☐Submittal ☐Substitution Request

To: ____

Firm: ____

Project: ____

Product Specified: ____

Specified Location:____

Attached information includes product description, installation instructions and technical data needed for review and evaluation of the submittal request.

Submitted By:

Name: _______________________ Signature: ___________________________

Firm: ____

Address: ____

____

Phone: ________________________ Fax: ___________________________

Email: ________________________ Submittal Date: __________________

For Architect / Engineer Use:

Reviewed, Accepted ~ No Exceptions: _____ Make Corrections as Noted: ___________

Revise and Resubmit: _____________ Rejected: ______________________________

Brief explanation for corrections needed, revisions needed or why rejected:

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3.3.4.1 KWIK Bolt TZ Product Description

The KWIK Bolt TZ (KB-TZ) is a torque controlled expansion anchor which is especially suited to seismic and cracked concrete applications. This anchor line is available in carbon steel, type 304 and type 316 stainless steel versions. The anchor diameters range from 3/8- and 3/4-inch in a variety of lengths. Applicable base materials include normal-weight concrete, structural lightweight concrete, and lightweight concrete over metal deck.

Guide Specifications

Torque controlled expansion anchors shall be KWIK Bolt TZ (KB-TZ) supplied by Hilti meeting the description in Federal Specification A-A 1923A, type 4. The anchor bears a length identification mark embossed into the impact section (dog point) of the anchor surrounded by four embossed notches identifying the anchor as a Hilti KWIK Bolt TZ in the installed condition. Anchors are manufactured to meet one of the following conditions:

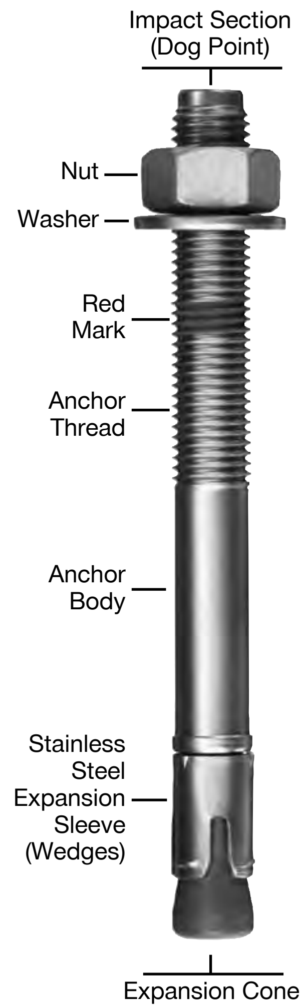
- The carbon steel anchor body, nut, and washer have an electro-plated zinc coating conforming to ASTM B633 to a minimum thickness of 5 µm. The stainless steel expansion sleeve conforms to type 316.
- Stainless steel anchor body, nut and washer conform to type 304. Stainless steel expansion sleeve conforms to type 316.
- Stainless steel anchor body, nut, washer, and expansion sleeve conform to type 316 stainless steel.

Product Features

- Product and length identification marks facilitate quality control after installation.
- Through fixture installation and variable thread lengths improve productivity and accommodate various base plate thicknesses.
- Type 316 Stainless Steel wedges provide superior performance in cracked concrete.
- Ridges on expansion wedges provide increased reliability.
- Mechanical expansion allows immediate load application.
- Raised impact section (dog point) prevents thread damage during installation.
- Bolt meets ductility requirements of ACI 318 Section D1.

Installation

Drill hole in base material to the appropriate depth using a Hilti carbide tipped drill bit. Drive the anchor into the hole using a hammer. A minimum of four threads must be below the fastening surface prior to applying installation torque. Tighten the nut to the installation torque.



Listings/Approvals

ICC-ES (International Code Council)
ESR-1917

FM (Factory Mutual)
Pipe Hanger Components for Automatic Sprinkler Systems (3/8" - 3/4")

UL (Underwriters Laboratories)
Pipe Hanger Equipment for Fire Protection Services (3/8" - 3/4")

Independent Code Evaluation

IBC® / IRC® 2009 (AC 193 / ACI 355.2)
IBC® / IRC® 2006

Supplemental Design Provisions for ACI 318 Appendix D

Design strengths are determined in accordance with ACI 318 Appendix D and ICC Evaluation Service ESR-1917 Hilti KWIK Bolt TZ Carbon and Stainless Steel Anchors in Concrete. The relevant design parameters are reiterated in Tables 1, 2, and 3 of this document. Supplemental provisions required for the design of the KB-TZ are enumerated in Section 4.0 of ESR-1917 (DESIGN AND INSTALLATION). Note that these design parameters are supplemental to the design provisions of ACI 318.

3.3.4 KWIK Bolt TZ Expansion Anchor

3.3.4.2 Material Properties

Carbon steel with electroplated zinc

- Carbon steel KB-TZ anchors have the following minimum bolt fracture loads[1]

Anchor Diameter (in.)	Shear (lb)	Tension (lb)
3/8	NA	6,744
1/2	7,419	11,240
5/8	11,465	17,535
3/4	17,535	25,853

- Carbon steel anchor components plated in accordance with ASTM B633 to a minimum thickness of 5µm.
- Nuts conform to the requirements of ASTM A 563, Grade A, Hex.
- Washers meet the requirements of ASTM F 844.
- Expansion sleeves (wedges) are manufactured from type 316 stainless steel.

Stainless steel

- Stainless steel KB-TZ anchors are made of type 304 or 316 material and have the following minimum bolt fracture loads[1]

Anchor Diameter (in.)	Shear (lb)	Tension (lb)
3/8	5,058	6,519
1/2	8,543	12,364
5/8	13,938	19,109
3/4	22,481	24,729

- All nuts and washers are made from type 304 or type 316 stainless steel respectively.
- Nuts meet the dimensional requirements of ASTM F 594.
- Washers meet the dimensional requirements of ANSI B18.22.1, Type A, plain.
- Expansion Sleeve (wedges) are made from type 316 stainless steel.

1 Bolt fracture loads are determined by testing in jig as part of product QC. These loads are not intended for design purposes. See Tables 2 and 3.

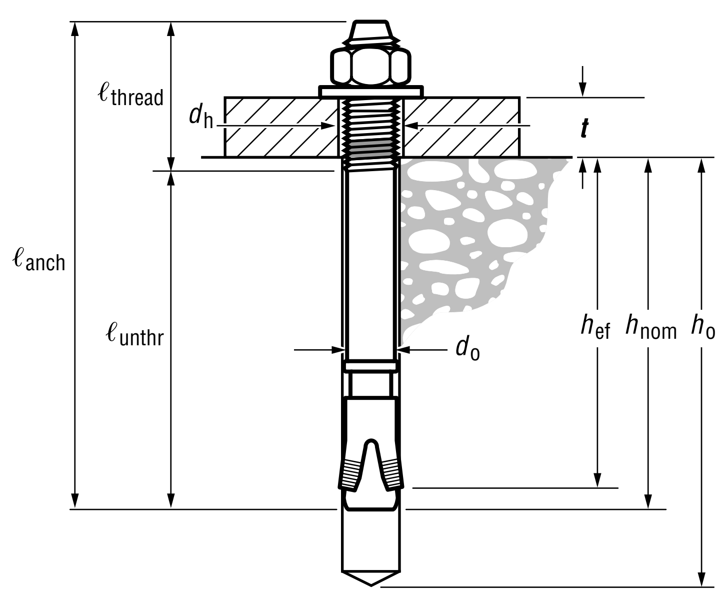
3.3.4.3 Technical Data

Table 1 — KWIK Bolt TZ Specification Table

Setting Information	Symbol	Units	Nominal anchor diameter (in.)													
			3/8			1/2				5/8				3/4		
Anchor O.D.	d_o	in.	0.375			0.5				0.625				0.75		
		(mm)	(9.5)			(12.7)				(15.9)				(19.1)		
Nominal bit diameter	d_{bit}	in.	3/8			1/2				5/8				3/4		
Effective minimum embedment	h_{ef}	in.	2			2		3-1/4		3-1/8		4		3-3/4		4-3/4
		(mm)	(51)			(51)		(83)		(79)		(102)		(95)		(121)
Min. hole depth	h_o	in.	2-5/8			2-5/8		4		3-3/4		4-3/4		4-5/8		5-3/4
		(mm)	(67)			(67)		(102)		(95)		(121)		(117)		(146)
Min. thickness of fixture[1]	t_{min}	in.	1/4			3/4		1/4		3/8		3/4		1/8		1-5/8
		(mm)	(6)			(19)		(6)		(9)		(19)		(3)		(41)
Max. thickness of fixture	t_{max}	in.	2-1/4			4		2-3/4		5-5/8		4-3/4		4-5/8		3-5/8
		(mm)	(57)			(101)		(70)		(143)		(121)		(117)		(92)
Installation torque	T_{inst}	ft-lb	25			40				60				110		
		(Nm)	(34)			(54)				(81)				(149)		
Minimum diameter of hole	d_h	in.	7/16			9/16				11/16				13/16		
		(mm)	(11.1)			(14.3)				(17.5)				(20.6)		
Available anchor lengths	ℓ_{anch}	in.	3	3-3/4	5	3-3/4	4-1/2	5-1/2	7	4-3/4	6	8-1/2	10	5-1/2	8	10
		(mm)	(76)	(95)	(127)	(95)	(114)	(140)	(178)	(121)	(152)	(216)	(254)	(140)	(203)	(254)
Threaded length including dog point	ℓ_{thread}	in.	7/8	1-5/8	2-7/8	1-5/8	2-3/8	3-3/8	4-7/8	1-1/2	2-3/4	5-1/4	6-3/4	1-1/2	4	6
		(mm)	(22)	(41)	(73)	(41)	(60)	(86)	(178)	(38)	(70)	(133)	(171)	(38)	(102)	(152)
Unthreaded length	ℓ_{unthr}	in.	2-1/8			2-1/8				3-1/4				4		
		(mm)	(54)			(54)				(83)				(102)		
Installation embedment	h_{nom}	in.	2-1/4			2-3/8		3-5/8		3-5/8		4-1/2		4-3/8		5-3/8
		(mm)	(57)			(60)		(92)		(92)		(114)		(111)		(137)

1 The minimum thickness of the fastened part is based on use of the anchor at minimum embedment and is controlled by the length of thread. If a thinner fastening thickness is required, increase the anchor embedment to suit.

