ICC-ES Evaluation Report

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

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EVALUATION SUBJECT:

HILTI KWIK HUS-EZ (KH-EZ) AND KWIK HUS-EZ I (KH-EZ I) CARBON STEEL SCREW ANCHORS FOR USE IN CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

■ 2009, 2006 and 2003 *International Building Code®* (IBC)

■ 2009, 2006 and 2003 *International Residential Code®* (IRC)

Property evaluated:

Structural

2.0 USES

The Hilti KWIK HUS-EZ (KH-EZ) screw anchors are used to resist static, wind and seismic tension and shear loads in cracked and uncracked normal-weight and sand-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).

The KWIK HUS-EZ I (KH-EZ I) screw anchors are used to resist static, wind and seismic tension loads only in cracked and uncracked normal-weight and sand-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).

The Hilti KWIK HUS-EZ (KH-EZ) and KWIK HUS-EZ I (KH-EZ I) screw anchors are an alternative to anchors described in Sections 1911 and 1912 of the 2009 and 2006 IBC and Sections 1912 and 1913 of the 2003 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 KWIK HUS-EZ (KH-EZ):

Hilti KWIK HUS-EZ (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 (6.4 mm, 9.5 mm, 12.7 mm, 15.9 mm and 19.1 mm). A typical KWIK HUS-EZ (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 KWIK HUS-EZ I (KH-EZ I):

The KWIK HUS-EZ I (KH-EZ I) anchors are comprised of a body with a long internally threaded ($^1/_4$ inch or $^3/_8$ 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 anchoring system is available in two lengths and a nominal diameter of $^1/_4$ inch (6.4 mm). A typical KWIK HUS-EZ I (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.

3.3 Concrete:

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

3.4 Steel Deck Panels:

Steel deck panels must comply with the configurations in Figure 5 and have a minimum base steel thickness of 0.035 inch (0.889 mm). Steel must comply with ASTM A 653/A 653M SS Grade 33 and have a minimum yield strength of 33,000 psi (228 MPa).

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design strength of anchors complying with the 2009 and 2003 IBC and Section R301.1.3 of the 2009 and 2003 IRC must be determined in accordance with ACI 318-08 Appendix D and this report.

Design strength of anchors complying with the 2006 IBC and 2006 IRC must be in accordance with ACI 318-05 Appendix D and this report.

Design parameters provided in Table 2 through Table 5 of this report are based on the 2009 IBC (ACI 318-08) unless noted otherwise in Sections 4.1.1 through 4.1.12.

The strength design of anchors must comply with ACI 318 D.4.1, except as required in ACI 318 D.3.3. Strength reduction factors, ϕ, as given in ACI 318 D.4.4, and noted in Tables 3 and 4 of this report, must be used for load combinations calculated in accordance with Section 1605.2.1 of the IBC and Section 9.2 of ACI 318. Strength reduction factors, ϕ, as given in ACI 318 D.4.5 must be used for load combinations calculated in accordance with ACI 318 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 D.3.5. An example calculation is provided in Figure 6.

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 D.5.1.2, is given in Table 3 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 D.5.2, with modifications as described in this section. The basic concrete breakout strength in tension, N_b, must be calculated in accordance with ACI 318 D.5.2.2, using the values of h_{ef} and k_{cr} as given in Table 3 of this report. The nominal concrete breakout strength in tension in regions where analysis indicates no cracking in accordance with ACI 318 D.5.2.6 must be calculated with the value of k_{uncr} as given in Table 3 and 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 5, calculation of the concrete breakout strength in accordance with ACI 318 D.5.2 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 D.5.3.1 and D.5.3.2 in cracked and uncracked concrete, $N_{p,cr}$, and $N_{p,uncr}$, respectively, is given in Table 3. In lieu of ACI 318 D.5.3.6, $\psi_{c,P} = 1.0$ for all design cases. In accordance with ACI 318 D.5.3, the nominal pullout strength in cracked concrete may be adjusted according to Eq.-1:

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

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

where f'_c is the specified concrete compressive strength and n is the factor defining the influence of concrete compressive strength on the pullout strength. For the

$^1/_4$-inch-diameter anchor at $1\text{-}^5/_8$ inch 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 D.5.3.6, the nominal pullout strength in tension may be adjusted according to Eq-2:

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

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

where f'_c is the specified concrete compressive strength and n is the 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 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 5, is provided in Table 5. In accordance with ACI 318 D.5.3.2, 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 5.3.6, 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 D.6.1.2 is given in Table 4 of this report and must be used in lieu of the values derived by calculation from ACI 318, Eq. D-20. 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 5, is given in Table 5.

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 D.6.2, with modifications as described in this section. The basic concrete breakout strength in shear, V_b, must be calculated in accordance with ACI 318 D.6.2.2 using the values of ℓ_e and d_a given in Table 4.

