# ICC-ES Evaluation Report

**ESR-3056**

| | |
|---|---|
| *Reissued October 2022* | *This report also contains:* |
| *Revised November 2023* | **- LABC Supplement** |
| *Subject to renewal October 2024* | **- FBC Supplement** |



| DIVISION: 04 00 00 — MASONRY<br>Section: 04 05 19.16 — Masonry Anchors | REPORT HOLDER: HILTI, INC. | EVALUATION SUBJECT: HILTI KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, AND KH-EZ CRC CARBON STEEL SCREW ANCHORS AND KH-EZ SS316 AND KH-EZ C SS316 STAINLESS STEEL SCREW ANCHORS FOR USE IN CRACKED AND UNCRACKED GROUTED CONCRETE MASONRY | |
|---|---|---|---|

## 1.0 EVALUATION SCOPE

**Compliance with the following codes:**

- 2021, 2018 and 2015 *International Building Code® (IBC)*
- 2021, 2018 and 2015 *International Residential Code® (IRC)*

For evaluation for compliance with codes adopted by the *Los Angeles Department of Building and Safety (LADBS)*, see ESR-3056 LABC and LARC Supplement.

**Property evaluated:**

Structural

## 2.0 USES

The Hilti KH-EZ, KH-EZ SS316, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ C SS316 and KH-EZ CRC screw anchors are used as anchorage in cracked and uncracked concrete masonry unit (CMU) walls to anchor building components to grouted lightweight, medium weight, or normal-weight 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 Hilti KH-EZ, KH-EZ SS316, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ C SS316 and KH-EZ CRC screw anchors are alternatives to cast-in-place anchors described in Section 8.1.3 (2016 or 2013 edition) of TMS 402/ ACI 530/ ASCE 5, as applicable, as referenced in Section 2107.1 of the IBC.

The Hilti KH-EZ, KH-EZ SS316, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ C SS316 and KH-EZ CRC screw anchors may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

## 3.0 DESCRIPTION

### 3.1 KH-EZ:

The KH-EZ screw anchors are comprised of a threaded body with hex washer head. The anchor is manufactured from carbon steel and is heat treated. It has a minimum 0.0003-inch (8 µm) zinc coating in accordance with DIN EN ISO 4042. The Hilti KH-EZ is available in a variety of lengths with nominal diameters of 1/4 inch, 3/8-inch, 1/2-inch, 5/8-inch, and 3/4-inch (6.4 mm, 9.5 mm, 12.7 mm, 15.9 mm and 19.1 mm). The KH-EZ is illustrated in Figure 1.

The hex head is larger than the anchor diameter and is formed with serrations on the underside. The anchor body is formed with threads running most of the length of the anchor body. The anchor is installed in a predrilled hole with a powered impact wrench or torque wrench. The anchor threads cut into the base material on the sides of the hole and interlock with the base material during installation.

### 3.2 KH-EZ P, KH-EZ PM and KH-EZ PL:

The KH-EZ P, KH-EZ PM and KH-EZ PL anchors are comprised of a body with round pan style head with an indented area in the top of the head with a six-point star configuration. The KH-EZ P, KH-EZ PM and KH-EZ PL have different size pan style heads: small (P), medium (PM) and large (PL). The anchor is manufactured from carbon steel and is heat-treated. It has a minimum 0.0003-inch-thick (8 µm) zinc coating in accordance with DIN EN ISO 4042. The KH-EZ P, KH-EZ PM and KH-EZ PL are available in nominal diameter of 1/4-inch (6.4 mm). The KH-EZ P, KH-EZ PM and KH-EZ PL are illustrated in Figure 2.

### 3.3 KH-EZ CRC:

The KH-EZ CRC anchors are comprised of a body with hex washer head. The anchor is manufactured from carbon steel and is heat-treated. It has a minimum of 0.0021-inch-thick (53 µm) mechanically deposited zinc coating in accordance with ASTM B695, Class 55. The KH-EZ CRC is available in a variety of lengths with nominal diameters of 3/8-inch, 1/2-inch, 5/8-inch and 3/4-inch (9.5 mm, 12.7 mm, 15.9 mm and 19.1 mm). The KH-EZ CRC is illustrated in Figure 4.

The hex head is larger than the anchor diameter and is formed with serrations on the underside. The anchor body is formed with threads running most of the length of the anchor body. The anchor is installed in a predrilled hole with a powered impact wrench or torque wrench. The anchor threads cut into the base material on the sides of the hole and interlock with the base material during installation.

### 3.4 KH-EZ C:

The KH-EZ C anchors are comprised of the same thread profile as the hex head but with a countersunk head. The anchor is manufactured from carbon steel and is heat-treated. It has a minimum of 0.0003-inch-thick (8 µm) zinc coating in accordance with DIN EN ISO 4042. The HK-EZ C is available in nominal diameters of 1/4 inch and 3/8 inch (6.4 mm and 9.5 mm). The KH-EZ C is illustrated in Figure 3.

### 3.5 KH-EZ SS316:

The KH-EZ SS316 screw anchors are comprised of a threaded body with hex washer head. The anchor is manufactured from AISI Type 316 stainless steel material. The KH-EZ SS316 is available in a variety of lengths with nominal diameters of 1/4-inch, 3/8-inch and 1/2-inch (6.4 mm, 9.5 mm and 12.7 mm). The KH-EZ SS316 is illustrated in Figure 5.

The hex head is larger than the anchor diameter and is formed with serrations on the underside. The anchor body is formed with threads running most of the length of the anchor body. The anchor is installed in a predrilled hole with a powered impact wrench. The anchor threads cut into the base material on the sides of the hole and interlock with the base material during installation.

### 3.6 KH-EZ C SS316:

The KH-EZ C SS316 anchors are comprised of the same thread profile as the stainless-steel hex head but with a countersunk head. The anchor is manufactured from AISI Type 316 stainless steel material. The KH-EZ C SS316 is available in nominal diameters of 1/4-inch and 3/8-inch (6.4 mm and 9.5 mm). The KH-EZ C SS316 is illustrated in Figure 6.

### 3.7 Grout-filled Concrete Masonry:

Grouted concrete masonry must comply with Chapter 21 of the IBC. The compressive strength of masonry, $f'_m$, at 28 days must be a minimum of 1,500 psi (10.3 MPa). Fully grouted masonry must be constructed from the following materials:

### 3.8 Concrete Masonry Units (CMUs):

Grouted concrete walls must be constructed from minimum lightweight, medium weight, or normal-weight, closed-end, or open-end, concrete masonry units (CMUs) conforming to ASTM C90. The minimum allowable nominal size of the CMU is 8 inches (203 mm) wide by 8 inches (203 mm) high by 16 inches (406 mm) long.

### 3.9 Grout:

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

### 3.10 Mortar:

Mortar must be Type N, S, or M, prepared in accordance with Section 2103.2.1 of the 2021, 2018, and 2015 IBC, Section R606.2.8 of the 2021 and 2018 IRC or Section R606.2.7 of the 2015 IRC, as applicable.

## 4.0 DESIGN AND INSTALLATION

### 4.1 Strength Design of Anchors in Fully Grouted Concrete Masonry Unit Construction:

**4.1.1 General:** Sections 4.1 and 4.2 provide strength design requirements used in fully grouted concrete masonry unit construction, where anchors are used to transmit structural loads by means of tension, shear or a combination of tension and shear.