Figure 1 — KWIK Bolt TZ Installed



3.3.4 KWIK Bolt TZ Expansion Anchor

Table 2 — Carbon Steel KWIK Bolt TZ Strength Design Information

Setting Information	Symbol	Units	Nominal anchor diameter											
			3/8		1/2				5/8			3/4		
Anchor O.D.	d_o	in. (mm)	0.375 (9.5)		0.5 (12.7)				0.625 (15.9)			0.75 (19.1)		
Effective minimum embedment[1]	h_{ef}	in. (mm)	2 (51)		2 (51)		3-1/4 (83)		3-1/8 (79)	4 (102)		3-3/4 (95)		4-3/4 (121)
Min. member thickness	h_{min}	in. (mm)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	6 (152)	8 (203)	8 (203)
Critical edge distance	c_{ac}	in. (mm)	4-3/8 (111)	4 (102)	5-1/2 (140)	4-1/2 (114)	7-1/2 (191)	6 (152)	6-1/2 (165)	8-3/4 (222)	6-3/4 (171)	10 (254)	8 (203)	9 (229)
Min. edge distance	$c_{a,min}$	in. (mm)	2-1/2 (64)		2-3/4 (70)		2-3/8 (60)		3-5/8 (92)	3-1/4 (83)		4-3/4 (121)		4-1/8 (105)
	for s ≥	in. (mm)	5 (127)		5-3/4 (146)		5-3/4 (146)		6-1/8 (156)	5-7/8 (149)		10-1/2 (267)		8-7/8 (225)
Min. anchor spacing	s_{min}	in. (mm)	2-1/2 (64)		2-3/4 (70)		2-3/8 (60)		3-1/2 (89)	3 (76)		5 (127)		4 (102)
	for c ≥	in. (mm)	3-5/8 (92)		4-1/8 (105)		3-1/2 (89)		4-3/4 (121)	4-1/4 (108)		9-1/2 (241)		7-3/4 (197)
Min. hole depth in concrete	h_o	in. (mm)	2-5/8 (67)		2-5/8 (67)		4 (102)		3-7/8 (98)	4-3/4 (121)		4-5/8 (117)		5-3/4 (146)
Min. specified yield strength	f_{ya}	lb/in² (N/mm²)	100,000 (690)		84,800 (585)				84,800 (585)			84,800 (585)		
Min. specified ult. strength	f_{uta}	lb/in² (N/mm²)	115,000 (793)		106,000 (731)				106,000 (731)			106,000 (731)		
Effective tensile stress area	A_{se}	in.² (mm²)	0.052 (33.6)		0.101 (65.0)				0.162 (104.6)			0.237 (152.8)		
Steel strength in tension	N_{sa}	lb (kN)	6,500 (28.9)		10,705 (47.6)				17,170 (76.4)			25,120 (111.8)		
Steel strength in shear	V_{sa}	lb (kN)	3,595 (16.0)		5,495 (24.4)				8,090 (36.0)			13,675 (60.8)		
Steel strength in shear, seismic	V_{eq}	lb (kN)	2,255 (10.0)		5,495 (24.4)				7,600 (33.8)			11,745 (52.2)		
Steel strength in shear, concrete on metal deck[2]	$V_{sa,deck}$	lb (kN)	2,130[10] (9.5)		3,000 (13.3)		4,945 (22)		4,600[10] (20.5)	6,040[10] (26.9)		NP		
Pullout strength uncracked concrete[3]	$N_{p,uncr}$	lb (kN)	2515 (11.2)		NA		5,515 (24.5)		NA	9,145 (40.7)		8,280 (36.8)		10,680 (47.5)
Pullout strength cracked concrete[3]	$N_{p,cr}$	lb (kN)	2270 (10.1)		NA		4,915 (21.9)		NA			NA		
Pullout strength concrete on metal deck[4]	$N_{p,deck,cr}$	lb (kN)	1,460 (6.5)		1,460 (6.5)		2,620 (11.7)		2,000 (8.9)	4,645 (20.7)		NP		
Anchor category[5]			1											
Effectiveness factor k_{uncr} uncracked concrete			24											
Effectiveness factor k_{cr} cracked concrete[6]			17											
$\psi_{c,N} = k_{uncr}/k_{cr}$ [7]			1.41											
Coefficient for pryout strength, k_{cp}			1.0				2.0							
Strength reduction factor Φ for tension, steel failure modes[8]			0.75											
Strength reduction factor Φ for shear, steel failure modes[8]			0.65											
Strength reduction factor Φ for tension, concrete failure modes, Condition B[9]			0.65											
Strength reduction factor Φ for shear, concrete failure modes			0.70											

1 See Fig. 1.
2 NP (not permitted) denotes that the condition is not supported.
3 NA (not applicable) denotes that this value does not control for design.
4 NP (not permitted) denotes that the condition is not supported. Values are for cracked concrete. Values are applicable to both static and seismic load combinations.
5 See ACI 318 D.4.4.
6 See ACI 318 D.5.2.2.
7 See ACI 318 D.5.2.6.
8 The KB-TZ is a ductile steel element as defined by ACI 318 D.1.
9 For use with the load combinations of ACI 318 Chapter 9 Section 9.2. Condition B applies where supplementary reinforcement in conformance with ACI 318 D.4.4 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.
10 For seismic applications, multiply the value of $V_{sa,deck}$ for the 3/8-inch-diameter by 0.63 and the 5/8-inch-diameter by 0.94.

KWIK Bolt TZ Expansion Anchor 3.3.4

Table 3 — Stainless Steel KWIK Bolt TZ Strength Design Information

Setting Information	Symbol	Units	Nominal anchor diameter											
			3/8		1/2				5/8			3/4		
Anchor O.D.	d_o	in. (mm)	0.375 (9.5)		0.5 (12.7)				0.625 (15.9)			0.75 (19.1)		
Effective minimum embedment[1]	h_{ef}	in. (mm)	2 (51)		2 (51)		3-1/4 (83)		3-1/8 (79)	4 (102)		3-3/4 (95)		4-3/4 (121)
Min. member thickness	h_{min}	in. (mm)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	6 (152)	8 (203)	
Critical edge distance	c_{ac}	in. (mm)	4-3/8 (111)	3-7/8 (98)	5-1/2 (140)	4-1/2 (114)	7-1/2 (191)	6 (152)	7 (178)	8-7/8 (225)	6 (152)	10 (254)	7 (178)	9 (229)
Min. edge distance	$c_{a,min}$	in. (mm)	2-1/2 (64)		2-7/8 (73)		2-1/8 (54)		3-1/4 (83)	2-3/8 (60)		4-1/4 (108)		4 (102)
	for s ≥	in. (mm)	5 (127)		5-3/4 (146)		5-1/4 (133)		5-1/2 (140)	5-1/2 (140)		10 (254)		8-1/2 (216)
Min. anchor spacing	s_{min}	in. (mm)	2-1/4 (57)		2-7/8 (73)		2 (51)		2-3/4 (70)	2-3/8 (60)		5 (127)		4 (102)
	for c ≥	in. (mm)	3-1/2 (89)		4-1/2 (114)		3-1/4 (83)		4-1/8 (105)	4-1/4 (108)		9-1/2 (241)		7 (178)
Min. hole depth in concrete	h_o	in. (mm)	2-5/8 (67)		2-5/8 (67)		4 (102)		3-3/4 (95)	4-3/4 (121)		4-5/8 (117)		5-3/4 (146)
Min. specified yield strength	f_{ya}	lb/in2 (N/mm2)	92,000 (634)		92,000 (634)				92,000 (634)			76,125 (525)		
Min. specified ult. strength	f_{uta}	lb/in2 (N/mm2)	115,000 (793)		115,000 (793)				115,000 (793)			101,500 (700)		
Effective tensile stress area	A_{se}	in2 (mm2)	0.052 (33.6)		0.101 (65.0)				0.162 (104.6)			0.237 (152.8)		
Steel strength in tension	N_{sa}	lb (kN)	5,980 (26.6)		11,615 (51.7)				18,630 (82.9)			24,055 (107.0)		
Steel strength in shear	V_{sa}	lb (kN)	4,870 (21.7)		6,880 (30.6)				9,350 (41.6)			12,890 (57.3)		
Steel strength in tension, seismic[2]	N_{eq}	lb (kN)	NA		2,735 (12.2)		NA		NA			NA		
Steel strength in shear, seismic[2]	V_{eq}	lb (kN)	2,825 (12.6)		6,880 (30.6)				11,835 (52.6)			14,615 (65.0)		
Pullout strength uncracked concrete[2]	$N_{p,uncr}$	lb (kN)	2,630 (11.7)		NA		5,760 (25.6)		NA			NA		12,040 (53.6)
Pullout strength cracked concrete[2]	$N_{p,cr}$	lb (kN)	2,340 (10.4)		3,180 (14.1)		NA		NA	5,840 (26.0)		8,110 (36.1)		NA
Anchor category[3]			1		2		1							
Effectiveness factor k_{uncr} uncracked concrete			24											
Effectiveness factor k_{cr} cracked concrete[4]			17		24		17		17	17		24		17
$\psi_{c,N} = k_{uncr}/k_{cr}$ [5]			1.41		1.00		1.41		1.41	1.41		1.00		1.41
Coefficient for pryout strength, k_{cp}			1.0				2.0							
Strength reduction factor Φ for tension, steel failure modes[6]			0.75											
Strength reduction factor Φ for shear, steel failure modes[6]			0.65		0.55		0.65							
Strength reduction factor Φ for tension, concrete failure modes, Condition B[7]			0.65											
Strength reduction factor Φ for shear, concrete failure modes			0.70											

1 See Fig. 1.
2 NA (not applicable) denotes that this value does not control for design.
3 See ACI 318 D.4.4.
4 See ACI 318 D.5.2.2.
5 See ACI 318 D.5.2.6.
6 The KB-TZ is a ductile steel element as defined by ACI 318 D.1.
7 For use with the load combinations of ACI 318 Chapter 9 Section 9.2. Condition B applies where supplementary reinforcement in conformance with ACI 318 D.4.4 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.

3.3.4 KWIK Bolt TZ Expansion Anchor

Figure 2 — Interpolation of Minimum Edge Distance and Anchor Spacing

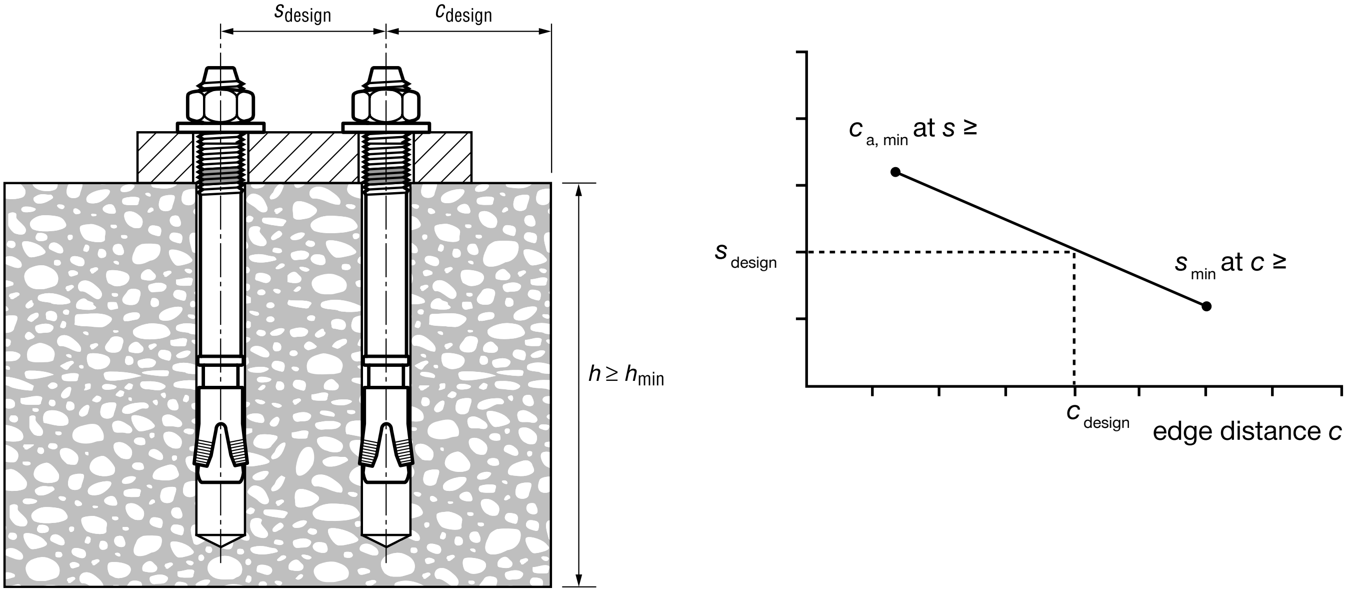
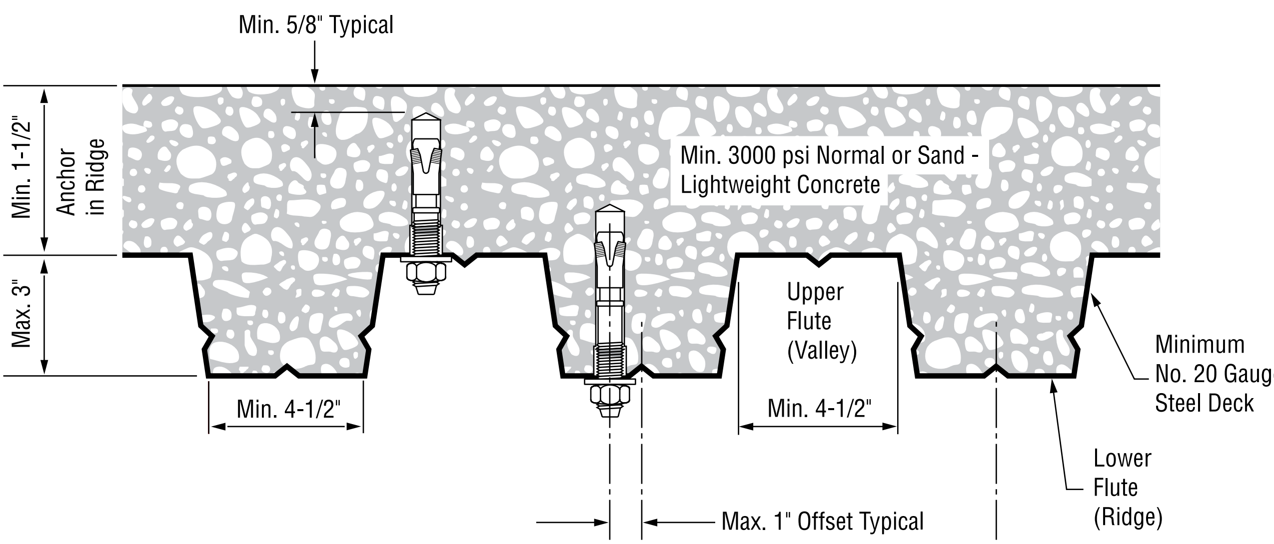


Table 4 — Mean Axial Stiffness Values (1,000 lb/in.) for KWIK Bolt TZ Carbon and Stainless Steel Anchors in Normal-Weight Concrete[1]

Concrete condition	carbon steel KB-TZ, all diameters	stainless steel KB-TZ, all diameters
uncracked concrete	700	120
cracked concrete	500	90

1 Mean values shown. Actual stiffness may vary considerably depending on concrete strength, loading and geometry of application.

