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ICC-ES Evaluation Report

ESR-3027

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DIVISION: 03 00 00—CONCRETE
Section: 03 16 00—Concrete Anchors

DIVISION: 05 00 00—METALS
Section: 05 05 19—Post-Installed Concrete Anchors

REPORT HOLDER:

HILTI, INC.

EVALUATION SUBJECT:

HILTI KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ E, KH-EZ I, 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 CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2021, 2018, 2015 and 2012 *International Building Code*® (IBC)
- 2021, 2018, 2015 and 2012 *International Residential Code*® (IRC)

For evaluation for compliance with codes adopted by the Los Angeles Department of Building and Safety (LADBS), see ESR-3027 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, KH-EZ E, KH-EZ I and KH-EZ CRC screw anchors are used as anchorage in cracked and uncracked normal-weight and lightweight concrete having a specified strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa); and cracked and uncracked normal-weight or sand-lightweight concrete over steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa) to resist static, wind and seismic (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, KH-EZ E, KH-EZ I and KH-EZ CRC screw anchors are an alternative to anchors described in Section 1901.3 of the 2021, 2018 and 2015 IBC and Sections 1908 and 1909 of the 2012 IBC. The anchors may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 KH-EZ:

The KH-EZ 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 0.0003-inch-thick (8 μm) zinc coating in accordance with DIN EN ISO 4042. The anchoring system 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. The KH-EZ is illustrated in Figure 2.

The hex head is larger than the diameter of the anchor 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 concrete on the sides of the hole and interlock with the base material during installation.

3.2 KH-EZ I:

The KH-EZ I anchors are comprised of a body with a long internally threaded ($^{1}/_{4}$-inch, $^{3}/_{8}$-inch, or $^{1}/_{2}$-inch internal thread) hex washer head. 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 I is illustrated in Figure 3.

The over-sized hex head is larger than the diameter of the anchor 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 directly to the supporting member surface. The anchor threads cut into the concrete on the sides of the hole and interlock with the base material during installation.

Shear design values in this report for the KH-EZ I are for threaded inserts with F_u equal to or greater than 125 ksi. For use with inserts with F_u less than 125 ksi, the shear values are multiplied by the ratio of F_u of insert and 125 ksi.

3.3 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 $^1/_4$-inch diameter. The KH-EZ P, KH-EZ PM and KH-EZ PL are illustrated in Figure 4.

3.4 KH-EZ E:

The KH-EZ E anchors are comprised of a body with a long externally threaded ($^3/_8$-inch external thread) head. 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 E is available in $^1/_4$-inch diameter. The KH-EZ E is illustrated in Figure 5.

3.5 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 0.0003-inch-thick (8 μm) zinc coating in accordance with DIN EN ISO 4042. The KH-EZ C is available in $^1/_4$-inch and $^3/_8$-inch diameter. The KH-EZ C is illustrated in Figure 7.

3.6 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 anchoring system is available in a variety of lengths with nominal diameters of $^3/_8$-inch, $^1/_2$-inch, $^5/_8$-inch and $^3/_4$-inch. The KH-EZ CRC is illustrated in Figure 6.

3.7 KH-EZ SS316:

The KH-EZ SS316 anchors are comprised of a body with hex washer head. The anchor is manufactured from AISI Type 316 stainless steel material. The anchoring system is available in a variety of lengths with nominal diameters of ¼-inch, $^3/_8$-inch and $^1/_2$-inch. The KH-EZ SS316 is illustrated in Figure 8.

The hex head is larger than the diameter of the anchor 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 concrete on the sides of the hole and interlock with the base material during installation.

3.8 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 $^1/_4$-inch and $^3/_8$-inch diameter. The KH-EZ C SS316 is illustrated in Figure 9.

3.9 Concrete:

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

3.10 Steel Deck Panels:

Steel deck panels must comply with the configurations in Figure 12 and have a minimum base steel thickness of 0.035 inch (0.889 mm). Steel must comply with ASTM A653/A653M SS Grade 50 and have a minimum yield strength of 50,000 psi (345 MPa).

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design strength of anchors complying with the 2021 IBC as well as Section R301.1.3 of the 2021 IRC must be determined in accordance with ACI 318-19 Chapter 17 and this report.

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

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

Design parameters provided in Table 1 through Table 9 of this report are based on the 2021 IBC (ACI 318-19), 2018 and 2015 IBC (ACI 318-14) and 2012 IBC (ACI 318-11) unless noted otherwise in Sections 4.1.1 through 4.1.12.

The strength design of anchors must comply with ACI 318-19 17.5.1.2, ACI 318-14 17.3.1 or ACI 318-11 D.4.1, as applicable, except as required in ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Strength reduction factors, ϕ, as given in ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, and noted in Tables 3, 4 and 7 of this report, must be used for load combinations calculated in accordance with Section 1605.1 of the 2021 IBC or Section 1605.2 of the 2018, 2015 and 2012 IBC and Section 5.3 of ACI 318 (-19 and -14) or Section 9.2 of ACI 318-11, as applicable. Strength reduction factors, ϕ, as given in ACI 318-11 D.4.4 must be used for load combinations calculated in accordance with ACI 318-11 Appendix C.

The value of f'_c used in the calculations must be limited to a maximum of 8,000 psi (55.2 MPa), in accordance with ACI 318-19 17.3.1, ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable. An example calculation in accordance with the 2021, 2018, 2015 and 2012 IBC is provided in Figure 13.

4.1.2 Requirements for Static Steel Strength in Tension, N_{sa}: The nominal static steel strength, N_{sa}, of a single anchor in tension calculated in accordance with ACI 318-19 17.6.1.2, ACI 318-14 17.4.1.2 or ACI 318-11 D.5.1.2, as applicable, is given in Tables 3, 4 and 7 of this report. Strength reduction factors, ϕ, corresponding to brittle steel elements must be used.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension, N_{cb} or N_{cbg}: The nominal concrete breakout strength of a single anchor or a group of anchors in tension, N_{cb} and N_{cbg}, respectively, must be calculated in accordance with ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, with modifications as described in this section. The basic concrete breakout strength of a single anchor in tension, N_b, must be calculated in accordance with ACI 318-19 17.6.2.2, ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2, as applicable, using the values of h_{ef} and k_{cr} as given in Tables 3, 4 and 7 of this report. The nominal concrete breakout strength in tension in regions where analysis indicates no cracking in accordance with ACI 318-19 17.6.2.5, ACI 318-14 17.4.2.6 or ACI 318-11 D.5.2.6, as applicable, must be calculated with the value of k_{uncr} as given in Tables 3, 4 and 7 with $\psi_{c,N} = 1.0$.

For anchors installed in the lower or upper flute of the soffit of sand-lightweight or normal-weight concrete-filled steel deck floor and roof assemblies, as shown in Figure 12, calculation of the concrete breakout strength in accordance with ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, is not required.

4.1.4 Requirements for Static Pullout Strength in Tension, N_p: The nominal pullout strength of a single anchor in accordance with ACI 318-19 17.6.3.1 and 17.6.3.2.1, ACI 318-14 17.4.3.1 and 17.4.3.2 or ACI 318-11 D.5.3.1 and D.5.3.2, as applicable, in cracked and uncracked concrete, $N_{p,cr}$, and $N_{p,uncr}$, respectively, is given in Tables 3, 4 and 7. In lieu of ACI 318-19 17.6.3.3, ACI 318-14 17.4.3.6 or ACI 318-11 D.5.3.6, as applicable, $\psi_{c,P}$ = 1.0 for all design cases. In accordance with ACI 318-19 17.6.3, ACI 318-14 17.4.3 or ACI 318-11 D.5.3, as applicable, the nominal pullout strength in cracked concrete may be adjusted according to Eq.-1:

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

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

where f'_c is the specified concrete compressive strength and n is the factor defining the influence of concrete compressive strength on the pullout strength. For the $^1/_4$-inch-diameter anchor at $1^5/_8$ inches nominal embedment in cracked concrete, n is 0.3. For all other cases, n is 0.5.

In regions where analysis indicates no cracking in accordance with ACI 318-19 17.6.3.3, ACI 318-14 17.4.3.6 or ACI 318-11 D.5.3.6, as applicable, the nominal pullout strength in tension may be adjusted according to Eq-2:

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

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

where f'_c is the specified concrete compressive strength and n is the factor defining the influence of concrete compressive strength on the pullout strength. For the $^1/_4$-inch-diameter anchor at a nominal embedment of $1^5/_8$ inches in uncracked concrete, n is 0.3. For all other cases, n is 0.5.

Where values for $N_{p,cr}$ or $N_{p,uncr}$ are not provided in Table 3, 4 or Table 7 of this report, the pullout strength in tension need not be considered.

The nominal pullout strength in tension of the anchors installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, as shown in Figure 12, is provided in Table 5 for KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC and Table 8 for KH-EZ I and KH-EZ E. In accordance with ACI 318-19 17.6.3.2.1, ACI 318-14 17.4.3.2 or ACI 318-11 D.5.3.2, as applicable, the nominal pullout strength in cracked concrete must be calculated according to Eq-1, whereby the value of $N_{p,deck,cr}$ must be substituted for $N_{p,cr}$ and the value of 3,000 psi (20.7 MPa) must be substituted for the value of 2,500 psi (17.2 MPa) in the denominator. In regions where analysis indicates no cracking in accordance with ACI 318-19 17.6.3.3, ACI 318-14 17.4.3.6 or ACI 318-11 5.3.6, as applicable, the nominal strength in uncracked concrete must be calculated according to Eq-2, whereby the value of $N_{p,deck,uncr}$ must be substituted for $N_{p,uncr}$ and the value of 3,000 psi (20.7 MPa) must be substituted for the value of 2,500 psi (17.2 MPa) in the denominator.

4.1.5 Requirements for Static Steel Shear Capacity, V_{sa}: The nominal steel strength in shear, V_{sa}, of a single anchor in accordance with ACI 318-19 17.7.1.2, ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable is given in Tables 3, 4 and 7 of this report and must be used in lieu of the values derived by calculation from ACI 318-19 Eq. 17.7.1.2b, ACI 318-14 Eq. 17.5.1.2b or ACI 318-11 Eq. D-29, as applicable. The strength reduction factor, ϕ, corresponding to brittle steel elements must be used. The nominal shear strength $V_{sa,deck}$, of anchors installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, as shown in Figure 12, is given in Table 5 for KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC and Table 8 for KH-EZ I and KH-EZ E. Shear values for KH-EZ I are for threaded inserts with $F_u \geq$ 125 ksi. For use with inserts with F_u less than 125 ksi, the shear values are multiplied by the ratio of F_u of insert and 125 ksi.

4.1.6 Requirements for Static Concrete Breakout Strength in Shear, V_{cb} or V_{cbg}: The nominal concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg}, respectively, must be calculated in accordance with ACI 318-19 17.7.2, ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, with modifications as described in this section. The basic concrete breakout strength in shear, V_b, must be calculated in accordance with ACI 318-19 17.7.2.2.1, ACI 318-14 17.5.2.2 or ACI 318-11 D.6.2.2, as applicable, using the values of ℓ_e and d_a given in Tables 3, 4 and 7.