Strength design of screw anchors in grouted concrete masonry unit construction shall be conducted in accordance with the provisions for the design of screw anchors in concrete in *ACI 318 (-19 or -14) Chapter 17*, and *TMS 402-16* as modified by the sections that follow. Design in accordance with this report cannot be conducted without reference to *ACI 318 (-19 or -14)* with the deletions and modifications summarized in Table 1A.

This report references sections, tables, and figures in both this report and *ACI 318*, with the following method 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 318-19 and the parenthetical reference corresponding to 318-14. For example, *Section 2.2 of ACI 318-19*, which is analogous to *Section 2.2 of 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 4.2.1.

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, $\lambda_a$, shall be taken as 1.0.

The following terms shall be replaced wherever they occur:

| ***ACI 318-14/19* term** | **Replacement term** |
|---|---|
| $f'_c$ | $f'_m$ |
| $N_{cb}$, $N_{cbg}$ | $N_{mb}$, $N_{mbg}$ |
| $V_{cb}$, $V_{cbg}$ | $V_{mb}$, $V_{mbg}$ |
| $V_{cp}$, $V_{cpg}$ | $V_{mp}$, $V_{mpg}$ |

**4.1.2** Restrictions for anchor placement are noted in Table 2 and 3 and shown in Figure 7. For CMU construction with closed end blocks and hollow head joints, in addition to the ends and edges of walls, 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 $c_{min,HJ}$ value provided in Table 2 & 3, 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 4.2.23.

**4.2 ACI Modifications Required for Design:** Table 1A provides a summary of all applicable ACI 318-19 and *ACI 318-14* sections for the design of screw anchors in fully grouted masonry. Where applicable, modifying sections contained within this report are also provided.

**4.2.1** *ACI 318-19 Section 17.1.1, 17.1.5 and 17.2.2 (ACI 318-14 Section 17.1.1-17.1.2)* apply with the general changes prescribed in Section 4.1.1.

**4.2.2** In lieu of *ACI 318-19 Section 17.1.2 (ACI 318-14 Section 17.1.3)*: Design provisions are included for screw anchors that meet the assessment criteria of ICC-ES AC01.

**4.2.3** *ACI 318-19 Section 17.1.4, 17.2.1, 17.4.1 and* 17.5.1.3.1 (*ACI 318-14 Section 17.1.4-17.2.2*) apply with the general changes prescribed in Section 4.1.1.

**4.2.4** In lieu of *ACI 318 Section 17.4.2* (*Section 17.2.3 or Section D.3.3*): The design of anchors in structures assigned to Seismic Design Category (SDC) C, D, E, or F shall satisfy the requirements of this section.

**4.2.4.1** The design of anchors in the plastic hinge zones of masonry structures under earthquake forces is beyond the scope of this acceptance criteria.

**4.2.4.2** 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 $\Omega_0$. The anchor design tensile strength shall satisfy the tensile strength requirements of 4.2.4.3.

**4.2.4.3** 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) $\phi N_{sa}$ 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) $0.75\ \phi N_{ma}\ or\ 0.75\ \phi N_{mag}$

**4.2.5** *ACI 318-19 Section 17.3.1* (*ACI 318-14 Section 17.2.7*) applies with the general changes prescribed in Section 4.1.1.

**4.2.6** 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 4.2.4 for earthquake loading.

**4.2.7** *ACI 318-19 Section 17.5.2.3* (*ACI 318-14 Section 17.3.1.3*) applies with the general changes prescribed in Section 4.1.1.

**4.2.8** *ACI 318-19 Section 17.5.1.2* (*ACI 318-14 Section 17.3.2* excluding *Section 17.3.2.1*) applies with the general changes prescribed in Section 4.1.1.

**4.2.9** 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 LFRD load combinations of ASCE 7 are used:

a) For 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.

**4.2.10** *ACI 318-19 Section 17.6.1* (*ACI 318-14 Section 17.4.1*) applies with the general changes prescribed in Section 4.1.1.

**4.2.11** 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

$$N_{mb} = \frac{A_{Nm}}{A_{Nmo}} \psi_{ed,N,m}\psi_{c,N,m}N_{b,m} \tag{17.6.2.1a}$$

b) For a group of anchors

$$N_{mbg} = \frac{A_{Nm}}{A_{Nmo}} \psi_{ec,N,m}\, \psi_{ed,N,m}\psi_{c,N,m}N_{b,m} \tag{17.6.2.1b}$$

Factors $\psi_{ec,N,m}$, $\psi_{ed,N,m}$, $\psi_{c,N,m}$ are defined in *ACI 318-19 Sections 17.6.2.3.1, 17.6.2.4* (*ACI 318-14 Sections 17.4.2.4, 17.4.2.5*), and *Section 4.2.13*, respectively. $A_{Nm}$ 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 $1.5 \cdot h_{ef}$ 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 $1.5 \cdot h_{ef}$.

$$A_{Nmo} = 9{h_{ef}}^2 \tag{17.6.2.1.4}$$

**4.2.12** In lieu of *ACI 318-19 Section 17.6.2.2.1* (*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

$$N_{b,m(cr,uncr)} = k_{m(cr,uncr)} \sqrt{f'_m}\, {h_{ef}}^{1.5} \tag{17.6.2.2.1}$$

Where

$k_{m,cr}$ = effectiveness factor for breakout strength in cracked masonry

= $\alpha_{masonry} \cdot k_{c,cr}$

$k_{c,cr}$ = effectiveness factor for breakout strength in concrete

= 17; and

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

=0.7

**4.2.13** *ACI 318-19 Section 17.6.2.1.2, 17.6.2.3.1 and 17.6.2.4* (*ACI 318-14 Section 17.4.2.3-17.4.2.5*) apply with the general changes prescribed in Section 4.1.1.

**4.2.14** 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, $N_{b,m}$, must be calculated using the values of $k_{m,cr}$ and $k_{m,uncr}$ as described in Table 4 and 5. Where analysis indicates no cracking is anticipated, $N_{b,m}$ must be calculated using $k_{m,uncr}$ and $\Psi_{c,N,m} = 1.0$.

**4.2.15** *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 Eq. 17.6.2.1a and 17.6.2.1b.(*Eq. 17.4.2.7a and 17.4.2.7b*).

**4.2.16** In lieu of *ACI 318-19 Section 17.6.3.1* (*ACI 318-14 Section 17.4.3.1* or *Section D.5.3.1*): The nominal pullout strength of a single screw anchor in tension shall not exceed

$$N_{pn} = \psi_{m,P}\, N_p \tag{17.6.3.1}$$

where $\psi_{m,P}$. is defined in *ACI 318 Section 17.6.3.3.*

**4.2.17** In lieu of ACI 318-19 Section 17.6.3.2.1 (ACI 318-14 Section 17.4.3.2): The nominal pullout strength of a single anchor in cracked and uncracked masonry, $N_{p,cr}$ and $N_{p,uncr}$, respectively, is given in Table 4 and 5 of this report, and shall not exceed the breakout strength calculated in accordance with Section 4.2.12 associated with $f'_m$.

