RSN: 1702607
Permit # 2023-2304917-CT
Sheet 1 of 60

TMCA MED CENTER SOUTH OR SURGERY WAITING

1501 SOUTH POTOMAC STREET
AURORA, CO 80012

FIRE PROTECTION SUBMITTAL

L. NOTHHAFT & SON INC.
FIRE SPRINKLER CONTRACTORS

2520 W. 62nd COURT DENVER, COLORADO 80221
(P) 303.433.3329
(F) 303.433.2432
STATE OF COLORADO REGISTRATION NUMBER 23-S-05273
CITY OF AURORA LICENSE #2023 2287562 00 CL

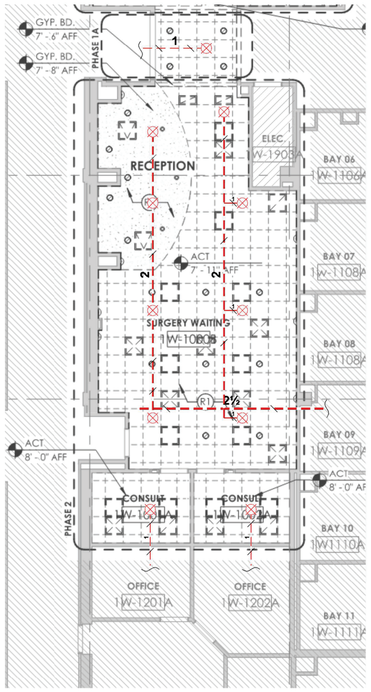
PROJECT DIRECTORY

ARCHITECT	OWNER	GENERAL CONTRACTOR
PATH21 ARCHITECTURE 2245 CURTIS ST. STE. 100 DENVER, CO 80502 303.630.9261	THE MEDICAL CENTER OF AURORA 1501 S. POTOMAC ST. AURORA, CO 80012 303.873.4895	THE TKM GROUP LLC 11891 EAST 33RD AVE. STE A&B AURORA, CO 80010 303.356.4550

Provide a full size set of legible approved construction documents **PRINTED IN COLOR** for review by the Field Inspector.

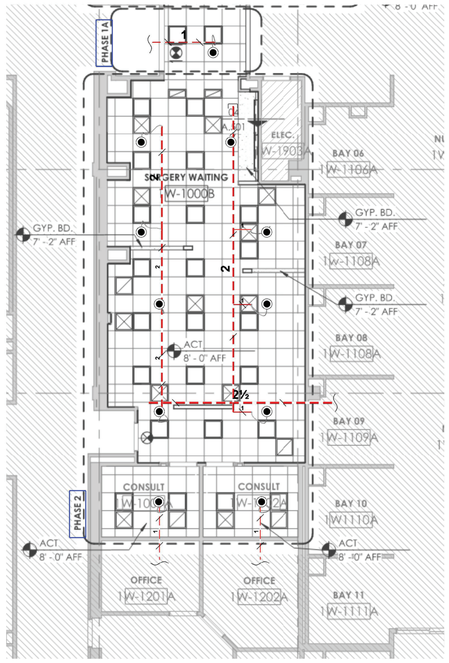
COA Adopted Codes for this project:
ICC-2021 - NEC-2020
NFPA 13-2019 - NFPA 72-2019
COA Amendments 22 & 66

City of Aurora Building Division
Counter Permit intake by: GRP
Date: Apr 18, 2023
RSN: 1702607
Permit: 2023-2304917-CT



TMCA MED CENTER SOUTH OR SURGERY WAITING-PHASE 2 DEMO
SCALE: 1/8" = 1'-0"

0' 2' 4' 8' 16'



TMCA MED CENTER SOUTH OR SURGERY WAITING-PHASE 2 NEW
SCALE: 1/8" = 1'-0"

0' 2' 4' 8' 16'

*THE SCOPE OF WORK WILL NOT AFFECT THE EXISTING HYDRAULIC DESIGN AREA.

PROJECT DESCRIPTION

REFINISH OF AN EXISTING OR WAITING AREA AND TWO CONSULT ROOMS TO IMPROVE CIRCULATION AND FLOW OF THE SPACE. THE REGISTRATION DESK WILL BE RELOCATED TO SUPPORT THIS NEW FLOW AND PARTITIONS WILL BE ADDED. THE WORK IS TO BE PHASED AND ACCESS TO THE OR SUITE MUST BE MAINTAINED THROUGHOUT CONSTRUCTION. SCOPE TO INCLUDE UPDATED LIGHTING, ELECTRICAL, PLUMBING, CASEWORK, FURNISHINGS AND FINISHES. OVERALL PROJECT AREA IS APPROXIMATELY 1885 SF.

PROJECT DATA

- **CODES/ LAWS:**
  CITY OF AURORA:
  2021 INTERNATIONAL BUILDING CODE (IBC)
  2021 INTERNATIONAL MECHANICAL CODE (IMC)
  2021 INTERNATIONAL FUEL GAS CODE (IFGC)
  2021 INTERNATIONAL FIRE CODE (IFC)
  2021 INTERNATIONAL PLUMBING CODE (IPC)
  2021 INTERNATIONAL EXISTING BUILDING CODE (IEBC)
  2021 INTERNATIONAL ENERGY CONSERVATION CODE (IECC)
  2020 NATIONAL ELECTRICAL CODE (NEC)

  STATE OF COLORADO:
  2006 COLORADO DEPARTMENT OF HEALTH AND ENVIRONMENT - HOSPITAL LICENSING RULES
  2012 NFPA 101 - LIFE SAFETY CODE
  FEDERAL:
  2010 AMERICANS WITH DISABILITIES ACT GUIDELINES
  2017 ICC / ANSI A117.1 ACCESSIBILITY CODE
- **OCCUPANCY CLASSIFICATION:**
  2015 IBC - GROUP I-2 (SECTION 308.4)
  2012 NFPA 101 - EXISTING HEALTHCARE OCCUPANCY (CHAPTER 19)
- **PRINCIPAL OCCUPANCY TYPE:** I-2
- **CONSTRUCTION TYPE:**

  EXISTING: SBC - TYPE 1-A, UNRESTRAINED, FULLY SPRINKLERED

  NEW: 2021 IBC - TYPE 1-A, FULLY SPRINKLERED
  2012 NFPA 220 - TYPE 1 (332)

DEMOLITION REFLECTED CEILING PLAN LEGEND

- EXISTING PARTITION TO REMAIN
- EXISTING PARTITION TO BE REMOVED
- OUT OF SCOPE
- EXISTING SUPPLY DIFFUSER TO BE REMOVED, RE: MECHANICAL
- EXISTING RETURN DIFFUSER TO BE REMOVED, RE: MECHANICAL
- EXISTING ACCESS PANEL TO BE REMOVED, RE: MECHANICAL
- EXISTING LIGHT FIXTURE TO BE REMOVED, RE: ELECTRICAL
- EXISTING CAN LIGHT TO BE REMOVED, RE: ELECTRICAL
- EXISTING WALL SCONCE TO BE REMOVED, RE: ELECTRICAL

DEMOLITION REFLECTED CEILING PLAN NOTES

(R1) WOODEN TRIM TO BE REMOVED THROUGHOUT.
(R2) REMOVE EXISTING GYPSUM BOARD SOFFIT.

Sprinkler Legend-Office Level 1

Symbol	Quantity	SIN	K-Factor	Type	Size	Response	Finish	Temperature	Note
◉	11	RA1414	5.6	Pendent	½	Quick	Chrome	175°F	
	Total = 11								

SCOPE OF WORK

1. REMODEL PHASE 2 TO INCLUDE: TURN 11 EXISTING TEMPORARY UPRIGHTS INTO PENDENT TYPE SPRINKLERS FOR NEW FLOOR AND CEILING LAYOUT.
2. PROVIDE DAILY DRAIN SYSTEM RE-FILL.
3. ALL OTHER SPRINKLERS TO REMAIN AS IS.
4. ALL WORK DURING NORMAL HOURS.

PIPING SPECIFICATIONS

WET PIPE SYSTEM: ALL WET PIPING IS BLACK STEEL.
1. THREADED PIPING IS SCHEDULE #40

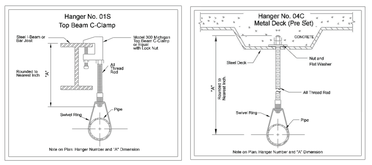
FITTING SPECIFICATIONS:
THREADED FITTINGS ARE BLACK CAST, MALLEABLE OR DUCTILE IRON AND CONFIRM WITH ANSI B16.4

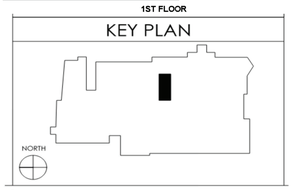
HANGERS:
PIPE HANGERS SHALL BE IN ACCORDANCE WITH NFPA #13 AND ARE LISTED BY UNDERWRITERS LABORATORIES. HANGER ROD DIAMETERS SHALL BE AS FOLLOWS:
1" THROUGH 4" PIPE 3/8" ROD

SHEET INDEX

FP1----------SPRINKLER WORKING, VICINITY MAP AND GENERAL NOTES

DEMO:
EXISTING:
NEW:





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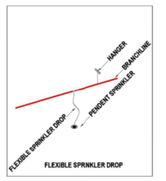

SPRINKLER DETAIL:
SCALE: NOT TO SCALE

REFLECTED CEILING PLAN LEGEND

- OUT OF SCOPE
- SUSPENDED 2' x 2' ACOUSTICAL CEILING SYSTEM
- GYPSUM WALL BOARD CEILING
- ~~METAL PLANK LINEAR CEILING SYSTEM~~
  ***CHANGED TO 2'X2' ACOUSTIC CEILING TILE**
- CEILING TYPE / CEILING HEIGHT DESIGNATION
  9'-0" AFF
- NEW RECESSED LIGHT FIXTURE, RE: ELECTRICAL
- SUPPLY AIR GRILLE, RE: MECHANICAL
- RETURN AIR GRILLE, RE: MECHANICAL
- SUPPLY STRIP DIFFUSER RE: MECHANICAL
- EXIT SIGN W/ DIRECTION, RE: ELECTRICAL
- ~~STRIP COVE LIGHTING, RE: ELECTRICAL~~
- ~~INTEGRATED CEILING SYSTEM LIGHTING, RE: ELECTRICAL~~
- UNDER CABINET TASK LIGHTING, RE: ELECTRICAL
- ACCENT PENDANT LIGHT, RE: ELECTRICAL

STEEL PIPE HANGER SPACING UNDER 100 PSI

PIPE SIZE	BETWEEN HANGERS	TO END OF LINE	ARM-OVER MAX. LEGNTH TOTAL OF HORZ PIPE TO A DROP AND/OR SPRIG)
1"	12'-0"	(SSP) 3'-0" (SSU) 3'-0"	(SSP) 2'-0" (SSU) 2'-0"
1¼"	12'-0"	(SSP) 4'-0" (SSU) 4'-0"	(SSP) 2'-0" (SSU) 2'-0"
1½"	15'-0"	(SSP) 5'-0" (SSU) 5'-0"	(SSP) 2'-0" (SSU) 2'-0"
2"	15'-0"	(SSP) 5'-0" (SSU) 5'-0"	(SSP) 2'-0" (SSU) 2'-0"

CHECKED BY
Harry Nothhaft - Nicet Level IV - 069601

Harold Nothhaft II
Digitally signed by Harold Nothhaft II
DN: C=US, E=hnothhaft@nothhaft.com, OU="NICET 4 #069601", CN=Harold Nothhaft II
Date: 2023.04.13 09:06:41-06'00'

REVISIONS

DESCRIPTION	DATE	BY
PERMIT	4-13-23	JN

PROJECT CONTACTS

ARCHITECT: JOHN MAS-303.830.0261
PATH21 ARCHITECTURE
2245 CURTIS ST. STE. 100
DENVER, CO 80502

GENERAL CONTRACTOR: KYLE MCLEAR-303.506.7964
THE TKM GROUP
11891 EAST 33RD AVE. STE A&B
AURORA, CO 80112

BUILDING OWNER: JONATHAN CONLON-303.873.4845
THE MEDICAL CENTER OF AURORA
1501 S. POTOMAC ST
AURORA, CO 80012

REVISIONS

DESCRIPTION	DATE	JN
Submittal	4-13-23	X
		X

TMCA MED CENTER SOUTH OR SURGERY WAITING
1501 S. POTOMAC STREET
AURORA, CO 80012

L. NOTHHAFT & SON, INC.
FIRE SPRINKLER CONTRACTORS
2520 W. 62nd Court
Denver, Co 80221
PHONE 303-433-3329 FAX 303-433-2432
STATE REGISTRATION #23-S-05273

NORTH

NOTHHAFT JOB #	22-072
DRAWN BY	J. Nothhaft
SCALE	1/8"= 1'-0"
DATE	04/13/23
DRAWING NO.	FP- 1 of 1

RSN: 1702607
Permit # 2023-2304917-CT
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TMCA MED CENTER SOUTH OR SURGERY WAITING

1501 S. POTOMAC STREET
AURORA, CO 80012

FIRE PROTECTION EQUIPMENT SUBMITTALS

PREPARED BY:

L. NOTHHAFT & SON, INC.
2520 W. 62nd Court
DENVER, CO 80221
303-433-3329

JOB NUMBER 22-072

TMCA MED CENTER SOUTH OR SURGERY WAITING
1501 S. POTOMAC STREET
AURORA, CO 80012

INDEX

ITEM	MAKE	MODEL
PIPE	STATEMENT OF COMPLIANCE	SCHEDULE#40 PIPE AND FITTINGS
SPRINKLERS	RELIABLE	RA1414 Q.R. CHROME RECESSED PENDENT ½" K=5.6 175°
FLEX HEAD	RELIABLE	RASCOFLEX SPRINKLER CONNECTION
FITTINGS	ANVIL STAR	DUCTILE IRON FITTINGS CAST IRON FITTINGS MT-30 THREADED MECHANICAL TEE
HANGERS	PHD	ALL THREAD ROD FIG.20 RING HANGER FIG.141 BEAM CLAMP FIG.350
	HILTI	KWIK BOLT-TX EXPANSION ANCHORS

FIRE PROTECTION SPRINKLER SYSTEM
STATEMENT OF COMPLIANCE

TMCA MED CENTER SOUTH OR SURGERY WAITING
1501 S. POTOMAC STREET
AURORA, CO 80012

This is to certify that the piping to be used on this project conforms to the NFPA#13.

All threaded piping shall be Schedule #40 conforming to ASTM A-135 or A-795 or A53 with black standard weight cast iron or malleable or ductile iron screwed fittings.

We also certify that the fittings to be used on this project will be the following:

1. **Black cast iron, malleable or ductile iron screwed standard weight.**

Pipe hangers shall be listed by Underwriters Laboratories. Hanger spacing will be in accordance with NFPA #13. Hanger rod diameters shall be in accordance with NFPA #13 as follows:

1" thru 4" pipe.....3/8" All Thread Rod

RSN: 1702007
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Reliable®

F1FR56 Series
Quick Response Sprinklers

K-factor 5.6 (80)

Features

- Standard coverage quick-response sprinklers
- Upright, pendent, horizontal sidewall, and vertical sidewall deflectors
- Low profile, compact design
- Available in a wide variety of finishes

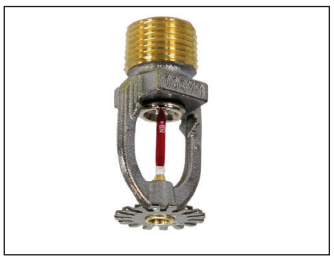
Product Description

Reliable Model F1FR56 series sprinklers are quick-response standard spray automatic fire sprinklers utilizing a sensitive 3.0 mm glass bulb thermal element.

Pendent and horizontal sidewall sprinklers may be installed exposed or surface mounted using escutcheons such as the Reliable Models B, C, or HB (reference Technical Bulletin 204). When installed recessed or concealed, the Model F1FR56 series sprinklers are specifically listed with and may only be installed with listed Reliable escutcheons and cover plates. Refer to the technical information on the following pages for specific listings for recessed and concealed installations and refer to Figures 5 and 6 for dimensional information.

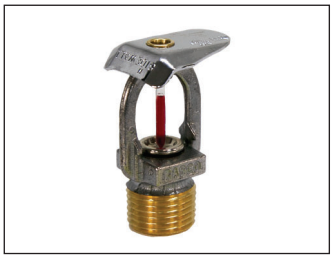
When fitted with an approved water shield, these sprinklers may considered intermediate sprinklers for use in racks, below grated walkways, and other areas where intermediate level sprinklers are required.

Table A provides a summary of the approvals and availability of specific Model F1FR series sprinkler configurations. Additional technical information for each sprinkler model is provided on the following pages.

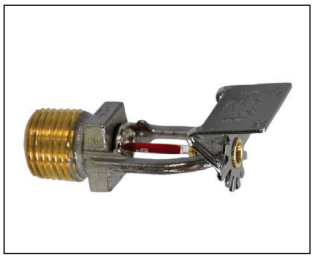


Model F1FR56 Pendent

Model F1FR56 Upright



Model F1FR56 Vertical Sidewall



Model F1FR56 Horizontal Sidewall

Note: Not all versions of the product are shown.

Note: This bulletin may contain information on New and Legacy sprinklers that reflects a dimensional change only. Sprinkler Identification Number (SIN), application, performance, and listings/approval are not otherwise affected. Sprinklers with New frames will include the suffix “N” in the order.

F1FR Series Sprinklers Summary — **Table A**

Sprinkler Model	K-Factor gpm/psi$^{1/2}$ (lpm/bar$^{1/2}$)	Orientation	Listings & Approvals	Max. Working Pressure psi (bar)	Sprinkler Identification Number (SIN)
F1FR56	5.6 (80)	Upright Intermediate Upright	cULus, FM, LPCB, VdS, EC, WM, UKCA	175 (12) 250 (17) (cULus only)	RA1425
		Pendent	cULus, FM, LPCB, VdS, EC, WM, UKCA	175 (12) 250 (17) (cULus only)	RA1414
		Concealed Pendent	cULus, VdS, EC, WM, UKCA	175 (12) 250 (17) (cULus only)	RA1414
		Horizontal Sidewall	cULus, FM	175 (12) 250 (17) (cULus only)	RA1435
		Vertical Sidewall	cULus, FM, LPCB, UKCA	175 (12)	RA1485

RSN: 1702607
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Model F1FR56 Upright Sprinkler

SIN RA1425

Technical Specifications
Style: Upright, Intermediate Upright
Threads: 1/2" NPT or ISO 7-R1/2
Nominal K-Factor: 5.6 (80 metric)
Max. Working Pressure:
175 psi (12 bar)
250 psi (17 bar) (cULus only)

Material Specifications
Thermal Sensor: 3 mm Glass Bulb
Sprinkler Frame: Brass Alloy
Cap: Bronze Alloy
Sealing Washer: Nickel with PTFE
Load Screw: Copper Alloy
Deflector: Brass Alloy

Sprinkler Finishes
(See Table B)

Sensitivity
Quick response

Temperature Ratings
135°F (57°C)
155°F (68°C)
175°F (79°C)
200°F (93°C)
286°F (141°C)

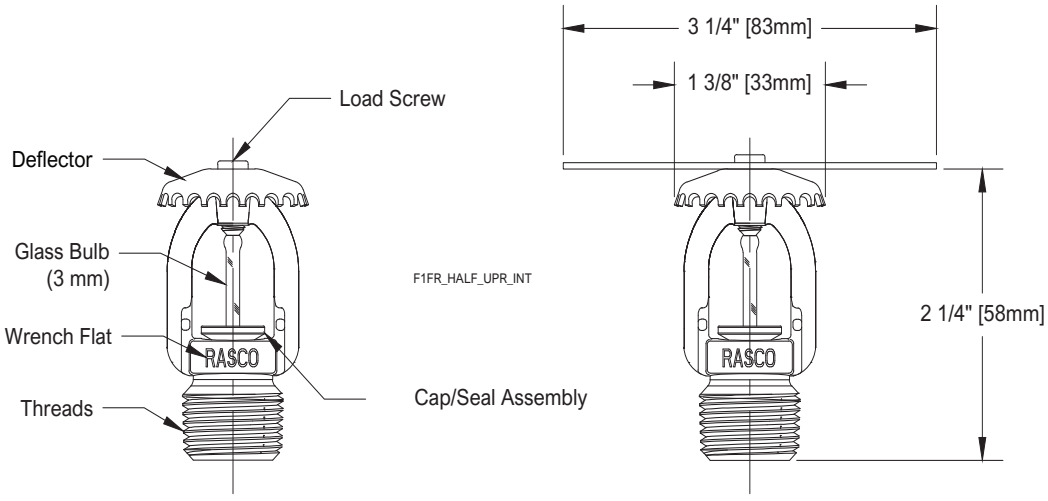
Guards & Shields (New Frames)
Factory Water Shield (cULus, FM)
F-1 Guard (cULus, FM)
F-3 Guard with Shield (cULus, FM)

Guards and Shields (Legacy Frames)
Factory Water Shield
C-1 Guard (FM)
C-3 Guard with Shield (cULus, FM)
D-1 Guard (cULus)
D-3 Guard with Shield (cULus)

Sprinkler Wrench
Model W2
Model J (New frame with guard installed)
Model JD (Legacy frame with guard installed)

Listings and Approvals
cULus Listed
FM Approved
LPCB
VdS
EC
WM
UKCA: 0832-UKCA-CPR-S5045

Model F1FR56 Upright Sprinkler Components and Dimensions — **Figure 1**



Shown with Optional
Factory Installed Water Shield
(Intermediate Upright)

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Model F1FR56 Pendent Sprinkler

SIN RA1414

Technical Specifications

Style:
Pendent
Recessed Pendent
Concealed Pendent

Threads: 1/2" NPT or ISO 7-R1/2

Nominal K-Factor: 5.6 (80 metric)

Max. Working Pressure:
175 psi (12 bar)
250 psi (17 bar) (cULus only)

Material Specifications

Thermal Sensor: 3 mm Glass Bulb
Sprinkler Frame: Brass Alloy
Cap: Bronze Alloy
Sealing Washer: Nickel with PTFE
Load Screw: Copper Alloy
Deflector: Brass Alloy

Sprinkler Finishes
(See Table B)

Sensitivity
Quick response

Temperature Ratings[1]
135°F (57°C)
155°F (68°C)
175°F (79°C)
200°F (93°C)
286°F (141°C)

Recessed Escutcheons
Model F1 (cULus, LPCB, VdS, CE, WM)
Model F2 (cULus, FM, LPCB, VdS, CE, WM)
Model FP (cULus, VdS, CE, WM)

Cover Plate
Model CCP (cULus, VdS[2], CE[2])

Guards & Shields (New Frames)[3]
F-1 Guard (FM)
F-5 Guard/Shield Kit (FM)
F-7 Guard (cULus)
F-8 Guard/Shield Kit (cULus)
S-1 Shield (cULus, FM)

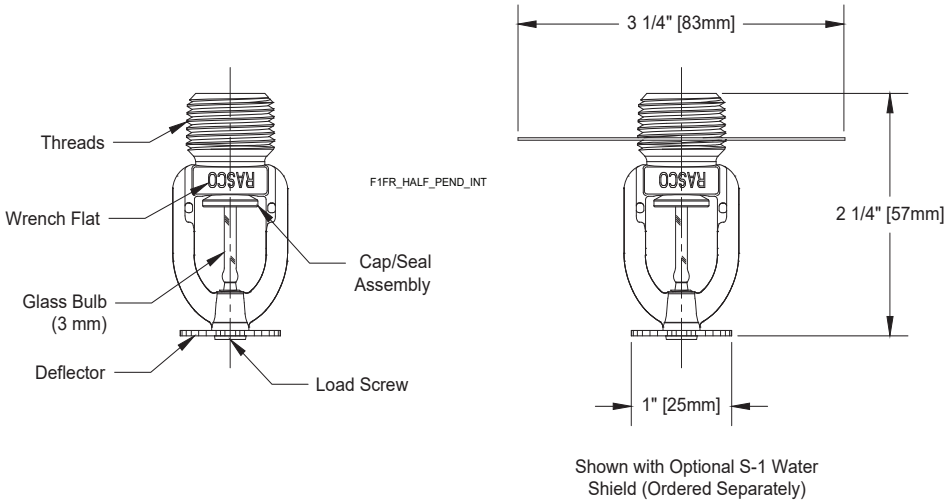
Guards & Shields (Legacy Frames)[3]
C-1 Guard (FM)
C-5 Guard/Shield Kit (FM)
D-1 Guard (cULus, FM)
D-4 Guard/Shield Kit (FM)
D-5 Guard/Shield Kit (cULus, FM)
S-1 Shield (cULus, FM)

Sprinkler Wrenches
Model W2 (pendent)
Model W4 (recessed or concealed)
Model J (New frame with guard installed)
Model JD (Legacy frame with guard installed)

Listings and Approvals[4]
cULus Listed
FM Approved
LPCB
VdS
EC
WM
UKCA: 0832-UKCA-CPR-S5045, 0831-UKCA-CPR-5072 (CCP)

Notes:
1. 286°F (141°C) temperature rated sprinkler not listed for recessed or concealed use.
2. VdS and CE approval for CCP concealed use is for 155°C (68°C) sprinkler ONLY.
3. Not suitable for recessed or concealed pendent installations.
4. When used surface mounted or exposed. See Recessed Escutcheon and Cover Plate section for specific approvals when installed recessed or concealed.