For anchors installed in the lower or upper flute of the soffit of sand-lightweight or normal-weight concrete-filled steel deck floor and roof assemblies, as shown in Figure 12, calculation of the concrete breakout strength in accordance with ACI 318-19 17.7.2, ACI 318-14 17.5.2 or ACI 318-11 D.6.2 is not required.

4.1.7 Requirements for Static Concrete Pryout Strength in Shear, V_{cp} or V_{cpg}: The nominal concrete pryout strength of a single anchor or group of anchors, V_{cp} or V_{cpg}, respectively, must be calculated in accordance with ACI 318-19 17.7.3, ACI 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable, using the coefficient for pryout strength, k_{cp} provided in Tables 3, 4 and 7 and the value of N_{cb} or N_{cbg} as calculated in Section 4.1.3 of this report.

For anchors installed in the lower or upper flute of the soffit of sand-lightweight or normal-weight concrete-filled steel deck floor and roof assemblies, as shown in Figure 12, calculation of the concrete pryout strength in accordance with ACI 318-19 17.7.3, ACI 318-14 17.5.3 or ACI 318-11 D.6.3 is not required.

4.1.8 Requirements for Seismic Design:

4.1.8.1 General: For load combinations including seismic, the design must be in accordance with ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Modifications to ACI 318-19 17.10 or ACI 318-14 17.2.3 shall be applied under Section 1905.1.8 of the 2021, 2018 and 2015 IBC, as applicable. For the 2012 IBC, Section 1905.1.9 shall be omitted.

The anchors comply with ACI 318 (-19 and -14) 2.3 or ACI 318-11 D.1, as applicable, as brittle steel elements and must be designed in accordance with ACI 318-19 17.10.5 or 17.10.6; ACI 318-14 17.2.3.4 or 17.2.3.5; ACI 318-11 D.3.3.4 or D.3.3.5, as applicable.

4.1.8.2 Seismic Tension: The nominal steel strength and nominal concrete breakout strength for anchors in tension must be calculated in accordance with ACI 318-19 17.6.1 and 17.6.2, ACI 318-14 17.4.1 and 17.4.2 or ACI 318-11 D.5.1 and D.5.2, respectively, as applicable, as described in Sections 4.1.2 and 4.1.3 of this report. In accordance with ACI 318-19 17.6.3.2.1, ACI 318-14 17.4.3.2 or ACI 318-11 D.5.3.2, as applicable, the appropriate value for pullout strength in tension for seismic loads, $N_{p,eq}$ or $N_{p,deck,cr}$ described in Tables 3, 4 and 5 for KH-EZ, KH-EZ SS316, KH-EZ C, KH-EZ C SS316, KH-EZ P, KH-EZ PM, KH-EZ PL and KH-EZ CRC; and in Tables 7 and 8 for KH-EZ I and KH-EZ E, must be used in lieu of N_p. $N_{p,eq}$ or $N_{p,deck,cr}$ may be adjusted by calculations for concrete compressive strength in accordance with Eq-1 of this report in addition for concrete-filled steel deck floor and roof assemblies the value of 3,000 psi (20.7 MPa) must be substituted for the value of

2,500 psi (17.2 MPa) in the denominator. Where values for $N_{p,eq}$ are not provided in Tables 3, 4 or 7 of this report, the pullout strength in tension for seismic loads need not be evaluated.

4.1.8.3 Seismic Shear: The nominal concrete breakout strength and pryout strength in shear must be calculated in accordance with ACI 318-19 17.7.2 and 17.7.3, ACI 318-14 17.5.2 and 17.5.3 or ACI 318-11 D.6.2 and D.6.3, respectively, as applicable, as described in Sections 4.1.6 and 4.1.7 of this report. In accordance with ACI 318-19 17.7.1.2, ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable, the appropriate value for nominal steel strength for seismic loads, $V_{sa,eq}$ or $V_{sa,deck,eq}$ described in Tables 3, 4 and 5 for KH-EZ, KH-EZ SS316, KH-EZ C, KH-EZ C SS316, KH-EZ P, KH-EZ PM, KH-EZ PL and KH-EZ CRC , and in Tables 7 and 8 for KH-EZ I and KH-EZ E, must be used in lieu of V_{sa}.

4.1.9 Requirements for Interaction of Tensile and Shear Forces: For anchors or groups of anchors that are subject to the effects of combined tensile and shear forces, the design must be determined in accordance with ACI 318-19 17.8, ACI 318-14 17.6 or ACI 318-11 D.7, as applicable.

4.1.10 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: In lieu of ACI 318-19 17.9.2, ACI 318-14 17.7.1 and 17.7.3 or ACI 318-11 D.8.1 and D.8.3, as applicable, values of s_{min} and c_{min}, respectively, as given in Tables 1, 2 and 6 of this report must be used. In lieu of ACI 318-19 17.9.4, ACI 318-14 17.7.5 or ACI 318-11 D.8.5, as applicable, minimum member thicknesses, h_{min} as given in Tables 1, 2 and 6 must be used. Additional combinations for minimum edge distance, c_{min}, and minimum spacing distance, s_{min}, may be derived by linear interpolation between the given boundary values as defined in Tables 1, 2 and 6 of this report.

For anchors installed through the lower flute of the soffit of steel deck assemblies, the anchors must be installed in accordance with Figure 12 and shall have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width. For installations in the upper flute of the soffit of steel deck assemblies the anchors shall have an axial spacing along the flute equal to or greater than $3h_{ef}$.

For ¼-inch, $^3/_8$-inch and $^1/_2$-inch KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL and KH-EZ C anchors installed on the top of steel deck assemblies, values of $c_{ac,deck,top}$, $s_{min,deck,top}$, and $c_{min,deck,top}$, as given in Table 9 of this report must be used.

4.1.11 Requirements for Critical Edge Distance, c_{ac}: In applications where $c < c_{ac}$ and supplemental reinforcement to control splitting of the concrete is not present, the concrete breakout strength in tension for uncracked concrete, calculated in accordance with ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, must be further multiplied by the factor $\Psi_{cp,N}$ as given by Eq-3:

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

where the factor $\Psi_{cp,N}$ need not be taken as less than $\frac{1.5h_{ef}}{c_{ac}}$. For all other cases, $\Psi_{cp,N}$ = 1.0. In lieu of using ACI 318-19 17.9.5, ACI 318-14 17.7.6 or ACI 318-11 D.8.6, as applicable, values of c_{ac} must comply with Tables 3, 4 and 7.

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

For ACI 318-19 (2021 IBC), ACI 318-14 (2018 and 2015 IBC) and ACI 318-11 (2012 IBC), λ shall be determined in accordance with the corresponding version of ACI 318.

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

4.2 Allowable Stress Design (ASD):

4.2.1 General: Design values for use with allowable stress design load combinations calculated in accordance with Section 1605.1 of the 2021 IBC or Section 1605.3 of the 2018, 2015 and 2012 IBC must be established using the following equations:

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

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

where:

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

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

ϕN_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 (-19 and -14) Chapter 17 and 2021, 2018 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, and Section 4.1 of this report, as applicable. For the 2012 IBC, Section 1905.1.9 shall be omitted.

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 (-19 and -14) Chapter 17 and 2021, 2018 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, and Section 4.1 of this report, as applicable. For the 2012 IBC, Section 1905.1.9 shall be omitted.

α = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, α must include all applicable factors to account for nonductile failure modes and required over-strength.

Limits on edge distance, anchor spacing and member thickness as given in Tables 1, 2 and 6 of this report must apply. An example of Allowable Stress Design tension values is given in Table 10 and Figure 13.

4.2.2 Interaction of Tensile and Shear Forces: The interaction must be calculated and consistent with ACI 318-19 17.8, ACI 318-14 17.6 or ACI 318-11 D.7, as follows:

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

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

For all other cases:

$$\frac{T_{applied}}{T_{allowable,ASD}}+\frac{V_{applied}}{V_{allowable,ASD}} \le 1.2 \quad \text{(Eq-6)}$$

4.3 Installation:

Installation parameters are provided in Tables 1, 2, 6 and 9 and Figures 1, 11A, 11B, 11C, 11D, 11E 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, KH-EZ E, KH-EZ I 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. Anchors must be installed in holes drilled into concrete perpendicular to the surface using carbide-tipped masonry drill bits complying with ANSI B212.15-1994 or using the Hilti SafeSet System™. The Hilti SafeSet System™ is comprised of Hilti TE-YD or TE-CD Hollow Drill Bits with a Hilti vacuum with a minimum value for the maximum volumetric flow rate of 129 CFM (61 ℓ/s). The Hollow Drill Bits are not permitted for use with the $^1/_4$-inch- and $^3/_8$-inch-diameter anchors. The nominal drill bit diameter must be equal to that of the anchor. The minimum drilled hole depth, h_0, is given in Tables 1, 2, 6 and 8. When drilling dust is not removed after hole drilling, make sure to drill deep enough to achieve h_{nom}, taking into account the depth of debris remaining in the hole. If dust and debris is removed from the drilled hole with the Hilti TE-YD or TE-CD Hollow Drill Bits or compressed air, vacuum, or a manual pump, h_{nom} is achieved at the specified value of h_0. 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 1, 2 and 6. The KH-EZ, KH-EZ SS316, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ C SS316, KH-EZ E, KH-EZ I 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.

For installation in the soffit of concrete on steel deck assemblies, the hole diameter in the steel deck must not exceed the diameter of the hole in the concrete by more the $^1/_8$ inch (3.2 mm). For member thickness and edge distance restrictions for installations into the soffit of concrete on steel deck assemblies, see Figure 12.

For installation of $^1/_4$-inch, $^3/_8$-inch and $^1/_2$-inch KH-EZ KH-EZ P, KH-EZ PM, KH-EZ PL and KH-EZ C, anchors on the top of steel deck assemblies, see Table 9 for installation setting information.

4.4 Special Inspection:

Periodic special inspection is required, in accordance with Section 1705.1.1 and Table 1705.3 of the 2021, 2018 and 2015 IBC and 2012 IBC. The special inspector must be on the site periodically during anchor installation to verify anchor type, anchor dimensions, hole dimensions, concrete type, concrete compressive strength, drill bit type and size, hole dimensions, hole cleaning procedures, anchor spacing(s), edge distance(s), concrete member thickness, anchor embedment, installation torque, impact wrench power and adherence to the manufacturer's printed installation instructions and the conditions of this report (in case of conflict, this report governs). The special inspector must be present as often as required in accordance with the "statement of special inspection." Under the IBC, additional requirements as set forth in Sections 1705, 1706 and 1707 must be observed, where applicable.

5.0 CONDITIONS OF USE

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

5.1 The anchors must be installed in accordance with the manufacturer's published installation instructions and this report. In case of conflict, this report governs.

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

5.3 Anchors must be installed in accordance with Section 4.3 of this report in uncracked or cracked normal-weight concrete and lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa), and cracked and uncracked normal-weight or sand-lightweight concrete over metal deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

5.4 The value of f'_c used for calculation purposes must not exceed 8,000 psi (55.2 MPa).

5.5 The concrete must have attained its minimum design strength prior to installation of the anchors.

5.6 Strength design values must be established in accordance with Section 4.1 of this report.

5.7 Allowable stress design values must be established in accordance with Section 4.2 of this report.

5.8 Anchor spacing(s) and edge distance(s), and minimum member thickness, must comply with Tables 1, 2 and 6 and Figure 12 of this report.

