The following excerpt are pages from the North American Product Technical Guide, Volume 2: Anchor Fastening, Edition 17.

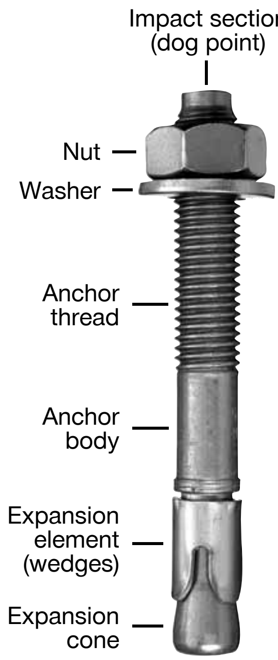
Please refer to the publication in its entirety for complete details on this product including data development, product specifications, general suitability, installation, corrosion and spacing and edge distance guidelines.
US: http://submittals.us.hilti.com/PTGVol2/
CA: http://submittals.us.hilti.com/PTGVol2CA/

To consult directly with a team member regarding our anchor fastening products, contact Hilti's team of technical support specialists between the hours of 7:00am – 6:00pm CST.
US: 877-749-6337 or HNATechnicalServices@hilti.com
CA: 1-800-363-4458, ext. 6 or CATechnicalServices@hilti.com

Hilti, Inc.
7250 Dallas Parkway, Suite 1000
Plano, TX 75024

1-800-879-8000
www.hilti.com

3.3.8 KWIK Bolt 3 Expansion Anchor



Listings/Approvals

ICC-ES (International Code Council)
ESR-2302

ICC-ES (International Code Council)
ESR-1385 Grout-filled concrete masonry

City of Los Angeles
Research Report No. 25577
Research Report No. 25577M masonry

FM (Factory Mutual)
Pipe Hanger Components for
Automatic Sprinkler for 3/8 through 3/4

UL LLC
UL 203 Pipe Hanger Equipment for Fire
Protection Services for 3/8 through 3/4

Qualified under an NQA-1 Nuclear
Quality Program

*Please refer to the reports to verify that the type and diameter specified is included

Independent code evaluation

IBC® / IRC® 2015
IBC® / IRC® 2012
IBC® / IRC® 2009
IBC® / IRC® 2006
IBC® / IRC® 2003

3.3.8.1 Product description

The KWIK Bolt 3 (KB3) is a torque controlled expansion anchor, which provides consistent performance for a wide range of mechanical anchor applications. This anchor series is available in carbon steel with zinc electroplated coating, carbon steel with hot-dip galvanized coating, 304 stainless steel and 316 stainless steel versions.The threaded stud version of the anchor is available in a variety of diameters ranging from 1/4- to 1-in. depending on the steel and coating type. Applicable base materials include normal-weight concrete, structural lightweight concrete, lightweight concrete over metal deck, and grout-filled concrete masonry.

Product features

- Length identification code facilitates quality control and inspection after installation.
- Through fixture installation and variable thread lengths improve productivity and accommodate various base plate thicknesses.
- Raised impact section (Dog Point) prevents thread damage during installation.
- Anchor size is same as drill bit size for easy installation. For temporary applications anchors may be driven into drilled holes after usage.
- Mechanical expansion allows immediate load application.
- Can be installed with innovative Hilti Torque Bar (seen below) in conjunction with Hilti impact tools. The first impact tool approved by ICC-ES to install an expansion anchor.

Guide specifications

Torque-controlled expansion anchor shall be KWIK Bolt 3. KWIK Bolt 3 anchors meet the description of Federal Specification A-A 1923A, Type 4. The anchor bears a length identification mark embossed on the impact section (dog point) of the anchor identifying the anchor as a Hilti KWIK Bolt 3.

Carbon steel KWIK Bolt 3 anchors have a carbon steel anchor body, carbon steel nut and carbon steel washer. Anchor body, nut and washer have zinc plating conforming to ASTM B633 with a minimum thickness of 5 µm.

AISI Type 304 stainless steel KWIK Bolt 3 anchors have an anchor body, nut and washer That conform to AISI Type 304. The expansion wedges conform to either AISI Type 304 stainless steel or either AISI Type 316 stainless steel.

AISI Type 316 stainless steel KWIK Bolt 3 anchors have an anchor body, nut and washer That conform to AISI Type 316. The expansion wedges conform to AISI Type 316 stainless steel.

Hot-dip galvanized KWIK Bolt 3 anchors have a carbon steel anchor body, carbon steel nut and carbon steel washer. Anchor body, nut and washer have zinc plating conforming to ASTM A153 with an average thickness of 53 µm. The expansion wedges conform to either AISI Type 304 stainless steel or either AISI Type 316 stainless steel.

S-TB torque bar

A18/A22 impact tool

3.3.8.2 Material specifications

Carbon steel with electroplated zinc

All carbon steel KWIK Bolt 3 and Rod Coupling Anchors, excluding the 3/4 x 12 and 1-inch diameter sizes, have the tensile bolt fracture loads shown in table 1.

All carbon steel 3/4 x 12 and 1 inch diameter sizes and carbon steel KWIK Bolt 3 Countersunk anchor bodies have mechanical properties as listed in table 1.

Carbon steel anchor components plated in accordance with ASTM B633 to a minimum thickness of 5 µm.

Nuts conform to the requirements of ASTM A563, Grade A, Hex.

Washers meet the requirements of ASTM F844.

Expansion wedges are manufactured from carbon steel, except the following anchors have stainless steel wedges:

- All 1/4-inch diameter anchors
- 3/4x12
- All 1-inch diameter anchors
- All KWIK Bolt 3 Countersunk

Carbon steel with hot-dip galvanized plating

Anchor bodies manufactured from carbon steel have the tensile bolt fracture loads shown in table 1.

Carbon steel anchor components have an average zinc plating thickness greater than 43 µm according to ASTM A153, Class C.

Nuts conform to the requirements of ASTM A563, Grade A, Hex.

Washers meet the requirements of ASTM F844.

Stainless steel expansion wedges are manufactured from either AISI Type 304 or Type 316.

Stainless steel

Anchor bodies smaller than 3/4-inch, excluding all KWIK Bolt 3 Countersunk, are produced from AISI Type 304 or Type 316 stainless steel having the bolt fracture loads shown in table 1.

Anchor bodies 3/4-inch and larger, and all stainless steel KWIK Bolt 3 Countersunk anchor bodies, are produced from AISI Type 304 or Type 316 stainless steel having the mechanical properties shown in table 1.

Nuts meet the dimensional requirements of ASTM F594.

Washers meet the dimensional requirements of ANSI B18.22.1, Type A, plain.

Stainless steel expansion wedges for AISI Type 304 are made from either AISI Type 304 or Type 316. Stainless steel expansion wedges for AISI Type 316 anchors are made from type 316. All stainless steel nuts and washers for AISI Type 304 or Type 316 anchors are manufactured from AISI Type 304 or 316, respectively.

Table 1 - Hilti KWIK Bolt 3 Bolt fracture load (lb)[1]

Nominal anchor diameter in.	Carbon steel	Hot-dip galvanized	Stainless steel
1/4	2,900	no offering	2,900
3/8	7,200	no offering	7,200
1/2	12,400	12,400	12,400
5/8	19,600	19,600	21,900
3/4	28,700	28,700	$f_{uta} \geq 76$, $f_{ya} \geq 64$[2]
1	$f_{uta} \geq 88$, $f_{ya} \geq 75$[2]	no offering	$f_{uta} \geq 76$, $f_{ya} \geq 64$[2]

1 Bolt fracture loads are determined by testing in a universal tensile machine for quality control at the manufacturing facility. These loads are not intended for design use. See tables 4 and 12 for the steel design strengths of carbon steel and stainless steel, respectively.

2 All 3/4-in. stainless steel, 3/4x12 carbon steel, all 1-in. carbon steel and all 1-in. stainless steel material strengths specified by the tensile and yield strengths expressed in (ksi). Bolt fracture loads not applicable for these models.

3.3.8 KWIK Bolt 3 Expansion Anchor

3.3.8.3 Technical data

3.3.8.3.1 ACI 318-14 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-2302 and the equations within ACI 318-14 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.7. Data tables from ESR-2302 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Allowable Stress Design or ASD technical information and data tables can be found at www.hilti.com.

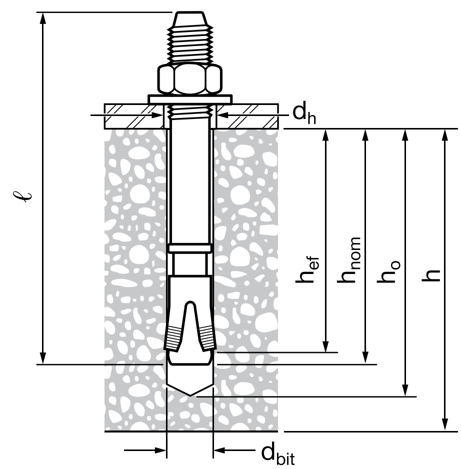


Figure 1 - KWIK Bolt 3 installation

Table 2 - Hilti KWIK Bolt 3 specifications

Setting information	Symbol	Units	Nominal anchor diameter									
			1/4	3/8	1/2		5/8		3/4		1	
Drill bit dia.	d_{bit}	in.	1/4	3/8	1/2		5/8		3/4		1	
Minimum nominal embedment	h_{nom}	in.	1-3/4	2-3/8	2-1/4	3-5/8	3-1/2	4-3/8	4-1/4	5-5/8	4-5/8	6-3/8
		(mm)	(44)	(60)	(57)	(92)	(89)	(111)	(108)	(143)	117	162
Minimum effective embedment	h_{ef}	in.	1-1/2	2	2	3-1/4	3-1/8	4	3-3/4	5	4	5-3/4
		(mm)	(38)	(51)	(51)	(83)	(79)	(102)	(95)	(127)	(102)	(146)
Minimum hole depth	h_o	in.	2	2-5/8	2-5/8	4	3-7/8	4-3/4	4-1/2	5-3/4	5	6-3/4
		(mm)	(51)	(67)	(67)	(102)	(98)	(121)	(114)	(146)	(127)	(171)
Fixture hole dia.	d_h	in.	5/16	7/16	9/16		11/16		13/16		1-1/8	
Anchor length	ℓ		See ordering information									
Installation torque concrete	T_{inst}	ft-lb	4	20	40		60		110		150	
		(Nm)	(5)	(27)	(54)		(81)		(149)		(203)	
Installation torque masonry	T_{inst}	ft-lb	4	15	25		65		120		not recommended	
		(Nm)	(5)	(20)	(34)		(88)		(163)			
Wrench size		in.	7/16	9/16	3/4		15/16		1-1/8		1-1/2	

1 For more information, see ESR-1385 and section 3.3.8.3.3. Approval value are for carbon steel anchors only.

Table 3 - Hilti KWIK Bolt 3 carbon steel design strength with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - ϕN_n				Shear - ϕV_n			
			f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
1/4	1-1/2 (38)	1-3/4 (44)	1,025 (4.6)	1,080 (4.8)	1,180 (5.2)	1,330 (5.9)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
3/8	2 (51)	2-3/8 (60)	2,205 (9.8)	2,415 (10.7)	2,790 (12.4)	3,420 (15.2)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
1/2	2 (51)	2-1/4 (57)	2,205 (9.8)	2,415 (10.7)	2,790 (12.4)	3,420 (15.2)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	3-1/4 (83)	3-1/2 (89)	4,420 (19.7)	4,840 (21.5)	5,590 (24.9)	6,845 (30.4)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	3-1/8 (79)	3-1/2 (89)	4,310 (19.2)	4,720 (21.0)	5,450 (24.2)	6,675 (29.7)	9,280 (41.3)	10,165 (45.2)	11,740 (52.2)	14,380 (64.0)
	4 (102)	4-3/8 (111)	6,240 (27.8)	6,835 (30.4)	7,895 (35.1)	9,665 (43.0)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-3/4 (95)	4-1/4 (108)	5,665 (25.2)	6,205 (27.6)	7,165 (31.9)	8,775 (39.0)	12,200 (54.3)	13,365 (59.5)	15,430 (68.6)	18,900 (84.1)
	5 (127)	5-5/8 (143)	6,880 (30.6)	7,535 (33.5)	8,705 (38.7)	10,660 (47.4)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)

1 See section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 10 as necessary. Compare to steel values in table 4. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

3.3.8

Table 4 - Steel design strength for Hilti KWIK Bolt 3 carbon steel anchors[1,2]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)
1/4	1-3/4 (44)	1,590 (7.1)	1,065 (4.7)
3/8	2-3/8 (60)	4,770 (21.2)	2,905 (12.9)
1/2	2-1/4 (57)	8,745 (38.9)	4,315 (19.2)
	3-1/2 (89)		4,390 (19.5)
5/8	3-1/2 (89)	13,515 (60.1)	7,950 (35.4)
	4-3/8 (111)		
3/4	4-1/4 (108)	19,080 (84.9)	10,180 (45.3)
	5-5/8 (143)		10,785 (48.0)

1 See section 3.1.8.6 to convert design strength value to ASD value.
2 KWIK Bolt 3 carbon steel anchors are to be considered ductile steel elements.
3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318-14 Chapter 17.
4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318-14 Chapter 17.