Model F1FR56 Pendent Sprinkler Components and Dimensions — **Figure 2**



Shown with Optional S-1 Water Shield (Ordered Separately)

Note: Please refer to Figure 8 for recessed and concealed installation.

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Model F1FR56 Horizontal Sidewall Sprinkler

SIN RA1435

Technical Specifications

Style:
Horizontal Sidewall
Recessed Horizontal Sidewall

Threads: 1/2" NPT or ISO 7-R1/2

Nominal K-Factor: 5.6 (80 metric)

Max. Working Pressure:
175 psi (12 bar)
250 psi (17 bar) (cULus only)

Material Specifications

Thermal Sensor: 3 mm Glass Bulb

Sprinkler Frame: Brass Alloy

Cap: Bronze Alloy

Sealing Washer: Nickel with PTFE

Load Screw: Copper Alloy

Deflector: Brass Alloy

Sprinkler Finishes
(See Table B)

Sensitivity
Quick response

Temperature Ratings [1]
135°F (57°C)
155°F (68°C)
175°F (79°C)
200°F (93°C)
286°F (141°C)

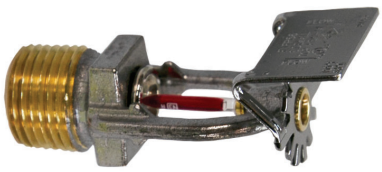
Recessed Escutcheons[2]
Model F1 (cULus)
Model F2 (cULus, FM)
Model FP (cULus)

Guards & Shields (New Frames)[3]
F-4 Guard (FM)
F-7 Guard (cULus)

Guards & Shields (Legacy Frames)[3]
C1 Guard (FM)
D1 Guard (cULus)

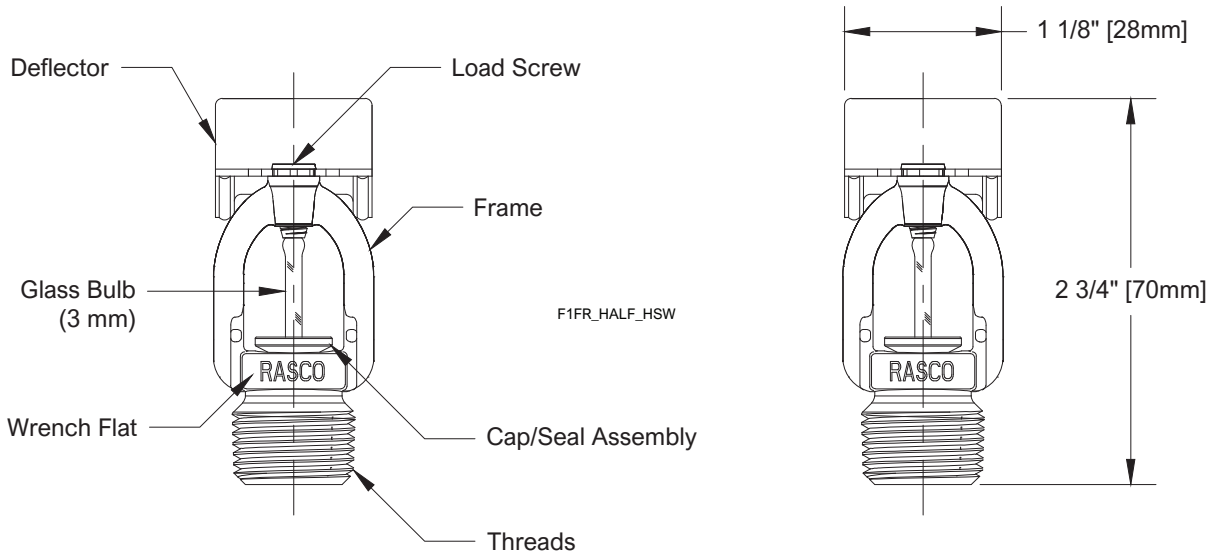
Sprinkler Wrenches
Model W2 (non-recessed)
Model W4 (recessed)
Model J (New frame with guard installed)
Model JD (Legacy frame with guard installed)

Listings and Approvals
cULus Listed[4]
FM Approved[5]



Notes:
1. 286°F (141°C) temperature rated sprinkler not listed for recessed use.
2. FM approved recessed installation when used with Model F2 escutcheon ONLY.
3. Not suitable for recessed horizontal sidewall installations.
4. cULus Listed for Light and Ordinary Hazard when installed exposed or surface mounted. Listed for Light Hazard ONLY when installed recessed.
5. FM Approved for Light Hazard ONLY.

Model F1FR56 Horizontal Sidewall Sprinkler Components and Dimensions — **Figure 3**



Note: Please refer to Figure 9 for recessed installation.

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Permit # 2023-2304917-CT
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Model F1FR56 Vertical Sidewall Sprinkler

SIN RA1485

Technical Specifications
Style:
Upright Vertical Sidewall
Pendent Vertical Sidewall
Threads: 1/2" NPT or ISO 7-R1/2
Nominal K-Factor: 5.6 (80 metric)
Max. Working Pressure: 175 psi (12 bar)

Material Specifications
Thermal Sensor: 3 mm Glass Bulb
Sprinkler Frame: Brass Alloy
Cap: Bronze Alloy
Sealing Washer: Nickel with PTFE
Load Screw: Copper Alloy
Deflector: Brass Alloy

Sprinkler Finishes
(See Table B)

Sensitivity
Quick response

Temperature Ratings
135°F (57°C)
155°F (68°C)
175°F (79°C)
200°F (93°C)
286°F (141°C)

Guards & Shields (New Frames)
F-2 Guard (FM)

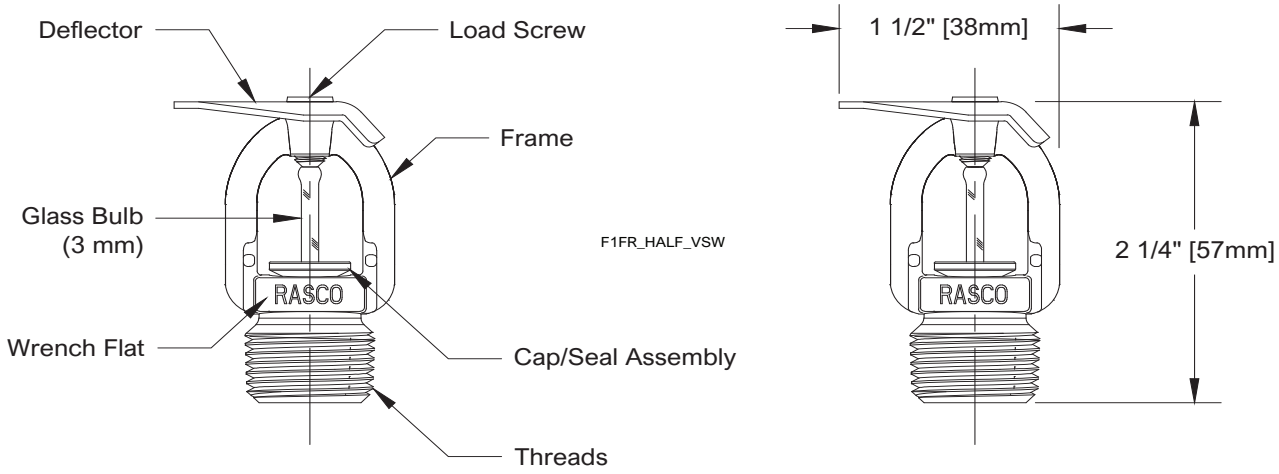
Guards & Shields (Legacy Frames)
C1 Guard (FM)

Sprinkler Wrenches
Model W2
Model J (New frame with guard installed)
Model JD (Legacy frame with guard installed)

Listings and Approvals[1]
cULus Listed
FM Approved
LPCB[2]
UKCA: 0832-UKCA-CPR-S5045

Notes:
1. Listed and approved for Light Hazard ONLY.
2. LPCB approved for use in pendent position ONLY.

Model F1FR56 Vertical Sprinkler Components and Dimensions — **Figure 4**



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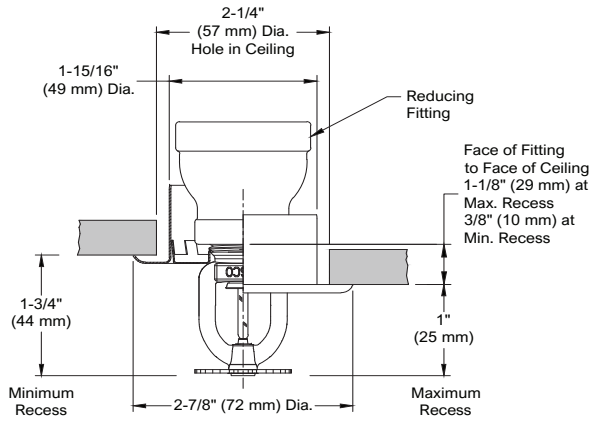
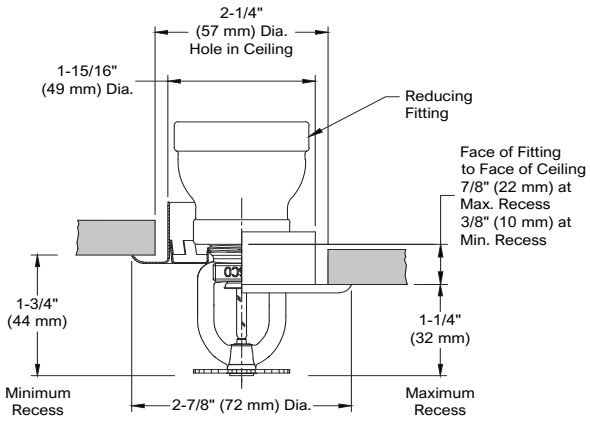
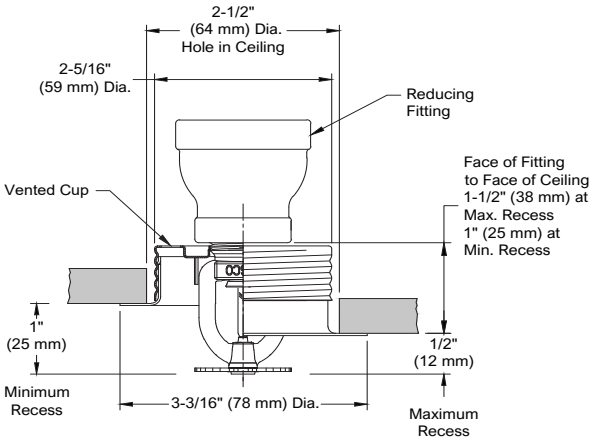


Models F1 & F1FR Pendent Sprinkler
with Model F1 Recessed Escutcheon
3/4" (19mm) Nominal Adjustment



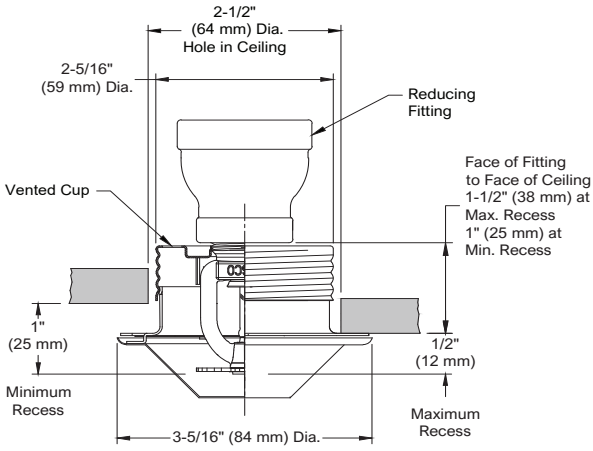
Models F1 & F1FR Pendent Sprinkler
with Model F2 Recessed Escutcheon
1/2" (13mm) Nominal Adjustment

F1_REC_PEND_CCP



Models F1 & F1FR Pendent Sprinkler
with Model FP Recessed Escutcheon
1/2" (13mm) Nominal Adjustment

Note: Model FP recessed assemblies may not be used where the pressure in the space above the ceiling is positive with respect to the protected area. Ensure that the openings in the Model FP cup are unobstructed following installation.



Model F1FR56 CCP Conical Concealed Sprinkler
1/2" (13mm) Nominal Adjustment
(Nominal Cover Plate Projection is 1" (25 mm))

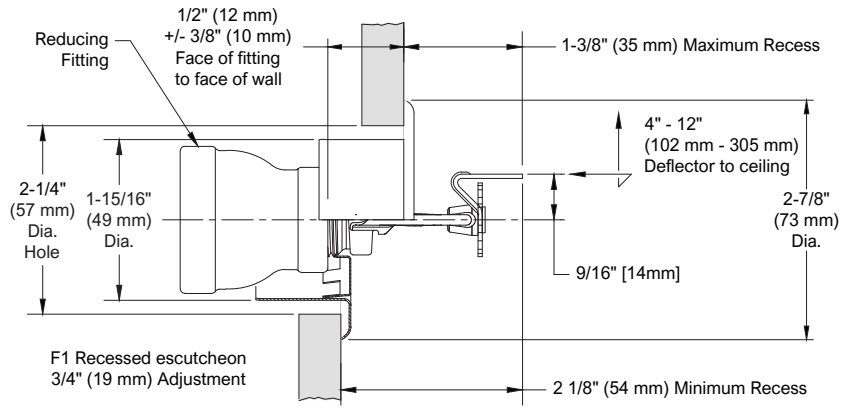
Note: Model CCP concealed assemblies may not be used where the pressure in the space above the ceiling is positive with respect to the protected area. Ensure that the openings in the Model CCP cup are unobstructed following installation.

F1 Escutcheon
(F2 Similar)

FP Escutcheon

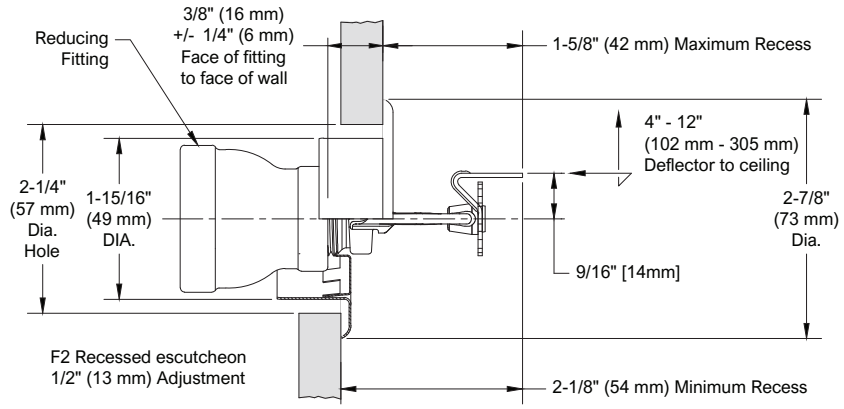
CCP Cover Plate

Recessed Installation: Horizontal Sidewall Sprinklers

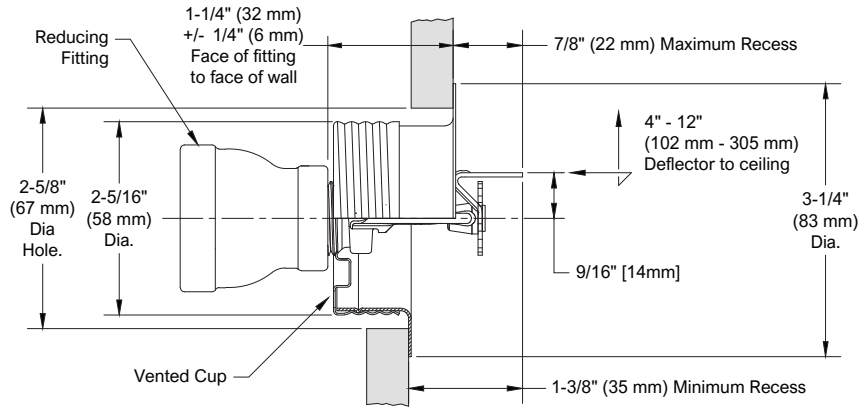


Model F1FR Horizontal Sidewall Sprinkler
with Model F1 Recessed Escutcheon
3/4" (19mm) Nominal Adjustment

F1FR_REC_HSW



Model F1FR Horizontal Sidewall Sprinkler
with Model F2 Recessed Escutcheon
1/2" (13mm) Nominal Adjustment



Model F1FR Horizontal Sidewall Sprinkler
with Model FP Recessed Escutcheon
1/2" (13mm) Nominal Adjustment

Note: Model FP recessed assemblies may not be used where the pressure in the space behind the sprinkler is positive with respect to the space in the protected area. Ensure that the openings in the Model FP cup are unobstructed following installation.

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Wrenches

Model W2 (upright, pendent)

Model J (New frame with guard installed)
Model JD (Legacy frame with guard installed, similar but with zinc finish)

Model W4
(recessed, concealed pendent)

Finishes[1]

Table B

Standard Finishes			Special Application Finishes		
Sprinkler	**F1, F2 and FP[2] Escutcheons**	**CCP Cover Plate[2]**	**Sprinkler**	**F1, F2 and FP[2] Escutcheons**	**CCP Cover Plate[2]**
Bronze	Brass	Chrome	Electroless Nickel PTFE[3][4]	Bright Brass	Bright Brass
Chrome	Chrome	White Paint	Bright Brass[5]	Satin Chrome	Satin Chrome
White Polyester[3]	White Polyester		Satin Chrome	Custom Color Polyester	Custom Color Paint
			Custom Color Polyester[3]		

Notes:
1. Paint or any other coating applied over the factory finish will void all approvals and warranties.
2. Model FP escutcheons and Model CCP sprinklers utilize a galvanized steel cup with a finished trim ring or cover plate.
3. cULus Listed as corrosion resistant.
4. FM Approved as corrosion resistant.
5. For 200°F (93°C) maximum temperature rated sprinklers only.

Installation

Model F1FR Series sprinklers must be installed in accordance with NFPA13 and the requirements of all applicable authorities having jurisdiction. Model F1FR Series sprinklers must be installed with the Reliable sprinkler installation wrench identified in this Bulletin. Any other wrench may damage the sprinkler. The Models W2 and W4 wrenches have two sets of jaws. Use the smallest set of jaws that fit on the wrench flats of the sprinkler. A leak tight sprinkler joint can be obtained with a torque of 8 to 18 lb-ft (11 to 24 N·m). Do not tighten sprinklers over the maximum recommended installation torque. Exceeding the maximum recommended installation torque may cause leakage or impairment of the sprinkler.

Glass bulb sprinklers have orange bulb protectors or protective caps to minimize bulb damage during shipping, handling and installation. Reliable sprinkler installation wrenches are designed to install sprinklers with bulb protectors in place. Remove the bulb protector at the time when the sprinkler system is placed in service for fire protection. Removal of the bulb protector before this time may leave the bulb vulnerable to damage. Remove bulb protectors by undoing the clasp by hand. Do not use tools to remove bulb protectors.

Maintenance

Reliable Model F1FR series sprinklers should be inspected and the sprinkler system maintained in accordance with NFPA 25, as well as the requirements of any Authorities Having Jurisdiction.

Prior to installation, sprinklers should remain in the original cartons and packaging until used. This will minimize the potential for damage to sprinklers that could cause improper operation or non-operation.

Do not clean sprinklers with soap and water, ammonia liquid or any other cleaning fluids. Remove dust by gentle vacuuming without touching the sprinkler.

Replace any sprinkler which has been painted (other than factory applied). A stock of spare sprinklers should be maintained to allow quick replacement of damaged or operated sprinklers. Failure to properly maintain sprinklers may result in inadvertent operation or non-operation during a fire event.

Guarantee

For the guarantee, terms, and conditions, visit www.reliablesprinkler.com.

Ordering Information

Specify the following when ordering:

Model
- F1FR56

Deflector/Orientation
- Upright
- Intermediate Upright
- Pendent
- CCP Concealed Pendent
- Horizontal Sidewall
- Vertical Sidewall

Temperature Rating
- See sprinkler technical specifications

Sprinkler Finish
- See Table B

Recessed Escutcheon[1][2]
- F1
- F2
- FP

Escutcheon Finish
- See Table B

CCP Cover Plate Temperature Rating
- 135°F (57°C) [For use with 135°F (57°C) and 155°F (68°C) sprinklers.]
- 165°F (74°C) [For use with 175°F (79°C) and 200°F (93°C) sprinklers.]

CCP Cover Plate Finish
- See Table B

Sprinkler Wrench
- Model W2
- Model W4 (recessed, concealed)
- Model J (New frame with guard installed)
- Model JD (Legacy frame with guard installed)

Notes:
1. 286°F (141°C) sprinklers are not listed to be used recessed or concealed.
2. For FM, recessed sprinklers must use the Model F2 escutcheon.

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RASCOFLEX® Sprinkler Connections

cULus Listed, FM Approved

Product Description

RASCOFLEX® Sprinkler Connections are intended to connect a branch line to a sprinkler using a flexible stainless steel hose assembly. RASCOFLEX® Sprinkler Connections are suitable for use in suspended and hard ceiling applications such as T-Bar ceiling grids, wood, metal stud, or hat furring channel hard lid ceilings. Every package contains one (1) fully assembled stainless steel flexible sprinkler system complete with hose, branch line connection, and sprinkler connection, as well as the pre-assembled bracket assembly to attach to the ceiling.

RASCOFLEX® Sprinkler Connections are designed for use in hydraulically calculated wet, preaction, or dry sprinkler systems per NFPA 13, 13R, 13D, and FM Global Loss Prevention Data Sheets.

