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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 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:

- 2018, 2015, and 2012 International Building Code® (IBC)
- 2018, 2015, and 2012 International Residential Code® (IRC)
- 2020 City of Los Angeles Building Code (LABC) – attached Supplement
- 2020 City of Los Angeles Residential Code (LARC) – attached Supplement
- 2020 and 2017 Florida Building Code, Building (FBC–Building) – attached Supplement
- 2020 and 2017 Florida Building Code, Residential (FBC–Residential) – attached Supplement

2.0 LIMITATIONS

KB1 expansion anchors described in this report comply with, or are a suitable alternative to what is specified in, those codes and regulations listed in Section 1.0 of this report, 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 Design of KB1 expansion anchors installed in fully grouted concrete masonry unit construction to resist dead, live, wind and earthquake load applications shall be in accordance with Section 4.0 of this report.

2.3 Anchors shall be installed in accordance with Section 3.3 of this report, and 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.

2.4 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.

2.5 Fire-resistance-rated Construction: 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.

2.6 Since acceptance criteria for evaluating the performance of expansion anchors in cracked masonry are unavailable at this time, the use of anchors is limited to installation in uncracked masonry. Cracking occurs when $f_t > f_r$ due to service loads or deformations, where:

f_r = masonry modulus of rupture, psi (MPa); defined in TMS 402/ACI 530/ASCE 5-11 Section 3.1.8, TMS 402/ACI 530/ASCE 5-13 Section 9.1.9, and TMS 402-16 Section 9.1.9.

f_t = masonry tensile strength

2.7 Calculations demonstrating that the applied loads are less than the allowable loads described in this report shall be submitted to the building official at the time of permit application. Calculations shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

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

2.9 Use of zinc-plated anchors is limited to dry, interior locations.

2.10 KB1 expansion anchors are manufactured by Hilti AG.

3.0 PRODUCT USE

3.1 General: The KB1 is a torque-controlled expansion anchor used to resist static, wind and seismic tension and shear loads in fully grouted uncracked, concrete-masonry unit (CMU) construction.

KB1 expansion anchors are alternatives to cast-in-place anchors described in Section 2107 of the IBC and Chapters 6 and 8 of the 2016 and 2013 TMS 402/ACI 530/ASCE 5 and Chapters 1 and 2 of 2011 and 2008 TMS 402/ACI 530/ASCE 5, as applicable. Anchors are permitted to be used in structures regulated by the IRC, provided an engineered design is submitted to the building official in accordance with IRC Section R301.1.3.

3.2 Design

3.1.1 General: KB1 expansion anchor capacities in this report are allowable load values for use in allowable stress design as set forth in Section 2107 of the IBC.

3.1.2 Design of KB1 Expansion Anchors Installed in Fully Grouted Concrete Masonry: For installations in fully grouted uncracked concrete masonry, KB1 expansion anchors are recognized to resist dead, live, wind, and earthquake loads.

Allowable tension and shear capacity values, embedment depths, critical and minimum edge and end distances, and critical and minimum spacing requirements for anchors installed in fully grouted concrete masonry unit construction are noted in Tables 3 and 4 of this report. Allowable load reduction factors for anchors installed at distances less than critical edge distance or critical spacing are noted in Tables 3 and 4 of this report. Allowable loads for anchors installed within $1^3/_8$ inches (35 mm) of the vertical head joint between CMU of the concrete masonry unit construction are outside the scope of this report. Figure 4 of this report provides additional details.

Allowable loads for the KB1 expansion anchors installed in fully grouted concrete masonry subjected to combined tension and shear forces shall be determined by the following equation:

$$\left(\frac{P_s}{P_t}\right)^{5/3} + \left(\frac{V_s}{V_t}\right)^{5/3} \leq 1.0$$

where:

P_s = Applied service tension load.
P_t = Allowable service tension load.
V_s = Applied service shear load.
V_t = Allowable service shear load.

3.3 Installation: Installation parameters are provided in Table 1 of this report and 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 1 of this report is achieved.

