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HILTI® KB1 EXPANSION ANCHORS FOR CRACKED AND UNCRACKED GROUTED CONCRETE MASONRY UNIT WALLS

CSI Division:
04 00 00—MASONRY
CSI Section:
04 05 19.16—Masonry Anchors

1.0 RECOGNITION

The Hilti KB1 Expansion Anchors are used as anchorage in cracked and uncracked concrete masonry unit (CMU) walls to anchor building components to grouted lightweight, mediumweight, or normalweight concrete masonry wall construction. The anchor system is designed to resist static, wind, and earthquake (Seismic Design Categories A through F) tension and shear loads.

The anchor system is an alternative to cast-in-place anchors described in Section 9.1.3 of TMS 402 (-22 and -16) and TMS 402-13 as referenced in Section 2108.1 of the IBC.

The anchor system is permitted to be used in structures regulated by the IRC provided an engineered design is submitted in accordance with IRC Section R301.1.3.

The structural performance properties of the Hilti KB1 Expansion Anchors comply with the intent of the provisions of the following codes and regulations:

- 2024, 2021, 2018, and 2015 International Building Code® (IBC)
- 2024, 2021, 2018, and 2015 International Residential Code® (IRC)
- 2023 City of Los Angeles Building Code (LABC) – attached Supplement
- 2023 City of Los Angeles Residential Code (LARC) – attached Supplement
- 2023 Florida Building Code, Building (FBC, Building) – attached Supplement
- 2023 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 Anchors are identified and installed in accordance with this report, the codes and regulations listed in Section 1.0 of this report, and the manufacturer's published installation instructions (MPII). Where conflicts occur, the more restrictive governs.

2.2 Anchors have been evaluated for use in cracked and uncracked grouted concrete masonry unit (CMU) construction with a minimum compressive strength of 1,500 psi (10.3 MPa) at the time of anchor installation.

2.3 Anchor sizes, dimensions, and minimum embedment depths shall be as set forth in this report.

2.4 Anchors installed in the face of fully grouted CMU masonry may be used to resist short-term loading due to wind or seismic forces in structures assigned to Seismic Design Categories A through F under the IBC.

2.5 Loads applied to the anchors shall be adjusted in accordance with Section 1605.1 (2024 and 2021 IBC) or Section 1605.2 (2018 and 2015 IBC) for strength design, and in accordance with Sections 1605.1 or 1605.2 (2024 and 2021 IBC) or Section 1605.3 (2018 and 2015 IBC) for allowable stress design.

2.6 Strength design values shall be established in accordance with Sections 3.1, 3.2, and 3.3 of this report.

2.7 Allowable design values shall be established in accordance with Section 3.4 of this report.

2.8 The design of anchors in fully grouted CMU construction shall avoid locating anchors in hollow head joints. Refer to Section 3.1.3 of this report.

2.9 Anchors shall be installed in accordance with Section 3.5 of this report and with the MPII provided in Figure 5 of this report. The holes for the anchors shall be predrilled with carbide-tipped masonry drill bits complying with ANSI B212.15 and have the same diameter as the nominal diameter of the anchor.

2.10 Since an acceptance criteria for evaluating data to determine the performance of anchors subjected to fatigue or shock loading are unavailable at this time, the use of these anchors under these conditions is outside the scope of this report.

2.11 Where not otherwise prohibited in the applicable code, 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 fire-resistance-rated construction or gravity load-bearing structural elements are within a fire-resistance-rated envelope or a fire-resistance-rated membrane, are protected by approved fire-resistance-rated materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchors are used to support nonstructural elements.

2.12 The design of anchors shall be in accordance with the provisions for cracked masonry where analysis indicates that cracking may occur ($f_t > f_r$) in the vicinity of the anchor due to service loads or deformations over the anchor service life.

2.13 Prior to installation, calculations and details demonstrating compliance with this report shall be submitted to the building official. The calculations and details shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

2.14 Periodic special inspection shall be provided in accordance with Section 3.6 of this report.

2.15 Use of zinc-plated carbon steel anchors is limited to dry, interior locations.

2.16 KB1 Expansion Anchors are manufactured by Hilti AG.

3.0 PRODUCT USE

3.1 Strength Design in Fully Grouted Concrete Masonry Unit Construction

3.1.1 General: This section and Section 3.2 of this report provide strength design requirements for anchors used in fully grouted concrete masonry unit construction, where anchors are used to transmit structural loads through tension, shear, or a combination of tension and shear.

The strength design of mechanical anchors in fully grouted concrete masonry unit construction shall be conducted in accordance with the provisions for the design of mechanical anchors in concrete in *ACI 318 (-19 and -14) Chapter 17* and TMS 402 (-22 and -16) as modified by the sections that follow. Design in accordance with this report shall not be conducted without reference to *ACI 318 (-19 and -14)* with the deletions and modifications summarized in Table 1A and TMS 402 (-22 and -16) Eq. 9-7.

3.1.2 This report references sections, tables, and figures in both this report and ACI 318. The following method is used to distinguish between the two document references:

- References to sections, tables, and figures originating from ACI 318 are *italicized* with the leading reference corresponding to ACI 318-19 and the parenthetical reference corresponding to ACI 318-14. For example, Section 2.2 in ACI 318-19, which is analogous to Section 2.2 in ACI 318-14, will be displayed as *ACI 318-19 Section 2.2 (ACI 318-14 Section 2.2)*.
- References to sections, tables, and figures originating from this report do not have any special font treatment, for example, Section 3.2.1 of this report.