**4.2.18** The following apply with the general changes prescribed in Section 4.1.1:

- *ACI 318-19 Section 17.6.3.3 (ACI 318-14 Section 17.4.3.6)*
- *ACI 318-19 Section 17.7.1 excluding Sections 17.7.1.2a & 17.7.1.2c (ACI 318-14 Section 17.5.1 excluding Sections 17.5.1.2a & 17.5.1.2c)*

- *ACI 318-19 Section 17.7.2.1-17.7.2.2.1 (ACI 318-14 Sections 17.5.2.1-17.5.2.2)*
- *ACI 318-19 Section 17.7.2.1.2, 17.7.2.3 and 17.7.2.4 (ACI 318-14 Section 17.5.2.4-17.5.2.6)*
- *ACI 318-19 Section 17.7.2.6 (ACI 318-14 Section 17.5.2.8)*
- *ACI 318-19 Section 17.7.3 (ACI 318-14 Section 17.5.3)*
- *ACI 318-19 Section 17.8 (ACI 318-14 Section 17.6)*
- *ACI 318-19 Section 17.9 (ACI 318-14 Section 17.7)*
- *ACI 318-19 Section 26.13.1.5 and 26.13.2.5 (ACI 318-14 Section 17.8.1)*

**4.2.19** 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 load levels, it shall be permitted to take $\psi_{m,V}$ as 1.4.

**4.2.20** In lieu of *ACI 318-19 Section 17.9* (*ACI 318-14 Section 17.7*): Minimum edge distances and spacings shall be as indicated in Table 2 and 3 of this report.

**4.2.21** [*In addition to the ACI 318 provisions*] For screw anchors with embedment depths $5d_a \leq h_{ef} \leq 10d_a$ and $h_{ef} \geq$ 1.5 in, 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 Section 17.4.2 and 17.5.2*).

**4.2.22** [*In addition to the ACI 318 provisions*] Masonry crushing strength for anchors in shear—The nominal strength of an anchor in shear as governed by masonry crushing, $V_{mc}$, shall be calculated using Eq. (4-1).

$$V_{mc} = 1750 \sqrt[4]{f'_{m} A_{se,v}} \qquad (4\ 1)$$

**4.2.23** [*In addition to the ACI 318 provisions*] Determination of shear capacity for bolts 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 anchor bolts 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 bolts shall be permitted to be calculated in accordance with Eq. (4-2) and Eq. (4-3), respectively, in lieu of Section 4.1.2.

$$v_{mb,horiz} = 0.75 \cdot V_{gov,horiz} \cdot \frac{12}{s_{horiz}} \qquad (4.2)$$

$$v_{mb,vert} = 0.75 \cdot V_{gov,vert} \cdot \frac{12}{s_{horiz}} \qquad (4.3)$$

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 or N)

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

$V_{sa}$ = shear capacity for a single bolt as given in Tables 6 and 7 of this report (lb or N)

$V_{mb,4}$ =breakout capacity for a single bolt with edge distance of 4 in. (lb or N)

$V_{mc}$ =crushing capacity for a single bolt calculated in accordance with Eq. (4-1) (lb or N)

$V_{mp,4}$ =pryout capacity for a single bolt with edge distance of 4 in. (lb or N)

**4.2.24** Interaction shall be calculated in compliance with ACI 318-19 Section 17.8 (ACI 318-14 Section 17.6) as follows:

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

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

For all other cases:

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

**4.2.25** 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 4.2.23. The parabolic equation is given as:

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

**4.3 Strength Design of Anchors in Partially Grouted Concrete Masonry Unit Construction:**

**4.3.1** In all cases, the minimum distance from hollow head joints shall be $c_{min,HJ}$ value provided in Table 2 and 3, which is measured from the centerline of the head joint.

**4.3.2** Group effects shall not be considered between anchors in grouted masonry and anchors in ungrouted masonry.

**4.3.3** Anchors located in grouted cells shall be designed in accordance with Sections 4.1 and 4.2, whereby the distance to the edge of the ungrouted cell shall be taken as a free edge.

**4.3.4** Use of the anchors in cases where the location of grouted cells is unknown is outside the scope of this report.

**4.4 Conversion of strength design to Allowable Stress Design (ASD):**

**4.4.1** For post-installed anchors designed using Allowable Stress Design load combinations from the legally adopted building code shall be established using the equations below:

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

and

$$V_{allowable,ASD} = \frac{\phi\, V_n}{\alpha} \qquad (4\text{-}5)$$

where

$T_{allowable,ASD}$ = Allowable tensile load (lb. or N);

$V_{allowable,ASD}$ = Allowable shear load (lb. or N);

$N_n$ = Lowest design strength of an anchor or anchor group in tension as determined in accordance with this report, as applicable, and 2021, 2018, and 2015 IBC Section 1905.1.8.

$V_n$ = Lowest design strength of an anchor or anchor group in shear as determined in accordance with this report, as applicable, and 2021, 2018, and 2015 IBC Section 1905.1.8.

$\alpha$ = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, $\alpha$ shall include all applicable factors to account for non-ductile failure modes and required overstrength; and

$\phi$ = relevant strength reduction factor for load case and Anchor Category.

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

**4.4.2** Interaction shall be calculated in compliance with *ACI 318-19 Section 17.8* (*ACI 318-14 Section 17.6*) as follows:

- For shear loads $V \leq 0.2V_{allowable,ASD}$ , the full allowable load in tension shall be permitted.
- For tensile loads $T \leq 0.2T_{allowable,ASD}$ , the full allowable load in shear shall be permitted.
- For all other cases:

$$\frac{T}{T_{allowable}} + \frac{V}{V_{allowable}} \leq 1.2$$

### 4.5 Installation

Installation parameters are provided in Table 2 and 3 and Figures 7, 8, 9, 10, 11 and 12. Anchor locations must comply with this report and plans and specifications approved by the code official. The Hilti KH-EZ, KH-EZ SS316, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ C SS316 and KH-EZ CRC must be installed in accordance with the manufacturer's published instructions and this report. In case of conflict, this report governs. Installation in head joints shall only be permitted in fully grouted walls constructed with open-ended units. Anchors must be installed in holes drilled into the masonry using carbide-tipped masonry drill bits complying with ANSI B212.15-1994. Nominal drill bit diameters must 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 concrete surface while drilling. The anchor must be installed into the predrilled hole using a powered impact wrench or installed with a torque wrench until the proper nominal embedment depth is obtained. The maximum impact wrench torque, $T_{impact,max}$ and maximum installation torque, $T_{inst,max}$ for the manual torque wrench must be in accordance with Tables 2 and 3. The KH-EZ, KH-EZ SS316, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ C SS316 and KH-EZ CRC may be loosened by a maximum of one turn and retightened with a torque wrench or powered impact wrench to facilitate fixture attachment or realignment. Complete removal and reinstallation of the anchor is not allowed.

### 4.6 Special Inspection:

At a minimum, periodic special inspection under the IBC and IRC must be provided in accordance with Sections 1704 and 1705 of the IBC. Under the IBC, additional requirements as set forth in Sections 1705 and 1706 must be observed, where applicable. The special inspector shall be on the jobsite initially during anchor installation to verify anchor type and dimensions, masonry type, masonry compressive strength, anchor identification, hole dimensions, hole cleaning procedures, spacing, edge distances, masonry unit dimensions, anchor embedment, tightening torque, maximum impact wrench torque rating and adherence to the Manufacturer's Printed Installation Instructions (MPII).

The special inspector shall verify the initial installations of each type and size of mechanical anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same construction personnel are permitted to be performed in the absence of the special inspector. Any change in the anchor product being installed or in the personnel performing the installation requires an initial inspection. For ongoing installations over an extended period, the special inspector must make regular inspections to confirm correct handling and installation of the product.

