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HILTI® KB1 EXPANSION ANCHORS FOR USE IN CRACKED AND UNCRACKED CONCRETE

CSI Division:
05 00 00—METALS

CSI Section:
05 05 19—Post-installed Concrete Anchors

1.0 RECOGNITION

HILTI KB1 Expansion Anchors recognized in this report have been evaluated for use as torque-controlled, mechanical expansion anchors. The structural performance properties of the HILTI KB1 Expansion Anchors comply with the intent of the provisions of the following codes and regulations:

- 2021, 2018, 2015, and 2012 International Building Code® (IBC)
- 2021, 2018, 2015, and 2012 International Residential Code® (IRC)
- 2023 City of Los Angeles Building Code (LABC) – attached Supplement
- 2023 City of Los Angeles Residential Code (LARC) – attached supplement
- 2020 Florida Building Code, Building (FBC–Building) – attached supplement
- 2020 Florida Building Code, Residential (FBC–Residential) – attached supplement

2.0 LIMITATIONS

Use of the HILTI KB1 Expansion Anchors recognized in this report is subject to the following limitations:

2.1 The anchors shall be installed in accordance with the IBC or IRC, this report, and the manufacturer's printed installation instructions (MPII). Where conflicts occur, the more restrictive governs.

2.2 The anchor sizes, dimensions, and minimum embedment depths shall be as set forth in this report.

2.3 The anchors shall be installed in cracked and uncracked normal-weight or lightweight concrete having a specified compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,500 psi (58.6 MPa), 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).

2.4 For calculation purposes, the compressive strength value, f'_c, shall not exceed 8,000 psi (55.2 MPa).

2.5 Strength design values shall be determined in accordance with Section 3.2.1 of this report. Loads applied to the anchors shall be adjusted in accordance with Section 1605.2 of the IBC for strength design.

2.6 Allowable stress design values shall be determined in accordance with Section 3.2.2 of this report. Loads applied to the anchors shall be adjusted in accordance with Section 1605.3 of the IBC.

2.7 Anchor spacing, edge distance, and minimum concrete thickness shall comply with Table 3 of this report.

2.8 Prior to installation, calculations and design details that demonstrate compliance with this report shall be submitted to the building official. The calculations and design details shall be prepared by a registered design professional where required by the laws and statutes of the jurisdiction in which the construction is to occur.

2.9 Since suitable criteria for evaluating performance is not available, the use of the subject anchors for fatigue or shock loading conditions is beyond the scope of this report.

2.10 Use of zinc-plated carbon steel anchor is limited to dry, interior locations.

2.11 Periodic special inspection shall be provided in accordance with Section 3.4 of this report.

2.12 Where not otherwise prohibited in the applicable code, anchors are permitted for use with fire-resistant-rated construction provided at least one of the following conditions is satisfied:

- Anchors are used to resist wind or seismic forces only.
- Anchors that support fire-resistance-rated construction or gravity load-bearing structural elements are within a fire-resistance-rated envelope or a fire-resistance 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.

2.13 Anchors are manufactured by Hilti AG.

3.0 PRODUCT USE

3.1 General: The KB1 Expansion Anchors are used to resist static, wind, and seismic (Seismic Design Categories A through F under the IBC) tension and shear loads in cracked and uncracked normal-weight concrete that has a specified compressive strength, f'_c, between 2,500 psi (17.2 MPa) and 8,500 psi (58.6 MPa), 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). Cracked concrete shall be assumed except for anchors located in a region of the concrete member where analysis indicates no cracking (uncracked) at service loads or restrained shrinkage in accordance with ACI 318-19 17.6.2.5 and 17.7.2.5. Cracked concrete also shall be assumed for anchors in structures assigned to Seismic Design Category C, D, E, or F.

The anchors comply with Section 1901.3 of the 2021, 2018, and 2015 IBC, and Section 1909 of the 2012 IBC. The anchors are alternatives to cast-in-place anchors described in Section 1908 of the 2012 IBC. The anchors may be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

Installation instructions and information are set forth in Section 3.3, Tables 1 through 3, and Figures 1 and 6 of this report.

3.2 Design

3.2.1 Strength Design

3.2.1.1 General: The design strength of anchors complying with the 2021 IBC, shall be determined in accordance with ACI 318-19 Chapter 17 and this report.

The design strength of anchors complying with the 2018 and 2015 IBC, or with Section R301.1.3 of the 2018 and 2015 IRC, shall be determined in accordance with ACI 318-14 Chapter 17 and this report.

The design strength of anchors complying with the 2012 IBC, or with Section R301.1.3 of the 2012 IRC, shall be determined in accordance with ACI 318-11 Appendix D and this report.

The strength design of anchors shall comply with ACI 318-19 17.5.1.2, ACI 318-14 17.3.1, or ACI 318-11 D.4.1, except as required in ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3. Strength reduction factors, ϕ, as given in ACI 318-19 17.5.3, ACI 318-14 17.3.3 (D.4.3 in ACI 318-11) and noted in Tables 3 and 4 of this report, shall be used for load combinations calculated in accordance with Section 1605.1 of the 2021 IBC or Section 1605.2 of the 2018, 2015, or 2012 IBC and ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2. Under the 2021, 2018, and 2015 IBC and IRC, anchor group effects shall be considered in accordance with ACI 318 (-19 or -14) 17.2.1.1. Strength reduction factors, ϕ, described in ACI 318-11 D.4.4 shall be used for load combinations calculated in accordance with ACI 318-11 Appendix C.

The value of f'_c used in the calculations shall be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318-19 17.3.1, ACI 318-14 17.2.7, or ACI 318-11 D.3.7.

Table 4 of this report provides the mean axial stiffness values, β, for each diameter in normal-weight concrete.

3.2.1.2 Requirements for Static Steel in Tension, N_{sa}: The nominal static steel strength of a single anchor in tension, N_{sa}, calculated in accordance with ACI 318-19 17.6.1.2, ACI 318-14 17.4.1.2, or ACI 318-11 D.5.1.2, as applicable, is given in Table 4 of this report. The strength reduction factors, ϕ, associated with ductile steel elements listed in Table 4 of this report shall be used.