Where language from ACI 318 is directly referenced, the following modifications generally apply:

- The term "masonry" shall be substituted for the term "concrete" wherever it occurs.
- The modification factor to reflect the reduced mechanical properties for mixtures with lightweight aggregate and lightweight units, λ_a, shall be taken as 1.0.

The following terms shall be replaced wherever they occur:

ACI 318 (-19 or -14) Term	Replacement Term
f'_c	f'_m
N_{cb}, N_{cbg}	N_{mb}, N_{mbg}
V_{cb}, V_{cbg}	V_{mb}, V_{mbg}
V_{cp}, V_{cpg}	V_{mp}, V_{mpg}

3.1.3 Restrictions for anchor placement are noted in Table 2 and shown in Figure 4 of this report. For CMU construction with closed-end blocks and hollow head joints, in addition to the ends and edges of the wall, the nearest head joint on a horizontal projection from the anchor shall be treated as an edge for design purposes. The minimum distance from the nearest adjacent head joint shall be the $c_{min,HJ}$ value provided in Table 2 of this report, which is measured from the centerline of the head joint in CMU construction with hollow head joints. For anchor groups installed in CMU construction with solid head joints, the nearest head joint outside of the group on a horizontal projection to the group shall be treated as an edge. If open-ended units are employed, only the ends and edges of walls shall be considered for edge distance determination. For horizontal ledgers in fully-grouted CMU walls with hollow head joint applications, see Section 3.2.22 of this report.

3.2 ACI Modifications Required for Design: Table 1A of this report provides a summary of all applicable *ACI 318-19* and *ACI 318-14* sections for the design of mechanical anchors

in fully grouted CMU masonry. Where applicable, modifying sections contained within this report are also provided.

3.2.1 *ACI 318-19 Sections 17.1.1, 17.1.5, and 17.2.2 (ACI 318-14 Sections 17.1.1-17.1.2)* apply with the general changes prescribed in Section 3.1.2.

3.2.2 In lieu of *ACI 318-19 Section 17.1.2 (ACI 318-14 Section 17.1.3)*: Design provisions are included for post-installed expansion (torque-controlled and displacement-controlled), undercut, and screw anchors that meet the assessment criteria of AC01.

3.2.3 *ACI 318-19 Sections 17.1.4, 17.2.1, 17.4.1, and 17.5.1.3.1 (ACI 318-14 Sections 17.1.4-17.2.2)* apply with the general changes prescribed in Section 3.1.2.

3.2.4 In lieu of *ACI 318-19 Section 17.10 (ACI 318-14 Section 17.2.3)*: The design of anchors in structures assigned to Seismic Design Category (SDC) C, D, E, or F shall satisfy the requirements of this section.

3.2.4.1 The design of anchors in plastic hinge zones of masonry structures under earthquake forces is beyond the scope of this report.

3.2.4.2 The anchor or group of anchors shall be designed for the maximum tension and shear obtained from the design load combinations that include E, with E_h increased by Ω_o. The anchor design tensile strength shall satisfy the tensile strength requirements of Section 3.2.4.3.

3.2.4.3 The anchor design tensile force for resisting earthquake forces shall be determined from consideration of (a) through (c) for the failure modes given in Table 1B assuming the masonry is cracked unless it can be demonstrated that the masonry remains uncracked.

(a) ϕN_{sa} for a single anchor or for the most highly stressed individual anchor in a group of anchors

(b) $0.75\phi N_{mb}$ or $0.75\phi N_{mbg}$

(c) $0.75\phi N_{pn}$ for a single anchor or for the most highly stressed individual anchor in an anchor group

where ϕ is in accordance with Section 3.2.9.

3.2.5 *ACI 318-19 Section 17.3.1 (ACI 318-14 Section 17.2.7)* applies with the general changes prescribed in Section 3.1.2.

3.2.6 In lieu of *ACI 318-19 Section 17.5.2 (ACI 318-14 Section 17.3.1.1)*: The design of anchors shall be in accordance with Table 1B. In addition, the design of anchors shall satisfy Section 3.2.4 for earthquake loading.

3.2.7 *ACI 318-19 Section 17.5.2.3 (ACI 318-14 Section 17.3.1.3)* applies with the general changes prescribed in Section 3.1.2.

3.2.8 *ACI 318-19 Section 17.5.1.2 excluding Section 17.5.2.1 (ACI 318-14 Section 17.3.2 excluding Section 17.3.2.1)* applies with the general changes prescribed in Section 3.1.2.

3.2.9 In lieu of *ACI 318-19 Section 17.5.3 (ACI 318-14 Section 17.3.3)*: Strength reduction factor ϕ for anchors in masonry shall be as follows when the LRFD load combinations of ASCE 7 are used:

a. For the steel capacity of ductile steel elements as defined in *ACI 318-19 Section 2.3 (ACI 318-14 Section 2.3)*, ϕ shall be taken as 0.75 in tension and 0.65 in shear. Where the ductility requirements of ACI 318 are not met, ϕ shall be taken as 0.65 in tension and 0.60 in shear.

b. For shear crushing capacity, ϕ shall be taken as 0.50.

c. For cases where the nominal strength of anchors in masonry is controlled by masonry breakout or pullout strength in tension, ϕ shall be taken as 0.65 for anchors qualifying for Category 1 and 0.55 for anchors qualifying for Category 2.

d. For cases where the nominal strength of anchors in masonry is controlled by masonry failure modes in shear, ϕ shall be taken as 0.70.

3.2.10 *ACI 318-19 Section 17.6.1 (ACI 318-14 Section 17.4.1)* applies with the general changes prescribed in Section 3.1.2.