5.9 Reported values for the KH-EZ I with an internally threaded hex washer head do not consider the steel insert element which must be verified by the design professional. Shear design values in this report for the KH-EZ I are for threaded inserts with F_u equal to or greater than 125 ksi. For use with inserts with F_u less than 125 ksi, the shear values are multiplied by the ratio of F_u of insert and 125 ksi.

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

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

5.12 Anchors may be installed in regions of concrete where cracking has occurred or where analysis indicates cracking may occur ($f_t>f_r$), subject to the conditions of this report.

5.13 Anchors may be used to resist short-term loading due to wind or seismic forces, subject to the conditions of this report.

5.14 Anchors are not permitted to support fire-resistance-rated construction. Where not otherwise prohibited in the 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 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.

5.15 Anchors have been evaluated for reliability against brittle failure and found to be not significantly sensitive to stress-induced hydrogen embrittlement.

5.16 Use of KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ E, and KH-EZ I carbon steel anchors are limited to dry, interior locations.

5.17 Use of KH-EZ SS316, KH-EZ C SS316 and KH-EZ CRC are permitted for exterior exposure or damp environments.

5.18 Special inspection must be provided in accordance with Sections 4.4.

5.19 KH-EZ, KH-EZ SS316, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ C SS316, KH-EZ E, KH-EZ I and KH-EZ CRC anchors are manufactured, under a quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated October 2017 (editorially revised December 2020), which incorporates requirements in ACI 355.2-19 / ACI 355.2-07, for use in cracked and uncracked concrete; and quality control documentation

7.0 IDENTIFICATION

7.1 HILTI KH-EZ, KH-EZ SS316, KH-EZ P, KH-EZ PL, KH-EZ C, KH-EZ C SS316, KH-EZ E, KH-EZ I and KH-EZ CRC anchors are identified by packaging with the company name (Hilti, Inc.), anchor name, anchor size, and evaluation report number (ESR-3027). The anchors with hex washer head, pan head and countersunk head, have KH-EZ, HILTI, and anchor size and anchor length embossed on the anchor head. Identifications are visible after installation, for verification.

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

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

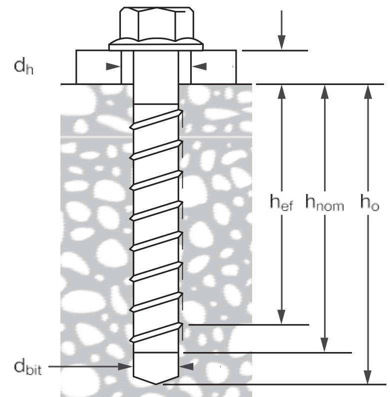


FIGURE 1—KWIK HUS EZ ANCHOR

FIGURE 2—HILTI KH-EZ CONCRETE SCREW ANCHOR

FIGURE 3—HILTI KH-EZ I SCREW ANCHOR

FIGURE 4—HILTI KH-EZ P, PM, PL SCREW ANCHORS

FIGURE 5—HILTI KH-EZ E SCREW ANCHOR

FIGURE 6—HILTI KH-EZ CRC SCREW ANCHOR

FIGURE 7—HILTI KH-EZ C SCREW ANCHOR

FIGURE 8—HILTI KH-EZ SS316 SCREW ANCHOR

FIGURE 9—HILTI KH-EZ C SS316 SCREW ANCHOR

Hilti SafeSet™ System with Hollow Drill Bit	 Hilti TE-CD or TE-YD Hollow Carbide Drill Bit with a Hilti Vacuum (per section 4.3)	
Hilti Dust Removal Systems	 Hilti Rotary Hammer Drill with DRS (Dust Removal System) Module	 Hilti TE DRS-D Dust Removal System with Hilti Vacuum