3.2.1.3 Requirements for Static Concrete Breakout Strength in Tension, N_{cb} or N_{cbg}: The nominal concrete breakout strength of a single anchor or group of anchors in tension, N_{cb} or N_{cbg}, respectively shall be calculated in accordance with ACI 318-19 17.6.2, ACI 318-14 17.4.2, or ACI 318-11 D.5.2, with modifications as described herein. The basic concrete breakout strength in tension, N_b, shall be calculated in accordance with ACI 318-19 17.6.2.2, ACI 318-14 17.4.2.2, or ACI 318-11 D.5.2.2, using the values of h_{ef} and k_{cr} as listed in Table 3 of this report. The nominal concrete breakout strength in tension in regions where analysis indicates no cracking in accordance with ACI 318-19 17.6.2.5, ACI 318-14 17.4.2.6, or ACI 318-11 D.5.2.6 shall be calculated with the value of k_{uncr} as listed in Table 4 of this report and with $\psi_{c,N} = 1.0$.

3.2.1.4 Requirements for Static Pullout Strength in Tension, N_{pn}: The nominal pullout strength of a single anchor in tension in accordance with ACI 318-19 17.6.3.1 and 17.6.3.2, ACI 318-14 17.4.3.1, or ACI 318-11 D.5.3.1 in cracked and uncracked concrete, $N_{p,cr}$ and $N_{p,uncr}$, respectively, is listed in Table 4 of this report. In lieu of ACI 318-19 17.6.3.3, ACI 318-14 17.4.3.6 or ACI 318-11 D.5.3.6, $\psi_{c,P} = 1.0$ for all design cases. The nominal pullout strength in cracked concrete shall be adjusted using Eq-1 of this report:

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

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

where f'_c is the specified concrete compressive strength and n is the concrete strength influencing factor, which is noted in Table 4 of this report.

In regions where analysis indicates no cracking in accordance with ACI 318-19 17.6.3.3, ACI 318-14 17.4.3.6, or ACI 318-11 D.5.3.6, the nominal pullout strength in tension shall be adjusted using Eq-2 of this report:

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

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

where f'_c is the specified concrete compressive strength and n is the concrete strength influencing factor, which is noted in Table 4 of this report.

Where values for $N_{p,cr}$ or $N_{p,uncr}$ are not listed in Table 4 of this report, the pullout strength in tension is not a controlling element and need not be evaluated.

The nominal pullout strength in tension of the anchors installed in the soffit of sand-lightweight or normalweight concrete-filled steel deck floor and roof assemblies, as shown in Figures 4A and 4B, is provided in Table 6 of this report. In accordance with ACI 318-19 17.6.3.2.1, ACI 318-14 17.4.3.2, or ACI 318-11 D.5.3.2, as applicable, the nominal pullout strength in cracked concrete shall be calculated according to Eq-1, whereby the value of $N_{p,deck,cr}$ shall be substituted for $N_{p,cr}$ and the value of 3,000 psi (20.7 MPa) shall 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 318-19 17.6.3.3, ACI 318-14 17.4.3.6, or ACI 318-11 D.5.3.6, as applicable, the nominal pullout strength in uncracked concrete shall be calculated according to Eq-2, whereby the value of $N_{p,deck,uncr}$ shall be substituted for $N_{p,uncr}$ and the value of 3,000 psi (20.7 MPa) shall be substituted for the value of 2,500 psi (17.2 MPa) in the denominator.

3.2.1.5 Requirements for Static Steel Strength in Shear, V_{sa}: The nominal steel strength in shear, V_{sa}, of a single anchor in accordance with ACI 318-19 17.7.1.2, ACI 318-14 17.5.1.2, or ACI 318-11 D.6.1.2 is given in Table 5 of this report and shall be used in lieu of the values derived by calculation from ACI 318-19 17.7.1.2b, ACI 318-14 Eq. 17.5.1.2b (Eq. D-29 in ACI 318-11). The strength reduction factors, ϕ, associated with ductile steel elements listed in Table 5 of this report shall be used.

The shear strength, $V_{sa,deck}$, as governed by the KB1 installed in the soffit of sand-lightweight or normalweight concrete on the steel deck floor and roof assemblies, as shown in Figures 4A and 4B, is given in Table 6 of this report.

3.2.1.6 Requirements for Static Concrete Breakout Strength in Shear, V_{cb} or V_{cbg}: The nominal concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg}, respectively, shall be calculated in accordance with ACI 318-19 17.7.2, ACI 318-14 17.5.2, or ACI 318-11 D.6.2, with modifications as described herein. The basic concrete breakout strength in shear, V_b, shall be calculated in accordance with ACI 318-19 17.7.2.2.1, ACI 318-14 17.5.2.2, or ACI 318-11 D.6.2.2 using the values of ℓ_e and d_a given in Table 5 of this report.

3.2.1.7 Requirements for Static Concrete Pryout Strength in Shear, V_{cp}, or V_{cpg}: The nominal concrete pryout strength of a single anchor or group of anchors in shear, V_{cp} or V_{cpg}, shall be calculated in accordance with ACI 318-19 17.7.3, ACI 318-14 17.5.3, or ACI 318-11 D.6.3, modified using the value of k_{cp} provide in Table 5 of this report and the value of N_{cb} or N_{cbg} as calculated in Section 3.2.1.3 of this report.

3.2.1.8 Requirements for Seismic Design

3.2.1.8.1 General: For load combinations including seismic loads, the design calculations shall be performed in accordance with ACI 318-19 17.10, ACI 318-14 17.2.3, or ACI 318-1 D.3.3, as applicable. Modifications to ACI 318-19 17.10, and ACI 318-14 17.2.3 shall be applied under Section 1905.1.8 of the 2021, 2018, and 2015 IBC. For the 2012 IBC, Section 1905.1.9 shall be omitted.

The anchors shall be designed in accordance with ACI 318-19 17.10.5 or 17.10.6; ACI 318-14 17.2.3.4, 17.2.3.5, 17.2.3.6, or 17.2.3.7; ACI 318-11 D.3.3.4, D.3.3.5, D.3.3.6, or D.3.3.7, as applicable. Strength reduction factors, ϕ, are listed in Tables 4 and 5 of this report.

All anchors listed in this report may be installed in structures assigned to IBC Seismic Design Categories A to F.

Section 1905.1.9 of the 2012 IBC shall be replaced with the following:

1905.1.9 ACI 318 Section D.3.3: Delete ACI 318 Sections D.3.3.4.2, D3.3.4.3 (d), and D.3.3.5.2 and replace with the following:

D.3.3.4.2 - Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments shall be designed in accordance with D.3.3.4.3. The anchor design tensile strength shall be determined in accordance with D.3.3.4.4.

Exception:

Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the force determined in accordance with ASCE 7 Equation 12.11-1 or 12.14-10 shall be deemed to satisfy Section D.3.3.4.3 (d).