Technical Data **Table A**

Maximum Working Pressure		FM: 200 psi (13.8 bar) UL: 175 psi (12.1 bar)
Maximum Working Temperature		300°F (149°C)
Connections	Inlet/Branch Line	1” NPT
	Outlet/Reducer	1/2” or 3/4” NPT
Minimum Allowable Bending Radius		UL: 3” (76 mm) FM: 7” (178 mm)
Maximum Number of Bends		See Friction Loss Chart
Maximum K-Factor	1/2” Outlet	5.6 (80 metric)
	3/4” Outlet	14.0 (200 metric)

Maintenance

RASCOFLEX® Sprinkler Connections should be inspected and the sprinkler system maintained in accordance with NFPA 25, as well as the requirements of any Authorities Having Jurisdiction.

Patents

RASCOFLEX® Sprinkler Connections may be covered by one or more of the following US Patent Nos. 10,173,088 and 10,328,296.

Listings and Approvals

FM Approved Class No. 1637 (FM)
UL Listed and UL Certified for Canada to ANSI/UL 2443 (cULus)

RASCOFLEX® Sprinkler Connections

Ordering Information

Specify:

Model Name
- Model RFB

Nominal Hose Length
- 24” (610 mm)
- 31” (790 mm)
- 40” (1015 mm)
- 48” (1220 mm)
- 60” 1525 mm)
- 72” (1830 mm)

Reducer Outlet: 1/2” NPT or 3/4” NPT

Reducer Type
Standard:
- 6-1/8” (155 mm) straight

Optional:
- 4-5/16” (110 mm) straight
- 5-5/16” (135 mm) straight
- 11-3/4” (300 mm) straight
- 5-5/8” (143 mm) elbow
- 7-3/8” (187 mm) elbow

Bracket Assembly Length
- 24” (610 mm) standard
- 48” (1220 mm) optional

Accessories
- See Table F

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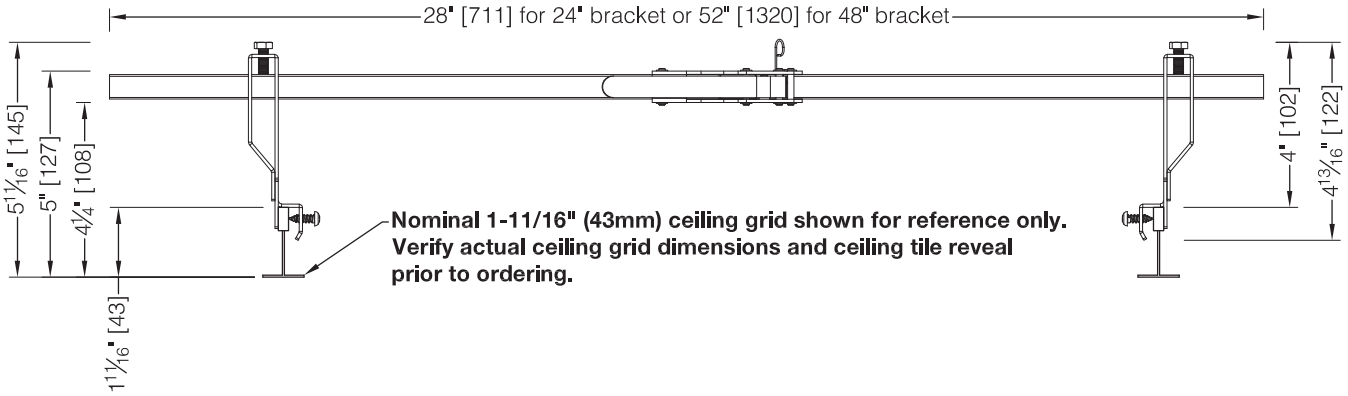
Bracket Dimensions **Figure 1**



Reducer Dimensions **Figure 2**

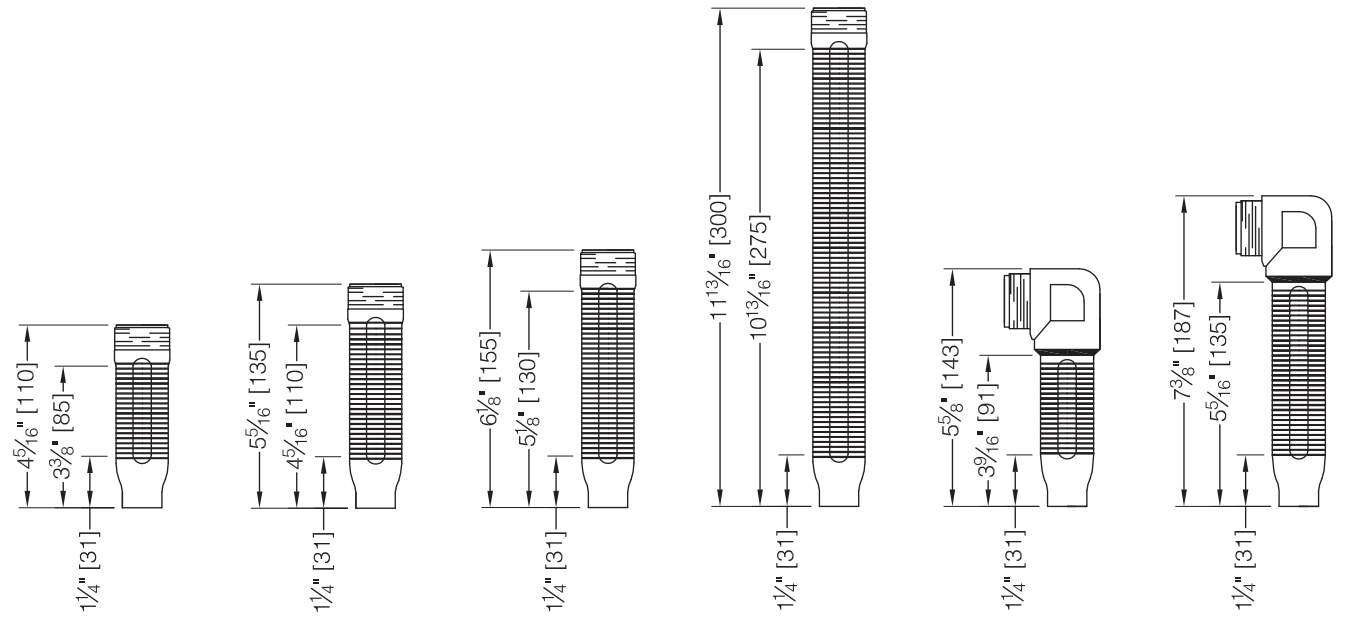


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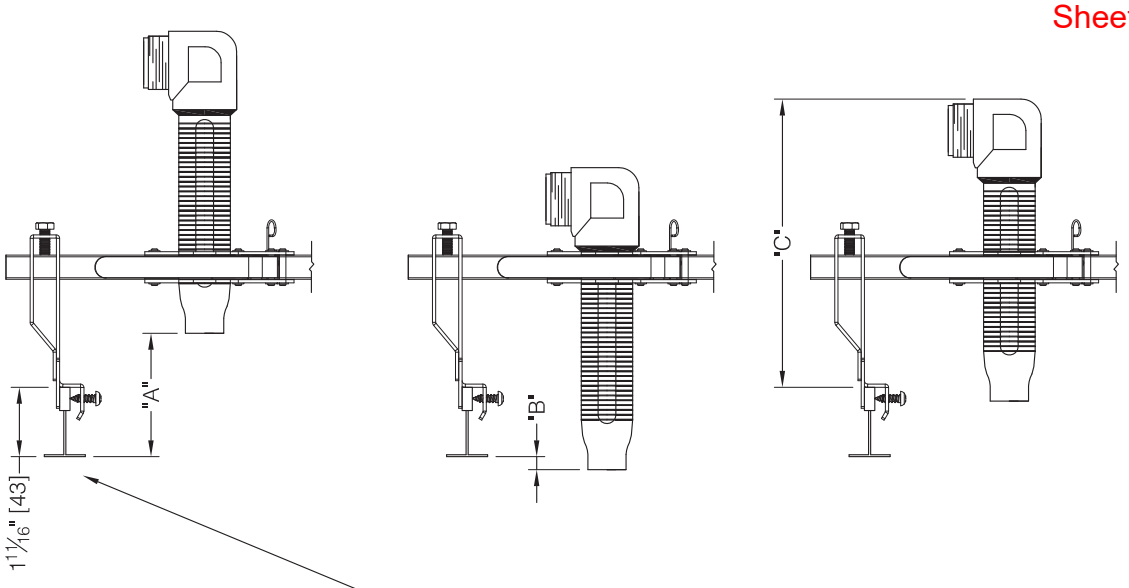
Figure 3



Nominal 1-11/16" (43mm) ceiling grid shown for reference only.
Verify actual ceiling grid dimensions and ceiling tile reveal prior to ordering.

Minimum and Maximum Face of Fitting to Bottom of Ceiling Grid for Each Reducer — **Table B**

Fitting Distance	6-1/8" (155mm) Straight Standard	4-5/16" (110mm) Straight	5-5/16" (135mm) Straight	11-13/16" (300mm) Straight	5-5/8" (143mm) Elbow	7-3/8" (187mm) Elbow
Max. Face of Fitting Distance Above Bottom of Ceiling Grid	3" (77mm)	3" (7mm)	3" (7mm)	3" (7mm)	3" (7mm)	3" (7mm)
Max. Face of Fitting Distance from Bottom of Ceiling Grid	1/8" (3mm) below	1-5/8" (42mm) above	11/16" (17mm) above	6-3/8" (148mm) below	1-7/16" (36mm) above	5/16" (60mm) below

Note: Based on 1-11/16" (43mm) tall ceiling grid.

Fig. 3 Dimension C - Clearance Above Ceiling Required at Max. Sprinkler Recess — **Table C**

Recessed Escutcheon or Concealed/Flush Sprinkler	Reducer	
	5-5/8" (143mm) Elbow	7-3/8" (187mm) Elbow
F1 recessed escutcheon	NC	5-5/8" (144mm)
F2 or FV recessed escutcheon	NC	5-3/8" (138mm)
FP recessed escutcheon	NC	6-1/4" (160mm)
CCP conical concealed cover plate	NC	6-1/4" (160mm)
G4 series concealed sprinklers	5-5/8" (144mm)	7-3/8" (188mm)
G5 series concealed sprinklers	5-1/4" (134mm)	7" (179mm)
RFC series concealed sprinklers	5-1/4" (134mm)	7" (179mm)
XL commercial flush sprinkler with flat escutcheon	4-7/8" (125mm)	6-5/8" (169mm)
XL commercial flush sprinkler with conical escutcheon	4-3/8" (112mm)	6-1/8" (157mm)

Note: NC - Reducer not compatible with sprinkler adjustment range.
Based on 1-11/16" (43mm) tall ceiling grid and flush ceiling tile.

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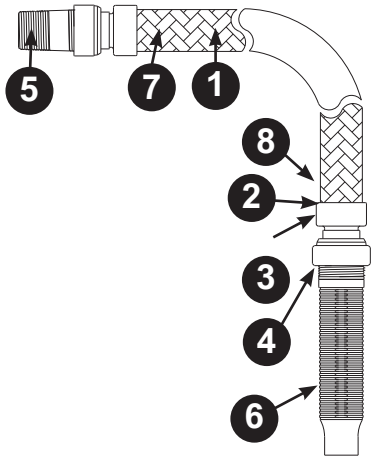
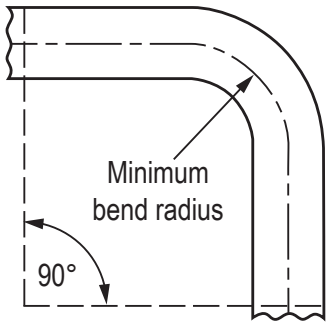
Materials — Figure 4

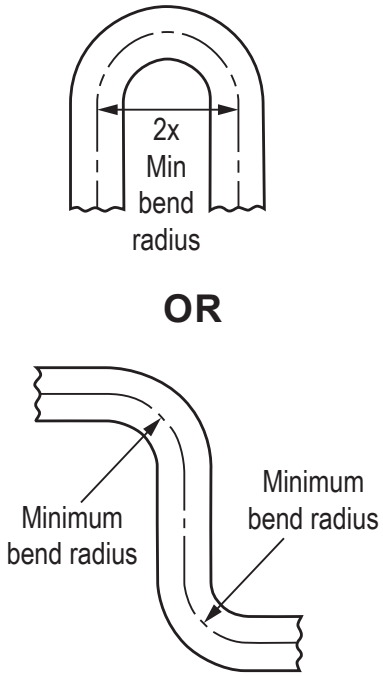
Number	Item Description	Material
1	Flexible Hose/Bellow	AISI Type 304 Stainless Steel
2	Isolation Ring	Nylon 66
3	Gasket	EPDM
4	Nut	Zinc Plated Carbon Steel
5	Branch Line Nipple (1”)	Zinc Plated Carbon Steel
6	Reducer	Zinc Plated Carbon Steel
7	Braid	AISI Type 304 Stainless Steel
8	Welded Collar Fitting	AISI Type 304 Stainless Steel
-	Bar Stock	Zinc Plated SGCC Steel
-	Brackets: Center and Side	Zinc Plated SPCC Steel

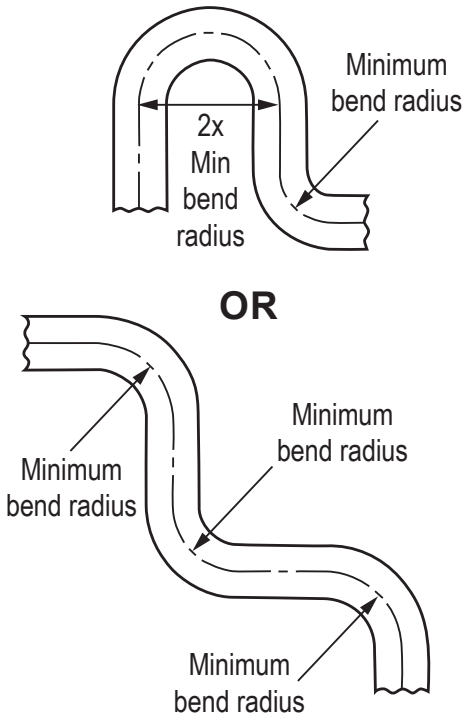


Flexible Hose Number of Bends — Figure 5

One Bend	Two Bends	Three Bends







Do NOT install the RASCOFLEX™ straight. Some flexibility in the form of an allowable bend (or bends) must be provided.

cULus Friction Loss Data

Table D

Nominal Length of Flexible Hose in (mm)	Reducer		Maximum Sprinkler K-Factor gpm/psi$^{1/2}$ (lpm/bar$^{1/2}$)	Maximum Number of 90° Bends at 3" (76mm) Bend Radius	Equivalent Length of 1" (33.7mm) Sch. 40 Pipe (C=120), ft (m)
	NPT Threads	Type			
24 (610)	1/2	Straight	5.6 (80)	2	10 (3)
	3/4	Straight	14.0 (200)	2	13 (4)
31 (790)	1/2	Straight	5.6 (80)	3	14 (4.3)
	3/4	Straight	14.0 (200)	3	16 (4.9)
40 (1015)	1/2	Straight	5.6 (80)	4	21 (6.4)
	3/4	Straight	14.0 (200)	4	23 (7)
48 (1220)	1/2	Straight	5.6 (80)	4	24 (7.3)
	3/4	Straight	14.0 (200)	4	26 (7.9)
60 (1525)	1/2	Straight	5.6 (80)	4	25 (7.6)
	3/4	Straight	14.0 (200)	4	30 (9.1)
72 (1830)	1/2	Straight	5.6 (80)	5	36 (11)
	3/4	Straight	14.0 (200)	5	33 (10.1)

UL Notes:

1. Available data for use with 6.1" straight reducers.
2. Sprinkler K-Factor: 5.6 (80 metric) for 1/2-inch reducer and 14.0 (200 metric) for 3/4-inch reducer.
3. RASCOFLEX® Sprinkler Connections have been tested and approved by Underwriter's Laboratories, Inc. for use in wet, preaction, and dry sprinkler systems per NFPA 13, 13D, 13R and UL2443.

FM APPROVED

FM Friction Loss Data

Table E

Nominal Length of Flexible Hose in (mm)	Reducer		Maximum Sprinkler K-Factor gpm/psi$^{1/2}$ (lpm/bar$^{1/2}$)	Maximum Number of 90° Bends at 7" 178mm) Bend Radius	Equivalent Length of 1" (33.7mm) Sch. 40 Pipe (C=120), ft (m)
	NPT Threads	Type			
24 (610)	1/2	Straight	5.6 (80)	1	9.7 (2.9)
	1/2	90° Elbow	5.6 (80)	0	11.5 (3.5)
	3/4	Straight	8.0 (115)	1	9.9 (3)
			11.2 (160)	1	9.8 (2.9)
			14.0 (200)	1	9.6 (2.9)
	3/4	90° Elbow	8.0 (115)	0	10.2 (3.1)
			11.2 (160)	0	10 (3)
			14.0 (200)	0	9.8 (2.9)
31 (790)	1/2	Straight	5.6 (80)	2	12.4 (3.8)
	1/2	90° Elbow	5.6 (80)	2	15.8 (4.8)
	3/4	Straight	8.0 (115)	2	13.7 (4.1)
			11.2 (160)	2	12.9 (3.9)
			14.0 (200)	2	12.2 (3.7)
	3/4	90° Elbow	8.0 (115)	2	14.5 (4.4)
			11.2 (160)	2	13.7 (4.1)
			14.0 (200)	2	13 (3.9)
40 (1015)	1/2	Straight	5.6 (80)	2	15.9 (4.8)
	1/2	90° Elbow	5.6 (80)	2	21.6 (6.6)
	3/4	Straight	8.0 (115)	2	18.5 (5.6)
			11.2 (160)	2	17.4 (5.3)
			14.0 (200)	2	16.3 (4.9)
	3/4	90° Elbow	8.0 (115)	2	20 (6)
			11.2 (160)	2	18.9 (5.7)
			14.0 (200)	2	20 (6)
48 (1220)	1/2	Straight	5.6 (80)	3	19.0 (5.8)
	1/2	90° Elbow	5.6 (80)	3	25.9 (7.9)
	3/4	Straight	8.0 (115)	3	22.7 (6.9)
			11.2 (160)	3	21.5 (6.5)
			14.0 (200)	3	20.5 (6.2)
	3/4	90° Elbow	8.0 (115)	3	24.8 (7.5)
			11.2 (160)	3	23.6 (7.2)
			14.0 (200)	3	22.6 (6.8)

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FM Friction Loss Data (cont.)

Table E

Nominal Length of Flexible Hose in (mm)	Reducer		Maximum Sprinkler K-Factor gpm/psi$^{1/2}$ (lpm/bar$^{1/2}$)	Maximum Number of 90° Bends at 7" (178mm) Bend Radius	Equivalent Length of 1" (33.7mm) Sch. 40 Pipe (C=120), ft (m)
	NPT Threads	Type			
60 (1525)	1/2	Straight	5.6 (80)	4	23.7 (7.2)
	1/2	90° Elbow	5.6 (80)	4	33.1 (10)
	3/4	Straight	8.0 (115)	4	29.1 (8.8)
			11.2 (160)	4	28 (8.5)
			14.0 (200)	4	27 (8.2)
	3/4	90° Elbow	8.0 (115)	4	32.2 (9.8)
			11.2 (160)	4	31.1 (9.5)
			14.0 (200)	4	30 (9.1)
72 (1830)	1/2	Straight	5.6 (80)	4	28.4 (8.6)
	1/2	90° Elbow	5.6 (80)	4	40.4 (12.3)
	3/4	Straight	8.0 (115)	4	35.5 (10.8)
			11.2 (160)	4	34.3 (10.4)
			14.0 (200)	4	33.2 (10.1)
	3/4	90° Elbow	8.0 (115)	4	39.5 (12)
			11.2 (160)	4	38.3 (11.6)
			14.0 (200)	4	37.2 (11.3)

FM Notes:

1. RASCOFLEX® Sprinkler Connections have been tested and approved by FM Approvals for use in wet, preaction, and dry sprinkler systems per FM data sheets 2-0, 2-5, and 2-8 per FM1637.
2. Maximum sprinkler K-Factor: 5.6 (80 metric) for 1/2-inch reducer and 14.0 (200 metric) for 3/4-inch reducer.
3. Differences in equivalent lengths are due to varying test methods, per FM 1637 standards.
4. Above data of friction loss for use with 6.1" straight reducers.

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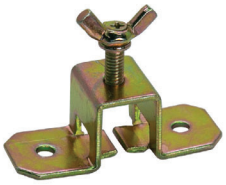
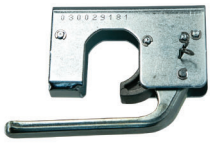
Accessories List

5-5/8” (143mm) Elbow Reducer- Short 1/2”: 7M99003303 3/4”: 7M99003305	7-3/8” (187mm) Elbow Reducer- Long 1/2”: 7M99003302 3/4”: 7M99003304	4-5/16” (110mm) Straight Reducer 1/2”: 7M99003306 3/4”: 7M99003325
5-5/16” (135mm) Straight Reducer 1/2”: 7M99003307 3/4”: 7M99003326	Replacement 6-1/8” (155mm) Standard Straight Reducer 1/2”: 7M99003308 3/4”: 7M99003327	11-13/16” (300mm) Straight Reducer 1/2”: 7M99003309 3/4”: 7M99003328
Hat Channel End Bracket- Short 3” (76mm) 7M99003310	Hat Channel End Bracket- Long 3-3/4” (95mm) 7M99003311	Metal Stud End Bracket-Short 1-1/2” (38mm) 7M99003312
Metal Stud End Bracket- Long 2-1/16” (53mm) 7M99003313	T-Bar End Bracket- Short 2-5/8” (68mm) 7M99003314	T-Bar End Bracket- Long 4-1/8” (105mm) 7M99003316
 Wood Beam Stud End Bracket 7M99003317	 Replacement Center Bracket 7M99003321	3” (76 mm) Bend Radius Indicator 7M99004179
Replacement 1” NPT Inlet Adapter 7M99003322	#2 Square Drive Bit 7M99004539	Replacement Gasket 7M99004319
48” (1220mm) Bracket Assembly 7M99003301		

RSN: 1702607
Permit # 2023-2304917-CT
Sheet 22 of 60

90° ELBOW

SPF/ANVIL

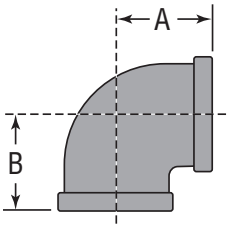
Ductile Iron

AnvilStar™ Fire Products Division of Anvil® International

Submittal Sheet

90° ELBOW

Nominal Size	Anvil Item Number	Universal Number	Max. Working Pressure	Dimensions- In.(mm)		Approx. Wt. Each
				A	B	
In. (mm)			*PSI (kPa)*	*In. (mm)*	*In. (mm)*	*Lbs. (kg)*
1 *20*	840000004	DB90033	500 *3450*	1.50 *38.10*	1.50 *38.10*	0.62 *0.28*
1¼ *32*	840000012	DB90044	500 *3450*	1.75 *44.45*	1.75 *44.45*	0.90 *0.41*
1½ *40*	840000020	DB90055	500 *3450*	1.94 *49.276*	1.94 *49.276*	1.20 *0.54*
2 *50*	840000038	DB90066	500 *3450*	2.25 *57.15*	2.25 *57.15*	1.85 *0.84*



MATERIAL SPECIFICATIONS

Ductile iron threaded fittings are UL & ULC Listed & Factory Mutual Approved for 500 psi service.