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 5, calculation of the concrete breakout strength in accordance with ACI 318 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 D.6.3, using the coefficient for pryout strength, k_{cp} provided in Table 4 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 5, calculation of the concrete pryout strength in accordance with ACI 318 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 D.3.3, as modified by Section 1908.1.9 of the 2009 IBC or Section 1908.1.16 of the 2006 IBC, as applicable, or the following:

CODE	ACI 318 SECTION D.3.3 SEISMIC REGION	CODE EQUIVALENT DESIGNATION
2003 IBC and 2003 IRC	Moderate or high seismic risk	Seismic Design Categories C, D, E and F

The nominal steel strength and nominal concrete breakout strength for anchors in tension, and the nominal concrete breakout strength and pryout strength for anchors in shear, must be calculated in accordance with ACI 318 D.5 and D.6, respectively, taking into account the corresponding values in Tables 2 through 5 of this report. The anchors comply with ACI 318 D.1 as brittle steel elements and must be designed in accordance with ACI 318-08 D.3.3.5 or D.3.3.6 or ACI 318-05 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 D.5.1 and D.5.2, as described in Sections 4.1.2 and 4.1.3 of this report. In accordance with ACI 318 D.5.3.2, the appropriate value for pullout strength in tension for seismic loads, $N_{p,eq}$ or $N_{p,deck,cr}$ described in Table 3 and 5, respectively, of this report 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 Table 3 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 D.6.2 and D.6.3, as described in Sections 4.1.6 and 4.1.7 of this report. In accordance with ACI 318 D.6.1.2, the appropriate value for nominal steel strength for seismic loads, $V_{sa,eq}$ or $V_{sa,deck,eq}$ described in Table 4 and 5, respectively, of this report, must be used in lieu of V_{sa}.

4.1.9 Requirements for Interaction of Tensile and Shear Forces: The effects of combined tensile and shear forces must be determined in accordance with ACI 318 D.7.

4.1.10 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: In lieu of ACI 318 D.8.1 and D.8.3, values of c_{min} and s_{min}, respectively, as given in Table 2 of this report must be used. In lieu of ACI 318 D.8.5, minimum member thicknesses, h_{min} as given in Table 2 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 Table 2 of this report.

For anchors installed through the soffit of steel deck assemblies, the anchors must be installed in accordance with Figure 5 and shall have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width.

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 D.5.2, must be further multiplied by the factor $\Psi_{cp,N}$ as given by Eq-3:

$$\Psi_{cp,N} = \frac{c}{c_{ac}} \tag{Eq-3}$$

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 D.8.6, values of c_{ac} must comply with Table 3.

4.1.12 Sand-lightweight Concrete: For ACI 318-08, when anchors are used in sand-lightweight concrete, the modification factor for concrete breakout, λ, must be taken as 0.6. In addition, the pullout strength $N_{p,uncr}$, $N_{p,cr}$, and $N_{p,eq}$ must be multiplied by 0.6, as applicable.

For ACI 318-05 the values N_b, $N_{p,uncr}$, $N_{p,cr}$, $N_{p,eq}$, and V_b determined in accordance with this report must be multiplied by 0.60, in lieu of ACI 318 D.3.4.

For anchors installed in the lower or upper flute of the soffit of sand-lightweight concrete-filled steel deck and floor and roof assemblies, this reduction 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 1605.3 of the IBC must be established using the following equations:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \tag{Eq-4}$$

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha} \tag{Eq-5}$$

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 Appendix D, Section 4.1 of this report and 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable.
ϕV_n	=	Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 Appendix D, Section 4.1 of this report and 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable.
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 Table 2 of this report must apply. An example of Allowable Stress Design tension values is given in Table 6 and Figure 6.

4.2.2 Interaction of Tensile and Shear Forces: The interaction must be calculated and consistent with ACI 318 D.7, as follows:

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

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

For all other cases:

$$\frac{T_{applied}}{T_{allowable}} + \frac{V_{applied}}{V_{allowable}} \leq 1.2 \qquad \text{(Eq-6)}$$

4.3 Installation:

Installation parameters are provided in Tables 1 and 2 and Figures 1, 4A, 4B and 5. Anchor locations must comply with this report and plans and specifications approved by the code official. The Hilti KWIK HUS-EZ (KH-EZ) and KWIK HUS-EZ I (KH-EZ I) 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. The nominal drill bit diameter must be equal to that of the anchor. The minimum drilled hole depth is given in Table 2. Prior to installation, dust and debris must be removed from the drilled hole using a hand pump, compressed air or a vacuum. 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 Table 2. The KWIK HUS-EZ (KH-EZ) and KWIK HUS-EZ I (KH-EZ I) 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 (3.2mm). For member thickness and edge distance restrictions for installations into the soffit of concrete on steel deck assemblies, see Figure 5.

4.4 Special Inspection:

Periodic special inspection is required, in accordance with Section 1704.15 of the 2009 IBC or Section 1704.13 of the 2006 or 2003 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 and 1706 must be observed, where applicable.

5.0 CONDITIONS OF USE

The Hilti KWIK HUS-EZ (KH-EZ) and KWIK HUS-EZ I (KH-EZ I) concrete anchors described in this report comply with, or 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 sand-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 Strength design values must be established in accordance with Section 4.1 of this report.