D.3.3.4.3 (d) – The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include E, with E increased by Ω_o. The anchor design tensile strength shall be calculated from D.3.3.4.4.

D.3.3.5.2 – Where the shear component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor shear force associated *with the same load combination, anchors and their attachments shall be designed in accordance with D.3.3.5.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with D.6.*

3.2.1.8.2 Seismic Tension: The nominal steel strength and nominal concrete breakout strength for anchors in tension shall be calculated in accordance with ACI 318-19 17.6.1 and 17.6.2, ACI 318-14 17.4.1 and 17.4.2, or ACI 318-11 D.5.1 and D.5.2, as described in Sections 3.2.1.2 and 3.2.1.3 of this report. In accordance with ACI 318-19 17.6.3.2.1, ACI 318-14 17.4.3.2, or ACI 318-11 D.5.3.2, the appropriate value for pullout strength in tension for seismic loads, $N_{p,eq}$, as listed in Table 4 of this report, shall be used in lieu of $N_{p,cr}$. $N_{p,eq}$ may be adjusted by calculations in accordance with Eq-3 of this report.

$$N_{p,eq,f'c} = N_{p,eq}\left(\frac{f'_c}{2{,}500}\right)^n \quad \text{(lb, psi)} \qquad \textbf{Eq-3}$$

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

where f'_c is the specified concrete compressive strength and n is the concrete strength influencing factor, which is noted in Table 4 of this report.

Where values for $N_{p,eq}$ are not listed in Table 4 of this report, the pullout strength in tension is not a controlling element and need not be evaluated.

The nominal pullout strength in tension for seismic loads of the anchors installed in the soffit of sand-lightweight or normalweight concrete-filled steel deck floor and roof assemblies, as shown in Figures 4A and 4B of this report, is provided in Table 6. In accordance with ACI 318-19 17.6.3.2.1, ACI 318-14 17.4.3.2, or ACI 318-11 D.5.3.2, as applicable, the nominal seismic pullout strength in cracked concrete shall be calculated according to Eq-3, whereby the value of $N_{p,deck,eq}$ shall be substituted for $N_{p,eq}$ and the value of 3,000 psi (20.7 MPa) shall be substituted for the value of 2,500 psi (17.2 MPa) in the denominator.

3.2.1.8.3 Seismic Shear: The nominal concrete breakout strength and concrete pryout strength for anchors in shear shall be calculated in accordance with ACI 318-19 17.7.2 and 17.7.3, ACI 318-14 17.5.2 and 17.5.3, or ACI 318-11 D.6.2 and D.6.3, as described in Sections 3.2.1.6 and 3.2.1.7 of this report. In accordance with ACI 318-19 17.7.1.2, ACI 318-14 17.5.1.2, or ACI 318-11 D.6.1.2, the appropriate value for nominal steel strength in shear for seismic loads, $V_{sa,eq}$, as listed in Table 5 of this report, shall be used in lieu of V_{sa}.

The seismic shear strength, $V_{sa,deck,eq}$, as governed by the KB1 installed in the soffit of sand-lightweight or normalweight concrete on the steel deck floor and roof assemblies, as shown in Figures 4A and 4B, is given in Table 6 of this report.

3.2.1.9 Requirements for Interaction of Tensile and Shear Forces: Anchors or groups of anchors that are subject to the effects of combined axial tension and shear forces shall be designed in accordance with ACI 318-19 17.8, ACI 318-14 17.6, or ACI 318-11 D.7.

3.2.1.10 Requirements for Critical Edge Distance: In applications where the design edge distance, c, is less than the critical edge distance, 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 318-19 17.6.2, ACI 318-14 17.4.2, or ACI 318-11 D.5.2, shall be further multiplied by the factor $\psi_{cp,N}$, which is given in Eq-4 of this report:

$$\psi_{cp,N} = \frac{c}{c_{ac}} \qquad \textbf{Eq-4}$$

where the factor $\psi_{cp,N}$ need not be taken as less than $\frac{1.5h_{ef}}{c_{ac}}$, where c_{ac} and h_{ef} shall be as listed in Tables 3 and 4 of this report. For all other cases, $\psi_{cp,N} = 1.0$.

3.2.1.11 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: In lieu of ACI 318-19 17.9.2; ACI 318-14 17.7.1, 17.7.3, and 17.7.5; or ACI 318-11 D.8.1 and D.8.3, values of c_{min}, $s_{min,}$ and h_{min} shall comply with the Table 3 of this report. Additional combinations for minimum edge distance c_{min} and spacing s_{min} may be derived by linear interpolation between the given boundary values.

For KB1 anchors installed in the soffit of normal-weight or sand-lightweight concrete over profile steel deck floor and roof assemblies, the anchor shall be installed in accordance with Figure 4A and Figure 4B of this report, and shall have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width.

3.2.1.12 Requirements for Lightweight Concrete: For the use of anchors in lightweight concrete, the modification factor λ_a equal to 0.8λ is applied to all values of $(f'_c)^{0.5}$ affecting N_n and V_n.

For ACI 318-19 (2021 IBC), ACI 318-14 (2018 and 2015 IBC), and ACI 318-11 (2012 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.

3.2.2 Allowable Stress Design

3.2.2.1 General: Design values for use with allowable stress design load combinations calculated in accordance with Section 1605.1 of the 2021 IBC or Section 1605.3 of the

2018, 2015, and 2012 IBC, shall be established using Eq-5 and Eq-6 of this report:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \qquad \textbf{Eq-5}$$

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha} \qquad \textbf{Eq-6}$$

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 with ACI 318 (-19 and -14) Chapter 17, and 2021, 2018 or 2015 IBC Section 1905.1.8, and ACI 318-11 Appendix D, and Section 3.2 of this report, as applicable (lbf or kN)

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined with ACI 318 (-19 and -14) Chapter 17, 2021, 2018, or 2015 IBC Section 1905.1.8, and ACI 318-11 Appendix D, and Section 3.2 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 shall include all applicable factors to account for non-ductile failure modes and required over-strength.

The requirements for member thickness, edge distance, and spacing, described in this report, shall apply.