3.2.11 In lieu of *ACI 318-19 Section 17.6.2.1 (ACI 318-14 Section 17.4.2.1)*: The nominal breakout strength in tension, N_{mb} of a single anchor or N_{mbg} of a group of anchors, shall not exceed:

a. For a single anchor:

$$N_{mb} = \frac{A_{Nm}}{A_{Nmo}} \Psi_{ed,N,m} \Psi_{c,N,m} N_{b,m} \qquad (17.6.2.1a)$$

b. For a group of anchors:

$$N_{mbg} = \frac{A_{Nm}}{A_{Nmo}} \Psi_{ec,N,m} \Psi_{ed,N,m} \Psi_{c,N,m} N_{b,m} \qquad (17.6.2.1b)$$

Factors $\Psi_{ec,N,m}$, $\Psi_{ed,N,m}$, and $\Psi_{c,N,m}$ are defined in *ACI 318-19 Sections 17.6.2.3.1, 17.6.2.4, and 17.6.2.5 (ACI 318-14 Sections 17.4.2.4-17.4.2.6)*. A_{Nm} is the projected masonry failure area of a single anchor or group of anchors that shall be approximated as the base of the rectilinear geometrical figure that results from projecting the failure surface outward $1.5h_{ef}$ from the centerlines of the anchor, or, in the case of a group of anchors, from a line through a row of adjacent anchors. A_{Nm} shall not exceed $n \cdot A_{Nmo}$, where n is the number of anchors in the group that resist tension.

A_{Nmo} is the projected masonry failure area of a single anchor with an edge distance equal to or greater than $1.5h_{ef}$.

$$A_{Nmo} = 9{h_{ef}}^2 \qquad (17.6.2.1.4)$$

3.2.12 In lieu of *ACI 318-19 Section 17.6.2.2 (ACI 318-14 Section 17.4.2.2)*: The basic masonry breakout strength of a single anchor in tension in cracked masonry, $N_{b,m}$, shall not exceed:

$$N_{b,m} = k_m\sqrt{{f'}_m}{h_{ef}}^{1.5} \qquad (17.6.2.2.1)$$

where

k_m = effectiveness factor for breakout strength in masonry
= $\alpha_{masonry} \cdot k_c$

k_c = effectiveness factor for breakout strength in concrete
= 17; and

$\alpha_{masonry}$ = reduction factor for the inhomogeneity of masonry materials in the breakout strength determination.
= 0.7

3.2.13 *ACI 318-19 Sections 17.6.2.1.2, 17.6.2.3.1, and 17.6.2.4 (ACI 318-14 Sections 17.4.2.3-17.4.2.5)* apply with the general changes prescribed in Section 3.1.2.

3.2.14 In lieu of *ACI 318-19 Section 17.6.2.5 (ACI 318-14 Section 17.4.2.6)*: The basic masonry breakout strength of a single anchor in tension, $N_{b,m}$, shall be calculated using the values of $k_{m,cr}$ and $k_{m,uncr}$ as described in Table 4 of this report. Where analysis indicates no cracking is anticipated, $N_{b,m}$ shall be calculated using $k_{m,uncr}$ and $\Psi_{c,N,m} = 1.0$.

3.2.15 *ACI 318-19 Section 17.6.2.6 (ACI 318-14 Section 17.4.2.7)* need not be considered since the modification factor for post-installed anchors, $\Psi_{cp,N}$, is not included in Eqs. 17.6.2.1a and 17.6.2.1b.

3.2.16 In lieu of *ACI 318-19 Section 17.6.3.1 (ACI 318-14 Section 17.4.3.1)*: The nominal pullout strength of a single post-installed expansion, undercut, and screw anchor in tension shall not exceed:

$$N_{pn} = \Psi_{m,P}N_p \qquad (17.6.3.1)$$

where $\Psi_{m,P}$ is defined in 17.6.3.3.

3.2.17 In lieu of *ACI 318-19 Section 17.6.3.2.1 (ACI 318-14 Section 17.4.3.2)*: For post-installed expansion and undercut anchors, the values of N_p shall be based on the 5 percent fractile of results of tests performed and evaluated in accordance with AC01 and shall not exceed the breakout strength calculated in accordance with Section 3.2.12 associated with ${f'}_m$.

3.2.18 The following apply with the general changes prescribed in Section 3.1.2:

1. *ACI 318-19 17.6.3.3.1 (ACI 318-14 Section 17.4.3.6)*
2. *ACI 318-19 Sections 17.7.1.1-17.7.2.2 (ACI 318-14 Sections 17.5.1.1-17.5.2.2)*
3. *ACI 318-19 Sections 17.7.2.1-17.7.2.2.1 (ACI 318-14 Sections 17.5.2.1-17.5.2.2)*
4. *ACI 318-19 Sections 17.7.2.1.2 & 17.7.2.3-17.7.2.4 (ACI 318-14 Sections 17.5.2.4-17.5.2.6)*
5. *ACI 318-19 Section 17.7.2.6 (ACI 318-14 Section 17.5.2.8)*
6. *ACI 318-19 Section 17.7.3 (ACI 318-14 Section 17.5.3)*
7. *ACI 318-19 Section 17.9 (ACI 318-14 Section 17.7)*
8. *ACI 318-19 Section 17.2.5 (ACI 318-14 Section 17.8.1)*

3.2.19 In lieu of *ACI 318-19 Section 17.7.2.5 (ACI 318-14 Section 17.5.2.7)*: For anchors located in a region of masonry construction where cracking is anticipated, $\Psi_{m,V}$ shall be taken as 1.0. For cases where analysis indicates no cracking at service levels, it shall be permitted to take $\Psi_{m,V}$ as 1.4.