Figure 3 — Installation in Concrete over Metal Deck Floor



KWIK Bolt TZ Expansion Anchor 3.3.4

Allowable Stress Design

Design values for use with allowable stress design (working stress design) shall be established as follows: $R_{allow,ASD} = \frac{R_d}{\alpha}$

where $R_d = \Phi R_k$ represents the limiting design strength in tension (ΦN_n) or shear (ΦV_n) as calculated according to ACI 318 D.4.1.1 and D.4.1.2

Table 5 - KWIK Bolt TZ Carbon and Stainless Steel Allowable Nonseismic Tension (ASD), Normal-Weight Uncracked Concrete (lb)[1,2,3,4,5,6]

Diameter	h_{ef} (in.)	Concrete Compressive Strength							
		f'_c = 2,500 psi		f'_c = 3,000 psi		f'_c = 4,000 psi		f'_c = 6,000 psi	
		Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel
3/8	2	1,168	1,221	1,279	1,338	1,477	1,545	1,809	1,892
1/2	2	1,576	1,576	1,726	1,726	1,993	1,993	2,441	2,441
	3-1/4	2,561	2,674	2,805	2,930	3,239	3,383	3,967	4,143
5/8	3-1/8	3,078	3,078	3,372	3,372	3,893	3,893	4,768	4,768
	4	4,246	4,457	4,651	4,883	5,371	5,638	6,578	6,905
3/4	3-3/4	3,844	4,046	4,211	4,432	4,863	5,118	5,956	6,268
	4-3/4	4,959	5,590	5,432	6,124	6,272	7,071	7,682	8,660

1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).

2 Concrete determined to remain uncracked for the life of the anchorage.

3 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.

4 For strength design, the required strength = 1.6D + 1.2L. For ASD, the factored load = 1.0D + 1.0L. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.

5 Assuming a 50% dead and 50% live contributions, $\alpha = (1.6 \cdot 0.5 + 1.2 \cdot 0.5) / (1.0 \cdot 0.5 + 1.0 \cdot 0.5) = 1.4$

6 $ASD = \Phi_{concrete} \cdot N_{p,uncr} / \alpha = 0.65 \cdot N_{p,uncr} / 1.4$

Table 6 - KWIK Bolt TZ Carbon and Stainless Steel Allowable Nonseismic Tension (ASD), Normal-Weight Cracked Concrete (lb)[1,2,3,4,5]

Diameter	h_{ef} (in.)	Concrete Compressive Strength							
		f'_c = 2500 psi		f'_c = 3000 psi		f'_c = 4000 psi		f'_c = 6000 psi	
		Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel
3/8	2	1,054	1,086	1,155	1,190	1,333	1,374	1,633	1,683
1/2	2	1,116	1,476	1,223	1,617	1,412	1,868	1,729	2,287
	3-1/4	2,282	2,312	2,500	2,533	2,886	2,886	3,535	3,582
5/8	3-1/8	2,180	2,180	2,388	2,388	2,758	2,925	3,377	3,377
	4	3,157	2,711	3,458	2,970	3,994	3,430	4,891	4,201
3/4	3-3/4	2,866	3,765	3,139	4,125	3,625	4,763	4,440	5,833
	4-3/4	4,085	4,085	4,475	4,475	5,168	5,168	6,329	6,329

1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).

2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.

3 For strength design, the required strength = 1.6D + 1.2L. For ASD, the factored load = 1.0D + 1.0L. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.

4 Assuming a 50% dead and 50% live contributions, $\alpha = (1.6 \cdot 0.5 + 1.2 \cdot 0.5) / (1.0 \cdot 0.5 + 1.0 \cdot 0.5) = 1.4$

5 $ASD = \Phi_{concrete} \cdot N_{p,cr} / \alpha = 0.65 \cdot N_{p,cr} / 1.4$

3.3.4 KWIK Bolt TZ Expansion Anchor

Table 7 - KWIK Bolt TZ Carbon and Stainless Steel Allowable Nonseismic Shear (ASD), Steel (lb)[1,2,3,4,5,6]

Diameter (in.)	Allowable Steel Capacity, Shear	
	Carbon Steel	Stainless Steel
3/8	1,925	2,530
1/2	2,945	3,685
5/8	4,335	5,290
3/4	7,325	8,415

1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).

2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.

3 For strength design, the required strength = 1.6D + 1.2L. For ASD, the factored load = 1.0D + 1.0L. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.

4 ASD = $\Phi_{steel} \cdot V_{sa} / \alpha = 0.75 \cdot V_{sa} / 1.4$

Table 8 - KWIK Bolt TZ Carbon and Stainless Steel Allowable Seismic Tension (ASD), Normal-Weight Cracked Concrete (lb)[1,2,3,4,5]

Diameter	h_{ef} (in.)	Concrete Compressive Strength[2]							
		f'_c = 2500 psi		f'_c = 3000 psi		f'_c = 4000 psi		f'_c = 6000 psi	
		Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel
3/8	2	774	882	937	966	1,082	1,115	1,225	1,366
1/2	2	906	1,198	992	1,312	1,146	1,515	1,297	1,856
	3-1/4	1,852	1,876	2,028	2,055	2,342	2,373	2,651	2,907
5/8	3-1/8	1,769	1,769	1,938	1,938	2,238	2,238	2,533	2,741
	4	2,562	2,200	2,806	2,410	3,240	2,783	3,668	3,408
3/4	3-3/4	2,325	3,055	2,547	3,347	2,941	3,865	3,330	4,733
	4-3/4	3,315	3,315	3,632	3,632	4,193	4,193	4,747	5,136

1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).

2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.

3 For strength design, the required strength = 1.2D + 1.0E. For ASD, the factored load = 1.0D + 0.7E. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.

4 Assuming a 50% dead and 50% earthquake contributions, $\alpha = (1.2 \cdot 0.5 + 1.0 \cdot 0.5) / (1.0 \cdot 0.5 + 0.7 \cdot 0.5) = 1.294$

5 ASD = $\phi_{concrete} \cdot \phi_{seismic} \cdot N_{p,uncr} / \alpha = 0.65 \cdot 0.75 \cdot N_{p,uncr} / 1.294$

Table 9 - KWIK Bolt TZ Carbon and Stainless Steel Allowable Seismic Shear (ASD), Steel (lb)[1,2,3,4,5]

Diameter (in.)	Allowable Steel Capacity, Shear	
	Carbon Steel	Stainless Steel
3/8	1,565	1,915
1/2	2,390	2,590
5/8	3,515	4,005
3/4	5,945	6,375

1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).

2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.

3 For strength design, the required strength = 1.2D + 1.0E. For ASD, the factored load = 1.0D + 0.7E. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.

4 Assuming a 50% dead and 50% earthquake contributions, $\alpha = (1.2 \cdot 0.5 + 1.0 \cdot 0.5) / (1.0 \cdot 0.5 + 0.7 \cdot 0.5) = 1.294$

5 Seismic ASD = $\Phi_{steel} \cdot \Phi_{seismic} \cdot V_{eq} / \alpha = 0.75 \cdot 0.75 \cdot Veq / 1.294$

Table 10 - KWIK Bolt TZ Allowable Tension and Shear Loads (ASD), Installed into the Underside of Lightweight Concrete over Metal Deck Slab[1,2]

Nominal Anchor Diameter	Embedment Depth h_{ef} (in.)	Tension Nonseismic[3,4,5] (lb)	Tension Seismic[7,8,9] (lb)	Shear Nonseismic[3,4,6] (lb)	Shear Seismic[7,8,10] (lb)
3/8	2	680	50	1,140	930
1/2	2	680	550	1,607	1,310
1/2	3 1/4	1,215	990	2,650	2,155
5/8	3 1/8	929	755	2,465	2,005
5/8	4	2,157	1,755	3,235	2,635

1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).

2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.

3 For strength design, the required strength = 1.6D + 1.2L. For ASD, the factored load = 1.0D + 1.0L. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.

4 Assuming a 50% dead and 50% live contributions, $\alpha = (1.6 \cdot 0.5 + 1.2 \cdot 0.5) / (1.0 \cdot 0.5 + 1.0 \cdot 0.5) = 1.4$

5 $ASD = \Phi_{concrete} \cdot N_{p,deck,cr} / \alpha = 0.65 \cdot N_{p,deck,cr} / 1.4$

6 $ASD = \Phi_{steel} \cdot V_{s,deck} / \alpha = 0.75 \cdot V_{s,deck} / 1.4$

7 For strength design, the required strength = 1.2D + 1.0E. For ASD, the factored load = 1.0D + 0.7E. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.

8 Assuming a 50% dead and 50% earthquake contributions, $\alpha = (1.2 \cdot 0.5 + 1.0 \cdot 0.5) / (1.0 \cdot 0.5 + 0.7 \cdot 0.5) = 1.294$

9 $ASD = \Phi_{concrete} \cdot \Phi_{seismic} \cdot N_{p,deck,cr} / \alpha = 0.65 \cdot 0.75 \cdot N_{p,deck,cr} / 1.294$

10 10. Seismic $ASD = \Phi_{concrete} \cdot \Phi_{seismic} \cdot V_{s,deck} / \alpha = 0.75 \cdot 0.75 \cdot V_{s,deck} / 1.294$

Table 11 — KWIK Bolt TZ Length Identification System

Length ID marking on bolt head		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
Length of anchor, ℓ_{anch} (in.)	From	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11	12	13	14	15
	Up to but not including	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11	12	13	14	15	16

Figure 4 — Bolt Head with Length Identification Mark and KWIK Bolt TZ Head Notch Embossment

3.3.4 KWIK Bolt TZ Expansion Anchor

TABLE 12 - KWIK Bolt TZ Design Information in accordance with CSA A23.3-04 Annex D[1]