3.2.2.2 Interaction of Tensile and Shear Forces: Anchors or groups of anchors that are subject to the effects of combined axial tension and shear forces shall be designed in accordance with ACI 318-19 17.8, ACI 318-14 17.6, or ACI 318-11 D.7, as follows:

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

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

For all other cases, Eq-7 of this report shall be satisfied:

$$\frac{T_{applied}}{T_{allowable,ASD}} + \frac{V_{applied}}{V_{allowable,ASD}} \leq 1.2 \qquad \textbf{Eq-7}$$

3.3 Installation: Installation parameters and instructions are provided in Tables 1, 2, and 3, and Figures 1 and 6 of this report. Anchor locations shall comply with this report and the plans and specifications approved by the building official. The KB1 Expansion Anchors shall be installed in accordance with the manufacturer's printed installation instructions and this report. Anchors shall be installed in holes drilled into the concrete using carbide-tipped drill bits that comply with ANSI B212.15-1994. The nominal drill bit diameter shall be equal to that of the anchor and listed in Table 1 of this report. The minimum drilled hole depth is listed in Table 1 of this report. Prior to anchor installation, the dust and debris resulting from drilling shall be removed from the hole using a hand pump, compressed air or a vacuum. The anchor shall be hammered into the predrilled and cleaned hole until the proper nominal embedment depth is achieved. The nut shall be tightened against the washer until the installation torque value, as listed in Table 1 of this report, is achieved or the anchors may be installed using the Hilti AT Tool in accordance with Figure 6.

3.4 Special Inspection: Periodic special inspection is required in accordance with Section 1705.1.1 and Table 1705.3 of the 2021, 2018, 2015, and 2012 IBC, as applicable. The special inspector shall make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, concrete member thickness, anchor spacing, anchor edge distance, drill bit type, drill bit size, hole dimensions, the hole cleaning method, installation torque procedure and verification and adherence to the manufacturer's printed installation instructions. The special inspector shall be present as often as required in accordance with the "statement of special inspection".

4.0 PRODUCT DESCRIPTION

4.1 Product Information: KB1 expansion anchors are torque-controlled, mechanical expansion anchors that are comprised of an anchor body, expansion element (clip), nut, and washer. A typical anchor is shown in Figure 1 of this report.

The anchor body has a tapered mandrel formed on the installed end of the anchor and a threaded upper end. The taper of the mandrel increases in diameter toward the installed end of the anchor. The expansion clip wraps around the tapered mandrel. Before installation, this expansion clip is free to rotate about the mandrel. The anchor is installed in a predrilled hole. When the anchor is set by applying torque to the hex nut, the mandrel is drawn into the expansion clip, which engages the drilled hole and transfers the load to the base material.

The anchors are available in $^3/_8$ inch (9.5 mm), $^1/_2$ inch (12.7 mm), $^5/_8$ inch (15.9 mm), and $^3/_4$ inch (19.05 mm) diameters of various lengths. The product names and sizes are presented in Table 1 of this report.

The KB1 anchor body is manufactured from carbon steel with a 5µm (0.0002 inch) minimum Fe/Zn plating per ASTM F1941. The expansion clip is manufactured from stainless or carbon steel. The nuts conform to the requirements of ASTM A563, Grade A, Hex. The washers conform to the requirements of ASTM F844.

4.2 Concrete Material Information: Normal-weight and lightweight concrete shall comply with Sections 1903 and 1905 of the IBC.

5.0 IDENTIFICATION

Hilti, KB1 expansion anchors are identified in the field by dimensional characteristics and packaging. The packaging label notes the name and address of Hilti; the manufacturing location; the anchor type, size, and length; and the IAPMO UES evaluation report number (ER-678). Either one of the IAPMO UES Marks of Conformity, as noted below, may also be used. The threaded end of each KB1 expansion anchor is stamped with a length identification code letter and a single notch above the letter code as indicated in Table 2 and Figure 2 of this report.

or

IAPMO UES ER-678

6.0 SUBSTANTIATING DATA

Testing and analytical data for cracked and uncracked concrete in accordance with ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), Approved October 2017, editorially revised December 2020, and ACI 355.2, Qualification of Post-Installed Anchors in Concrete, including testing for seismic tension and seismic shear. Test reports are from laboratories accredited to ISO/IEC 17025.

7.0 STATEMENT OF RECOGNITION

This evaluation report describes the results of research completed by IAPMO Uniform Evaluation Service on HILTI KB1 Expansion Anchors to assess conformance to the codes shown in Section 1.0 of this report and serves as documentation of the product certification. Products are manufactured as noted in Section 2.13 of this report under a quality control program with periodic inspection under the supervision of IAPMO UES.

For additional information about this evaluation report please visit www.uniform-es.org or email us at info@uniform-es.org

TABLE 1 - HILTI KB1 EXPANSION ANCHOR INSTALLATION PARAMETERS

Design Information	Symbol	Units	Nominal anchor diameter (in.)							
			3/8		1/2		5/8		3/4	
Nominal drill bit diameter	d_0	in.	3/8		1/2		5/8		3/4	
Effective minimum embedment	h_{ef}	in. (mm)	1-1/2 (38)	2 (51)	2 (51)	3-1/4 (83)	2-3/4 (70)	4 (102)	3-1/4 (83)	4-3/4 (121)
Nominal minimum embedment	h_{nom}	in. (mm)	1-7/8 (48)	2-3/8 (60)	2-3/8 (60)	3-5/8 (92)	3-1/4 (83)	4-1/2 (114)	4 (102)	5-1/2 (140)
Minimum hole depth in concrete	h_o	in. (mm)	2-1/8 (54)	2-3/4 (70)	2-3/4 (70)	4-1/4 (108)	3-3/4 (95)	4-3/4 (121)	4-1/4 (108)	5-3/4 (146)
Fixture hole diameter	d_h	in. (mm)	7/16 (11.1)		9/16 (14.3)		11/16 (17.5)		13/16 (20.6)	
Installation torque	T_{inst}	ft-lb (Nm)	20 (27)		40 (54)		60 (81)		110 (149)	

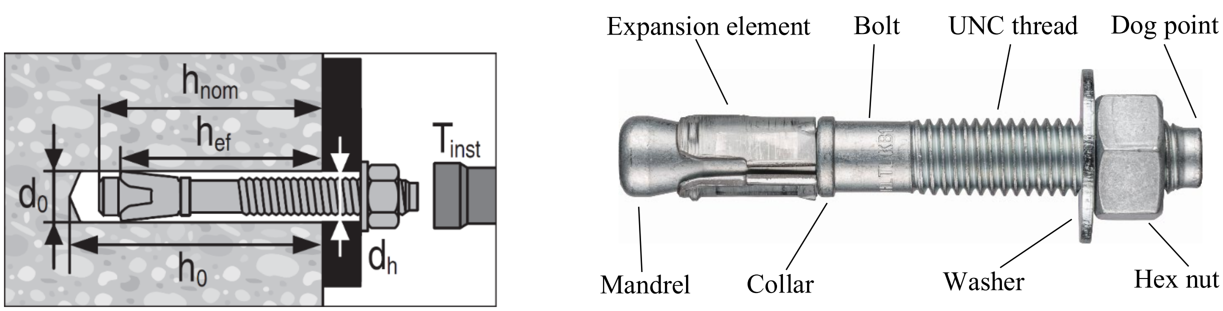


FIGURE 1 - HILTI KB1 INSTALLATION PARAMETERS AND COMPONENTS

TABLE 2 – LENGTH IDENTIFICATION SYSTEM

Stamp on anchor		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 (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