3.2.20 [In addition to the ACI 318 provisions] For screw anchors with embedment depths $5d_a \le h_{ef} \le 10d_a$ and $h_{ef} \ge 1.5in.$, masonry breakout strength requirements shall be considered satisfied by the design procedures of *ACI 318-19 Sections 17.6.2 and 17.7.2 (ACI 318-14 Sections 17.4.2 and 17.5.2)*.

3.2.21 [In addition to the ACI 318 provisions] Masonry crushing strength for anchors in shear shall be calculated in accordance with TMS 402 (-22 and -16) Eq. 9-7. The nominal strength of an anchor in shear as governed by masonry crushing, V_{mc}, shall be calculated using Eq. (3-1).

$$V_{mc} = 1750 \cdot \sqrt[4]{{f'}_m A_{se,V}} \qquad (3\text{-}1)$$

3.2.22 [In addition to the ACI 318 provisions] Determination of shear capacity for anchors in horizontal ledgers in fully grouted CMU walls with hollow head joint applications with an assumed masonry unit length of 16 inches, standard:

Where six or more anchors are placed at uniform horizontal spacing in continuous wood or steel ledgers connecting floor and roof diaphragms to fully grouted CMU walls constructed with hollow head joints (using closed-end block), the horizontal and vertical shear capacity of the anchors may be permitted to be calculated in accordance with Eq. (3-2) and Eq. (3-3), respectively, in lieu of Section 3.1.3 of this report.

$$v_{mb,horiz} = 0.75 \cdot V_{gov,horiz} \cdot \frac{12}{s_{horiz}} \quad (3\text{-}2)$$

$$v_{mb,vert} = 0.75 \cdot V_{gov,vert} \cdot \frac{12}{s_{horiz}} \quad (3\text{-}3)$$

where

s_{horiz} = horizontal anchor spacing in the ledger, (in.). For anchor spacings that are multiples of 8 inches, locate the first anchor in the ledger at least 2 inches from the head joint and the center of the block. For other anchor spacings, minimum edge distance as specified in the evaluation report shall apply.

$V_{gov,horiz}$ = min(V_{sa}, $V_{mb,4}$, V_{mc}, $V_{mp,4}$), (lb)

$V_{gov,vert}$ = min(V_{sa}, $2 \cdot V_{mb,4}$, V_{mc}, $V_{mp,4}$), (lb)

V_{sa} = shear capacity for a single anchor calculated in accordance with *ACI 318-19 Section 17.7.1.2 (ACI 318-14 Section 17.5.1.2), (lb)*

$V_{mb,4}$ = breakout capacity for a single anchor with an edge distance of 4 inches, (lb)

V_{mc} = crushing capacity for a single anchor calculated in accordance with Eq. (3-1), (lb)

$V_{mp,4}$ = pryout capacity for a single anchor with an edge distance of 4 inches, (lb)

Where anchors are spaced at 8 inches on center or another multiple of 8 inches on center, multiply the calculated $V_{mb,horiz}$ and $V_{mb,vert}$ by $\frac{4}{3}$.

3.2.23 Interaction of tension and shear shall be calculated in compliance with *ACI 318-19 Section 17.8 (ACI 318-14 Section 17.6)* as follows:

1. If $\frac{V_{ua}}{\phi V_n} \leq 0.2$ for the governing strength in shear, then full strength in tension shall be permitted: $\phi N_n \geq N_{ua}$.
2. If $\frac{N_{ua}}{\phi N_n} \leq 0.2$ for the governing strength in tension, then full strength in shear shall be permitted: $\phi V_n \geq V_{ua}$.
3. For all other cases:

$$\frac{N_{ua}}{\phi N_n} + \frac{V_{ua}}{\phi V_n} \leq 1.2 \quad (17.8.3)$$

3.2.23.1 Satisfying the parabolic equation complying with *ACI 318-19 Section R17.8 (ACI 318-14 Section R17.6)* may be used in lieu of satisfying Section 3.2.23 of this report. The parabolic equation is given as:

$$\left(\frac{N_{ua}}{\phi N_n}\right)^{5/3} + \left(\frac{V_{ua}}{\phi V_n}\right)^{5/3} \leq 1.0$$

3.3 Strength Design in Partially Grouted Concrete Masonry Unit Construction

3.3.1 The KB1 Expansion Anchor is not permitted to be installed in ungrouted cells.

3.3.2 For cases where the location of grouted cells is known, the following provisions shall apply:

Anchors located in grouted cells shall be designed in accordance with Sections 3.1 and 3.2 of this report, whereby the distance to the extent of the ungrouted cell shall be taken as a free edge.

The minimum distance from hollow head joints shall be the $c_{min,HJ}$ value provided in Table 2 of this report, which is measured from the centerline of the head joint.

3.4 Conversion of Strength Design to Allowable Stress Design

For mechanical anchors designed using load combinations in accordance with 2024 and 2021 IBC Sections 1605.1 or 1605.2, or 2018 and 2015 IBC Section 1605.3 (Allowable Stress Design), allowable loads shall be established using the Eq. 3-4 and Eq. 3-5:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \quad (3\text{-}4)$$

and

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha} \quad (3\text{-}5)$$

where

$T_{allowable,ASD}$ = Allowable tensile load (lb)

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

N_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with this report, as applicable, and 2024 IBC Section 1905.7, and 2021, 2018, and 2015 IBC Section 1905.1.8, (lb)

V_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with this report, as applicable, and 2024 IBC Section 1905.7, and 2021, 2018, and 2015 IBC Section 1905.1.8, (lb)

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 overstrength; and

ϕ = relevant strength reduction factor for load case and Anchor Category

3.5 Installation: Installation parameters are provided in Table 2 of this report and illustrated in Figures 1 and 5 of this report. Anchor locations shall comply with this report and the plans and specifications approved by the building official. KB1 expansion anchors shall be installed in accordance with the MPII and this report. Anchors shall be installed in holes drilled into the base material using carbide-tipped drill bits conforming to ANSI B212.15. Nominal drill bit diameters shall be equal to the nominal diameter of the anchors and holes shall be drilled to a depth allowing proper embedment. It is permitted to utilize Hilti Dust Removal System (DRS) attachments to clean the drilling dust from the CMU surface while drilling. Anchors shall be driven into the hole using a hammer until the proper embedment depth is achieved. Nuts and washers shall be tightened against the base material or material to be fastened until the appropriate installation torque value specified in Table 2 of this report is achieved.

