.8) | 2,500 (11.1) | 2,500 (11.1) | 3,010 (13.4) | 3,010 (13.4) |

For SI: 1 inch = 25.4 mm, 1 lb = 4.45 N, 1 psi = 0.00689 MPa. For pound-inch units: 1 mm = 0.0394 inches.

¹ Installations must comply with Sections 4.1.10 and 4.3 and Figure 5A of this report.

² The values for ϕ_t in tension and ϕ_v in shear can be found in Table 4 of this report.

³ The characteristic pullout resistance for concrete compressive strengths greater than 3,000 psi may be increased by multiplying the value in the table by $(f'_c / 3000)^{1/2}$ for psi or $(f'_c / 20.7)^{1/2}$ for MPa [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

⁴ Evaluation of concrete breakout capacity in accordance with ACI 318-14 17.4.2, 17.5.2 and 17.5.3 or ACI 318-11 D.5.2, D.6.2, and D.6.3, as applicable, is not required for anchors installed in the deck soffit.

⁵ The values listed must be used in accordance with Section 4.1.4 of this report.

⁶ The values listed must be used in accordance with Sections 4.1.4 and 4.1.8.2 of this report.

⁷ The values listed must be used in accordance with Section 4.1.5 of this report.

⁸ The values listed must be used in accordance with Section 4.1.8.3 of this report. Values are applicable to both static and seismic load combinations.

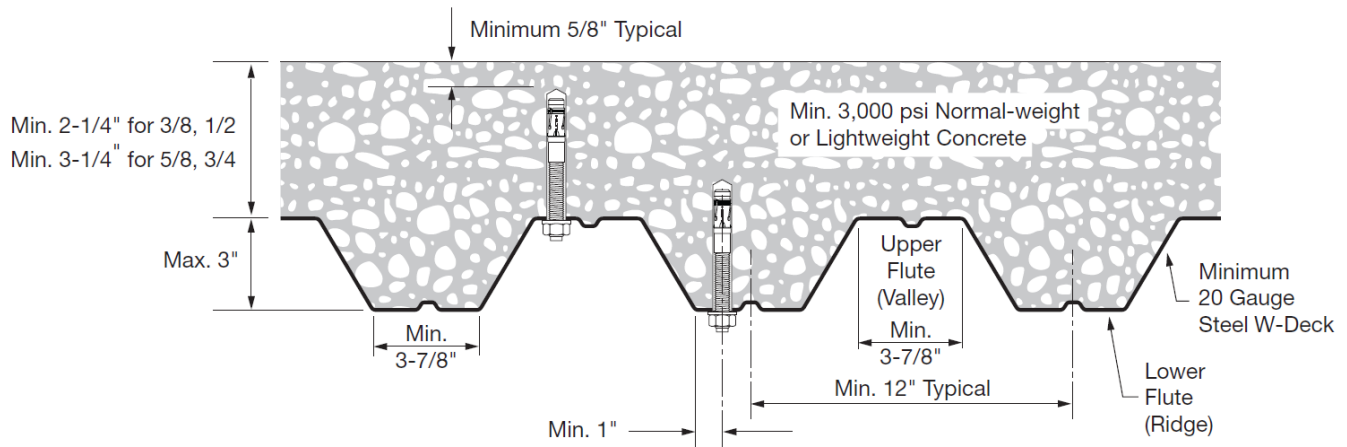


FIGURE 5A—INSTALLATION IN THE SOFFIT OF CONCRETE OVER METAL DECK FLOOR AND ROOF ASSEMBLIES – W DECK^{1,2}

¹ Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum hole clearance is satisfied. Anchors in the lower flute may be installed with a maximum 1/8-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

² Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum concrete thickness above the upper flute is satisfied and the minimum hole clearance of 5/8 in. is satisfied.