3.4 Special Inspection: Periodic special inspection is required in accordance with IBC Section 1705.4 (2018 and 2015 IBC), or1705.3 (2012 IBC), as applicable, provided the masonry construction is under Level 2 Quality Assurance in accordance with Table 3.1 of TMS 402-16 (2018 IBC); or Level B Quality Assurance in accordance with Section 3.1 of TMS 402-13 (2015 IBC); or Section 1.19 of TMS 402-11(2012 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 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: 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 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 Grout-filled Concrete Masonry: When prism tests are required, The compressive strength of masonry, f'_m, at 28 days shall be a minimum of 1,500 psi (10.3 MPa) by unit strength method or by the prism test method in accordance with TMS 402. Concrete masonry shall be fully grouted and constructed from the following materials:

4.2.1.1 Concrete Masonry Units (CMUs): CMUs shall be lightweight, medium-weight, or normal-weight conforming to ASTM C90. 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 (i.e., 8×8×16).

4.2.1.2 Grout: Coarse grout shall comply with IBC Section 2103 or IRC Section R606 (2018 and 2015 IRC) or R609 (2012 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 Types M, S, or N in compliance with IBC Section 2103 or IRC Section R606 (2018 and 2015 IRC) or R607 (2012 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; the IAPMO UES evaluation report number (ER-677) and one of the IAPMO UES Marks of Conformity below. The threaded end of each KB1 expansion anchor is stamped with a length identification code letter and single notch above letter code as indicated in Table 2 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 Expansion Anchors in Masonry Elements (AC01), approved March 2018. 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 2.10 of this report under a quality control program with periodic inspections under the supervision of IAPMO UES.

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

TABLE 1 – KB1 SETTING INFORMATION

Design information	Symbol	Units	Nominal anchor diameter (in.)							
			3/8	½		5/8		3/4	
Nominal bit diameter	d_o	in.	3/8	1/2		5/8		3/4	
Effective min. embedment	h_{ef}	in.	2	2	3-1/4	2-3/4	4	3-1/4	4-3/4
		(mm)	(51)	(51)	(83)	(70)	(102)	(83)	(121)
Nominal embedment	h_{nom}	in.	2-3/8	2-3/8	3-5/8	3-1/4	4-1/2	4	5-1/2
		(mm)	(60)	(60)	(92)	(83)	(114)	(102)	(140)
Min. hole depth	h_o	in.	2-3/4	2-3/4	4-1/4	3-3/4	4-3/4	4-1/4	5-3/4
		(mm)	(70)	(70)	(108)	(95)	(121)	(108)	(146)
Fixture hole diameter	d_h	in.	7/16	9/16		11/16		13/16	
		(mm)	(11.1)	(14.3)		(17.5)		(20.6)	
Installation torque	T_{inst}	ft-lb	15	25		35		50	
		(Nm)	(20)	(34)		(47)		(68)	