Design Parameter	Symbol	Units	Nominal anchor diameter												Ref.
			3/8		1/2				5/8			3/4			A23.3-04
Anchor O.D.	d_o	mm	9.5		12.7				15.9			19.1			
		(in.)	0.375		0.5				0.625			0.75			
Effective min. embedment depth	$h_{ef, min}$	mm	51		51		83		79	102		95		121	
		(in.)	2		2		3-1/4		3-1/8	4		3-3/4		4-3/4	
Min. member thickness	h_{min}	mm	102	127	102	152	152	203	127	152	203	152	203	203	
Critical edge distance	c_{ac}	mm	111	102	140	114	191	152	165	222	171	254	203	229	
Minimum edge distance	c_{ac}	mm	64		70		60		92	83		121		105	
	for s >	mm	127		146		146		156	149		267		225	
Minimum anchor spacing	s_{min}	mm	64		70		60		89	76		127		102	
	for c >	mm	92		105		89		121	108		241		197	
Minimum hole depth in concrete	h_o	mm	67		67		102		98	121		117		146	
Min. edge distance	1, 2 or 3		1												D.5.4c
Concrete material resistance factor for concrete	Φ_c		0.65												8.4.2
Steel embedment material resistance factor for reinforcement	Φ_s		0.85												8.4.3
Strength reduction factor for tension, steel failure modes	R		0.80												D.5.4a
Strength reduction factor for shear, steel failure modes	R		0.75												D.5.4a
Strength reduction factor for tension, concrete failure modes	R	Cond. A	1.15												D.5.4c
	R	Cond. B	1.00												D.5.4c
Strength reduction factor for shear, concrete failure modes	R	Cond. A	1.15												D.5.4c
	R	Cond. B	1.00												D.5.4c
Yield strength of anchor steel	f_y	MPa	690		585				585			585			
Ultimate strength of anchor steel	f_{ut}	MPa	862		731				731			731			
Effective cross-sectional area	A_{se}	mm^2	33.6		65.0				104.6			152.8			
Coefficient for factored concrete breakout resistance in tension	k		7												D.6.2.6
Modification factor for resistance in tension to account for uncracked concrete	$\psi_{c,N}$		1.4												D.6.2.6
Factored Steel Resistance in tension	N_{sr}	kN	19.7		32.3				52.0			76.0			D.6.1.2
Factored Steel Resistance in shear	V_{sr}	kN	10.2		18.2				29.9			45.2			D.7.1.2c
Factored Steel Resistance in shear, seismic	$V_{sr, seismic}$	kN	6.4		18.2				29.9			40.4			
Factored Steel Resistance in shear, concrete on metal deck	$V_{sr, deck}$	kN	6.0		8.5		14.0		13.0	17.1		Not Permitted			
Factored pullout resistance in 20 MPa uncracked concrete	$N_{pr, uncr}$	kN	7.8		N/A		17.1		N/A	28.4		25.7		33.2	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete	$N_{pr, cr}$	kN	7.1		N/A		15.3		N/A			N/A			D.6.3.2
20 MPa cracked concrete	$N_{pr,deck\ cr}$	kN	4.5		4.5		8.1		6.2	14.4		Not Permitted			D.6.3.2

1 For more information, please visit www.hilti.ca and navigate Service/Downloads, then Technical Downloads and open the Limit States Design Guide.

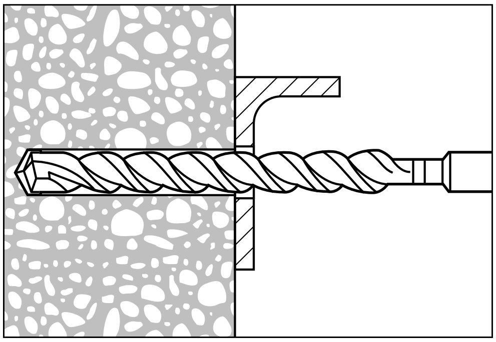
TABLE 13 - KWIK Bolt RTZ Design Information in accordance with CSA A23.3-04 Annex D[1]

Design Parameter	Symbol	Units	Nominal anchor diameter												Ref.
			3/8		1/2				5/8			3/4			A23.3-04
Anchor O.D.	d_o	mm	9.5		12.7				15.9			19.1			
		(in.)	0.375		0.5				0.625			0.75			
Effective min. embedment depth	$h_{ef, min}$	mm	51		51		83		79	102		95		121	
		(in.)	2		2		3-1/4		3-1/8	4		3-3/4		4-3/4	
Min. member thickness	h_{min}	mm	102	127	102	152	152	203	127	152	203	152	203	203	
Critical edge distance	c_{ac}	mm	111	98	140	114	191	152	178	225	152	254	178	229	
Minimum edge distance	c_{ac}	mm	64		73		54		83	60		108		102	
	for s >	mm	127		146		133		140	140		254		216	
Minimum anchor spacing	s_{min}	mm	57		73		51		70	60		127		102	
	for c >	mm	89		114		83		105	108		241		178	
Minimum hole depth in concrete	h_o	mm	67		67		102		98	121		117		146	
Anchor category	1, 2 or 3		1												D.5.4c
Concrete material resistance factor for concrete	ϕ_c		0.65												8.4.2
Steel embedment material resistance factor for reinforcement	ϕ_s		0.85												8.4.3
Strength reduction factor for tension, steel failure modes	R		0.80												D.5.4a
Strength reduction factor for shear, steel failure modes	R		0.75												D.5.4a
Strength reduction factor for tension, concrete failure modes	R	Cond. A	1.15												D.5.4c
	R	Cond. B	1.00												D.5.4c
Strength reduction factor for shear, concrete failure modes	R	Cond. A	1.15												D.5.4c
	R	Cond. B	1.00												D.5.4c
Yield strength of anchor steel	f_y	MPa	634		634				634			525			
Ultimate strength of anchor steel	f_{ut}	MPa	793		793				793			700			
Effective cross-sectional area	A_{se}	mm^2	33.6		65.0				104.6			152.8			
Coefficient for factored concrete breakout resistance in tension	k		7		10		7		7			10		7	D.6.2.6
Modification factor for resistance in tension to account for uncracked concrete	$\psi_{c,N}$		1.40		1.00		1.40		1.40			1.00		1.40	D.6.2.6
Factored Steel Resistance in tension	N_{sr}	kN	18.1		35.1				56.4			72.7			D.6.1.2
Factored Steel Resistance in shear	V_{sr}	kN	13.8		19.5				33.6			56.9			D.7.1.2c
Factored Steel Resistance in shear, seismic	$V_{sr, seismic}$	kN	8.0		19.5				33.6			41.4			
Factored pullout resistance in 20 MPa uncracked concrete	$N_{pr, cr}$	kN	8.2		N/A		17.9		N/A			N/A		37.4	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete	$N_{pr, cr}$	kN	7.3		9.9		N/A		N/A	18.1		25.2	N/A		D.6.3.2

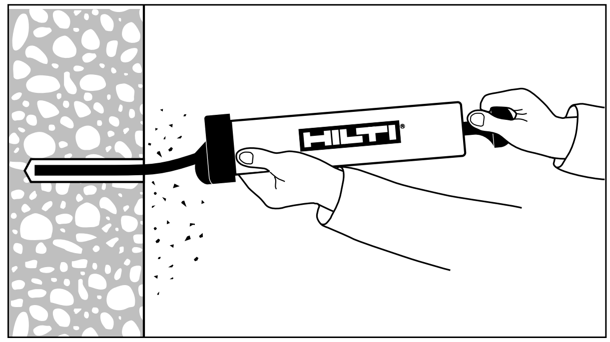
1 For more information, please visit www.hilti.ca and navigate Service/Downloads, then Technical Downloads and open the Limit States Design Guide.

3.3.4 KWIK Bolt TZ Expansion Anchor

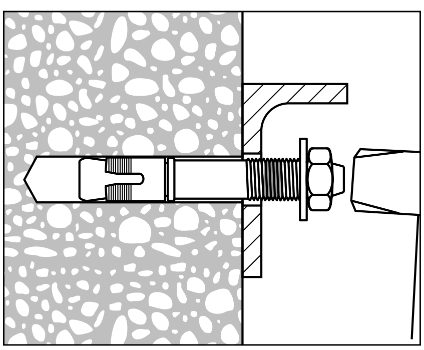
3.3.4.4 KWIK Bolt TZ Anchor Installation Instructions into normal-weight and lightweight concrete



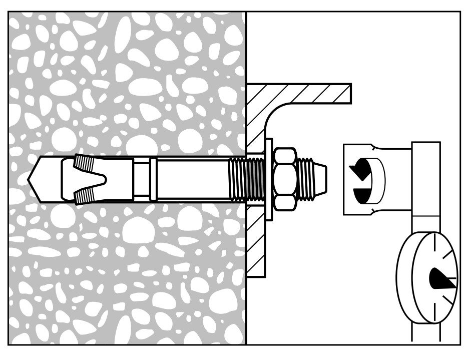
1. Hammer drill a hole to the same nominal diameter as the KWIK Bolt TZ. The minimum hole depth must conform with the instructions for use adhered to the packaging and the ICC-ES evaluation report, if applicable. The fixture may be used as a drilling template to ensure proper anchor location.



2. Clean hole.



3. Drive the KWIK Bolt TZ into the hole using a hammer. The anchor must be driven until at least 4 threads are below the surface of the fixture.



4. Tighten the nut to the installation torque.

3.3.4.5 KWIK Bolt TZ Anchor Ordering Information

Description	Length (in.)	Threaded Length (in.)	Box Quantity
KB-TZ 3/8x3	3	7/8	50
KB-TZ 3/8x3-3/4	3-3/4	1-5/8	50
KB-TZ 3/8x5	5	2-7/8	50
KB-TZ 1/2x3-3/4	3-3/4	1-5/8	20
KB-TZ 1/2x4-1/2	4-1/2	2-3/8	20
KB-TZ 1/2x5-1/2	5-1/2	3-3/8	20
KB-TZ 1/2x7	7	4-7/8	20
KB-TZ 5/8x4-3/4	4-3/4	1-1/2	15
KB-TZ 5/8x6	6	2-3/4	15
KB-TZ 5/8x8-1/2	8-1/2	5-1/4	15
KB-TZ 5/8x10	10	6-3/4	15
KB-TZ 3/4x5-1/2	5 1/2	1-1/2	10
KB-TZ 3/4x8	8	4	10
KB-TZ 3/4x10	10	6	10
KB-TZ SS304 3/8x3	3	7/8	50
KB-TZ SS304 3/8x3-3/4	3-3/4	1-5/8	50
KB-TZ SS304 3/8x5	5	2-7/8	50
KB-TZ SS304 1/2x3-3/4	3-3/4	1-5/8	20
KB-TZ SS304 1/2x4-1/2	4-1/2	2-3/8	20
KB-TZ SS304 1/2x5-1/2	5-1/2	3-3/8	20
KB-TZ SS304 1/2x7	7	4-7/8	20
KB-TZ SS304 5/8x4-3/4	4-3/4	1-1/2	15
KB-TZ SS304 5/8x6	6	2-3/4	15
KB-TZ SS304 5/8x8-1/2	8-1/2	5-1/4	15
KB-TZ SS304 5/8x10	10	6-3/4	15
KB-TZ SS304 3/4x5-1/2	5-1/2	1-1/2	10
KB-TZ SS304 3/4x8	8	4	10
KB-TZ SS304 3/4x10	10	6	10
KB-TZ SS316 3/8x3	3	7/8	50
KB-TZ SS316 3/8x3-3/4	3-3/4	1-5/8	50
KB-TZ SS316 1/2x3-3/4	3-3/4	1-5/8	20
KB-TZ SS316 1/2x4-1/2	4-1/2	2-3/8	20
KB-TZ SS316 1/2x5-1/2	5-1/2	3-3/8	20
KB-TZ SS316 5/8x4-3/4	4-3/4	1-1/2	15
KB-TZ SS316 5/8x6	6	2-3/4	15
KB-TZ SS316 3/4x5-1/2	5-1/2	1-1/2	10
KB-TZ SS316 3/4x10	10	6	10

ICC-ES Evaluation Report

ESR-1917*

Reissued May 1, 2011

This report is subject to renewal May 1, 2013.

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

REPORT HOLDER:

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EVALUATION SUBJECT:

HILTI KWIK BOLT TZ CARBON AND STAINLESS STEEL ANCHORS IN CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2012, 2009 and 2006 *International Building Code®* (IBC)
- 2012, 2009 and 2006 *International Residential Code®* (IRC)

Property evaluated:

Structural

2.0 USES

The Hilti Kwik Bolt TZ anchor (KB-TZ) is used to resist static, wind, and seismic tension and shear loads in cracked and uncracked 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).