## 5.0 CONDITIONS OF USE:

The Hilti KH-EZ, KH-EZ SS316, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ C SS316 and KH-EZ CRC Screw Anchors described in this report are suitable alternatives to what is specified in the codes listed in Section 1.0 of this report, subject to the following conditions:

**5.1** Anchors must be installed in accordance with the manufacturer's printed installation instructions (MPII) and this report. In case of conflict, this report governs.

**5.2** Anchor sizes, dimensions and minimum embedment depths are as set forth in the tables of this report.

**5.3** The 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.

**5.4** Strength design values are established in accordance with Section 4.1, 4.2 and 4.3 of this report.

**5.5** Allowable stress design values are established in accordance with Section 4.4 of this report.

**5.6** Design of anchors in fully grouted CMU construction must avoid location of anchors in hollow head joints.

**5.7** Construction documents prepared or reviewed by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed specifying the screw anchors must indicate compliance with this evaluation report and applicable codes and must be submitted to the code official for approval.

**5.8** Since an ICC-ES acceptance criteria for evaluating data to determine the performance of mechanical anchors subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under these conditions is beyond the scope of this report.

**5.9** The design of anchors must be in accordance with the provisions for cracked masonry where analysis indicates that cracking could occur ($f_t \geq f_r$) in the vicinity of the anchor due to service loads or deformations over the anchor service life.

**5.10** Anchors installed in the face or the top 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.

Loads applied to the anchors must be adjusted in accordance with Section 1605.1 of the 2021 IBC or Section 1605.2 of the 2018 and 2015 IBC for strength design and in accordance with Section 1605.1 of the 2021 IBC or Section 1605.3 of the 2018 and 2015 IBC for allowable stress design.

**5.11** Anchors are not permitted to support fire-resistance-rated construction. Where not otherwise prohibited by the code, anchors are permitted for installation in fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:

- Anchors are used to resist wind or seismic forces in Seismic Design Categories A and F.
- Anchors that support gravity load-bearing structural elements are within a fire-resistance-rated envelope or a fire-resistance-rated membrane, are protected by approved fire-resistance-rated materials or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchors are used to support nonstructural elements.

**5.12** Use of carbon steel KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, and KH-EZ C screw anchors must be limited to dry, interior locations.

**5.13** Use of stainless-steel KH-EZ SS316, KH-EZ C SS316 and KH-EZ CRC screw anchors as specified in this report are permitted for exterior exposure and damp environments.

**5.14** Use of stainless-steel KH-EZ SS316, KH-EZ C SS316 and KH-EZ CRC screw anchors as specified in this report are permitted for contact with preservative-treated and fire-retardant-treated wood.

**5.15** Special inspection must be provided in accordance with Section 4.6 of this report.

**5.16** The Hilti KH-EZ, KH-EZ SS316, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ C SS316 and KH-EZ CRC screw anchors are manufactured under a quality control program with inspections by ICC-ES.

## 6.0 EVIDENCE SUBMITTED

**6.1** Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Cracked and Uncracked Masonry Elements (AC01), dated February 2021 (Editorially revised February 2023), which incorporates requirements in ACI 355.2-19, for use in cracked and uncracked masonry.

**6.2** Quality control documentation.

## 7.0 IDENTIFICATION

**7.1** The ICC-ES mark of conformity, electronic labeling, or the evaluation report number (ICC-ES ESR-3056) along with the name, registered trademark, or registered logo of the report holder must be included in the product label.

**7.2** In addition, the anchors are identified by packaging with the company name (Hilti, Inc.) and contact information, anchor name and anchor size. The anchors have KH-EZ (Hex, P, PM, PL, C, C SS316, CRC or SS316) accordingly, HILTI, and the anchor diameter and anchor length embossed on the anchor head. Identifications are visible after installation, for verification.

**7.3** The report holder's contact information is the following:

**HILTI, INC.**
**7250 DALLAS PARKWAY, SUITE 1000**
**PLANO, TEXAS 75024**
**(800) 879-8000**
**www.us.hilti.com**
**HiltiTechEng@us.hilti.com**

**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 4.2.2 |
| *17.1.4, 17.2.1, 17.4.1, & 17.5.1.3.1* | *(17.1.4 – 17.2.2)* | Unchanged* |
| *17.4.2* | *(17.2.3)* | Section 4.2.4 |
| *17.3.1* | *(17.2.7)* | Unchanged* |
| *17.5.2* | *(17.3.1.1)* | Section 4.2.6 |
| *17.5.2.3* | *(17.3.1.3)* | Unchanged* |
| *17.5.1.2* | *(17.3.2 excluding 17.3.2.1)* | |
| *17.5.3* | *(17.3.3)* | Section 4.2.9 |
| *17.6.1* | *(17.4.1)* | Unchanged* |
| *17.6.2.1* | *(17.4.2.1)* | Section 4.2.11 |
| *17.6.2.2.1* | *(17.4.2.2)* | Section 4.2.12 |
| *17.6.2.1.2 & 17.6.2.3 – 17.6.2.4* | *(17.4.2.3 – 17.4.2.5)* | Unchanged* |
| *17.6.2.5* | *(17.4.2.6)* | Section 4.2.14 |
| *17.6.2.6* | *(17.4.2.7 – 17.4.2.9)* | Section 4.2.15 and Section 4.2.16 |
| *17.6.3.1* | *(17.4.3.1)* | Section 4.2.16 |
| *17.6.3.2.1* | *(17.4.3.2)* | Section 4.2.17 |
| *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 – 17.7.2.4* | *(17.5.2.4 – 17.5.2.6)* | |
| *17.7.2.5* | *(17.5.2.7)* | Section 4.2.19 |
| *17.7.2.6* | *(17.5.2.8)* | Unchanged* |
| *17.7.3* | *(17.5.3)* | |
| *17.8* | *(17.6)* | |
| *R17.8* | *(R17.6)* | |
| *17.9* | *(17.7)* | Section 4.2.20 |
| *26.13.1.5 and 26.13.2.5* | *(17.8.1)* | Unchanged* |

*Sections marked as unchanged adopt the general changes prescribed in Section 4.1.1.