3.6 Special Inspection: Periodic special inspection is required in accordance with IBC Section 1705.4 of the IBC, as applicable, provided the masonry construction is under Level 2 Quality Assurance in accordance with Table 3.1 of TMS 402 (-22 and -16) (2024, 2021, and 2018 IBC); or Level B Quality Assurance in accordance with Section 3.1 of TMS 402-13 (2015 IBC), as applicable. The special inspector shall be present as often as required by the "statement of special inspection." The special inspector shall conduct periodic inspections during anchor installation to verify anchor type, anchor dimensions, masonry unit type, and compliance with ASTM C90; grout and mortar compressive strengths, and (when required) masonry prism compressive strength; drill bit size and compliance with ANSI B212.15; and anchor type, size, embedment depth, spacing, edge distance, and end distance. The special inspector shall inspect and verify that the anchor installation complies with this evaluation report and the MPII. Additional requirements as set forth in Sections 1704, 1705, 1706, and 1707 of the IBC shall be observed, where applicable.

4.0 PRODUCT DESCRIPTION

4.1. General: Hilti KB1 Expansion Anchors are torque-controlled, mechanical expansion anchors consisting of an anchor body, expansion clip, nut, and washer. A typical anchor is shown in Figure 2 of this report.

The anchor body has a tapered mandrel formed on the installed end of the anchor and a threaded section at the opposite 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 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 Masonry Materials

4.2.1 Fully Grouted CMU Construction: The specified compressive strength of masonry at the time of installation, f'_m, at 28 days shall be a minimum of 1,500 psi (10.3 MPa). Fully grouted CMU walls shall be constructed from the following materials:

4.2.1.1 Concrete Masonry Units (CMUs): CMUs shall be minimum Grade N, Type II, lightweight, medium-weight, or normal-weight, closed-end or open-end, conforming to ASTM C90. The minimum allowable nominal size of the CMU shall be 8 inches (203 mm) wide by 8 inches (203 mm) high by 16 inches (406 mm) long.

4.2.1.2 Grout: Grout shall comply with IBC Section 2103.3 (2024, 2021, 2018, and 2015 IBC), or IRC Section R606.2.12 (2024, 2021, and 2018 IRC) or IRC Section R606.2.11 (2015 IRC), as applicable. Alternatively, the grout shall have a minimum compressive strength when tested in accordance with ASTM C1019 equal to its specified strength, f'_g, but not less than 2,000 psi (13.8 MPa).

4.2.1.3 Mortar: Mortar shall be minimum Type N in compliance with IBC Section 2103.2.1 (2024, 2021, 2018, and 2015 IBC) or IRC Section R606.2.8 (2024, 2021, and 2018 IRC) or IRC Section R606.2.7 (2015 IRC), as applicable.

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-677). One of the IAPMO UES Marks of Conformity may also be used as shown below. 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 3 and Figure 3 of this report.

or

IAPMO UES ER-677

6.0 EVIDENCE SUBMITTED

Testing and analysis data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Cracked and Uncracked Masonry Elements (AC01), June 2024, including seismic shear and seismic tension tests. Test reports are from laboratories in compliance with 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 2.16 of this report under a quality control program with periodic inspections 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 1A — ACI 318-19 AND -14 SECTIONS APPLICABLE OR MODIFIED BY THIS REPORT

ACI 318-19 Section	*(ACI 318-14 Section)*	Modified by this Report Section:
2.2	*(2.2)*	Unchanged*
2.3	*(2.3)*	
17.1.1, 17.1.5 & 17.2.2	*(17.1.1 – 17.1.2)*	
17.1.2	*(17.1.3)*	Section 3.2.2
17.1.4, 17.2.1, 17.4.1, & 17.5.1.3.1	*(17.1.4 – 17.2.2)*	Unchanged*
17.10	*(17.2.3)*	Section 3.2.4
17.3.1	*(17.2.7)*	Unchanged*
17.5.2	*(17.3.1.1)*	Section 3.2.6
17.5.2.3	*(17.3.1.3)*	Unchanged*
17.5.1.2, excluding 17.5.2.	*(17.3.2 excluding 17.3.2.1)*	
17.5.3	*(17.3.3)*	Section 3.2.9
17.6.1	*(17.4.1)*	Unchanged*
17.6.2.1	*(17.4.2.1)*	Section 3.2.11
17.6.2.2	*(17.4.2.2)*	Section 3.2.12
17.6.2.1.2, 17.6.2.3.1 and 17.6.2.4	*(17.4.2.3 – 17.4.2.5)*	Unchanged*
17.6.2.5	*(17.4.2.6)*	Section 3.2.14
17.6.2.6	*(17.4.2.7)*	Section 3.2.15
17.6.3.1	*(17.4.3.1)*	Section 3.2.16
17.6.3.2.1	*(17.4.3.2)*	Section 3.2.17
17.7.1.1 – 17.7.2.2	*(17.5.1.1 – 17.5.2.2)*	Unchanged*
17.7.2.1.2, 17.7.2.3 and 17.7.2.4	*(17.5.2.4 – 17.5.2.6)*	
17.7.2.5	*(17.5.2.7)*	Section 3.2.19
17.7.2.6	*(17.5.2.8)*	Unchanged*
17.7.3	*(17.5.3)*	
17.8	*(17.6)*	
R17.8	(R17.6)	
26.7.1	*(17.8.1)*	

*Sections marked as unchanged adopt the general changes prescribed in Section 3.1.2.