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.36 Nm

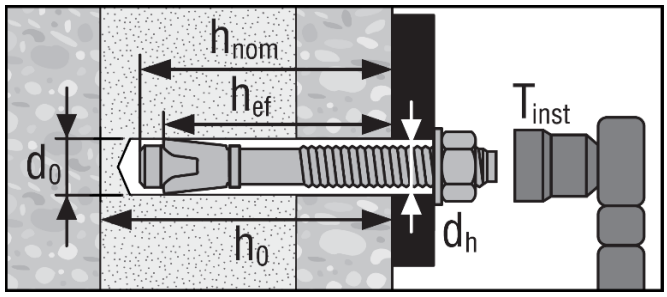

FIGURE 1 – KB1 INSTALLATION PARAMETERS

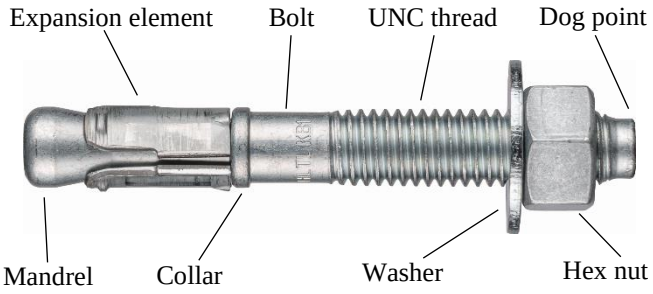

FIGURE 2 – HILTI KB1

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

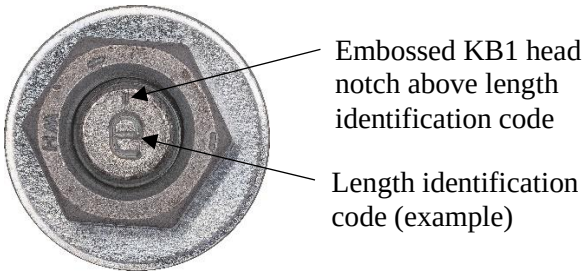

FIGURE 3 – ANCHOR HEAD WITH LENGTH IDENTIFICATION CODE AND KB1 HEAD NOTCH

TABLE 3 – ALLOWABLE TENSILE LOADS FOR KB1 IN THE FACE OF GROUT-FILLED CONCRETE MASONRY WALLS [1,3,4,5,6]

Nominal anchor diameter	Nominal embedment		Allowable tension capacity at s_{cr} and c_{cr}		Spacing				Edge Distance				
					Critical spacing, s_{cr}		Minimum spacing, s_{min} [2]		Load reduction factor at s_{min}	Critical edge distance, c_{cr}		Minimum edge distance, c_{min}		Load reduction factor at c_{min}
in.	in.	(mm)	lb	(kN)	in	(mm)	in	(mm)		in	(mm)	in	(mm)	
3/8	2-3/8	(60)	350	(1.6)	8	(203)	3	(76)	0.56	12	(305)	4	(102)	0.87
1/2	2-3/8	(60)	615	(2.7)	8	(203)	4	(102)	0.54					0.88
	3-5/8	(92)	1,055	(4.7)	13	(330)			0.48					0.94
5/8	3-1/4	(83)	965	(4.3)	11	(279)	5	(127)	0.62					0.86
	4-1/2	(114)	1,140	(5.1)	16	(406)			0.76					1.00
3/4	4	(102)	1,085	(4.8)	13	(330)	6	(152)	0.55					0.84
	5-1/2	(140)	1,130	(5.0)	19	(483)			0.69					0.75

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

TABLE 4 – ALLOWABLE SHEAR LOADS FOR KB1 IN THE FACE OF GROUT-FILLED CONCRETE MASONRY WALLS [1,3,4,5,6]

Nominal anchor diameter	Nominal embedment		Allowable shear capacity at s_{cr} and c_{cr}		Spacing					Edge Distance					
					Critical spacing, s_{cr}		Minimum spacing, s_{min} [2]		Load reduction factor at s_{min}	Critical edge distance, c_{cr}		Minimum edge distance, c_{min}		Perpen-dicular load reduction factor at c_{min}	Parallel load reduction factor at c_{min}
in.	in.	(mm)	lb	(kN)	in	(mm)	in	(mm)		in	(mm)	in	(mm)		
3/8	2-3/8	(60)	575	(2.6)	8	(203)	3	(76)	0.84	12	(305)	4	(102)	0.94	0.94
1/2	2-3/8	(60)	960	(4.3)	8	(203)	4	(102)						0.72	1.00
	3-5/8	(92)													
5/8	3-1/4	(83)	1,370	(6.1)	11	(279)	5	(127)						0.64	0.83
	4-1/2	(114)													
3/4	4	(102)	1,370	(6.1)	13	(330)	6	(152)						0.64	0.83
	5-1/2	(140)													

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

Footnotes for Table 3 and Table 4

[1] Values valid for anchors installed in face shells of Type 1, Grade N, lightweight, medium-weight, or normal-weight concrete masonry units conforming to ASTM C90. The masonry units shall be fully grouted with coarse grout conforming to 2018 and 2015 IBC Section 2103.3, or 2012 IBC Section 2103.13. Mortar shall comply as Type M, S, or N with 2018 and 2015 IBC Section 2103.2.1, or 2012 IBC Section 2103.9. Masonry compressive strength shall be at least 1,500 psi (10.3 MPa) at 28 days, by the unit strength method or by the prism test method set forth in TMS 402.