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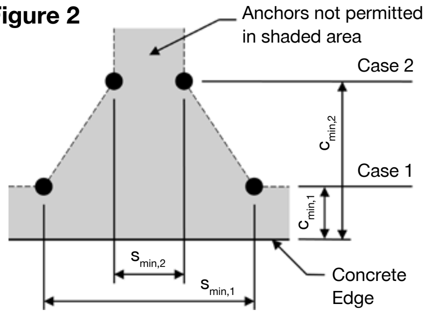
Figure 2



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}\,(c - c_{min,2})$$

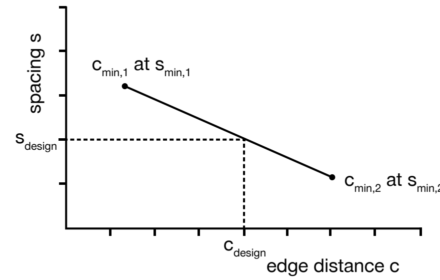


Table 5 - Carbon steel Hilti KWIK Bolt 3 installation parameters[1]

Setting information	Symbol	Units	Nominal anchor diameter d_o												
			1/4	3/8		1/2				5/8			3/4		
Effective minimum embedment	h_{ef}	in.	1-1/2	2		2		3-1/4		3-1/8	4		3-3/4		5
		(mm)	(38)	(51)		(51)		(83)		(79)	(102)		(95)		(127)
Minimum member thickness	h_{min}	in.	4	4	5	4	5	6	8	5	6	8	6	8	8
		(mm)	(102)	(102)	(127)	(102)	(127)	(152)	(203)	(127)	(152)	(203)	(152)	(203)	(203)
Case 1	$c_{min,1}$	in.	1-3/8	2	1-1/2	2-1/8	2	1-5/8	1-5/8	2-1/4	1-3/4	1-3/4	2-3/4	2-5/8	2-1/2
		(mm)	(35)	(51)	(38)	(54)	(51)	(41)	(41)	(57)	(44)	(44)	(70)	(67)	(64)
	for $s_{min,1}$ ≥	in.	1-3/4	2-7/8	3-1/2	4-7/8	4-3/4	4-1/4	4	5-1/4	4-3/4	4	6-7/8	6-1/2	6-3/8
		(mm)	(44)	(73)	(89)	(124)	(121)	(108)	(102)	(133)	(121)	(102)	(175)	(165)	(162)
Case 2	$c_{min,2}$	in.	1-5/8	2-3/8	2/3/8	2-5/8	2-3/8	2-1/4	2	3-1/8	2-3/8	2-1/4	3-3/4	3-3/8	3-3/8
		(mm)	(41)	(60)	(60)	(67)	(60)	(57)	(51)	(79)	(60)	(57)	(95)	(86)	(86)
	for $s_{min,2}$ ≥	in.	1-1/4	1-3/4	1-3/4	2-1/2	2-1/4	2	1-7/8	2-3/8	2-1/8	2-1/8	3-3/4	3-3/8	3-1/4
		(mm)	(32)	(44)	(44)	(64)	(57)	(51)	(48)	(60)	(54)	(54)	(95)	(86)	(83)

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2.
Linear interpolation for a specific edge .distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacings.

Table 6 - Load adjustment factors for 1/4-in. diameter Hilti KWIK Bolt 3 carbon steel anchor in uncracked concrete[1,2]

1/4-in. KB3 carbon steel uncracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear[3] f_{AV}	Edge distance in shear: ⊥ toward edge f_{RV}	Edge distance in shear: II To and away from edge f_{RV}	Concrete thickness factor in shear[4] f_{HV}
Embedment h_{nom}	in.	(mm)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/4	(32)	0.64	n/a	0.56	n/a	n/a	n/a
	1-3/8	(35)	0.65	0.58	0.57	0.26	0.51	n/a
	1-1/2	(38)	0.67	0.61	0.57	0.29	0.58	n/a
	2	(51)	0.72	0.75	0.60	0.45	0.75	n/a
	3	(76)	0.83	1.00	0.65	0.83	1.00	n/a
	3-1/2	(89)	0.89		0.67	1.00		n/a
	4	(102)	0.94		0.70			0.88
	4-1/2	(114)	1.00		0.72			0.94
	5	(127)			0.74			0.99
	5-1/2	(140)			0.77			1.00
	6	(152)			0.79			
	7	(178)			0.84			
	8	(203)			0.89			
	9	(229)			0.94			
	10	(254)			0.99			
	11	(279)			1.00			

1 Linear interpolation not permitted.
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Anchor Design software or perform anchor calculation using design equations from ACI 318-14 Chapter 17.
3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

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Table 7 - Load adjustment factors for 3/8-in. diameter Hilti KWIK Bolt 3 carbon steel anchor in uncracked concrete[1,2]

3/8-in. KB3 carbon steel uncracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear[3] f_{AV}	Edge distance in shear ⊥ Toward edge f_{RV}	Edge distance in shear II To and away from edge f_{RV}	Concrete thickness factor in shear[4] f_{HV}
Embedment h_{nom}		in. (mm)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-3/4	(44)	0.65	n/a	0.57	n/a	n/a	n/a
	2	(51)	0.67	0.50	0.58	0.35	0.50	n/a
	2-1/2	(64)	0.71	0.58	0.60	0.49	0.58	n/a
	3	(76)	0.75	0.67	0.62	0.64	0.67	n/a
	3-1/4	(83)	0.77	0.72	0.63	0.72	0.72	n/a
	3-1/2	(89)	0.79	0.78	0.64	0.81	0.81	n/a
	4	(102)	0.83	0.89	0.67	0.99	0.99	0.81
	4-1/2	(114)	0.88	1.00	0.69	1.00	1.00	0.86
	5	(127)	0.92		0.71			0.91
	6	(152)	1.00		0.75			1.00
	7	(178)			0.79			
	8	(203)			0.83			
	9	(229)			0.87			
	10	(254)			0.91			
	11	(279)			0.95			
	12	(305)			1.00			

Table 8 - Load adjustment factors for 1/2-in. diameter Hilti KWIK Bolt 3 carbon steel anchor in uncracked concrete[1,2]

3.3.8

1/2-in. KB3 carbon steel uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear ⊥ Toward edge f_{RV}		Edge distance in shear II To and away from edge f_{RV}		Concrete thickness factor in shear[4] f_{HV}	
Embedment h_{nom}		in. (mm)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-5/8	(41)	n/a	n/a	n/a	0.39	n/a	n/a	n/a	0.07	n/a	0.15	n/a	n/a
	2	(51)	n/a	0.60	n/a	0.42	n/a	0.54	n/a	0.10	n/a	0.20	n/a	n/a
	2-1/8	(54)	n/a	0.61	0.48	0.43	n/a	0.54	0.42	0.11	0.48	0.22	n/a	n/a
	2-1/2	(64)	0.71	0.63	0.54	0.47	0.61	0.55	0.53	0.14	0.54	0.28	n/a	n/a
	3	(76)	0.75	0.65	0.62	0.52	0.63	0.55	0.70	0.19	0.70	0.37	n/a	n/a
	3-1/2	(89)	0.79	0.68	0.72	0.57	0.65	0.56	0.88	0.23	0.88	0.47	n/a	n/a
	4	(102)	0.83	0.71	0.82	0.62	0.68	0.57	1.00	0.29	1.00	0.57	0.84	n/a
	4-1/2	(114)	0.88	0.73	0.92	0.68	0.70	0.58		0.34		0.68	0.89	n/a
	5	(127)	0.92	0.76	1.00	0.74	0.72	0.59		0.40		0.74	0.94	n/a
	6	(152)	1.00	0.81		0.89	0.76	0.61		0.53		0.89	1.00	0.66
	7	(178)		0.86		1.00	0.81	0.63		0.66		1.00		0.71
	8	(203)		0.91			0.85	0.64		0.81				0.76
	9	(229)		0.96			0.89	0.66		0.97				0.81
	10	(254)		1.00			0.94	0.68		1.00				0.85
	11	(279)					0.98	0.70						0.89
	12	(305)					1.00	0.72						0.93
	14	(356)						0.75						1.00
	16	(406)						0.79						
	18	(457)						0.83						
	20	(508)						0.86						
	> 24	(610)						0.93						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Anchor Design software or perform anchor calculation using design equations from ACI 318-14 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

(Shaded cell) If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

3.3.8 KWIK Bolt 3 Expansion Anchor

Table 9 - Load adjustment factors for 5/8-in. diameter Hilti KWIK Bolt 3 carbon steel anchor in uncracked concrete[1,2]

5/8-in. KB3 carbon steel uncracked concrete		Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear: ⊥ toward edge f_{RV}		Edge distance in shear: II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in. (mm)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)													
1-3/4	(44)	n/a	n/a	n/a	0.32	n/a	n/a	n/a	0.07	n/a	0.14	n/a	n/a
2	(51)	n/a	n/a	n/a	0.34	n/a	n/a	n/a	0.08	n/a	0.17	n/a	n/a
2-1/8	(54)	n/a	0.59	n/a	0.34	n/a	0.53	n/a	0.09	n/a	0.18	n/a	n/a
2-1/4	(57)	n/a	0.59	0.39	0.35	n/a	0.54	0.14	0.10	0.27	0.20	n/a	n/a
2-3/8	(60)	0.63	0.60	0.40	0.36	0.55	0.54	0.15	0.11	0.30	0.21	n/a	n/a
2-1/2	(64)	0.63	0.60	0.41	0.37	0.55	0.54	0.16	0.12	0.32	0.23	n/a	n/a
3	(76)	0.66	0.63	0.46	0.40	0.56	0.55	0.21	0.15	0.42	0.30	n/a	n/a
4	(102)	0.71	0.67	0.55	0.47	0.58	0.56	0.32	0.23	0.55	0.47	n/a	n/a
5	(127)	0.77	0.71	0.67	0.55	0.60	0.58	0.45	0.33	0.67	0.55	0.63	n/a
6	(152)	0.82	0.75	0.80	0.63	0.62	0.59	0.59	0.43	0.80	0.63	0.69	0.62
7	(178)	0.87	0.79	0.93	0.74	0.64	0.61	0.75	0.54	0.93	0.74	0.74	0.67
8	(203)	0.93	0.83	1.00	0.84	0.66	0.63	0.91	0.66	1.00	0.84	0.79	0.71
9	(229)	0.98	0.88		0.95	0.68	0.64	1.00	0.79		0.95	0.84	0.75
10	(254)	1.00	0.92		1.00	0.70	0.66		0.92		1.00	0.89	0.80
11	(279)		0.96			0.72	0.67		1.00			0.93	0.83
12	(305)		1.00			0.74	0.69					0.97	0.87
14	(356)					0.77	0.72					1.00	0.94
16	(406)					0.81	0.75						1.00
18	(457)					0.85	0.78						
20	(508)					0.89	0.82						
24	(610)					0.97	0.88						
> 30	(762)					1.00	0.97						

Table 10 - Load adjustment factors for 3/4-in. diameter Hilti KWIK Bolt 3 carbon steel anchor in uncracked concrete[1,2]