TABLE 1B — REQUIRED STRENGTH OF ANCHORS IN FULLY GROUTED CMU

Failure Mode	Single Anchor	Anchor Group[1]	
		Individual Anchor in a Group	Anchors as a Group
Steel Strength in Tension	$\phi N_{sa} \geq N_{ua}$	$\phi N_{sa} \geq N_{ua,i}$	
Masonry Breakout Strength in Tension	$\phi N_{mb} \geq N_{ua}$		$\phi N_{mbg} \geq N_{ua,g}$
Pullout Strength in Tension	$\phi N_{pn} \geq N_{ua}$	$\phi N_{pn} \geq N_{ua,i}$	
Steel Strength in Shear	$\phi V_{sa} \geq V_{ua}$	$\phi V_{sa} \geq V_{ua,i}$	
Masonry Breakout Strength in Shear	$\phi V_{mb} \geq V_{ua}$		$\phi V_{mbg} \geq V_{ua,g}$
Masonry Crushing Strength in Shear	$\phi V_{mc} \geq V_{ua}$	$\phi V_{mc} \geq V_{ua,i}$	
Masonry Pryout Strength in Shear	$\phi V_{mp} \geq V_{ua}$		$\phi V_{mpg} \geq V_{ua,g}$

[1]Required strengths for steel, pullout, and crushing failure modes shall be calculated for the most highly stressed anchor in the group.

TABLE 2 – KB1 SETTING INFORMATION

Design Information	Symbol	Units	Nominal Anchor Diameter (in.)							
			3/8	1/2		5/8		3/4		
Nominal Bit Diameter	d_o	in.	3/8	1/2		5/8		3/4		
Effective Min. Embedment	h_{ef}	in. (mm)	2 (51)	2 (51)	3 1/4 (83)	2 3/4 (70)	4 (102)	3 1/4 (83)	4 3/4 (121)	
Nominal Embedment	h_{nom}	in. (mm)	2 3/8 (60)	2 3/8 (60)	3 5/8 (92)	3 1/4 (83)	4 ½ (114)	4 (102)	5 1/2 (140)	
Min. Hole Depth	h_o	in. (mm)	2 3/4 (70)	2 ¾ (70)	4 1/4 (108)	3 3/4 (95)	4 ¾ (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)	15 (20.3)	25 (33.9)		35 (47.5)		50 (67.8)		
Minimum Masonry Thickness	h_{min}	in. (mm)	7 5/8 (194)							
Minimum Distance to Hollow Head Joint[1]	$c_{min,HJ}$	in. (mm)	2 1/2 (64)	2 1/2 (64)		2 ½ (64)		2 1/2 (64)		
Minimum Edge Distance	c_{min}	in. (mm)	4 (102)	4 (102)		4 (102)		4 (102)		
Minimum Anchor Spacing	s_{min}	in. (mm)	6 (152)	5 (127)		5 (127)		6 (152)		

For **SI**: 1 inch = 25.4 mm | 1 ft-lbf = 1.356 Nm

[1] The minimum distance from the center of an anchor to the centerline of a hollow head joint (vertical mortar joint) is $c_{min,HJ}$ as shown in Figure 4. See Section 3.1.3.