For **SI:** 1 inch = 25.4 mm

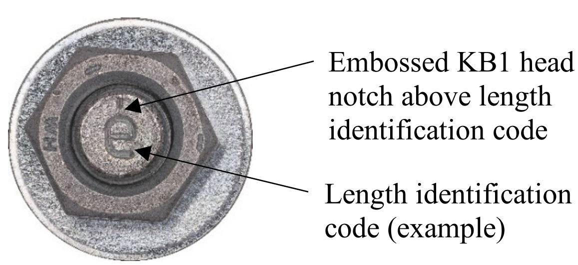


FIGURE 2 – ANCHOR HEAD WITH LENGTH IDENTIFICATION CODE AND KB1 HEAD NOTCH

TABLE 3 - MINIMUM EDGE DISTANCE, SPACING, AND CONCRETE THICKNESS FOR KB1[1]

Setting information	Symbol	Units	Nominal anchor diameter (mm)							
			3/8		1/2		5/8		3/4	
Effective minimum embedment	h_{ef}	in. (mm)	1-1/2 (38)	2 (51)	2 (51)	3-1/4 (83)	2-3/4 (70)	4 (102)	3-1/4 (83)	4-3/4 (121)
Minimum concrete thickness	h_{min}	in. (mm)	3-3/8 (83)	4 (102)	4 (102)	6 (152)	5 (127)	6 (152)	5-1/2 (140)	8 (203)
Minimum edge distance	c_{min}	in. (mm)	8 (203)	2-1/2 (64)	4 (102)	2-3/4 (70)	5-1/2 (140)	4-1/4 (108)	9-1/2 (241)	4-1/2 (114)
	for $s \geq$	in. (mm)	8 (203)	7 (178)	8-1/2 (216)	7 (178)	8 (203)	4-1/4 (108)	5 (127)	7 (178)
Minimum anchor spacing	s_{min}	in. (mm)	8 (203)	3-1/2 (89)	5 (127)	4 (102)	5-1/2 (140)	4-1/4 (108)	5 (127)	4 (102)
	for $c \geq$	in. (mm)	8 (203)	6 (152)	7 (178)	4 (102)	8 (203)	4-1/4 (108)	9-1/2 (241)	6-1/2 (165)

[1] Linear interpolation for c_{min} and s_{min} is permitted. Figure 3 of this report illustrates the interpolation method.

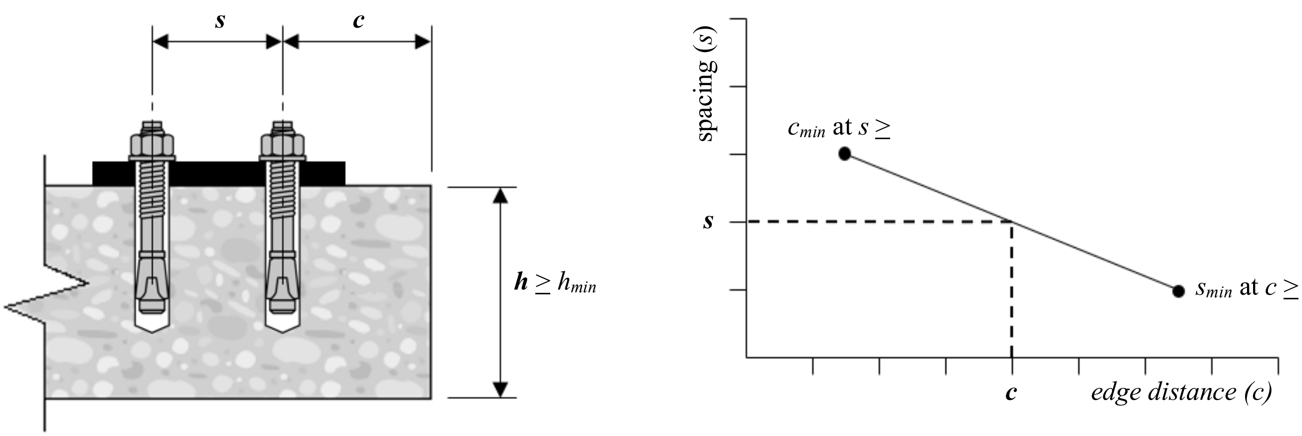


FIGURE 3 – INTERPOLATION OF MINIMUM EDGE AND SPACING DISTANCE

TABLE 4 - HILTI KB1 DESIGN INFORMATION, TENSION

Design parameter	Symbol	Units	Nominal anchor diameter (in)							
			3/8		1/2		5/8		3/4	
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)	3-1/4 (83)	4-3/4 (121)
Tension, steel failure modes										
Strength reduction factor for steel in tension [2]	$\phi_{sa,N}$	-	0.75		0.75		0.75		0.75 [2)]	
Min. specified yield strength	f_{ya}	psi (N/mm^2)	95,100 (656)		84,700 (584)		83,500 (576)		81,200 (560)	
Min. specified ult. strength	f_{uta}	psi (N/mm^2)	118,900 (820)		105,900 (730)		104,400 (720)		101,500 (700)	
Effective-cross sectional steel area in tension	$A_{se,N}$	in^2 (mm^2)	0.053 (34)		0.103 (66)		0.164 (106)		0.239 (154)	
Nominal steel strength in tension	N_{sa}	lb (kN)	6,345 (28.2)		10,860 (48.3)		17,165 (76.4)		24,295 (108.1)	
Tension, concrete failure modes										
Anchor category	-	-	1		1		1		1	
Strength reduction factor for concrete and pullout failure in tension, Condition B [3]	$\phi_{c,N}$, $\phi_{p,N}$	-	0.65		0.65		0.65		0.65	
Effectiveness factor for uncracked concrete	k_{uncr}	-	24		24		24		24	
Effectiveness factor for cracked concrete	k_{cr}	-	17		17		17		21	
Modification factor for anchor resistance, tension, uncracked concrete [4]	$\psi_{c,N}$	-	1.0		1.0		1.0		1.0	
Critical edge distance	c_{ac}	in. (mm)	8.00 (203)	5.00 (127)	6.00 (152)	10.00 (254)	11.00 (279)	9.00 (229)	12.00 (305)	11.00 (279)
Pullout strength in uncracked concrete [5]	$N_{p,uncr}$	lb (kN)	NA	3,185 (14.2)	NA	NA	4,840 (21.5)	9,040 (40.2)	NA	NA
Pullout strength in cracked concrete [5]	$N_{p,cr}$	lb (kN)	NA	NA	NA	NA	NA	NA	4,990 (22.2)	8,895 (39.6)
Pullout strength in cracked concrete, seismic [5]	$N_{p,eq}$	lb (kN)	NA	NA	NA	4,955 (22.0)	NA	NA	4,990 (22.2)	7,995 (35.6)
Tension, axial stiffness										
Axial stiffness uncracked concrete	β_{uncr}	lb/in	152,740		128,110		132,520		132,840	
Axial stiffness, cracked concrete	β_{cr}	lb/in	124,060		66,680		70,180		68,910	