**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.

FIGURE 1—HILTI KH-EZ SCREW ANCHOR

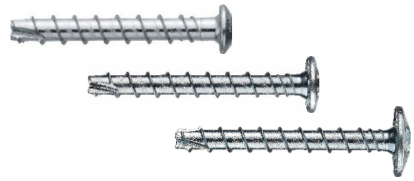

FIGURE 2—HILTI KH-EZ P, KH-EZ PM, KH-EZ PL SCREW ANCHOR

FIGURE 3—HILTI KH-EZ C SCREW ANCHOR

FIGURE 4—HILTI KH-EZ CRC SCREW ANCHOR

FIGURE 5—HILTI KH-EZ SS316 SCREW ANCHOR

FIGURE 6—HILTI KH-EZ C SS316 SCREW ANCHOR

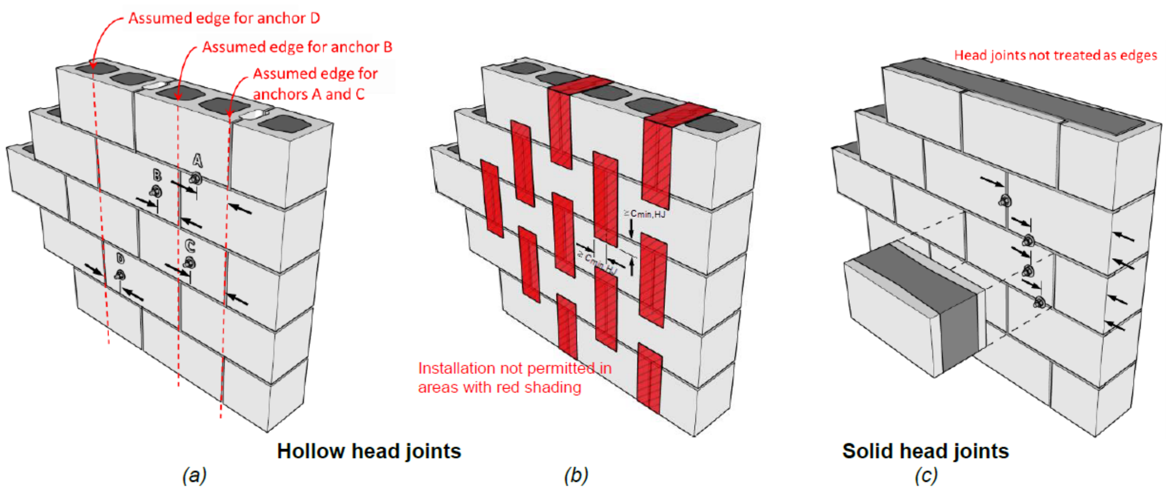


**FIGURE 7—(a) Edge distance considerations in fully grouted CMU construction with hollow head joints, (b) exclusion zones in fully grouted construction with hollow head joints, and (c) edge distance considerations in fully grouted CMU construction with solid head joints. Note: dimensions to upper and lower edges omitted for clarity.**

**TABLE 2— HILTI KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C AND KH-EZ CRC SETTING INFORMATION**

| Design Information | Symbol | Units | Nominal Anchor Diameter (in.) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | | 3/8 | | 1/2 | | 5/8 | | 3/4 | |
| Head Style and Coating | - | - | Hex, P, PM, PL, C Head | | Hex, C Head | Hex, C Head (incl. CRC) | Hex Head (incl. CRC) | | Hex Head (incl. CRC) | | Hex Head (incl. CRC) | |
| Nominal Bit Diameter | $d_o$ | in. | 1/4 | | 3/8 | | 1/2 | | 5/8 | | 3/4 | |
| Effective Min. Embedment | $h_{ef}$ | in. (mm) | 1.18 (30) | 1.92 (49) | 1.11 (28) | 2.50 (64) | 1.52 (39) | 3.22 (82) | 2.39 (61) | 3.88 (99) | 2.92 (74) | 4.84 (123) |
| Nominal Embedment | $h_{nom}$ | in. (mm) | 1 5/8 (41) | 2 1/2 (64) | 1 5/8 (41) | 3 1/4 (83) | 2 1/4 (57) | 4 1/4 (108) | 3 1/4 (83) | 5 (127) | 4 (102) | 6 1/4 (159) |
| Min. Hole Depth | $h_1$ | in. (mm) | 2 (51) | 2 7/8 (73) | 1 7/8 (48) | 3 1/2 (89) | 2 5/8 (67) | 4 5/8 (117) | 3 5/8 (92) | 5 3/8 (137) | 4 3/8 (111) | 6 5/8 (168) |
| Maximum Installation Torque KH-EZ (Hex, P, PM, PL, C) | $T_{inst,max}$[4] | ft-lb (Nm) | 7 (9.5) | | 10 (13.6) | | 25 (33.9) | | 38 (51.5) | | 70 (94.9) | |
| Maximum Installation Torque KH-EZ CRC | $T_{inst,max}$[4] | ft-lb (Nm) | - | | 10 (13.6) | | 25 (33.9) | | 35 (47.5) | | 45 (61.0) | |
| Maximum Impact Wrench Torque Rating KH-EZ (Hex, P, PM, PL, C, CRC) | $T_{impact,max}$[3] | ft-lb (Nm) | 66 (89) | 100 (136) | 66 (89) | 332 (450) | 157 (213) | 332 (450) | 332 (450) | | 332 (450) | |
| Minimum Fixture Diameter | $d_f$ | in. (mm) | 3/8 (9.5) | | 1/2 (12.7) | | 5/8 (15.9) | | 3/4 (19.1) | | 7/8 (22.2) | |
| 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 1/2 (64) | | 2 1/2 (64) | | 2 1/2 (64) | |
| Face of Wall: Minimum Edge Distance[1] | $c_{min}$ | in. (mm) | 4 (102) | | 4 (102) | | 4 (102) | | 4 (102) | | 4 (102) | |
| Face of Wall: Minimum Anchor Spacing | $s_{min}$ | in. (mm) | 4 (102) | | 4 (102) | | 4 (102) | | 4 (102) | | 4 (102) | |
| Top of Wall: Minimum Edge Distance[1,2] | $c_{min,top}$ | in. (mm) | N/A | | N/A | | N/A | 1 3/4 (44) | N/A | 1 3/4 (44) | N/A | |
| Top of Wall: Minimum Anchor Spacing | $s_{min,top}$ | in. (mm) | N/A | | N/A | | N/A | 8 (203) | N/A | 10 (254) | N/A | |

For **SI***:* 1 inch = 25.4 mm, 1 ft-lb = 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 7. See Section 4.1.2.

[2] The minimum end distance from the center of an anchor to the end of the top of the CMU wall is 4 inches. Edge and end distances are illustrated in Figure 9.

[3] Because of the variability in measurement procedures, the published torque of an impact tool may not correlate properly with the above setting torques. Over-torquing can damage the anchor and/or reduce its holding capacity.

[4] Maximum Installation Torque applies to installations using a calibrated torque wrench.