FIGURE 10—HILTI SAFESET^{TM} AND DUST REMOVAL SYSTEMS

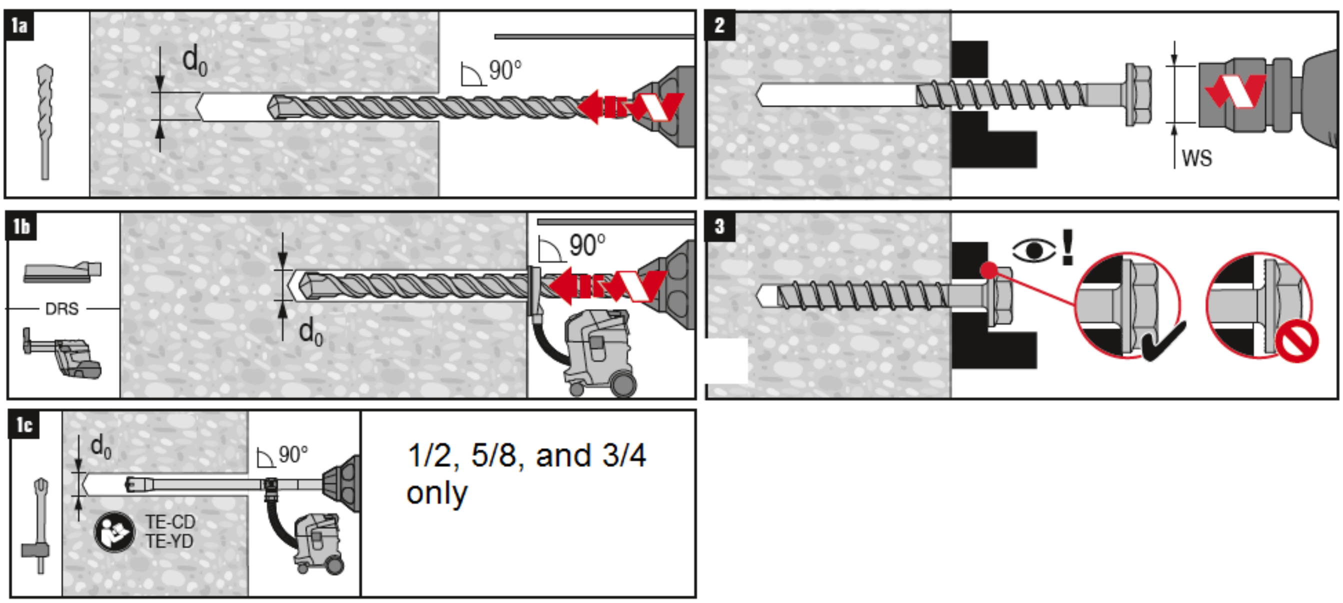


FIGURE 11A—INSTALLATION INSTRUCTIONS – HILTI KH-EZ, KH-EZ SS316 AND KH-EZ CRC SCREW ANCHORS

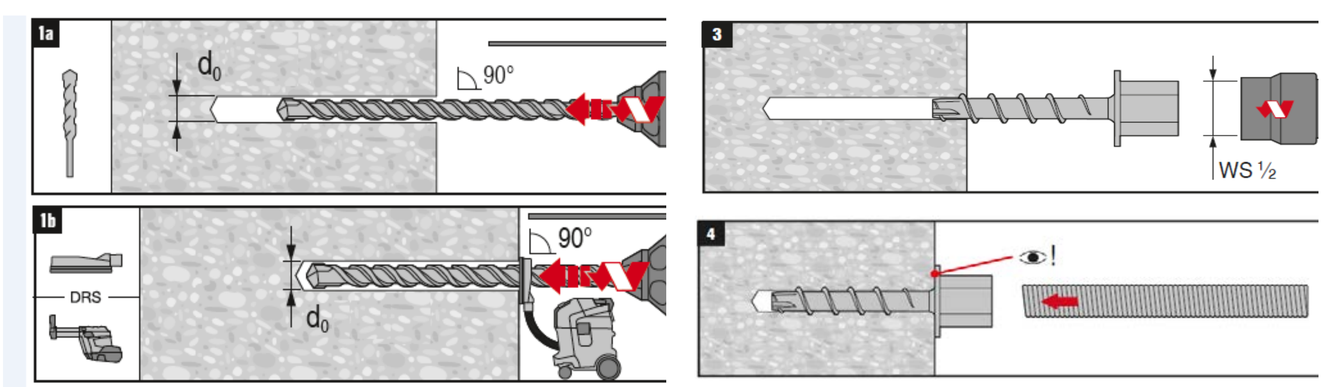


FIGURE 11B—INSTALLATION INSTRUCTIONS – HILTI KH-EZ I SCREW ANCHORS

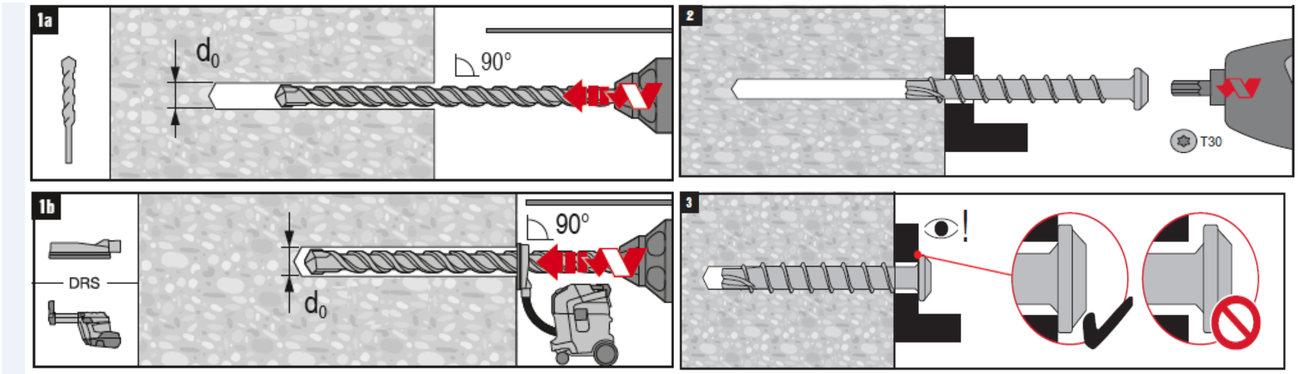


FIGURE 11C—INSTALLATION INSTRUCTIONS – HILTI KH-EZ P, PM, PL SCREW ANCHORS

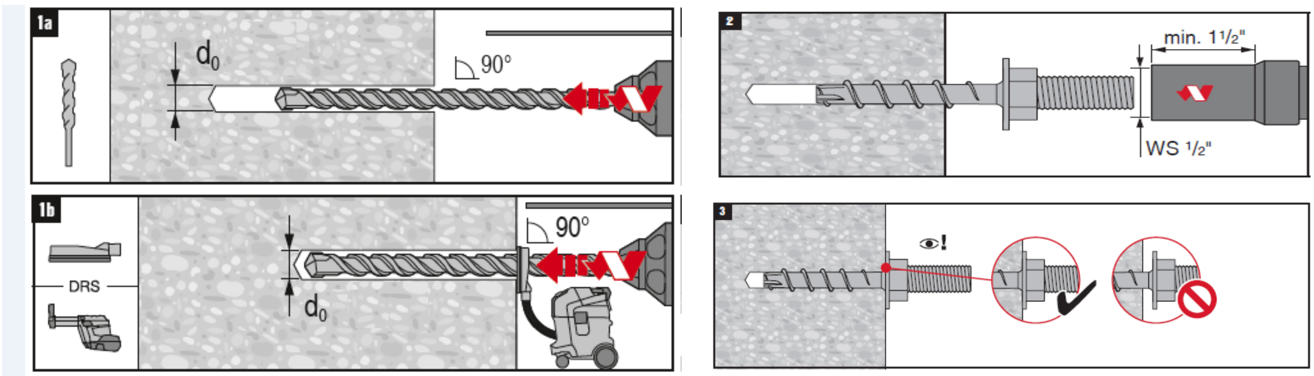


FIGURE 11D—INSTALLATION INSTRUCTIONS – HILTI KH-EZ E SCREW ANCHORS

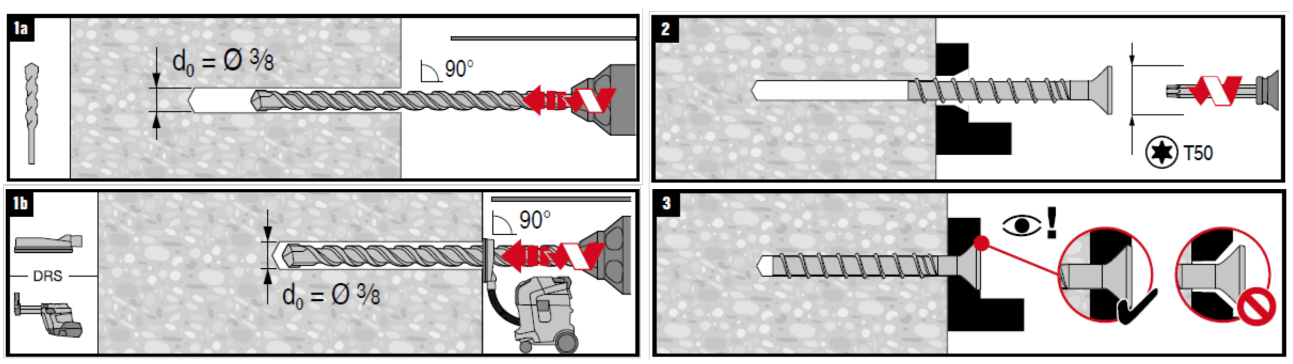


FIGURE 11E—INSTALLATION INSTRUCTIONS – HILTI KH-EZ C AND KH-EZ C SS316 SCREW ANCHORS

TABLE 1—HILTI KH-EZ, KH-EZ P, KH-EZ PL, KH-EZ C AND KH-EZ CRC INSTALLATION INFORMATION AND ANCHOR SPECIFICATION[1]

Characteristic	Symbol	Units	Nominal Anchor Diameter (inches)																		
			1/4		3/8					1/2				5/8				3/4			
Nominal drill bit diameter	d_{bit}	in. (mm)	1/4 (6.4)		3/8 (9.5)					1/2 (12.7)				5/8 (15.9)				3/4 (19.1)			
Head Style and Coating	-	-	Hex, P, PM, PL, C Head		Hex, C Head		Hex, C Head (including CRC)		Hex Head (including CRC)	Hex Head (including CRC)				Hex Head (including CRC)				Hex Head (including CRC)			
Minimum Nominal Embedment depth	h_{nom}	in. (mm)	1 5/8 (41)	2 1/2 (64)	1 5/8 (41)	2 1/8 (54)	2 1/2 (64)	3 1/4 (83)	4 1/2 (114)	2 1/4 (57)	3 (76)	4 1/4 (108)	5 1/2 (140)	3 1/4 (83)	4 (102)	5 (127)	6 (152)	4 (102)	5 (127)	6 1/4 (159)	7 1/4 (184)
Effective Embedment (min.)	h_{ef}	in. (mm)	1.18 (30)	1.92 (49)	1.11 (28)	1.54 (39)	1.86 (47)	2.50 (64)	3.55 (90)	1.52 (39)	2.16 (55)	3.22 (82)	4.28 (109)	2.39 (61)	3.03 (77)	3.88 (99)	4.73 (120)	2.92 (74)	3.77 (96)	4.84 (123)	5.69 (145)
Minimum Hole Depth (min.)	h_o	in. (mm)	2 (51)	2 7/8 (73)	1 7/8 (48)	2 3/8 (60)	2 3/4 (70)	3 1/2 (89)	4 3/4 (121)	2 5/8 (67)	3 3/8 (86)	4 5/8 (117)	5 7/8 (149)	3 5/8 (92)	4 3/8 (111)	5 3/8 (137)	6 3/8 (162)	4 3/8 (111)	5 3/8 (137)	6 5/8 (168)	7 5/8 (194)
Minimum Baseplate Clearance Hole Diameter	d_h	in. (mm)	3/8 (9.5)		1/2 (12.7)					5/8 (15.9)				3/4 (19.1)				7/8 (22.2)			
Maximum Installation Torque	$T_{inst,max}$[4]	ft-lbf (Nm)	18 (24)		19 (26)	40 (54)				45 (61)			50 (68)	85 (115)				95[6] (129)			
Maximum Impact Wrench Torque Rating[3]	$T_{impact,max}$	ft-lbf (Nm)	157 (213)		157 (213)	450 (610)				137 (186)	450 (610)			590 (800)				590 (800)			
Wrench socket size	WS	in. (mm)	7/16 (11.1)		9/16 (14.3)					3/4 (19.1)				15/16 (23.8)				1 1/8 (28.6)			
Minimum Concrete Thickness	h_{min}	in. (mm)	3.25 (83)	4.125 (105)	3.25 (83)	3.67 (93)	4 (102)	4.75 (121)	7.75 (197)	4.5 (114)	4.75 (121)	6.75 (171)	8.75 (222)	5 (127)	6 (152)	7 (178)	9.5 (241)	6 (152)	7 (178)	8.125 (206)	11.5 (292)
Minimum edge distance[2]	c_{min}	in. (mm)	1 1/2 (38)		1 1/2 (38)					1 3/4 (44)				1 3/4 (44)				1 3/4 (44)			
	for s ≥	in. (mm)	3 (76)		3 (76)					3 (76)				4 (102)				4 (102)			
Minimum spacing[2]	s_{min}	in. (mm)	1 1/2 (38)		2 1/4 (57)					3 (76)				3 (76)				3 (76)			
	for c ≥	in. (mm)	2.00 (51)	2.78 (71)	2.63 (67)	2.75 (70)	2.92 (74)	3.75 (95)	14.2 (361)	2.75 (70)	3.75 (95)	5.25 (133)	17.1 (434)	3.63 (92)	4.57 (116)	5.82 (148)	18.9 (480)	4.41 (112)	5.69 (145)	7.28 (185)	22.8 (579)
Max. Head height	-	in. (mm)	0.17 (P Head) 0.24 (Hex Head) (4.3) P Head (6.1) Hex Head		0.35 (8.9)					0.49 (12.4)				0.57 (14.5)				0.70 (17.8)			

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 kPa, 1 in^2 = 645 mm^2, 1 lb/in = 0.175 N/mm.

[1]The data presented in this table is to be used in conjunction with the design criteria of ACI 318-19 Chapter 17, ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable.

[2]Linear interpolation permitted for minimum spacing and edge distance.

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

[4]$T_{inst,max}$ applies to installations using a calibrated torque wrench.

[5]Additional combinations for minimum edge distance, c_{min}, and minimum spacing distance, s_{min} or $s_{min,cac}$, may be derived by linear interpolation between the given boundary values.

[6] Maximum installation torque for 3/4-in diameter KH-EZ CRC is 85 ft-lbs (115 Nm).

TABLE 2—HILTI KH-EZ SS316 AND KH-EZ C SS316 INSTALLATION INFORMATION AND ANCHOR SPECIFICATION[1]

Characteristic	Symbol	Units	Nominal anchor diameter (in)							
			1/4		3/8			1/2		
Nominal drill bit diameter	d_{bit}	in.	1/4		3/8			1/2		
Head style	-	-	Hex and C		Hex and C			Hex		
Effective embedment (min.)	h_{ef}	in.	1.19	1.93	1.49	1.92	2.55	1.56	2.20	3.26
		(mm)	(30)	(49)	(38)	(49)	(65)	(40)	(56)	(83)
Nominal embedment	h_{nom}	in.	1 5/8	2 1/2	2	2 1/2	3 1/4	2 1/4	3	4 1/4
		(mm)	(41)	(64)	(51)	(64)	(83)	(57)	(76)	(108)
Hole depth in concrete (min.)	h_0	in.	2	2 7/8	2 1/4	2 3/4	3 1/2	2 5/8	3 3/8	4 5/8
		(mm)	(51)	(73)	(57)	(70)	(89)	(67)	(86)	(117)
Fixture hole diameter	d_h	in.	3/8		1/2			5/8		
		(mm)	(9.5)		(12.7)			(15.9)		
Maximum impact wrench[2] torque rating	$T_{impact,max}$	ft-lb	100		157			332		
		(Nm)	(136)		(213)			(450)		
Wrench socket size	*WS*	in.	7/16		9/16			3/4		
Minimum concrete thickness	h_{min}	in.	3 1/4	4 1/8	3 1/2	4	4 3/4	4 1/2	4 3/4	6 3/4
		(mm)	(83)	(105)	(89)	(102)	(121)	(114)	(121)	(171)
Minimum edge distance[3]	c_{min}	in.	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 3/4	1 3/4	1 3/4
		(mm)	(38)	(38)	(38)	(38)	(38)	(44)	(44)	(44)
	for $s \geq$	in.	3	3	3	3	3	3	3	3
		(mm)	(76)	(76)	(76)	(76)	(76)	(76)	(76)	(76)
Minimum anchor spacing[3]	s_{min}	in.	1 1/2	1 1/2	2 1/4	2 1/4	2 1/4	3	3	3
		(mm)	(38)	(38)	(57)	(57)	(57)	(76)	(76)	(76)
	for $c \geq$	in.	2	2	3	3	3	1 3/4	1 3/4	1 3/4
		(mm)	(51)	(51)	(76)	(76)	(76)	(44)	(44)	(44)

For **SI**: 1 inch = 25.4mm, 1 ft-lb = 1.3558 Nm

[1]The data presented in this table is to be used in conjunction with the design criteria of ACI 318-19 Chapter 17, ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable.

[2]Because of 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.

[3]Linear interpolation permitted for minimum spacing and edge distance.