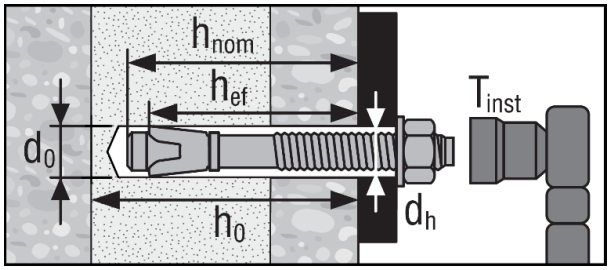

FIGURE 1 – KB1 INSTALLATION PARAMETERS

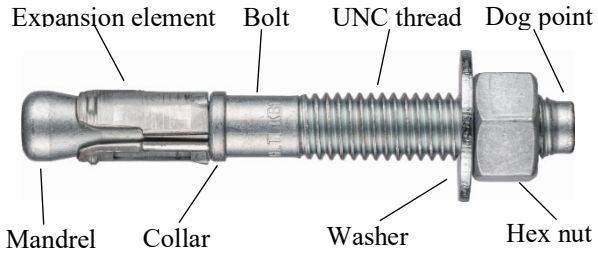

FIGURE 2 – HILTI KB1

TABLE 3 – 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

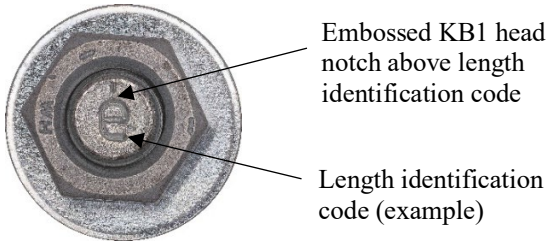

FIGURE 3 – ANCHOR HEAD WITH LENGTH IDENTIFICATION CODE AND KB1 HEAD NOTCH

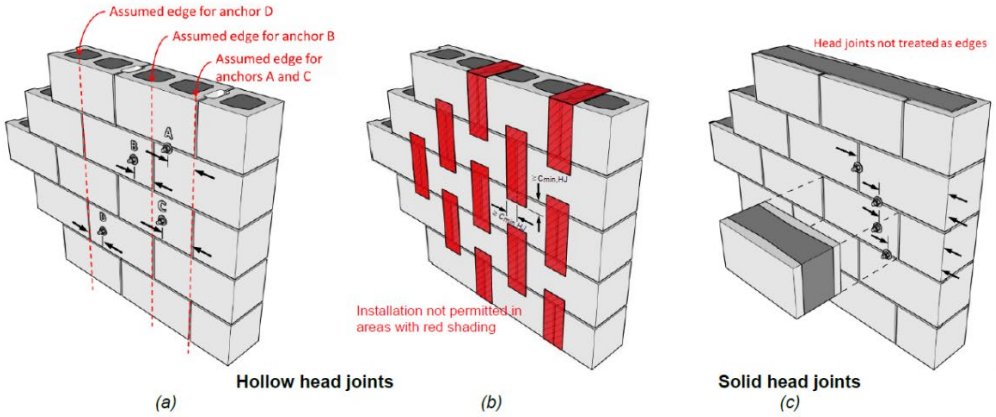

FIGURE 4 – (A) EDGE DISTANCE CONSIDERATIONS IN FULLY GROUTED CMU CONSTRUCTION WITH HOLLOW HEAD JOINTS, (B) EXCLUSION ZONES IN FULLY GROUTED CONSTRUCTION WITH HOLLOW HEAD JOINTS, AND (C) EDGE DISTANCE CONSIDERATIONS IN FULLY GROUTED CMU CONSTRUCTION WITH SOLID HEAD JOINTS. NOTE: DIMENSIONS TO UPPER AND LOWER EDGES OMITTED FOR CLARITY.

TABLE 4 – KB1 DESIGN INFORMATION - TENSION

Design Information	Symbol	Units	Nominal Anchor Diameter (in.)						
			3/8	1/2		5/8		3/4	
Effective Min. Embedment[1]	h_{ef}	in. (mm)	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 Mode									
Strength Reduction Factor for Steel — Tension[2,3]	Φ	-	0.75	0.75		0.75		0.75[(2)]	
Effective Tensile Stress Area	$A_{se,N}$	in.^{2} (mm^2)	0.053 (34.2)	0.103 (66.5)		0.164 (105.8)		0.239 (154.2)	
Min. Specified Yield Strength	f_y	lb/in^2 (N/mm^2)	95,100 (656)	84,700 (584)		83,500 (576)		81,200 (560)	
Min. Specified Ult. Strength	f_{uta}	lb/in^2 (N/mm^2)	118,900 (820)	105,900 (730)		104,400 (720)		101,500 (700)	
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 - Masonry Failure Modes									
Anchor Category	-	-	1	2		1		1	
Strength Reduction Factor for Masonry Breakout and Pullout Failure — Tension[3]	Φ	-	0.65	0.55		0.65		0.65	
Effectiveness Factor for Uncracked Masonry[4]	$k_{m,uncr}$	-	17	17		17		17	
Effectiveness Factor for Cracked Masonry[4]	$k_{m,cr}$	-	12	12		12		12	
Pullout Strength Uncracked Masonry[5]	$N_{p,uncr}$	Lb (kN)	1,170 (5.2)	2,450 (10.9)	3,575 (15.9)	3,080 (13.7)	4,530 (20.2)	3,535 (15.7)	4,995 (22.2)
Pullout Strength Cracked Masonry[5]	$N_{p,cr}$	Lb (kN)	880 (3.9)	1,225 (5.5)	1,785 (7.9)	2,465 (11.0)	3,620 (16.1)	2,050 (9.1)	2,895 (12.9)
Pullout Strength Seismic[5]	$N_{p,eq}$	Lb (kN)	880 (3.9)	1,225 (5.5)	1,785 (7.9)	2,465 (11.0)	3,620 (16.1)	2,050 (9.1)	2,895 (12.9)

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 and -14) Section 2.3* except for the ¾" x 12" KB1, which is considered a brittle steel element with a strength reduction factor for steel in tension, ϕ = 0.65.
[3] The tabulated values of ϕ apply when the LRFD load combinations of ASCE7 are used.
[4] For all design cases, $\Psi_{c,N,m}$ = 1.0. The appropriate effectiveness factor for cracked masonry ($k_{m,cr}$) or uncracked masonry ($k_{m,uncr}$) shall be used.
[5] For all design cases, $\Psi_{m,P}$ = 1.0. The tabular value for pullout strength is for a masonry compressive strength of 1,500 psi (10.3 MPa).

TABLE 5 – KB1 DESIGN INFORMATION - SHEAR

Design Information	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)	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 Mode									
Strength Reduction Factor for Steel — Shear[2,3]	ϕ	-	0.65	0.65		0.65		0.65[(2)]	
Steel Strength in Shear	V_{sa}	lb (kN)	1,800 (8.0)	3,030 (13.5)		5,320 (23.7)		7,670 (34.1)	
Steel Strength in Shear, Seismic	$V_{sa,eq}$	lb (kN)	1,800 (8.0)	3,030 (13.5)		5,320 (23.7)		7,670 (34.1)	
Shear - Masonry Failure Modes									
Strength Reduction Factor for Masonry Breakout and Pryout Failure - Shear[3]	ϕ	-	0.70	0.70		0.70		0.70	
Strength Reduction Factor for Masonry Crushing Failure — Shear[3]	ϕ	-	0.50	0.50		0.50		0.50	
Load Bearing Length of Anchor in Shear	l_e	in. (mm)	2 (51)	2 (51)	3 1/4 (83)	2 3/4 (70)	4 (102)	3 1/4 (83)	4 3/4 (121)
Coefficient for Pryout Strength	k_{cp}	-	1	1	2	2	2	2	2

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 and -14) Section 2.3* except for the 3/4" x 12" KB1, which is considered a brittle steel element with a strength reduction factor for steel in tension, $\phi = 0.60$.
[3] The tabulated values of ϕ apply when the LRFD load combinations of ASCE7 are used.