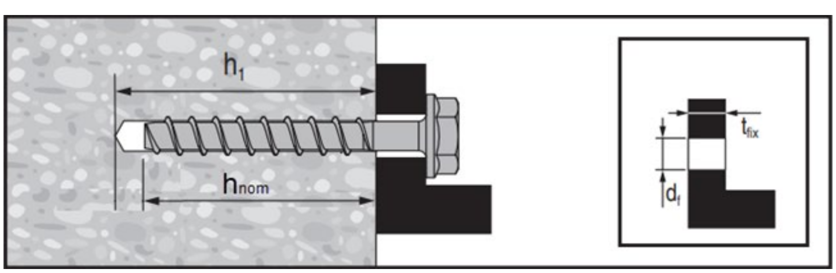


**FIGURE 8 — HILTI KH-EZ INSTALLED**

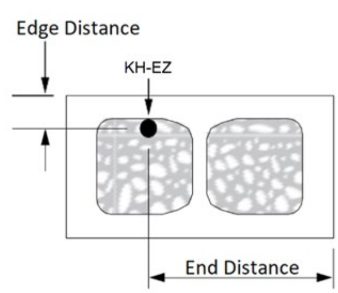


**FIGURE 9 – EDGE & END DISTANCES FOR TOP OF WALL INSTALLATION**

**TABLE 3— HILTI KH-EZ SS316 INSTALLATION SETTING INFORMATION**

| Design Information | | Symbol | Units | Nominal Anchor Diameter (in.) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1/4 | | 3/8 | | 1/2 | |
| Head Style | | - | - | Hex and C | | Hex and C | | Hex | |
| Nominal Bit Diameter | | $d_o$ | in. | 1/4 | | 3/8 | | 1/2 | |
| Effective Min. Embedment | | $h_{ef}$ | in. (mm) | 1.19 (30) | 1.93 (49) | 1.49 (38) | 2.55 (65) | 1.56 (40) | 3.26 (83) |
| Nominal Embedment | | $h_{nom}$ | in. (mm) | 1 5/8 (41) | 2 1/2 (64) | 2 (51) | 3 1/4 (83) | 2 1/4 (57) | 4 1/4 (108) |
| Min. Hole Depth | | $h_1$ | in. (mm) | 2 (51) | 2 7/8 (73) | 2 1/4 (57) | 3 1/2 (89) | 2 5/8 (67) | 4 5/8 (117) |
| Maximum Installation Torque | | $T_{inst,max}$[4] | | 2 (2.7) | N/A | N/A | | N/A | |
| Maximum Impact Wrench Torque Rating | | $T_{impact,max}$[3] | ft-lb (Nm) | N/A | 66 (89) | 100 (136) | | 157 (213) | |
| Minimum Fixture Diameter | | $d_f$ | in. (mm) | 3/8 (9.5) | | 1/2 (12.7) | | 5/8 (15.9) | |
| 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 1/2 (64) | |
| Face of Wall | Minimum Edge Distance[1] | $c_{min}$ | in. (mm) | 4 (102) | | 4 (102) | | 4 (102) | |
| Face of Wall | Minimum Anchor Spacing | $s_{min}$ | in. (mm) | 6 (152) | | 4 (102) | | 6 (152) | |
| Top of Wall | Minimum Edge Distance[1,2] | $c_{min,top}$ | in. (mm) | N/A | | N/A | | N/A | 1 3/4 (44) |
| Top of Wall | Minimum Anchor Spacing | $s_{min,top}$ | in. (mm) | N/A | | N/A | | N/A | 8 (203) |

For **SI**: 1 inch = 25.4 mm, 1 ft-lb = 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 7. See Section 4.1.2.
[2] The minimum end distance from the center of an anchor to the end of the top of the CMU wall is 4 inches. Edge and end distances are illustrated in Figure 9.
[3] Because of the variability in measurement procedures, the published torque of an impact tool may not correlate properly with the above setting torques Over-torquing can damage the anchor and/or reduce its holding capacity.
[4] Maximum Installation Torque applies to installations using a calibrated torque wrench.

**TABLE 4— HILTI KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C AND KH-EZ CRC DESIGN INFORMATION - TENSION**

| Design Information | Symbol | Units | Nominal Anchor Diameter (in.) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | | 3/8 | | 1/2 | | 5/8 | | 3/4 | |
| Effective Min. Embedment[1] | $h_{ef}$ | in. (mm) | 1.18 (30) | 1.92 (49) | 1.11 (28) | 2.50 (64) | 1.52 (39) | 3.22 (82) | 2.39 (61) | 3.88 (99) | 2.92 (74) | 4.84 (123) |
| **Tension - Steel Failure Mode** | | | | | | | | | | | | |
| Strength Reduction Factor for Steel - Tension[2,3] | $\phi$ | - | 0.65 | | 0.65 | | 0.65 | | 0.65 | | 0.65 | |
| Effective Tensile Stress Area | $A_{se,N}$ | in.$^2$ (mm$^2$) | 0.045 (29.0) | | 0.086 (55.5) | | 0.161 (103.9) | | 0.268 (172.9) | | 0.392 (252.9) | |
| Carbon Steel: Min. Specified Yield Strength | $f_y$ | lb/in$^2$ (N/mm$^2$) | 100,000 (690) | | 71,500 (493) | 103,265 (712) | 96,450 (665) | | 60,190 (415) | | 54,385 (375) | |
| Carbon Steel: Min. Specified Ult. Strength | $f_{uta}$ | lb/in$^2$ (N/mm$^2$) | 125,000 (862) | | 106,975 (738) | 120,300 (829) | 112,540 (776) | | 90,180 (622) | | 81,600 (563) | |
| Carbon Steel: Steel Strength in Tension | $N_{sa}$ | lb (kN) | 5,660 (25.2) | | 9,200 (40.9) | 10,335 (46.0) | 18,120 (80.6) | | 24,210 (107.7) | | 32,015 (142.5) | |
| **Tension - Masonry Failure Modes** | | | | | | | | | | | | |
| Anchor Category | - | - | 1 | | 1 | | 1 | | 1 | | 2 | |
| Strength Reduction Factor for Masonry Breakout and Pullout Failure - Tension[3] | $\phi$ | - | 0.65 | | 0.65 | | 0.65 | | 0.65 | | 0.55 | |
| Effectiveness Factor for Uncracked Masonry[4] | $k_{m,uncr}$ | - | 17 | | 17 | | 17 | | 17 | | 17 | |
| Effectiveness Factor for Cracked Masonry[4] | $k_{m,cr}$ | - | 12 | | 12 | | 12 | | 12 | | 12 | |
| Face of Wall: Pullout Strength Uncracked Masonry[5] | $N_{p,uncr}$ | lb (kN) | 700 (3.1) | 1,360 (6.1) | 735 (3.3) | 2,940 (13.1) | 1,560 (6.9) | 4,910 (21.8) | 2,250 (10.0) | 3,825 (17.0) | 4,325 (19.2) | 6,390 (28.4) |
| Face of Wall: Pullout Strength Cracked Masonry[5] | $N_{p,cr}$ | lb (kN) | 240 (1.1) | 460 (2.0) | 545 (2.4) | 2,175 (9.7) | 1,290 (5.7) | 3,800 (16.9) | 2,250 (10.0) | 3,825 (17.9) | 2,990 (13.3) | 4,410 (19.6) |
| Face of Wall: Pullout Strength Seismic[5] | $N_{p,eq}$ | lb (kN) | 240 (1.1) | 460 (2.0) | 530 (2.4) | 2,175 (9.7) | 1,290 (5.7) | 3,600 (16.0) | 2,250 (10.0) | 3,600 (16.0) | 2,990 (13.3) | 4,175 (18.6) |
| Top of Wall: Pullout Strength Uncracked Masonry[5] | $N_{p,top,uncr}$ | lb (kN) | - | - | - | - | - | 3,045 (13.6) | - | 3,825 (17.0) | - | - |
| Top of Wall: Pullout Strength Cracked Masonry[5] | $N_{p,top,cr}$ | lb (kN) | - | - | - | - | - | 2,530 (11.3) | - | 3,800 (16.9) | - | - |
| Top of Wall: Pullout Strength Seismic[5] | $N_{p,top,eq}$ | lb (kN) | - | - | - | - | - | 2,530 (8.1) | - | 3,600 (16.0) | - | - |
| **Tension – Axial Stiffness** | | | | | | | | | | | | |
| Axial Stiffness in Service Load Range | $\beta_{uncr}$ | lb/in | 307,500 | | 370,780 | | 643,115 | | 725,260 | | 766,120 | |
| | $\beta_{cr}$ | lb/in | 227,710 | | 311,730 | | 388,455 | | 277,785 | | 275,475 | |

For **SI**: 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 MPa. For pound-inch units: 1 mm = 0.03937 inches

[1] Figure 8 of this report illustrates the installation parameters.

[2] The KH-EZ is considered a brittle steel element in accordance with *ACI 318 (-19 and -14) Section 2.3*.

[3] The tabulated values of $\phi$ apply when the LRFD load combinations of ASCE 7 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 ($k_{m,uncr}$) must be used.

[5] For all design cases, $\psi_{m,P} = 1.0$. Tabular value for pullout strength is for a masonry compressive strength of 1,500 psi (10.3 Mpa).