TABLE 3—HILTI KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C AND KH-EZ CRC TENSION AND SHEAR STRENGTH DESIGN DATA[1,2,3,6]

Characteristic	Symbol	Units	Nominal Anchor Diameter (inches)																		
			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 (including CRC)		Hex Head (including CRC)	Hex Head (including CRC)				Hex Head (including CRC)				Hex Head (including CRC)			
Nominal diameter	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 embedment	h_{ef}	in. (mm)	1.18 (30)	1.92 (49)	1.11 (28)	1.54 (39)	1.86 (47)	2.50 (64)	3.55 (90)	1.52 (39)	2.16 (55)	3.22 (82)	4.28 (109)	2.39 (61)	3.03 (77)	3.88 (99)	4.73 (120)	2.92 (74)	3.77 (96)	4.84 (123)	5.69 (145)
Nominal embedment	h_{nom}	in. (mm)	1 5/8 (41)	2 1/2 (64)	1 5/8 (41)	2 1/8 (54)	2 1/2 (64)	3 1/4 (83)	4 1/2 (114)	2 1/4 (57)	3 (76)	4 1/4 (108)	5 1/2 (140)	3 1/4 (83)	4 (102)	5 (127)	6 (127)	4 (102)	5 (127)	6 1/4 (159)	7 1/4 (184)
Strength reduction factor for steel in tension [2,7]	ϕ_{sa}	-	0.65		0.65					0.65				0.65				0.65			
Effective tensile stress area	A_{se}	in.^{2} (mm^2)	0.045 (29.0)		0.086 (55.5)					0.161 (103.9)				0.268 (172.9)				0.392 (252.9)			
Minimum specified ultimate strength	f_{uta}	psi (MPa)	125,000 (862)		106,975 (738)		120,300 (829)			112,540 (776)				90,180 (622)				81,600 (563)			
Tension resistance of steel	N_{sa}	lbf. (kN)	5,660 (25)		9,200 (41)		10,335 (46)			18,120 (81)				24,210 (108)				32,015 (142)			
Anchor category	-	-	3	1	1					1				1			2	1			
Strength reduction factor for concrete failure modes in tension[2]	$\phi_{c,N}$	-	0.45	0.65	0.65					0.65				0.65			0.55	0.65			
Effectiveness factor – uncracked concrete	k_{uncr}	-	24		24					27			24	27			24	27			24
Effectiveness factor – cracked concrete	k_{cr}	-	17		17					17				17				17			
Modification factor for cracked and uncracked concrete[6]	$\Psi_{c,N}$	-	1.0		1.0					1.0				1.0				1.0			
Critical edge distance	c_{ac}	in. (mm)	2.00 (51)	2.78 (71)	2.63 (67)	2.75 (70)	2.92 (74)	3.75 (95)	14.2 (361)	2.75 (70)	3.75 (95)	5.25 (133)	17.1 (434)	3.63 (92)	4.57 (116)	5.82 (148)	18.9 (480)	4.41 (112)	5.69 (145)	7.28 (185)	22.8 (578)
Pullout strength in uncracked concrete	$N_{p,uncr}$[6]	lbf. (kN)	1,305[5] (5.8)	2,350[4] (10.5)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pullout strength in cracked concrete	$N_{p,cr}$[6]	lbf. (kN)	665[5] (3.0)	1,165[4] (5.2)	725[4] (3.2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pullout strength in cracked concrete, seismic	$N_{p,eq}$[6]	lbf. (kN)	535[5] (2.4)	1,165[4] (5.2)	725[4] (3.2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Strength reduction factor for steel in shear [2,7]	ϕ_{sa}	-	0.60		0.60					0.60				0.60				0.60			
Nominal steel strength in shear [8]	V_{sa}	lbf. (kN)	1,550 (6.9)		3,670 (16.3)		5,185 (23.1)			9,245 (41.1)				11,220 (49.9)				16,660 (74.1)			
Nominal steel strength in shear, seismic [8]	$V_{sa,eq}$	lbf. (kN)	1,395 (6.2)		3,670 (16.3)		3,110 (13.8)			5,545 (24.7)				6,735 (30.0)				11,555 (51.4)			
Load bearing length of anchor	ℓ_e	in. (mm)	1.18 (30)	1.92 (49)	1.11 (28)	1.54 (39)	1.86 (47)	2.50 (64)	3 (76)	1.52 (39)	2.16 (55)	3.22 (82)	4 (102)	2.39 (61)	3.03 (77)	3.88 (99)	4.73 (120)	2.92 (74)	3.77 (96)	4.84 (123)	5.69 (145)
Strength reduction factor for concrete failure modes in shear [2]	$\phi_{c,V}$	-	0.70		0.70					0.70				0.70				0.70			
Effectiveness factor for pryout	k_{cp}	-	1.0	1.0	1.0	1.0	1.0	2.0	2.0	1.0	1.0	2.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Mean axial stiffness, uncracked concrete	β_{uncr}	lb/in.	437,000		540,000					835,000				819,000				261,000			
Mean axial stiffness, cracked concrete	β_{cr}	lb/in.	284,000		239,000					272,000				332,000				252,000			

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 kPa, 1 in^2 = 645 mm^2, 1 lb/in = 0.175 N/mm.

[1]The data in this table is intended for use with the design provisions of ACI 318-19 Chapter 17, ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable; for anchors resisting seismic load combinations the additional requirements of ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable, shall apply.
[2]The strength reduction factor applies when the load combinations from the IBC or ACI 318 are used and the requirements of ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate strength reduction factor must be determined in accordance with ACI 318-11 D.4.4.
[3]In this report, N/A denotes that pullout resistance does not govern and does not need to be considered.
[4]The characteristic pullout resistance for concrete compressive strengths greater than 2,500 psi may be increased by multiplying the value in the table by $(f'_c/2,500)^{0.5}$ for psi or $(f'_c/17.2)^{0.5}$ for MPa.
[5]The characteristic pullout resistance for concrete compressive strengths greater than 2,500 psi may be increased by multiplying the value in the table by $(f'_c/2,500)^{0.3}$ for psi or $(f'_c/17.2)^{0.3}$ for MPa.
[6]For lightweight concrete, calculate values according to Section 4.1.12 of this report.
[7]The KH-EZ**,** KH-EZ P, PM, PL and KH-EZ CRC are considered brittle steel elements as defined by ACI 318 (-19 and -14) 2.3 or ACI 318-11 D.1, as applicable.
[8]Reported values for steel strength in shear are based on test results per ACI 355.2, Section 9.4 and must be used for design in lieu of calculated results using equation 17.7.1.2b of ACI 318-19, equation 17.5.1.2b of ACI 318-14 or equation D-29 of ACI 318-11, as applicable.

TABLE 4—HILTI KH-EZ SS316 AND KH-EZ C SS316 TENSION AND SHEAR STRENGTH DESIGN DATA[1]

Characteristic	Symbol	Units	Nominal anchor diameter (in)							
			1/4		3/8			1/2		
Head style	-	-	Hex and C		Hex and C			Hex		
Anchor O.D.	d_a	in. (mm)	0.250 (6.4)		0.375 (9.5)			0.5 (12.7)		
Effective embedment	h_{ef}	in. (mm)	1.19 (30)	1.93 (49)	1.49 (38)	1.92 (49)	2.55 (65)	1.56 (40)	2.20 (56)	3.26 (83)
Nominal embedment	h_{nom}	in. (mm)	$1^{5}/_{8}$ (41)	$2^{1}/_{2}$ (64)	2 (51)	$2^{1}/_{2}$ (64)	$3^{1}/_{4}$ (83)	$2^{1}/_{4}$ (57)	3 (76)	$4^{1}/_{4}$ (108)
Strength reduction factor for steel in tension[1,2]	$\phi_{sa,N}$	-	0.75		0.75			0.75		
Min. specified yield strength	f_{ya}	psi (N/mm^2)	135,600 (935)		125,000 (862)			101,400 (699)		
Min. specified ult. strength	f_{uta}	psi (N/mm^2)	153,000 (1055)		139,300 (961)			120,100 (828)		
Effective-cross sectional steel area in tension	$A_{se,N}$	in^2 (mm^2)	0.040 (25.5)		0.094 (60.8)			0.172 (111.2)		
Nominal steel strength in tension[4]	N_{sa}	lb (kN)	6,120 (27.2)		13,095 (58.2)			20,655 (91.9)		
Anchor category	-	-	2	3	1			2		
Strength reduction factor for concrete failure modes in tension[2]	$\phi_{c,N}$	-	0.55	0.45	0.65			0.55		
Effectiveness factor for uncracked concrete	k_{uncr}	in-lb (SI)	24 (10.0)		27 (11.3)			27 (11.3)		
Effectiveness factor for cracked concrete	k_{cr}	in-lb (SI)	17 (7.1)		17 (7.1)			21 (8.8)		
Modification factor for anchor resistance, tension, uncracked conc.[3]	$\psi_{c,N}$	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Critical edge distance	c_{ac}	in. (mm)	4.76 (121)	7.72 (196)	5.96 (151)	7.68 (195)	10.20 (259)	6.24 (158)	8.80 (224)	7.50 (191)
Pullout strength in uncracked concrete	$N_{p,uncr}$	lb (kN)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pullout strength in cracked concrete[4]	$N_{p,cr}$	lb (kN)	570 (2.5)	1,100 (4.9)	1,510 (6.7)	2,215 (9.9)	N/A	N/A	N/A	N/A
Pullout strength in cracked concrete, seismic[4]	$N_{p,eq}$	lb (kN)	390 (1.7)	1,100 (4.9)	1,510 (6.7)	2,215 (9.9)	N/A	N/A	N/A	N/A
Strength reduction factor for steel in shear[1,2]	$\phi_{sa,V}$	-	0.65		0.65			0.65		
Nominal steel strength in shear	V_{sa}	lb (kN)	1,830 (8.1)	1,830 (8.1)	4,355 (19.4)	4,355 (19.4)	4,355 (19.4)	4,790 (21.3)	4,790 (21.3)	4,790 (21.3)
Nominal steel strength in shear, seismic	$V_{sa,eq}$	lb (kN)	1,200 (5.3)	1,200 (5.3)	4,355 (19.4)	4,355 (19.4)	4,355 (19.4)	4,790 (21.3)	4,790 (21.3)	4,790 (21.3)
Strength reduction factor for concrete failure modes in shear[2]	$\phi_{c,V}$	-	0.70		0.70			0.70		
Effectiveness factor for pryout	k_{cp}	-	1.0	1.0	1.0	1.0	2.0	1.0	1.0	2.0
Mean axial stiffness, uncracked concrete[5]	β_{uncr}	lbf/in	519,400		770,900			1,244,000		
Mean axial stiffness, cracked concrete[5]	β_{cr}	lbf/in	341,600		452,600			757,000		

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 kPa, 1 in^2 = 645 mm^2, 1 lb/in = 0.175 N/mm.

[1] The KH-EZ SS is considered a ductile steel element as defined by ICC-ES AC193 Section 6.3.6.

[2] The strength reduction factor applies when the load combinations from the IBC or ACI 318 are used and the requirements of ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate strength reduction factor must be determined in accordance with ACI 318-11 D.4.4.

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

[4] For all design cases, $\psi_{c,P}$ = 1.0. Tabular value for pullout strength is for a concrete compressive strength of 2,500 psi (17.2 MPa). Pullout strength for concrete compressive strength greater than 2,500 psi (17.2 MPa) may be increased by multiplying the tabular pullout strength by $(f'_c / 2{,}500)^n$ for psi or $(f'_c / 17.2)^n$ for MPa where n=0.15 for 1/4" x 1-5/8" and n=0.35 for 1/4" x 2-1/2". NA (not applicable) denotes that pullout strength does not need to be considered for design.