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

5.7 Anchor spacing(s) and edge distance(s), and minimum member thickness, must comply with Table 2 and Figure 5 of this report.

5.8 The KWIK HUS-EZ I (KH-EZ I) version is used to resist static, wind and seismic tension loads only.

5.9 Reported values for the KWIK HUS-EZ I (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.

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 carbon steel anchors is limited to dry, interior locations.

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

5.18 KWIK HUS-EZ (KH-EZ) and KWIK HUS-EZ I (KH-EZ I) anchors are manufactured by Hilti AG, under a quality control program with inspections by Underwriters Laboratories Inc. (AA-668).

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated November 2010; and quality control documentation.

7.0 IDENTIFICATION

The HILTI KWIK HUS-EZ (KH-EZ) and KWIK HUS-EZ I (KH-EZ I) anchors are identified by packaging with the manufacturer's name (Hilti, Inc.) and contact information, anchor name, anchor size, evaluation report number (ICC-ES ESR-3027), and the name of the inspection agency (Underwriters Laboratories Inc.). The anchors with hex washer head have KH-EZ, HILTI, and anchor size and anchor length embossed on the anchor head. Identifications are visible after installation, for verification.

TABLE 1—KWIK HUS-EZ (KH-EZ) AND KWIK HUS-EZ I (KH-EZ I) PRODUCT INFORMATION

Name and Size	Diameter	Total Length - under the anchor head (l_{anch})	Minimum Nominal Embedment (h_{nom})
KH-EZ $^1/_4$″ x1 $^5/_8$″ I $^1/_4$″	$^1/_4$″ ($^1/_4$″UNC-20 –Internal Thread Length - .375″)	$1^5/_8$″	$1^5/_8$″
KH-EZ $^1/_4$″ x1 $^5/_8$″ I $^3/_8$″	$^1/_4$″ ($^3/_8$″ UNC-16 –Internal Thread Length - .453″)	$1^5/_8$″	$1^5/_8$″
KH-EZ $^1/_4$″ x2 $^1/_2$″ I $^1/_4$″	$^1/_4$″ ($^1/_4$″UNC-20 –Internal Thread Length - .375″)	$2^1/_2$″	$2^1/_2$″
KH-EZ $^1/_4$″ x2 $^1/_2$″ I $^3/_8$″	$^1/_4$″ ($^3/_8$″ UNC-16 –Internal Thread Length - .453″)	$2^1/_2$″	$2^1/_2$″
KH-EZ $^1/_4$″x1 $^7/_8$″	$^1/_4$″	$1^7/_8$″	$1^5/_8$″
KH-EZ $^1/_4$″x2$^5/_8$″	$^1/_4$″	$2^5/_8$″	$1^5/_8$″
KH-EZ $^1/_4$″x3″	$^1/_4$″	3″	$1^5/_8$″
KH-EZ $^1/_4$″x3$^1/_2$″	$^1/_4$″	$3^1/_2$″	$1^5/_8$″
KH-EZ $^1/_4$″x4″	$^1/_4$″	4″	$1^5/_8$″
KH-EZ $^3/_8$″x1$^7/_8$″	$^3/_8$″	$1^7/_8$″	$1^5/_8$″
KH-EZ $^3/_8$″x2$^1/_8$″	$^3/_8$″	$2^1/_8$″	$1^5/_8$″
KH-EZ $^3/_8$″x3″	$^3/_8$″	3″	$2^1/_2$″
KH-EZ $^3/_8$″x3$^1/_2$″	$^3/_8$″	$3^1/_2$″	$2^1/_2$″
KH-EZ $^3/_8$″x4″	$^3/_8$″	4″	$3^1/_4$″
KH-EZ $^3/_8$″x5″	$^3/_8$″	5″	$3^1/_4$″
KH-EZ $^1/_2$″x2$^1/_2$″	$^1/_2$″	$2^1/_2$″	$2^1/_4$″
KH-EZ $^1/_2$″x3″	$^1/_2$″	3″	$2^1/_4$″
KH-EZ $^1/_2$″x3$^1/_2$″	$^1/_2$″	$3^1/_2$″	3″
KH-EZ $^1/_2$″x4″	$^1/_2$″	4″	3″
KH-EZ $^1/_2$″x4$^1/_2$″	$^1/_2$″	$4^1/_2$″	3″
KH-EZ $^1/_2$″x5″	$^1/_2$″	5″	3″
KH-EZ $^1/_2$″x6″	$^1/_2$″	6″	3″
KH-EZ $^5/_8$″x3$^1/_2$″	$^5/_8$″	$3^1/_2$″	$3^1/_4$″
KH-EZ $^5/_8$″x4″	$^5/_8$″	4″	$3^1/_4$″
KH-EZ $^5/_8$″x5$^1/_2$″	$^5/_8$″	$5^1/_2$″	$3^1/_4$″
KH-EZ $^5/_8$″x6$^1/_2$″	$^5/_8$″	$6^1/_2$″	$3^1/_4$″
KH-EZ $^5/_8$″x8″	$^5/_8$″	8″	$3^1/_4$″
KH-EZ $^3/_4$″x4$^1/_2$″	$^3/_4$″	$4^1/_2$″	4″
KH-EZ $^3/_4$″x5$^1/_2$″	$^3/_4$″	$5^1/_2$″	4″
KH-EZ $^3/_4$″x7″	$^3/_4$″	7″	4″
KH-EZ $^3/_4$″x8″	$^3/_4$″	8″	4″
KH-EZ $^3/_4$″x9″	$^3/_4$″	9″	4″

