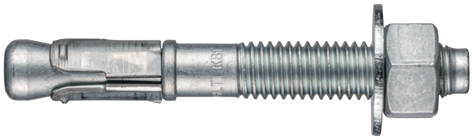
KWIK BOLT 1 (KB1) PREMIUM EXPANSION ANCHOR

KB1 concrete and masonry technical supplement

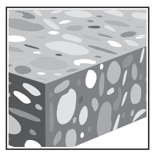


Carbon Steel KB1

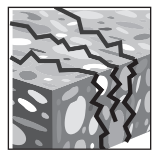
PRODUCT DESCRIPTION

Features and Benefits

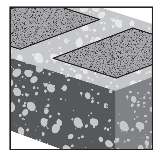
- Instructions For Use (IFU) provides multiple installation methods including Hilti Hollow Drill bit, or no hole cleaning with hammer drill and Hilti Dust Removal System (DRS) for virtually dustless installation (OSHA 1926.1153 Table 1 compliant).
- Accurate SafeSet™ installation when using the Hilti SIW-6AT-A22 impact wrench and the SI-AT-A22 Adaptive Torque Module.
- Product and length identification marks facilitate quality control after installation.
- Maximized thread lengths and multiple embedment depths to accommodate various base plate thicknesses.
- Functional coatings and profiled expansion wedges provide increased reliability.
- Mechanical expansion allows immediate load application.
- Raised impact section (dog point) prevents thread damage during installation.



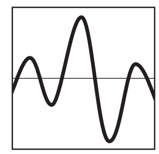
Uncracked concrete



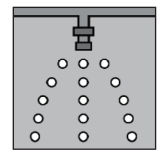
Cracked concrete



Grout-filled concrete masonry



Seismic Design Categories A-F



Fire sprinkler listings

Profis Engineering design software

SAFESET

Hollow Drill Bit and Adaptive Torque Tool (AT)

CLASSÉ c UL US HOMOLOGUÉ

FM APPROVÉ

Approvals/ Listings	
IAPMO Uniform ES • 2018 International Building Code / International Residential Code (IBC/IRC)	ER-678 in concrete per ACI 318-14 Ch. 17 / ACI 355.2 ER-677 in grout-filled CMU per AC01
City of Los Angeles	2020 LABC Supplement (within ER-677 & ER-678)
Florida Building Code	2020 FBC Supplement with HVHZ (within ER-677 & ER-678)
FM (Factory Mutual)	Pipe hanger components for automatic sprinkler systems 3/8 (up to 4-inch nominal pipe diameter) 1/2 (up to 8-inch nominal pipe diameter) 3/4 (up to 12-inch nominal pipe diameter)
UL and cUL (Underwriters Laboratory)	Pipe hanger equipment for fire protection services 3/8 (up to 4-inch nominal pipe diameter) 1/2 (up to 8-inch nominal pipe diameter) 5/8 & 3/4 (up to 12-inch nominal pipe diameter)

MATERIAL SPECIFICATIONS

Carbon steel with electroplated zinc

- Hilti KB1 anchor bodies manufactured from carbon steel with Fe/Zn plating per ASTM F1941 to a minimum thickness of 5 μm.
- Nuts conform to the requirements of ASTM A563, Grade A, Hex.
- Washers conform to the requirements of ASTM F844.
- Expansion sleeves (wedges) are manufactured from carbon steel.

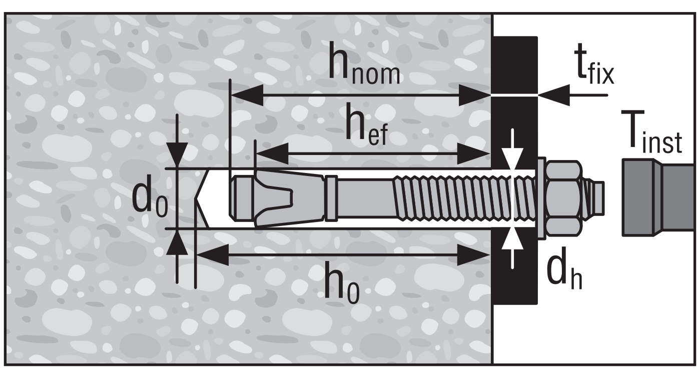
INSTALLATION PARAMETERS

Table 1 — Hilti KB1 setting information for installation in concrete and grout-filled concrete masonry units (CMU)

Setting information	Symbol	Units	Nominal anchor diameter (in)							
			3/8		1/2		5/8		3/4	
Nominal drill bit diameter	d_o	in.	3/8		1/2		5/8		3/4	
Effective minimum embedment	h_{ef}	in.	1-1/2 [1]	2	2	3-1/4	2-3/4	4	3-1/4	4-3/4
		(mm)	(38)	(51)	(51)	(83)	(70)	(102)	(83)	(121)
Nominal minimum embedment	h_{nom}	in.	1-7/8 [1]	2-3/8	2-3/8	3-5/8	3-1/4	4-1/2	4	5-1/2
		(mm)	(48)	(60)	(60)	(92)	(83)	(114)	(102)	(140)
Minimum hole depth	h_0	in.	2-1/8 [1]	2-3/4	2-3/4	4-1/4	3-3/4	4-3/4	4-1/4	5-3/4
		(mm)	(54)	(70)	(70)	(108)	(95)	(121)	(108)	(146)
Fixture hole diameter	d_h	in.	7/16		9/16		11/16		13/16	
		(mm)	(11.1)		(14.3)		(17.5)		(20.6)	
Installation torque Concrete	$T_{inst,conc}$	ft-lb	20		40		60		110	
		(Nm)	(27)		(54)		(81)		(149)	
Installation torque Grout-filled CMU	$T_{inst,CMU}$	ft-lb	15		25		35		50	
		(Nm)	(20)		(34)		(47)		(68)	

1 Effective embedment, h_{ef} = 1-1/2-in. not applicable for grout-filled CMU base material.

Figure 1 — Hilti KB1 setting information for installation in concrete and grout-filled (CMU)



DESIGN INFORMATION IN CONCRETE PER ACI 318

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 IAPMO UES ER-678 and the equations within ACI 318-14 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables refer to section 3.1.8 of the North American Product Technical Guide: Volume 2: Anchor Fastening Technical Guide, Edition 19 (PTG 19). Data tables from ER-678 are not contained in this section but can be found at www.uniform-es.org or at www.hilti.com.