[5] Mean values shown. Actual stiffness varies considerably depending on concrete strength, loading, and geometry of application.

TABLE 5—HILTI KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C AND KH-EZ CRC TENSION AND SHEAR DESIGN DATA FOR INSTALLATION IN THE UNDERSIDE OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES[1,5,6,7]

Characteristic	Symbol	Units	Lower Flute											Upper Flute				
			Anchor Diameter															
			$^1/_4$		$^3/_8$			$^1/_2$			$^5/_8$		$^3/_4$	$^1/_4$		$^3/_8$		$^1/_2$
Head Style and Coating	-	-	Hex, P, PM, PL, C Head		Hex, C Head	Hex Head (including CRC)								Same as previous				
Embedment	h_{nom}	in.	$1^5/_8$	$2^1/_2$	$1^5/_8$	$2^1/_2$	$3^1/_4$	$2^1/_4$	3	$4^1/_4$	$3^1/_4$	5	4	$1^5/_8$	$2^1/_2$	$1^5/_8$	$2^1/_2$	$2^1/_4$
		(mm)	(41)	(64)	(41)	(64)	(83)	(57)	(76)	(108)	(83)	(127)	(102)	(41)	(64)	(41)	(64)	(57)
Minimum Hole Depth	h_o	in.	2	$2^7/_8$	$1^7/_8$	$2^3/_4$	$3^1/_2$	$2^5/_8$	$3^3/_8$	$4^5/_8$	$3^5/_8$	$5^3/_8$	$4^3/_8$	2	$2^7/_8$	$1^7/_8$	$2^7/_8$	$2^5/_8$
		(mm)	(51)	(73)	(47)	(70)	(83)	(67)	(86)	(117)	(92)	(137)	(111)	(51)	(73)	(48)	(73)	(67)
Effective Embedment Depth	h_{ef}	in.	1.18	1.92	1.11	1.86	2.50	1.52	2.16	3.22	2.39	3.88	2.92	1.18	1.92	1.11	1.86	1.52
		(mm)	(30)	(49)	(28)	(47)	(64)	(39)	(55)	(82)	(61)	(99)	(74)	(30)	(49)	(28)	(47)	(39)
Pullout Resistance, (uncracked concrete)[2]	$N_{p,deck,uncr}$	lbf.	1,210	1,875	1,300	2,240	3,920	1,305	3,060	5,360	4,180	9,495	4,180	1,490	1,960	1,490	2,920	1,395
		(kN)	(5.4)	(8.3)	(5.8)	(10.0)	(17.4)	(5.8)	(13.6)	(23.8)	(18.6)	(42.2)	(18.6)	(6.6)	(8.7)	(6.6)	(13.0)	(6.2)
Pullout Resistance (cracked conc. / seismic loads)[3]	$N_{p,deck,cr}$	lbf.	620	930	810	1,590	2,780	820	1,930	3,375	2,630	5,980	2,630	760	975	1,185	2,070	985
		(kN)	(2.8)	(4.1)	(3.6)	(7.1)	(12.4)	(3.6)	(8.6)	(15.0)	(11.7)	(26.6)	(11.7)	(3.4)	(4.3)	(5.3)	(9.2)	(4.4)
Steel Strength in Shear[4]	$V_{sa,deck}$	lbf.	1,205	2,210	1,510	1,510	3,605	1,605	2,920	3,590	3,470	4,190	3,760	1,205	3,265	3,670	6,090	7,850
		(kN)	(5.4)	(9.8)	(6.7)	(6.7)	(16.0)	(7.1)	(13.0)	(16.0)	(15.4)	(18.6)	(16.7)	(5.4)	(14.5)	(16.3)	(27.1)	(34.9)
Steel Strength in Shear, Seismic	$V_{sa,deck,eq}$	lbf.	905	1,990	905	905	2,165	965	1,750	2,155	2,080	2,515	2,610	1,080	2,940	3,670	3,650	4,710
		(kN)	(4.0)	(8.9)	(4.0)	(4.0)	(9.6)	(4.3)	(7.8)	(9.6)	(9.3)	(11.2)	(11.6)	(4.8)	(13.1)	(16.3)	(16.2)	(21.0)

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 kPa, 1 in^2 = 645 mm^2, 1 lb/in = 0.175 N/mm.

[1]Installation must comply with Sections 4.1.10 and 4.3 and Figure 12 of this report.
[2]The values listed must be used in accordance with Section 4.1.4 of this report.
[3]The values listed must be used in accordance with Section 4.1.4 and 4.1.8.2 of this report.
[4]The values listed must be used in accordance with Section 4.1.5 and 4.1.8.3 of this report.
[5]The values for ϕ_p in tension and the values for ϕ_{sa} in shear can be found in Table 3 of this report.
[6]For the $^1/_4$-inch-diameter (KH-EZ) at $2^1/_2$-inch nominal embedment and the $^3/_8$-inch- through $^3/_4$-inch-diameter anchors the characteristic pullout resistance for concrete compressive strengths greater than 3,000 psi may be increased by multiplying the value in the table by $(f'_c/3,000)^{1/2}$ for psi or $(f'_c/20.7)^{1/2}$ for MPa.
[7]For the $^1/_4$-inch-diameter anchors (KH-EZ and KH-EZ P, PM, PL) at $1^5/_8$-inch nominal embedment characteristic pullout resistance for concrete compressive strengths greater than 3,000 psi may be increased by multiplying the value in the table by $(f'_c/3,000)^{0.3}$ for psi or $(f'_c/20.7)^{0.3}$ for MPa.

TABLE 6—HILTI KH-EZ E AND KH-EZ I, INSTALLATION INFORMATION AND ANCHOR SPECIFICATION[1]

Characteristic	Symbol	Units	Nominal Anchor Diameter (inches)		
			1/4 (KH-EZ I and KH-EZ E)		3/8 (KH-EZ I)
Nominal drill bit diameter	d_{bit}	in.	1/4		3/8
Head style	-	-	Internally (I) or Externally (E) Threaded		Internally (I)
Effective embedment	h_{ef}	in. (mm)	1.18 (30)	1.92 (49)	1.54 (39)
Nominal embedment	h_{nom}	in. (mm)	1 5/8 (41)	2 1/2 (64)	2 1/8 (54)
Hole depth in concreteHole depth in concrete (min.)	h_o	in. (mm)	2 (51)	2 7/8 (73)	2 3/8 (60)
Maximum installation torque	$T_{inst,max}$[4]	ft-lbf (Nm)	18 (24)		40 (54)
Maximum impact wrench torque rating [3]	$T_{impact,max}$	ft-lbf (Nm)	114 (155)	137 (186)	450 (610)
Wrench socket size – KH-EZ I	1/4″ Internal Thread	in. (mm)	3/8 (9.5)		N/A
	3/8″ Internal Thread	in. (mm)	1/2 (12.7)		N/A
	1/2″ Internal Thread	in. (mm)	N/A		3/4 (19.1)
Wrench socket size – KH-EZ E	*WS*	in. (mm)	1/2 (12.7)		N/A
Minimum concrete thickness	h_{min}	in. (mm)	3 1/4 (83)	4 1/8 (105)	3 5/8 (92)
Minimum edge distance [2]	c_{min} [6]	in. (mm)	1 1/2 (38)		1 1/2 (38)
	for s ≥ [6]	in. (mm)	3 (76)		3 (76)
Minimum anchor spacing	s_{min} [6]	in. (mm)	1 1/2 (38)		2 1/4 (57)
	for c ≥ [6]	in. (mm)	2.00 (51)	2.78 (71)	2.75 (70)
Max. head height – KH-EZ I	1/4″ Internal Thread	in. (mm)	5/8 (15.9)		N/A
	3/8″ Internal Thread	in. (mm)	11/16 (17.5)		N/A
	½" Internal Thread	in. (mm)	N/A		3/4 (19.1)
Max. head height KH-EZ E	3/8" External thread	in. (mm)	1 3/8 (35)		N/A

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 kPa, 1 in^2 = 645 mm^2, 1 lb/in = 0.175 N/mm.

[1]The data presented in this table is to be used in conjunction with the design criteria of ACI 318-19 Chapter 17, ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable.

[2]For installations through the soffit of steel deck into concrete (see Figure 12) anchors installed in the lower flute may be installed with a maximum 1 inch offset in either direction from the center of the flute.

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

[4]$T_{inst,max}$ applies to installations using a calibrated torque wrench.

[5]The KH-EZ I and KH-EZ E versions are driven directly to the supporting member surface.

[6]Additional combinations for minimum edge distance, c_{min}, and minimum spacing distance, s_{min}, may be derived by linear interpolation between the given boundary values.

TABLE 7—HILTI KH-EZ E AND KH-EZ I TENSION AND SHEAR STRENGTH DESIGN DATA[1,2,3,6]

Characteristic	Symbol	Units	Nominal Anchor Dimension		
			$^1/_4$ (KH-EZ I and KH-EZ E)		$^3/_8$ (KH-EZ I)
Head style	-	-	Internally (I) or Externally (E) Threaded		Internally (I)
Nominal diameter	d_a	in. (mm)	0.250 (6.4)		0.375 (9.5)
Effective embedment	h_{ef}	in. (mm)	1.18 (30)	1.92 (49)	1.54 (39)
Nominal embedment	h_{nom}	in. (mm)	$1^5/_8$ (41)	$2^1/_2$ (64)	$2^1/_8$ (54)
Strength reduction factor for steel in tension [2,7]	ϕ_{sa}	-	0.65		0.65
Min. specified ult. strength	A_{se}	in.^{2} (mm^2)	0.045 (29.0)		0.086 (55.5)
Effective-cross sectional steel area in tension	f_{uta}	psi (MPa)	125,000 (862)		106,975 (738)
Nominal steel strength in tension	N_{sa}	lbf. (kN)	5,660 (25)		9,200 (41)
Anchor category 1, 2 or 3	-	-	3	1	1
Strength reduction factor for concrete failure modes in tension [2]	$\phi_{c,N}$	-	0.45	0.65	0.65
Effectiveness factor for uncracked oncrete	k_{uncr}	-	24		24
Effectiveness factor for cracked concrete	k_{cr}	-	17		17
Modification factor for anchor resistance, tension, uncracked concrete	$\Psi_{c,N}$	-	1.0		1.0
Critical edge distance	c_{ac}	in. (mm)	2.00 (51)	2.78 (71)	2.75 (70)
Pullout strength in uncracked concrete	$N_{p,uncr}$[6]	lbf. (kN)	1,305[5] (5.8)	2,350[4] (10.5)	N/A
Pullout strength in cracked concrete	$N_{p,cr}$[6]	lbf. (kN)	665[5] (3.0)	1,165[4] (5.2)	N/A
Pullout strength in cracked concrete, seismic	$N_{p,eq}$[6]	lbf. (kN)	535[5] (2.4)	1,165[4] (5.2)	N/A
Strength reduction factor for steel in shear [2]	$\phi_{sa,V}$	-	0.60		0.60
Nominal steel strength in shear[8]	V_{sa}	lbf. (mm)	1,360 (6.4)	1,315 (9.5)	1,885 (12.7)
Nominal steel strength in shear, seismic[8]	$V_{sa,eq}$	lbf. (kN)	605 (2.7)	1,120 (5.0)	1,885 (8.4)
Load bearing length of anchor	ℓ_e	in. (mm)	1.18 (30)	1.92 (49)	1.54 (39)
Strength reduction factor for concrete failure modes in shear [2]	$\phi_{c,V}$	-	0.70		0.70
Coefficient for Pryout Strength	k_{cp}	-	1.0	1.0	1.0
Mean axial stiffness, uncracked concrete	β_{uncr}	lb/in. (N/mm)	760,000 (133,000)		
Mean axial stiffness, cracked concrete	β_{cr}	lb/in. (N/mm)	293,000 (51,275)		

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 kPa, 1 in^2 = 645 mm^2, 1 lb/in = 0.175 N/mm.