Ductile iron per ASTM A536 Class 65-45-12.

Dimensions conform to ASME B16.3 Class 150.

Threads are NPT per ANSI/ASME B1.20.1.

NOTICE: Ductile iron fittings have higher tensile strength than that of steel pipe. Therefore, over tightening can cause damage to pipe threads which may cause leakage. Ductile iron fittings should be tightened three turns beyond hand tight, but no more than four turns.

UL FM ULC
APPROVED
For Listing / Approval details contact your AnvilStar™ Representative.

PROJECT INFORMATION:		APPROVAL STAMP:
Project:		
Date:	**Phone:**	
Architect / Engineer:		
Contractor:		
Address:		
Notes 1:		
Notes 2:		

For the latest UL/ULC Listed and FM Approved pressure ratings, versus pipe schedule, go to **www.anvilstar.com** or contact your local AnvilStar representative

ANVIL INTERNATIONAL, INC.

ANVIL® INTERNATIONAL, INC.

Research and Development Center

20 Thurber Blvd.
Smithfield, RI 02917 USA
Phone: 401-349-3020
Fax: 401-233-8142

May 11, 2005

AnvilStar Certificate of Compliance / Ductile Iron Products

To Whom It May Concern:

Ductile iron threaded fittings and bushings manufactured under the supervision of AnvilStar bearing the SPF® logo are manufactured in China and comply with the following specifications:

Dimensional	ANSI/ASME B16.3 Class 150 for all items except bushings. Bushings conform to ANSI/ASME B16.14
Material	ASTM A-536 Gr. 65-45-12
Threading	ANSI/ASME B1.20.1
Pressure Rating	Fittings UL/ULC listed and FM approved for 500 psi service. Bushings FM approved for 500 psi service.

Note: Ductile iron threaded fittings are UL/ULC listed. Ductile iron fittings and bushings are FM approved.

Mark R. Ward
Senior Project Engineer

RSN: 1702607
Permit # 2023-2304917-CT
Sheet 24 of 60

90° ELBOW

SPF/ANVIL

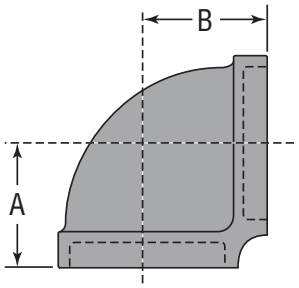
Cast Iron - Class 125 Fittings

AnvilStar™ Fire Products Division of Anvil® International

Submittal Sheet

90° ELBOW

Nominal Size	Anvil Item Number	Universal Number	Max. Working Pressure	Dimensions		Approx. Wt. Each
				A	B	
In. (mm)			*PSI (kPa)*	*In. (mm)*	*In. (mm)*	*Lbs. (kg)*
1 *25*	800000002	CB90033	300 *2065*	1.50 *38.10*	1.50 *38.10*	0.84 *0.38*
1¼ *32*	800000010	CB90044	300 *2065*	1.75 *44.45*	1.75 *44.45*	1.34 *0.61*
1½ *40*	800000028	CB90055	300 *2065*	1.94 *49.27*	1.94 *49.27*	1.80 *0.82*
2 *50*	800000036	CB90066	300 *2065*	2.25 *57.15*	2.25 *57.15*	2.90 *1.32*
2½ *65*	800000044	CB90077	300 *2065*	2.70 *68.58*	2.70 *68.58*	4.75 *2.15*



MATERIAL SPECIFICATIONS

Cast iron threaded fittings are UL & ULC Listed & Factory Mutual Approved for 300 psi service.

Gray iron per ASTM A126 Class B.

Dimensions conform to ANSI B16.4 Class 125.

Threads are NPT per ANSI/ASME B1.20.1.

APPROVED
For Listing / Approval details contact your AnvilStar™ Representative.

Project Information:		Approval Stamp:
Project:		
Date:	**Phone:**	
Architect / Engineer:		
Contractor:		
Address:		
Notes 1:		
Notes 2:		

For the latest UL/ULC Listed and FM Approved pressure ratings, versus pipe schedule, go to **www.anvilstar.com** or contact your local AnvilStar representative

ANVIL INTERNATIONAL, INC.

ANVIL® INTERNATIONAL, INC.

Research and Development Center

20 Thurber Blvd.
Smithfield, RI 02917 USA
Phone: 401-349-3020
Fax: 401-233-8142

May 11, 2005

AnvilStar Certificate of Compliance / Cast Iron Products

To Whom It May Concern:

Cast iron threaded fittings, plugs and bushings manufactured under the supervision of AnvilStar bearing the SPF® logo are manufactured in China and comply with the following specifications:

Dimensional	ANSI/ASME B16.4 for all items except bushings and plugs. Bushings & Plugs conform to ANSI/ASME B16.14
Material	ASTM A-126 Class B Gray Iron
Threading	ANSI/ASME B1.20.1
Pressure Rating	ANSI/ASME B16.4 Class 125

Note: Cast iron threaded plugs and fittings are UL/ULC listed and FM approved.

Mark R. Ward
Senior Project Engineer

RSN: 1702607
Permit # 2023-2304917-CT
Sheet 26 of 60

MT-30 Threaded Mechanical Branch Tee

AnvilStar™ Fire Products Division of Anvil® International

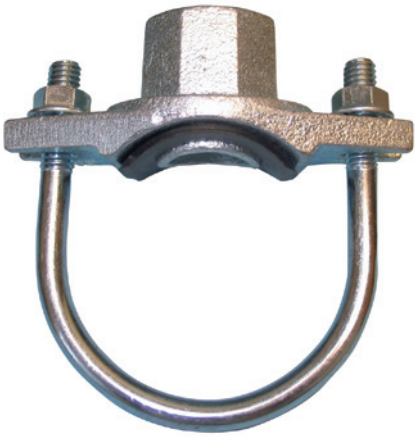
Submittal Sheet

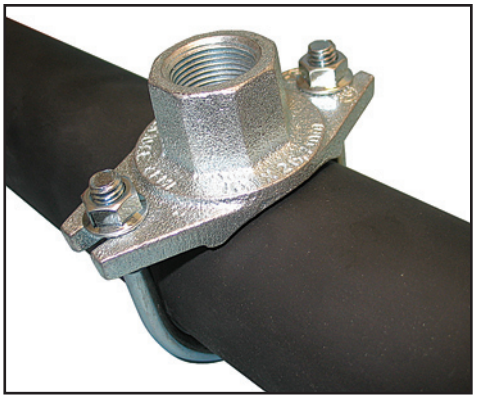
SPF/ANVIL

Model MT-30 mechanical tee serves the same function as MT-1 & MT-8 but uses a steel electro-plated U-Bolt to save space and for easier installation in tight places. It is ideal for direct connections with sprinkler heads and drop nipples.

UL FM ULC
APPROVED

For Listing/Approval Details and Limitations visit our Web Site *www.anvilintl.com* or contact an Anvil®/AnvilStar™ Sales Representative.





⚠ WARNING

For dry pipe systems and freezer applications lubrication of the gasket is required, Gruvlok® Xtreme™ Lubricant is Required.

MATERIAL SPECIFICATIONS

HOUSING:
Ductile Iron conforming to ASTM A-536, Grade 65-45-12.

U-BOLT & NUTS:
U-bolt is carbon steel SAE J429 Gr. 2, zinc plated complete with hex flanged lock nuts conforming to ASTM A-563 Gr. A or B or SAE J995 Gr. 2.

THREADS:
MT-30 NPT per ANSI/ASME B1.20.1

COATINGS:
❑ Zinc Electroplated
❑ Other (Specify): _____ Example: RAL3000 or RAL9000 Series
For other Coating requirements contact an AnvilStar Representative.

GASKETS: Materials
Properties as designated in accordance with ASTM D-2000.
❑ **Grade "E" EPDM** (Green color code)
-40°F to 230°F (Service Temperature Range) (-40°C to 110°C)
Recommended for water service, diluted acids, alkalies solutions, salts, oil-free air and many chemical services not involving hydrocarbons, oils or gases.
NOT FOR USE WITH HYDROCARBONS.
❑ Other_____

Project Information:		Approval Stamp:
Project: undefined		
Date: undefined	**Phone:** undefined	
Architect / Engineer: undefined		
Contractor: undefined		
Address: undefined		
Notes 1: undefined		
Notes 2: undefined		

For the latest UL/ULC Listed and FM Approved pressure ratings, versus pipe schedule, go to **www.anvilstar.com** or contact your local AnvilStar representative

ANVIL® INTERNATIONAL

MT-30 Threaded Mechanical Branch Tee

RSN: 1702607
Permit # 2023-2304917-CT
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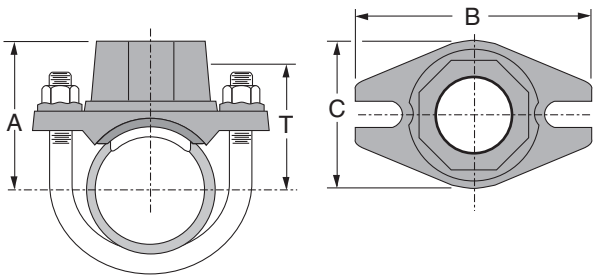
AnvilStar™ Fire Products Division of Anvil International

SPF/ANVIL™

Submittal Sheet



MT-30 MECHANICAL TEES

Nominal Size	O.D.	Hole Diameter		Max. Wk. Pressure	Dimensions				Approx. Wt. Ea.
		Min. Diameter	Max. Diameter		A	B	C	T Take-Out	
In./DN(mm)	*In./mm*	*In./mm*	*In./mm*	*PSI/bar*	*In./mm*	*In./mm*	*In./mm*	*In./mm*	*Lbs./kg*
1¼ x ½	1.660 x 0.840	1 3/16	1 5/16	300	2⅛	3½	2¼	1⅝	0.8
32 x 12	*42.4 x 21.3*	*30*	*33*	*20.7*	*54*	*89*	*57.2*	*42*	*0.4*
1¼ x ¾	1.660 x 1.050	1 3/16	1 5/16	300	2⅛	3½	2¼	1⅝	0.8
32 x 19	*42.4 x 26.7*	*30*	*33*	*20.7*	*54*	*89*	*57.2*	*42*	*0.4*
1¼ x 1	1.660 x 1.315	1 3/16	1 5/16	300	2¼	3½	2¼	1⅝	1.1
32 x 25	*42.4 x 33.7*	*30*	*33*	*20.7*	*58*	*89*	*57.2*	*41*	*0.5*
1½ x ½	1.900 x 0.840	1 3/16	1 5/16	300	2¼	3½	2¼	1¾	0.8
40 x 12	*48.3 x 21.3*	*30*	*33*	*20.7*	*57*	*89*	*57.2*	*48*	*0.4*
1½ x ¾	1.900 x 1.050	1 3/16	1 5/16	300	2¼	3½	2¼	1¾	0.9
40 x 19	*48.3 x 26.7*	*30*	*33*	*20.7*	*57*	*89*	*57.2*	*48*	*0.4*
1½ x 1	1.900 x 1.315	1 3/16	1 5/16	300	2⅜	3½	2¼	1¾	1.1
40 x 25	*48.3 x 33.7*	*30*	*33*	*20.7*	*61*	*89*	*57.2*	*44*	*0.5*
2 x ½	2.375 x 0.840	1 3/16	1 5/16	300	2½	3¾	2¼	2	0.9
50 x 12	*60.3 x 21.3*	*30*	*33*	*20.7*	*64*	*95*	*57.2*	*51*	*0.4*
2 x ¾	2.375 x 1.050	1 3/16	1 5/16	300	2½	3¾	2¼	2	0.9
50 x 19	*60.3 x 26.7*	*30*	*33*	*20.7*	*64*	*95*	*57.2*	*51*	*0.4*
2 x 1	2.375 x 1.315	1 3/16	1 5/16	300	2⅝	3¾	2¼	2	1.1
50 x 25	*60.3 x 33.7*	*30*	*33*	*20.7*	*67*	*95*	*57.2*	*50*	*0.5*
2½ x ½	2.875 x 0.840	1 3/16	1 5/16	300	2¾	4¼	2¼	2¼	0.9
65 x 12	*73.0 x 21.3*	*30*	*33*	*20.7*	*70*	*108*	*57.2*	*57*	*0.4*
2½ x ¾	2.875 x 1.050	1 3/16	1 5/16	300	2¾	4¼	2¼	2¼	0.9
65 x 19	*73.0 x 26.7*	*30*	*33*	*20.7*	*70*	*108*	*57.2*	*57*	*0.4*
2½ x 1	2.875 x 1.315	1 3/16	1 5/16	300	2⅞	4¼	2¼	2¼	1.1
65 x 25	*73.0 x 33.7*	*30*	*33*	*20.7*	*73*	*108*	*57.2*	*56*	*0.5*

BSP equivalent is available as a MT-90.

NOTE: Tighten nuts alternatively to a recommended torque of 18 -22 ft-lbs (25 - 30 N-m) on pipe wall less than schedule 10 or 23 -27 ft-lbs (31 - 37 N-m) on pipe walls schedule 10 and above.

For the latest UL/ULC Listed and FM Approved pressure ratings, versus pipe schedule, go to **www.anvilstar.com** or contact your local AnvilStar representative

ANVIL® INTERNATIONAL

RSN: 1702607
Permit # 2023-2304917-CT

THREADED ACCESSORIES

Fig. 20 & 21 CONTINUOUS THREADED ROD

Fig. 20* PLAIN
Fig. 21 ELECTRO-GALVANIZED

Available in stainless steel. To order, specify 304 or 316 and add suffix SS to figure number.
Price on request.

FUNCTION: Useful in applications where stud lengths cannot be predetermined.

MATERIAL: Low carbon steel

ORDERING: Specify rod size, length and figure number.

Rod Size	Packaging Feet Per Bundle						Max. Rec. Load 650°F (343°C)		Max. Rec. Load 750°F (399°C)		Wt. Per Inch	
	6ft.	(1.83)	10ft.	(3.05)	12ft.	(3.66)	lbs.	kN	lbs.	kN	lbs.	kg
1/4 -20	300	(91.44)	500	(152.4)	600	(182.88)	240	(1.07)	210	(.93)	.12	(.05)
3/8 -16	150	(45.72)	250	(76.2)	240	(73.15)	730	(3.25)	540	(2.40)	.29	(.13)
1/2 -13	72	(21.95)	120	(36.58)	144	(43.90)	1350	(6.01)	1010	(4.49)	.54	(.25)
5/8 -11	48	(14.63)	80	(24.38)	96	(29.26)	1810	(8.05)	1610	(7.16)	.83	(.38)
3/4 -10	30	(9.14)	50	(15.24)	60	(18.29)	2710	(12.05)	2420	(10.76)	1.25	(.57)
7/8 -9	24	(7.32)	40	(12.19)	48	(14.63)	3770	(16.77)	3360	(14.95)	1.65	(.75)
1-8	12	(3.66)	20	(6.10)	24	(7.32)	4960	(22.06)	4420	(19.66)	2.25	(1.02)

Unless otherwise specified, all dimensions on drawings and in charts are in inches and dimensions shown in parentheses are in millimeters.

Adjustable Swivel Ring Hangers

RSN: 1702607
Permit # 2023-2304917-OT
Sheet 29 of 60

Fig. 141 & 141F NFPA SWIVEL RING HANGER

FUNCTION: Designed for the suspension of non-insulated stationary pipe lines. The knurled insert nut that allows a vertical adjustment after installation, is tapped to NFPA reduced rod size standards. Fig. 141F has a layer of felt which separates the pipe from the hanger to reduce vibration and sound.

APPROVALS: Underwriters' Laboratories Listed in the U.S. (UL), Canada (CUL), and Factory Mutual Approved for sizes ¾" to 8". Complies with Federal Specifications A-A-1192A (Type 10), and Manufacturers' Standardization Society ANSI/SP-69 and SP-58 (Type 10).

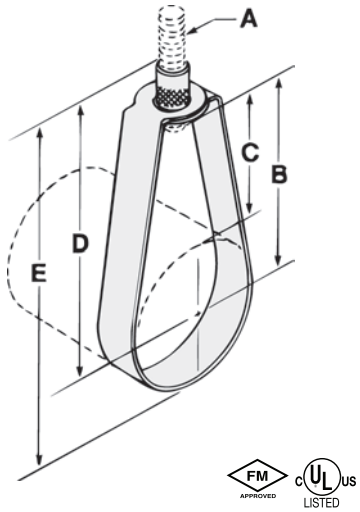
ORDERING: Specify pipe size and figure number.

Fig. 141 PRE-GALVANIZED

Fig. 141F PRE-GALVANIZED WITH FELT LINING

Pipe Size	Rod Size A	B	Adj. C	D	E	Max. Rec. Load/lbs.	Wt. Each (in lbs.)
1/2	3/8	1 7/8	1 7/16	2 3/4	3 1/16	300	.10
3/4	3/8	1 11/16	1 1/8	2 1/2	3 1/16	300	.10
1	3/8	1 5/8	1	2 1/2	3 3/16	300	.10
1 1/4	3/8	1 15/16	1 1/16	2 13/16	3 9/16	300	.11
1 1/2	3/8	2 1/8	1 1/16	3 1/8	3 7/8	300	.11
2	3/8	2 7/16	1 1/8	3 5/16	4 3/8	300	.14
2 1/2	3/8	3 1/16	1 5/8	3 15/16	5 3/8	525	.19
3	3/8	3 11/16	1 7/8	4 9/16	6 5/16	525	.23
3 1/2	3/8	3 3/4	1 7/8	4 5/8	6 5/8	525	.25
4	3/8	4 3/16	1 7/8	5 1/16	7 5/16	650	.30
5	1/2	4 5/8	1 5/8	5 5/8	8 3/8	1000	.50
6	1/2	5 5/8	2 1/4	6 1/2	9 13/16	1000	.58
8	1/2	6 13/16	2 7/16	7 15/16	12 1/4	1000	.90

Note: If ordering Fig. 141F felt lined hangers for pipe sizes of 3 1/2" or under, order the next largest size to allow for the thickness of the felt lining.



MATERIAL: Low carbon steel

Fig. 151 & 151F SWIVEL RING HANGER

FUNCTION: Designed for the suspension of non-insulated stationary pipe lines. The knurled insert nut, allows for vertical adjustment after installation. Fig. 151F has a layer of felt which separates the pipe from the hanger to reduce vibration and sound.

APPROVALS: Underwriters' Laboratories Listed in the U.S. (UL) and Factory Mutual Approved for all sizes. Complies with Federal Specification A-A-1192A (Type 10), and Manufacturers' Standardization Society ANSI/SP-69 and SP-58 (Type 10).

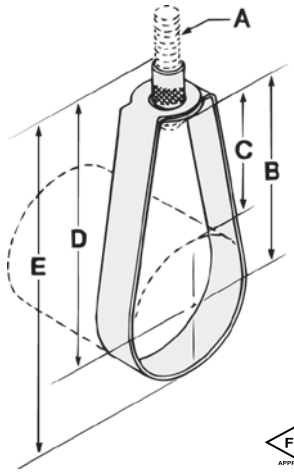
ORDERING: Specify pipe size and figure number.

Fig. 151 PRE-GALVANIZED

Fig. 151F PRE-GALVANIZED WITH FELT LINING

Pipe Size	Rod Size A	B	Adj. C	D	E	Max. Rec. Load/lbs.	Wt. Each (in lbs.)
2 1/2	1/2	2 3/4	1 1/4	3 11/16	5 1/8	600	.33
3	1/2	3 1/8	1 1/8	4	5 7/8	600	.35
3 1/2	1/2	3 5/8	1 1/2	4 5/16	6 5/8	600	.37
4	5/8	3 7/8	1 1/4	4 15/16	7 1/8	1000	.48
5	5/8	4 3/8	1 3/8	5 5/8	8 1/2	1000	.57
6	3/4	5 5/16	2	6 11/16	10 1/8	1250	1.06
8	3/4	6 15/16	2 5/8	8 5/16	12 7/8	1250	1.32

Note: If ordering Fig. 151F felt lined hangers for pipe sizes of 3 1/2" or under, order the next largest size to allow for the thickness of the felt lining.



MATERIAL: Low carbon steel

RSN: 1702607
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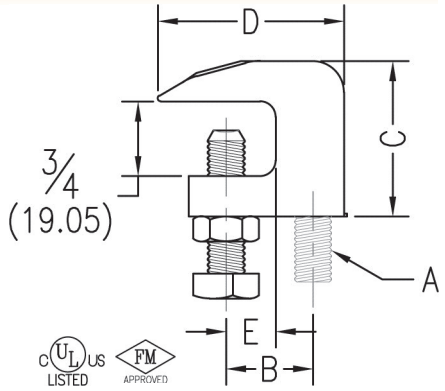
DOMESTIC BEAM CLAMP FIG. 350, 353, 354, 355, 356, & 357



Function: Designed for attaching hanger rod to the top flange of a beam or bar joist, where the flange thickness does not exceed $^{3}/_{4}$" (19.05mm). The open U design permits rod adjustment. The universal design of the $^{3}/_{8}$" Fig. 353 allows it to be used in an inverted position on the bottom flange of a beam as well.

Material: Malleable iron with hardened steel cup point set screw and locknut

Finish: Plain or electro-galvanized (Hot dipped galvanized with electro-galvanized hardware upon request)

Approvals: Underwriters' Laboratories Listed in the U.S. (UL), Canada (CUL), for sizes $^{3}/_{8}$" to $^{7}/_{8}$" only. Factory Mutual Approved for rod sizes $^{3}/_{8}$" and $^{1}/_{2}$" only. Complies with Federal Specifications A-A-1192A (Type 19) and Manufacturers' Standardization Society ANSI/MSS SPSP-58 (Type 19) which supersedes ANSI/MSS SP-69. Fig. 353 sized for $^{3}/_{8}$" rod can be used in an inverted position (bottom of beam) and follows the same U.S. (UL), Canada (CUL), and Factory Mutual Approvals. Used in this manner the $^{3}/_{8}$" Fig. 353 also complies with Federal Specifications A-A-1192A (Type 23) and Manufacturers' Standardization Society ANSI/MSS SPSP-58 (Type 23) which supersedes ANSI/MSS SP-69. (Approvals are only valid for beam clamps with locknut).
Buy American Act compliant.

Ordering: Specify figure number, rod size, material, and finish.

NOTE: When a torque wrench is unavailable, the setscrew should be tightened so it contacts the I-beam and then an additional $^{1}/_{4}$ to $^{1}/_{2}$ turn.