Table 2 — Hilti KB1 design strength based on concrete failure modes in uncracked concrete [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
3/8	1-1/2 (38)	1-7/8 (48)	1,435 (6.4)	1,570 (7.0)	1,815 (8.1)	2,220 (9.9)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
	2 (51)	2-3/8 (60)	2,070 (9.2)	2,130 (9.5)	2,230 (9.9)	2,380 (10.6)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
1/2	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)
	3-1/4 (83)	3-5/8 (92)	4,570 (20.3)	5,005 (22.3)	5,780 (25.7)	7,080 (31.5)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	2-3/4 (70)	3-1/4 (83)	3,145 (14.0)	3,445 (15.3)	3,980 (17.7)	4,875 (21.7)	7,660 (34.1)	8,395 (37.3)	9,690 (43.1)	11,870 (52.8)
	4 (102)	4-1/2 (114)	5,875 (26.1)	6,435 (28.6)	7,435 (33.1)	9,105 (40.5)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-1/4 (83)	4 (102)	4,570 (20.3)	5,005 (22.3)	5,780 (25.7)	7,080 (31.5)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
	4-3/4 (121)	5-1/2 (140)	8,075 (35.9)	8,845 (39.3)	10,215 (45.4)	12,510 (55.6)	17,390 (77.4)	19,050 (84.7)	22,000 (97.9)	26,945 (119.9)

Table 3 — Hilti KB1 design strength based on concrete failure modes in cracked concrete [1,2,3,4,5]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
3/8	1-1/2 (38)	1-7/8 (48)	1,015 (4.5)	1,110 (4.9)	1,285 (5.7)	1,570 (7.0)	1,095 (4.9)	1,195 (5.3)	1,385 (6.2)	1,695 (7.5)
	2 (51)	2-3/8 (60)	1,565 (7.0)	1,710 (7.6)	1,975 (8.8)	2,420 (10.8)	1,685 (7.5)	1,845 (8.2)	2,130 (9.5)	2,605 (11.6)
1/2	2 (51)	2-3/8 (60)	1,565 (7.0)	1,710 (7.6)	1,975 (8.8)	2,420 (10.8)	1,685 (7.5)	1,845 (8.2)	2,130 (9.5)	2,605 (11.6)
	3-1/4 (83)	3-5/8 (92)	3,235 (14.4)	3,545 (15.8)	4,095 (18.2)	5,015 (22.3)	6,970 (31.0)	7,640 (34.0)	8,820 (39.2)	10,800 (48.0)
5/8	2-3/4 (70)	3-1/4 (83)	2,520 (11.2)	2,760 (12.3)	3,185 (14.2)	3,905 (17.4)	5,425 (24.1)	5,945 (26.4)	6,865 (30.5)	8,405 (37.4)
	4 (102)	4-1/2 (114)	4,420 (19.7)	4,840 (21.5)	5,590 (24.9)	6,845 (30.4)	9,520 (42.3)	10,430 (46.4)	12,040 (53.6)	14,750 (65.6)
3/4	3-1/4 (83)	4 (102)	3,245 (14.4)	3,555 (15.8)	4,105 (18.3)	5,025 (22.4)	8,615 (38.3)	9,435 (42.0)	10,895 (48.5)	13,345 (59.4)
	4-3/4 (121)	5-1/2 (140)	5,780 (25.7)	6,335 (28.2)	7,315 (32.5)	8,955 (39.8)	15,220 (67.7)	16,670 (74.2)	19,250 (85.6)	23,575 (104.9)

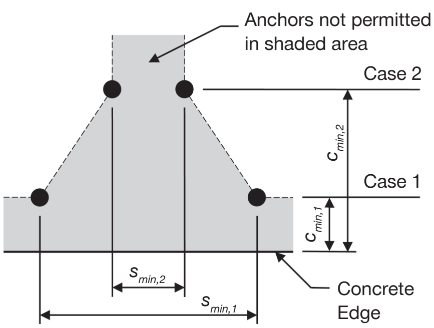
1 See PTG 19 Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 13 as necessary. Compare to the steel values in 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. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.67. No reduction needed for seismic shear. See PTG 19 Section 3.1.8 for additional information on seismic applications.

Table 4 — Hilti KB1 design strength based on steel failure [1,2]

Nominal anchor diameter in.	Tensile [3] ΦN_{sa} lb (kN)	Shear [4] ΦV_{sa} lb (kN)	Seismic Shear [5] ΦV_{sa} lb (kN)
3/8	4,760 (21.2)	1,655 (7.4)	1,655 (7.4)
1/2	8,145 (36.2)	3,395 (15.1)	3,395 (15.1)
5/8	12,875 (57.3)	5,790 (25.8)	5,790 (25.8)
3/4	18,220 (81.0)	6,995 (31.1)	5,950 (26.5)
3/4x12	15,790 (70.2)	6,460 (28.7)	5,490 (24.4)

1 See PTG 19 Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KB1 anchors are to be considered ductile steel elements, with the exception of the 3/4x12 KB1 which is a brittle steel element.
3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Ch. 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 Ch. 17.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17. See PTG 19 Section 3.1.8 for additional information on seismic applications.

Figure 2



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

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

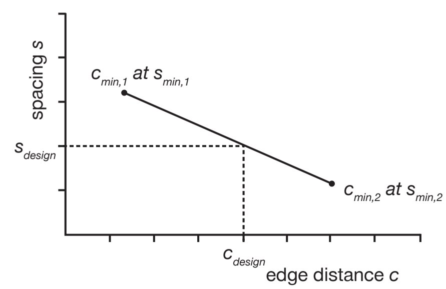


Table 5 — Hilti KB1 installation parameters in concrete [1]

Setting information	Symbol	Units	Nominal anchor diameter (mm)							
			3/8		1/2		5/8		3/4	
Effective minimum embedment	h_{ef}	in. (mm)	1-1/2 (38)	2 (51)	2 (51)	3-1/4 (83)	2-3/4 (70)	4 (102)	3-1/4 (83)	4-3/4 (121)
Minimum concrete thickness	h_{min}	in. (mm)	3-3/8 (83)	4 (102)	4 (102)	6 (152)	5 (127)	6 (152)	5-1/2 (140)	8 (203)
Case 1	$c_{min,1}$	in. (mm)	8 (203)	2-1/2 (64)	4 (102)	2-3/4 (70)	5-1/2 (140)	4-1/4 (108)	9-1/2 (241)	4-1/2 (114)
	for $s_{min,1} \geq$	in. (mm)	8 (203)	7 (178)	8-1/2 (216)	7 (178)	8 (203)	4-1/4 (108)	5 (127)	7 (178)
Case 2	$c_{min,2}$	in. (mm)	8 (203)	6 (152)	7 (178)	4 (102)	8 (203)	4-1/4 (108)	9-1/2 (241)	6-1/2 (165)
	for $s_{min,2} \geq$	in. (mm)	8 (203)	3-1/2 (89)	5 (127)	4 (102)	5-1/2 (140)	4-1/4 (108)	5 (127)	4 (102)

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 $c_{min1} < c < c_{min2}$ will determine the permissible spacings.

Table 6 — Load adjustment factors for 3/8-in. diameter Hilti KB1 in uncracked concrete [1,2]

3/8-in. KB1 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: ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Embedment h_{ef} in (mm)		1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)
Embedment h_{nom} in (mm)		1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/2 (64)	n/a	n/a	n/a	0.52	n/a	n/a	n/a	0.35	n/a	0.52	n/a	n/a
	3-3/8 (86)	n/a	n/a	n/a	0.68	n/a	n/a	n/a	0.55	n/a	0.68	0.53	n/a
	3-1/2 (89)	n/a	0.79	n/a	0.70	n/a	0.62	n/a	0.59	n/a	0.70	0.54	n/a
	4 (102)	n/a	0.83	n/a	0.80	n/a	0.63	n/a	0.72	n/a	0.80	0.58	0.73
	5 (127)	n/a	0.92	n/a	1.00	n/a	0.67	n/a	1.00	n/a	1.00	0.65	0.82
	6 (152)	n/a	1.00	n/a	1.00	n/a	0.70	n/a	1.00	n/a	1.00	0.71	0.89
	7 (178)	n/a	1.00	n/a		n/a	0.73	n/a		n/a		0.76	0.97
	8 (203)	1.00		1.00		0.67	0.77	1.00		1.00		0.82	1.00
	9 (229)					0.69	0.80					0.87	
	10 (254)					0.71	0.83					0.91	
	11 (279)					0.73	0.87					0.96	
	12 (305)					0.75	0.90					1.00	
	> 14 (356)					0.79	0.97						