TABLE 5B—HILTI KB-VTZ ANCHORS TENSION AND SHEAR DESIGN DATA FOR INSTALLATION IN THE SOFFIT OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES ACCORDING TO FIGURE 5B^{1,2,3,4}

| DESIGN INFORMATION | Symbol | Units | Anchor Diameter | | | | |
|---|-------------------|-------------|-----------------|-----------------|----------------|-----------------|-----------------|
| | | | $\frac{3}{8}$ | $\frac{1}{2}$ | $\frac{5}{8}$ | $\frac{3}{4}$ | $\frac{7}{8}$ |
| Effective Embedment Depth | h_{ef} | in. (mm) | 1½ (38) | 2 (51) | 2 (51) | 3¼ (83) | 2¾ (70) |
| Minimum Hole Depth | h_o | in. (mm) | 2 (51) | 2½ (64) | 2¾ (70) | 4 (102) | 3⅝ (92) |
| Strength in tension | | | | | | | |
| Pullout Resistance, uncracked concrete ⁵ | $N_{p,deck,uncr}$ | lb (kN) | 1,180 (5.2) | 1,540 (6.9) | 1,870 (8.3) | 2,690 (12.0) | 2,380 (10.6) |
| Pullout Resistance, cracked concrete ⁶ | $N_{p,deck,cr}$ | lb (kN) | 660 (2.9) | 1,260 (5.6) | 1,470 (6.5) | 1,600 (7.1) | 1,910 (8.5) |
| Pullout Resistance, seismic ⁶ | $N_{p,deck,eq}$ | lb (kN) | 660 (2.9) | 1,260 (5.6) | 1,470 (6.5) | 1,600 (7.1) | 1,910 (8.5) |
| Strength in shear | | | | | | | |
| Steel Strength in Shear ⁷ | $V_{sa,deck}$ | lb (kN) | 1,750 (7.8) | 2,550 (11.3) | 2,080 (9.3) | 3,490 (15.5) | 2,310 (10.3) |
| Steel Strength in Shear, Seismic ⁸ | $V_{sa,deck,eq}$ | lb (kN) | 1,590 (7.1) | 2,450 (10.9) | 2,080 (9.3) | 3,490 (15.5) | 1,570 (7.0) |

For SI: 1 inch = 25.4 mm, 1 lb. = 4.45 N, 1 psi = 0.00689 MPa. For pound-inch units: 1 mm = 0.0394 inches.

- ¹ Installations must comply with Sections 4.1.10 and 4.3 and Figure 5B of this report.
- ² The values for ϕ_p in tension and ϕ_{sa} in shear can be found in Table 4 of this report.
- ³ The characteristic pullout resistance for concrete compressive strengths greater than 3,000 psi may be increased by multiplying the value in the table by $(f'_c / 3,000)^{1/2}$ for psi or $(f'_c / 20.7)^{1/2}$ for MPa [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].
- ⁴ Evaluation of concrete breakout capacity in accordance with ACI 318-14 17.4.2, 17.5.2 and 17.5.3 or ACI 318-11 D.5.2, D.6.2, and D.6.3, as applicable, is not required for anchors installed in the deck soffit.
- ⁵ The values listed must be used in accordance with Section 4.1.4 of this report.
- ⁶ The values listed must be used in accordance with Sections 4.1.4 and 4.1.8.2 of this report.
- ⁷ The values listed must be used in accordance with Section 4.1.5 of this report.
- ⁸ The values listed must be used in accordance with Section 4.1.8.3 of this report. Values are applicable to both static and seismic load combinations.