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.00689476 MPa

[1] Figure 1 of this report illustrates the installation parameters.

[2] The KB1 is considered a ductile steel element in accordance with ACI 318-19 17.5.3, ACI 318-14 17.3.3, or ACI 318-11 D.1, except for the 3/4" x 12" KB1, which is considered a brittle steel element with a strength reduction factor for steel in tension, $\phi_{sa,N}$ = 0.65.

[3] For use with the load combinations of ACI 318-19 and -14 5.3, ACI 318-11 9.2, or IBC Section 1605.2. Condition B applies where supplementary reinforcement in conformance with ACI 318 -19 and -14 17.3.3 (c) or ACI 318-11 4.3 (c) is not provided, or where pullout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A for concrete breakout failure may be used.

[4] For all design cases, $\psi_{c,N}$ = 1.0. The appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}) shall be used.

[5] For all design cases, $\psi_{c,P}$ = 1.0. The tabular value for pullout strength is for a concrete compressive strength of 2,500 psi. Pullout strength for concrete compressive strength greater than 2,500 psi may be increased by multiplying the tabular pullout strength by $(f'_c / 2{,}500)^n$ for psi, or $(f'_c / 17.2)^n$ for MPa, where n is as follows:
3/8-in. diameter: n = 0.16
1/2-in. diameter: n = 0.23
5/8-in and 3/4-in diameter: n = 0.50
NA (not applicable) denotes that pullout strength does not need to be considered for design.

TABLE 5 - HILTI KB1 DESIGN INFORMATION, SHEAR

Design parameter	Symbol	Units	Nominal anchor diameter (in)							
			3/8		1/2		5/8		3/4	
Anchor O.D.	d_a	in. (mm)	0.375 (9.5)		0.500 (12.7)		0.625 (15.9)		0.750 (19.1)	
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)	3-1/4 (83)	4-3/4 (121)
Shear, steel failure modes										
Strength reduction factor for steel in shear [2]	$\phi_{sa,V}$	-	0.65		0.65		0.65		0.65 [2)]	
Nominal steel strength in shear	V_{sa}	lb (kN)	2,545 (11.3)		5,220 (23.2)		8,905 (39.6)		10,765 (47.9)	
Nominal steel strength in shear, seismic	$V_{sa,eq}$	lb (kN)	2,545 (11.3)		5,220 (23.2)		8,905 (39.6)		9,150 (40.7)	
Shear, concrete failure modes										
Strength reduction factor for concrete breakout and pryout failure in shear, Condition B [3]	$\phi_{c,V}$, $\phi_{p,V}$	-	0.7		0.7		0.7		0.7	
Load bearing length of anchor in shear	ℓ_e	in. (mm)	1-1/2 (38)	2 (51)	2 (51)	3-1/4 (83)	2-3/4 (70)	4 (102)	3-1/4 (83)	4-3/4 (121)
Effectiveness factor for pryout	k_{cp}	-	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0

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

[1] Figure 1 of this report illustrates the installation parameters.
[2] The KB1 is considered a ductile steel element in accordance with ACI 318-19 17.5.3, ACI 318-14 17.3.3, or ACI 318-11 D.1, except for the 3/4" x 12" KB1, which is considered a brittle steel element with a strength reduction factor for steel in shear, $\phi_{sa,V} = 0.60$.
[3] For use with the load combinations of ACI 318-19 and -14 5.3, ACI 318-11 9.2, or IBC Section 1605.2. Condition B applies where supplementary reinforcement in conformance with ACI 318-19 and -14 17.3.3 (c) or ACI 318-11 4.3 (c) is not provided, or where pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A for concrete breakout failure may be used.

TABLE 6 – HILTI KB1 DESIGN DATA FOR INSTALLATION IN THE SOFFIT OF MIN. 3,000 PSI LIGHTWEIGHT CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES [1,2,3]

Design Information	Symbol	Units	Nominal Anchor Diameter						
			3/8		1/2		5/8		3/4
Effective min. embedment [1]	h_{ef}	in.	1-1/2	2	2	3-1/4	2-3/4	4	3-1/4
Minimum hole depth	h_0	in.	2-1/8	2-3/4	2-3/4	3-7/8	3-1/2	4-3/4	4-1/4
			Loads According to Figure 4A						
Min. concrete thickness over upper flute [4]	$h_{min,deck}$	in.	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2
Pullout strength, uncracked concrete [5,6]	$N_{p,deck,uncr}$	lb	1,575	2,465	2,300	4,195	3,710	5,075	3,515
Pullout strength, cracked concrete [5,6]	$N_{p,deck,cr}$	lb	1,115	1,860	1,630	2,970	2,970	3,815	3,075
Pullout strength, seismic [5,7]	$N_{p,deck,eq}$	lb	1,115	1,860	1,630	2,970	2,970	3,815	3,075
Steel strength in shear [8]	$V_{sa,deck}$	lb	995	2,205	2,280	3,625	3,500	4,740	4,660
Steel strength in shear, seismic [7]	$V_{sa,deck,eq}$	lb	995	2,205	2,280	3,625	3,500	4,740	3,965
			Loads According to Figure 4B						
Min. concrete thickness over upper flute [4]	$h_{min,deck}$	in.	NA	2-1/2	2-1/2	3-1/4	3-1/4	NA	NA
Pullout strength, uncracked concrete [5,6]	$N_{p,deck,uncr}$	lb	NA	1,945	2,085	2,955	2,315	NA	NA
Pullout strength, cracked concrete [5,6]	$N_{p,deck,cr}$	lb	NA	1,470	1,475	2,090	1,855	NA	NA
Pullout strength, seismic [5,7]	$N_{p,deck,eq}$	lb	NA	1,470	1,475	2,090	1,855	NA	NA
Steel strength in shear [8]	$V_{sa,deck}$	lb	NA	2,795	3,100	4,775	3,990	NA	NA
Steel strength in shear, seismic [7]	$V_{sa,deck,eq}$	lb	NA	2,795	3,100	4,775	3,990	NA	NA