Table 7 — Load adjustment factors for 3/8-in. diameter Hilti KB1 in cracked concrete [1,2]

3/8-in. KB1 cracked 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: ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Embedment h_{ef} in (mm)		1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)	1-1/2 (38)	2 (51)
Embedment h_{nom} in (mm)		1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)	1-7/8 (48)	2-3/8 (60)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/2 (64)	n/a	n/a	n/a	0.87	n/a	n/a	n/a	0.49	n/a	0.87	n/a	n/a
	3-3/8 (86)	n/a	n/a	n/a	1.00	n/a	n/a	n/a	0.77	n/a	1.00	0.85	n/a
	3-1/2 (89)	n/a	0.79	n/a	1.00	n/a	0.65	n/a	0.82	n/a	1.00	0.86	n/a
	4 (102)	n/a	0.83	n/a	1.00	n/a	0.67	n/a	1.00	n/a	1.00	0.92	0.82
	5 (127)	n/a	0.92	n/a	1.00	n/a	0.71	n/a	1.00	n/a	1.00	1.00	0.91
	6 (152)	n/a	1.00	n/a	1.00	n/a	0.75	n/a		n/a	1.00		1.00
	7 (178)	n/a	1.00	n/a		n/a	0.79	n/a		n/a			
	8 (203)	1.00		1.00		0.93	0.83	1.00		1.00			
	9 (229)					0.98	0.87						
	10 (254)					1.00	0.92						
	11 (279)						0.96						
	12 (305)						1.00						
	> 14 (356)												

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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ 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 Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 8 — Load adjustment factors for 1/2-in. diameter Hilti KB1 in uncracked concrete [1,2]

1/2-in. KB1 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 ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Embedment h_{ef} in (mm)		2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)
Embedment h_{nom} in (mm)		2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm): 2-3/4	(70)	n/a	n/a	n/a	0.33	n/a	n/a	n/a	0.14	n/a	0.29	n/a	n/a
3	(76)	n/a	n/a	n/a	0.35	n/a	n/a	n/a	0.16	n/a	0.33	n/a	n/a
3-1/2	(89)	n/a	n/a	n/a	0.38	n/a	n/a	n/a	0.21	n/a	0.38	n/a	n/a
4	(102)	n/a	0.71	0.67	0.42	n/a	0.57	0.54	0.25	0.67	0.42	0.67	n/a
5	(127)	0.92	0.76	0.83	0.50	0.64	0.58	0.76	0.35	0.83	0.50	0.75	n/a
6	(152)	1.00	0.81	1.00	0.60	0.67	0.60	1.00	0.46	1.00	0.60	0.82	0.63
7	(178)	1.00	0.86	1.00	0.70	0.69	0.62	1.00	0.59	1.00	0.70	0.88	0.68
8	(203)		0.91		0.80	0.72	0.63		0.72		0.80	0.94	0.73
8-1/2	(216)		0.94		0.85	0.74	0.64		0.78		0.85	0.97	0.75
9	(229)		0.96		0.90	0.75	0.65		0.85		0.90	1.00	0.77
10	(254)		1.00		1.00	0.78	0.67		1.00		1.00		0.82
11	(279)					0.81	0.68						0.86
12	(305)					0.83	0.70						0.89
14	(356)					0.89	0.73						0.97
16	(406)					0.94	0.77						1.00
18	(457)					1.00	0.80						
20	(508)						0.83						
> 24	(610)						0.90						

Table 9 — Load adjustment factors for 1/2-in. diameter Hilti KB1 in cracked concrete [1,2]

1/2-in. KB1 cracked 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 ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Embedment h_{ef} in (mm)		2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)	2 (51)	3-1/4 (83)
Embedment h_{nom} in (mm)		2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)	2-3/8 (60)	3-5/8 (92)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm): 2-3/4	(70)	n/a	n/a	n/a	0.68	n/a	n/a	n/a	0.16	n/a	0.33	n/a	n/a
3	(76)	n/a	n/a	n/a	0.71	n/a	n/a	n/a	0.19	n/a	0.38	n/a	n/a
3-1/2	(89)	n/a	n/a	n/a	0.79	n/a	n/a	n/a	0.24	n/a	0.47	n/a	n/a
4	(102)	n/a	0.71	1.00	0.86	n/a	0.57	1.00	0.29	1.00	0.58	0.84	n/a
5	(127)	0.92	0.76	1.00	1.00	0.72	0.59	1.00	0.40	1.00	0.81	0.94	n/a
6	(152)	1.00	0.81	1.00		0.76	0.61	1.00	0.53	1.00	1.00	1.00	0.66
7	(178)	1.00	0.86	1.00		0.81	0.63	1.00	0.67	1.00			0.71
8	(203)	1.00	0.91			0.85	0.65		0.82				0.76
8-1/2	(216)	1.00	0.94			0.87	0.65		0.90				0.79
9	(229)		0.96			0.90	0.66		0.98				0.81
10	(254)		1.00			0.94	0.68		1.00				0.85
11	(279)					0.98	0.70						0.90
12	(305)					1.00	0.72						0.94
14	(356)						0.76						1.00
16	(406)						0.79						
18	(457)						0.83						
20	(508)						0.86						
> 24	(610)						0.94						

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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ 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 Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 10 — Load adjustment factors for 5/8-in. diameter Hilti KB1 in uncracked concrete [1,2]

5/8-in. KB1 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 ‖ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Embedment h_{ef} in (mm)			2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)
Embedment h_{nom} in (mm)			3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	4-1/4	(108)	n/a	0.68	n/a	0.52	n/a	0.57	n/a	0.26	n/a	0.51	n/a	n/a
	5	(127)	n/a	0.71	n/a	0.58	n/a	0.58	n/a	0.33	n/a	0.58	0.55	n/a
	5-1/2	(140)	0.83	0.73	0.50	0.62	0.58	0.59	0.35	0.38	0.50	0.62	0.58	n/a
	6	(152)	0.86	0.75	0.55	0.67	0.59	0.59	0.40	0.43	0.55	0.67	0.60	0.62
	7	(178)	0.92	0.79	0.64	0.78	0.61	0.61	0.51	0.54	0.64	0.78	0.65	0.67
	8	(203)	0.98	0.83	0.73	0.89	0.62	0.63	0.62	0.66	0.73	0.89	0.70	0.71
	9	(229)	1.00	0.88	0.82	1.00	0.64	0.64	0.74	0.79	0.82	1.00	0.74	0.75
	10	(254)		0.92	0.91		0.65	0.66	0.87	0.92	0.91		0.78	0.80
	12	(305)		1.00	1.00		0.68	0.69	1.00	1.00	1.00		0.85	0.87
	14	(356)					0.71	0.72					0.92	0.94
	16	(406)					0.74	0.75					0.98	1.00
	18	(457)					0.77	0.78					1.00	
	20	(508)					0.80	0.82						
	24	(610)					0.86	0.88						
	> 30	(762)					0.95	0.97						

Table 11 — Load adjustment factors for 5/8-in. diameter Hilti KB1 in cracked concrete [1,2]