For **SI:** 1 inch = 25.4 mm.
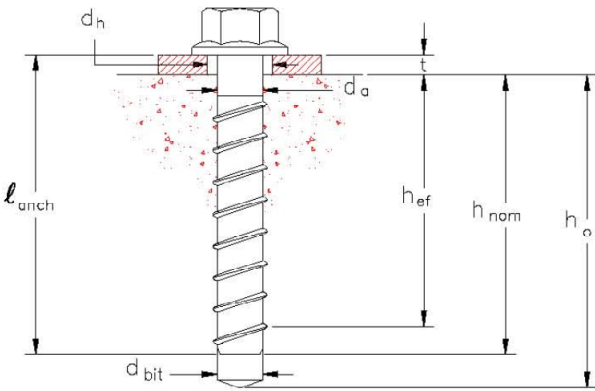
FIGURE 1—KWIK HUS EZ ANCHOR

FIGURE 2—HILTI KWIK HUS EZ CONCRETE SCREW ANCHOR
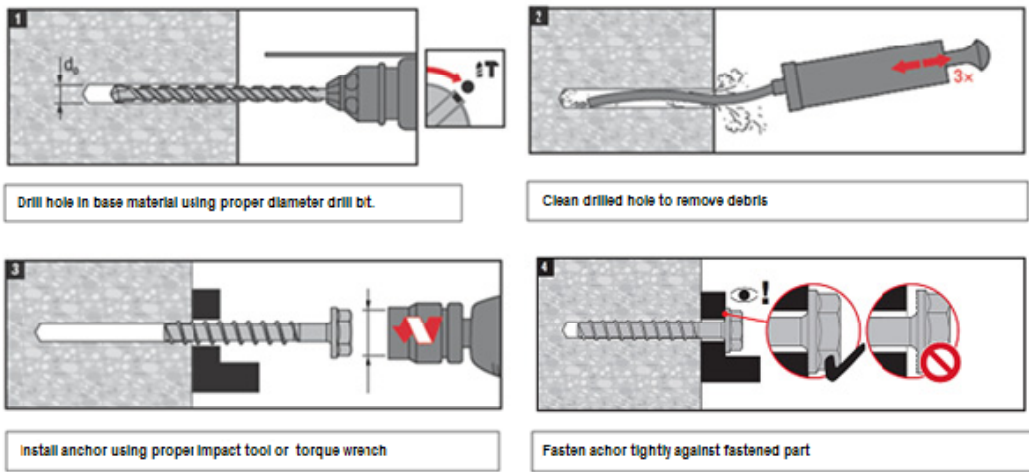

FIGURE 3—HILTI KWIK HUS-EZ I ANCHOR

Drill hole in base material using proper diameter drill bit.

Clean drilled hole to remove debris

Install anchor using proper impact tool or torque wrench

Fasten anchor tightly against fastened part

FIGURE 4A—INSTALLATION INSTRUCTIONS – HILTI KWIK HUS EZ (KH-EZ)

Drill hole in base material using proper diameter drill bit

Clean drilled hole to remove debris

Install anchor using proper impact tool or torque wrench

Insert threaded rod into installed anchor
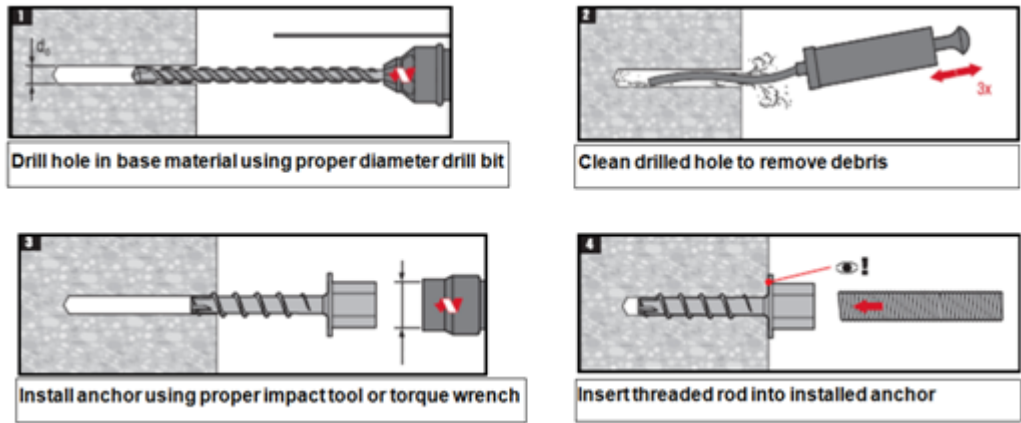
FIGURE 4B—INSTALLATION INSTRUCTIONS - HILTI KWIK HUS EZ I (KH-EZ I)