[1] Installation shall comply with Figure 1 and Figures 4A or 4B of this report.
[2] The values for $\phi_{p,N}$ in tension may be found in Table 4 of this report. The values for $\phi_{sa,V}$ in shear may be found in Table 5 of this report.
[3] Evaluation of concrete breakout capacity in accordance with ACI 318-19 17.6.2, 17.7.2, 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.
[4] Minimum concrete thickness refers to a concrete thickness above the upper flute. See Figures 4A and 4B.
[5] Characteristic pullout resistance for concrete compressive strengths greater than 3,000 psi (20.7 MPa) may be increased by multiplying the value in the table by $(f'_c / 3000)^n$ for psi or $(f'_c / 20.7)^n$ for MPa, where n = 0.16 for 3/8" dia., n = 0.23 for 1/2" dia., and n = 0.50 for 5/8" and 3/4" dia. anchors.
[6] The values listed shall be used in accordance with Section 3.2.1.4 of this report.
[7] The values listed shall be used in accordance with Sections 3.2.1.4 and 3.2.1.8 of this report.
[8] The values listed shall be used in accordance with Section 3.2.1.5 of this report.

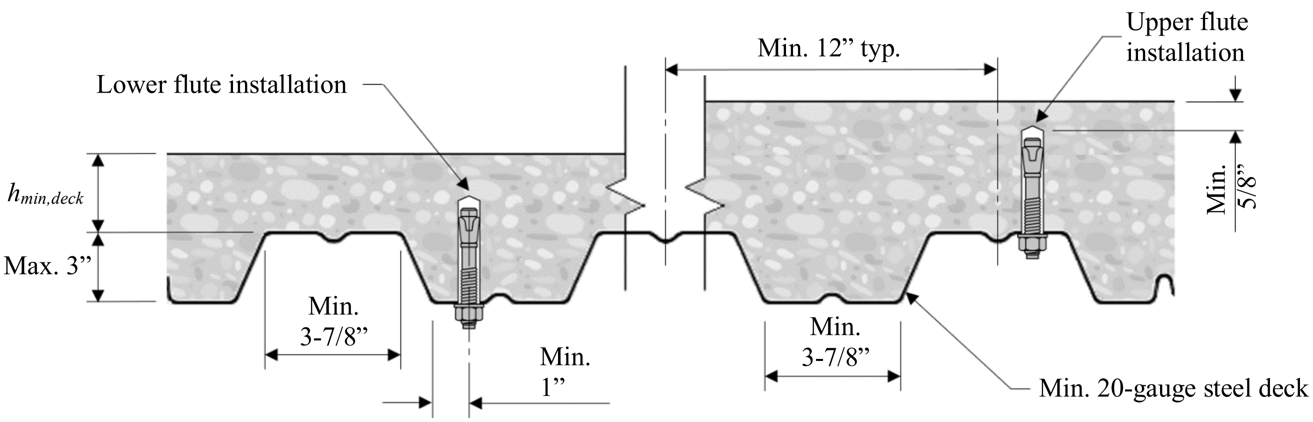


FIGURE 4A – KB1 IN THE SOFFIT OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES – W-DECK

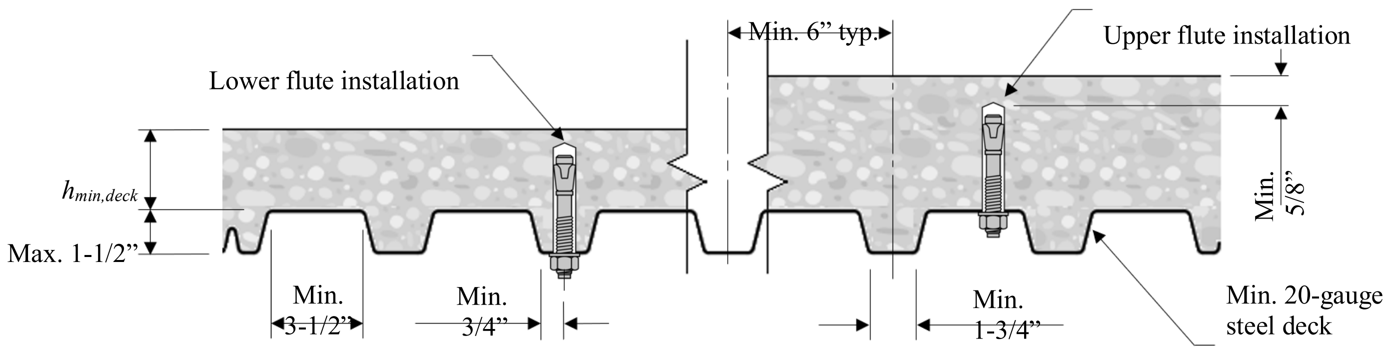
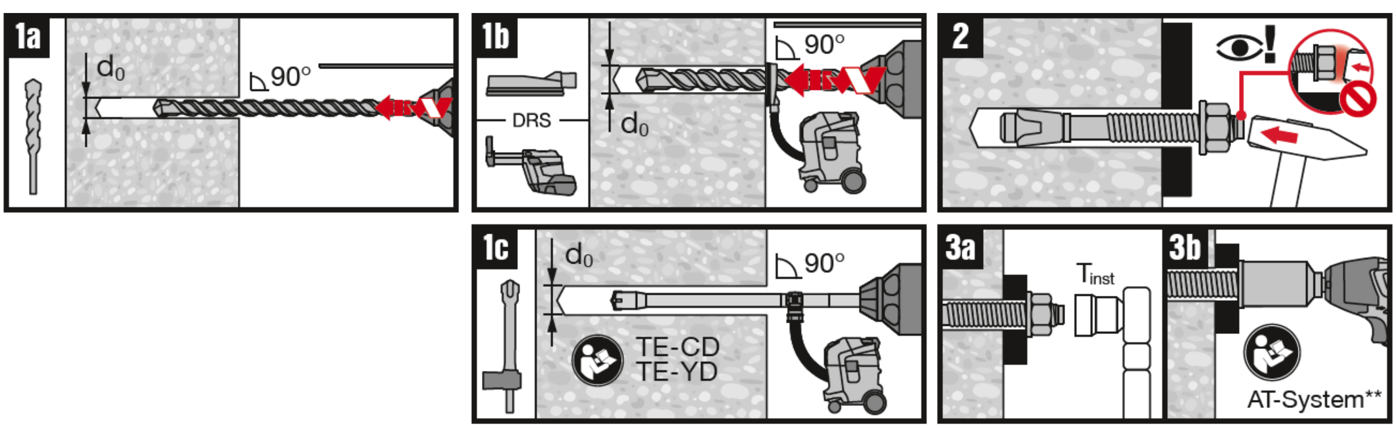