3/4-in. KB3 carbon steel uncracked concrete		Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear: ⊥ toward edge f_{RV}		Edge distance in shear: II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in. (mm)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)													
2-1/2	(64)	n/a	n/a	n/a	0.42	n/a	n/a	n/a	0.09	n/a	0.18	n/a	n/a
2-3/4	(70)	n/a	n/a	0.36	0.44	n/a	n/a	0.15	0.11	0.31	0.21	n/a	n/a
3	(76)	n/a	n/a	0.38	0.45	n/a	n/a	0.17	0.12	0.35	0.24	n/a	n/a
3-1/4	(83)	n/a	0.61	0.40	0.47	n/a	0.54	0.20	0.14	0.39	0.27	n/a	n/a
3-1/2	(89)	n/a	0.62	0.41	0.49	n/a	0.55	0.22	0.15	0.41	0.30	n/a	n/a
3-3/4	(95)	0.67	0.63	0.43	0.50	0.57	0.55	0.24	0.17	0.43	0.34	n/a	n/a
4	(102)	0.68	0.63	0.45	0.52	0.57	0.55	0.27	0.18	0.45	0.37	n/a	n/a
4-1/2	(114)	0.70	0.65	0.49	0.56	0.58	0.56	0.32	0.22	0.49	0.44	n/a	n/a
5	(127)	0.72	0.67	0.53	0.59	0.59	0.57	0.38	0.26	0.53	0.52	n/a	n/a
6	(152)	0.77	0.70	0.62	0.67	0.60	0.58	0.49	0.34	0.62	0.67	0.65	n/a
7	(178)	0.81	0.73	0.72	0.75	0.62	0.59	0.62	0.43	0.72	0.75	0.70	n/a
8	(203)	0.86	0.77	0.82	0.84	0.64	0.61	0.76	0.52	0.82	0.84	0.75	0.66
9	(229)	0.90	0.80	0.92	0.95	0.66	0.62	0.91	0.62	0.92	0.95	0.79	0.70
10	(254)	0.94	0.83	1.00	1.00	0.67	0.64	1.00	0.73	1.00	1.00	0.83	0.74
11	(279)	0.99	0.87			0.69	0.65		0.84			0.87	0.77
12	(305)	1.00	0.90			0.71	0.66		0.96			0.91	0.81
14	(356)		0.97			0.74	0.69		1.00			0.99	0.87
16	(406)		1.00			0.78	0.72					1.00	0.93
18	(457)					0.81	0.74						0.99
20	(508)					0.85	0.77						1.00
24	(610)					0.92	0.82						
30	(762)					1.00	0.91						
> 36	(914)						0.99						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Anchor Design software or perform anchor calculation using design equations from ACI 318-14 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

(Shaded cell) If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

Table 11 - Hilti KWIK Bolt 3 stainless steel design strength with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - ϕN_n				Shear - ϕV_n			
			f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
1/4	1-1/2 (38)	1-3/4 (44)	730 (3.2)	770 (3.4)	840 (3.7)	950 (4.2)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
3/8	2 (51)	2-3/8 (60)	1,925 (8.6)	2,110 (9.4)	2,440 (10.9)	2,985 (13.3)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
1/2	2 (51)	2-1/4 (57)	2,150 (9.6)	2,355 (10.5)	2,720 (12.1)	3,335 (14.8)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	3-1/4 (83)	3-1/2 (89)	3,920 (17.4)	4,295 (19.1)	4,960 (22.1)	6,070 (27.0)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	3-1/8 (79)	3-1/2 (89)	4,050 (18.0)	4,435 (19.7)	5,120 (22.8)	6,275 (27.9)	9,280 (41.3)	10,165 (45.2)	11,740 (52.2)	14,380 (64.0)
	4 (102)	4-3/8 (111)	5,090 (22.6)	5,575 (24.8)	6,440 (28.6)	7,885 (35.1)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-3/4 (95)	4-1/4 (108)	5,560 (24.7)	6,090 (27.1)	7,035 (31.3)	8,615 (38.3)	12,200 (54.3)	13,365 (59.5)	15,430 (68.6)	18,900 (84.1)
	5 (127)	5-1/2 (140)	7,040 (31.3)	7,710 (34.3)	8,905 (39.6)	10,905 (48.5)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)
1	4 (102)	4-1/2 (114)	6,240 (27.8)	6,835 (30.4)	7,895 (35.1)	9,665 (43.0)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
	5-3/4 (146)	6-1/4 (159)	10,110 (45.0)	11,070 (49.2)	12,785 (56.9)	15,660 (69.7)	23,165 (103.0)	25,375 (112.9)	29,300 (130.3)	35,885 (159.6)

1 See section 3.1.8.6 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 14 to 19 as necessary. Compare to steel values in table 12. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

3.3.8 KWIK Bolt 3 Expansion Anchor

Table 12 - Steel design strength for Hilti KWIK Bolt 3 stainless steel anchors[1,2]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Tensile[3] ϕN_{sa} lb (kN)	Shear[4] ϕV_{sa} lb (kN)
1/4	1-3/4 (44)	1,725 (7.7)	1,090 (4.8)
3/8	2-3/8 (60)	5,175 (23.0)	3,235 (14.4)
1/2	2-1/4 (57)	9,490 (42.2)	2,725 (12.1)
	3-1/2 (89)		4,510 (20.1)
5/8	3-1/2 (89)	14,665 (65.2)	5,820 (25.9)
	4-3/8 (111)		9,295 (41.3)
3/4	4-1/4 (108)	16,200 (72.1)	7,735 (34.4)
	5-1/2 (140)		15,305 (68.1)
1	4-1/2 (114)	31,735 (141.2)	8,130 (36.2)
	6-1/4 (159)		17,775 (79.1)

1 See section 3.1.8.6 to convert design strength value to ASD value.

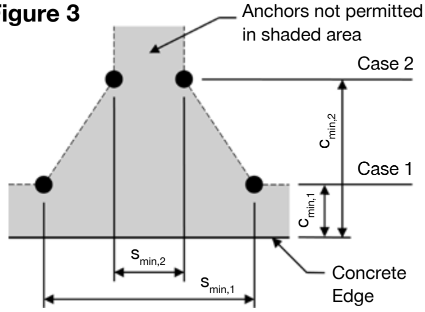
2 KWIK Bolt 3 stainless steel anchors are to be considered ductile steel elements.

3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318-14 Chapter 17.

4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60 A_{se,V} f_{uta}$ as noted in ACI 318-14 Chapter 17.

KWIK Bolt 3 Expansion Anchor 3.3.8

Figure 3



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})}(c - c_{min,2})$$

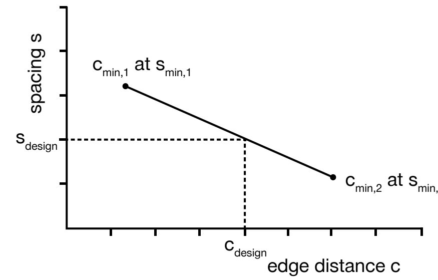


Table 13 - Stainless steel Hilti KWIK Bolt 3 installation parameters[1]

Setting information	Symbol	Units	Nominal anchor diameter d_o														
			1/4	3/8		1/2				5/8			3/4			1	
Effective minimum embedment	h_{ef}	in.	1-1/2	2		2		3-1/4		3-1/8	4		3-3/4		5	4	5-3/4
		(mm)	(38)	(51)		(51)		(83)		(79)	(102)		(95)		(127)	(102)	(146)
Minimum member thickness	h_{min}	in.	4	4	5	4	6	6	8	5	6	8	6	8	8	8	10
		(mm)	(102)	(102)	(127)	(102)	(152)	(152)	(203)	(127)	(152)	(203)	(152)	(203)	(203)	(203)	(254)
Case 1	$c_{min,1}$	in.	1-3/8	2	1-5/8	2-1/2	1-7/8	1-5/8	1-5/8	3-1/4	2-1/2	2-1/2	3-1/4	3	2-7/8	3-1/2	3
		(mm)	(35)	(51)	(41)	(68)	(48)	(41)	(41)	(83)	(64)	(64)	(83)	(76)	(73)	(89)	(76)
	for $s_{min,1}$ ≥	in.	1-3/4	4	3-5/8	5	4-5/8	4-1/2	4-1/4	5-5/8	5-1/4	5	7	6-7/8	6-5/8	6-3/4	6-3/4
		(mm)	(44)	(102)	(92)	(127)	(117)	(114)	(108)	(143)	(133)	(127)	(178)	(175)	(168)	(172)	(172)
Case 2	$c_{min,2}$	in.	1-5/8	3-1/4	2-1/2	2-7/8	2-3/8	2-3/8	2-1/8	3-7/8	3	2-3/4	4-1/8	3-3/4	3-3/4	4-1/4	3-3/4
		(mm)	(41)	(83)	(64)	(73)	(60)	(60)	(54)	(98)	(76)	(70)	(105)	(95)	(95)	(108)	(95)
	for $s_{min,2}$ ≥	in.	1-1/4	2	1-3/4	2-1/2	2-1/4	2-1/8	1-7/8	3-1/8	2-1/8	2-1/8	4	3-1/2	3-1/2	5	4-3/4
		(mm)	(32)	(51)	(44)	(64)	(57)	(54)	(48)	(79)	(54)	(54)	(102)	(89)	(89)	(127)	(121)

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge .distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacings.

Table 14 - Load adjustment factors for 1/4-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

1/4-in. KB3 stainless steel uncracked uoncrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear[3] f_{AV}	Edge distance in shear: ⊥ toward edge f_{RV}	Edge distance in shear: II to and away from edge f_{RV}	Concrete thickness factor in shear[4] f_{HV}
Embedment h_{nom}		in. (mm)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)	1-3/4 (44)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-1/4	(32)	0.64	n/a	0.56	n/a	n/a	n/a
	1-3/8	(35)	0.65	0.53	0.57	0.26	0.51	n/a
	1-1/2	(38)	0.67	0.56	0.57	0.29	0.56	n/a
	2	(51)	0.72	0.68	0.60	0.45	0.68	n/a
	3	(76)	0.83	1.00	0.65	0.83	1.00	n/a
	3-1/2	(89)	0.89		0.67	1.00		n/a
	4	(102)	0.94		0.70			0.88
	4-1/2	(114)	1.00		0.72			0.94
	5	(127)			0.74			0.99
	5-1/2	(140)			0.77			1.00
	6	(152)			0.79			
	7	(178)			0.84			
	8	(203)			0.89			
	9	(229)			0.94			
	10	(254)			0.99			
	11	(279)			1.00			

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Anchor Design software or perform anchor calculation using design equations from ACI 318-14 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

(shaded cell) If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

3.3.8 KWIK Bolt 3 Expansion Anchor

Table 15 - Load adjustment factors for 3/8-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

3/8-in. KB3 stainless steel uncracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear[3] f_{AV}	Edge distance in shear: ⊥ toward edge f_{RV}	Edge distance in shear: II to and away from edge f_{RV}	Concrete thickness factor in shear[4] f_{HV}
Embedment h_{nom}	in. (mm)		2-3/8 (60)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	2	(51)	0.67	0.51	0.58	0.35	0.51	n/a
	2-1/2	(64)	0.71	0.60	0.60	0.49	0.60	n/a
	3	(76)	0.75	0.69	0.62	0.64	0.69	n/a
	3-1/2	(89)	0.79	0.80	0.64	0.81	0.81	n/a
	4	(102)	0.83	0.91	0.67	0.99	0.99	0.81
	4-1/2	(114)	0.88	1.00	0.69	1.00	1.00	0.86
	5	(127)	0.92		0.71			0.91
	6	(152)	1.00		0.75			1.00
	7	(178)			0.79			
	8	(203)			0.83			
	9	(229)			0.87			
	10	(254)			0.91			
	11	(279)			0.95			
	12	(305)			1.00			
	14	(356)						

Table 16 - Load adjustment factors for 1/2-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