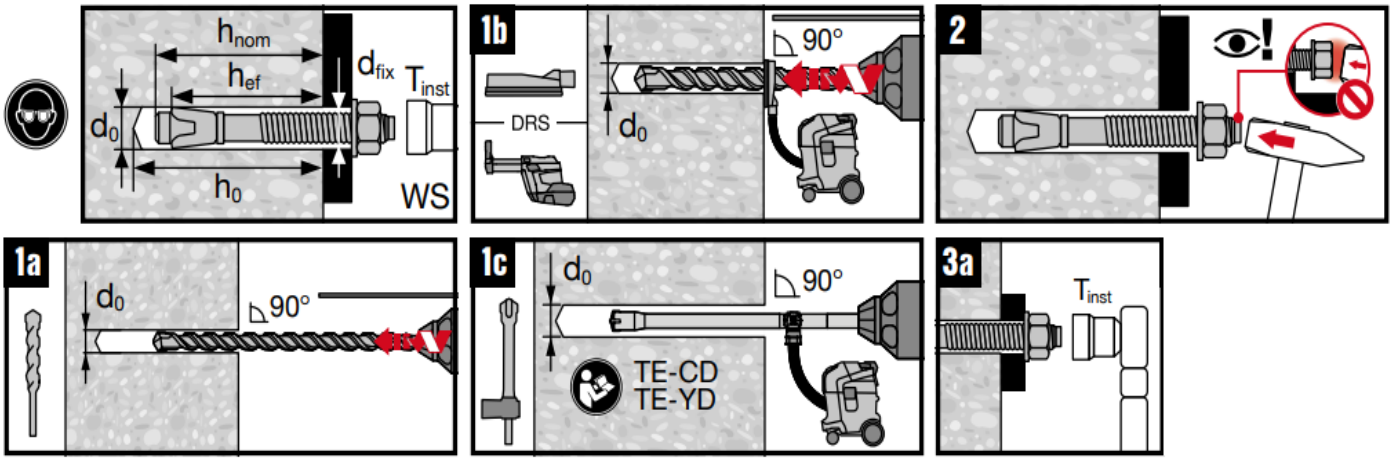

FIGURE 5 – MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII)

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HILTI® KB1 EXPANSION ANCHORS IN MASONRY

CSI Division:
04 00 00 MASONRY
CSI Section:
04 05 19.16 Masonry Anchors

1.0 RECOGNITION

Hilti KB1 Expansion Anchors recognized in ER-677 have been evaluated for use to resist dead, live, wind, and seismic tension and shear loads in fully grouted uncracked, concrete-masonry unit (CMU) construction.

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-677 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-677.

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-677 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-677.

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HILTI® KB1 EXPANSION ANCHORS IN MASONRY

CSI Division:
04 00 00 MASONRY
CSI Section:
04 05 19.16 Masonry Anchors

1.0 RECOGNITION

Hilti KB1 Expansion Anchors recognized in ER-677 have been evaluated for use to resist dead, live, wind, and seismic tension and shear loads in fully grouted uncracked, concrete-masonry unit (CMU) construction.

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

- 2023 Florida Building Code, Building (FBC, Building)
- 2023 Florida Building Code, Residential (FBC, Residential)

2.0 LIMITATIONS

Hilti KB1 Expansion Anchors described in ER-677 comply with the 2023 FBC, Building, and the 2023 FBC, Residential, subject to the following limitations:

2.1 The design and installation of the Hilti KB1 Expansion Anchors shall be in accordance with the 2021 International Building Code and the 2021 International Residential Code as noted in ER-677.

2.2 Construction documents, including calculations showing compliance with FBC--Building Sections 107 and 1603, and this report shall be submitted to the building official. The construction documents shall be prepared by a registered design professional where required by Chapter 471, Florida Statutes, or Chapter 481, Florida Statutes.

2.3 Load combinations shall be in accordance with Sections 1605.1 or 1605.2 of the FBC, Building, as applicable.

2.4 Design wind loads shall be in accordance with Section 1609.1.1 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).

2.5 Use of Hilti KB1 Expansion 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.

2.6 Use of Hilti KB1 Expansion 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 required in Section 1620 (HVHZ) of the FBC, Building, or 700 pounds (3114 N), whichever is greater, per FBC, Building Section 2321.7.

2.7 Use of Hilti KB1 Expansion Anchors in High-velocity Hurricane Zones (HVHZ) as set forth in Section 2122.7 of the FBC, Building, and Section 4407 of the FBC, Residential to resist wind forces is permitted. Loading shall comply with TMS 402 Section 4.1. The anchors shall be designed to resist the horizontal forces as required in Section 1620 (HVHZ) of the FBC, Building or 200 pounds per lineal foot (2919 N/m) of wall, whichever is greater, per FBC, Building Section 2122.7.3. The Hilti KB1 Expansion Anchors shall be embedded in reinforced grouted cells in accordance with Section 2122.7.4 of the FBC, Building.

2.8 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.

2.9 This supplement expires concurrently with ER-677.