FIGURE 4B – KB1 IN THE SOFFIT OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES – B-DECK

Hilti SafeSet™ System with Hollow Drill Bit	Hilti SafeSet™ System with the Adaptive Torque Tool	Hilti Dust Removal Systems
 Hilti TE-CD or TE-YD Hollow Carbide Drill Bit, with  Hilti Vacuum (per section 4.3)	 Hilti SIW-6AT-A22/SIW-4AT-22/ SIW-6AT-22 Impact Wrench, with  Hilti SI-AT-A22/SI-AT-22 Adaptive Torque Module	 Hilti Rotary Hammer Drill with DRS (Dust Removal System) Module, or  Hilti TE DRS-D Dust Removal System with Hilti Vacuum

FIGURE 5 – HILTI SYSTEM COMPONENTS FOR USE WITH KB1 EXPANSION ANCHORS



Symbol	Setting Information	Units	Anchor Diameter [inch]			
			⅜	½	⅝	¾
HDB	Hollow Drill Bit	–	–	✔	✔	✔
DRS	Dust Removal Systems	–	✔	✔	✔	✔
AT-System	SIW 6AT-A22 + SI AT-A22	–	✔	✔	✔	–
	SIW 4AT-22 + SI-AT-22	–	✔	✔	✔	–
	SIW 6AT-22 + SI-AT-22	–	–	✔	✔	✔

FIGURE 6 – KB1 MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII)

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HILTI® KB1 EXPANSION ANCHORS FOR USE IN CRACKED AND UNCRACKED CONCRETE

CSI Division:
05 00 00 METALS

CSI Section:
05 05 19 Post-installed Concrete Anchors

1.0 RECOGNITION

HILTI KB1 Expansion anchors recognized in ER-678 have been evaluated for use to resist dead, live, wind, and seismic tension and shear loads in cracked and uncracked concrete.

The structural performance properties of the Hilti anchors were evaluated for compliance with the following codes:

- 2023 City of Los Angeles Building Code (LABC)
- 2023 City of Los Angeles Residential Code (LARC)

2.0 LIMITATIONS

Use of the Hilti KB1 Expansion anchors recognized in ER-678 is subject to the following limitations:

2.1 The design, installation, conditions of use, and identification of the Hilti KB1 Expansion anchors shall be in accordance with the 2021 International Building Code and the 2021 International Residential Code, as applicable, as noted in ER-678.

2.2 Prior to installation, calculations and details demonstrating compliance with this approval report and the 2023 Los Angeles Building Code or 2023 Los Angeles Residential Code shall be submitted to the structural plan check section for review and approval. The calculations and details shall be prepared, stamped, and signed by a California registered design professional.

2.3 The design, installation, and inspection of the Hilti KB1 Expansion Anchors shall be in accordance with LABC Chapters 16 and 17, as applicable, due to local amendments to these chapters.

2.4 The allowable and strength design values listed in ER-678 are for the anchors only. Connected members shall be checked for their capacity (which may govern).

2.5 Periodic special inspection shall be provided by the Registered Deputy Inspector in accordance with Section 1705 of the 2023 LABC during installations of the Hilti KB1 Expansion anchors.

2.6 Under the LARC, a design in accordance with Section R301.1.3 shall be submitted.

2.7 This supplement expires concurrently with ER-678.

For additional information about this evaluation report please visit www.uniform-es.org or email us at info@uniform-es.org

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HILTI® KB1 EXPANSION ANCHORS FOR USE IN CRACKED AND UNCRACKED CONCRETE

CSI Division:
05 00 00 METALS

CSI Section:
05 05 19 Post-installed Concrete Anchors

1.0 RECOGNITION

HILTI KB1 Expansion anchors recognized in ER-678 have been evaluated for use to resist dead, live, wind, and seismic tension and shear loads in cracked and uncracked concrete.

The structural performance properties of the Hilti anchors were evaluated for compliance with the following codes:

- 2020 Florida Building Code, Building (FBC–Building)
- 2020 Florida Building Code, Residential (FBC–Residential)

2.0 LIMITATIONS

Hilti KB1 anchors described in ER-678 comply with the 2020 FBC--Building and the 2020 FBC--Residential, subject to the following limitations:

2.1 The design and installation of the Hilti KB1 anchors shall be in accordance with the 2018 International Building Code and the 2018 International Residential Code as noted in ER-678.

2.2 Load combinations shall be in accordance with Sections 1605.2 or 1605.3 of the FBC--Building, as applicable.

2.3 Design wind loads shall be in accordance with Section 1609.5 of the FBC--Building or Section R301.2.1.1 of the FBC--Residential, as applicable, and Section 1620 of the FBC-Building where used in High-velocity Hurricane Zones (HVHZ).

2.4 The use of Hilti KB1 anchors in applications exposed to the weather within High-velocity Hurricane Zones (HVHZ) as set forth in FBC--Building and the FBC--Residential is beyond the scope of this supplement report.

2.5 Use of Hilti KB1 anchors in High-velocity Hurricane Zones (HVHZ) as set forth in Section 2321.5.2 of the FBC--Building and Section 4409 of the FBC--Residential to resist wind uplift is permitted. The anchors shall be designed to resist the uplift forces as required in Section 1620 (HVHZ) of the FBC--Building or 700 pounds (3114 N), whichever is greater, per FBC--Building Section 2321.7.

2.6 For products falling under Section (5)(d) of Florida Rule 61G20-3.008, verification that the report holder's quality assurance program is audited by a quality assurance entity approved by the Florida Building Commission (or the building official when the report holder does not possess an approval by the Commission) is required to provide oversight and determine that the products are being manufactured as described in this evaluation report to establish continual product performance.

2.7 This supplement expires concurrently with ER-678.