1/2-in. KB3 stainless steel uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear: ⊥ toward edge f_{RV}		Edge distance in shear: II to and away from edge f_{RV}		Concrete thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in. (mm)		2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	1-5/8	(41)	n/a	n/a	n/a	0.39	n/a	n/a	n/a	0.07	n/a	0.15	n/a	n/a
	2	(51)	n/a	n/a	n/a	0.42	n/a	n/a	n/a	0.10	n/a	0.20	n/a	n/a
	2-1/8	(54)	n/a	0.61	n/a	0.43	n/a	0.54	n/a	0.11	n/a	0.22	n/a	n/a
	2-1/2	(64)	0.71	0.63	0.54	0.47	0.61	0.55	0.53	0.14	0.54	0.28	n/a	n/a
	3	(76)	0.75	0.65	0.62	0.52	0.63	0.55	0.70	0.19	0.70	0.37	n/a	n/a
	3-1/2	(89)	0.79	0.68	0.72	0.57	0.65	0.56	0.88	0.23	0.88	0.47	n/a	n/a
	4	(102)	0.83	0.71	0.82	0.62	0.68	0.57	1.00	0.29	1.00	0.57	0.84	n/a
	4-1/2	(114)	0.88	0.73	0.92	0.68	0.70	0.58		0.34		0.68	0.89	n/a
	5	(127)	0.92	0.76	1.00	0.74	0.72	0.59		0.40		0.74	0.94	n/a
	6	(152)	1.00	0.81		0.89	0.76	0.61		0.53		0.89	1.00	0.66
	7	(178)		0.86		1.00	0.81	0.63		0.66		1.00		0.71
	8	(203)		0.91			0.85	0.64		0.81				0.76
	9	(229)		0.96			0.89	0.66		0.97				0.81
	10	(254)		1.00			0.94	0.68		1.00				0.85
	11	(279)					0.98	0.70						0.89
	12	(305)					1.00	0.72						0.93
	14	(356)						0.75						1.00
	16	(406)						0.79						
	18	(457)						0.83						
	20	(508)						0.86						
	> 24	(610)						0.93						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Anchor Design software or perform anchor calculation using design equations from ACI 318-14 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

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Table 17 - Load adjustment factors for 5/8-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

5/8-in. KB3 stainless steel uncracked concrete		Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear ⊥ toward edge f_{RV}		Edge distance in shear II to and away from edge f_{RV}		Concrete thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in. (mm)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm) 2-1/8	(54)	n/a	0.59	n/a	n/a	n/a	0.53	n/a	n/a	n/a	n/a	n/a	n/a
2-1/2	(64)	n/a	0.60	n/a	0.37	n/a	0.54	n/a	0.12	n/a	0.23	n/a	n/a
3	(76)	n/a	0.63	n/a	0.40	n/a	0.55	n/a	0.15	n/a	0.30	n/a	n/a
3-1/8	(79)	0.67	0.63	n/a	0.41	0.56	0.55	n/a	0.16	n/a	0.32	n/a	n/a
3-1/4	(83)	0.67	0.64	0.49	0.42	0.56	0.55	0.24	0.17	0.47	0.34	n/a	n/a
3-1/2	(89)	0.69	0.65	0.51	0.44	0.57	0.56	0.26	0.19	0.51	0.38	n/a	n/a
4	(102)	0.71	0.67	0.56	0.47	0.58	0.56	0.32	0.23	0.56	0.47	n/a	n/a
5	(127)	0.77	0.71	0.68	0.55	0.60	0.58	0.45	0.33	0.68	0.55	0.63	n/a
6	(152)	0.82	0.75	0.81	0.63	0.62	0.59	0.59	0.43	0.81	0.63	0.69	0.62
7	(178)	0.87	0.79	0.95	0.74	0.64	0.61	0.75	0.54	0.95	0.74	0.74	0.67
8	(203)	0.93	0.83	1.00	0.84	0.66	0.63	0.91	0.66	1.00	0.84	0.79	0.71
9	(229)	0.98	0.88		0.95	0.68	0.64	1.00	0.79		0.95	0.84	0.75
10	(254)	1.00	0.92		1.00	0.70	0.66		0.92		1.00	0.89	0.80
11	(279)		0.96			0.72	0.67		1.00			0.93	0.83
12	(305)		1.00			0.74	0.69					0.97	0.87
14	(356)					0.77	0.72					1.00	0.94
16	(406)					0.81	0.75						1.00
18	(457)					0.85	0.78						
20	(508)					0.89	0.82						
24	(610)					0.97	0.88						
> 30	(762)					1.00	0.97						

3.3.8

Table 18 - Load adjustment factors for 3/4-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

3/4-in. KB3 stainless steel uncracked concrete		Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear ⊥ toward edge f_{RV}		Edge distance in shear II to and away from edge f_{RV}		Concrete thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in. (mm)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm) 2-7/8	(73)	n/a	n/a	n/a	0.43	n/a	n/a	n/a	0.11	n/a	0.23	n/a	n/a
3	(76)	n/a	n/a	n/a	0.44	n/a	n/a	n/a	0.12	n/a	0.24	n/a	n/a
3-1/4	(83)	n/a	n/a	0.37	0.46	n/a	n/a	0.20	0.14	0.37	0.27	n/a	n/a
3-1/2	(89)	n/a	0.62	0.39	0.47	n/a	0.55	0.22	0.15	0.39	0.30	n/a	n/a
4	(102)	0.68	0.63	0.42	0.51	0.57	0.55	0.27	0.18	0.42	0.37	n/a	n/a
4-1/2	(114)	0.70	0.65	0.45	0.54	0.58	0.56	0.32	0.22	0.45	0.44	n/a	n/a
5	(127)	0.72	0.67	0.49	0.58	0.59	0.57	0.38	0.26	0.49	0.52	n/a	n/a
6	(152)	0.77	0.70	0.57	0.65	0.60	0.58	0.49	0.34	0.57	0.65	0.65	n/a
7	(178)	0.81	0.73	0.67	0.73	0.62	0.59	0.62	0.43	0.67	0.73	0.70	n/a
8	(203)	0.86	0.77	0.76	0.82	0.64	0.61	0.76	0.52	0.76	0.82	0.75	0.66
9	(229)	0.90	0.80	0.86	0.92	0.66	0.62	0.91	0.62	0.91	0.92	0.79	0.70
10	(254)	0.94	0.83	0.95	1.00	0.67	0.64	1.00	0.73	1.00	1.00	0.83	0.74
11	(279)	0.99	0.87	1.00		0.69	0.65		0.84			0.87	0.77
12	(305)	1.00	0.90			0.71	0.66		0.96			0.91	0.81
14	(356)		0.97			0.74	0.69		1.00			0.99	0.87
16	(406)		1.00			0.78	0.72					1.00	0.93
18	(457)					0.81	0.74						0.99
20	(508)					0.85	0.77						1.00
24	(610)					0.92	0.82						
30	(762)					1.00	0.91						
> 36	(914)						0.99						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Anchor Design software or perform anchor calculation using design equations from ACI 318-14 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

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Table 19 - Load adjustment factors for 1-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]

1-in. KB3 stainless steel uncracked concrete		Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear ⊥ toward edge f_{RV}		Edge distance in shear II to and away from edge f_{RV}		Concrete thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in. (mm)	4-1/2 (114)	6-1/4 (159)	4-1/2 (114)	6-1/4 (159)	4-1/2 (114)	6-1/4 (159)	4-1/2 (114)	6-1/4 (159)	4-1/2 (114)	6-1/4 (159)	4-1/2 (114)	6-1/4 (159)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	3 (76)	n/a	n/a	n/a	0.43	n/a	n/a	n/a	0.10	n/a	0.20	n/a	n/a
	3-1/2 (89)	n/a	n/a	0.42	0.45	n/a	n/a	0.21	0.12	0.42	0.25	n/a	n/a
	4 (102)	n/a	n/a	0.45	0.48	n/a	n/a	0.26	0.15	0.45	0.30	n/a	n/a
	4-1/2 (114)	n/a	n/a	0.49	0.51	n/a	n/a	0.31	0.18	0.49	0.36	n/a	n/a
	4-3/4 (121)	n/a	0.64	0.50	0.53	n/a	0.56	0.34	0.20	0.50	0.39	n/a	n/a
	5 (127)	0.71	0.64	0.52	0.54	0.59	0.56	0.37	0.21	0.52	0.43	n/a	n/a
	6 (152)	0.75	0.67	0.60	0.60	0.60	0.57	0.48	0.28	0.60	0.56	n/a	n/a
	7 (178)	0.79	0.70	0.70	0.67	0.62	0.58	0.61	0.35	0.70	0.67	n/a	n/a
	8 (203)	0.83	0.73	0.80	0.74	0.64	0.60	0.74	0.43	0.80	0.74	0.74	n/a
	9 (229)	0.88	0.76	0.90	0.82	0.65	0.61	0.89	0.51	0.90	0.82	0.78	n/a
	10 (254)	0.92	0.79	1.00	0.91	0.67	0.62	1.00	0.60	1.00	0.91	0.83	0.69
	11 (279)	0.96	0.82		1.00	0.69	0.63		0.69		1.00	0.87	0.72
	12 (305)	1.00	0.85			0.70	0.64		0.79			0.91	0.76
	14 (356)		0.91			0.74	0.67		1.00			0.98	0.82
	16 (406)		0.96			0.77	0.69					1.00	0.87
	18 (457)		1.00			0.81	0.71						0.92
	20 (508)					0.84	0.74						0.98
	24 (610)					0.91	0.79						1.00
	30 (762)					1.00	0.86						
	> 36 (914)						0.93						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Anchor Design software or perform anchor calculation using design equations from ACI 318-14 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

[shaded cell] If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

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Table 20 - Hilti KWIK Bolt 3 hot-dip galvanized design strength with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - ϕN_n				Shear - ϕV_n			
			f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
1/2	2 (51)	2-1/4 (57)	2,205 (9.8)	2,415 (10.7)	2,790 (12.4)	3,420 (15.2)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	3-1/4 (83)	3-1/2 (89)	4,250 (18.9)	4,655 (20.7)	5,375 (23.9)	6,585 (29.3)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	3-1/8 (79)	3-1/2 (89)	4,200 (18.7)	4,605 (20.5)	5,315 (23.6)	6,510 (29.0)	9,280 (41.3)	10,165 (45.2)	11,740 (52.2)	14,380 (64.0)
	4 (102)	4-3/8 (111)	5,860 (26.1)	6,420 (28.6)	7,415 (33.0)	9,080 (40.4)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-3/4 (95)	4-1/4 (108)	5,665 (25.2)	6,205 (27.6)	7,165 (31.9)	8,775 (39.0)	12,200 (54.3)	13,365 (59.5)	15,430 (68.6)	18,900 (84.1)
	5 (127)	5-1/2 (140)	6,615 (29.4)	7,245 (32.2)	8,365 (37.2)	10,245 (45.6)	18,785 (83.6)	20,575 (91.5)	23,760 (105.7)	29,100 (129.4)

1 See section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 23 to 25 as necessary. Compare to steel values in table 21. The lesser of the values is to be used for the design.
4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ = 0.68; for all-lightweight, λ = 0.60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 21 - Steel design strength for Hilti KWIK Bolt 3 hot-dip galvanized anchors[1,2]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Tensile ϕN_{sa}[3] lb (kN)	Shear ϕV_{sa}[4] lb (kN)
1/2	2-1/4 (57)	8,745 (38.9)	2,925 (13.0)
	3-1/2 (89)		3,815 (17.0)
5/8	3-1/2 (89)	13,515 (60.1)	7,565 (33.7)
	4-3/8 (111)		
3/4	4-1/4 (108)	19,080 (84.9)	11,050 (49.2)
	5-1/2 (140)		

1 See section 3.1.8.6 to convert design strength value to ASD value.
2 KWIK Bolt 3 carbon steel anchors are to be considered ductile steel elements.
3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318-14 Chapter 17.
4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318-14 Chapter 17.

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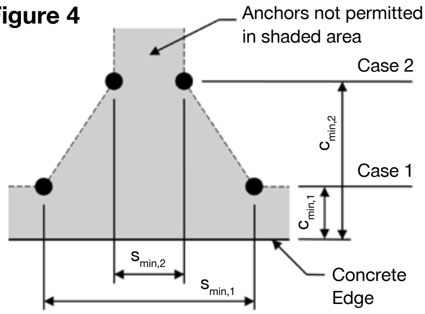
Figure 4



For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$

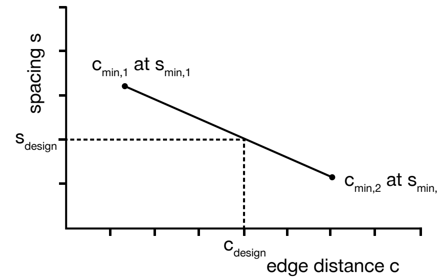


Table 22 - Hot-dip galvanized KWIK Bolt 3 installation parameters[1]

Setting information	Symbol	Units	Nominal anchor diameter d_o									
			1/2				5/8			3/4		
Effective minimum embedment	h_{ef}	in.	2		3-1/4		3-1/8	4		3-3/4		5
		(mm)	(51)		(83)		(79)	(102)		(95)		(127)
Minimum member thickness	h_{min}	in.	4	6	6	8	5	6	8	6	8	8
		(mm)	(102)	(152)	(152)	(203)	(127)	(152)	(203)	(152)	(203)	(203)
Case 1	$c_{min,1}$	in.	3-1/4	2-5/8	2		2-1/4	2	1-78	3-1/2		3-5/8
		(mm)	(83)	(67)	(51)		(57)	(51)	(48)	(89)		(92)
	for $s_{min,1}$ ≥	in.	6-1/4	5-1/2	4-7/8		5-1/4	5	4-3/4	7-1/2		7-3/8
		(mm)	(158)	(140)	(124)		(133)	(127)	(121)	(191)		(187)
Case 2	$c_{min,2}$	in.	3-3/4	2-3/4	2-5/8	2-1/4	3-1/2	2-1/2	2-1/4	6-1/2		4-3/4
		(mm)	(95)	(70)	(67)	(57)	(89)	(64)	(57)	(165)		(121)
	for $s_{min,2}$ ≥	in.	3-1/8	2-3/4	2-3/8	2-1/8	2-1/2	2-1/8	2-1/8	4		3-7/8
		(mm)	(79)	(70)	(60)	(54)	(64)	(54)	(54)	(102)		(98)

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge .distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacings.