Set Screw Torque				
Nominal Thread Size		$^{3}/_{8}$	$^{1}/_{2}$	Caution should be taken not to over tighten the set screw
Rec. Torque	in-lbs.	60	125	
	N-m	(6.8)	(14.1)	

Figure Numbers	Rod Size A	B		C		D		E		Max. Pipe Size		Max. Rec. Load		Wt. Each	
												lbs.	kN	lbs.	kg
* 350	$^{1}/_{4}$	$^{7}/_{8}$	(22.23)	$1^{1}/_{2}$	(38.10)	$1^{5}/_{8}$	(41.28)	$^{1}/_{2}$	(12.70)	N/A	N/A	250	(1.11)	.34	(.15)
Δ 353	$^{3}/_{8}$	$^{7}/_{8}$	(22.23)	$1^{1}/_{2}$	(38.10)	$1^{5}/_{8}$	(41.28)	$^{1}/_{2}$	(12.70)	4	(100)	400	(1.78)	.33	(.15)
354	$^{1}/_{2}$	1	(25.40)	$1^{1}/_{2}$	(38.10)	$1^{11}/_{16}$	(42.86)	$^{1}/_{2}$	(12.70)	8	(200)	500	(2.22)	.34	(.15)
355	$^{5}/_{8}$	$1^{1}/_{16}$	(26.99)	$1^{1}/_{2}$	(38.10)	$1^{7}/_{8}$	(47.63)	$^{5}/_{8}$	(15.88)	8	(200)	600	(2.67)	.39	(.18)
356	$^{3}/_{4}$	$1^{5}/_{16}$	(33.34)	$1^{3}/_{4}$	(44.45)	$2^{3}/_{8}$	(60.33)	$^{5}/_{8}$	(15.88)	8	(200)	800	(3.56)	.63	(.29)
357	$^{7}/_{8}$	$1^{5}/_{16}$	(33.34)	$1^{3}/_{4}$	(44.45)	$2^{3}/_{8}$	(60.33)	$^{5}/_{8}$	(15.88)	8	(200)	1200	(5.34)	.60	(.27)

* $^{1}/_{4}$" Fig. 350 Not UL or FM approved.

Δ $^{3}/_{8}$" Fig. 353 Reversible design approved for bottom beam use.

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The following excerpt are pages from the North American Product Technical Guide, Volume 2: Anchor Fastening, Edition 19.

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&CA: https://submittals.us.hilti.com/PTGVol2/

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

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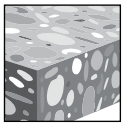
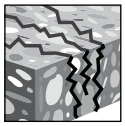
3.3.5 KWIK BOLT TZ EXPANSION ANCHOR

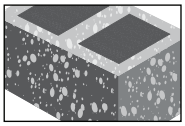
PRODUCT DESCRIPTION

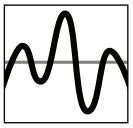
KWIK Bolt TZ carbon steel and stainless steel anchors

Anchor System	Features and Benefits
Carbon Steel KB-TZ Stainless Steel KB-TZ Hilti SIW-6AT-A22 impact wrench and the SI-AT-A22 Adaptive Torque Module	• Used with Hilti Dust Removal System (DRS) for dustless drilling and installation (compliant with Table 1 of OSHA 1926.1153 regulations for silica dust exposure). • 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. • Through fixture installation and variable thread lengths improve productivity and accommodate various base plate thicknesses. • Type 316 stainless steel wedges provide superior performance in cracked concrete. • Ridges on expansion wedges provide increased reliability. • Mechanical expansion allows immediate load application. • Raised impact section (dog point) prevents thread damage during installation. • Bolt meets ductility requirements of ACI 318-14 Section 2.3. • ACI 349-01 Nuclear Design Guide is available. Call Hilti Technical Support.


Uncracked concrete

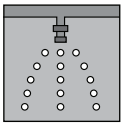

Cracked concrete


Grout-filled concrete masonry


Seismic Design Categories A-F

Hollow Drill Bit with Adaptive Torque Tool (AT)

Profis Anchor design software


Fire sprinkler listings

Approvals/Listings	
ICC-ES (International Code Council) - 2018 International Building Code / International Residential Code (IBC/IRC) - 2015 National Building Code of Canada (NBC-C)	ESR-1917 in concrete per ACI 318-14 Ch. 17 / ACI 355.2/ ICC-ES AC193 ESR-3785 in grout-filled CMU per ICC-ES AC01 ELC-1917 in concrete per CSA A23.3-14 / ACI 355.2
City of Los Angeles	2017 LABC Supplement (within ESR-1917) RR 26057 grout-filled CMU
Florida Building Code	2010 FBC with HVHZ
FM (Factory Mutual)	Pipe hanger components for automatic sprinkler systems 3/8 through 3/4
UL and cUL (Underwriters Laboratory)	Pipe hanger equipment for fire protection services for 3/8 through 3/4

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MATERIAL SPECIFICATIONS

Carbon steel with electroplated zinc

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

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

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

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

Washers meet the requirements of ASTM F844.

Expansion sleeves (wedges) are manufactured from type 316 stainless steel

Stainless steel

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

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

All nuts and washers for type 304 anchors are made from type 304 stainless.

All nuts and washers for type 316 anchors are made from type 316 stainless.

Nuts meet the dimensional requirements of ASTM F594.

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

Expansion sleeve (wedges) are made from type 316 stainless steel.

1 Bolt fracture loads are determined by testing in a universal tensile machine for quality control at the manufacturing facility. These loads are not intended for design purposes. See tables 4 and 16 for the steel design strengths of carbon steel and stainless steel, respectively.

INSTALLATION PARAMETERS

Figure 1 - Hilti KWIK Bolt TZ specifications

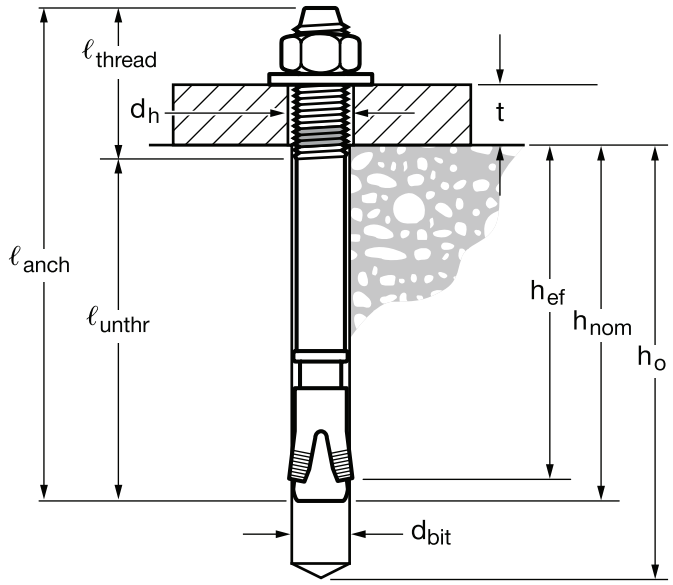

Table 1 - Hilti KWIK Bolt TZ carbon steel specifications

Setting information	Symbol	Units	Nominal anchor diameter d_o														
			3/8			1/2			5/8				3/4				
Nominal bit diameter	d_{bit}	in.	3/8			1/2			5/8				3/4				
Minimum nominal embedment	h_{nom}	in.	1-13/16	2-5/16	3-1/16	2-3/8		3-5/8	3-9/16		4-7/16		3-13/16	4-5/16		5-5/16	
		(mm)	(46)	(59)	(78)	(60)		(91)	(91)		(113)		(97)	(110)		(135)	
Effective minimum embedment	h_{ef}	in.	1-1/2	2	2-3/4	2		3-1/4	3-1/8		4		3-1/4	3-3/4		4-3/4	
		(mm)	(38)	(51)	(70)	(51)		(83)	(79)		(102)		(83)	(95)		(121)	
Min. hole depth	h_o	in.	2	2-5/8	3-3/8	2-5/8		4	3-3/4		4-3/4		4	4-5/8		5-3/4	
		(mm)	(51)	(67)	(83)	(67)		(102)	(95)		(121)		(102)	(117)		(146)	
Min. thickness of fixture[1]	t_{min}	in.	0	0	0	3/4		1/4	3/8		3/4		0	0		7/8	
		(mm)	(0)	(0)	(0)	(19)		(6)	(9)		(19)		(0)	(0)		(23)	
Max. thickness of fixture	t_{max}	in.	2-13/16	2-5/16	1-9/16	4		2-3/4	5-5/8		4-3/4		5-9/16	4-15/16		3-15/16	
		(mm)	(71)	(59)	(40)	(101)		(70)	(143)		(121)		(141)	(125)		(100)	
Installation torque (concrete)	T_{inst}	ft-lb	25			40			60				110				
		(Nm)	(34)			(54)			(81)				(149)				
Installation torque (masonry)	T_{inst}	ft-lb	n/a	15	n/a	25			35				n/a	70			
		(Nm)		(20)		(34)			(47)					(95)			
Fixture hole diameter	d_h	in.	7/16			9/16			11/16				13/16				
		(mm)	(11.1)			(14.3)			(17.5)				(20.6)				
Available anchor lengths	ℓ_{anch}	in.	3	3-3/4	5	3-3/4	4-1/2	5-1/2	7	4-3/4	6	8-1/2	10	5-1/2	7	8	10
		(mm)	(76)	(95)	(127)	(95)	(114)	(140)	(178)	(121)	(152)	(216)	(254)	(140)	(178)	(203)	(254)
Threaded length including dog point	ℓ_{thread}	in.	1-1/2	2-1/4	3-1/2	1-5/8	2-3/8	3-3/8	4-7/8	1-1/2	2-3/4	5-1/4	6-3/4	2-1/2	4	5	7
		(mm)	(38)	(57)	(89)	(41)	(60)	(86)	(124)	(38)	(70)	(133)	(171)	(63)	(103)	(128)	(179)
Unthreaded length	ℓ_{unthr}	in.	1-1/2			2-1/8			3-1/4				3				
		(mm)	(39)			(54)			(83)				(77)				

1 Minimum thickness of fixture is a concern only when the anchor is installed at the minimum nominal embedment. When KWIK Bolt TZ anchors are installed at this embedment, the anchor threading ends near the surface of the concrete. If the fixture is sufficiently thin, it could be possible to run the nut to the bottom of the threading during application of the installation torque. If fixtures are thin, it is recommended that embedment be increased accordingly.

Table 2 - Hilti KWIK Bolt TZ stainless steel specifications[1]

Setting information	Symbol	Units	Nominal anchor diameter (in.)														
			3/8			1/2			5/8				3/4				
Nominal bit diameter	d_{bit}	in.	3/8			1/2			5/8				3/4				
Nominal min. embedment	h_{nom}	in.	2-5/16			2-3/8		3-5/8	3-9/16		4-7/16		4-5/16	5-5/16			
		(mm)	(59)			(60)		(91)	(91)		(113)		(110)	(142)			
Effective min. embedment	h_{ef}	in.	2			2		3-1/4	3-1/8		4		3-3/4	4-3/4			
		(mm)	(51)			(51)		(83)	(79)		(102)		(95)	(121)			
Min. hole depth	h_o	in.	2-5/8			2-5/8		4	3-3/4		4-3/4		4-5/8	5-3/4			
		(mm)	(67)			(67)		(102)	(95)		(121)		(117)	(146)			
Min. thickness of fixture[1]	t_{min}	in.	1/4			3/4		1/4	3/8		3/4		1/8	1-5/8			
		(mm)	(6)			(19)		(6)	(9)		(19)		(3)	(41)			
Max. thickness of fixture	t_{max}	in.	2-1/4			4		2-3/4	5-5/8		4-3/4		4-5/8	3-5/8			
		(mm)	(57)			(101)		(70)	(143)		(121)		(117)	(92)			
Installation torque (concrete)	T_{inst}	ft-lb	25			40			60				110				
		(Nm)	(34)			(54)			(81)				(149)				
Installation torque (masonry)	T_{inst}	ft-lb	15			25			35				70				
		(Nm)	(20)			(34)			(47)				(95)				
Fixture hole diameter	d_h	in.	7/16			9/16			11/16				13/16				
		(mm)	(11.1)			(14.3)			(17.5)				(20.6)				
Available anchor lengths	l_{anch}	in.	3	3-3/4	5	3-3/4	4-1/2	5-1/2	7	4-3/4	6	8.5	10	5-1/2	8	10	
		(mm)	(76)	(95)	(127)	(95)	(114)	(140)	(178)	(121)	(152)	(216)	(254)	(140)	(203)	(254)	
Threaded length including dog point	l_{thread}	in.	7/8	1-5/8	2-7/8	1-5/8	2-3/8	3-3/8	4-7/8	1-1/2	2-3/4	5-1/4	6-3/4	1-1/2	4	6	
		(mm)	(22)	(41)	(73)	(41)	(60)	(86)	(124)	(38)	(70)	(133)	(171)	(38)	(102)	(152)	
Unthreaded length	l_{unthr}	in.	2-1/8			2-1/8			3-1/4				4				
		(mm)	(54)			(54)			(83)				(102)				

1 Refer to figure 1 of this section for diagram of installation parameters

2 Minimum thickness of fixture is a concern only when the anchor is installed at the minimum nominal embedment. When KWIK Bolt TZ anchors are installed at this embedment, the anchor threading ends near the surface of the concrete. If the fixture is sufficiently thin, it could be possible to run the nut to the bottom of the threading during application of the installation torque. If fixtures are thin, it is recommended that embedment be increased accordingly.

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DESIGN DATA 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 ESR-1917 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. Data tables from ESR-1917 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Table 3 - Hilti KWIK Bolt TZ 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)
3/8	1-1/2 (38)	1-13/16 (46)	1,185 (5.3)	1,300 (5.8)	1,500 (6.7)	1,835 (8.2)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
	2 (51)	2-5/16 (59)	1,635 (7.3)	1,790 (8.0)	2,070 (9.2)	2,535 (11.3)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	2-3/4 (70)	3-1/16 (78)	2,670 (11.9)	2,925 (13.0)	3,380 (15.0)	4,140 (18.4)	7,660 (34.1)	8,395 (37.3)	9,690 (43.1)	11,870 (52.8)
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 (91)	3,585 (15.9)	3,925 (17.5)	4,535 (20.2)	5,555 (24.7)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	3-1/8 (79)	3-9/16 (91)	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)	4-7/16 (113)	5,945 (26.4)	6,510 (29.0)	7,520 (33.5)	9,210 (41.0)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-1/4 (83)	3-13/16 (97)	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)
	3-3/4 (95)	4-5/16 (110)	5,380 (23.9)	5,895 (26.2)	6,810 (30.3)	8,340 (37.1)	12,200 (54.3)	13,365 (59.5)	15,430 (68.6)	18,900 (84.1)
	4-3/4 (121)	5-9/16 (142)	6,940 (30.9)	7,605 (33.8)	8,780 (39.1)	10,755 (47.8)	17,390 (77.4)	19,050 (84.7)	22,000 (97.9)	26,945 (119.9)

Table 4 - Hilti KWIK Bolt TZ carbon steel design strength with concrete / pullout failure in cracked 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)
3/8	1-1/2 (38)	1-13/16 (46)	860 (3.8)	940 (4.2)	1,085 (4.8)	1,330 (5.9)	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)
	2-3/4 (70)	3-1/8 (79)	2,050 (9.1)	2,245 (10.0)	2,595 (11.5)	3,175 (14.1)	5,425 (24.1)	5,945 (26.4)	6,865 (30.5)	8,405 (37.4)
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 (91)	3,195 (14.2)	3,500 (15.6)	4,040 (18.0)	4,950 (22.0)	6,970 (31.0)	7,640 (34.0)	8,820 (39.2)	10,800 (48.0)
5/8	3-1/8 (79)	3-9/16 (91)	3,050 (13.6)	3,345 (14.9)	3,860 (17.2)	4,730 (21.0)	6,575 (29.2)	7,200 (32.0)	8,315 (37.0)	10,185 (45.3)
	4 (102)	4-7/16 (113)	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)	3-13/16 (97)	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)
	3-3/4 (95)	4-5/16 (110)	4,010 (17.8)	4,395 (19.5)	5,075 (22.6)	6,215 (27.6)	8,640 (38.4)	9,465 (42.1)	10,930 (48.6)	13,390 (59.6)
	4-3/4 (121)	5-9/16 (142)	5,720 (25.4)	6,265 (27.9)	7,235 (32.2)	8,860 (39.4)	12,320 (54.8)	13,495 (60.0)	15,585 (69.3)	19,085 (84.9)

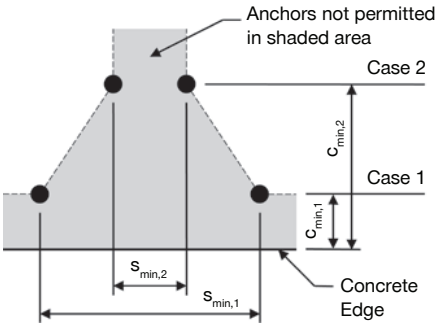
1 See section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 7 to 14 as necessary. Compare to the steel values in table 4. 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.
No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

Table 5 - Steel strength for Hilti KWIK Bolt TZ carbon steel anchors[1,2]

Nominal anchor diameter in	Effective embedment in. (mm)			Tensile ϕN_{sa} [3] lb (kN)	Shear ϕV_{sa} [4] lb (kN)	Seismic shear $\phi V_{sa,eq}$ [5] lb (kN)
3/8	1-1/2 (38)			4,875 (21.7)	1,415 (6.3)	1,415 (6.3)
	2 (51)	2-3/4 (70)		4,875 (21.7)	2,335 (10.4)	1,465 (6.5)
1/2	2 (51)	3-1/4 (83)		8,030 (35.7)	3,570 (15.9)	3,570 (15.9)
5/8	3-1/8 (79)	4 (102)		12,880 (57.3)	5,260 (23.4)	4,940 (22.0)
3/4	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	18,840 (83.8)	8,890 (39.5)	7,635 (34.0)

1 See section 3.1.8 to convert design strength value to ASD value.
2 Hilti KWIK Bolt TZ 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.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa,eq} < \phi 0.60 A_{se,V} f_{uta}$ as noted in ACI 318-14 Chapter 17. See section 3.1.8 for additional information on seismic applications.

Figure 2



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

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

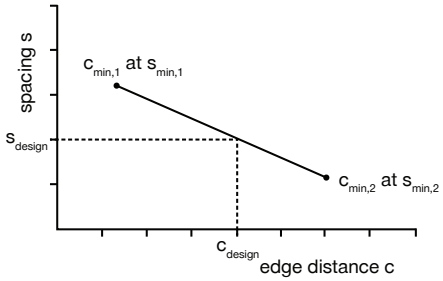


Table 6 - Carbon steel Hilti KWIK Bolt TZ installation parameters[1]

Setting information	Symbol	Units	Nominal anchor diameter d_o												
			3/8			1/2			5/8			3/4			
Effective minimum embedment	h_{ef}	in.	1-1/2	2	2-3/4	2	3-1/4		3-1/8	4		3-1/4	3-3/4		4-3/4
		(mm)	(38)	(51)	(70)	(51)	(83)		(79)	(102)		(83)	(95)		(121)
Min. member thickness	h_{min}	in.	3-1/4	4	5	5	4	6	6	8	5	6	8	5-1/2	6	8	8
		(mm)	(83)	(102)	(127)	(127)	(102)	(152)	(152)	(203)	(127)	(152)	(203)	(140)	(152)	(203)	(203)
Case 1	$c_{min,1}$	in.	8	2-1/2		2-1/2	2-3/4		2-3/8		3-5/8	3-1/4		9-1/2	4-3/4		4-1/8
		(mm)	(203)	(64)		(64)	(70)		(60)		(92)	(83)		(241)	(121)		(105)
	for $s_{min,1} \geq$	in.	8	5		5	5-3/4		5-3/4		6-1/8	5-7/8		5	10-1/2		8-7/8
		(mm)	(203)	(127)		(127)	(146)		(146)		(156)	(149)		(127)	(267)		(225)
Case 2	$c_{min,2}$	in.	8	3-5/8		3-5/8	4-1/8		3-1/2		4-3/4	4-1/4		9-1/2	9-1/2		7-3/4
		(mm)	(203)	(92)		(92)	(105)		(89)		(121)	(108)		(241)	(241)		(197)
	for $s_{min,2} \geq$	in.	8	2-1/2		2-1/2	2-3/4		2-3/8		3-1/2	3		5	5		4
		(mm)	(203)	(64)		(64)	(70)		(60)		(89)	(76)		(127)	(127)		(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 $c_{min,1} < c < c_{min,2}$, will determine the permissible spacings.

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

3/8-in. KB-TZ CS 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}		
Effective embed. h_{ef}	in.	1-1/2	2	2-3/4	1-1/2	2	2-3/4	1-1/2	2	2-3/4	1-1/2	2	2-3/4	1-1/2	2	2-3/4	1-1/2	2	2-3/4
	(mm)	(38)	(51)	(70)	(38)	(51)	(70)	(38)	(51)	(70)	(38)	(51)	(70)	(38)	(51)	(70)	(38)	(51)	(70)
Nominal embed. h_{nom}	in.	1-13/16	2-5/16	3-1/8	1-13/16	2-5/16	3-1/8	1-13/16	2-5/16	3-1/8	1-13/16	2-5/16	3-1/8	1-13/16	2-5/16	3-1/8	1-13/16	2-5/16	3-1/8
	(mm)	(46)	(59)	(79)	(46)	(59)	(79)	(46)	(59)	(79)	(46)	(59)	(79)	(46)	(59)	(79)	(46)	(59)	(79)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)																			
2-1/2	(64)	n/a	0.71	0.65	n/a	0.60	0.71	n/a	0.60	0.55	n/a	0.49	0.16	n/a	0.60	0.32	n/a	n/a	n/a
3	(76)	n/a	0.75	0.68	n/a	0.69	0.79	n/a	0.62	0.56	n/a	0.64	0.21	n/a	0.69	0.42	n/a	n/a	n/a
3-1/2	(89)	n/a	0.79	0.71	n/a	0.80	0.88	n/a	0.64	0.57	n/a	0.81	0.27	n/a	0.81	0.53	0.62	n/a	n/a
3-5/8	(92)	n/a	0.80	0.72	n/a	0.83	0.91	n/a	0.65	0.57	n/a	0.85	0.28	n/a	0.85	0.56	0.63	n/a	n/a
4	(102)	n/a	0.83	0.74	n/a	0.91	0.98	n/a	0.67	0.58	n/a	0.99	0.33	n/a	0.99	0.65	0.67	0.81	n/a
4-1/2	(114)	n/a	0.88	0.77	n/a	1.00	1.00	n/a	0.69	0.59	n/a	1.00	0.39	n/a	1.00	0.78	0.71	0.86	n/a
5	(127)	n/a	0.92	0.80	n/a			n/a	0.71	0.60	n/a		0.46	n/a		0.91	0.75	0.91	0.63
5-1/2	(140)	n/a	0.96	0.83	n/a			n/a	0.73	0.61	n/a		0.53	n/a		1.00	0.78	0.95	0.66
6	(152)	n/a	1.00	0.86	n/a			n/a	0.75	0.62	n/a		0.60	n/a			0.82	1.00	0.69
7	(178)	n/a		0.92	n/a			n/a	0.79	0.64	n/a		0.76	n/a			0.88		0.74
8	(203)	1.00		0.98	1.00			0.72	0.83	0.66	1.00		0.92	1.00			0.94		0.80
9	(229)	1.00		1.00				0.75	0.87	0.68			1.00				1.00		0.84
10	(254)	1.00						0.78	0.91	0.70							1.00		0.89
11	(279)	1.00						0.81	0.95	0.72									0.93
12	(305)	1.00						0.83	1.00	0.74									0.97
13	(330)	1.00						0.86	1.00	0.76									1.00

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

3/8-in. KB-TZ CS 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: II To and away from edge f_{RV}			Conc. thickness factor in shear[4] f_{HV}		
Effective embed. h_{ef}	in.	1-1/2	2	2-3/4	1-1/2	2	2-3/4	1-1/2	2	2-3/4	1-1/2	2	2-3/4	1-1/2	2	2-3/4	1-1/2	2	2-3/4
	(mm)	(38)	(51)	(70)	(38)	(51)	(70)	(38)	(51)	(70)	(38)	(51)	(70)	(38)	(51)	(70)	(38)	(51)	(70)
Nominal embed. h_{nom}	in.	1-13/16	2-5/16	3-1/8	1-13/16	2-5/16	3-1/8	1-13/16	2-5/16	3-1/8	1-13/16	2-5/16	3-1/8	1-13/16	2-5/16	3-1/8	1-13/16	2-5/16	3-1/8
	(mm)	(46)	(59)	(79)	(46)	(59)	(79)	(46)	(59)	(79)	(46)	(59)	(79)	(46)	(59)	(79)	(46)	(59)	(79)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)																			
2-1/2	(64)	n/a	0.71	0.65	n/a	0.87	0.71	n/a	0.60	0.55	n/a	0.49	0.16	n/a	0.87	0.33	n/a	n/a	n/a
3	(76)	n/a	0.75	0.68	n/a	1.00	0.79	n/a	0.62	0.56	n/a	0.65	0.21	n/a	1.00	0.43	n/a	n/a	n/a
3-1/2	(89)	n/a	0.79	0.71	n/a	1.00	0.88	n/a	0.65	0.57	n/a	0.82	0.27	n/a	1.00	0.54	0.62	n/a	n/a
3-5/8	(92)	n/a	0.80	0.72	n/a	1.00	0.91	n/a	0.65	0.57	n/a	0.86	0.28	n/a	1.00	0.57	0.63	n/a	n/a
4	(102)	n/a	0.83	0.74	n/a		0.98	n/a	0.67	0.58	n/a	1.00	0.33	n/a		0.66	0.67	0.82	n/a
4-1/2	(114)	n/a	0.88	0.77	n/a		1.00	n/a	0.69	0.59	n/a		0.39	n/a		0.79	0.71	0.87	n/a
5	(127)	n/a	0.92	0.80	n/a			n/a	0.71	0.60	n/a		0.46	n/a		0.92	0.75	0.91	0.63
5-1/2	(140)	n/a	0.96	0.83	n/a			n/a	0.73	0.61	n/a		0.53	n/a		1.00	0.78	0.96	0.66
6	(152)	n/a	1.00	0.86	n/a			n/a	0.75	0.62	n/a		0.61	n/a			0.82	1.00	0.69
7	(178)	n/a		0.92	n/a			n/a	0.79	0.64	n/a		0.76	n/a			0.88		0.75
8	(203)	1.000		0.98	1.00			0.72	0.83	0.66	1.00		0.93	1.00			0.94		0.80
9	(229)	1.000		1.00				0.75	0.87	0.68			1.00				1.00		0.85
10	(254)	1.000						0.78	0.92	0.70									0.89
11	(279)	1.000						0.81	0.96	0.72									0.94
12	(305)	1.000						0.83	1.00	0.74									0.98
13	(330)	1.000						0.86		0.76									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.