5/8-in. KB1 cracked 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 ‖ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Embedment h_{ef} in (mm)			2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)	2-3/4 (70)	4 (102)
Embedment h_{nom} in (mm)			3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)	3-1/4 (83)	4-1/2 (114)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	4-1/4	(108)	n/a	0.68	n/a	0.78	n/a	0.57	n/a	0.26	n/a	0.52	n/a	n/a
	5	(127)	n/a	0.71	n/a	0.87	n/a	0.58	n/a	0.33	n/a	0.66	0.66	n/a
	5-1/2	(140)	0.83	0.73	1.00	0.93	0.62	0.59	0.62	0.38	1.00	0.76	0.70	n/a
	6	(152)	0.86	0.75	1.00	1.00	0.63	0.60	0.71	0.43	1.00	0.87	0.73	0.62
	7	(178)	0.92	0.79	1.00		0.65	0.61	0.89	0.55	1.00	1.00	0.79	0.67
	8	(203)	0.98	0.83	1.00		0.68	0.63	1.00	0.67	1.00		0.84	0.71
	9	(229)	1.00	0.88			0.70	0.64		0.80			0.89	0.76
	10	(254)		0.92			0.72	0.66		0.93			0.94	0.80
	12	(305)		1.00			0.76	0.69		1.00			1.00	0.87
	14	(356)					0.81	0.72						0.94
	16	(406)					0.85	0.75						1.00
	18	(457)					0.90	0.79						
	20	(508)					0.94	0.82						
	24	(610)					1.00	0.88						
	> 30	(762)						0.98						

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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ 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 Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 12 — Load adjustment factors for 3/4-in. diameter Hilti KB1 in uncracked concrete [1,2]

3/4-in. KB1 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 ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Embedment h_{ef} in (mm)		3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)
Embedment h_{nom} in (mm)		4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)													
4	(102)	n/a	0.64	n/a	n/a	n/a	0.56	n/a	n/a	n/a	n/a	n/a	n/a
4-1/2	(114)	n/a	0.66	n/a	0.47	n/a	0.56	n/a	0.24	n/a	0.47	n/a	n/a
5	(127)	0.76	0.68	n/a	0.50	0.57	0.57	n/a	0.28	n/a	0.50	n/a	n/a
5-1/2	(140)	0.78	0.69	n/a	0.53	0.58	0.58	n/a	0.32	n/a	0.53	0.55	n/a
6-1/2	(165)	0.83	0.73	n/a	0.60	0.59	0.59	n/a	0.41	n/a	0.60	0.60	n/a
7	(178)	0.86	0.75	n/a	0.64	0.60	0.60	n/a	0.46	n/a	0.64	0.62	n/a
8	(203)	0.91	0.78	n/a	0.73	0.61	0.61	n/a	0.56	n/a	0.73	0.67	0.67
9-1/2	(241)	0.99	0.83	0.79	0.86	0.63	0.63	0.70	0.72	0.79	0.86	0.73	0.73
10	(254)	1.00	0.85	0.83	0.91	0.64	0.64	0.76	0.78	0.83	0.91	0.75	0.75
12	(305)		0.92	1.00	1.00	0.67	0.67	1.00	1.00	1.00	1.00	0.82	0.82
16	(406)		1.00			0.72	0.73					0.94	0.95
20	(508)					0.78	0.78					1.00	1.00
24	(610)					0.83	0.84						
30	(762)					0.92	0.92						
> 36	(914)					1.00	1.00						

Table 13 — Load adjustment factors for 3/4-in. diameter Hilti KB1 in cracked concrete [1,2]

3/4-in. KB1 cracked 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 ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Embedment h_{ef} in (mm)		3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)	3-1/4 (83)	4-3/4 (121)
Embedment h_{nom} in (mm)		4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)	4 (102)	5-1/2 (140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)													
4	(102)	n/a	0.64	n/a	n/a	n/a	0.55	n/a	n/a	n/a	n/a	n/a	n/a
4-1/2	(114)	n/a	0.66	n/a	0.73	n/a	0.56	n/a	0.19	n/a	0.39	n/a	n/a
5	(127)	0.76	0.68	n/a	0.77	0.59	0.56	n/a	0.23	n/a	0.45	n/a	n/a
5-1/2	(140)	0.78	0.69	n/a	0.83	0.59	0.57	n/a	0.26	n/a	0.52	0.61	n/a
6-1/2	(165)	0.83	0.73	n/a	0.93	0.61	0.58	n/a	0.33	n/a	0.67	0.67	n/a
7	(178)	0.86	0.75	n/a	0.99	0.62	0.59	n/a	0.37	n/a	0.75	0.69	n/a
8	(203)	0.91	0.78	n/a	1.00	0.64	0.60	n/a	0.46	n/a	0.91	0.74	0.63
9-1/2	(241)	0.99	0.83	1.00		0.66	0.62	0.97	0.59	1.00	1.00	0.81	0.69
10	(254)	1.00	0.85			0.67	0.62	1.00	0.64			0.83	0.70
12	(305)		0.92			0.71	0.65		0.84			0.91	0.77
16	(406)		1.00			0.77	0.70		1.00			1.00	0.89
20	(508)					0.84	0.75						0.99
24	(610)					0.91	0.80						1.00
30	(762)					1.00	0.87						
> 36	(914)						0.94						

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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ 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 Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 14 — Hilti KB1 design strength in the soffit of uncracked lightweight concrete over metal deck [1,2,3,4,5,6]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Installation per Figure 3				Installation per Figure 4			
			Min. conc. thickness [10] in. (mm)	Tension - ΦN_n		Shear - ΦV_n	Min. conc. thickness [10] in. (mm)	Tension - ΦN_n		Shear - ΦV_n
				f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c ≥ 3,000 psi (20.7 MPa) lb (kN)		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c ≥ 3,000 psi (20.7 MPa) lb (kN)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	1,025 (4.6)	1,185 (5.3)	645 (2.9)	n/a	n/a	n/a	n/a
	2 (51)	2-3/8 (60)	2-1/2 (64)	1,600 (7.1)	1,850 (8.2)	1,435 (6.4)	2-1/2 (64)	1,265 (5.6)	1,460 (6.5)	1,815 (8.1)
1/2	2 (51)	2-3/8 (60)	2-1/2 (64)	1,495 (6.7)	1,725 (7.7)	1,480 (6.6)	2-1/2 (64)	1,355 (6.0)	1,565 (7.0)	2,015 (9.0)
	3-1/4 (83)	3-5/8 (92)	2-1/2 (64)	2,725 (12.1)	3,145 (14.0)	2,355 (10.5)	3-1/4 (83)	1,920 (8.5)	2,215 (9.9)	3,105 (13.8)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	2,410 (10.7)	2,785 (12.4)	2,275 (10.1)	3-1/4 (83)	1,505 (6.7)	1,740 (7.7)	2,595 (11.5)
	4 (102)	4-1/2 (114)	2-1/2 (64)	3,300 (14.7)	3,810 (16.9)	3,080 (13.7)	n/a	n/a	n/a	n/a
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	2,285 (10.2)	2,640 (11.7)	3,030 [9] (13.5) [9]	n/a	n/a	n/a	n/a