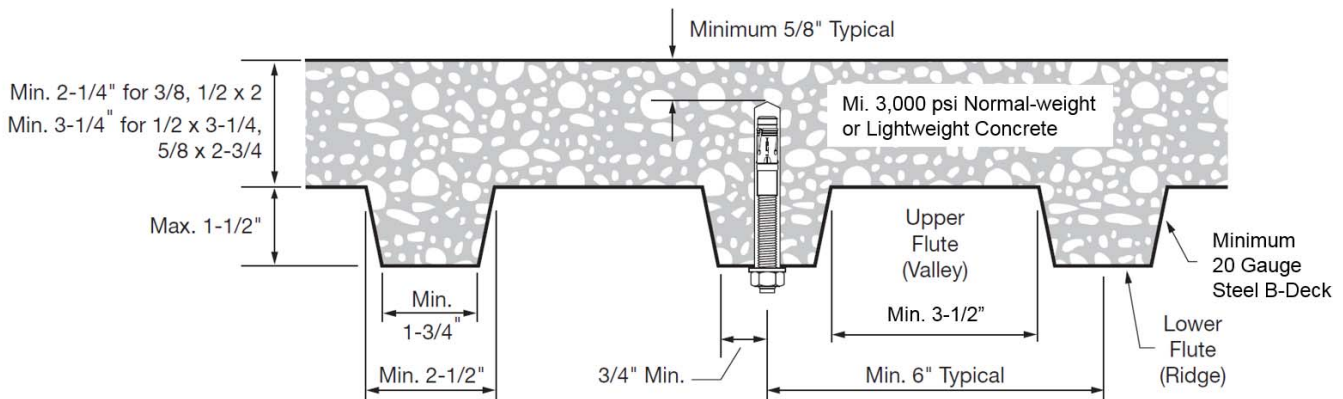


FIGURE 5B—INSTALLATION IN THE SOFFIT OF CONCRETE OVER METAL DECK FLOOR AND ROOF ASSEMBLIES – B DECK^{1,2}

- ¹ Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum hole clearance is satisfied. Anchors in the lower flute may be installed with a maximum ⅛-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.
- ² Anchors may be placed in the upper flute of the steel deck profiles in accordance with Figure 5B provided the concrete thickness above the upper flute is satisfied and the minimum hole clearance of ⅝-inch is satisfied.

TABLE 5C—HILTI KB-VTZ ANCHORS SETTING INFORMATION FOR INSTALLATION ON THE TOPSIDE OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES ACCORDING TO FIGURE 5C^{1,2,3,4}

| DESIGN INFORMATION | Symbol | Units | Nominal anchor diameter | |
|---|--------------------|-----------------|---|--|
| | | | ³ / ₈ | |
| Effective Embedment Depth | h_{ef} | in. (mm) | 1 ¹ / ₂ (38) | 2 (51) |
| Nominal Embedment Depth | h_{nom} | in. (mm) | 1 ¹³ / ₁₆ (46) | 2 ⁵ / ₁₆ (59) |
| Minimum Hole Depth | h_o | in. (mm) | 2 (51) | 2 ¹ / ₂ (64) |
| Minimum concrete thickness ⁵ | $h_{min,deck}$ | in. (mm) | 2 ¹ / ₄ (57) | 3 ¹ / ₄ (83) |
| Critical edge distance | $C_{ac,deck,top}$ | in. (mm) | 6 (152) | 5 (127) |
| Minimum edge distance | $C_{min,deck,top}$ | in. (mm) | 6 (152) | 2-3/4 (70) |
| Minimum spacing | $S_{min,deck,top}$ | in. (mm) | 5 ¹ / ₂ (140) | 6 (152) |
| Required Installation Torque | T_{inst} | ft.-lb (N-m) | 20 (27) | 20 (27) |

For SI: 1 inch = 25.4 mm, 1 lb = 4.45 N, 1 psi = 0.00689 MPa. For pound-inch units: 1 mm = 0.0394 inches.

¹ Installation must comply with Sections 4.1.10 and 4.3 and Figure 5C of this report.

² For all other anchor diameters and embedment depths refer to Table 3 for applicable values of h_{min} , C_{min} , and S_{min} .

³ Design capacity shall be based on calculations according to values provided in Table 4 of this report.

⁴ Applicable for a concrete thickness above the upper flute of metal deck less than h_{min} as shown in Table 3 of this report. For a concrete thickness above the upper deck flute equal to or greater than h_{min} shown in Table 3 refer to all setting information and values in Table 3.

⁵ Minimum concrete thickness refers to concrete thickness above upper flute. See Figure 5C.