TABLE 2—KWIK HUS-EZ (KH-EZ) AND KWIK HUS-EZ I (KH-EZ I) INSTALLATION INFORMATION AND ANCHOR SPECIFICATION[1]

Characteristic	Symbol	Units	1/4 (KH-EZ I)		1/4		3/8			1/2			5/8		3/4	
Head Style	-	-	Internally Threaded		Standard Hex Head		Standard Hex Head			Standard Hex Head			Standard Hex Head		Standard Hex Head	
Nominal Diameter	d_a (d_o)[5]	in.	1/4				3/8			1/2			5/8		3/4	
Drill Bit Diameter	d_{bit}	in.	1/4				3/8			1/2			5/8		3/4	
Minimum Baseplate Clearance Hole Diameter	d_h	in.	N/A[7]		3/8		1/2			5/8			3/4		7/8	
Maximum Installation Torque[4]	$T_{inst,max}$	ft-lbf	18				40			45			85		115	
Maximum Impact Wrench Torque Rating[3]	$T_{impact,max}$	ft-lbf	114	137	114	137	114	450		137	450		450		450	
Minimum Nominal Embedment depth	h_{nom}	in.	1 5/8	2 1/2	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	6 1/4
Effective Embedment Depth	h_{ef}	in.	1.18	1.92	1.18	1.92	1.11	1.86	2.50	1.52	2.16	3.22	2.39	3.88	2.92	4.84
Minimum Hole Depth	h_{hole}	in.	2	2 7/8	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	6 5/8
Critical Edge Distance[2]	c_{ac}	in.	2.00	2.78	2.00	2.78	2.10	2.92	3.75	2.75	3.75	5.25	3.63	5.81	4.41	7.28
Minimum Spacing at Critical Edge distance[2]	$s_{min,cac}$[8]	in.	1.50				2.25			3.0						
Minimum Edge Distance[2]	c_{min}[8]	in.	1.50							1.75						
Minimum Spacing Distance at Minimum Edge Distance[2]	s_{min}[8]	in.	3.0										4.0			
Minimum Concrete Thickness	h_{min}	in.	3.25	4.125	3.25	4.125	3.25	4	4.75	4.5	4.75	6.75	5	7	6	8.125
Wrench socket size – KH-EZ I Model	1/4″ Internal Thread	in.	3/8		Not Applicable											
	3/8″ Internal Thread		1/2													
Wrench socket size – KH-EZ Model	-	in.	N/A		7/16		9/16			3/4			15/16		1 1/8	
Max. Head height – KH-EZ I Model	1/4″ Internal Thread	in.	5/8		Not Applicable											
	3/8″ Internal Thread		11/16													
Max. Head height	-	in.	N/A		0.24		0.35			0.49			0.57		0.70	
Effective tensile stress area	A_{se} $(A_{se,N})$[5]	in.²	0.045				0.086			0.161			0.268		0.392	
Minimum specified ultimate strength	f_{uta} (f_{ut})[6]	psi	134,000				106,225	120,300		112,540			90,180		81,600	

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 Pa, 1 in² = 645 mm², 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 Appendix D.

[2]For installations through the soffit of steel deck into concrete (see Figure 3) 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-torquing can damage the anchor and/or reduce its holding capacity.

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

[5]The notation in parenthesis is for the 2006 IBC.

[6]The notation in parenthesis is for the 2003 IBC.

[7]The KWIK HUS-EZ I (KH-EZ I) version is driven directly to the supporting member surface.

[8]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.

TABLE 3—HILTI KWIK HUS-EZ (KH-EZ) and KWIK HUS-EZ I (KH-EZ I) TENSION STRENGTH DESIGN DATA[1,2,4,7]