**TABLE 5— HILTI KH-EZ SS316 DESIGN INFORMATION - TENSION**

| Design Information | | Symbol | Units | Nominal Anchor Diameter (in.) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1/4 | | 3/8 | | 1/2 | |
| Effective Min. Embedment[1] | | $h_{ef}$ | in. (mm) | 1.19 (30) | 1.93 (49) | 1.49 (38) | 2.55 (65) | 1.56 (40) | 3.26 (83) |
| **Tension - Steel Failure Mode** | | | | | | | | | |
| Strength Reduction Factor for Steel - Tension[2,3] | | $\phi$ | - | 0.75 | | 0.75 | | 0.75 | |
| Effective Tensile Stress Area | | $A_{se,N}$ | in.$^2$ (mm$^2$) | 0.040 (25.8) | | 0.094 (60.6) | | 0.172 (111.0) | |
| Stainless Steel | Min. Specified Yield Strength | $f_y$ | lb/in$^2$ (N/mm$^2$) | 100,00 (690) | | 100,000 (692) | | 101,400 (699) | |
| Stainless Steel | Min. Specified Ult. Strength | $f_{uta}$ | lb/in$^2$ (N/mm$^2$) | 125,000 (862) | | 125,000 (862) | | 120,100 (828) | |
| Stainless Steel | Steel Strength in Tension | $N_{sa}$ | lb (kN) | 5,000 (22.3) | | 11,750 (52.3) | | 20,655 (91.9) | |
| **Tension - Masonry Failure Modes** | | | | | | | | | |
| Anchor Category | | - | - | 2 | | 2 | | 2 | |
| Strength Reduction Factor for Masonry Breakout and Pullout Failure - Tension[3] | | $\phi$ | - | 0.55 | | 0.55 | | 0.55 | |
| Effectiveness Factor for Uncracked Masonry[4] | | $k_{m,uncr}$ | - | 17 | | 17 | | 17 | |
| Effectiveness Factor for Cracked Masonry[4] | | $k_{m,cr}$ | - | 12 | | 12 | | 12 | |
| Face of Wall | Pullout Strength Uncracked Masonry[5] | $N_{p,uncr}$ | lb (kN) | 355 (1.6) | 760 (3.4) | 935 (4.2) | 3,410 (15.2) | 1,595 (7.1) | 4,795 (21.3) |
| Face of Wall | Pullout Strength Cracked Masonry[5] | $N_{p,cr}$ | lb (kN) | 160 (0.7) | 340 (1.5) | 385 (1.7) | 1,400 (6.2) | 1,255 (5.6) | 3,790 (16.9) |
| Face of Wall | Pullout Strength Seismic[5] | $N_{p,eq}$ | lb (kN) | 150 (0.7) | 340 (1.5) | 385 (1.7) | 1,400 (6.2) | 1,255 (5.6) | 3,790 (16.9) |
| Top of Wall | Pullout Strength Uncracked Masonry[5] | $N_{p,top,uncr}$ | lb (kN) | - | - | - | - | - | 2,050 (9.1) |
| Top of Wall | Pullout Strength Cracked Masonry[5] | $N_{p,top,cr}$ | lb (kN) | - | - | - | - | - | 1,620 (7.2) |
| Top of Wall | Pullout Strength Seismic[5] | $N_{p,top,eq}$ | lb (kN) | - | - | - | - | - | 1,620 (7.2) |
| **Tension – Axial Stiffness** | | | | | | | | | |
| Axial Stiffness in Service Load Range | | $\beta_{uncr}$ | lb/in | 335,625 | | 493,775 | | 759,105 | |
| | | $\beta_{cr}$ | lb/in | 159,065 | | 262,510 | | 479,805 | |

For **SI***:* 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 Mpa. For pound-inch units: 1 mm = 0.03937 inches

[1] Figure 8 of this report illustrates the installation parameters.

[2] The KH-EZ SS316 is considered a ductile steel element in accordance with *ACI 318 (-19 and -14) Section 2.3*.

[3] The tabulated values of $\phi$ apply when the LRFD load combinations of ASCE 7 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 ($k_{m,uncr}$) must be used.

[5] For all design cases, $\psi_{m,P} = 1.0$. Tabular value for pullout strength is for a masonry compressive strength of 1,500 psi (10.3 Mpa).

**TABLE 6— HILTI KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C AND KH-EZ CRC DESIGN INFORMATION - SHEAR**

| Design Information | Symbol | Units | Nominal Anchor Diameter (in.) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | | 3/8 | | 1/2 | | 5/8 | | 3/4 | |
| Anchor O.D. | $d_a$ | in. (mm) | 0.250 (6.4) | | 0.375 (9.5) | | 0.500 (12.7) | | 0.625 (15.9) | | 0.750 (19.1) | |
| Effective Min. Embedment[1] | $h_{ef}$ | in. (mm) | 1.18 (30) | 1.92 (49) | 1.11 (28) | 2.50 (64) | 1.52 (39) | 3.22 (82) | 2.39 (61) | 3.88 (99) | 2.92 (74) | 4.84 (123) |
| **Shear - Steel Failure Mode** | | | | | | | | | | | | |
| Strength Reduction Factor for Steel - Shear[2,3] | $\phi$ | - | 0.60 | | 0.60 | | 0.60 | | 0.60 | | 0.60 | |
| Steel Strength in Shear | $V_{sa}$ | lb (kN) | 1,445 (6.4) | 1,750 (7.8) | 1,810 (8.1) | 5,080 (22.6) | 3,145 (14.0) | 6,545 (29.1) | 8,450 (37.6) | | 10,300 (45.8) | |
| Steel Strength in Shear, Seismic | $V_{sa,eq}$ | lb (kN) | 1,445 (6.6) | | 1,630 (7.3) | | 2,830 (12.6) | | 6,760 (30.1) | | 9,755 (43.4) | |
| **Shear - Masonry Failure Modes** | | | | | | | | | | | | |
| Strength Reduction Factor for Masonry Breakout and Pryout Failure - Shear[3] | $\phi$ | - | 0.70 | | 0.70 | | 0.70 | | 0.70 | | 0.70 | |
| Strength Reduction Factor for Masonry Crushing Failure - Shear[3] | $\phi$ | - | 0.50 | | 0.50 | | 0.50 | | 0.50 | | 0.50 | |
| Load Bearing Length of Anchor in Shear | $l_e$ | in. (mm) | 1.18 (30) | 1.92 (49) | 1.11 (28) | 2.50 (64) | 1.52 (39) | 3.22 (82) | 2.39 (61) | 3.88 (99) | 2.92 (74) | 4.84 (123) |
| Coefficient for Pryout Strength | $k_{cp}$ | - | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |

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

[1] Figure 8 of this report illustrates the installation parameters.

[2] The KH-EZ is considered a brittle steel element in accordance with *ACI 318 (-19 and -14) Section 2.3*.

[3] The tabulated values of $\phi$ apply when the LRFD load combinations of ASCE 7 are used.