Table 15 — Hilti KB1 design strength in the soffit of cracked lightweight concrete over metal deck [1,2,3,4,5,6,7]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Installation per Figure 3				Installation per Figure 4			
			Min. conc. thickness [10] in. (mm)	Tension - ΦN_n		Shear - ΦV_n	Min. conc. thickness [10] in. (mm)	Tension - ΦN_n		Shear - ΦV_n
				f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c ≥ 3,000 psi (20.7 MPa) lb (kN)		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c ≥ 3,000 psi (20.7 MPa) lb (kN)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	725 (3.2)	835 (3.7)	645 (2.9)	n/a	n/a	n/a	n/a
	2 (51)	2-3/8 (60)	2-1/2 (64)	1,210 (5.4)	1,395 (6.2)	1,435 (6.4)	2-1/2 (64)	955 (4.2)	1,105 (4.9)	1,815 (8.1)
1/2	2 (51)	2-3/8 (60)	2-1/2 (64)	1,060 (4.7)	1,225 (5.4)	1,480 (6.6)	2-1/2 (64)	960 (4.3)	1,110 (4.9)	2,015 (9.0)
	3-1/4 (83)	3-5/8 (92)	2-1/2 (64)	1,930 (8.6)	2,230 (9.9)	2,355 (10.5)	3-1/4 (83)	1,360 (6.0)	1,570 (7.0)	3,105 (13.8)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	1,930 (8.6)	2,230 (9.9)	2,275 (10.1)	3-1/4 (83)	1,205 (5.4)	1,390 (6.2)	2,595 (11.5)
	4 (102)	4-1/2 (114)	2-1/2 (64)	2,480 (11.0)	2,865 (12.7)	3,080 (13.7)	n/a	n/a	n/a	n/a
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	2,000 (8.9)	2,310 (10.3)	3,030 [8,9] (13.5) [8,9]	n/a	n/a	n/a	n/a

1 See PTG 19 Section 3.1.8 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 for lightweight concrete is needed.
5 Minimum edge distance is 3 x h_{ef} (effective embedment).
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. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.67. See PTG 19 Section 3.1.8 for additional information on seismic applications.
8 For the 3/4-inch diameter anchor, an additional factor for seismic shear, $\alpha_{N,seis}$ = 0.85, must be applied to the cracked concrete tabular values for seismic conditions. See PTG 19 Section 3.1.8 for additional information on seismic applications.
9 For the 3/4x12 KB1, multiply tabular value by 0.92.
10 Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 3 and 4.

Figure 3 — Installation in the soffit of concrete over metal deck floor and roof assemblies – W deck

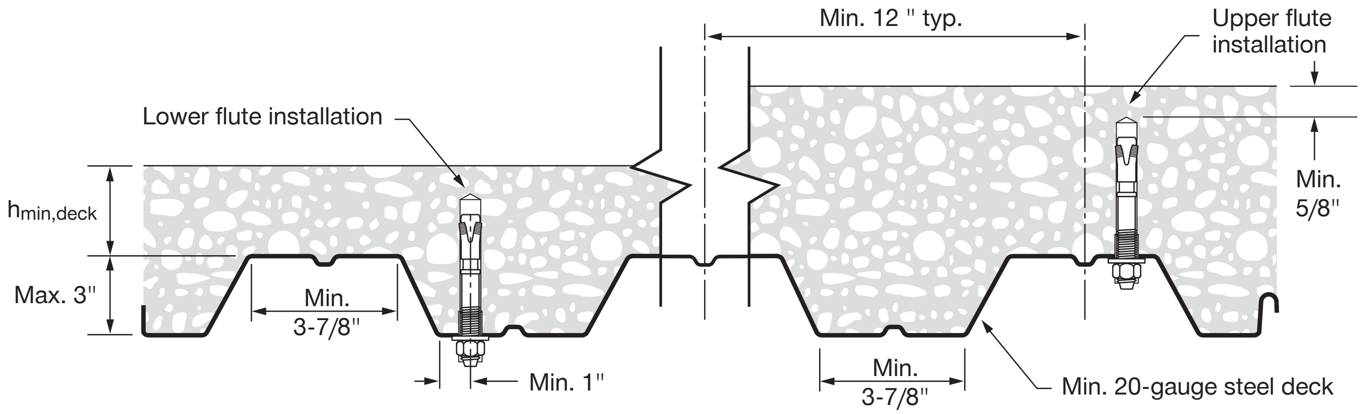
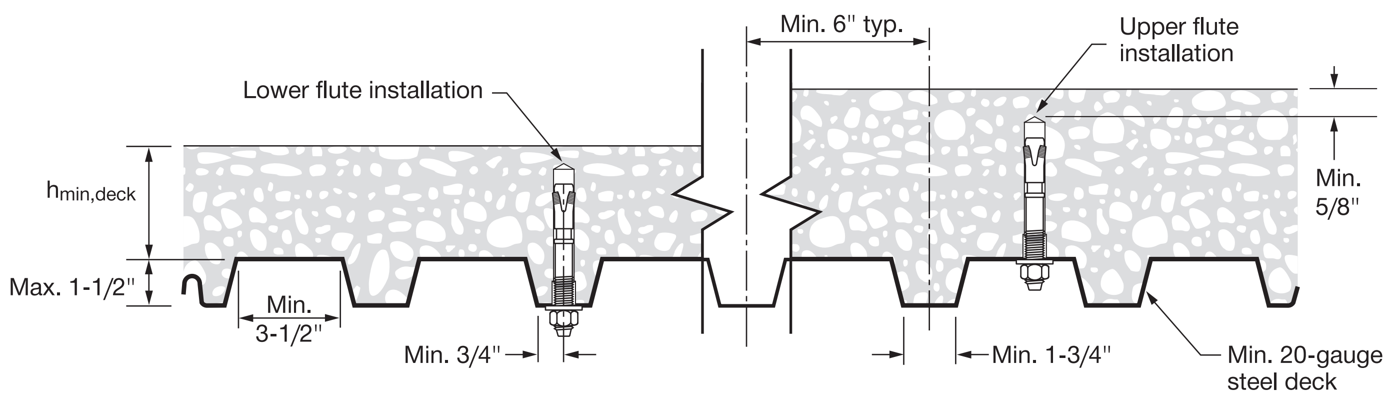


Figure 4 — Installation in the soffit of concrete over metal deck floor and roof assemblies – B deck



DESIGN DATA IN CONCRETE PER CSA A23.3

CSA A23.3-14 Annex D Design

Limit State Design of anchors is described in the provisions of CSA A23.3-19 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. Table 19 in this section contains the Limit State Design tables that are based on the published loads in IAPMO Evaluation Report ER 678 and converted for use with CSA A23.3 Annex D. Tables 16 to 18 and Tables 21 and 22 below are Hilti Simplified Design Tables which are pre-factored resistance tables based on the design parameters and variables in Table 19. 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 Annex D, refer to Section 3.1.8 of the Volume 2: Anchor Fastening Technical Guide Ed. 19 (PTG 19). Technical assistance is available by contacting Hilti Canada at (800) 363 4458 or at www.hilti.ca.