Characteristic	Symbol	Units	Nominal Anchor Diameter (inches)												
			1/4 (KH-EZ I)		1/4		3/8			1/2			5/8		3/4	
Anchor Category 1,2 or 3			3	1	3	1	1									
Head Style	-	-	Internally Threaded		Standard Hex Head		Standard Hex Head			Standard Hex Head			Standard Hex Head		Standard Hex Head	
Nominal Embedment Depth	h_{nom}	in.	1 5/8	2 1/2	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	6 1/4
Steel Strength in Tension (ACI 318 D.5.1)[7]																
Tension Resistance of Steel	N_{sa}	lb.	6,070				9,125	10,335		18,120			24,210		32,013	
Reduction Factor for Steel Strength[3,8]	ϕ_{sa}	-	0.65													
Concrete Breakout Strength in Tension (ACI 318 D.5.2)																
Effective Embedment Depth	h_{ef}	in.	1.18	1.92	1.18	1.92	1.11	1.86	2.50	1.52	2.16	3.22	2.39	3.88	2.92	4.84
Critical Edge Distance	c_{ac}	in.	2.00	2.78	2.00	2.78	2.10	2.92	3.74	2.75	3.67	5.25	3.63	5.82	4.41	7.28
Effectiveness Factor – Uncracked Concrete	k_{uncr}	-	24							27						
Effectiveness Factor – Cracked Concrete	k_{cr}	-	17													
Modification factor for cracked and uncracked concrete[6]	$\Psi_{c,N}$	-	1.0													
Reduction Factor for Concrete Breakout Strength[2]	ϕ_{cb}	-	0.45	0.65	0.45	0.65										
Pullout Strength in Tension (Non Seismic Applications) (ACI318 D.5.3)																
Characteristic pullout strength, uncracked concrete (2,500psi)	$N_{p,uncr}$	lb.	1,305[6]	2,348[5]	1,305[6]	2,348[5]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Characteristic pullout strength, cracked concrete (2500 psi)	$N_{p,cr}$	lb.	667[6]	1,166[5]	667[6]	1,166[5]	728[5]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Reduction factor for pullout strength[2]	ϕ_p	-	0.45	0.65	0.45	0.65										
Pullout Strength in Tension (Seismic Applications) (ACI 318 D.5.3)																
Characteristic Pullout Strength, Seismic (2,500 psi)	$N_{p,eq}$	lb.	534[6]	1,166[5]	534[6]	1,166[5]	728[5]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Reduction Factor for Pullout Strength[2] (2,500 psi)	ϕ_{eq}	-	0.45	0.65	0.45	0.65										
Axial Stiffness in Service Load Range																
Uncracked Concrete	β_{uncr}	lb/in.	760,000													
Cracked Concrete	β_{cr}		293,000													

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 Pa, 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 Appendix D; for anchors resisting seismic load combinations the additional requirements of ACI D.3.3 shall apply.

[2] Values of ϕ in this table apply when the load combinations for ACI 318 Section 9.2, IBC Section 1605.2.1 are used and the requirements of ACI 318 D.4.4 for Condition B are met. For situations where reinforcement meets the requirements of Condition A, ACI 318 D.4.4 or D.4.5 provides the appropriate ϕ factor, as applicable.

[3] If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.5.

[4] In this report, N/A denotes that pullout resistance does not govern and does not need to be considered.

[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 $(f'_c/2,500)^{0.5}$ for psi or $(f'_c/17.2)^{0.5}$ for MPa.

[6] 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.

[7] For sand-lightweight concrete, calculate values according to Section 4.1.12 of this report.

[8] The KWIK HUS-EZ (KH-EZ) and KWIK HUS-EZ I (KH-EZ I) is considered a brittle steel element as defined by ACI 318 D.1.

TABLE 4—HILTI KWIK HUS-EZ (KH-EZ) SHEAR STRENGTH DESIGN DATA[1,8]

Characteristic	Symbol	Units	Nominal Anchor Diameter(inches)										
			$1/4$		$3/8$			$1/2$			$5/8$		$3/4$
Anchor Category	1,2 or 3		3		1								
Embedment Depth	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	$6^1/4$
Steel Strength in Shear (ACI 318 D.6.1)[5,6]														
Shear Resistance of Steel - Static	V_{sa}[4]	lb.	1,548		4,507		5,185	9,245			11,221		16,662	
Shear Resistance of Steel - Seismic	$V_{sa,eq}$[4]	lb.	1,393		2,524		3,111	5,547			6,733		11,556	
Reduction Factor for Steel Strength[3]	ϕ_{sa}	-	0.60											
Concrete Breakout Strength in Shear (ACI 318 D.6.2)														
Nominal Diameter	$d_a [d_o]$[7]	in.	0.250		0.375			0.500			0.625		0.750	
Load Bearing Length of Anchor	ℓ_e[4]	in.	1.18	1.92	1.11	1.86	2.50	1.52	2.16	3.22	2.39	3.88	2.92	4.84
Reduction Factor for Concrete Breakout Strength[2]	ϕ_{cb}	-	0.70											
Concrete Pryout Strength in Shear (ACI 318 D.6.3)														
Coefficient for Pryout Strength	k_{cp}	-	1.0	1.0	1.0	1.0	2.0	1.0	1.0	2.0	1.0	2.0	2.0	2.0
Reduction Factor for Pryout Strength[2]	ϕ_{cp}	-	0.70											

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 Pa, 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 Appendix D

[2] Values of ϕ in this table apply when the load combinations for ACI 318 Section 9.2, IBC Section 1605.2.1 are used and the requirements of ACI 318 D.4.4 for Condition B are met. For situations where reinforcement meets the requirements of Condition A, ACI 318 D.4.4 or D.4.5 provides the appropriate ϕ factor, as applicable.

[3]If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.5.

[4]For 2003 IBC code basis replace ℓ_e with ℓ, V_{sa} with V_s, and $V_{sa,eq}$ with $V_{sa,seis}$.

[5]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 D-20 of ACI 318.