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

1/2-in. KB-TZ CS 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}	
Effective embed. h_{ef}	in.	2	3-1/4	2	3-1/4	2	3-1/4	2	3-1/4	2	3-1/4	2	3-1/4
	(mm)	(51)	(83)	(51)	(83)	(51)	(83)	(51)	(83)	(51)	(83)	(51)	(83)
Nominal embed. h_{nom}	in.	2-3/8	3-5/8	2-3/8	3-5/8	2-3/8	3-5/8	2-3/8	3-5/8	2-3/8	3-5/8	2-3/8	3-5/8
	(mm)	(60)	(92)	(60)	(92)	(60)	(92)	(60)	(92)	(60)	(92)	(60)	(92)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)													
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
2-3/4	(70)	0.73	0.64	0.51	0.44	0.62	0.55	0.51	0.16	0.51	0.33	n/a	n/a
3	(76)	0.75	0.65	0.55	0.46	0.63	0.55	0.55	0.19	0.55	0.37	n/a	n/a
3-1/2	(89)	0.79	0.68	0.64	0.51	0.65	0.56	0.64	0.23	0.64	0.47	n/a	n/a
4	(102)	0.83	0.71	0.73	0.56	0.68	0.57	0.73	0.29	0.73	0.56	0.84	n/a
4-1/8	(105)	0.84	0.71	0.75	0.57	0.68	0.57	0.75	0.30	0.75	0.57	0.85	n/a
4-1/2	(114)	0.88	0.73	0.82	0.61	0.70	0.58	0.82	0.34	0.82	0.61	0.89	n/a
5	(127)	0.92	0.76	0.91	0.67	0.72	0.59	0.91	0.40	0.91	0.67	0.94	n/a
5-1/2	(140)	0.96	0.78	1.00	0.73	0.74	0.60	1.00	0.46	1.00	0.73	0.98	n/a
5-3/4	(146)	0.98	0.79		0.77	0.75	0.60		0.49		0.77	1.00	n/a
6	(152)	1.00	0.81		0.80	0.76	0.61		0.53		0.80		0.66
7	(178)		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						

Table 10 - Load adjustment factors for 1/2-in. diameter carbon steel Hilti KWIK Bolt TZ in cracked concrete[1,2]

1/2-in. KB-TZ CS 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: II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Effective embed. h_{ef}	in.	2	3-1/4	2	3-1/4	2	3-1/4	2	3-1/4	2	3-1/4	2	3-1/4
	(mm)	(51)	(83)	(51)	(83)	(51)	(83)	(51)	(83)	(51)	(83)	(51)	(83)
Nominal embed. h_{nom}	in.	2-3/8	3-5/8	2-3/8	3-5/8	2-3/8	3-5/8	2-3/8	3-5/8	2-3/8	3-5/8	2-3/8	3-5/8
	(mm)	(60)	(92)	(60)	(92)	(60)	(92)	(60)	(92)	(60)	(92)	(60)	(92)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)													
2-3/8	(60)	n/a	0.62	n/a	0.63	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	0.65	n/a	0.55	n/a	0.14	n/a	0.29	n/a	n/a
2-3/4	(70)	0.73	0.64	0.93	0.68	0.62	0.55	0.62	0.16	0.93	0.33	n/a	n/a
3	(76)	0.75	0.65	1.00	0.71	0.63	0.55	0.71	0.19	1.00	0.38	n/a	n/a
3-1/2	(89)	0.79	0.68	1.00	0.79	0.65	0.56	0.89	0.24	1.00	0.47	n/a	n/a
4	(102)	0.83	0.71	1.00	0.86	0.68	0.57	1.00	0.29	1.00	0.58	0.84	n/a
4-1/8	(105)	0.84	0.71	1.00	0.88	0.68	0.58	1.00	0.30	1.00	0.61	0.85	n/a
4-1/2	(114)	0.88	0.73		0.94	0.70	0.58		0.34		0.69	0.89	n/a
5	(127)	0.92	0.76		1.00	0.72	0.59		0.40		0.81	0.94	n/a
5-1/2	(140)	0.96	0.78			0.74	0.60		0.47		0.93	0.98	n/a
5-3/4	(146)	0.98	0.79			0.75	0.60		0.50		1.00	1.00	n/a
6	(152)	1.00	0.81			0.76	0.61		0.53		1.00		0.66
7	(178)		0.86			0.81	0.63		0.67				0.71
8	(203)		0.91			0.85	0.65		0.82				0.76
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						

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.

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Table 11 - Load adjustment factors for 5/8-in. diameter carbon steel Hilti KWIK Bolt TZ in uncracked concrete[1,2]

5/8-in. KB-TZ CS 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}	
Effective embed. h_{ef}	in.		3-1/8	4	3-1/8	4	3-1/8	4	3-1/8	4	3-1/8	4	3-1/8	4
	(mm)		(79)	(102)	(79)	(102)	(79)	(102)	(79)	(102)	(79)	(102)	(79)	(102)
Nominal embed. h_{nom}	in.		3-9/16	4-7/16	3-9/16	4-7/16	3-9/16	4-7/16	3-9/16	4-7/16	3-9/16	4-7/16	3-9/16	4-7/16
	(mm)		(90)	(113)	(90)	(113)	(90)	(113)	(90)	(113)	(90)	(113)	(90)	(113)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	3	(76)	n/a	0.63	n/a	n/a	n/a	0.55	n/a	n/a	n/a	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.64	n/a	0.46	n/a	0.55	n/a	0.17	n/a	0.34	n/a	n/a
	3-1/2	(89)	0.69	0.65	n/a	0.48	0.57	0.56	n/a	0.19	n/a	0.38	n/a	n/a
	3-5/8	(92)	0.69	0.65	0.60	0.48	0.57	0.56	0.28	0.20	0.56	0.40	n/a	n/a
	4	(102)	0.71	0.67	0.64	0.51	0.58	0.56	0.32	0.23	0.64	0.47	n/a	n/a
	4-1/4	(108)	0.73	0.68	0.67	0.53	0.58	0.57	0.35	0.26	0.67	0.51	n/a	n/a
	4-1/2	(114)	0.74	0.69	0.70	0.56	0.59	0.57	0.38	0.28	0.70	0.56	n/a	n/a
	4-3/4	(121)	0.75	0.70	0.73	0.58	0.59	0.58	0.42	0.30	0.73	0.58	n/a	n/a
	5	(127)	0.77	0.71	0.77	0.60	0.60	0.58	0.45	0.33	0.77	0.60	0.63	n/a
	5-1/2	(140)	0.79	0.73	0.85	0.64	0.61	0.59	0.52	0.38	0.85	0.64	0.66	n/a
	5-7/8	(149)	0.81	0.74	0.90	0.67	0.62	0.59	0.57	0.42	0.90	0.67	0.68	n/a
	6	(152)	0.82	0.75	0.92	0.69	0.62	0.59	0.59	0.43	0.92	0.69	0.69	0.62
	6-1/8	(156)	0.83	0.76	0.94	0.70	0.62	0.60	0.61	0.44	0.94	0.70	0.69	0.62
	8	(203)	0.93	0.83	1.00	0.91	0.66	0.63	0.91	0.66	1.00	0.91	0.79	0.71
	10	(254)	1.00	0.92		1.00	0.70	0.66	1.00	0.92		1.00	0.89	0.80
	12	(305)		1.00			0.74	0.69		1.00			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						
	22	(559)					0.93	0.85						
	> 24	(610)					0.97	0.88						

Table 12 - Load adjustment factors for 5/8-in. diameter carbon steel Hilti KWIK Bolt TZ in cracked concrete[1,2]

5/8-in. KB-TZ CS 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: II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Effective embed. h_{ef}	in.		3-1/8	4	3-1/8	4	3-1/8	4	3-1/8	4	3-1/8	4	3-1/8	4
	(mm)		(79)	(102)	(79)	(102)	(79)	(102)	(79)	(102)	(79)	(102)	(79)	(102)
Nominal embed. h_{nom}	in.		3-9/16	4-7/16	3-9/16	4-7/16	3-9/16	4-7/16	3-9/16	4-7/16	3-9/16	4-7/16	3-9/16	4-7/16
	(mm)		(90)	(113)	(90)	(113)	(90)	(113)	(90)	(113)	(90)	(113)	(90)	(113)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	3	(76)	n/a	0.63	n/a	n/a	n/a	0.55	n/a	n/a	n/a	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.64	n/a	0.66	n/a	0.55	n/a	0.17	n/a	0.35	n/a	n/a
	3-1/2	(89)	0.69	0.65	n/a	0.69	0.57	0.56	n/a	0.19	n/a	0.39	n/a	n/a
	3-5/8	(92)	0.69	0.65	0.83	0.71	0.57	0.56	0.28	0.20	0.56	0.41	n/a	n/a
	4	(102)	0.71	0.67	0.89	0.75	0.58	0.56	0.33	0.24	0.65	0.47	n/a	n/a
	4-1/4	(108)	0.73	0.68	0.93	0.78	0.58	0.57	0.36	0.26	0.71	0.52	n/a	n/a
	4-1/2	(114)	0.74	0.69	0.97	0.81	0.59	0.57	0.39	0.28	0.78	0.56	n/a	n/a
	4-3/4	(121)	0.75	0.70	1.00	0.84	0.59	0.58	0.42	0.31	0.84	0.61	n/a	n/a
	5	(127)	0.77	0.71		0.87	0.60	0.58	0.45	0.33	0.91	0.66	0.63	n/a
	5-1/2	(140)	0.79	0.73		0.93	0.61	0.59	0.52	0.38	1.00	0.76	0.66	n/a
	5-7/8	(149)	0.81	0.74		0.98	0.62	0.59	0.58	0.42		0.84	0.68	n/a
	6	(152)	0.82	0.75		1.00	0.62	0.60	0.60	0.43		0.87	0.69	0.62
	6-1/8	(156)	0.83	0.76			0.62	0.60	0.62	0.45		0.89	0.69	0.62
	8	(203)	0.93	0.83			0.66	0.63	0.92	0.67		1.00	0.79	0.71
	10	(254)	1.00	0.92			0.70	0.66	1.00	0.93			0.89	0.80
	12	(305)		1.00			0.74	0.69		1.00			0.97	0.87
	14	(356)					0.78	0.72					1.00	0.94
	16	(406)					0.82	0.75						1.00
	18	(457)					0.85	0.79						
	20	(508)					0.89	0.82						
	22	(559)					0.93	0.85						
	> 24	(610)					0.97	0.88						

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.

Table 13 - Load adjustment factors for 3/4-in. diameter carbon steel Hilti KWIK Bolt TZ in uncracked concrete[1,2]

3/4-in. KB-TZ CS 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}		
Effective embed. h_{ef}		in.	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4
		(mm)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)
Nominal embed. h_{nom}		in.	3-13/16	4-5/16	5-9/16	3-13/16	4-5/16	5-9/16	3-13/16	4-5/16	5-9/16	3-13/16	4-5/16	5-9/16	3-13/16	4-5/16	5-9/16	3-13/16	4-5/16	5-9/16
		(mm)	(97)	(110)	(141)	(97)	(110)	(141)	(97)	(110)	(141)	(97)	(110)	(141)	(97)	(110)	(141)	(97)	(110)	(142)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	4	(102)	n/a	n/a	0.640	n/a	n/a	n/a	n/a	n/a	0.557	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4-1/8	(105)	n/a	n/a	0.645	n/a	n/a	0.546	n/a	n/a	0.558	n/a	n/a	0.207	n/a	n/a	0.414	n/a	n/a	n/a
	4-1/2	(114)	n/a	n/a	0.658	n/a	n/a	0.574	n/a	n/a	0.564	n/a	n/a	0.236	n/a	n/a	0.472	n/a	n/a	n/a
	4-3/4	(121)	n/a	n/a	0.667	n/a	0.495	0.594	n/a	n/a	0.567	n/a	0.348	0.256	n/a	0.495	0.512	n/a	n/a	n/a
	5	(127)	0.756	0.722	0.675	n/a	0.514	0.613	0.569	0.587	0.571	n/a	0.376	0.276	n/a	0.514	0.552	n/a	n/a	n/a
	5-1/2	(140)	0.782	0.744	0.693	n/a	0.553	0.653	0.576	0.595	0.578	n/a	0.433	0.319	n/a	0.553	0.637	0.553	n/a	n/a
	6	(152)	0.808	0.767	0.711	n/a	0.600	0.695	0.583	0.604	0.585	n/a	0.494	0.363	n/a	0.600	0.695	0.577	0.645	n/a
	7	(178)	0.859	0.811	0.746	n/a	0.700	0.781	0.597	0.621	0.599	n/a	0.622	0.458	n/a	0.700	0.781	0.624	0.697	n/a
	7-3/4	(197)	0.897	0.844	0.772	n/a	0.775	0.861	0.608	0.634	0.610	n/a	0.725	0.533	n/a	0.775	0.861	0.656	0.733	n/a
	8	(203)	0.910	0.856	0.781	n/a	0.800	0.889	0.611	0.639	0.613	n/a	0.760	0.559	n/a	0.800	0.889	0.667	0.745	0.673
	8-7/8	(225)	0.955	0.894	0.811	n/a	0.888	0.986	0.623	0.654	0.625	n/a	0.888	0.653	n/a	0.888	0.986	0.702	0.785	0.708
	9-1/2	(241)	0.987	0.922	0.833	0.792	0.950	1.000	0.632	0.665	0.634	0.704	0.984	0.723	0.792	0.984	1.000	0.726	0.812	0.733
	10	(254)	1.000	0.944	0.851	0.833	1.000		0.639	0.674	0.641	0.761	1.000	0.781	0.833	1.000		0.745	0.833	0.752
	10-1/2	(267)		0.967	0.868	0.875			0.646	0.682	0.648	0.818		0.841	0.875			0.764	0.854	0.771
	12	(305)		1.000	0.921	1.000			0.667	0.708	0.670	1.000		1.000	1.000			0.816	0.913	0.824
	14	(356)			0.991				0.694	0.743	0.698							0.882	0.986	0.890
	16	(406)			1.000				0.722	0.778	0.726							0.943	1.000	0.951
	18	(457)							0.750	0.812	0.754							1.000		1.000
	20	(508)							0.778	0.847	0.783									
	22	(559)							0.806	0.882	0.811									
	> 24	(610)							0.833	0.916	0.839									

Table 14 - Load adjustment factors for 3/4-in. diameter carbon steel Hilti KWIK Bolt TZ in cracked concrete[1,2]

3/4-in. KB-TZ CS 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: II to and away from edge f_{RV}			Conc. thickness factor in shear[4] f_{HV}		
Effective embed. h_{ef}		in.	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4	3-1/4	3-3/4	4-3/4
		(mm)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)	(83)	(95)	(121)
Nominal embed. h_{nom}		in.	3-13/16	4-5/16	5-9/16	3-13/16	4-5/16	5-9/16	3-13/16	4-5/16	5-9/16	3-13/16	4-5/16	5-9/16	3-13/16	4-5/16	5-9/16	3-13/16	4-5/16	5-9/16
		(mm)	(97)	(110)	(141)	(97)	(110)	(141)	(97)	(110)	(141)	(97)	(110)	(141)	(97)	(110)	(141)	(97)	(110)	(142)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	4	(102)	n/a	n/a	0.640	n/a	n/a	n/a	n/a	n/a	0.557	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	4-1/8	(105)	n/a	n/a	0.645	n/a	n/a	0.690	n/a	n/a	0.559	n/a	n/a	0.209	n/a	n/a	0.417	n/a	n/a	n/a
	4-1/2	(114)	n/a	n/a	0.658	n/a	n/a	0.726	n/a	n/a	0.564	n/a	n/a	0.238	n/a	n/a	0.476	n/a	n/a	n/a
	4-3/4	(121)	n/a	n/a	0.667	n/a	0.879	0.750	n/a	n/a	0.568	n/a	0.351	0.258	n/a	0.701	0.516	n/a	n/a	n/a
	5	(127)	0.756	0.722	0.675	n/a	0.913	0.775	0.599	0.587	0.571	n/a	0.379	0.279	n/a	0.757	0.557	n/a	n/a	n/a
	5-1/2	(140)	0.782	0.744	0.693	n/a	0.982	0.825	0.609	0.596	0.578	n/a	0.437	0.321	n/a	0.874	0.643	0.659	n/a	n/a
	6	(152)	0.808	0.767	0.711	n/a	1.000	0.877	0.619	0.605	0.585	n/a	0.498	0.366	n/a	0.996	0.732	0.689	0.647	n/a
	7	(178)	0.859	0.811	0.746	n/a	1.000	0.986	0.638	0.622	0.600	n/a	0.627	0.461	n/a	1.000	0.923	0.744	0.699	n/a
	7-3/4	(197)	0.897	0.844	0.772	n/a	1.000	1.000	0.653	0.635	0.610	n/a	0.731	0.538	n/a		1.000	0.783	0.735	n/a
	8	(203)	0.910	0.856	0.781	1.000	1.000		0.658	0.640	0.614	0.923	0.767	0.564	1.000			0.795	0.747	0.674
	8-7/8	(225)	0.955	0.894	0.811	1.000	1.000		0.675	0.655	0.626	1.000	0.896	0.659				0.837	0.787	0.710
	9-1/2	(241)	0.987	0.922	0.833	1.000	1.000		0.688	0.666	0.635		0.992	0.729				0.866	0.814	0.735
	10	(254)	1.000	0.944	0.851				0.698	0.674	0.642		1.000	0.788				0.889	0.835	0.754
	10-1/2	(267)		0.967	0.868				0.707	0.683	0.649			0.848				0.911	0.856	0.773
	12	(305)		1.000	0.921				0.737	0.709	0.671			1.000				0.974	0.915	0.826
	14	(356)			0.991				0.777	0.744	0.699							1.000	0.989	0.892
	16	(406)			1.000				0.816	0.779	0.727								1.000	0.954
	18	(457)							0.856	0.814	0.756									1.000
	20	(508)							0.895	0.849	0.784									
	22	(559)							0.935	0.884	0.813									
	> 24	(610)							0.974	0.919	0.841									

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.

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Table 15 - Hilti KWIK Bolt TZ 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)
3/8	2 (51)	2-5/16 (59)	1,710 (7.6)	1,875 (8.3)	2,160 (9.6)	2,650 (11.8)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
1/2	2 (51)	2-3/8 (60)	1,865 (8.3)	2,045 (9.1)	2,360 (10.5)	2,890 (12.9)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	3-1/4 (83)	3-5/8 (91)	3,745 (16.7)	4,100 (18.2)	4,735 (21.1)	5,800 (25.8)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	3-1/8 (79)	3-9/16 (91)	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)	4-7/16 (113)	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)	4-5/16 (110)	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)
	4-3/4 (121)	5-9/16 (142)	7,825 (34.8)	8,575 (38.1)	9,900 (44.0)	12,125 (53.9)	17,390 (77.4)	19,050 (84.7)	22,000 (97.9)	26,945 (119.9)

Table 16 - Hilti KWIK Bolt TZ stainless steel design strength with concrete / pullout failure in cracked 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)
3/8	2 (51)	2-5/16 (59)	1,520 (6.8)	1,665 (7.4)	1,925 (8.6)	2,355 (10.5)	1,685 (7.5)	1,845 (8.2)	2,130 (9.5)	2,605 (11.6)
1/2	2 (51)	2-3/8 (60)	1,750 (7.8)	1,915 (8.5)	2,210 (9.8)	2,710 (12.1)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	3-1/4 (83)	3-5/8 (91)	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	3-1/8 (79)	3-9/16 (91)	3,050 (13.6)	3,345 (14.9)	3,860 (17.2)	4,730 (21.0)	6,575 (29.2)	7,200 (32.0)	8,315 (37.0)	10,185 (45.3)
	4 (102)	4-7/16 (113)	3,795 (16.9)	4,160 (18.5)	4,800 (21.4)	5,880 (26.2)	9,520 (42.3)	10,430 (46.4)	12,040 (53.6)	14,750 (65.6)
3/4	3-3/4 (95)	4-5/16 (110)	5,270 (23.4)	5,775 (25.7)	6,670 (29.7)	8,165 (36.3)	12,200 (54.3)	13,365 (59.5)	15,430 (68.6)	18,900 (84.1)
	4-3/4 (121)	5-9/16 (142)	5,720 (25.4)	6,265 (27.9)	7,235 (32.2)	8,860 (39.4)	12,320 (54.8)	13,495 (60.0)	15,585 (69.3)	19,085 (84.9)

1 See 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 19 to 26 as necessary. Compare to the steel values in table 17. 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

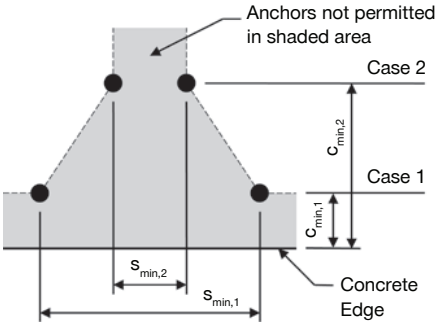
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/2-in diameter by 2-in effective embedment depth - $\alpha_{N,seis}$ = 0.64
All other sizes - $\alpha_{N,seis}$ = 0.75
No reduction needed for seismic shear. See Section 3.1.8 for additional information on seismic applications.