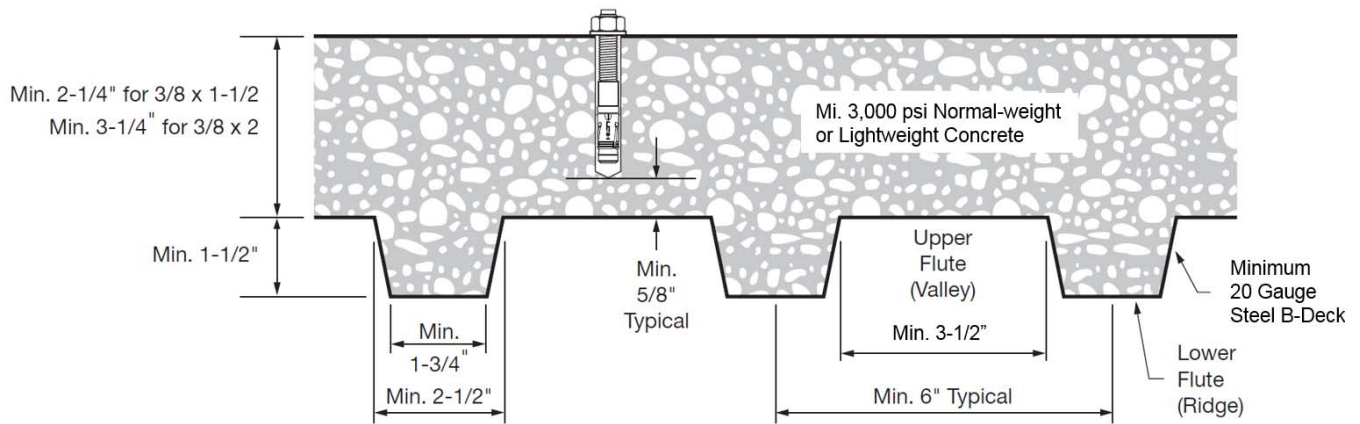


FIGURE 5C—INSTALLATION ON THE TOP OF CONCRETE OVER METAL DECK FLOOR AND ROOF ASSEMBLIES – B DECK^{1,2}

¹ Refer to Table 5C for setting information for anchors installed over the topside of concrete-filled metal deck assemblies.

² Applicable for 2¹/₄-in ≤ h_{min} < 4-in. For h_{min} ≥ 4-inch use setting information in Table 3 of this report.

TABLE 6—EXAMPLE ALLOWABLE STRESS DESIGN LOADS (30% DEAD LOAD, 70% LIVE LOAD) FOR ILLUSTRATIVE PURPOSES

| Nominal Anchor diameter (in.) | Embedment depth | | Allowable tension load for $f'_c = 2,500$ psi | |
|-------------------------------|-----------------|-------|---|--------|
| | in. | (mm) | lb | (kN) |
| $\frac{3}{8}$ | 1½ | (38) | 931 | (4.1) |
| | 2 | (51) | 1,090 | (4.9) |
| $\frac{1}{2}$ | 2 | (51) | 1,340 | (6.0) |
| | 3¼ | (83) | 2,400 | (10.7) |
| $\frac{5}{8}$ | 2¾ | (79) | 2,120 | (9.4) |
| | 4 | (102) | 2,770 | (12.3) |
| $\frac{3}{4}$ | 3⅞ | (95) | 2,910 | (13.0) |
| | 4¾ | (121) | 4,640 | (20.6) |

For SI: 1 inch = 25.4 mm, 1 lb = 4.45 N, 1 psi = 0.00689 MPa. For pound-inch units: 1 mm = 0.0394 inches.

¹ Single anchors with static tension load only.

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

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

⁴ 30% dead load and 70% live load with controlling LRFD load combination 1.2D + 1.6 L.

⁵ Calculation of the weighted average $\alpha = (0.3 \cdot 1.2 + 0.7 \cdot 1.6) / 1.0 = 1.48$.