[2] Loads tabulated are applicable to anchors spaced at critical spacing distance, s_{cr}. The anchors may be placed at a minimum spacing, s_{min}, provided that reductions are applied to the tabulated values.

[3] Anchors shall be installed a minimum of 1-3/8 inches from any vertical mortar joint in accordance with Figure 4.

[4] Embedment depth shall be measured from the outside face of the concrete masonry unit.

[5] For intermediate edge distances, allowable loads may be determined by linearly interpolating between the allowable loads at the two tabulated edge distances.

[6] The tabulated allowable loads have been calculated based on a safety factor of 5.0.

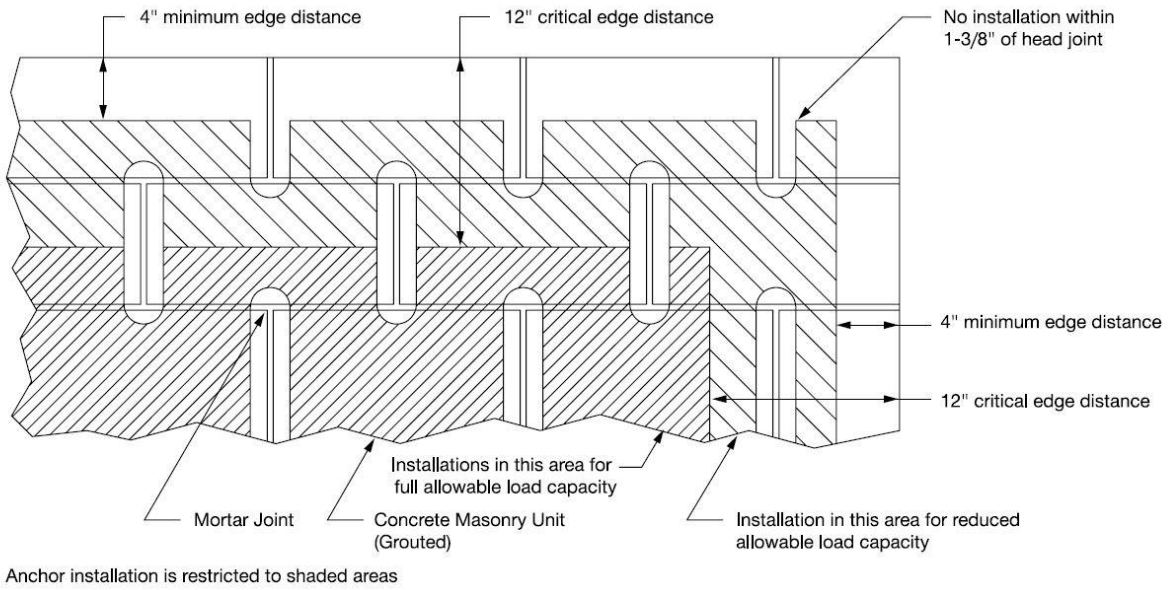

FIGURE 4 – ACCEPTABLE INSTALLATION LOCATIONS (SHADED AREAS) FOR KB1 ANCHORS IN GROUT-FILLED CONCRETE MASONRY CONSTRUCTION