Table 17 - Steel strength for Hilti KWIK Bolt TZ stainless steel anchors[1,2]

Nominal anchor diameter in.	Tensile ϕN_{sa}[3] lb (kN)	Shear ϕV_{sa}[4] lb (kN)	Seismic shear $\phi V_{sa,eq}$[5] lb (kN)
3/8	4,475 (19.9)	3,070 (13.7)	1,835 (8.2)
1/2	8,665 (38.5)	4,470 (19.9)	4,470 (19.9)
5/8	13,410 (59.7)	6,415 (28.5)	6,080 (27.0)
3/4	18,040 (80.2)	10,210 (45.4)	8,380 (37.3)

1 See section 3.1.8 to convert design strength value to ASD value.
2 Hilti KWIK Bolt TZ 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.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa,eq} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318-14 Chapter 17. See section 3.1.8 for additional information on seismic applications.

Figure 3



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

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

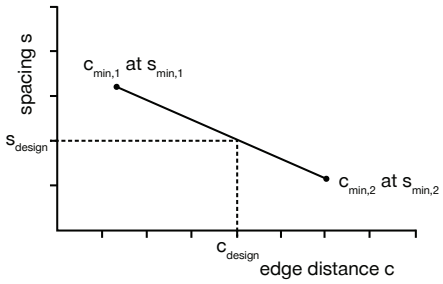


Table 18 - Stainless steel Hilti KWIK Bolt TZ installation parameters[1]

Setting information	Symbol	Units	Nominal anchor diameter d_o										
			3/8		1/2			5/8			3/4		
Effective minimum embedment[1]	h_{ef}	in. (mm)	2 (51)		2 (51)		3-1/4 (83)	3-1/8 (79)	4 (102)		3-3/4 (95)		4-3/4 (121)
Min. member thickness	h_{min}	in. (mm)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	6 (152)	8 (203)	8 (203)
Case 1	$c_{min,1}$	in. (mm)	2-1/2 (64)		2-7/8 (73)		2-1/8 (54)	3-1/4 (83)	2-3/8 (60)		4-1/4 (108)		4 (102)
	for $s_{min,1} \geq$	in. (mm)	5 (127)		5-3/4 (146)		5-1/4 (133)	5-1/2 (140)	5-1/2 (140)		10 (254)		8-1/2 (216)
Case 2	$c_{min,2}$	in. (mm)	3-1/2 (89)		4-1/2 (114)		3-1/4 (83)	4-1/8 (105)	4-1/4 (108)		9-1/2 (241)		7 (178)
	for $s_{min,2} \geq$	in. (mm)	2-1/4 (57)		2-7/8 (73)		2 (51)	2-3/4 (70)	2-3/8 (60)		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 $c_{min,1} < c < c_{min,2}$, will determine the permissible spacings.

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Table 19 - Load adjustment factors for 3/8-in. diameter stainless steel Hilti KWIK Bolt TZ in uncracked concrete[1,2]

3/8-in. KB-TZ SS 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		Conc. thickness factor in shear[4] f_{HV}
						⊥ toward edge f_{RV}	II to and away from edge f_{RV}	
Effective embed. h_{ef}		in. (mm)	2 (51)	2 (51)	2 (51)	2 (51)	2 (51)	2 (51)
Nominal embed. h_{nom}		in. (mm)	2-5/16 (59)	2-5/16 (59)	2-5/16 (59)	2-5/16 (59)	2-5/16 (59)	2-5/16 (59)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	2-1/4	(57)	0.69	n/a	0.59	n/a	n/a	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
	5-1/2	(140)	0.96		0.73			0.95
	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 20 - Load adjustment factors for 3/8-in. diameter stainless steel Hilti KWIK Bolt TZ in cracked concrete[1,2]

3/8-in. KB-TZ SS 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		Conc. thickness factor in shear[4] f_{HV}
						⊥ toward edge f_{RV}	II to and away from edge f_{RV}	
Effective embed. h_{ef}		in. (mm)	2 (51)	2 (51)	2 (51)	2 (51)	2 (51)	2 (51)
Nominal embed. h_{nom}		in. (mm)	2-5/16 (59)	2-5/16 (59)	2-5/16 (59)	2-5/16 (59)	2-5/16 (59)	2-5/16 (59)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	2-1/4	(57)	0.69	n/a	0.59	n/a	n/a	n/a
	2-1/2	(64)	0.71	0.87	0.60	0.49	0.87	n/a
	3	(76)	0.75	1.00	0.62	0.65	1.00	n/a
	3-1/2	(89)	0.79	1.00	0.65	0.82	1.00	n/a
	4	(102)	0.83		0.67	1.00		0.82
	4-1/2	(114)	0.88		0.69			0.87
	5	(127)	0.92		0.71			0.91
	5-1/2	(140)	0.96		0.73			0.96
	6	(152)	1.00		0.75			1.00
	7	(178)			0.79			
	8	(203)			0.83			
	9	(229)			0.87			
	10	(254)			0.92			
	11	(279)			0.96			
	12	(305)			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 17 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 21 - Load adjustment factors for 1/2-in. diameter stainless steel Hilti KWIK Bolt TZ in uncracked concrete[1,2]

1/2-in. KB-TZ SS 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}	
Effective embed. 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)
Nominal embed. 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	(51)	n/a	0.60	n/a	n/a	n/a	0.54	n/a	n/a	n/a	n/a	n/a	n/a
2-1/8	(54)	n/a	0.61	n/a	0.39	n/a	0.54	n/a	0.11	n/a	0.22	n/a	n/a
2-7/8	(73)	0.74	0.65	0.53	0.45	0.63	0.55	0.53	0.17	0.53	0.35	n/a	n/a
3	(76)	0.75	0.65	0.55	0.46	0.63	0.55	0.55	0.19	0.55	0.37	n/a	n/a
3-1/4	(83)	0.77	0.67	0.59	0.49	0.64	0.56	0.59	0.21	0.59	0.42	n/a	n/a
3-1/2	(89)	0.79	0.68	0.64	0.51	0.65	0.56	0.64	0.23	0.64	0.47	n/a	n/a
4	(102)	0.83	0.71	0.73	0.56	0.68	0.57	0.73	0.29	0.73	0.56	0.84	n/a
4-1/2	(114)	0.88	0.73	0.82	0.61	0.70	0.58	0.82	0.34	0.82	0.61	0.89	n/a
5	(127)	0.92	0.76	0.91	0.67	0.72	0.59	0.91	0.40	0.91	0.67	0.94	n/a
5-1/4	(133)	0.94	0.77	0.95	0.70	0.73	0.60	0.95	0.43	0.95	0.70	0.96	n/a
5-1/2	(140)	0.96	0.78	1.00	0.73	0.74	0.60	1.00	0.46	1.00	0.73	0.98	n/a
6	(152)	1.00	0.81		0.80	0.76	0.61		0.53		0.80	1.00	0.66
7	(178)		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						

Table 22 - Load adjustment factors for 1/2-in. diameter stainless steel Hilti KWIK Bolt TZ in cracked concrete[1,2]

1/2-in. KB-TZ SS 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: II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Effective embed. 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)
Nominal embed. 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	(51)	n/a	0.60	n/a	n/a	n/a	0.54	n/a	n/a	n/a	n/a	n/a	n/a
2-1/8	(54)	n/a	0.61	n/a	0.60	n/a	0.54	n/a	0.11	n/a	0.22	n/a	n/a
2-7/8	(73)	0.74	0.65	0.97	0.70	0.60	0.55	0.47	0.18	0.94	0.35	n/a	n/a
3	(76)	0.75	0.65	1.00	0.71	0.60	0.55	0.50	0.19	1.00	0.38	n/a	n/a
3-1/4	(83)	0.77	0.67	1.00	0.75	0.61	0.56	0.56	0.21	1.00	0.42	n/a	n/a
3-1/2	(89)	0.79	0.68	1.00	0.79	0.62	0.56	0.63	0.24	1.00	0.47	n/a	n/a
4	(102)	0.83	0.71	1.00	0.86	0.64	0.57	0.77	0.29	1.00	0.58	0.75	n/a
4-1/2	(114)	0.88	0.73	1.00	0.94	0.66	0.58	0.92	0.34	1.00	0.69	0.79	n/a
5	(127)	0.92	0.76		1.00	0.67	0.59	1.00	0.40		0.81	0.84	n/a
5-1/4	(133)	0.94	0.77			0.68	0.60		0.43		0.87	0.86	n/a
5-1/2	(140)	0.96	0.78			0.69	0.60		0.47		0.93	0.88	n/a
6	(152)	1.00	0.81			0.71	0.61		0.53		1.00	0.92	0.66
7	(178)		0.86			0.74	0.63		0.67			0.99	0.71
8	(203)		0.91			0.78	0.65		0.82			1.00	0.76
9	(229)		0.96			0.81	0.66		0.98				0.81
10	(254)		1.00			0.85	0.68		1.00				0.85
11	(279)					0.88	0.70						0.90
12	(305)					0.92	0.72						0.94
14	(356)					0.99	0.76						1.00
16	(406)					1.00	0.79						
18	(457)						0.83						
> 20	(508)						0.86						

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 17 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

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Table 23 - Load adjustment factors for 5/8-in. diameter stainless steel Hilti KWIK Bolt TZ in uncracked concrete[1,2]

5/8-in. KB-TZ SS 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}	
Effective embed. h_{ef}		in. (mm)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)
Nominal embed. h_{nom}		in. (mm)	3-9/16 (90)	4-7/16 (113)	3-9/16 (90)	4-7/16 (113)	3-9/16 (90)	4-7/16 (113)	3-9/16 (90)	4-7/16 (113)	3-9/16 (90)	4-7/16 (113)	3-9/16 (90)	4-7/16 (113)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	2-3/8	(60)	n/a	0.60	n/a	0.39	n/a	0.54	n/a	0.11	n/a	0.21	n/a	n/a
	2-3/4	(70)	0.65	0.61	n/a	0.41	0.55	0.54	n/a	0.13	n/a	0.27	n/a	n/a
	3	(76)	0.66	0.63	n/a	0.43	0.56	0.55	n/a	0.15	n/a	0.30	n/a	n/a
	3-1/4	(83)	0.67	0.64	0.51	0.45	0.56	0.55	0.24	0.17	0.47	0.34	n/a	n/a
	3-1/2	(89)	0.69	0.65	0.54	0.47	0.57	0.56	0.26	0.19	0.53	0.38	n/a	n/a
	4	(102)	0.71	0.67	0.59	0.51	0.58	0.56	0.32	0.23	0.59	0.47	n/a	n/a
	4-1/2	(114)	0.74	0.69	0.65	0.55	0.59	0.57	0.38	0.28	0.65	0.55	n/a	n/a
	5	(127)	0.77	0.71	0.71	0.59	0.60	0.58	0.45	0.33	0.71	0.59	0.63	n/a
	5-1/2	(140)	0.79	0.73	0.79	0.63	0.61	0.59	0.52	0.38	0.79	0.63	0.66	n/a
	6	(152)	0.82	0.75	0.86	0.68	0.62	0.59	0.59	0.43	0.86	0.68	0.69	0.62
	7	(178)	0.87	0.79	1.00	0.79	0.64	0.61	0.75	0.54	1.00	0.79	0.74	0.67
	8	(203)	0.93	0.83		0.90	0.66	0.63	0.91	0.66		0.90	0.79	0.71
	10	(254)	1.00	0.92		1.00	0.70	0.66	1.00	0.92		1.00	0.89	0.80
	12	(305)		1.00			0.74	0.69		1.00			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						
	22	(559)					0.93	0.85						
	> 24	(610)					0.97	0.88						

Table 24 - Load adjustment factors for 5/8-in. diameter stainless steel Hilti KWIK Bolt TZ in cracked concrete[1,2]

5/8-in. KB-TZ SS 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: II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Effective embed. h_{ef}		in. (mm)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)
Nominal embed. h_{nom}		in. (mm)	3-9/16 (90)	4-7/16 (113)	3-9/16 (90)	4-7/16 (113)	3-9/16 (90)	4-7/16 (113)	3-9/16 (90)	4-7/16 (113)	3-9/16 (90)	4-7/16 (113)	3-9/16 (90)	4-7/16 (113)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	2-3/8	(60)	n/a	0.60	n/a	0.57	n/a	0.54	n/a	011	n/a	0.22	n/a	n/a
	2-3/4	(70)	n/a	0.61	n/a	0.61	n/a	0.54	n/a	0.13	n/a	0.27	n/a	n/a
	3	(76)	0.66	0.63	n/a	0.64	0.56	0.55	n/a	0.15	n/a	0.31	n/a	n/a
	3-1/4	(83)	0.67	0.64	0.77	0.66	0.56	0.55	0.24	0.17	0.48	0.35	n/a	n/a
	3-1/2	(89)	0.69	0.65	0.81	0.69	0.57	0.56	0.27	0.19	0.53	0.39	n/a	n/a
	4	(102)	0.71	0.67	0.89	0.75	0.58	0.56	0.33	0.24	0.65	0.47	n/a	n/a
	4-1/2	(114)	0.74	0.69	0.97	0.81	0.59	0.57	0.39	0.28	0.78	0.56	n/a	n/a
	5	(127)	0.77	0.71	1.00	0.87	0.60	0.58	0.45	0.33	0.91	0.66	0.63	n/a
	5-1/2	(140)	0.79	0.73		0.93	0.61	0.59	0.52	0.38	1.00	0.76	0.66	n/a
	6	(152)	0.82	0.75		1.00	0.62	0.60	0.60	0.43		0.87	0.69	0.62
	7	(178)	0.87	0.79			0.64	0.61	0.75	0.55		1.00	0.74	0.67
	8	(203)	0.93	0.83			0.66	0.63	0.92	0.67			0.79	0.71
	10	(254)	1.00	0.92			0.70	0.66	1.00	0.93			0.89	0.80
	12	(305)		1.00			0.74	0.69		1.00			0.97	0.87
	14	(356)					0.78	0.72					1.00	0.94
	16	(406)					0.82	0.75						1.00
	18	(457)					0.85	0.79						
	20	(508)					0.89	0.82						
	22	(559)					0.93	0.85						
	> 24	(610)					0.97	0.88						

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 17 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

Table 25 - Load adjustment factors for 3/4-in. diameter stainless steel Hilti KWIK Bolt TZ in uncracked concrete[1,2]

3/4-in. KB-TZ CS 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}	
Effective embed. h_{ef}		in. (mm)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)	3-1/8 (79)	4 (102)
Nominal embed. h_{nom}		in. (mm)	4-5/16 (110)	5-9/16 (141)	4-5/16 (110)	5-9/16 (141)	4-5/16 (110)	5-9/16 (141)	4-5/16 (110)	5-9/16 (141)	4-5/16 (110)	5-9/16 (141)	4-5/16 (110)	5-9/16 (142)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	4	(102)	n/a	0.64	n/a	0.54	n/a	0.56	n/a	0.20	n/a	0.40	n/a	n/a
	4-1/4	(108)	n/a	0.65	0.46	0.56	n/a	0.56	0.29	0.22	0.46	0.43	n/a	n/a
	4-1/2	(114)	n/a	0.66	0.48	0.57	n/a	0.56	0.32	0.24	0.48	0.47	n/a	n/a
	5	(127)	0.72	0.68	0.51	0.61	0.59	0.57	0.38	0.28	0.51	0.55	n/a	n/a
	5-1/2	(140)	0.74	0.69	0.55	0.65	0.60	0.58	0.43	0.32	0.55	0.64	n/a	n/a
	6	(152)	0.77	0.71	0.60	0.69	0.60	0.58	0.49	0.36	0.60	0.69	0.65	n/a
	7	(178)	0.81	0.75	0.70	0.78	0.62	0.60	0.62	0.46	0.70	0.78	0.70	n/a
	8	(203)	0.86	0.78	0.80	0.89	0.64	0.61	0.76	0.56	0.80	0.89	0.75	0.67
	9	(229)	0.90	0.82	0.90	1.00	0.66	0.63	0.91	0.67	0.91	1.00	0.79	0.71
	9-1/2	(241)	0.92	0.83	0.95		0.66	0.63	0.98	0.72	0.98		0.81	0.73
	10	(254)	0.94	0.85	1.00		0.67	0.64	1.00	0.78	1.00		0.83	0.75
	12	(305)	1.00	0.92			0.71	0.67		1.00			0.91	0.82
	14	(356)		0.99			0.74	0.70					0.99	0.89
	16	(406)		1.00			0.78	0.73					1.00	0.95
	18	(457)					0.81	0.75						1.00
	20	(508)					0.85	0.78						
	22	(559)					0.88	0.81						
	> 24	(610)					0.92	0.84						

Table 26 - Load adjustment factors for 3/4-in. diameter stainless steel Hilti KWIK Bolt TZ in cracked concrete[1,2]

3/4-in. KB-TZ SS 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: II to and away from edge f_{RV}		Conc. thickness factor in shear[4] f_{HV}	
Effective embed. h_{ef}		in. (mm)	3-3/4 (95)	4-3/4 (121)	3-3/4 (95)	4-3/4 (121)	3-3/4 (95)	4-3/4 (121)	3-3/4 (95)	4-3/4 (121)	3-3/4 (95)	4-3/4 (121)	3-3/4 (95)	4-3/4 (121)
Nominal embed. h_{nom}		in. (mm)	4-5/16 (110)	5-9/16 (141)	4-5/16 (110)	5-9/16 (141)	4-5/16 (110)	5-9/16 (141)	4-5/16 (110)	5-9/16 (141)	4-5/16 (110)	5-9/16 (141)	4-5/16 (110)	5-9/16 (142)
Spacing (s) / edge distance (c_a) / concrete thickness (h) - in. (mm)	4	(102)	n/a	0.64	n/a	0.68	n/a	0.56	n/a	0.20	n/a	0.40	n/a	n/a
	4-1/4	(108)	n/a	0.65	0.81	0.70	n/a	0.56	0.21	0.22	0.42	0.44	n/a	n/a
	4-1/2	(114)	n/a	0.66	0.85	0.73	n/a	0.56	0.23	0.24	0.46	0.48	n/a	n/a
	5	(127)	0.72	0.68	0.91	0.77	0.57	0.57	0.27	0.28	0.54	0.56	n/a	n/a
	5-1/2	(140)	0.74	0.69	0.98	0.83	0.58	0.58	0.31	0.32	0.62	0.64	n/a	n/a
	6	(152)	0.77	0.71	1.00	0.88	0.58	0.59	0.35	0.37	0.71	0.73	0.58	n/a
	7	(178)	0.81	0.75	1.00	0.99	0.60	0.60	0.44	0.46	0.89	0.92	0.62	n/a
	8	(203)	0.86	0.78	1.00	1.00	0.61	0.61	0.54	0.56	1.00	1.00	0.67	0.67
	9	(229)	0.90	0.82	1.00		0.62	0.63	0.65	0.67	1.00		0.71	0.72
	9-1/2	(241)	0.92	0.83	1.00		0.63	0.64	0.70	0.73	1.00		0.73	0.74
	10	(254)	0.94	0.85			0.64	0.64	0.76	0.79			0.74	0.75
	12	(305)	1.00	0.92			0.67	0.67	1.00	1.00			0.82	0.83
	14	(356)		0.99			0.69	0.70					0.88	0.89
	16	(406)		1.00			0.72	0.73					0.94	0.95
	18	(457)					0.75	0.76					1.00	1.00
	20	(508)					0.78	0.78						
	22	(559)					0.81	0.81						
	> 24	(610)					0.83	0.84						

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 17 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

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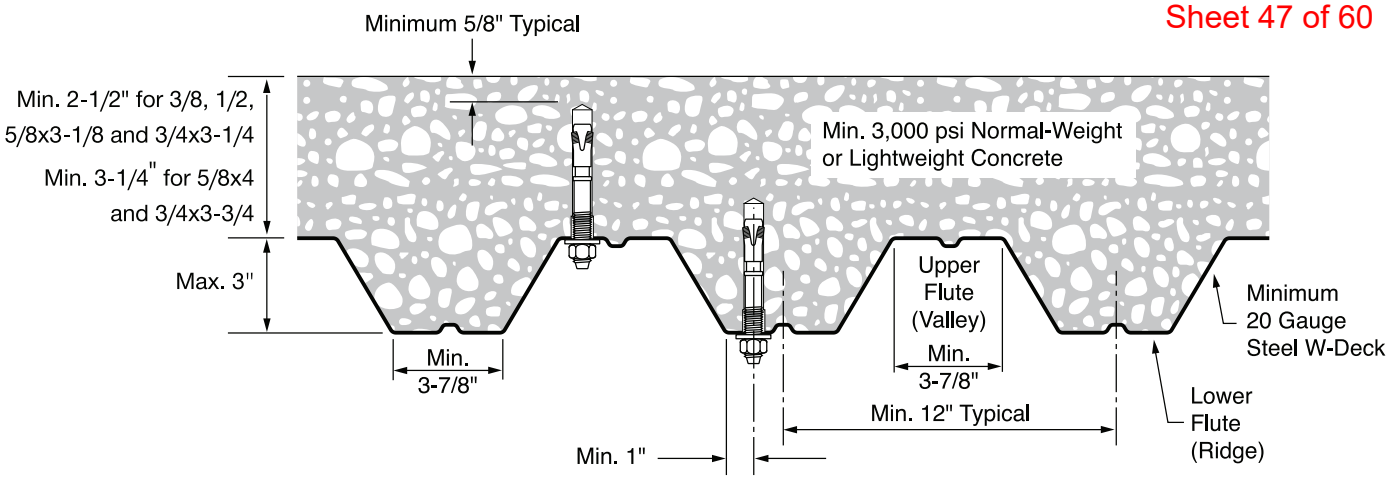

Figure 4 - Installation of Hilti KWIK Bolt TZ in the soffit of concrete over metal deck floor and roof assemblies - W Deck

3.3.5

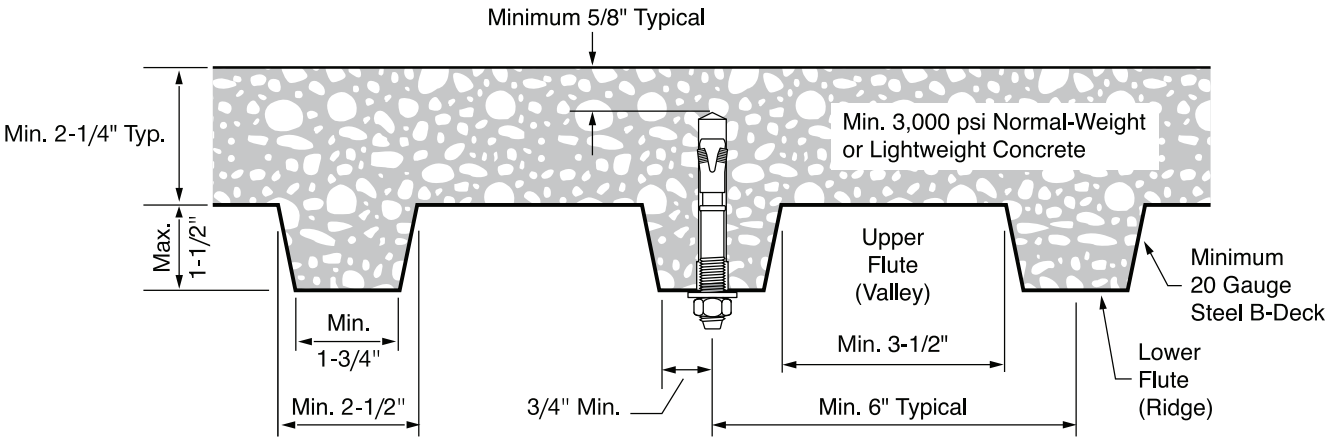

Figure 5 - Installation of Hilti KWIK Bolt TZ in the soffit of concrete over metal deck floor and roof assemblies - B Deck