The $^3/_8$-inch- and $^1/_2$-inch-diameter (9.5 mm and 12.7 mm) carbon steel KB-TZ anchors may be installed in the topside of cracked and uncracked normal-weight or sand-lightweight concrete-filled steel deck having a minimum member thickness, $h_{min,deck}$, as noted in Table 6 of this report and a specified compressive strength, f'_c, of 3,000 psi to 8,500 psi (20.7 MPa to 58.6 MPa).

The $^3/_8$-inch-, $^1/_2$-inch- and $^5/_8$-inch-diameter (9.5 mm, 12.7 mm and 15.9 mm) carbon steel KB-TZ anchors may be installed in the soffit of 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).

The anchoring system complies with anchors as described in Section 1909 of the 2012 IBC and Section 1912 of the 2009 and 2006 IBC. The anchoring system is an alternative to cast-in-place anchors described in Section1908 of the 2012 IBC and Section 1911 of the 2009 and 2006 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 KB-TZ:

KB-TZ anchors are torque-controlled, mechanical expansion anchors. KB-TZ anchors consist of a stud (anchor body), wedge (expansion elements), nut, and washer. The anchor (carbon steel version) is illustrated in Figure 1. The stud is manufactured from carbon steel or AISI Type 304 or Type 316 stainless steel materials. Carbon steel KB-TZ anchors have a minimum 5 μm (0.0002 inch) zinc plating. The expansion elements for the carbon and stainless steel KB-TZ anchors are fabricated from Type 316 stainless steel. The hex nut for carbon steel conforms to ASTM A563-04, Grade A, and the hex nut for stainless steel conforms to ASTM F594.

The anchor body is comprised of a high-strength rod threaded at one end and a tapered mandrel at the other end. The tapered mandrel is enclosed by a three-section expansion element which freely moves around the mandrel. The expansion element movement is restrained by the mandrel taper and by a collar. The anchor is installed in a predrilled hole with a hammer. When torque is applied to the nut of the installed anchor, the mandrel is drawn into the expansion element, which is in turn expanded against the wall of the drilled hole.

3.2 Concrete:

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

3.3 Steel Deck Panels:

Steel deck panels must be in accordance with the configuration in Figures 5A, 5B and 5C and have a minimum base steel thickness of 0.035 inch (0.899mm). Steel must comply with ASTM A653/A653M 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 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 strength of anchors complying with the 2009 IBC and Section R301.1.3 of the 2009 IRC must be determined in accordance with ACI 318-08 Appendix D and this report.

***Revised April 2012**

Design strength of anchors complying with the 2006 IBC and Section R301.1.3 of the 2006 IRC must be in accordance with ACI 318-05 Appendix D and this report.

Design parameters provided in Tables 3, 4, 5 and 6 of this report are based on the 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 D.4.1, except as required in ACI 318 D.3.3.

Strength reduction factors, ϕ, as given in ACI 318-11 D.4.3 and noted in Tables 3 and 4 of this report, must be used for load combinations calculated in accordance with Section 1605.2 of the IBC and Section 9.2 of ACI 318. 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 Appendix C. An example calculation in accordance with the 2012 IBC is provided in Figure 7. 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 318-11 D.3.7.

4.1.2 Requirements for Static Steel Strength in Tension: The nominal static steel strength, N_{sa}, of a single anchor in tension must be calculated in accordance with ACI 318 D.5.1.2. The resulting N_{sa} values are provided in Tables 3 and 4 of this report. Strength reduction factors ϕ corresponding to ductile steel elements may be used.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension: The nominal concrete breakout strength of a single anchor or group of anchors in tension, N_{cb} or 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 Tables 3, 4 and 6. 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 k_{uncr} as given in Tables 3 and 4 and with $\Psi_{c,N}$ = 1.0.

For carbon steel KB-TZ anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 5A and 5B, calculation of the concrete breakout strength is not required.

4.1.4 Requirements for Static Pullout Strength in Tension: 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 Tables 3 and 4. For all design cases $\Psi_{c,P}$ = 1.0. In accordance with ACI 318 D.5.3, the nominal pullout strength in cracked concrete may be calculated in accordance with the following equation:

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

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

In regions where analysis indicates no cracking in accordance with ACI 318 D.5.3.6, the nominal pullout strength in tension may be calculated in accordance with the following equation:

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

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

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

The nominal pullout strength in cracked concrete of the carbon steel KB-TZ installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 5A and 5B, is given in Table 5. In accordance with ACI 318 D.5.3.2, the nominal pullout strength in cracked concrete must be calculated in accordance with 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. The use of stainless steel KB-TZ anchors installed in the soffit of concrete on steel deck assemblies is beyond the scope of this report.

4.1.5 Requirements for Static Steel Strength in Shear:

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 3 and Table 4 of this report and must be used in lieu of the values derived by calculation from ACI 318-11, Eq. D-29. The shear strength $V_{sa,deck}$ of the carbon-steel KB-TZ as governed by steel failure of the KB-TZ installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 5A and 5B, is given in Table 5.

4.1.6 Requirements for Static Concrete Breakout Strength in Shear: 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, V_b, must be calculated in accordance with ACI 318 D.6.2.2 based on the values provided in Tables 3 and 4. The value of ℓ_e used in ACI 318 Eq. D-24 must be taken as no greater than the lesser of h_{ef} or $8d_a$.

For carbon steel KB-TZ anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 5A and 5B, calculation of the concrete breakout strength in shear is not required.

4.1.7 Requirements for Static Concrete Pryout Strength in Shear: 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, modified by using the value of k_{cp} provided in Tables 3 and 4 of this report and the value of N_{cb} or N_{cbg} as calculated in Section 4.1.3 of this report.

For carbon steel KB-TZ anchors installed in the soffit of sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, as shown in Figures 5A and 5B, calculation of the concrete pry-out 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 performed in accordance with ACI 318 D.3.3, as modified by Section 1905.1.9 of the 2012 IBC, Section 1908.1. 9 of the 2009 IBC or Section 1908.1.16 of the 2006 IBC. The nominal steel strength and the 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 given in Tables 3, 4 and 5 of this report. The anchors may be installed in Seismic Design Categories A through F of the IBC. The anchors comply with ACI 318 D.1 as ductile steel elements and must be designed in accordance with ACI 318-11 D.3.3.4, D.3.3.5, D.3.3.6 or D.3.3.7, ACI 318-08 D.3.3.4, D.3.3.5 or D.3.3.6, or ACI 318-05 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 D.5.1 and ACI 318 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 pullout strength in tension for seismic loads, $N_{p,eq}$, described in Table 4 or $N_{p,deck,cr}$ described in Table 5 must be used in lieu of N_p, as applicable. The value of $N_{p,eq}$ or $N_{p,deck,cr}$ may be adjusted by calculation for concrete strength in accordance with Eq-1 and Section 4.1.4 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. If no values for $N_{p,eq}$ are given in Table 3 or Table 4, the static design strength values govern.

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, $V_{sa,eq}$ described in Table 3 and Table 4 or $V_{sa,deck}$ described in Table 5 must be used in lieu of V_{sa}, as applicable.

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 tension and shear forces, the design must be performed 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 s_{min} and c_{min} as given in Tables 3 and 4 of this report must be used. In lieu of ACI 318 D.8.5, minimum member thicknesses h_{min} as given in Tables 3 and 4 of this report must be used. Additional combinations for minimum edge distance, c_{min}, and spacing, s_{min}, may be derived by linear interpolation between the given boundary values as described in Figure 4.

For carbon steel KB-TZ anchors installed on the top of normal-weight or sand-lightweight concrete over profile steel deck floor and roof assemblies, the anchor must be installed in accordance with Table 6 and Figure 5C.

For carbon steel KB-TZ anchors installed in the soffit of sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, the anchors must be installed in accordance with Figure 5A or 5B 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: 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-1:

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

whereby the factor $\Psi_{cp,N}$ need not be taken as less than $\frac{1.5 h_{ef}}{c_{ac}}$. 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 or Table 4 and values of $c_{ac,deck}$ must comply with Table 6.

4.1.12 Sand-lightweight Concrete: For ACI 318-11 and 318-08, when anchors are used in sand-lightweight concrete, the modification factor λ_a or λ, respectively, for concrete breakout strength must be taken as 0.6 in lieu of ACI 318-11 D.3.6 (2012 IBC) or ACI 318-08 D.3.4 (2009 IBC). In addition the pullout strength $N_{p,cr}$, $N_{p,uncr}$ and $N_{p,eq}$ must be multiplied by 0.6, as applicable.

For ACI 318-05, the values N_b, $N_{p,cr}$, $N_{p,uncr}$, $N_{p,eq}$ and V_b determined in accordance with this report must be multiplied by 0.6, in lieu of ACI 318 D.3.4.

For carbon steel KB-TZ anchors installed in the soffit of sand-lightweight concrete-filled steel deck and floor and roof assemblies, this reduction is not required. Values are presented in Table 5 and installation details are show in Figures 5A and 5B.

4.2 Allowable Stress Design (ASD):

4.2.1 General: Design values for use with allowable stress design (working stress design) load combinations calculated in accordance with Section 1605.3 of the IBC, must be established as follows:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha}$$

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha}$$

where:

$T_{allowable,ASD}$ = Allowable tension load (lbf or kN).

$V_{allowable,ASD}$ = Allowable shear load (lbf or kN).

ϕN_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 D.4.1, and 2012 IBC Section 1905.1.9, 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable (lbf or N).

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 D.4.1, and 2012 IBC Section 1905.1.9, 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable (lbf or N).

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.

The requirements for member thickness, edge distance and spacing, described in this report, must apply. An example of allowable stress design values for illustrative purposes in shown in Table 7.

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 must be permitted.

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

For all other cases:

$$\frac{T_{applied}}{T_{allowable,ASD}} + \frac{V_{applied}}{V_{allowable,ASD}} \leq 1.2 \quad \text{(Eq-4)}$$

4.3 Installation:

Installation parameters are provided in Tables 1 and 6 and Figures 2, 5A, 5B and 5C. Anchor locations must comply with this report and plans and specifications approved by the code official. The Hilti KB-TZ must be installed in accordance with manufacturer's published instructions and this report. In case of conflict, this report governs. Anchors must be installed in holes drilled into the concrete using carbide-tipped masonry drill bits complying with ANSI B212.15-1994. The minimum drilled hole depth is given in Table 1. Prior to installation, dust and debris must be removed from the drilled hole to enable installation to the stated embedment depth. The anchor must be hammered into the predrilled hole until h_{nom} is achieved. The nut must be tightened against the washer until the torque values specified in Table 1 are achieved. For installation in the soffit of concrete on steel deck assemblies, the hole diameter in the steel deck not exceed the diameter of the hole in the concrete by more than $^1/_8$ inch (3.2 mm). For member thickness and edge distance restrictions for installations into the soffit of concrete on steel deck assemblies, see Figures 5A and 5B.

4.4 Special Inspection:

Periodic special inspection is required in accordance with Section 1705.1.1 and Table 1705.3 of the 2012 IBC, or Section 1704.15 of the 2009 IBC and Table 1704.4 or Section 1704.13 of the 2006 IBC, as applicable. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, anchor spacing, edge distances, concrete member thickness, tightening torque, hole dimensions, anchor embedment and adherence to the manufacturer's printed installation instructions. 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

The Hilti KB-TZ anchors described in this report comply with the codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Anchor sizes, dimensions, minimum embedment depths and other installation parameters are as set forth in this report.

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

5.3 Anchors must be limited to use in cracked and uncracked 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 values of f'_c used for calculation purposes must not exceed 8,000 psi (55.1 MPa).

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

5.6 Allowable design values are established in accordance with Section 4.2.

5.7 Anchor spacing and edge distance as well as minimum member thickness must comply with Tables 3, 4, and 6, and Figures 4, 5A, 5B, and 5C.

5.8 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.

5.9 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of expansion 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.

5.10 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.

5.11 Anchors may be used to resist short-term loading due to wind or seismic forces in locations designated as Seismic Design Categories A through F of the IBC, subject to the conditions of this report.