[1]The data in this table is intended for use with the design provisions of ACI 318-19 Chapter 17, ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable; for anchors resisting seismic load combinations the additional requirements of ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable, shall apply.
[2]The strength reduction factor applies when the load combinations from the IBC or ACI 318 are used and the requirements of ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate strength reduction factor must be determined in accordance with ACI 318-11 D.4.4.
[3]In this report, N/A denotes that pullout resistance does not govern and does not need to be considered.
[4]The characteristic pullout resistance for concrete compressive strengths greater than 2,500 psi may be increased by multiplying the value in the table by $(f'_c/2,500)^{0.5}$ for psi or $(f'_c/17.2)^{0.5}$ for MPa.
[5]The characteristic pullout resistance for concrete compressive strengths greater than 2,500 psi may be increased by multiplying the value in the table by $(f'_c/2,500)^{0.3}$ for psi or $(f'_c/17.2)^{0.3}$ for MPa.
[6]For lightweight concrete, calculate values according to Section 4.1.12 of this report.
[7]The KH-EZ E and KH-EZ I are considered brittle steel elements as defined by ACI 318 (-19 and -14) 2.3 or ACI 318-11 D.1, as applicable.
[8]Reported values for steel strength in shear are based on test results per ACI 355.2, Section 9.4 and must be used for design in lieu of calculated results using equation 17.7.1.2b of ACI 318-19, equation 17.5.1.2b of ACI 318-14 or equation D-29 of ACI 318-11, as applicable.

TABLE 8—HILTI KH-EZ I AND KH-EZ E TENSION AND SHEAR DESIGN DATA FOR INSTALLATION IN THE UNDERSIDE OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES[1,6,7]

Characteristic	Symbol	Units	Lower Flute					Upper Flute				
			Nominal Anchor Diameter									
			1/4				3/8	1/4				3/8
Head Style	-	-	Internally (I) Threaded and Externally (E) Threaded				Internally Threaded	Internally (I) Threaded and Externally (E) Threaded				Internally Threaded
Embedment	h_{nom}	in. (mm)	1 5/8 (41)	2 1/2 (64)	1 5/8 (41)	2 1/2 (64)	2 1/8 (54)	1 5/8 (41)	2 1/2 (64)	1 5/8 (41)	2 1/2 (64)	2 1/8 (54)
Minimum Hole Depth	h_o	in. (mm)	2 (51)	2 7/8 (73)	2 (51)	2 7/8 (73)	2 3/8 (60)	2 (51)	2 7/8 (73)	2 (51)	2 7/8 (73)	2 3/8 (60)
Internal Thread Diameter	-	in. (mm)	1/4 (6.4)		3/8 (9.5)		1/2 (12.7)	1/4 (6.4)		3/8 (9.5)		1/2 (12.7)
Effective Embedment Depth	h_{ef}	in. (mm)	1.18 (30)	1.92 (49)	1.18 (30)	1.92 (49)	1.54 (39)	1.18 (30)	1.92 (49)	1.18 (30)	1.92 (49)	1.54 (39)
Pullout Resistance, (uncracked concrete)[2]	$N_{p,deck,uncr}$	lbf. (kN)	1,210 (5.4)	1,875 (8.3)	1,210 (5.4)	1,875 (8.3)	1,720 (7.7)	1,490 (6.6)	1,960 (8.7)	1,490 (6.6)	1,960 (8.7)	2,660 (11.8)
Pullout Resistance (cracked concrete and seismic loads)[3]	$N_{p,deck,cr}$	lbf. (kN)	620 (2.8)	930 (4.1)	620 (2.8)	930 (4.1)	1,220 (5.4)	730 (3.2)	975 (4.3)	730 (3.2)	975 (4.3)	1,885 (8.4)
Steel Strength in Shear[4]	$V_{sa,deck}$	lbf. (kN)	860 (3.8)		1,025 (4.6)		2,380 (10.6)	1,015 (4.5)		1,525 (6.8)		3,650 (16.2)
Steel Strength in Shear, Seismic	$V_{sa,deck,eq}$	lbf. (kN)	385 (1.7)		875 (3.9)		2,380 (10.6)	445 (2.0)		1,295 (5.8)		3,650 (16.2)

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 kPa, 1 in^2 = 645 mm^2, 1 lb/in = 0.175 N/mm.

[1]Installation must comply with Sections 4.1.10 and 4.3 and Figures 11B, 11D, and 12 of this report.
[2]The values listed must be used in accordance with Section 4.1.4 of this report.
[3]The values listed must be used in accordance with Section 4.1.4 and 4.1.8.2 of this report.
[4]The values listed must be used in accordance with Section 4.1.5 and 4.1.8.3 of this report.
[5]The values for ϕ_p in tension and the values for ϕ_{sa} in shear can be found in Table 3 of this report.
[6]For the 1/4-inch-diameter (KH-EZ I) at 2-1/2 inch nominal embedment the characteristic pullout resistance for concrete compressive strengths greater than 3,000 psi may be increased by multiplying the value in the table by $(f'_c/3,000)^{1/2}$ for psi or $(f'_c/20.7)^{1/2}$ for MPa.
[7]For the 1/4-inch-diameter anchors (KH-EZ I and KH-EZ E) at 1 5/8-inch nominal embedment characteristic pullout resistance for concrete compressive strengths greater than 3,000 psi may be increased by multiplying the value in the table by $(f'_c/3,000)^{0.3}$ for psi or $(f'_c/20.7)^{0.3}$ for MPa.

TABLE 9—HILTI KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C AND KH-EZ E, SETTING INFORMATION FOR INSTALLATION ON THE TOP OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES.[1,2,3,4,5,6,7]

DESIGN INFORMATION	Symbol	Units	Nominal Anchor Diameter						
			1/4		3/8			1/2	
Effective Embedment Depth	h_{ef}	in. (mm)	1.18 (30)	1.92 (49)	1.11 (28)	1.86 (47)	2.50 (64)	1.52 (39)	2.16 (55)
Nominal Embedment Depth	h_{nom}	in. (mm)	1 5/8 (41)	2 1/2 (64)	1 5/8 (41)	2 1/2 (64)	3 1/4 (83)	2 1/4 (57)	3 (76)
Minimum concrete thickness	$h_{min,deck}$	in. (mm)	2 1/2 (64)	2 1/2 (64)	2 1/2 (64)	2 1/2 (64)	3 1/4 (83)	2 1/2 (64)	3 1/4 (83)
Critical edge distance	$c_{ac,deck,top}$	in. (mm)	4 (104)	7 1/2 (191)	3 (76)	7 1/2 (191)	4 1/4 (108)	6 (152)	8 3/4 (83)
Minimum edge distance	$c_{min,deck,top}$	in. (mm)	1 3/4 (44)	1 3/4 (44)	1 3/4 (44)	3 (76)	1 3/4 (44)	3 (76)	1 3/4 (222)
Minimum spacing	$s_{min,deck,top}$	in. (mm)	3 (76)	3 (76)	3 (76)	3 (76)	3 (76)	3 (76)	3 (76)

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

[1]Installation must comply with Sections 4.1.10 and 4.3 of this report.
[2]For all other anchor diameters and embedment depths refer to Table 1 for values of h_{min},c_{min} and s_{min}.
[3]Design capacity must be based on calculations according to values in Tables 3 and 6 of this report.
[4]Applicable for 2½-inch ≤ $h_{min,deck}$ <3 1/4-inch. For $h_{min,deck}$ ≥ 3 1/4-inch, use setting information in Tables 3 and 6 of this report.
[5]Minimum concrete thickness ($h_{min,deck}$) refers to concrete thickness above upper flute.
[6]Minimum flute depth (distance from top of flute to bottom of flute) is 3 inches.
[7]Steel deck thickness must be minimum 20 gauge.

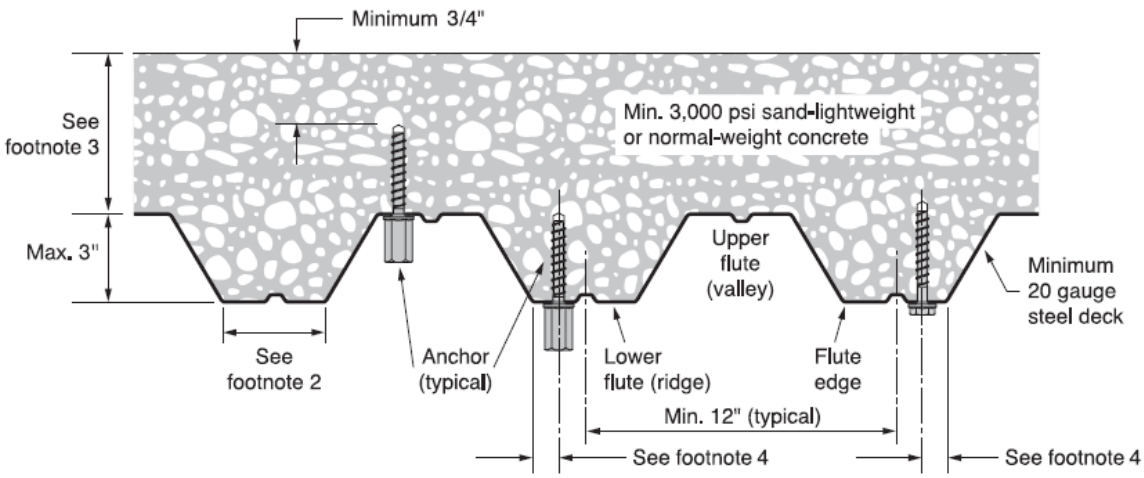


FIGURE 12—INSTALLATION OF KH-EZ, KH-EZ CRC AND KH-EZ I IN SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES[1]

[1]Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum hole clearance is satisfied. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.
[2]Minimum flute width for ¼-inch diameter KH-EZ and KH-EZ I and 3/8-inch diameter KH-EZ I is 3 7/8 inches. Minimum flute width for KH-EZ 3/8-, ½-, 5/8- and ¾-inch diameters is 4 1/2 inches.
[3]Minimum concrete thickness above upper flute for ¼-inch diameter KH-EZ and 3/8-inch KH-EZ I is 2 1/2 inches. Minimum concrete thickness above upper flute for KH-EZ 3/8-, ½-, 5/8- and ¾-inch diameter is 3-1/4 inches.
[4]Minimum distance from edge of flute to centerline of anchor for KH-EZ and KH-EZ I ¼-inch diameter is 1-inch. Minimum distance from edge of flute to centerline of anchor for KH-EZ 3/8-, ½-, 5/8- and ¾-inch diameter is 1 1/4 inches.