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

⁷ $C_{a1} = C_{a2} \geq C_{ac}$

⁸ $h \geq h_{min}$

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

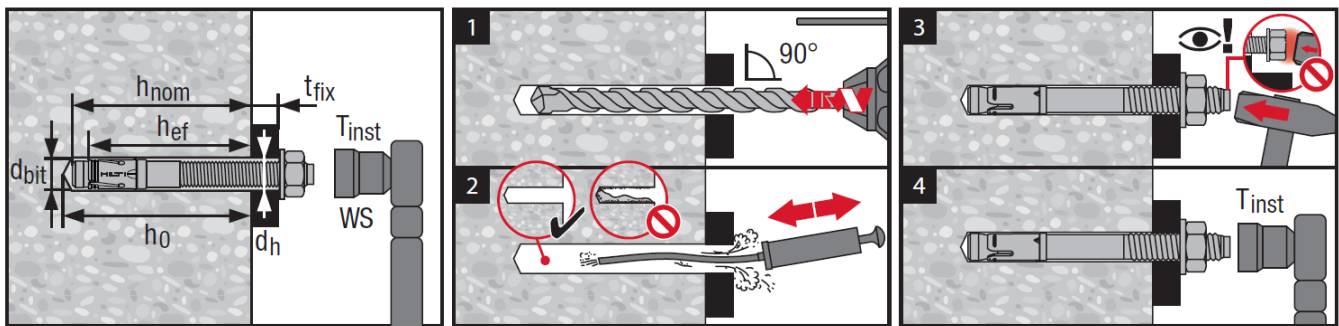
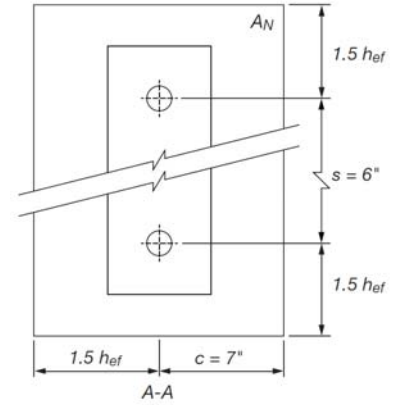
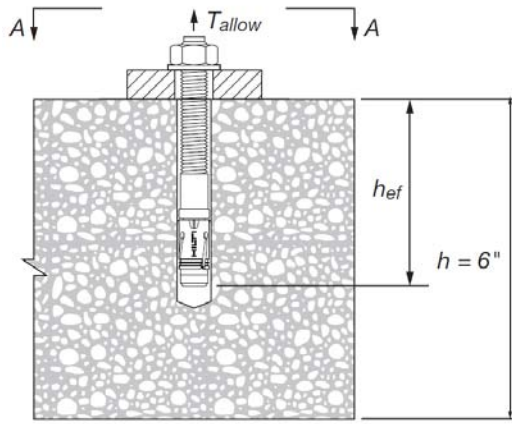


FIGURE 5—INSTALLATION INSTRUCTIONS

Given:

- Two 1/2-inch KB-VTZ anchors with $h_{ef} = 3.25$ in. under static tension load with installation dimensions shown in the figure to the right
- Normal weight concrete with $f'_c = 3,000$ psi
- 30% dead load, 70% live load
- No supplementary reinforcement (Condition B per ACI 318-14 17.3.3(c) or ACI 318-11 D.4.3(c), as applicable)
- Assume cracked concrete since no concrete condition information is available

Needed: Using Allowable Stress Design (ASD), calculate the allowable tension load for this configuration.