5.12 Where not otherwise prohibited in the code, KB-TZ 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 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.

5.13 Use of zinc-coated carbon steel anchors is limited to dry, interior locations.

5.14 Special inspection must be provided in accordance with Section 4.4.

5.15 Anchors are manufactured by Hilti AG under an approved quality control program with inspections by UL LLC (AA-668).

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated March 2012 (ACI 355.2-07).

6.2 Quality control documentation.

7.0 IDENTIFICATION

The anchors are identified by packaging labeled with the manufacturer's name (Hilti, Inc.) and contact information, anchor name, anchor size, evaluation report number (ICC-ES ESR-1917), and the name of the inspection agency (UL LLC). The anchors have the letters KB-TZ embossed on the anchor stud and four notches embossed into the anchor head, and these are visible after installation for verification.

TABLE 1—SETTING INFORMATION (CARBON STEEL AND STAINLESS STEEL ANCHORS)

SETTING INFORMATION	Symbol	Units	Nominal anchor diameter (in.)													
			3/8			1/2				5/8				3/4		
Anchor O.D.	d_a (d_o)[2]	In. (mm)	0.375 (9.5)			0.5 (12.7)				0.625 (15.9)				0.75 (19.1)		
Nominal bit diameter	d_{bit}	In.	3/8			1/2				5/8				3/4		
Effective min. embedment	h_{ef}	In. (mm)	2 (51)			2 (51)	3-1/4 (83)			3-1/8 (79)	4 (102)			3-3/4 (95)	4-3/4 (121)	
Nominal embedment	h_{nom}	in. (mm)	2-5/16 (59)			2-3/8 (60)	3-5/8 (91)			3-9/16 (91)	4-7/16 (113)			4-5/16 (110)	5-9/16 (142)	
Min. hole depth	h_o	In. (mm)	2-5/8 (67)			2-5/8 (67)	4 (102)			3-3/4 (95)	4-3/4 (121)			4-1/2 (114)	5-3/4 (146)	
Min. thickness of fastened part[1]	t_{min}	In. (mm)	1/4 (6)			3/4 (19)	1/4 (6)			3/8 (9)	3/4 (19)			1/8 (3)	1 5/8 (41)	
Required Installation torque	T_{inst}	ft-lb (Nm)	25 (34)			40 (54)				60 (81)				110 (149)		
Min. dia. of hole in fastened part	d_h	In. (mm)	7/16 (11.1)			9/16 (14.3)				11/16 (17.5)				13/16 (20.6)		
Standard anchor lengths	ℓ_{anch}	In.	3	3-3/4	5	3-3/4	4-1/2	5-1/2	7	4-3/4	6	8-1/2	10	5-1/2	8	10
		(mm)	(76)	(95)	(127)	(95)	(114)	(140)	(178)	(121)	(152)	(216)	(254)	(140)	(203)	(254)
Threaded length (incl. dog point)	ℓ_{thread}	In.	7/8	1-5/8	2-7/8	1-5/8	2-3/8	3-3/8	4-7/8	1-1/2	2-3/4	5-1/4	6-3/4	1-1/2	4	6
		(mm)	(22)	(41)	(73)	(41)	(60)	(86)	(124)	(38)	(70)	(133)	(171)	(38)	(102)	(152)
Unthreaded length	ℓ_{unthr}	In. (mm)	2-1/8 (54)			2-1/8 (54)				3-1/4 (83)				4 (102)		

[1]The minimum thickness of the fastened part is based on use of the anchor at minimum embedment and is controlled by the length of thread. If a thinner fastening thickness is required, increase the anchor embedment to suit.
[2]The notation in parenthesis is for the 2006 IBC.

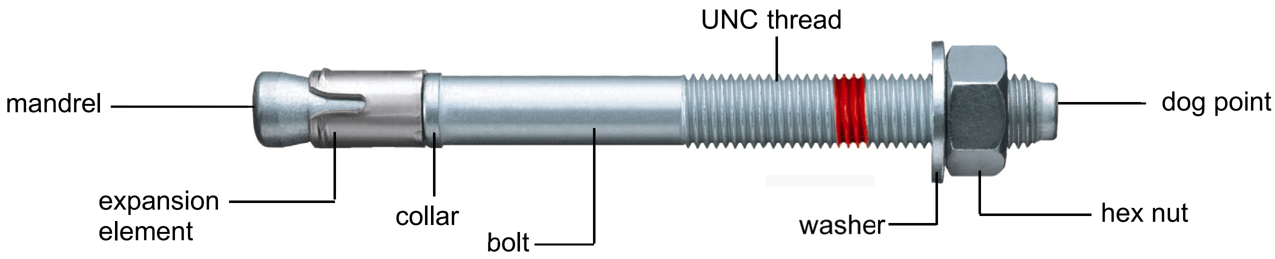


FIGURE 1—HILTI CARBON STEEL KWIK BOLT TZ (KB-TZ)

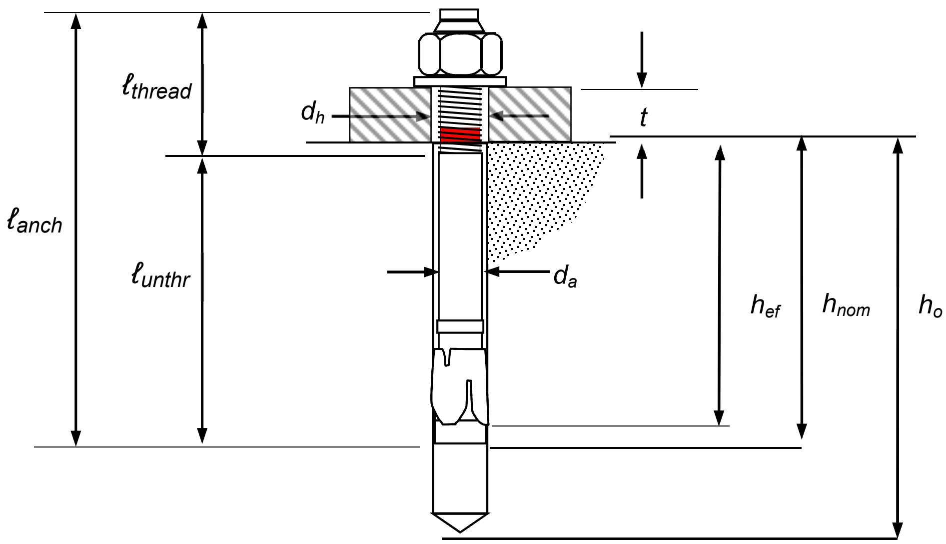


FIGURE 2—KB-TZ INSTALLED

TABLE 2—LENGTH IDENTIFICATION SYSTEM (CARBON STEEL AND STAINLESS STEEL ANCHORS)

Length ID marking on bolt head		**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**
Length of anchor, ℓ_{anch} (inches)	From	1 ½	2	2 ½	3	3 ½	4	4 ½	5	5 ½	6	6 ½	7	7 ½	8	8 ½	9	9 ½	10	11	12	13	14	15
	Up to but not including	2	2 ½	3	3 ½	4	4 ½	5	5 ½	6	6 ½	7	7 ½	8	8 ½	9	9 ½	10	11	12	13	14	15	16

FIGURE 3—BOLT HEAD WITH LENGTH IDENTIFICATION CODE AND KB-TZ HEAD NOTCH EMBOSSMENT

TABLE 3—DESIGN INFORMATION, CARBON STEEL KB-TZ

DESIGN INFORMATION	Symbol	Units	Nominal anchor diameter											
			3/8		1/2				5/8			3/4		
Anchor O.D.	$d_a(d_o)$	in. (mm)	0.375 (9.5)		0.5 (12.7)				0.625 (15.9)			0.75 (19.1)		
Effective min. embedment[1]	h_{ef}	in. (mm)	2 (51)		2 (51)		3-1/4 (83)		3-1/8 (79)	4 (102)		3-3/4 (95)		4-3/4 (121)
Min. member thickness[2]	h_{min}	in. (mm)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	6 (152)	8 (203)	8 (203)
Critical edge distance	c_{ac}	in. (mm)	4-3/8 (111)	4 (102)	5-1/2 (140)	4-1/2 (114)	7-1/2 (191)	6 (152)	6-1/2 (165)	8-3/4 (222)	6-3/4 (171)	10 (254)	8 (203)	9 (229)
Min. edge distance	c_{min}	In. (mm)	2-1/2 (64)		2-3/4 (70)		2-3/8 (60)		3-5/8 (92)	3-1/4 (83)		4-3/4 (121)		4-1/8 (105)
	for $s \geq$	in. (mm)	5 (127)		5-3/4 (146)		5-3/4 (146)		6-1/8 (156)	5-7/8 (149)		10-1/2 (267)		8-7/8 (225)
Min. anchor spacing	s_{min}	in. (mm)	2-1/2 (64)		2-3/4 (70)		2-3/8 (60)		3-1/2 (89)	3 (76)		5 (127)		4 (102)
	for $c \geq$	In. (mm)	3-5/8 (92)		4-1/8 (105)		3-1/2 (89)		4-3/4 (121)	4-1/4 (108)		9-1/2 (241)		7-3/4 (197)
Min. hole depth in concrete	h_o	in. (mm)	2-5/8 (67)		2-5/8 (67)		4 (102)		3-3/4 (98)	4-3/4 (121)		4-1/2 (117)		5-3/4 (146)
Min. specified yield strength	f_y	lb/in^2 (N/mm^2)	100,000 (690)		84,800 (585)				84,800 (585)			84,800 (585)		
Min. specified ult. strength	f_{uta}	lb/in^2 (N/mm^2)	115,000 (793)		106,000 (731)				106,000 (731)			106,000 (731)		
Effective tensile stress area	$A_{se,N}$	In^2 (mm^2)	0.052 (33.6)		0.101 (65.0)				0.162 (104.6)			0.237 (152.8)		
Steel strength in tension	N_{sa}	lb (kN)	6,500 (28.9)		10,705 (47.6)				17,170 (76.4)			25,120 (111.8)		
Steel strength in shear	V_{sa}	lb (kN)	3,595 (16.0)		5,495 (24.4)				8,090 (36.0)			13,675 (60.8)		
Steel strength in shear, seismic[3]	$V_{sa,eq}$	lb (kN)	2,255 (10.0)		5,495 (24.4)				7,600 (33.8)			11,745 (52.2)		
Pullout strength uncracked concrete[4]	$N_{p,uncr}$	lb (kN)	2,515 (11.2)		NA		5,515 (24.5)		NA	9,145 (40.7)		8,280 (36.8)		10,680 (47.5)
Pullout strength cracked concrete[4]	$N_{p,cr}$	lb (kN)	2,270 (10.1)		NA		4,915 (21.9)		NA	NA		NA		NA
Anchor category[5]			1											
Effectiveness factor k_{uncr} uncracked concrete			24											
Effectiveness factor k_{cr} cracked concrete[6]			17											
$\Psi_{c,N} = k_{uncr}/k_{cr}$ [7]			1.0											
Coefficient for pryout strength, k_{cp}			1.0				2.0							
Strength reduction factor ϕ for tension, steel failure modes[8]			0.75											
Strength reduction factor ϕ for shear, steel failure modes[8]			0.65											
Strength reduction ϕ factor for tension, concrete failure modes or pullout, Condition B[9]			0.65											
Strength reduction ϕ factor for shear, concrete failure modes, Condition B[9]			0.70											
Axial stiffness in service load range[10]	β_{uncr}	lb/in.	700,000											
	β_{cr}	lb/in.	500,000											

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

[1]See Fig. 2.
[2] For sand-lightweight concrete over metal deck, see Figures 5A, 5B and 5C and Table 6.
[3] See Section 4.1.8 of this report.
[4] For all design cases $\Psi_{c,P}$ =1.0. NA (not applicable) denotes that this value does not control for design. See Section 4.1.4 of this report.
[5]See ACI 318-11 D.4.3.
[6]See ACI 318 D.5.2.2.
[7] 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.
[8]The KB-TZ is a ductile steel element as defined by ACI 318 D.1.
[9]For use with the load combinations of ACI 318 Section 9.2. Condition B applies where supplementary reinforcement in conformance with ACI 318-11 D.4.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.
[10] Mean values shown, actual stiffness may vary considerably depending on concrete strength, loading and geometry of application.