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Table 23 - Load adjustment factors for 1/2-in. diameter Hilti KWIK Bolt 3 hot-dip galvanized anchor in uncracked concrete[1,2]

1/2-in. KB3 hot-dip galvanized uncracked concrete		spacing factor in tension f_{AN}		edge distance factor in tension f_{RN}		spacing factor in shear[3] f_{AV}		Edge distance in shear: ⊥ toward edge f_{RV}		Edge distance in shear: II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in. (mm)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm): 2	(51)	n/a	n/a	n/a	0.38	n/a	n/a	n/a	0.10	n/a	0.20	n/a	n/a
2-3/8	(60)	n/a	0.62	n/a	0.41	n/a	0.54	n/a	0.13	n/a	0.26	n/a	n/a
2-1/2	(64)	n/a	0.63	n/a	0.42	n/a	0.55	n/a	0.14	n/a	0.28	n/a	n/a
3	(76)	n/a	0.65	n/a	0.46	n/a	0.55	n/a	0.19	n/a	0.37	n/a	n/a
3-1/8	(79)	0.76	0.66	n/a	0.48	0.64	0.56	n/a	0.20	n/a	0.40	n/a	n/a
3-1/4	(83)	0.77	0.67	0.67	0.49	0.64	0.56	0.79	0.21	0.79	0.42	n/a	n/a
3-1/2	(89)	0.79	0.68	0.72	0.51	0.65	0.56	0.88	0.23	0.88	0.47	n/a	n/a
4	(102)	0.83	0.71	0.82	0.56	0.68	0.57	1.00	0.29	1.00	0.56	0.84	n/a
4-1/2	(114)	0.88	0.73	0.92	0.61	0.70	0.58		0.34		0.61	0.89	n/a
5	(127)	0.92	0.76	1.00	0.67	0.72	0.59		0.40		0.67	0.94	n/a
6	(152)	1.00	0.81		0.80	0.76	0.61		0.53		0.80	1.00	0.66
7	(178)	1.00	0.86		0.93	0.81	0.63		0.66		0.93		0.71
8	(203)		0.91		1.00	0.85	0.64		0.81		1.00		0.76
9	(229)		0.96			0.89	0.66		0.97				0.81
10	(254)		1.00			0.94	0.68		1.00				0.85
11	(279)					0.98	0.70						0.89
12	(305)					1.00	0.72						0.93
14	(356)						0.75						1.00
16	(406)						0.79						
18	(457)						0.83						
20	(508)						0.86						
> 24	(610)						0.93						

Table 24 - Load adjustment factors for 5/8-in. diameter Hilti KWIK Bolt 3 hot-dip galvanized anchor in uncracked concrete[1,2]

5/8-in. KB3 hot-dip galvanized uncracked concrete		Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear: ⊥ toward edge f_{RV}		Edge distance in shear: II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in. (mm)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)	3-1/2 (89)	4-3/8 (111)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm): 2	(51)	n/a	n/a	n/a	0.34	n/a	n/a	n/a	0.08	n/a	0.17	n/a	n/a
2-1/8	(54)	n/a	0.59	n/a	0.34	n/a	0.53	n/a	0.09	n/a	0.18	n/a	n/a
2-1/4	(57)	n/a	0.59	0.38	0.35	n/a	0.54	0.14	0.10	0.27	0.20	n/a	n/a
2-1/2	(64)	0.63	0.60	0.41	0.37	0.55	0.54	0.16	0.12	0.32	0.23	n/a	n/a
3	(76)	0.66	0.63	0.45	0.40	0.56	0.55	0.21	0.15	0.42	0.30	n/a	n/a
3-1/2	(89)	0.69	0.65	0.50	0.44	0.57	0.56	0.26	0.19	0.50	0.38	n/a	n/a
4	(102)	0.71	0.67	0.54	0.47	0.58	0.56	0.32	0.23	0.54	0.47	n/a	n/a
4-1/2	(114)	0.74	0.69	0.60	0.51	0.59	0.57	0.38	0.28	0.60	0.51	n/a	n/a
5	(127)	0.77	0.71	0.66	0.55	0.60	0.58	0.45	0.33	0.66	0.55	0.63	n/a
6	(152)	0.82	0.75	0.79	0.63	0.62	0.59	0.59	0.43	0.79	0.63	0.69	0.62
7	(178)	0.87	0.79	0.92	0.74	0.64	0.61	0.75	0.54	0.92	0.74	0.74	0.67
8	(203)	0.93	0.83	1.00	0.84	0.66	0.63	0.91	0.66	1.00	0.84	0.79	0.71
9	(229)	0.98	0.88		0.95	0.68	0.64	1.00	0.79		0.95	0.84	0.75
10	(254)	1.00	0.92		1.00	0.70	0.66		0.92		1.00	0.89	0.80
11	(279)		0.96			0.72	0.67		1.00			0.93	0.83
12	(305)		1.00			0.74	0.69					0.97	0.87
14	(356)					0.77	0.72					1.00	0.94
16	(406)					0.81	0.75						1.00
18	(457)					0.85	0.78						
20	(508)					0.89	0.82						
24	(610)					0.97	0.88						
> 30	(762)					1.00	0.97						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Anchor Design software or perform anchor calculation using design equations from ACI 318-14 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then f_{HV} = 1.0.

(shaded cell) If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 22 and figure 4 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

3.3.8 KWIK Bolt 3 Expansion Anchor

Table 25 - Load adjustment factors for 3/4-in. diameter Hilti KWIK Bolt 3 hot-dip galvanized anchor in uncracked concrete[1,2]

3/4-in. KB3 hot-dip galvanized uncracked concrete		Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear[3] f_{AV}		Edge distance in shear ⊥ toward edge f_{RV}		Edge distance in shear II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Embedment h_{nom}	in. (mm)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)	4-1/4 (108)	5-1/2 (140)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	3-1/2 (89)	n/a	n/a	0.41	n/a	n/a	n/a	0.22	n/a	0.41	n/a	n/a	n/a
	3-5/8 (92)	n/a	n/a	0.42	0.49	n/a	n/a	0.23	0.16	0.42	0.32	n/a	n/a
	3-7/8 (98)	n/a	0.63	0.44	0.51	n/a	0.55	0.26	0.18	0.44	0.35	n/a	n/a
	4 (102)	0.68	0.63	0.45	0.52	0.57	0.55	0.27	0.18	0.45	0.37	n/a	n/a
	4-1/2 (114)	0.70	0.65	0.49	0.56	0.58	0.56	0.32	0.22	0.49	0.44	n/a	n/a
	5 (127)	0.72	0.67	0.53	0.59	0.59	0.57	0.38	0.26	0.53	0.52	n/a	n/a
	5-1/2 (140)	0.74	0.68	0.57	0.63	0.60	0.57	0.43	0.30	0.57	0.60	n/a	n/a
	6 (152)	0.77	0.70	0.62	0.67	0.60	0.58	0.49	0.34	0.62	0.67	0.65	n/a
	7 (178)	0.81	0.73	0.72	0.75	0.62	0.59	0.62	0.43	0.72	0.75	0.70	n/a
	8 (203)	0.86	0.77	0.82	0.84	0.64	0.61	0.76	0.52	0.82	0.84	0.75	0.66
	9 (229)	0.90	0.80	0.92	0.95	0.66	0.62	0.91	0.62	0.92	0.95	0.79	0.70
	10 (254)	0.94	0.83	1.00	1.00	0.67	0.64	1.00	0.73	1.00	1.00	0.83	0.74
	11 (279)	0.99	0.87			0.69	0.65		0.84			0.87	0.77
	12 (305)	1.00	0.90			0.71	0.66		0.96			0.91	0.81
	14 (356)		0.97			0.74	0.69		1.00			0.99	0.87
	16 (406)		1.00			0.78	0.72					1.00	0.93
	18 (457)					0.81	0.74						0.99
	20 (508)					0.85	0.77						1.00
	24 (610)					0.92	0.82						
	30 (762)					1.00	0.91						
	> 36 (914)						0.99						

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Anchor Design software or perform anchor calculation using design equations from ACI 318-14 Chapter 17.

3 Spacing factor reduction in shear, f_{AV}, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, f_{HV}, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

(Shaded cell) If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 22 and figure 4 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

Table 26 - Hilti KWIK Bolt 3 carbon steel design strength in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6,8]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Loads according to figure 5			
			Tension - ϕN_n		Shear - ϕV_n	
			f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)
1/4	1-1/2 (38)	1-3/4 (44)	1,140 (5.1)	1,315 (5.8)	1,255 (5.6)	1,255 (5.6)
3/8	2 (51)	2-3/8 (60)	1,460 (6.5)	1,685 (7.5)	1,845 (8.2)	1,845 (8.2)
1/2	2 (51)	2-1/4 (57)	1,775 (7.9)	2,050 (9.1)	2,050 (9.1)	2,050 (9.1)
	3-1/4 (83)	3-1/2 (89)				
5/8	3-1/8 (79)	3-1/2 (89)	3,095 (13.8)	3,575 (15.9)	4,280 (19.0)	4,280 (19.0)
	4 (102)	4-3/8 (111)				

Table 27 - Hilti KWIK Bolt 3 stainless steel design strength in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,7,8]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Loads according to figure 5			
			Tension - ϕN_n		Shear - ϕV_n	
			f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)
1/4	1-1/2 (38)	1-3/4 (44)	1,175 (5.2)	1,355 (6.0)	1,315 (5.8)	1,315 (5.8)
3/8	2 (51)	2-3/8 (60)	1,675 (7.5)	1,935 (8.6)	1,675 (7.5)	1,675 (7.5)
1/2	2 (51)	2-1/4 (57)	1,265 (5.6)	1,460 (6.5)	1,135 (5.0)	1,135 (5.0)
	3-1/4 (83)	3-1/2 (89)				
5/8	3-1/8 (79)	3-1/2 (89)	2,880 (12.8)	3,325 (14.8)	3,700 (16.5)	3,700 (16.5)
	4 (102)	4-3/8 (111)				

1 See section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular values are lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison to steel values in table 4 is not required. Values in tables 26 control.
7 Comparison to steel values in table 12 is not required. Values in tables 27 control.
8 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

3.3.8 KWIK Bolt 3 Expansion Anchor

3.3.8.3.2 Canadian Limit State design

Limit State Design of anchors is described in the provisions of CSA A23.3-14 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-2302. These tables are followed by factored resistance tables. The factored resitance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318-14 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3-14 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

Table 28 - Steel resistance for Hilti KWIK Bolt 3 carbon steel anchors[1,2]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Tensile N_{sar} [3] lb (kN)	Shear V_{sar} [4] lb (kN)
1/4	1-11/16 (43)	1,440 (6.4)	1,045 (4.6)
3/8	2-3/8 (60)	4,325 (19.2)	2,850 (12.7)
1/2	2-1/4 (57)	7,930 (35.3)	4,230 (18.8)
	3-1/2 (89)		4,305 (19.1)
5/8	3-1/2 (89)	12,255 (54.5)	7,795 (34.7)
	4-3/8 (111)		
3/4	4-1/4 (108)	17,300 (77.0)	9,985 (44.4)
	5-1/2 (140)		10,580 (47.1)

1 See Section 3.1.8.6 to convert factored resistance value to ASD value.

2 Hilti KWIK Bolt 3 carbon steel anchors are to be considered ductile steel elements.

3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3-14 Annex D.