| Calculation per ACI 318-14 Chapter 17, ACI 318-11 Appendix D and this report | ACI 318-14 Ref. | ACI 318-11 Ref. | Report Ref. | |
|--|-----------------------|---------------------|---------------------|---------------------------------|
| <p>Step 1. Calculate steel capacity, $\phi \cdot n \cdot N_s$</p> $\phi \cdot n \cdot N_s = \phi \cdot n \cdot A_{se} \cdot f_{uta} = 0.75 \cdot 2 \cdot 0.103 \text{ in}^2 \cdot 104,500 \text{ psi} = 16,145 \text{ lb}$ <p>Check whether f_{uta} is not greater than $1.9 f_{ya}$ and 125,000 psi.</p> $1.9 \cdot f_{ya} = 1.9 \cdot 83,500 = 158,650 \text{ psi} > 125,000 \text{ psi} > f_{uta} = 104,500 \text{ psi} \therefore \text{okay}$ | 17.3.3(a) | D.4.3(a) | Table 4 | |
| <p>Step 2. Calculate concrete breakout strength of anchor in tension using steps 2a through 2h</p> | 17.4.1.2 | D.5.1.2 | §4.1.2 | |
| <p>Step 2a. Verify minimum member thickness, spacing and edge distance:</p> $h = 6 \text{ in.} \geq h_{min} = 6 \text{ in.} \therefore \text{okay}$ $\text{slope} = \frac{2.75-6}{5-4} = -3.25$ <p>For $c_{min} = 7 \text{ in.}$,</p> $s_{min} = 6 - (2.75 - 7)(-3.25) = -7.81 < 6 \text{ in.} \therefore \text{okay}$ | | 17.7 | D.8 | Table 3 Figure 3 Figure 4 |
| <p>Step 2b. Calculate A_{Nco} and A_{Nc} for the group:</p> $A_{Nco} = 9h_{ef}^2 = 9 \cdot (3.25)^2 = 95.1 \text{ in.}^2$ $A_{Nc} = (1.5h_{ef} + c)(3h_{ef} + s) = [1.5 \cdot (3.25) + 7][3 \cdot (3.25) + 6] = 187 \text{ in.}^2 < 2 \cdot A_{Nco} = 190 \text{ in.}^2 \therefore \text{okay}$ | 17.4.2.1 | D.5.2.1 | Table 4 | |
| <p>Step 2c. Determine $\Psi_{ec,N}$: $e'_n = 0 \therefore \Psi_{ec,N} = 1.0$</p> | 17.4.2.4 | D.5.2.4 | - | |
| <p>Step 2d. Calculate breakout capacity of a single anchor</p> $N_b = k_{cr} \lambda \alpha \sqrt{f'_c} h_{ef}^{1.5} = 17 \cdot 1.0 \cdot \sqrt{3,000} \cdot 3.25^{1.5} = 5456 \text{ lb.}$ | 17.4.2.2 | D.5.2.2 | Table 4 | |
| <p>Step 2e. Determine $\Psi_{ed,N}$: $c_{a,min} \geq 1.5 \cdot h_{ef} \therefore \Psi_{ed,N} = 1.0$</p> | 17.4.2.5 | D.5.2.5 | Table 4 | |
| <p>Step 2f. Determine $\Psi_{c,N}$: $\Psi_{c,N} = 1.0$ for both cracked and uncracked concrete with k_{cr} and k_{uncr} from Table 4.</p> | 17.4.2.6 | D.5.2.6 | Table 4 | |
| <p>Step 2g. Determine $\Psi_{cp,N}$: $\Psi_{cp,N} = 1.0$ for cracked concrete.</p> | - | - | § 4.1.10 Table 4 | |
| <p>Step 2h. Calculate $\phi \cdot N_{cbg} = \phi \cdot \frac{A_{Nc}}{A_{Nco}} \cdot \Psi_{ec,N} \cdot \Psi_{ed,N} \cdot \Psi_{c,N} \cdot \Psi_{cp,N} \cdot N_b = 0.65 \cdot \frac{187}{190} \cdot 1.0 \cdot 1.0 \cdot 1.0 \cdot 1.0 \cdot 5456 = 6,977 \text{ lb}$</p> | 17.4.2.1 17.3.3(c) | D.5.2.1 D.4.3(c) | § 4.1.3 Table 4 | |
| <p>Step 3. Check pullout strength: Table 3, $\phi \cdot n \cdot N_{p,cr} \cdot \sqrt{\frac{f'_c}{2,500 \text{ psi}}} = 0.65 \cdot 2 \cdot 3260 \cdot \sqrt{\frac{3000 \text{ psi}}{2,500 \text{ psi}}} = 4,642 \text{ lb}$</p> | 17.4.3.2 17.3.3(c) | D.5.3.2 D.4.3(c) | § 4.1.4 Table 4 | |
| <p>Step 4. Controlling strength: $\phi \cdot n \cdot N_s = 16,145 \text{ lb}$; $\phi \cdot N_{cbg} = 6,977 \text{ lb}$; $\phi \cdot n \cdot N_{p,cr} = 4,642 \text{ lb}$</p> <p style="text-align: center;">\therefore pullout strength controls</p> | 17.3.1.2 | D.4.1.2 | Table 4 | |
| <p>Step 5. To convert to ASD with 30% DL and 70% LL,</p> $4,642 / ((1.2 \cdot 0.3 + 1.6 \cdot 0.7) / 1.0) = 3,136 \text{ lb}$ | - | - | § 4.2 | |