Table 16 — Hilti KB1 factored resistance based on concrete failure modes in uncracked concrete [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				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)	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)
3/8	1-1/2 (38)	1-7/8 (48)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
	2 (51)	2-1/2 (64)	2,125 (9.5)	2,200 (9.8)	2,265 (10.1)	2,375 (10.6)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)
1/2	2 (51)	2-1/2 (64)	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)	4,940 (22.0)	5,525 (24.6)	6,050 (26.9)	6,990 (31.1)	9,885 (44.0)	11,050 (49.2)	12,105 (53.8)	13,975 (62.2)
5/8	2-3/4 (70)	3-1/4 (83)	3,385 (15.1)	3,785 (16.8)	4,145 (18.4)	4,785 (21.3)	7,655 (34.0)	8,560 (38.1)	9,375 (41.7)	10,825 (48.2)
	4 (102)	4-1/2 (114)	6,330 (28.2)	7,075 (31.5)	7,750 (34.5)	8,950 (39.8)	13,465 (59.9)	15,055 (67.0)	16,490 (73.4)	19,040 (84.7)
3/4	3-1/4 (83)	4 (102)	4,940 (22.0)	5,525 (24.6)	6,050 (26.9)	6,990 (31.1)	9,885 (44.0)	11,050 (49.2)	12,105 (53.8)	13,975 (62.2)
	4-3/4 (121)	5-1/2 (140)	8,700 (38.7)	9,725 (43.3)	10,655 (47.4)	12,300 (54.7)	17,395 (77.4)	19,450 (86.5)	21,305 (94.8)	24,600 (109.4)

Table 17 — Hilti KB1 factored resistance based on concrete failure modes in cracked concrete [1,2,3,4,5]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				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)	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)
3/8	1-1/2 (38)	1-7/8 (48)	1,090 (4.9)	1,220 (5.4)	1,335 (5.9)	1,545 (6.9)	1,090 (4.9)	1,220 (5.4)	1,335 (5.9)	1,545 (6.9)
	2 (51)	2-1/2 (64)	1,680 (7.5)	1,880 (8.4)	2,060 (9.2)	2,375 (10.6)	1,680 (7.5)	1,880 (8.4)	2,060 (9.2)	2,375 (10.6)
1/2	2 (51)	2-1/2 (64)	1,690 (7.5)	1,890 (8.4)	2,070 (9.2)	2,390 (10.6)	1,690 (7.5)	1,890 (8.4)	2,070 (9.2)	2,390 (10.6)
	3-1/4 (83)	3-5/8 (92)	3,510 (15.6)	3,925 (17.4)	4,295 (19.1)	4,960 (22.1)	7,015 (31.2)	7,845 (34.9)	8,595 (38.2)	9,925 (44.1)
5/8	2-3/4 (70)	3-1/4 (83)	2,715 (12.1)	3,040 (13.5)	3,330 (14.8)	3,845 (17.1)	5,435 (24.2)	6,075 (27.0)	6,655 (29.6)	7,685 (34.2)
	4 (102)	4-1/2 (114)	4,780 (21.3)	5,345 (23.8)	5,855 (26.0)	6,760 (30.1)	9,560 (42.5)	10,690 (47.5)	11,710 (52.1)	13,520 (60.1)
3/4	3-1/4 (83)	4 (102)	3,495 (15.5)	3,905 (17.4)	4,280 (19.0)	4,945 (22.0)	8,695 (38.7)	9,725 (43.3)	10,650 (47.4)	12,300 (54.7)
	(121)	5-1/2 (140)	6,235 (27.7)	6,970 (31.0)	7,635 (34.0)	8,815 (39.2)	15,310 (68.1)	17,115 (76.1)	18,750 (83.4)	21,650 (96.3)

1 See PTG 19 Section 3.1.8 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 13 as necessary. Compare to the steel values in table 18. 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. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.67. No reduction needed for seismic shear. See PTG 19 Section 3.1.8 for additional information on seismic applications

Table 18 — Steel resistance for Hilti KB1 carbon steel anchors[1,2]

Anchor diameter in.	Tensile [3] N_{sar} lb (kN)	Shear [4] V_{sar} lb (kN)	Seismic Shear [5] $V_{sar,eq}$ lb (kN)
3/8	4,315 (19.2)	1,620 (7.2)	1,620 (7.2)
1/2	7,385 (32.8)	3,330 (14.8)	3,330 (14.8)
5/8	11,670 (51.9)	5,675 (25.2)	5,675 (25.2)
3/4	16,520 (73.5)	6,865 (30.5)	5,835 (26.0)
3/4x12	14,455 (64.3)	5,950 (26.5)	5,055 (22.5)

1 See PTG 19 Section 3.1.8 to convert factored resistance value to ASD value.
2 Hilti KB1 anchors are to be considered ductile steel elements, with the exception of the 3/4x12 KB1 which is a brittle steel element.
3 Tensile N_{sar} = Ase,N ϕ_s f_{uta} R as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with $V_{sar} < 0.6\ {}_{Ase,V}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \le 0.60\ A_{se,V}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D. See PTG 19 Section 3.1.8 for additional information on seismic applications.

Table 19 — Hilti KB1 carbon steel design information in concrete in accordance with CSA A23.3-14 Annex D [1]

Design parameter	Symbol	Units	3/8		1/2		5/8		3/4		Ref A23.3-04
Anchor O.D.	d_a	in. (mm)	0.375 (9.5)		0.5 (12.7)		0.625 (15.9)		0.75 (19.1)		
Effective min. embedment [2]	h_{ef}	in. (mm)	1-1/2 (38)	2 (51)	2 (51)	3-1/4 (83)	2-3/4 (70)	4 (102)	3-1/4 (83)	4-3/4 (121)	
Min. concrete thickness	h_{min}	in. (mm)	See Table 5								
Minimum edge distance	c_{min}	in. (mm)	See Table 5								
Minimum anchor spacing	s_{min}	in. (mm)	See Table 5								
Min. specified yield strength	f_{ya}	psi (N/mm²)	95,100 (656)		84,700 (584)		83,500 (576)		81,200 (560)		
Min. specified ult. strength	f_{ut}	psi (N/mm²)	118,900 (820)		105,900 (730)		104,400 (720)		101,500 (700)		
Effective tensile stress area	$A_{se,N}$	in² (mm²)	0.053 (34)		0.103 (66)		0.164 (106)		0.239 (154)		
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85		0.85		0.85		0.85		8.4.3
Resistance modification factor for tension, steel failure modes [3]	R	-	0.80		0.80		0.80		0.80 [4]		D.5.3
Resistance modification factor for shear, steel failure modes [3]	R	-	0.75		0.75		0.75		0.75 [4]		D.5.3
Factored steel resistance in tension	N_{sar}	lb (kN)	4,315 (19.2)		7,385 (32.8)		11,670 (51.9)		16,520 [4] (73.5)		D.6.1.2
Factored steel resistance in shear	V_{sar}	lb (kN)	1,620 (7.2)		3,330 (14.8)		5,675 (25.2)		6,865 [4] (30.5)		D.7.1.2
Factored steel resistance in shear, seismic	$V_{sar,eq}$	lb (kN)	1,620 (7.2)		3,330 (14.8)		5,675 (25.2)		5,835 [4] (26.0)		
Critical edge distance	c_{ac}	in. (mm)	8 (203)	5 (127)	6 (152)	10 (254)	11 (279)	9 (229)	12 (305)	11 (279)	
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10.0		10.0		10.0		10.0		D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	-	7.1		7.1		7.1		8.8		D.6.2.2
Modification factor for anchor resistance, tension, uncracked conc. [5]	$y_{c,N}$	-	1.0		1.0		1.0		1.0		D.6.2.6
Anchor category	-	-	1		1		1		1		D.5.3 (c)
Concrete material resistance factor	Φ_c	-	0.65		0.65		0.65		0.65		8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [6]	R	-	1.00		1.00		1.00		1.00		D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete [7]	$N_{pr,uncr}$	lb (kN)	n/a	2,190 (9.7)	n/a	n/a	3,390 (15.1)	6,335 (28.2)	n/a	n/a	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete [7]	$N_{pr,cr}$	lb (kN)	n/a	n/a	n/a	n/a	n/a	n/a	3,500 (15.6)	6,235 (27.7)	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete, seismic [7]	$N_{pr,eq}$	lb (kN)	n/a	n/a	n/a	3,335 (14.8)	n/a	n/a	3,500 (15.6)	5,605 (24.9)	D.6.3.2