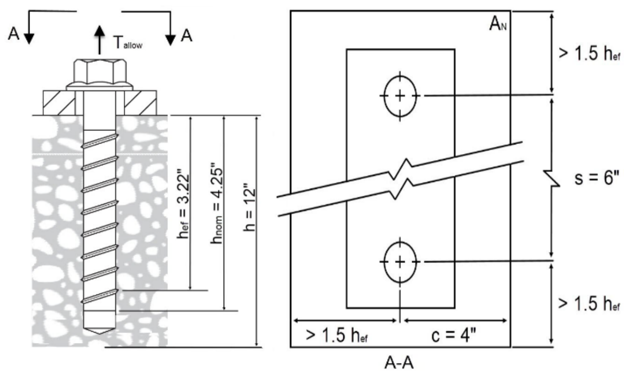
TABLE 10—HILTI KH-EZ, KH-EZ SS316, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ C SS316, KH-EZ CRC, KH-EZ E, AND KH-EZ I ALLOWABLE STRESS DESIGN VALUES FOR ILLUSTRATIVE PURPOSES[1, 2, 3, 4, 5, 6, 7, 8, 9,10]

Nominal Anchor Diameter	Nominal Embedment Depth, h_{nom}	Effective Embedment Depth, h_{ef}	Allowable Tension Load
[in.]	[in.]	[in.]	[lbs]
1/4	1 5/8	1.18	407
	2 1/2	1.92	1,031
3/8	1 5/8	1.11	620
	2 1/2	1.86	1,334
	3 1/4	2.5	2,077
1/2	2 1/4	1.52	1,111
	3	2.16	1,882
	4 1/4	3.22	3,426
5/8	3 1/4	2.39	2,192
	4	3.03	3,127
	5	3.88	4,530
3/4	4	2.92	2,963
	6 1/4	4.84	6,305
KH-EZ SS316 and KH-EZ C SS316 Allowable stress design values			
1/4	1 5/8	1.19	595
	2 1/2	1.93	1,006
3/8	2	1.49	1,108
	2 1/2	1.92	1,622
	3 1/4	2.55	2,481
1/2	2 1/4	1.56	1,005
	3	2.2	1,683
	4 1/4	3.26	3,035

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

[1]Single anchor with static tension load only.
[2]Concrete determined to remain uncracked for the life of the anchorage.
[3]Load combinations are taken from ACI 318 (-19 and -14) Section 5.3 or ACI 318-11 Section 9.2, as applicable, (no seismic loading).
[4]40% dead load and 60% live load, controlling load combination 1.2*D* + 1.6*L*.
[5]Calculation of weighted average for conversion factor α = 1.2(0.4) + 1.6(0.6) = 1.44.
[6] f'_c = 2,500 psi (normal weight concrete).
[7] $c_{a1} = c_{a2} \geq c_{ac}$.
[8] $h \geq h_{min}$.
[9]Values are for Condition B where supplementary reinforcement in accordance with ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, is not provided.
[10]KH-EZ P, PM, PL and KH-EZ E available in 1/4-inch diameter only. KH-EZ I, KH-EZ C and KH-EZ C SS316 available in 1/4-inch and 3/8" diameters only.

Given: Two $^1/_2''$ diameter KH-EZ with static tension load
h_{nom} = 4.25 inches
h_{ef} = 3.22 inches
Normal Weight Concrete: f'_c = 3,000 psi
No supplementary reinforcement (Cond. B)
No eccentricity, 60% live load, 40% dead load.
Assume cracked concrete since no other information is available.
h_{min}=6.375 in.
c_{min}=1.75 in.
s_{min}=3 in.
Needed: Allowable stress design (ASD) tension capacity



Calculation per ACI 318-19 Chapter 17, ACI 318-14 Chapter 17, ACI 318-11 Appendix D and this report	**ACI 318-19 Ref.**	**ACI 318-14 Ref.**	**ACI 318-11 Ref.**	**ESR Reference**
Step 1: Calculate steel capacity: $\phi N_s = n\phi N_{sa} = 2(0.65)(18{,}120) = 23{,}556$ lbs.	17.6.1.2	17.4.1.2	D.5.1.2	Table 3
Step 2: Verify minimum member thickness, spacing and edge distance: h_{min}=6.375 in. ≤12 in. →ok c_{min}=1.75 in. ≤4 in. →ok s_{min}=3 in. ≤6 in. →ok	17.9	17.7	D.8	Table 1
Step 3: Calculate concrete breakout strength of anchor group in tension: $N_{cbg} = \frac{A_{Nc}}{A_{Nco}} \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$	17.6.2.1	17.4.2.1	D.5.2.1	4.1.3
Step 3a: Calculate A_{Nc} and A_{Nco}: $A_{Nc} = (1.5h_{ef}+4)(3h_{ef}+6) = (8.83)(15.66) = 138.3 \text{ in.}^2$ $A_{Nco} = 9(h_{ef})^2 = 9(3.22)^2 = 93.32 \text{ in.}^2$	17.6.2.1	17.4.2.1	D.5.2.1	Table 3
Step 3b: Determine $\Psi_{ec,N} \rightarrow e'_n = 0 \rightarrow \Psi_{ec,N} = 1.0$	17.6.2.3.1	17.4.2.4	D.5.2.4	----
Step 3c: Calculate $\Psi_{ed,N} \rightarrow \Psi_{ed,N} = 0.7 + 0.3\left(\frac{4}{4.83}\right) = 0.948$	17.6.2.4.1	17.4.2.5	D.5.2.5	Table 3
Step 3d: Determine $\Psi_{cp,N} \rightarrow \Psi_{cp,N} = 1.0$ because concrete is cracked.	17.6.3.3	17.4.3.6	D.5.3.6	----
Step 3e: Calculate N_b: $N_b = k_{cr}\lambda_a\sqrt{f'_c}(h_{ef})^{1.5} = 17(1.0)\sqrt{3{,}000}(3.22)^{1.5} = 5{,}380$ lbs (λ_a =1.0 for normal weight concrete)	17.6.2.2	17.4.2.2	D.5.2.2	Table 3
Step 3f: Calculate ϕN_{cbg}: $\phi N_{cbg} = (0.65)\left(\frac{138.3}{93.32}\right)(1.0)(0.948)(1.0)(1.0)(5{,}380) = 4{,}914$ lbs	17.6.2.1 17.5.3 (c)	17.4.2.1 17.3.3 (c)	D.5.2.1 D.4.3 (c)	4.1.3 Table 3
Step 4: Check Pullout Strength → per Table 2 does not control	----	----	----	Table 3
Step 5: Controlling Strength: Lesser of $n\phi N_{sa}$ and ϕN_{cbg} → 4,914 lbs	17.5.2.2	17.3.1.2	D.4.1.2	Table 3
Step 6: Convert to ASD based on 1.6 (0.60)+1.2(0.40)=1.44 60% Live Load and 40% Dead Load: $T_{allowable,ASD} = \frac{4{,}914}{1.44} = 3{,}412$ lbs	---	---	---	4.2.1

FIGURE 13—EXAMPLE CALCULATION

ICC-ES Evaluation Report ESR-3027 LABC and LARC Supplement

Reissued December 2021
Revised April 2022
This report is subject to renewal December 2023.

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DIVISION: 03 00 00—CONCRETE
Section: 03 16 00—Concrete Anchors

DIVISION: 05 00 00—METALS
Section: 05 05 19—Post-Installed Concrete Anchors

REPORT HOLDER:

HILTI, INC.

EVALUATION SUBJECT:

HILTI KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ E, KH-EZ I, 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 CONCRETE

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ E, KH-EZ I, and KH-EZ CRC carbon steel screw anchors and KH-EZ SS316 and KH-EZ C SS316 stainless steel screw anchors in cracked and uncracked concrete, described in ICC-ES evaluation report ESR-3027, have also been evaluated for compliance with the codes noted below as adopted by Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:

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

2.0 CONCLUSIONS

The Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ E, KH-EZ I, and KH-EZ CRC carbon steel screw anchors and KH-EZ SS316 and KH-EZ C SS316 stainless steel screw anchors in cracked and uncracked concrete, described in Sections 2.0 through 7.0 of the evaluation report ESR-3027, comply with LABC Chapter 19, and LARC, and are subject to the conditions of use described in this report.

3.0 CONDITIONS OF USE

The Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ E, KH-EZ I, and KH-EZ CRC carbon steel screw anchors and KH-EZ SS316 and KH-EZ C SS316 stainless steel screw anchors described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-3027.
- The design, installation, conditions of use and labeling of the anchors are in accordance with the 2018 *International Building Code®* (IBC) provisions noted in the evaluation report ESR-3027.
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.
- Under the LARC, an engineered design in accordance with LARC Section R301.1.3 must be submitted.
- The allowable and strength design values listed in the evaluation report and tables are for the connection of the anchors to the concrete. The connection between the anchors and the connected members shall be checked for capacity (which may govern).
- For use in wall anchorage assemblies to flexible diaphragm applications, anchors shall be designed per the requirements of City of Los Angeles Information Bulletin P/BC 2020-071.

This supplement expires concurrently with the evaluation report, reissued December 2021 and revised April 2022.

ICC-ES Evaluation Report

ESR-3027 FBC Supplement

Reissued December 2021

Revised April 2022

This report is subject to renewal December 2023.

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Compliance with the following codes:

- 2020 *Florida Building Code—Building*
- 2020 *Florida Building Code—Residential*

2.0 CONCLUSIONS

The Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ E, KH-EZ I, and KH-EZ CRC carbon steel screw anchors and KH-EZ SS316 and KH-EZ C SS316 stainless steel screw anchors, described in Sections 2.0 through 7.0 of the evaluation report ESR-3027, comply with the *Florida Building Code—Building* and the *Florida Building Code—Residential*, provided the design requirements are determined in accordance with the *Florida Building Code—Building* or the *Florida Building Code—Residential*, as applicable. The installation requirements noted in ICC-ES evaluation report ESR-3027 for the 2018 *International Building Code*® meet the requirements of the *Florida Building Code—Building* or the *Florida Building Code—Residential*, as applicable.

Use of the Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C, KH-EZ E, KH-EZ I, and KH-EZ CRC carbon steel screw anchors, and KH-EZ SS316 and KH-EZ C SS316 stainless steel screw anchors in cracked and uncracked concrete have also been found to be in compliance with the High-Velocity Hurricane Zone provisions of the *Florida Building Code—Building* and the *Florida Building Code—Residential*, with the following condition:

a) For anchorage to wood members, the connection subject to uplift, must be designed for no less than 700 pounds (3114 N).

For products falling under Florida Rule 61G20-3, verification that the report holder's quality assurance program is audited by a quality assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official, when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the evaluation report, reissued December 2021 and revised April 2022.