[6]The KWIK HUS-EZ (KH-EZ) is considered a brittle steel element as defined by ACI 318 D.1.

[7]The notation in brackets is for the 2006 IBC.

[8]The KWIK HUS-EZ I (KH-EZ I) version are used to resist static, wind and seismic tension loads only.

TABLE 5—HILTI KWIK HUS-EZ (KH-EZ) AND KWIK HUS-EZ I (KH-EZ I) TENSION AND SHEAR DESIGN DATA FOR INSTALLATION IN THE UNDERSIDE OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES[1,6,7,8]

Characteristic	Symbol	Units	Lower Flute													Upper Flute					
			Anchor Diameter													Anchor Diameter					
			$1/4$ (KH-EZ I)		$1/4$		$3/8$			$1/2$			$5/8$		$3/4$	$1/4$ (KH-EZ I)		$1/4$		$3/8$	$1/2$
Head Style	-	-	Internally Threaded		Standard Hex Head											Internally Threaded		Standard Hex Head			
Embedment	h_{nom}	in.	$1^5/8$	$2^1/2$	$1^5/8$	$2^1/2$	$1^5/8$	$2^1/2$	$3^1/4$	$2^1/4$	3	$4^1/4$	$3^1/4$	5	4	$1^5/8$	$2^1/2$	$1^5/8$	$2^1/2$	$1^5/8$	$2^1/2$	$2^1/4$
Minimum Hole Depth	h_{hole}	in.	2	$2^7/8$	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	$2^7/8$	2	$2^7/8$	$1^7/8$	$2^7/8$	$2^5/8$
Effective Embedment Depth	h_{ef}	in.	1.18	1.92	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	1.18	1.92	1.11	1.86	1.52
Pullout Resistance, (uncracked concrete)[2]	$N_{p,deck,uncr}$	lb.	1,210	1,875	1,210	1,875	1,285	2,240	3,920	1,305	3,060	5,360	4,180	9,495	4,180	1,490	1,960	1,490	1,960	1,015	2,920	1,395
Pullout Resistance (cracked concrete and seismic loads)[3]	$N_{p,deck,cr}$	lb.	620	930	620	930	670	1,590	2,780	820	1,930	3,375	2,630	5,980	2,630	760	975	760	975	530	2,070	985
Steel Strength in Shear[4]	$V_{sa,deck}$[8]	lb.	N/A	N/A	1,205	2,210	1,500	1,510	3,605	1,605	2,920	3,590	3,470	4,190	3,760	N/A	N/A	1,205	3,265	3,935	6,090	7,850
Steel Strength in Shear, Seismic	$V_{sa,deck,eq}$	lb.	N/A	N/A	905	1,990	905	905	2,165	965	1,750	2,155	2,080	2,515	2,610	N/A	N/A	1,080	2,940	2,200	3,650	4,710

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 Pa, 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 3 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 can be found in Table 3 of this report and the values for ϕ_{sa} in shear can be found in Table 4 of this report.

[6]For the $1/4$-inch-diameter (KH-EZ, KH-EZ I) 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, KH-EZ I) 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 $(f'_c/2,500)^{0.3}$ for psi or $(f'_c/17.2)^{0.3}$ for MPa.

[8]The KWIK HUS-EZ I (KH-EZ I) version are used to resist static, wind and seismic tension loads only.
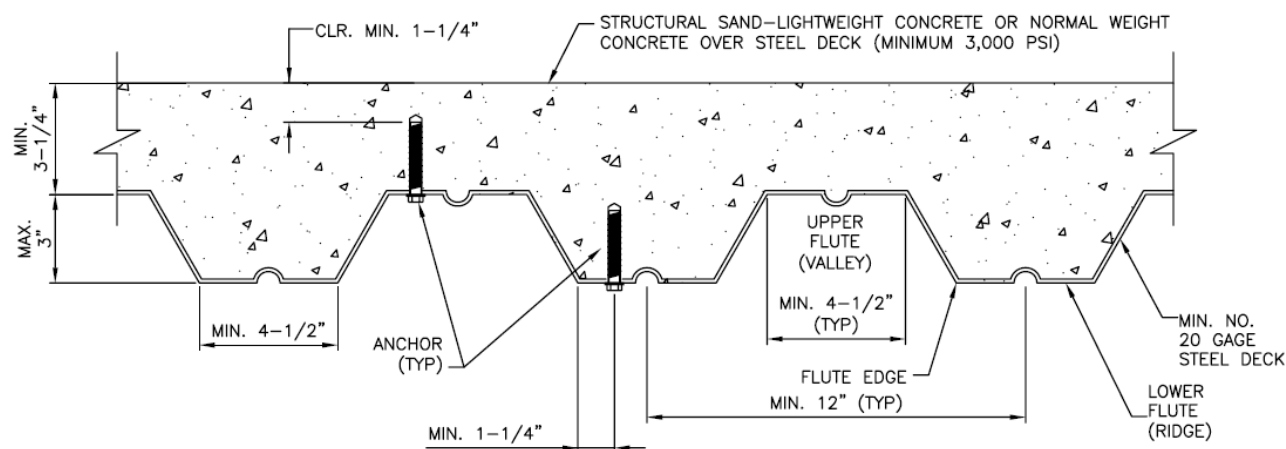
FIGURE 5—INSTALLATION OF KWIK HUS-EZ (KH-EZ) AND KWIK HUS-EZ I (KH-EZ I) IN SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES[1]

[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.