TABLE 4—DESIGN INFORMATION, STAINLESS STEEL KB-TZ

DESIGN INFORMATION	Symbol	Units	Nominal anchor diameter											
			3/8		1/2				5/8			3/4		
Anchor O.D.	$d_a(d_o)$	in. (mm)	0.375 (9.5)		0.5 (12.7)				0.625 (15.9)			0.75 (19.1)		
Effective min. embedment[1]	h_{ef}	in. (mm)	2 (51)		2 (51)		3-1/4 (83)		3-1/8 (79)	4 (102)		3-3/4 (95)		4-3/4 (121)
Min. member thickness	h_{min}	in. (mm)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	6 (152)	8 (203)	8 (203)
Critical edge distance	c_{ac}	in. (mm)	4-3/8 (111)	3-7/8 (98)	5-1/2 (140)	4-1/2 (114)	7-1/2 (191)	6 (152)	7 (178)	8-7/8 (225)	6 (152)	10 (254)	7 (178)	9 (229)
Min. edge distance	c_{min}	in. (mm)	2-1/2 (64)		2-7/8 (73)		2-1/8 (54)		3-1/4 (83)	2-3/8 (60)		4-1/4 (108)		4 (102)
	for $s \geq$	in. (mm)	5 (127)		5-3/4 (146)		5-1/4 (133)		5-1/2 (140)	5-1/2 (140)		10 (254)		8-1/2 (216)
Min. anchor spacing	s_{min}	in. (mm)	2-1/4 (57)		2-7/8 (73)		2 (51)		2-3/4 (70)	2-3/8 (60)		5 (127)		4 (102)
	for $c \geq$	in. (mm)	3-1/2 (89)		4-1/2 (114)		3-1/4 (83)		4-1/8 (105)	4-1/4 (108)		9-1/2 (241)		7 (178)
Min. hole depth in concrete	h_o	in. (mm)	2-5/8 (67)		2-5/8 (67)		4 (102)		3-3/4 (98)	4-3/4 (121)		4-1/2 (117)		5-3/4 (146)
Min. specified yield strength	f_y	lb/in^2 (N/mm^2)	92,000 (634)		92,000 (634)				92,000 (634)			76,125 (525)		
Min. specified ult. Strength	f_{uta}	lb/in^2 (N/mm^2)	115,000 (793)		115,000 (793)				115,000 (793)			101,500 (700)		
Effective tensile stress area	$A_{se,N}$	in^2 (mm^2)	0.052 (33.6)		0.101 (65.0)				0.162 (104.6)			0.237 (152.8)		
Steel strength in tension	N_{sa}	lb (kN)	5,968 (26.6)		11,554 (51.7)				17,880 (82.9)			24,055 (107.0)		
Steel strength in shear	V_{sa}	lb (kN)	4,720 (21.0)		6,880 (30.6)				9,870 (43.9)			15,711 (69.9)		
Pullout strength in tension, seismic[2]	$N_{p,eq}$	lb (kN)	NA		2,735 (12.2)		NA		NA			NA		
Steel strength in shear, seismic[2]	$V_{sa,eq}$	lb (kN)	2,825 (12.6)		6,880 (30.6)				9,350 (41.6)			12,890 (57.3)		
Pullout strength uncracked concrete[3]	$N_{p,uncr}$	lb (kN)	2,630 (11.7)		NA		5,760 (25.6)		NA			NA		12,040 (53.6)
Pullout strength cracked concrete[3]	$N_{p,cr}$	lb (kN)	2,340 (10.4)		3,180 (14.1)		NA		NA	5,840 (26.0)		8,110 (36.1)		NA
Anchor category[4]			1		2		1							
Effectiveness factor k_{uncr} uncracked concrete			24											
Effectiveness factor k_{cr} cracked concrete[5]			17		24		17		17	17		24		17
$\Psi_{C,N} = k_{uncr}/k_{cr}$[6]			1.0											
Strength reduction factor ϕ for tension, steel failure modes[7]			0.75											
Strength reduction factor ϕ for shear, steel failure modes[7]			0.65											
Strength reduction ϕ factor for tension, concrete failure modes, Condition B[8]			0.65		0.55		0.65							
Coefficient for pryout strength, k_{cp}			1.0				2.0							
Strength reduction ϕ factor for shear, concrete failure modes, Condition B[8]			0.70											
Axial stiffness in service load range[9]	β_{uncr}	lb/in.	120,000											
	β_{cr}	lb/in.	90,000											

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

[1]See Fig. 2.
[2]See Section 4.1.8 of this report. NA (not applicable) denotes that this value does not control for design.
[3]For all design cases $\Psi_{c,P}$=1.0. NA (not applicable) denotes that this value does not control for design. See Section 4.1.4 of this report.
[4]See ACI 318-11 D.4.3.
[5]See ACI 318 D.5.2.2.
[6]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.
[7]The KB-TZ is a ductile steel element as defined by ACI 318 D.1.
[8]For use with the load combinations of ACI 318 Section 9.2. Condition B applies where supplementary reinforcement in conformance with ACI 318-11 D.4.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.
[9]Mean values shown, actual stiffness may vary considerably depending on concrete strength, loading and geometry of application.

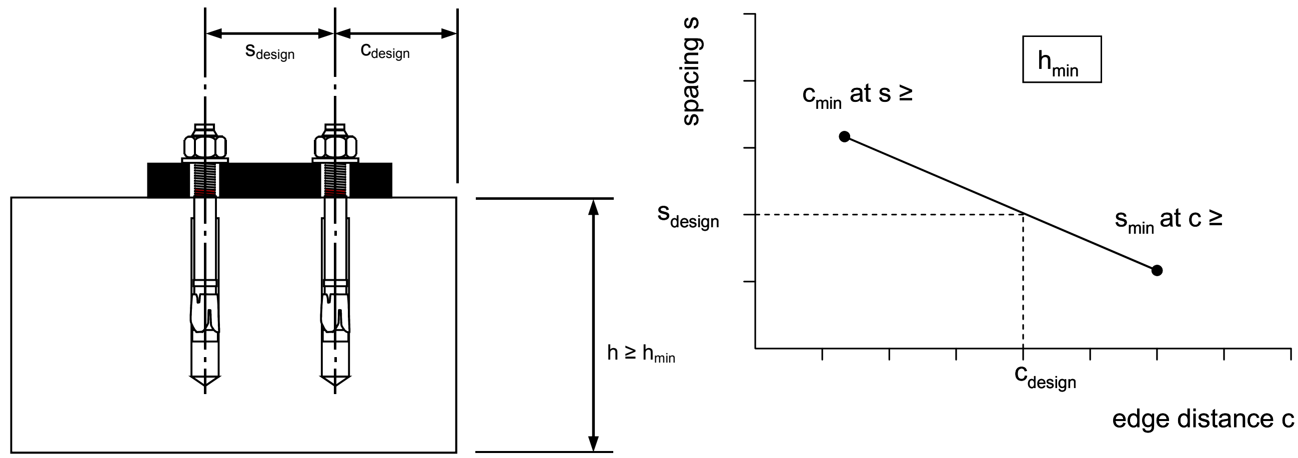


FIGURE 4—INTERPOLATION OF MINIMUM EDGE DISTANCE AND ANCHOR SPACING

TABLE 5—HILTI KWIK BOLT TZ (KB-TZ) CARBON STEEL ANCHORS TENSION AND SHEAR DESIGN DATA FOR INSTALLATION IN THE UNDERSIDE OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES[1,6,7,8]

DESIGN INFORMATION	Symbol	Units	Loads According to Figure 5A					Loads According to Figure 5B			
			Anchor Diameter					Anchor Diameter			
			3/8	1/2		5/8		3/8	1/2		5/8
Effective Embedment Depth	h_{ef}	in.	2	2	3-1/4	3-1/8	4	2	2	3-1/4	3-1/8
Minimum Hole Depth	h_o	in.	2-5/8	2-5/8	4	3-3/4	4-3/4	2-5/8	2-5/8	4	3-3/4
Pullout Resistance, (uncracked concrete)[2]	$N_{p,deck,uncr}$	lb.	2,060	2,060	3,695	2,825	6,555	1,845	1,865	3,375	4,065
Pullout Resistance (cracked concrete)[3]	$N_{p,deck,cr}$	lb.	1,460	1,460	2,620	2,000	4,645	1,660	1,325	3,005	2,885
Steel Strength in Shear[4]	$V_{sa,deck}$	lb.	2,130	3,000	4,945	4,600	6,040	2,845	2,585	3,945	4,705
Steel Strength in Shear, Seismic[5]	$V_{sa,deck,eq}$	lb.	1,340	3,000	4,945	4,320	5,675	1,790	2,585	3,945	4,420

[1] Installation must comply with Sections 4.1.10 and 4.3 and Figure 5A and 5B 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 of this report.
[5] The values listed must be used in accordance with 4.1.8.3 of this report. Values are applicable to both static and seismic load combinations.
[6] The values for ϕ_p in tension and the values for ϕ_{sa} in shear can be found in Table 3 of this report.
[7] 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.
[8] Evaluation of concrete breakout capacity in accordance with ACI 318 D.5.2, D.6.2, and D.6.3 is not required for anchors installed in the deck soffit.

TABLE 6—HILTI KWIK BOLT TZ (KB-TZ) CARBON STEEL ANCHORS SETTING INFORMATION FOR INSTALLATION ON THE TOP OF CONCRETE-FILLED PROFILE STEEL DECK ASSEMBLIES ACCORDING TO FIGURE 5C[1,2,3,4]

DESIGN INFORMATION	Symbol	Units	Nominal anchor diameter	
			3/8	1/2
Effective Embedment Depth	h_{ef}	in.	2	2
Minimum concrete thickness[5]	$h_{min,deck}$	in.	3-1/4	3-1/4
Critical edge distance	$c_{ac,deck,top}$	in.	9	9
Minimum edge distance	$c_{min,deck,top}$	in.	3	4-1/2
Minimum spacing	$s_{min,deck,top}$	in.	4	6-1/2

[1] Installation must comply with Sections 4.1.10 and 4.3 and Figure 5C of this report.
[2] For all other anchor diameters and embedment depths refer to Table 3 and 4 for applicable values of h_{min}, c_{min}, and s_{min}.
[3] Design capacity shall be based on calculations according to values in Table 3 and 4 of this report.
[4] Applicable for $3^1/_4$-in ≤ $h_{min,deck}$ < 4-in. For $h_{min,deck}$ ≥ 4-inch use setting information in Table 3 of this report.
[5] Minimum concrete thickness refers to concrete thickness above upper flute. See Figure 5C.

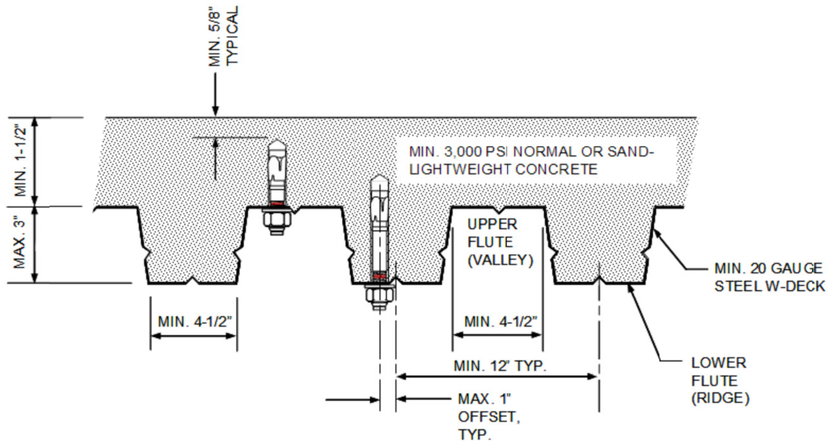


FIGURE 5A—INSTALLATION IN THE SOFFIT OF CONCRETE OVER METAL DECK FLOOR AND ROOF ASSEMBLIES[1]

[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.