1 Design information in this table is taken from IAPMO ER-678, dated December 1, 2020,Tables 4 and 5, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB1 is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2, with the exception of the 3/4x12 KB1 which is considered a brittle steel element with R = 0.70 for steel failure in tension and R = 0.65 for steel failure in shear.
4 For the 3/4x12 KB1, R = 0.70 for steel failure in tension and R = 0.65 for steel failure in shear. Multiply factored steel resistance in tension, N_{sar}, by 0.875, and multiply factored steel resistance in shear, V_{sar}, and seismic shear, $V_{sar,eq}$, by 0.87.
5 For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
6 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 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.
7 For all design cases, $\Psi_{c,P}$ = 1.0. Tabular value for pullout strength is for a concrete compressive strength of 2,900 psi (20.0 MPa). Pullout strength for concrete compressive strength greater than 2,900 psi (20.2 MPa) may be increased by multiplying the tabular pullout strength by $(f'_c / 2{,}900)n$ for psi, or $(f'_c / 20.2)n$ for MPa, where n is as follows:
3/8-in. diameter: n = 0.16
1/2-in. diameter: n = 0.23
5/8-in and 3/4-in diameter: n = 0.50
NA (not applicable) denotes that pullout strength does not need to be considered for design.

Table 20 — Hilti KB1 factored resistance in the soffit of uncracked lightweight concrete over metal deck [1,2,3,4,5,6]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Installation per Figure 3				Installation per Figure 4			
			Min. conc. thickness [10] in. (mm)	Tension - N_r		Shear - V_r	Min. conc. thickness [10] in. (mm)	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)		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)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	860 (3.8)	1,000 (4.4)	635 (2.8)	n/a	n/a	n/a	n/a
	2 (51)	2-3/8 (60)	2-1/2 (64)	1,580 (7.0)	1,845 (8.2)	1,405 (6.2)	2-1/2 (64)	1,250 (5.6)	2,130 (9.5)	1,815 (8.1)
1/2	2 (51)	2-3/8 (60)	2-1/2 (64)	1,485 (6.6)	1,630 (7.3)	1,455 (6.5)	2-1/2 (64)	1,345 (6.0)	1,830 (8.1)	1,650 (7.3)
	3-1/4 (83)	3-5/8 (92)	2-1/2 (64)	2,705 (12.0)	2,970 (13.2)	2,310 (10.3)	3-1/4 (83)	1,905 (8.5)	2,795 (12.4)	2,515 (11.2)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	2,370 (10.5)	2,905 (12.9)	2,230 (9.9)	3-1/4 (83)	1,480 (6.6)	3,685 (16.4)	3,000 (13.3)
	4 (102)	4-1/2 (114)	2-1/2 (64)	3,245 (14.4)	3,970 (17.7)	3,020 (13.4)	n/a	n/a	n/a	n/a
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	2,245 (10.0)	2,750 (12.2)	2,970 [9] (13.2) [9]	n/a	n/a	n/a	n/a

Table 21 — Hilti KB1 carbon steel factored resistance in the soffit of cracked lightweight concrete over metal deck [1,2,3,4,5,6,7]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Installation per Figure 3				Installation per Figure 4			
			Min. conc. thickness [10] in. (mm)	Tension - N_r		Shear - V_r	Min. conc. thickness [10] in. (mm)	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)		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)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	610 (2.7)	710 (3.2)	635 (2.8)	n/a	n/a	n/a	n/a
	2 (51)	2-3/8 (60)	2-1/2 (64)	1,195 (5.3)	1,390 (6.2)	1,405 (6.2)	2-1/2 (64)	945 (4.2)	1,100 (4.9)	1,780 (7.9)
1/2	2 (51)	2-3/8 (60)	2-1/2 (64)	1,050 (4.7)	1,155 (5.1)	1,455 (6.5)	2-1/2 (64)	950 (4.2)	1,045 (4.6)	1,975 (8.8)
	3-1/4 (83)	3-5/8 (92)	2-1/2 (64)	1,915 (8.5)	2,105 (9.4)	2,310 (10.3)	3-1/4 (83)	1,350 (6.0)	1,480 (6.6)	3,045 (13.5)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	1,900 (8.5)	2,325 (10.3)	2,230 (9.9)	3-1/4 (83)	1,185 (5.3)	1,450 (6.4)	2,545 (11.3)
	4 (102)	4-1/2 (114)	2-1/2 (64)	2,440 (10.9)	2,985 (13.3)	3,020 (13.4)	n/a	n/a	n/a	n/a
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	1,965 (8.7)	2,405 (10.7)	2,970 [8,9] (13.2) [8,9]	n/a	n/a	n/a	n/a

1 See PTG 19 Section 3.1.8 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 for lightweight concrete is needed.
5 Minimum edge distance is 3 x h_{ef} (effective embedment).
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. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.67. See PTG 19 Section 3.1.8 for additional information on seismic applications.
8 For the 3/4-inch diameter anchor, an additional factor for seismic shear, $\alpha_{V,seis}$ = 0.85, must be applied to the cracked concrete tabular values for seismic conditions. See PTG 19 Section 3.1.8 for additional information on seismic applications.
9 For the 3/4x12 KB1, multiply tabular value by 0.92.
10 Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 3 and 4.

DESIGN DATA IN GROUT-FILLED CMU

The following design information is the allowable load tables for use in grout-filled CMU block walls that are based on the published loads in IAPMO Evaluation Report ER 677. This data is applicable for both the US and Canada.

Table 22 — Allowable tensile loads for Hilti KB1 in the face of grout-filled concrete masonry unit (CMU) walls [1,3,4,5,6]

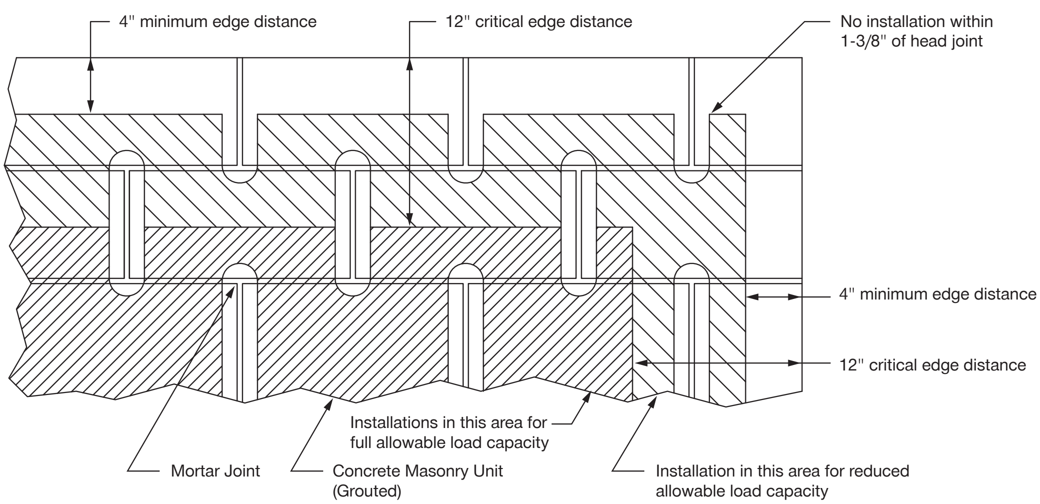
Nominal anchor diameter	Nominal embedment		Allowable tension capacity at s_{cr} and c_{cr}		Spacing					Edge Distance				
					Critical spacing, s_{cr}		Minimum spacing, s_{min} [2]		Load reduction factor at s_{min}	Critical edge distance, c_{cr}		Minimum edge distance, c_{min}		Load reduction factor at c_{min}
in.	in.	(mm)	lb	(kN)	in	(mm)	in	(mm)		in	(mm)	in	(mm)	
3/8	2-3/8	(60)	350	(1.6)	8	(203)	3	(76)	0.56	12	(305)	4	(102)	0.87
1/2	2-3/8	(60)	615	(2.7)	8	(203)	4	(102)	0.54					0.88
	3-5/8	(92)	1,055	(4.7)	13	(330)			0.48					0.94
5/8	3-1/4	(83)	965	(4.3)	11	(279)	5	(127)	0.62					0.86
	4-1/2	(114)	1,140	(5.1)	16	(406)			0.76					1.00
3/4	4	(102)	1,085	(4.8)	13	(330)	6	(152)	0.55					0.84
	5-1/2	(140)	1,130	(5.0)	19	(483)			0.69					0.75