FIGURE 6—EXAMPLE CALCULATION

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:**

HILTI, INC.

EVALUATION SUBJECT:**HILTI KB-VTZ CARBON STEEL ANCHORS IN CRACKED AND UNCRACKED CONCRETE****1.0 REPORT PURPOSE AND SCOPE****Purpose:**

The purpose of this evaluation report supplement is to indicate that the Hilti KB-VTZ carbon steel anchors in cracked and uncracked concrete, described in ICC-ES evaluation report [ESR-3904](#), have also been evaluated for compliance with the codes noted below as adopted by Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:

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

2.0 CONCLUSIONS

The Hilti KB-VTZ carbon steel anchors in cracked and uncracked concrete, described in Sections 2.0 through 7.0 of the evaluation report [ESR-3904](#), comply with LABC Chapter 19, and LARC, and are subject to the conditions of use described in this report.

3.0 CONDITIONS OF USE

The Hilti KB-VTZ carbon steel anchors in cracked and uncracked concrete described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report [ESR-3904](#).
- The design, installation, conditions of use and labeling of the anchors are in accordance with the 2018 *International Building Code*® (2018 IBC) provisions noted in the evaluation report [ESR-3904](#).
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.
- Under the LARC, an engineered design in accordance with LARC Section R301.1.3 must be submitted.
- The allowable and strength design values listed in the evaluation report and tables are for the connection of the anchors to the concrete. The connection between the anchors and the connected members shall be checked for capacity (which may govern).
- For the design of wall anchorage assemblies to flexible diaphragms, the anchor shall be designed per the requirements of City of Los Angeles Information Bulletin P/BC 2020-071.

This supplement expires concurrently with the evaluation report, reissued December 2019 and revised January 2020.

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:

HILTI, INC.

EVALUATION SUBJECT:

HILTI KB-VTZ CARBON STEEL ANCHORS IN CRACKED AND UNCRACKED CONCRETE

1.0 REPORT PURPOSE AND SCOPE**Purpose:**

The purpose of this evaluation report supplement is to indicate that the Hilti KB-VTZ Carbon Steel Anchors in cracked and uncracked concrete, recognized in ICC-ES master evaluation report ESR-3904, have also been evaluated for compliance with the codes noted below.

Applicable code editions:

- 2017 *Florida Building Code—Building*
- 2017 *Florida Building Code—Residential*

2.0 CONCLUSIONS

The Hilti KB-VTZ Carbon Steel Anchors in cracked and uncracked concrete, described in Sections 2.0 through 7.0 of the master evaluation report ESR-3904, comply with the *Florida Building Code—Building* and the *Florida Building Code—Residential*, provided the design and installation are in accordance with the 2015 *International Building Code*® provisions noted in the master report.

Use of the Hilti KB-VTZ Carbon Steel Anchors in cracked and uncracked concrete for use in dry, interior locations have also been found to be in compliance with the High-Velocity Hurricane Zone Provisions of the *Florida Building Code—Building* and the *Florida Building Code—Residential*.

For products falling under Florida Rule 9N-3, verification that the report holder's quality assurance program is audited by a quality assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official, when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the evaluation report, reissued December 2019 and revised January 2020.