**TABLE 7— HILTI KH-EZ SS316 DESIGN INFORMATION – SHEAR**

| Design Information | Symbol | Units | Nominal Anchor Diameter (in.) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | | 3/8 | | 1/2 | |
| Anchor O.D. | $d_a$ | in.<br>(mm) | 0.250<br>(6.4) | | 0.375<br>(9.5) | | 0.500<br>(12.7) | |
| Effective Min. Embedment[1] | $h_{ef}$ | in.<br>(mm) | 1.19<br>(30) | 1.93<br>(49) | 1.49<br>(38) | 2.55<br>(65) | 1.56<br>(40) | 3.26<br>(83) |
| **Shear - Steel Failure Mode** | | | | | | | | |
| Strength Reduction Factor for Steel - Shear[2,3] | $\phi$ | - | 0.65 | | 0.65 | | 0.65 | |
| Steel Strength in Shear | $V_{sa}$ | lb<br>(kN) | 1,410<br>(6.3) | 2,035<br>(9.1) | 3,825<br>(17.0) | 4,700<br>(20.9) | 3,770<br>(16.8) | 8,185<br>(36.4) |
| Steel Strength in Shear, Seismic | $V_{sa,eq}$ | lb<br>(kN) | 1,410<br>(6.3) | | 3,635<br>(16.2) | | 3,770<br>(16.8) | |
| **Shear - Masonry Failure Modes** | | | | | | | | |
| Strength Reduction Factor for Masonry Breakout and Pryout Failure - Shear[3] | $\phi$ | - | 0.70 | 0.70 | 0.70 | | 0.70 | |
| Strength Reduction Factor for Masonry Crushing Failure - Shear[3] | $\phi$ | - | 0.50 | 0.50 | 0.50 | | 0.50 | |
| Load Bearing Length of Anchor in Shear | $l_e$ | in.<br>(mm) | 1.19<br>(30) | 1.93<br>(49) | 1.49<br>(38) | 2.55<br>(65) | 1.56<br>(40) | 3.26<br>(83) |
| Coefficient for Pryout Strength | $k_{cp}$ | - | 1 | 1 | 1 | 2 | 1 | 2 |

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

[1] Figure 8 of this report illustrates the installation parameters.

[2] The KH-EZ SS316 is considered a ductile steel element in accordance with *ACI 318 (-19 and -14) Section 2.3*.

[3] The tabulated values of $\phi$ apply when the LRFD load combinations of ASCE 7 are used.

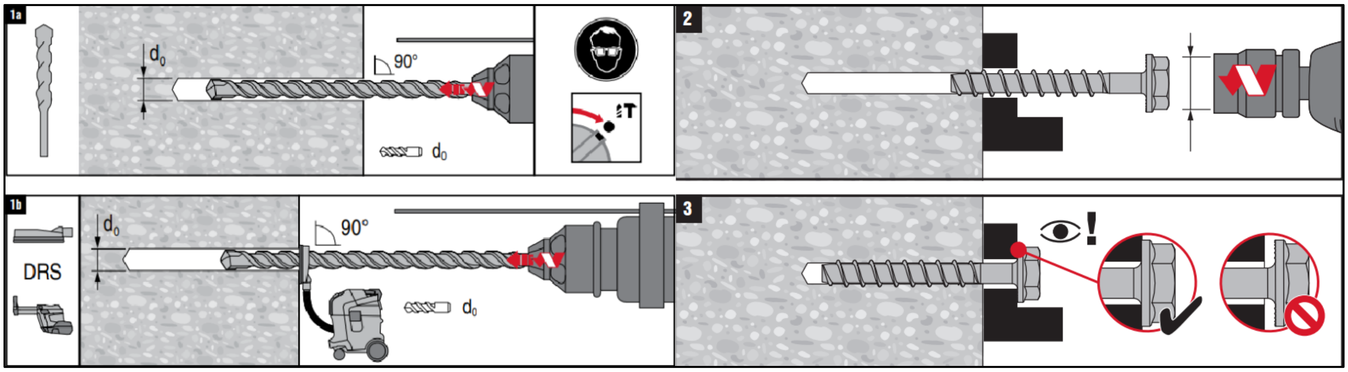


FIGURE 10—INSTALLATION INSTRUCTIONS—HILTI KH-EZ, KH-EZ CRC AND KH-EZ SS316

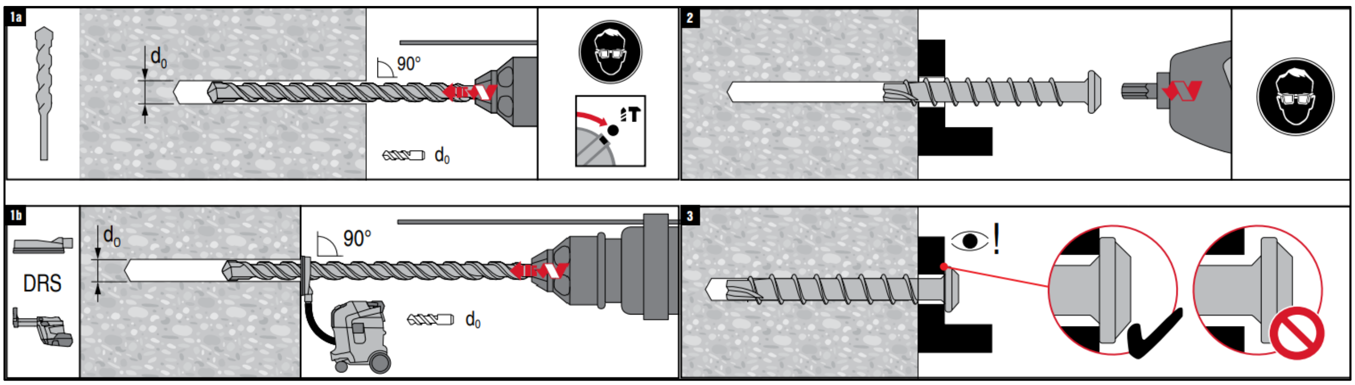


FIGURE 11—INSTALLATION INSTRUCTIONS – HILTI KH-EZ P, KH-EZ PM AND KH-EZ PL

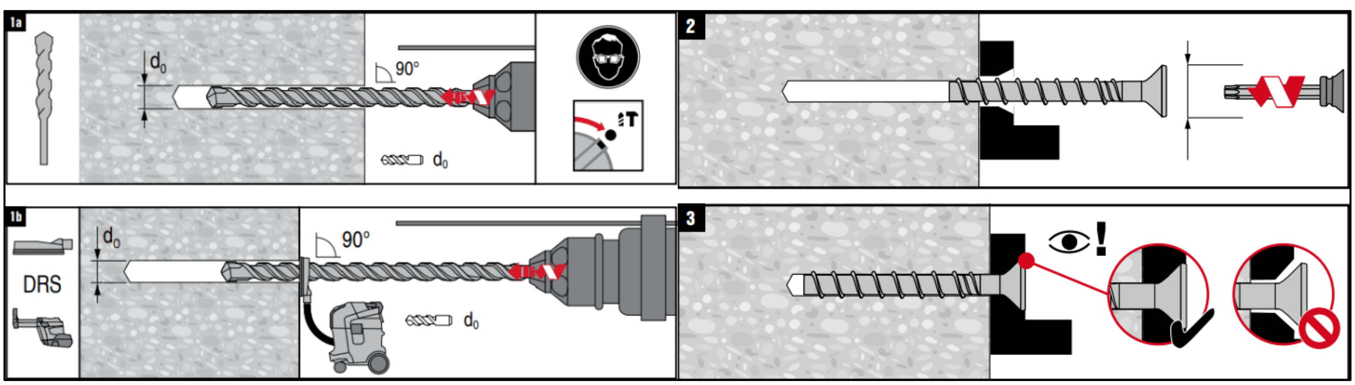


FIGURE 12—INSTALLATION INSTRUCTIONS – HILTI KH-EZ C AND KH-EZ C SS316