Table 23 — Allowable shear loads for Hilti KB1 in the face of grout-filled concrete masonry unit (CMU) walls [1,3,4,5,6]

Nominal anchor diameter	Nominal embedment		Allowable tension capacity at s_{cr} and c_{cr}		Spacing					Edge Distance					
					Critical spacing, s_{cr}		Minimum spacing, s_{min} [2]		Load reduction factor at s_{min}	Critical edge distance, c_{cr}		Minimum edge distance, c_{min}		Perpendicular load reduction factor at c_{min}	Parallel load reduction factor at c_{min}
in.	in.	(mm)	lb	(kN)	in	(mm)	in	(mm)		in	(mm)	in	(mm)		
3/8	2-3/8	(60)	575	(2.6)	8	(203)	3	(76)	0.84	12	(305)	4	(102)	0.94	0.94
1/2	2-3/8	(60)	960	(4.3)	8	(203)	4	(102)						0.72	1.00
	3-5/8	(92)													
5/8	3-1/4	(83)	1,370	(6.1)	11	(279)	5	(127)						0.64	0.83
	4-1/2	(114)													
3/4	4	(102)	1,370	(6.1)	13	(330)	6	(152)						0.64	0.83
	5-1/2	(140)													

1 Values valid for anchors installed in face shells of Type 1, Grade N, lightweight, medium-weight, or normal-weight concrete masonry units conforming to ASTM C90. The masonry units must be fully grouted with coarse grout conforming to the 2018 and 2015 IBC Section 2103.3, or 2012 IBC Section 2103.13. Mortar must comply with 2018 and 2015 IBC Section 2103.2, or 2012 IBC Section 2103.9. Masonry compressive strength must be at least 1,500 psi at the time of anchor installation.
2 Loads tabulated are applicable to anchors spaced a critical distance of 4 times the embedment depth. The anchors may be placed at a minimum spacing, s_{min}, provided that reductions are applied to the tabulated values.
3 Anchors must be installed a minimum of 1-3/8 inches from any vertical mortar joint (head joint) in accordance with Figure 5.
4 Embedment depth must be measured from the outside face of the concrete masonry unit.
5 For intermediate edge distances and spacings, allowable loads may be determined by linearly interpolating between the allowable loads at the two tabulated edge distances.
6 The tabulated allowable loads have calculated based on a safety factor of 5.0

Figure 5 — Acceptable locations (shaded areas) for Hilti KB1 anchors in the face of grout-filled concrete masonry unit (CMU) walls



Anchor installation is restricted to shaded areas

INSTALLATION INSTRUCTIONS

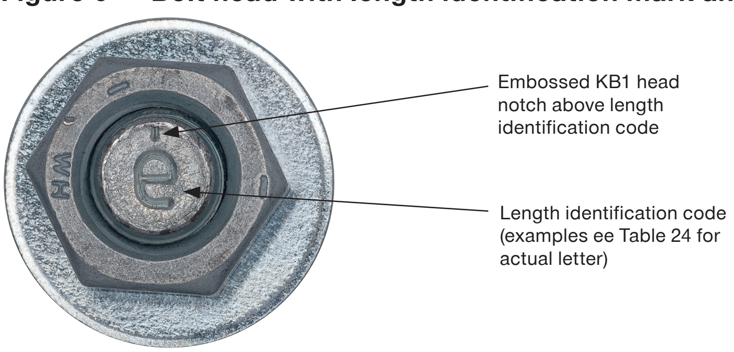
Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training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

ORDERING INFORMATION

Table 24 — Hilti KB1 product portfolio

Description	Length (in)	Length ident. letter	Thread length (in)	Nominal embed. 1 (in)	Min. fixture thickness 1 (in)	Max. fixture thickness 1 (in)	Nominal embed. 2 (in)	Min. fixture thickness 2 (in)	Max. fixture thickness 2 (in)	Packaging quantity
KB1 3/8x2 1/2	2-1/2	c	1	1-7/8	0	1/4	-	-	-	50
KB1 3/8x3	3	d	1-5/8	1-7/8	0	3/4	2-3/8	0	1/4	50
KB1 3/8x3 3/4	3-3/4	e	2-3/8	1-7/8	0	1-1/2	2-3/8	0	1	50
KB1 3/8x5	5	h	3-5/8	1-7/8	0	2-3/4	2-3/8	0	2-1/4	50
KB1 1/2x3	3	d	1-1/8	2-3/8	0	1/16	-	-	-	20
KB1 1/2x3 3/4	3-3/4	e	2	2-3/8	0	3/4	-	-	-	20
KB1 1/2x4 1/2	4-1/2	g	2-5/8	2-3/8	0	1-1/2	3-5/8	0	1/4	20
KB1 1/2x5 1/2	5-1/2	i	3-5/8	2-3/8	0	2-1/2	3-5/8	0	1-1/4	20
KB1 1/2x7	7	l	4-1/2	2-3/8	1/2	4	3-5/8	0	2-3/4	20
KB1 5/8x4 1/4	4-1/4	f	2-1/4	3-1/4	0	3/8	-	-	-	15
KB1 5/8x4 3/4	4-3/4	g	2-3/4	3-1/4	0	7/8	-	-	-	15
KB1 5/8x6	6	j	4	3-1/4	0	2-1/8	4-1/2	0	7/8	15
KB1 5/8x7	7	l	5	3-1/4	0	3-1/8	4-1/2	0	1-7/8	15
KB1 5/8x8 1/2	8-1/2	o	6-1/2	3-1/4	0	4-5/8	4-1/2	0	3-3/8	15
KB1 3/4x4 3/4	4-3/4	g	2-1/2	4	0	1/8	-	-	-	10
KB1 3/4x5 1/2	5-1/2	i	3-1/4	4	0	7/8	-	-	-	10
KB1 3/4x7	7	l	4	4	0	2-3/8	5-1/2	0	7/8	10
KB1 3/4x8	8	n	5	4	0	3-3/8	5-1/2	0	1-7/8	10
KB1 3/4x10	10	r	7	4	0	5-3/8	5-1/2	0	3-7/8	10
KB1 3/4x12	12	t	6	4	2-5/8	7-3/8	5-1/2	1-1/8	5-7/8	10

Figure 6 — Bolt head with length identification mark and KB1 head notch embossment



Hilti, Inc.
1-800-879-8000 | en español 1-800-879-5000
www.hilti.com

Hilti (Canada) Corporation
1-800-363-4458
www.hilti.ca

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