4 Shear determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}\ R$ as noted in CSA A23.3-14 Annex D.

KWIK Bolt 3 Expansion Anchor 3.3.8

Table 29 - Hilti KWIK Bolt 3 carbon steel design information in accordance with CSA A23.3-14 Annex D[1]

Design parameter	Symbol	Units	Nominal anchor diameter													Ref
			1/4	3/8		1/2				5/8			3/4			A23.3-14
Anchor O.D.	d_a	in.	0.25	0.375		0.5				0.625			0.75			
		(mm)	(6.4)	(9.5)		(12.7)				(15.9)			(19.1)			
Effective minimum embedment[2]	h_{ef}	in.	1-1/2	2		2		3-1/4		3-1/8	4		3-3/4		5	
		(mm)	(38)	(51)		(51)		(83)		(79)	(102)		(95)		(127)	
Minimum concrete thickness[3]	h_{min}	in.	4	4	5	4	6	6	8	5	6	8	6	8	8	
		(mm)	(102)	(102)	(127)	(102)	(152)	(152)	(203)	(127)	(152)	(203)	(152)	(203)	(203)	
Critical edge distance	c_{ac}	in.	2-3/4	4-1/2	3-7/8	4-7/8	3-5/8	6-3/4	5-5/8	7-1/2	9-1/2	7-1/2	9-3/4	7-1/2	9-1/2	
		(mm)	(70)	(114)	(98)	(124)	(92)	(171)	(143)	(191)	(241)	(191)	(248)	(191)	(241)	
Minimum edge distance	c_{min}	in.	1-3/8	2	1-1/2	2-1/8	2	1-5/8	1-5/8	2-1/4	1-3/4	1-3/4	2-3/4	2-5/8	2-1/2	
		(mm)	(35)	(51)	(38)	(54)	(51)	(41)	(41)	(57)	(44)	(44)	(70)	(67)	(64)	
	for s >	in.	1-3/4	2-7/8	3-1/2	4-7/8	4-3/4	4-1/4	4	5-1/4	4-3/4	4	6-7/8	6-1/2	6-3/8	
		(mm)	(44)	(73)	(89)	(124)	(121)	(108)	(102)	(133)	(121)	(102)	(175)	(165)	(162)	
Minimum anchor spacing	s_{min}	in.	1-1/4	1-3/4	1-3/4	2-1/2	2-1/4	2	1-7/8	2-3/8	2-1/8	2-1/8	3-3/4	3-3/8	2-1/2	
		(mm)	(32)	(44)	(44)	(64)	(57)	(2)	(48)	(60)	(54)	(54)	(95)	(86)	(64)	
	for c >	in.	1-5/8	2-3/8	2-3/8	2-5/8	2-3/8	2-1/4	2	3-1/8	2-3/8	2-1/4	3-3/4	3-3/8	6-3/8	
		(mm)	(41)	(60)	(60)	(67)	(60)	(57)	(51)	(79)	(60)	(57)	(95)	(86)	(162)	
Minimum hole depth in concrete	h_o	in.	2	2-5/8		2-5/8		4		3-7/8	4-3/4		4-1/2		5-3/4	
		(mm)	(50.8)	(67)		(67)		(102)		(98)	(121)		(117)		(146)	
Minimum specified yield strength	f_{ya}	psi	84,800	84,800		84,800				84,800			84,800			
		(N/mm²)	(585)	(585)		(585)				(585)			(585)			
Minimum specified ultimate strength	f_{uta}	psi	106,000	106,000		106,000				106,000			106,000			
		(N/mm²)	(731)	(731)		(731)				(731)			(731)			
Effective tensile stress area	$A_{se,N}$	in²	0.02	0.06		0.11				0.17			0.24			
		(mm²)	(12.9)	(38.7)		(71.0)				(109.7)			(154.8)			
Steel embedment material resistance factor for reinforcement	ϕ_s	-	0.85													8.4.3
Resistance modification factor for tension, steel failure modes[3]	R	-	0.80													D.5.3
Resistance modification factor for shear, steel failure modes[3]	R	-	0.75													D.5.3
Factored steel resistance in tension	N_{sar}	lb	1,440	4,325		7,930				12,255			17,300			D.6.1.2
		(kN)	(6.4)	(19.2)		(35.3)				(54.5)			(77.0)			
Factored steel resistance in shear	V_{sar}	lb	1,045	2,850		4,230		4,305		7,795			9,985		10,580	D.7.1.2
		(kN)	(4.6)	(12.7)		(18.8)		(19.2)		(34.7)			(44.4)		(47.1)	
Coeff. for factored concrete breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10													D.6.2.2
Modification factor for anchor resistance, tension, uncracked concrete[4]	$\psi_{c,N}$	-	1.0													D.6.2.6
Anchor category	-	-	1													D.5.3 (c)
Concrete material resistance factor	ϕ_c	-	0.65													8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]	R	-	1.00													D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete[6]	$N_{pr,uncr}$	lb	1,100	N/A		N/A		4,745		NA			NA		7,420	D.6.3.2
		(kN)	(4.9)					(21.1)							(33.0)	

1 Design information in this table is taken from ICC-ES ESR-2302, dated December 1, 2015, table 4, and converted for use with CSA A23.3-14 Annex D.
2 See figure 1 of this section.
3 The carbon steel KWIK Bolt 3 is considered a ductile steel element as defined by CSA A23.3-14 Annex D section D.2.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3-14 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3-14 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 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 ESR-2302 for additional information.

3.3.8 KWIK Bolt 3 Expansion Anchor

Table 30 - Hilti KWIK Bolt 3 carbon steel factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1 1/2 (38)	1-11/16 43	1,100 (4.9)	1,230 (5.5)	1,350 (6.0)	1,560 (6.9)	1,530 (6.8)	1,710 (7.6)	1,875 (8.3)	2,165 (9.6)
3/8	2 (51)	2-5/16 (59)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)
1/2	2 (51)	2 3/8 (60)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)
	3-1/4 (83)	3 5/8 (92)	4,755 (21.1)	5,315 (23.6)	5,825 (25.9)	6,725 (29.9)	9,885 (44.0)	11,050 (49.2)	12,105 (53.8)	13,975 (62.2)
5/8	3-1/8 (79)	3-9/16 (90)	4,590 (20.4)	5,130 (22.8)	5,620 (25.0)	6,490 (28.9)	9,175 (40.8)	10,260 (45.6)	11,240 (50.0)	12,980 (57.7)
	4 (102)	4-7/16 (113)	6,730 (29.9)	7,525 (33.5)	8,245 (36.7)	9,520 (42.3)	13,465 (59.9)	15,055 (67.0)	16,490 (73.4)	19,040 (84.7)
3/4	3-3/4 (95)	4-5/16 (110)	6,050 (26.9)	6,765 (30.1)	7,410 (33.0)	8,555 (38.1)	12,100 (53.8)	13,530 (60.2)	14,820 (65.9)	17,115 (76.1)
	4-3/4 (121)	5-9/16 (141)	7,415 (33.0)	8,290 (36.9)	9,080 (40.4)	10,485 (46.6)	17,395 (77.4)	19,450 (86.5)	21,305 (94.8)	24,600 (109.4)

1 See section 3.1.8.6 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 10 as necessary. Compare to the steel values in table 28. The lesser of the values is to be used for the design.
4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 31 - Steel resistance for Hilti KWIK Bolt 3 stainless steel anchors[1,2]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Tensile N_{sar} [3] lb (kN)	Shear V_{sar} [4] lb (kN)
1/4	1-11/16 (42.9)	1,565 (7.0)	1,070 (4.8)
3/8	2-3/8 (60.3)	4,690 (20.9)	3,175 (14.1)
1/2	2-1/4 (57.2)	8,600 (38.3)	2,675 (11.9)
	3-1/2 (88.9)		4,425 (19.7)
5/8	3-1/2 (88.9)	13,295 (59.1)	5,710 (25.4)
	4-3/8 (111.1)		9,115 (40.5)
3/4	4-1/4 (108.0)	14,690 (65.3)	7,585 (33.7)
	5-1/2 (139.7)		15,010 (66.8)
1	4-5/8 (117.5)	28,770 (128.0)	7,975 (35.5)
	5-7/8 (149.2)		17,430 (77.5)

1 See Section 3.1.8.6 to convert factored resistance value to ASD value.
2 Hilti KWIK Bolt 3 carbon steel anchors are to be considered ductile steel elements.
3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3-14 Annex D.
4 Shear determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}\ R$ as noted in CSA A23.3-14 Annex D.

Table 32 - Hilti KWIK Bolt 3 stainless steel design information in accordance with CSA A23.3-14 Annex D[1]

Design parameter	Symbol	Units	Nominal anchor diameter															Ref
			1/4	3/8		1/2				5/8			3/4			1		A23.3-14
Anchor O.D.	d_a	in.	0.25	0.375		0.5				0.625			0.75			1		
		(mm)	(6.4)	(9.5)		(12.7)				(15.9)			(19.1)			(25.4)		
Effective minimum embedment[2]	h_{ef}	in.	1-1/2	2		2		3-1/4		3-1/8	4		3-3/4		5	4	5-1/4	
		(mm)	(38)	(51)		(51)		(83)		(79)	(102)		(95)		(127)	(102)	(133)	
Minimum concrete thickness[2]	h_{min}	in.	4	4	5	4	6	6	8	5	6	8	6	8	8	8	10	
		(mm)	(102)	(102)	(127)	(102)	(152)	(152)	(203)	(127)	(152)	(203)	(152)	(203)	(203)	(203)	(254)	
Critical edge distance	c_{ac}	in.	3	4-3/8	3-7/8	4-7/8	4	6-3/4	5-3/4	7-3/8	9-1/2	7-1/2	10-1/2	9-1/4	9-3/4	10	11	
		(mm)	(76)	(111)	(98)	(124)	(102)	(171)	(146)	(187)	(241)	(191)	(267)	(235)	(248)	(254)	(279)	
Minimum edge distance	c_{min}	in.	1-3/8	2	1-5/8	2-1/2	1.875	1-5/8	1-5/8	3-1/4	2-1/2	2-1/2	3-1/4	3	2-7/8	3-1/2	3	
		(mm)	(35)	(51)	(41)	(64)	(48)	(41)	(41)	(83)	(64)	(64)	(83)	(76)	(73)	(89)	(76)	
	for s >	in.	1-3/4	4	3-3/8	5	4-5/8	4-1/2	4.25	5-5/8	5-1/4	5	7	6-7/8	6-5/8	6-3/4	6-3/4	
		(mm)	(44)	(102)	(86)	(127)	(117)	(114)	(108)	(143)	(133)	(127)	(178)	(175)	(168)	(171)	(171)	
Minimum anchor spacing	s_{min}	in.	1-1/4	2	1-3/4	2-1/2	2-1/4	2	1-7/8	3-1/8	2-1/8	2-1/8	4	3-1/2	3-1/2	5	4-3/4	
		(mm)	(32)	(51)	(44)	(64)	(57)	(2)	(48)	(79)	(54)	(54)	(102)	(89)	(89)	(127)	(121)	
	for c >	in.	1-5/8	3-1/4	2-1/2	2-7/8	2-3/8	2-3/8	2-1/8	3-7/8	3	2-3/4	4-1/8	3-3/4	3-3/4	4-1/4	3-3/4	
		(mm)	(41)	(83)	(64)	(73)	(60)	(60)	(54)	(98)	(76)	(70)	(105)	(95)	(95)	(108)	(95)	
Minimum hole depth in concrete	h_o	in.	2	2-5/8		2-5/8		4		3-7/8	4-3/4		4-1/2		5-3/4	5	6-3/4	
		(mm)	(50.8)	(67)		(67)		(102)		(98)	(121)		(117)		(146)			
Minimum specified yield strength	f_{ya}	psi	84,800	92,000		92,000				92,000			76,000			76,000		
		(N/mm²)	(585)	(634)		(634)				(634)			(524)			(524)		
Minimum specified ultimate strength	f_{uta}	psi	115,000	115,000		115,000				115,000			90,000			90000		
		(N/mm²)	(793)	(793)		(793)				(793)			(621)			(621)		
Effective tensile stress area	$A_{se,N}$	in²	0.02	0.06		0.11				0.17			0.24			0.47		
		(mm²)	(12.9)	(38.7)		(71.0)				(109.7)			(154.8)			(154.8)		
Steel embedment material resistance factor for reinforcement	ϕ_s	-	0.85															8.4.3
Resistance modification factor for tension, steel failure modes[3]	R	-	0.80															D.5.3
Resistance modification factor for shear, steel failure modes[3]	R	-	0.75															D.5.3
Factored steel resistance in tension	N_{sar}	lb	1,565	4,690		8,600				13,295			14,690			28,770		D.6.1.2
		(kN)	(7.0)	(20.9)		(38.3)				(59.1)			(65.3)			(128.0)		
Factored steel resistance in shear	V_{sar}	lb	1,070	3,175		2,675		4,425		5,710	9,115		7,585		15,010	7,975	17,430	D.7.1.2
		(kN)	(4.8)	(14.1)		(11.9)		(19.7)		(25.4)	(66.8)		(33.7)		(66.8)	(35.5)	(77.5)	
Coeff. for factored concrete breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10															D.6.2.2
Modification factor for anchor resistance, tension, uncracked concrete[4]	$\psi_{c,N}$	-	1.0															D.6.2.6
Anchor category	-	-	2	1														D.5.3 (c)
Concrete material resistance factor	ϕ_c	-	0.65															8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]	R	-	0.85	1.00														D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete[6]	$N_{pr,uncr}$	lb	1,100	2,070		2,315		4,225		4,360	5,485		6,000		7,600	NA	10,905	D.6.3.2
		(kN)	(4.9)	(9.2)		(10.3)		(18.8)		(19.4)	(24.4)		(26.7)		(33.8)		(48.5)	