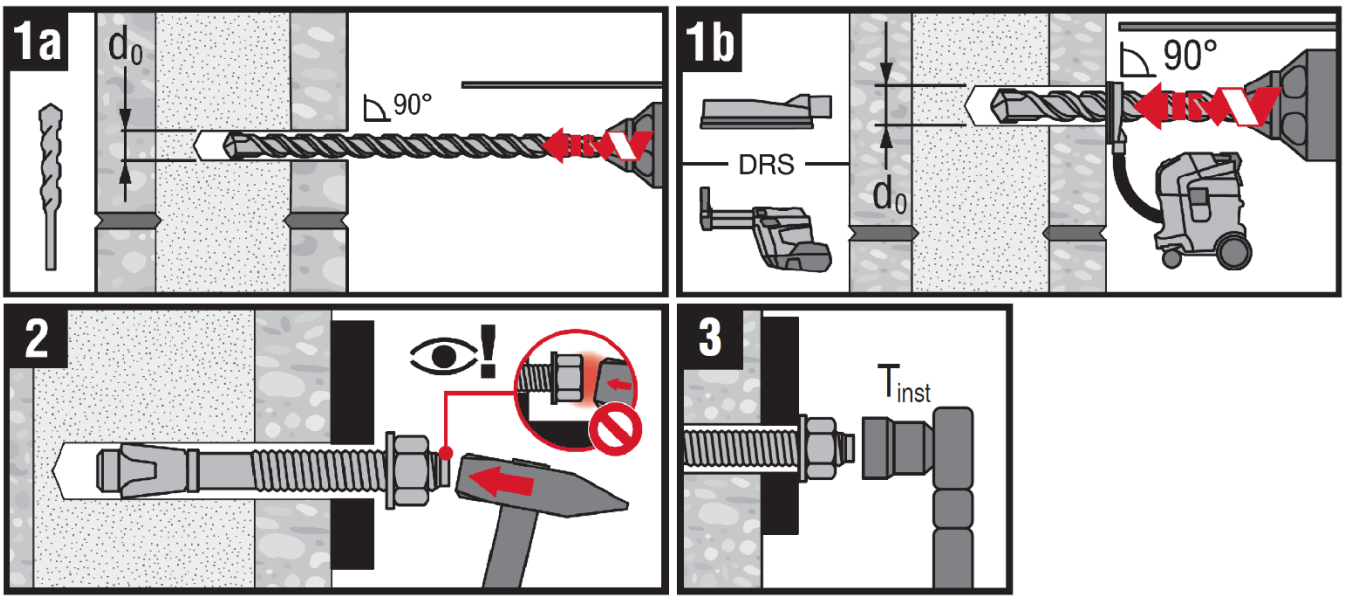

FIGURE 5 – MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII)

CITY OF LOS ANGELES SUPPLEMENT

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1.0 RECOGNITION

HILTI KB1 Expansion anchors recognized in ER-677 has 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:

- 2020 City of Los Angeles Building Code (LABC)
- 2020 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:

1. All applicable sections of ER-677.

2. The design, installation, conditions of use and identification of the Hilti KB1 Expansion anchors shall be in accordance with the 2018 International Building Code and the 2018 International Residential Code, as applicable, as noted in ER-677.

3. Prior to installation, calculations and details demonstrating compliance with this approval report and the 2020 Los Angeles Building Code or 2020 Los Angeles Residential Code shall be submitted to the structural plan check section for review and approval. The calculations and details shall be prepared by a registered engineer, licensed in the State of California.

4. The design and installation of the Hilti KB1 Expansion anchors shall be in accordance with LABC Chapters 16 and 17, as applicable.

5. The allowable and strength design values listed in ER-677 are for the connection of anchors to fully grouted masonry only. Connected members shall be checked for capacity (which may govern).

6. Periodic special inspection shall be provided by the Registered Deputy Inspector in accordance with Section 1705 of the 2020 LABC during installations of the Hilti KB1 Expansion anchors.

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

8. The use of anchors as out-of-plane wall anchorage for horizontal flexible diaphragms to resist tension loads is beyond the scope of this LABC and LARC supplement.

This supplement expires concurrently with ER-677.

FLORIDA SUPPLEMENT

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1.0 RECOGNITION

HILTI KB1 Expansion anchors recognized in ER-677 has 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:

- 2020 and 2017 Florida Building Code, Building (FBC–Building)
- 2020 and 2017 Florida Building Code, Residential (FBC–Residential)

2.0 LIMITATIONS

Hilti KB1 anchors described in ER-677 comply with the 2020 and 2017 FBC--Building and the 2020 and 2017 FBC--Residential, subject to the following limitations:

1. The design and installation of the Hilti KB1 anchors shall be in accordance with the 2018 or 2015 International Building Code and the 2018 or 2015 International Residential Code as noted in ER-677.

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

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).

4. 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.

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.

6. Use of Hilti KB1 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 TMS402 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 shall be embedded in reinforced grouted cells in accordance with Section 2122.7.4 of the FBC-Building.

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.

This supplement expires concurrently with ER-677.