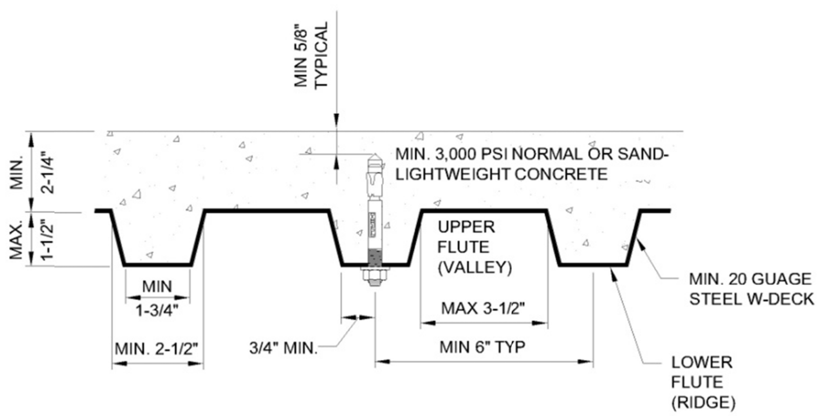


FIGURE 5B—INSTALLATION IN THE SOFFIT OF CONCRETE OVER METAL DECK FLOOR AND ROOF ASSEMBLIES – B DECK[1,2]

[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 $^1/_8$-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] Anchors may be placed in the upper flute of the steel deck profiles in accordance with Figure 5B provided the concrete thickness above the upper flute is minimum $3^1/_4$-inch and the minimum hole clearance of $^5/_8$-inch is satisfied.

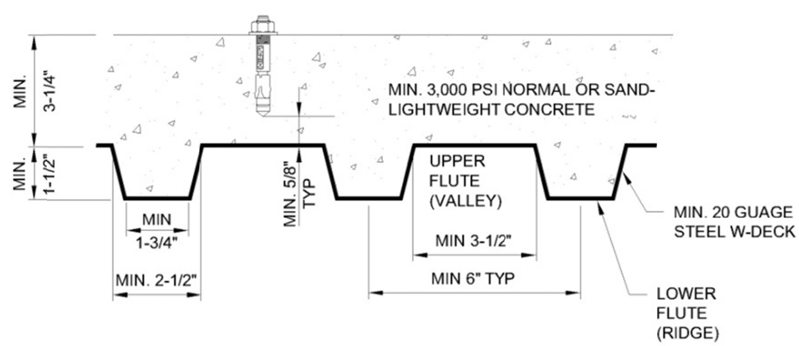


FIGURE 5C—INSTALLATION ON THE TOP OF CONCRETE OVER METAL DECK FLOOR AND ROOF ASSEMBLIES[1,2]

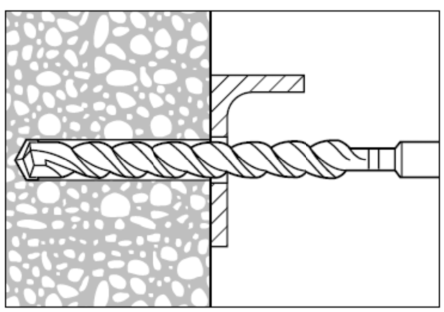
[1]Refer to Table 6 for setting information for anchors in to the top of concrete over metal deck.
[2]Applicable for 3-1/4-in ≤ h_{min} < 4-in. For h_{min} ≥ 4-inch use setting information in Table 3 of this report.

TABLE 7—EXAMPLE ALLOWABLE STRESS DESIGN VALUES FOR ILLUSTRATIVE PURPOSES

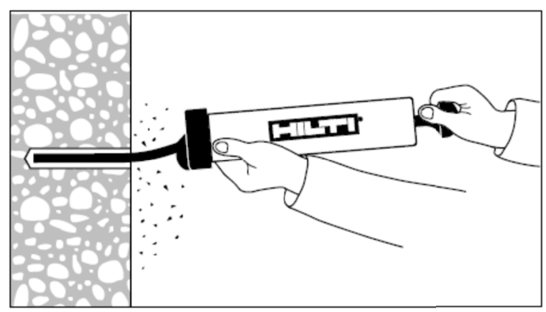
Nominal Anchor diameter (in.)	Embedment depth (in.)	Allowable tension (lbf)	
		Carbon Steel	Stainless Steel
		f'_c = 2500 psi	
		Carbon Steel	Stainless Steel
3/8	2	1105	1155
1/2	2	1490	1260
	3-1/4	2420	2530
5/8	3-1/8	2910	2910
	4	4015	4215
3/4	3-3/4	3635	3825
	4-3/4	4690	5290

For **SI:** 1 lbf = 4.45 N, 1 psi = 0.00689 MPa 1 psi = 0.00689 MPa. 1 inch = 25.4 mm.

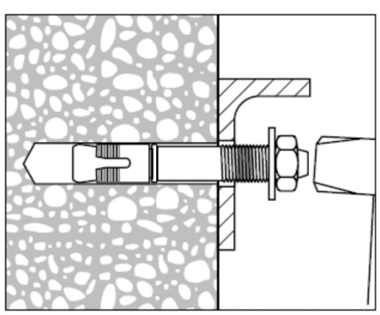
[1]Single anchors with static tension load only.
[2]Concrete determined to remain uncracked for the life of the anchorage.
[3]Load combinations from ACI 318 Section 9.2 (no seismic loading).
[4]30% dead load and 70% live load, controlling load combination 1.2D + 1.6 L.
[5]Calculation of the weighted average for $\alpha = 0.3*1.2 + 0.7*1.6 = 1.48$.
[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 318-11 D.4.3 is not provided



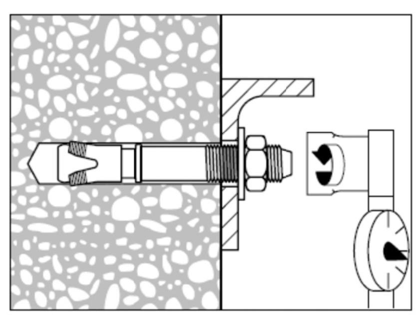
1. Hammer drill a hole to the same nominal diameter as the Kwik Bolt TZ. The hole depth must equal the anchor embedment listed in Table 1. The fixture may be used as a drilling template to ensure proper anchor location.



2. Clean hole.



3. Drive the Kwik Bolt TZ into the hole using a hammer. The anchor must be driven until the nominal embedment is achieved.

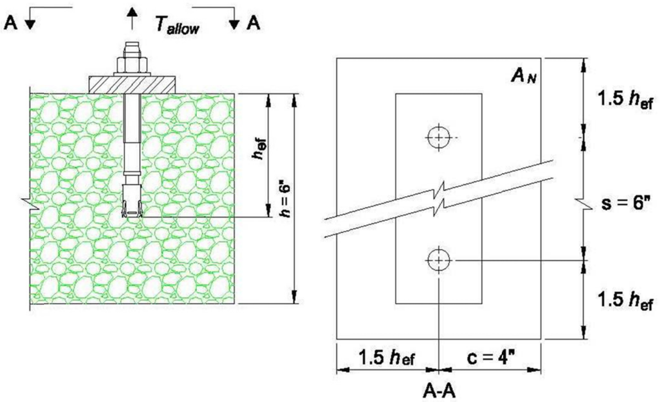


4. Tighten the nut to the required installation torque.

FIGURE 6—INSTALLATION INSTRUCTIONS

Given:
Two 1/2-inch carbon steel KB-TZ anchors under static tension load as shown.
h_{ef} = 3.25 in.
Normal weight concrete, f'_c = 3,000 psi
No supplementary reinforcement (Condition B per ACI 318-11 D.4.3 c)
Assume cracked concrete since no other information is available.

Needed: Using Allowable Stress Design (ASD) calculate the allowable tension load for this configuration.



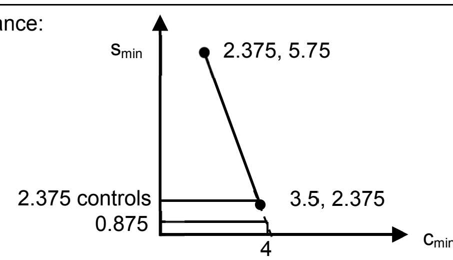
Calculation per ACI 318-11 Appendix D and this report.	Code Ref.	Report Ref.
Step 1. Calculate steel capacity: $\phi N_s = \phi n A_{se} f_{ut} = 0.75 \times 2 \times 0.101 \times 106{,}000 = 16{,}059 \text{lb}$ Check whether f_{uta} is not greater than $1.9f_{ya}$ and 125,000 psi.	D.5.1.2 D.4.3 a	§4.1.2 Table 3
Step 2. Calculate concrete breakout strength of anchor in tension: $N_{cbg} = \frac{A_{Nc}}{A_{Nco}} \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$	D.5.2.1	§ 4.1.3
Step 2a. Verify minimum member thickness, spacing and edge distance: h_{min} = 6 in. ≤ 6 in. ∴ ok slope = $\frac{2.375 - 5.75}{3.5 - 2.375}$ = -3.0 For c_{min} = 4in ⇒ $s_{min} = 5.75 - [(2.375 - 4.0)(-3.0)] = 0.875 < 2.375\text{in} < 6\text{in} \therefore \text{ok}$ 	D.8	Table 3 Fig. 4
Step 2b. For A_N check $1.5h_{ef} = 1.5(3.25) = 4.88 \text{ in} > c$ $\quad 3.0h_{ef} = 3(3.25) = 9.75 \text{ in} > s$	D.5.2.1	Table 3
Step 2c. Calculate A_{Nco} and A_{Nc} for the anchorage: $A_{Nco} = 9h_{ef}^2 = 9 \times (3.25)^2 = 95.1 in.^2$ $A_{Nc} = (1.5h_{ef} + c)(3h_{ef} + s) = [1.5 \times (3.25) + 4][3 \times (3.25) + 6] = 139.8 in.^2 < 2A_{Nco} \therefore ok$	D.5.2.1	Table 3
Step 2d. Determine $\psi_{ec,N}$: $e'_N = 0 \therefore \psi_{ec,N} = 1.0$	D.5.2.4	-
Step 2e. Calculate N_b:$N_b = k_{cr} \lambda_a \sqrt{f'_c} h_{ef}^{1.5} = 17 \times 1.0 \times \sqrt{3{,}000} \times 3.25^{1.5} = 5{,}456\ lb$	D.5.2.2	Table 3
Step 2f. Calculate modification factor for edge distance: $\psi_{ed,N} = 0.7 + 0.3\frac{4}{1.5(3.25)} = 0.95$	D.5.2.5	Table 3
Step 2g. Calculate modification factor for cracked concrete: $\psi_{c,N}$ =1.00 (cracked concrete)	D.5.2.6	Table 3
Step 2h. Calculate modification factor for splitting: $\psi_{cp,N}$ =1.00 (cracked concrete)	-	§ 4.1.10 Table 3
Step 2i. Calculate ϕN_{cbg} : $\phi N_{cbg} = 0.65 \times \frac{139.8}{95.1} \times 1.00 \times 0.95 \times 1.00 \times 5{,}456 = 4{,}952$ lb	D.5.2.1 D.4.3 c)	§ 4.1.3 Table 3
Step 3. Check pullout strength: Table 3, $\phi n N_{pn,f'c} = 0.65 \times 2 \times 5{,}515 \text{ lb} \times \sqrt{\frac{3{,}000}{2{,}500}} = 7{,}852 \text{ lb} > 4{,}952$ ∴ OK	D.5.3.2 D.4.3 c)	§ 4.1.4 Table 3
Step 4. Controlling strength: $\phi N_{cbg} = 4{,}952 \text{ lb} < \phi n N_{pn} < \phi N_s \therefore \phi N_{cbg}$ controls	D.4.1.2	Table 3
Step 5. To convert to ASD, assume U = 1.2D + 1.6L: $T_{allow} = \frac{4{,}952}{1.48}$ = 3,346 lb.	-	§ 4.2

FIGURE 7—EXAMPLE CALCULATION