1 Design information in this table is taken from ICC-ES ESR-2302, dated December 1, 2015, table 4, and converted for use with CSA A23.3-14 Annex D.
2 See figure 1 of this section.
3 The stainless steel KWIK Bolt 3 is considered a ductile steel element as defined by CSA A23.3-14 Annex D section D.2.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3-14 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3-14 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 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 ESR-2302 for additional information.

3.3.8 KWIK Bolt 3 Expansion Anchor

Table 33 - Hilti KWIK Bolt 3 stainless steel factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	Shear - V_r f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1 1/2 (38)	1-11/16 43	930 (4.1)	1,040 (4.6)	1,140 (5.1)	1,315 (5.8)	1,300 (5.8)	1,455 (6.5)	1,595 (7.1)	1,840 (8.2)
3/8	2 (51)	2-5/16 (59)	2,080 (9.2)	2,325 (10.3)	2,545 (11.3)	2,940 (13.1)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)
1/2	2 (51)	2 3/8 (60)	2,315 (10.3)	2,585 (11.5)	2,835 (12.6)	3,275 (14.6)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)
	3-1/4 (83)	3 5/8 (92)	4,220 (18.8)	4,715 (21.0)	5,165 (23.0)	5,965 (26.5)	9,885 (44.0)	11,050 (49.2)	12,105 (53.8)	13,975 (62.2)
5/8	3-1/8 (79)	3-9/16 (90)	4,360 (19.4)	4,875 (21.7)	5,340 (23.8)	6,165 (27.4)	9,175 (40.8)	10,260 (45.6)	11,240 (50.0)	12,980 (57.7)
	4 (102)	4-7/16 (113)	5,480 (24.4)	6,125 (27.2)	6,710 (29.8)	7,750 (34.5)	13,465 (59.9)	15,055 (67.0)	16,490 (73.4)	19,040 (84.7)
3/4	3-3/4 (95)	4-5/16 (110)	6,000 (26.7)	6,705 (29.8)	7,345 (32.7)	8,480 (37.7)	12,100 (53.8)	13,530 (60.2)	14,820 (65.9)	17,115 (76.1)
	4-3/4 (121)	5-9/16 (141)	7,590 (33.8)	8,485 (37.7)	9,295 (41.3)	10,730 (47.7)	17,395 (77.4)	19,450 (86.5)	21,305 (94.8)	24,600 (109.4)
1	4 (102)	4-5/16 (110)	6,730 (29.9)	7,525 (33.5)	8,245 (36.7)	9,520 (42.3)	13,465 (59.9)	15,055 (67.0)	16,490 (73.4)	19,040 (84.7)
	5 3/4 (146)	5-9/16 (141)	10,895 (48.5)	12,180 (54.2)	13,340 (59.3)	15,405 (68.5)	23,055 (102.6)	25,780 (114.7)	28,240 (125.6)	32,610 (145.0)

1 See section 3.1.8.6 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 14 to 19 as necessary. Compare to the steel values in table 31. The lesser of the values is to be used for the design.
4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 34 - Steel resistance for Hilti KWIK Bolt 3 hot-dip galvanized carbon steel anchors[1,2]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Tensile N_{sar} [3] lb (kN)	Shear V_{sar} [4] lb (kN)
1/2	2-1/4 (57)	7,930 (35.3)	2,870 (12.8)
	3-1/2 (89)		3,740 (16.6)
5/8	3-1/2 (89)	12,255 (54.5)	7,415 (33.0)
	4-3/8 (111)		
3/4	4-1/4 (108)	17,300 (77.0)	10,840 (48.2)
	5-1/2 (140)		

1 See section 3.1.8.6 to convert design strength value to ASD value.
2 KWIK Bolt 3 hot-dip galvanized carbon steel anchors are to be considered ductile steel elements.
3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}\ R$ as noted in ACI 318-14 Chapter 17.
4 Shear values determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}\ R$ as noted in ACI 318-14 Chapter 17.

Table 35 - Hilti KWIK Bolt 3 hot-dip galvanized carbon steel design information in accordance with CSA A23.3-14 Annex D[1]

Design parameter	Symbol	Units											Ref A23.3-14
			1/2				5/8			3/4			
Anchor O.D.	d_a	in. (mm)	0.5 (12.7)				0.625 (15.9)			0.75 (19.1)			
Effective minimum embedment[2]	h_{ef}	in. (mm)	2 (51)		3-1/4 (83)		3-1/8 (79)	4 (102)		3-3/4 (95)		4-3/4 (121)	
Minimum concrete thickness	h_{min}	in. (mm)	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)	4-7/8 (124)	3-5/8 (92)	7-1/2 (191)	5.75 (146)	8 (194)	9-1/2 (241)	8 (197)	9-3/4 (248)	7-1/2 (191)	9-1/2 (241)	
Minimum edge distance	c_{min}	in. (mm)	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)	5-3/4 (146)		5-1/4 (133)		5-1/2 (140)	5-1/2 (140)		10 (254)		8-1/2 (216)	
Minimum anchor spacing	s_{min}	in. (mm)	2-7/8 (73)		2 (51)		2-3/4 (70)	2-3/8 (60)		5 (127)		4 (102)	
	for c >	in. (mm)	4-1/2 (114)		3-1/4 (83)		4-1/8 (105)	4-1/4 (108)		9-1/2 (241)		7 (178)	
Minimum hole depth in concrete	h_o	in. (mm)	2-5/8 (67)		4 (102)		3-3/4 (98)	4-3/4 (121)		4-1/2 (117)		5-3/4 (146)	
Minimum specified yield strength	f_{ya}	psi (N/mm^2)	92,000 (634)				92,000 (634)			76,125 (525)			
Minimum specified ultimate strength	f_{uta}	psi (N/mm^2)	115,000 (793)				115,000 (793)			101,500 (700)			
Effective tensile stress area	$A_{se,N}$	in^2 (mm^2)	0.101 (65.0)				0.162 (104.6)			0.237 (152.8)			
Steel embedment material resistance factor for reinforcement	ϕ_s	-	0.85										8.4.3
Resistance modification factor for tension, steel failure modes[4]	R	-	0.80										D.5.3
Resistance modification factor for shear, steel failure modes[4]	R	-	0.75										D.5.3
Factored steel resistance in tension	N_{sar}	lb (kN)	7,930 (35.3)				12,255 (54.5)			17,300 (77.0)			D.6.1.2
Factored steel resistance in shear	V_{sar}	lb (kN)	2,870 (12.8)		3,740 (16.6)		7,415 (33.0)			10,840 (48.2)			D.7.1.2
Coefficient for factored concrete breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10										D.6.2.2
Modification factor for anchor resistance, tension, uncracked concrete[4]	$\psi_{c,N}$	-	1.00										D.6.2.6
Anchor category	-	-	1										D.5.3 (c)
Concrete material resistance factor	ϕ_c	-	0.65										8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B[5]	R	-	1.00										D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete[6]	$N_{pr,uncr}$	lb (kN)	N/A		4,585 (20.4)		4,540 (20.2)	6,315 (28.1)		NA		7,125 (31.7)	D.6.3.2

1 Design information in this table is taken from ICC-ES ESR-2302, dated December 1, 2015, table 4, and converted for use with CSA A23.3-14 Annex D.
2 See figure 1 of this section.
3 The hot-dip galvanized carbon steel KWIK Bolt 3 is considered a ductile steel element as defined by CSA A23.3-14 Annex D section D.2.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3-14 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3-14 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 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 ESR-2302 for additional information.

3.3.8 KWIK Bolt 3 Expansion Anchor

Table 36 - Hilti KWIK Bolt 3 hot-dip galvanized carbon steel factored resistance with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/2	2 (51)	2 3/8 (60)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)
	3-1/4 (83)	3 5/8 (92)	4,580 (20.4)	5,120 (22.8)	5,610 (25.0)	6,480 (28.8)	9,885 (44.0)	11,050 (49.2)	12,105 (53.8)	13,975 (62.2)
5/8	3-1/8 (79)	3-9/16 (90)	4,535 (20.2)	5,070 (22.5)	5,555 (24.7)	6,410 (28.5)	9,175 (40.8)	10,260 (45.6)	11,240 (50.0)	12,980 (57.7)
	4 (102)	4-7/16 (113)	6,315 (28.1)	7,060 (31.4)	7,730 (34.4)	8,930 (39.7)	13,465 (59.9)	15,055 (67.0)	16,490 (73.4)	19,040 (84.7)
3/4	3-3/4 (95)	4-5/16 (110)	6,050 (26.9)	6,765 (30.1)	7,410 (33.0)	8,555 (38.1)	12,100 (53.8)	13,530 (60.2)	14,820 (65.9)	17,115 (76.1)
	4-3/4 (121)	5-9/16 (141)	7,130 (31.7)	7,975 (35.5)	8,735 (38.9)	10,085 (44.9)	17,395 (77.4)	19,450 (86.5)	21,305 (94.8)	24,600 (109.4)

1 See section 3.1.8.6 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 23 to 25 as necessary. Compare to the steel values in table 34. The lesser of the values is to be used for the design.
4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 37 - Hilti KWIK Bolt 3 carbon steel factored resistance in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6,7]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Loads according to figure 5		
			Tension - N_r		Shear - V_r
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c ≥ 20 MPa (2,900 psi) lb (kN)
1/4	1-1/2 (38)	1-11/16 (43)	1,120 (5.0)	1,370 (6.1)	1,230 (5.5)
3/8	2 (51)	2-5/16 (59)	1,435 (6.4)	1,755 (7.8)	1,810 (8.1)
1/2	2 (51)	2-3/8 (60)	1,745 (7.8)	2,135 (9.5)	2,010 (8.9)
	3-1/4 (83)	3-5/8 (92)			
5/8	3-1/8 (79)	3-9/16 (90)	3,045 (13.5)	3,730 (16.6)	4,200 (18.7)
	4 (102)	4-7/16 (113)			

1 See section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular value is for lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

Table 38 - Hilti KWIK Bolt 3 stainless steel factored resistance in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6,7]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Loads according to figure 5		
			Tension - N_r		Shear - V_r
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	$f'_c \geq$ 20 MPa (2,900 psi) lb (kN)
1/4	1-1/2 (38)	1-11/16 (43)	980 (4.4)	1,200 (5.3)	1,290 (5.7)
3/8	2 (51)	2-5/16 (59)	1,650 (7.3)	2,020 (9.0)	1,645 (7.3)
1/2	2 (51)	2-3/8 (60)	1,245 (5.5)	1,520 (6.8)	1,110 (4.9)
	3-1/4 (83)	3-5/8 (92)			
5/8	3-1/8 (79)	3-9/16 (90)	2,830 (12.6)	3,465 (15.4)	3,625 (16.1)
	4 (102)	4-7/16 (113)			