TABLE 6—HILTI KWIK HUS-EZ (KH-EZ) AND KWIK HUS-EZ I (KH-EZ I) ALLOWABLE STRESS DESIGN VALUES FOR ILLUSTRATIVE PURPOSES[1, 2, 3, 4, 5, 6, 7, 8, 9]

Nominal Anchor Diameter	Nominal Embedment Depth, h_{nom}	Effective Embedment Depth, h_{ef}	Allowable Tension Load
[in.]	[in.]	[in.]	[lbs]
$1/4$	$1\frac{5}{8}$	1.18	407
	$2\frac{1}{2}$	1.92	1,031
$3/8$	$1\frac{5}{8}$	1.11	620
	$2\frac{1}{2}$	1.86	1,334
	$3\frac{1}{4}$	2.5	2,077
$1/2$	$2\frac{1}{4}$	1.52	1,111
	3	2.16	1,882
	$4\frac{1}{4}$	3.22	3,426
$5/8$	$3\frac{1}{4}$	2.39	2,192
	5	3.88	4,530
$3/4$	4	2.92	2,963
	$6\frac{1}{4}$	4.84	6,305

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 Section 9.2 (no seismic loading).

[4]40% dead load and 60% live load, controlling load combination $1.2D + 1.6L$.

[5]Calculation of weighted average for conversion factor $\alpha = 1.2(0.4) + 1.6(0.6) = 1.44$.

[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 D.4.4 is not provided.

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)
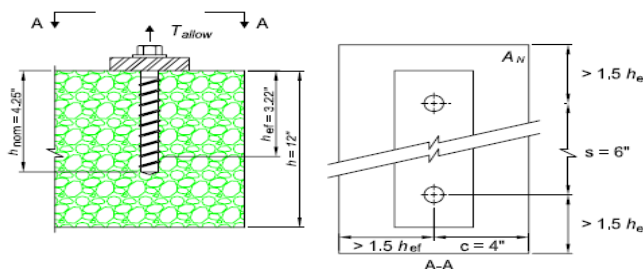No eccentricity, 60% live load, 40% dead load.
Assume cracked concrete since no other information is available.
  h_{min}=6.375 in.
  c_{min}=1.75 in.
  s_{min}=3 in.
Needed: Allowable stress design (ASD) tension capacity

Calculation per ACI 318-08 and this report	Code Reference	ESR Reference
Step 1: Calculate steel capacity: $\phi N_s = n\phi N_{sa} = 2(0.65)(18,120) = 23,556$ lbs.	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	D.8	Table 2
Step 3: Calculate concrete breakout strength of anchor group in tension: $N_{cbg} = \dfrac{A_{Nc}}{A_{Nco}} \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$	D.5.2.1	4.1.3
Step 3a: Calculate A_{Nc} and A_{Nco}: $A_{Nc}=(1.5h_{ef}+4)(3h_{ef}+6)=(8.83)(15.66)=138.3$ in.^{2} $A_{Nco}=9(h_{ef})^2=9(3.22)^2=93.32$ in.^{2}	D.5.2.1	Table 3
Step 3b: Determine $\Psi_{ec,N} \rightarrow e'_n=0 \rightarrow \Psi_{ec,N}=1.0$	D.5.2.4	----
Step 3c: Calculate $\Psi_{ed,N} \rightarrow \Psi_{ed,N}=0.7+0.3\left(\dfrac{4}{4.83}\right)=0.948$	D.5.2.5	Table 3
Step 3d: Determine $\Psi_{cp,N} \rightarrow \Psi_{cp,N}=1.0$ because concrete is cracked.	D.5.3.6	----
Step 3e: Calculate N_b: $N_b=k_{cr}\lambda\sqrt{f_c}(h_{ef})^{1.5}=17(1.0)\sqrt{3,000}(3.22)^{1.5}=5,380$ lbs (λ=1.0 for normal weight concrete)	D.5.2.2	Table 3
Step 3f: Calculate ϕN_{cbg}: $\phi N_{cbg}=(0.65)\left(\dfrac{138.3}{93.32}\right)(1.0)(0.948)(1.0)(1.0)(5,380)=4,914$ lbs	D.5.2.1 D.4.4 (c)	4.1.3 Table 3
Step 4: Check Pullout Strength → per Table 3 does not control	----	Table 3
Step 5: Controlling Strength: Lesser of $n\phi N_{sa}$ and ϕN_{cbg} → 4,914 lbs	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: $T_{allowable,ASD}=\dfrac{4,914}{1.44}=3,412$ lbs	---	4.2.1

FIGURE 6—EXAMPLE CALCULATION