1 See section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x h_{ef} (effective embedment).
4 Tabular value is for lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

3.3.8

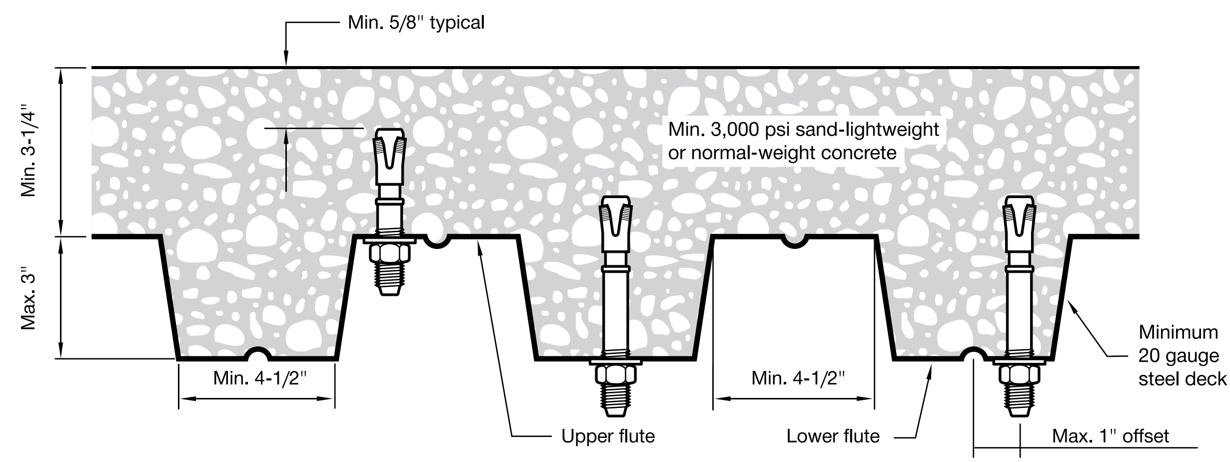


Figure 5 - Installation in concrete over metal deck

3.3.8 KWIK Bolt 3 Expansion Anchor

3.3.8.3.3 Allowable Stress Design for masonry

Table 39 - Carbon steel Hilti KWIK Bolt 3 allowable loads in grout-filled concrete masonry units[1, 2, 3, 4, 5, 6]

Nominal anchor diameter	Nominal embedment		Minimum distance from edge of block		Tension		Shear lb (kN)	
in.	in.	(mm)	in.	(mm)	lb	(kN)	lb	(kN)
1/4	1-1/8	(29)	4	(102)	150	(0.7)	380	(1.7)
			12	(305)				
	2	(51)	4	(102)	540	(2.4)	445	(2.0)
			12	(305)				
3/8	1-5/8	(41)	4	(102)	320	(1.4)	735	(3.3)
			12	(305)	340	(1.5)	940	(4.2)
	2-1/2	(64)	4	(102)	780	(3.5)	1,010	(4.5)
			12	(305)			1,395	(6.2)
1/2	2-1/4	(57)	4	(102)	630	(2.8)	830	(3.7)
			12	(305)	665	(3.0)	1,465	(6.5)
	3-1/2	(89)	4	(102)	905	(4.0)	1,080	(4.8)
			12	(305)			2,375	(10.6)
5/8	2-3/4	(70)	4	(102)	815	(3.6)	890	(4.0)
			12	(305)	865	(3.8)	2,165	(9.6)
	4	(102)	4	(102)	1,240	(5.5)	970	(4.3)
			12	(305)	1,295	(5.8)	2,770	(12.3)
3/4	3-1/4	(83)	4	(102)	1,035	(4.6)	785	(3.5)
			12	(305)			3,135	(13.8)
	4-3/4	(121)	4	(102)	1,645	(7.3)	825	(3.7)
			12	(305)	1,710	(7.6)	3,305	(14.7)

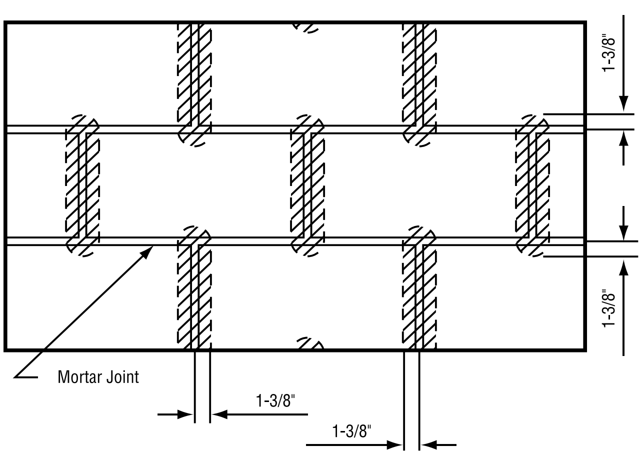


Figure 6 - Installation in grout-filled concrete masonry unit

KWIK Bolt 3 Expansion Anchor 3.3.8

Table 40 - Carbon steel Hilti KWIK Bolt 3 allowable loads for anchors installed in top of grout-filled concrete masonry wall[1,6]

Nominal anchor diameter	Nominal embedment		Tension		Shear			
					V_1		V_2	
in.	in.	(mm)	lb	(kN)	lb	(kN)	lb	(kN)
1/2	3	(76)	645	(2.9)	310	(1.4)	615	(2.7)
5/8	3-1/2	(89)	850	(3.8)	310	(1.4)	615	(2.7)

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight, medium-weight or normal-weight conforming to ASTM C90. Allowable loads are calculated using safety factor of 4.

2 Anchors must be installed a minimum of 1-3/8 inch from any vertical mortar joint (see figure below).

3 Anchor locations are limited to one per masonry cell.

4 Embedment depth is measured from the outside face of the concrete masonry unit.

5 Linear interpolation to determine load values at intermediate edge distances is permitted.

6 All allowable loads based on safety factor of 4.

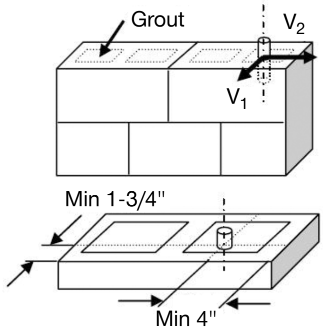


Figure 7 - Hilti KWIK Bolt 3 installed in the top of masonry walls

Table 41 - Countersunk Hilti KWIK Bolt Allowable Loads in Normal-Weight Concrete[1]

Anchor Material	Nominal anchor diameter in.	Embedment depth in. (mm)		f'_c = 3000 psi (20.7 MPa)			
				Tension lb (kN)		Shear[2] lb (kN)	
Carbon Steel	1/4	1-1/8	(29)	365	(1.6)	350	(1.6)
	3/8	1-5/8	(41)	810	(3.6)	750	(3.3)
Stainless Steel	1/4	1-1/8	(29)	320	(1.4)	500	(2.2
	3/8	1-5/8	(41)	670	(3.0)	1330	(5.9)

1 Allowable loads based on using a safety factor of 4.0.

2 Shear values acting thru threads of anchor bolt. If acting through the empty shell, reduce loads by 70%.

3.3.8.4 Installation instructions

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

3.3.8 KWIK Bolt 3 Expansion Anchor

3.3.8.5 Ordering information

KWIK Bolt 3 anchor product line

Size	Length (ℓ)		Thread length (ℓ_{th})		ID stamp	Box	Carbon steel	304 SS	316 SS	HDG
	in.	(mm)	in.	(mm)						
1/4 x 1-3/4	1-3/4	(44)	3/4	(18)	A	100	●	●		
1/4 x 2-1/4	2-1/4	(57)	7/8	(22)	B		●	●	●	
1/4 x 3-1/4	3-1/4	(83)	2	(51)	D		●	●		
			7/8	(22)					●	
1/4 x 4-1/2	4-1/2	(114)	2-7/8	(75)	G		●	●		
3/8 x 2-1/4	2-1/4	(57)	7/8	(22)	B	50	●	●		
3/8 x 3	3	(76)	1-1/4	(32)	D				●	
			1-1/2	(40)			●	●		
3/8 x 3-3/4	3-3/4	(95)	1-1/4	(32)	E				●	
			2-1/4	(59)			●	●		
3/8 x 5	5	(127)	3-1/2	(91)	H		●	●		
3/8 x 7	7	(178)	5-1/2	(142)	L		●	●		
1/2 x 2-3/4	2-3/4	(70)	1-1/4	(33)	C	25	●	●		
1/2 x 3-3/4	3-3/4	(95)	1-5/16	(35)	E				●	
			2-3/16	(56)			●	●		●
1/2 x 4-1/2	4-1/2	(114)	1-5/16	(35)	G				●	
			2-7/8	(75)			●	●		●
1/2 x 5-1/2	5-1/2	(140)	1-5/16	(35)	I				●	
			3-3/4	(96)			●	●		●
1/2 x 7	7	(178)	4-3/4	(121)	L		●	●		●
5/8 x 3-3/4	3-3/4	(95)	1-1/2	(41)	E	15	●	●	●	
5/8 x 4-3/4	4-3/4	(121)	1-1/2	(41)	G				●	
			2-3/4	(70)			●	●		●
5/8 x 6	6	(152)	1-1/2	(41)	J			●	●	
			4	(102)			●			●
5/8 x 7	7	(178)	4-3/4	(121)			●			
5/8 x 8-1/2	8-1/2	(216)	6-1/2	(166)	O		●	●		
5/8 x 10	10	(254)	7	(180)	R		●	●		
3/4 x 4-3/4	4-3/4	(121)	1-1/2	(41)	G	20		●	●	
			2-7/16	(62)		10	●			●
						20		●		
3/4 x 5-1/2	5-1/2	(140)	1-1/2	(41)	I	20		●		
			3-7/16	(85)		10	●			●
						20		●		
3/4 x 7	7	(178)	1-1/2	(41)	L	10		●		
			4-5/8	(119)			●			
3/4 x 8	8	(203)	5-3/4	(146)	N		●	●		●
3/4 x 10	10	(254)	5-7/8	(152)	R		●	●	●	
3/4 x 12	12	(305)	5-7/8	(152)	T		●	●		
1 x 6	6	(152)	2-1/4	(57)	J	5	●	●	●	
1 x 9	9	(114)	2-1/4	(57)	P		●	●		
1 x 12	12	(114)	6	(152)	T		●	●		

KWIK Bolt 3 Expansion Anchor 3.3.8

Countersunk KWIK Bolt anchor product line

Size	Length in.	(mm)	Box	Carbon steel	304 SS
C1/4 x 2	**2**	(51)	100	•	
C1/4 x 3	**3**	(76)	100	•	•
C1/4 x 5	**5**	(127)	100	•	
C3/8 x 2-1/4	**2-1/4**	(57)	100	•	
C3/8 x 3	**3**	(76)	100	•	
C3/8 x 4	**4**	(102)	50	•	•
C3/8 x 5	**5**	(127)	50	•	

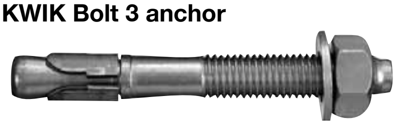
Rod Coupling KWIK Bolt 3 anchor product line

Size	Length in.	(mm)	Thread length in.	(mm)	ID stamp	Box quantity
3/8 x 2-1/4	**2-1/4**	(57)	**7/8**	(22)	B	100

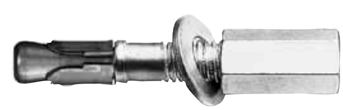
HHDCA ceiling anchor product line

Size	Length in.	(mm)	Eyelet size in.	Box quantity
1/4 x 2	**2-1/32**	(52)	**5/16**	100

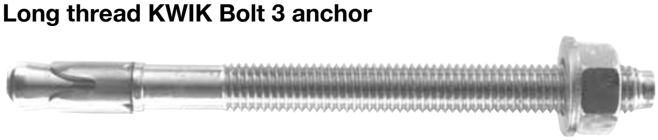
KWIK Bolt 3 anchor



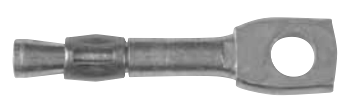
Rod coupling KWIK Bolt 3 anchor 3/8 x 2 1/4



Long thread KWIK Bolt 3 anchor



HHDCA ceiling hanger 1/4 x 2



Countersunk KWIK Bolt 3 anchor

Table 32 - 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