Table 27 - Hilti KWIK Bolt TZ carbon steel design strength in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6]

Nominal anchor diameter in.	Effective embed. depth in. (mm)	Nominal embed. depth in. (mm)	Loads according to Figure 4				Loads according to Figure 5			
			Tension - ϕN_n		Shear - ϕV_n		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 = 4,000 psi (27.6 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)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
3/8	1-1/2 (38)	1-13/16 (46)	750 (3.3)	865 (3.8)	1,135 (5.0)	1,135 (5.0)	705 (3.1)	815 (3.6)	1,200 (5.3)	1,200 (5.3)
	2 (51)	2-5/16 (59)	1,305 (5.8)	1,505 (6.7)	1,385 (6.2)	1,385 (6.2)	1,200 (5.3)	1,385 (6.2)	1,850 (8.2)	1,850 (8.2)
	2-3/4 (70)	2-5/16 (59)	1,995 (8.9)	2,305 (10.3)	1,765 (7.9)	1,765 (7.9)	n/a	n/a	n/a	n/a
1/2	2 (51)	2-3/8 (60)	1,305 (5.8)	1,505 (6.7)	1,690 (7.5)	1,690 (7.5)	1,210 (5.4)	1,395 (6.2)	1,680 (7.5)	1,680 (7.5)
	3-1/4 (83)	3-5/8 (92)	2,400 (10.7)	2,770 (12.3)	2,640 (11.7)	2,640 (11.7)	2,195 (9.8)	2,535 (11.3)	2,565 (11.4)	2,565 (11.4)
5/8	3-1/8 (79)	3-9/16 (90)	1,835 (8.2)	2,120 (9.4)	2,990 (13.3)	2,990 (13.3)	2,640 (11.7)	3,050 (13.6)	3,060 (13.6)	3,060 (13.6)
	4 (102)	4-7/16 (113)	3,385 (15.1)	3,910 (17.4)	3,650 (16.2)	3,650 (16.2)	n/a	n/a	n/a	n/a
3/4	3-1/4 (83)	3-13/16 (97)	2,750 (12.2)	3,175 (14.1)	3,145 (14.0)	3,145 (14.0)	n/a	n/a	n/a	n/a
	3-3/4 (95)	4-5/16 (110)	2,765 (12.3)	3,195 (14.2)	4,025 (17.9)	4,025 (17.9)	n/a	n/a	n/a	n/a

Table 28 - Hilti KWIK Bolt TZ carbon steel design strength in the soffit of cracked lightweight concrete over metal deck[1,2,3,4,5,6,7]

Nominal anchor diameter in.	Effective embed. depth in. (mm)	Nominal embed. depth in. (mm)	Loads according to Figure 4				Loads according to Figure 5			
			Tension - ϕN_n		Shear - ϕV_n		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 = 4,000 psi (27.6 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)	f'_c = 4,000 psi (27.6 MPa) lb (kN)
3/8	1-1/2 (38)	1-13/16 (46)	630 (2.8)	725 (3.2)	1,135 (5.0)	1,135 (5.0)	595 (2.6)	685 (3.0)	1,200 (5.3)	1,200 (5.3)
	2 (51)	2-5/16 (59)	925 (4.1)	1,070 (4.8)	1,385 (6.2)	1,385 (6.2)	1,080 (4.8)	1,245 (5.5)	1,850 (8.2)	1,850 (8.2)
	2-3/4 (70)	2-5/16 (59)	1,535 (6.8)	1,770 (7.9)	1,495 (6.7)	1,495 (6.7)	n/a	n/a	n/a	n/a
1/2	2 (51)	2-3/8 (60)	925 (4.1)	1,070 (4.8)	1,690 (7.5)	1,690 (7.5)	860 (3.8)	995 (4.4)	1,680 (7.5)	1,680 (7.5)
	3-1/4 (83)	3-5/8 (92)	1,705 (7.6)	1,970 (8.8)	2,640 (11.7)	2,640 (11.7)	1,955 (8.7)	2,255 (10.0)	2,565 (11.4)	2,565 (11.4)
5/8	3-1/8 (79)	3-9/16 (90)	1,300 (5.8)	1,500 (6.7)	2,990 (13.3)	2,990 (13.3)	1,875 (8.3)	2,165 (9.6)	3,060 (13.6)	3,060 (13.6)
	4 (102)	4-7/16 (113)	2,520 (11.2)	2,910 (12.9)	3,650 (16.2)	3,650 (16.2)	n/a	n/a	n/a	n/a
3/4	3-1/4 (83)	3-13/16 (97)	1,950 (8.7)	2,250 (10.0)	3,145 (14.0)	3,145 (14.0)	n/a	n/a	n/a	n/a
	3-3/4 (95)	4-5/16 (110)	2,060 (9.2)	2,380 (10.6)	4,025 (17.9)	4,025 (17.9)	n/a	n/a	n/a	n/a

1 See 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 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 to steel values in table 4 is not required. Values in tables 28 and 29 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.
See section 3.1.8 for additional information on seismic applications.

8 For the following anchor sizes, an additional factor must be applied to the cracked concrete tabular values for seismic shear conditions:
3/8-in diameter with 1-1/2" effective embedment - $\alpha_{v,seis}$ = 0.77, 3/8-inch diameter with 2" and 2-3/4" effective embedment - $\alpha_{v,seis}$ = 0.63
5/8-inch diameter - $\alpha_{v,seis}$ = 0.94
3/4-inch diameter with 3-1/4" effective embedment - $\alpha_{v,seis}$ = 0.80, 3/4-inch diameter - $\alpha_{v,seis}$ = 0.86

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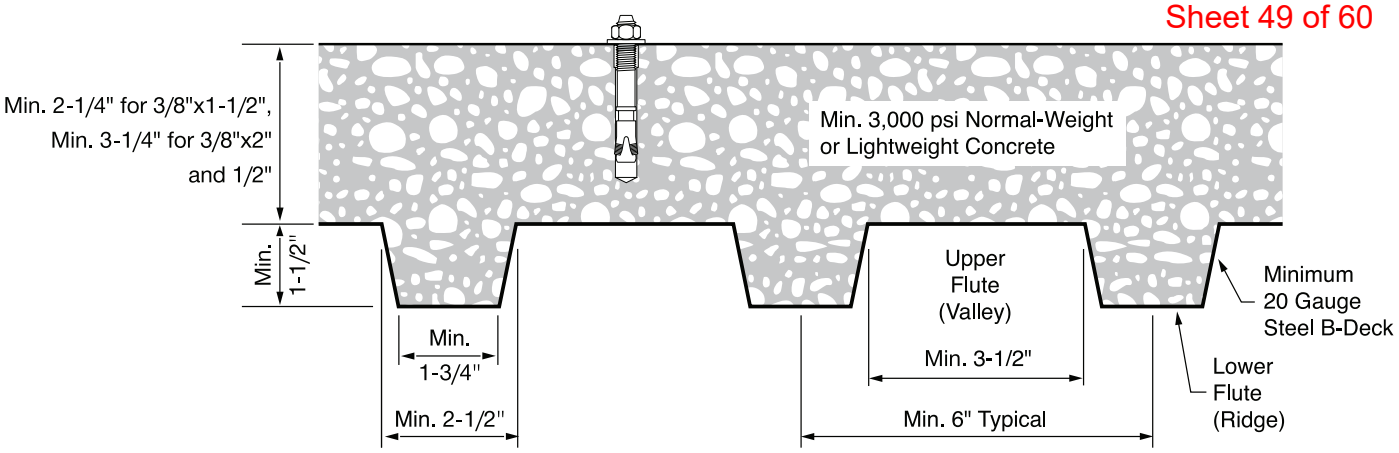

Figure 6 - Installation of the Hilti KWIK Bolt TZ on the top of sand-lightweight concrete over metal deck floor and roof assemblies

Table 29 - Hilti KWIK Bolt TZ carbon steel design strength in the top of uncracked concrete over metal deck[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 = 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)
3/8	1-1/2 (38)	1-13/16 (46)	1,300 (5.8)	1,500 (6.7)	1,690 (7.5)	1,950 (8.7)
	2 (51)	2-5/16 (59)	1,790 (8.0)	2,070 (9.2)	2,605 (11.6)	3,005 (13.4)
1/2	2 (51)	2-3/8 (60)	2,415 (10.7)	2,790 (12.4)	2,605 (11.6)	3,005 (13.4)

Table 30 - Hilti KWIK Bolt TZ carbon steel design strength in the top of cracked concrete over metal deck[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 = 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)
3/8	1-1/2 (38)	1-13/16 (46)	940 (4.2)	1,085 (4.8)	1,195 (5.3)	1,385 (6.2)
	2 (51)	2-5/16 (59)	1,615 (7.2)	1,865 (8.3)	1,845 (8.2)	2,130 (9.5)
1/2	2 (51)	2-3/8 (60)	1,710 (7.6)	1,975 (8.8)	1,845 (8.2)	2,130 (9.5)

1 See 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 31 and 32 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.
No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

Table 31 - Load adjustment factors for carbon steel Hilti KWIK Bolt TZ in the top of uncracked concrete over metal deck[1,2]

3/8-in. and 1/2-in. KB-TZ CS uncracked concrete over metal deck		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}		
Anchor diameter d_a	in.	3/8	3/8	1/2	3/8	3/8	1/2	3/8	3/8	1/2	3/8	3/8	1/2	3/8	3/8	1/2	3/8	3/8	1/2
	(mm)	(9.5)	(9.5)	(12.7)	(9.5)	(9.5)	(12.7)	(9.5)	(9.5)	(12.7)	(9.5)	(9.5)	(12.7)	(9.5)	(9.5)	(12.7)	(9.5)	(9.5)	(12.7)
Effective embed. h_{ef}	in.	1-1/2	2	2	1-1/2	2	2	1-1/2	2	2	1-1/2	2	2	1-1/2	2	2	1-1/2	2	2
	(mm)	(38)	(51)	(51)	(38)	(51)	(51)	(38)	(51)	(51)	(38)	(51)	(51)	(38)	(51)	(51)	(38)	(51)	(51)
Nominal embed. h_{nom}	in.	1-13/16	2-5/16	2-3/8	1-13/16	2-5/16	2-3/8	1-13/16	2-5/16	2-3/8	1-13/16	2-5/16	2-3/8	1-13/16	2-5/16	2-3/8	1-13/16	2-5/16	2-3/8
	(mm)	(46)	(59)	(60)	(46)	(59)	(60)	(46)	(59)	(60)	(46)	(59)	(60)	(46)	(59)	(60)	(46)	(59)	(60)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	2-1/4 (57)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.500	n/a	n/a
	3 (76)	n/a	n/a	n/a	n/a	0.33	n/a	n/a	n/a	n/a	n/a	0.33	n/a	n/a	0.33	n/a	0.58	n/a	n/a
	3-1/4 (83)	n/a	n/a	n/a	n/a	0.36	n/a	n/a	n/a	n/a	n/a	0.36	n/a	n/a	0.36	n/a	0.60	0.73	0.76
	3-1/2 (89)	n/a	n/a	n/a	n/a	0.39	n/a	n/a	n/a	n/a	n/a	0.39	n/a	n/a	0.39	n/a	0.62	0.76	0.78
	4 (102)	n/a	0.83	n/a	n/a	0.44	n/a	n/a	0.67	n/a	n/a	0.44	n/a	n/a	0.44	n/a	0.67	0.81	0.84
	4-1/2 (114)	n/a	0.88	n/a	n/a	0.50	0.50	n/a	0.67	n/a	n/a	0.50	0.50	n/a	0.50	0.50			
	5 (127)	n/a	0.92	n/a	n/a	0.56	0.56	n/a	0.71	n/a	n/a	0.56	0.56	n/a	0.56	0.56			
	5-1/2 (140)	n/a	0.96	n/a	n/a	0.61	0.61	n/a	0.73	n/a	n/a	0.61	0.61	n/a	0.61	0.61			
	6 (152)	n/a	1.00	n/a	n/a	0.67	0.67	n/a	0.75	n/a	n/a	0.67	0.67	n/a	0.67	0.67			
	6-1/2 (165)	n/a		1.00	n/a	0.72	0.72	n/a	0.77	0.79	n/a	0.72	0.72	n/a	0.72	0.72			
	7 (178)	n/a			n/a	0.78	0.78	n/a	0.79	0.81	n/a	0.78	0.78	n/a	0.78	0.78			
	8 (203)	1.00			n/a	0.89	0.89	0.72	0.83	0.85	n/a	0.89	0.89	n/a	0.89	0.89			
	9 (229)				n/a	1.00	1.00	0.75	0.87	0.89	n/a	1.00	1.00	n/a	1.00	1.00			
	10 (254)				n/a			0.78	0.91	0.94	n/a			n/a					
	11 (279)				n/a			0.81	0.96	0.98	n/a			n/a					
	12 (305)				n/a			0.83	1.00	1.00	n/a			n/a					
	13 (330)				n/a			0.86			n/a			n/a					
	16 (406)				1.00			0.94			1.00			1.00					

Table 32 - Load adjustment factors for carbon steel Hilti KWIK Bolt TZ in the top of cracked concrete over metal deck[1,2]

3/8-in. and 1/2-in. KB-TZ CS cracked concrete over metal deck		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}		
Anchor diameter d_a	in.	3/8	3/8	1/2	3/8	3/8	1/2	3/8	3/8	1/2	3/8	3/8	1/2	3/8	3/8	1/2	3/8	3/8	1/2
	(mm)	(9.5)	(9.5)	(12.7)	(9.5)	(9.5)	(12.7)	(9.5)	(9.5)	(12.7)	(9.5)	(9.5)	(12.7)	(9.5)	(9.5)	(12.7)	(9.5)	(9.5)	(12.7)
Effective embed. h_{ef}	in.	1-1/2	2	2	1-1/2	2	2	1-1/2	2	2	1-1/2	2	2	1-1/2	2	2	1-1/2	2	2
	(mm)	(38)	(51)	(51)	(38)	(51)	(51)	(38)	(51)	(51)	(38)	(51)	(51)	(38)	(51)	(51)	(38)	(51)	(51)
Nominal embed. h_{nom}	in.	1-13/16	2-5/16	2-3/8	1-13/16	2-5/16	2-3/8	1-13/16	2-5/16	2-3/8	1-13/16	2-5/16	2-3/8	1-13/16	2-5/16	2-3/8	1-13/16	2-5/16	2-3/8
	(mm)	(46)	(59)	(60)	(46)	(59)	(60)	(46)	(59)	(60)	(46)	(59)	(60)	(46)	(59)	(60)	(46)	(59)	(60)
Spacing (s)/edge distance (c_a)/concrete thickness (h) - in. (mm)	2-1/4 (57)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.693	n/a	n/a
	3 (76)	n/a	n/a	n/a	n/a	1.00	n/a	n/a	n/a	n/a	n/a	0.65	n/a	n/a	1.00	n/a	0.80	n/a	n/a
	3-1/4 (83)	n/a	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	0.73	n/a	n/a		n/a	0.83	0.74	0.76
	3-1/2 (89)	n/a	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	0.82	n/a	n/a		n/a	0.86	0.76	0.79
	4 (102)	n/a	0.83	n/a	n/a		n/a	n/a	0.67	n/a	n/a	1.00	n/a	n/a		n/a	0.92	0.82	0.84
	4-1/2 (114)	n/a	0.88	n/a	n/a		1.00	n/a	0.69	n/a	n/a		1.00	n/a		1.00			
	5 (127)	n/a	0.92	n/a	n/a			n/a	0.71	n/a	n/a			n/a					
	5-1/2 (140)	n/a	0.96	n/a	n/a			n/a	0.73	n/a	n/a			n/a					
	6 (152)	n/a	1.00	n/a	n/a			n/a	0.75	n/a	n/a			n/a					
	6-1/2 (165)	n/a		1.00	n/a			n/a	0.77	0.79	n/a			n/a					
	7 (178)	n/a			n/a			n/a	0.79	0.81	n/a			n/a					
	8 (203)	n/a			n/a			0.93	0.83	0.85	n/a			n/a					
	9 (229)	1.00			n/a			0.98	0.87	0.90	n/a			n/a					
	10 (254)				n/a			1.00	0.92	0.94	n/a			n/a					
	11 (279)				n/a				0.96	0.98	n/a			n/a					
	12 (305)				n/a				1.00	1.00	n/a			n/a					
	13 (330)				n/a						n/a			n/a					
	16 (406)				1.00						1.00			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 $f_{HV} = 1.0$.

☐ - For concrete thickness greater than or equal to 4-inches, the anchor can be designed using either table 2 or table 3 of this section.

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DESIGN INFORMATION IN CONCRETE PER CSA A23.3

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 ESL-1067. These tables are followed by factored resistance tables. The factored resistance 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 33 - Steel resistance for Hilti KWIK Bolt TZ carbon steel anchors[1,2]

Nominal anchor diameter in.	Effective anchor embedment in. (mm)			Tensile N_{sar} [3] lb (kN)	Shear V_{sar} [4] lb (kN)	Seismic shear $V_{sar,eq}$ [5] lb (kN)
3/8	1-1/2 (38)			4,410 (19.6)	1,390 (6.2)	1,390 (6.2)
	2 (51)	2-3/4 (70)		4,410 (19.6)	2,290 (10.2)	1,440 (6.4)
1/2	2 (51)	3-1/4 (83)		7,280 (32.4)	3,505 (15.6)	3,505 (15.6)
5/8	3-1/8 (79)	4 (102)		11,675 (51.9)	5,155 (22.9)	4,845 (21.6)
3/4	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	17,080 (76.0)	8,720 (38.8)	7,485 (33.3)

1 See section 3.1.8 to convert design strength value to ASD value.
2 Hilti KWIK Bolt TZ 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.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3-14, Annex D. See section 3.1.8 for additional information on seismic applications.

Table 34 - Steel resistance for Hilti KWIK Bolt TZ stainless steel anchors[1,2]

Nominal anchor diameter in.	Tensile N_{sar} [3] lb (kN)	Shear V_{sar} [4] lb (kN)	Seismic Shear $V_{sar,eq}$ [5] lb (kN)
3/8	4,060 (18.1)	3,010 (13.4)	1,800 (8.0)
1/2	7,890 (35.1)	4,385 (19.5)	4,385 (19.5)
5/8	12,680 (56.4)	6,290 (28.0)	5,960 (26.5)
3/4	16,355 (72.8)	10,015 (44.5)	8,215 (36.5)

1 See section 3.1.8 to convert factored resistance value to ASD value.
2 Hilti KWIK Bolt TZ stainless 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.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3-14, Annex D. See section 3.1.8 for additional information on seismic applications.

Table 35 - Hilti KWIK Bolt TZ carbon steel design information in accordance with CSA A23.3-14[1]

Design parameter	Symbol	Units	Nominal anchor diameter																Ref
			3/8				1/2				5/8			3/4					A23.3-14
Nominal anchor diameter	d_a	in. (mm)	0.375 (9.5)				0.5 (12.7)				0.625 (15.9)			0.75 (19.1)					
Effective minimum embedment[2]	h_{ef}	in. (mm)	1-1/2 (38)	2 (51)		2-3/4 (70)	2 (51)		3-1/4 (83)		3-1/8 (79)	4 (102)		3-1/4 (83)	3-3/4 (95)		4-3/4 (121)		
Min. member thickness[3]	h_{min}	in. (mm)	3-1/4 (83)	4 (102)	5 (127)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	5-1/2 (140)	6 (152)	8 (203)	8 (203)		
Critical edge distance	c_{ac}	in. (mm)	6 (152)	4-3/8 (111)	4 (102)	4-1/8 (105)	5-1/2 (140)	4-1/2 (114)	7-1/2 (191)	6 (152)	6-1/2 (165)	8-3/4 (222)	6-3/4 (171)	12 (305)	10 (254)	8 (203)	9 (229)		
Min. edge distance	c_{min}	in. (mm)	8 (203)	2-1/2 (64)		2-1/2 (64)	2-3/4 (70)		2-3/8 (60)		3-5/8 (92)	3-1/4 (83)		9-1/2 (241)	4-3/4 (121)		4-1/8 (105)		
	for s >	in. (mm)	8 (203)	5 (127)		5 (127)	5-3/4 (146)		5-3/4 (146)		6-1/8 (156)	5-7/8 (149)		5 (127)	10-1/2 (267)		8-7/8 (225)		
Min. anchor spacing	s_{min}	in. (mm)	8 (203)	2-1/2 (64)		2-1/2 (64)	2-3/4 (70)		2-3/8 (60)		3-1/2 (89)	3 (76)		5 (127)	5 (127)		4 (102)		
	for c >	in. (mm)	8 (203)	3-5/8 (92)		3-5/8 (92)	4-1/8 (105)		3-1/2 (89)		4-3/4 (121)	4-1/4 (108)		9-1/2 (241)	9-1/2 (241)		7-3/4 (197)		
Min. hole depth in concrete	h_o	in. (mm)	2 (51)	2-5/8 (67)		3-3/8 (86)	2-5/8 (67)		4 (102)		3-7/8 (98)	4-3/4 (121)		4 (102)	4-5/8 (117)		5-3/4 (146)		
Min. specified yield strength	f_{ya}	psi (N/mm^2)	100,000 (690)				84,800 (585)				84,800 (585)			84,800 (585)					
Min. specified ult. strength	f_{uta}	psi (N/mm^2)	125,000 (862)				106,000 (731)				106,000 (731)			106,000 (731)					
Effective tensile stress area	$A_{se,N}$	in^2 (mm^2)	0.052 (33.6)				0.101 (65.0)				0.162 (104.6)			0.237 (152.8)					
Steel embed. 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)	4,410 (19.7)				7,280 (32.4)				11,675 (51.9)			17,080 (76.0)					D.6.1.2
Factored steel resistance in shear	V_{sar}	lb (kN)	1,390 (6.2)	2,290 (10.2)			3,505 (15.6)				5,155 (22.9)			8,720 (38.8)					D.7.1.2
Factored steel resistance in shear, seismic	$V_{sar,eq}$	lb (kN)	1,390 (6.2)	1,440 (6.4)			3,505 (15.6)				4,845 (21.6)			7,485 (33.3)					
Coeff. for factored concrete breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10																D.6.2.2
Coeff. for factored concrete breakout resistance, cracked concrete	$k_{c,cr}$	-	7																D.6.2.2
Modification factor for anchor resistance, tension, uncracked concrete[5]	$\psi_{c,N}$	-	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[6]	R	-	0.85	1.00															D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete[7]	$N_{pr,uncr}$	lb (kN)	1,285 (5.7)	1,765 (7.8)		2,880 (12.8)	N/A		3,855 (17.2)		N/A	6,405 (28.5)		N/A	5,795 (25.8)		7,480 (33.3)		D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete[7]	$N_{pr,cr}$	lb (kN)	N/A	1,590 (7.1)		2,220 (9.9)	N/A		3,450 (15.3)		N/A	N/A		N/A	N/A		N/A		D.6.3.2

1 Design information in this table is taken from ICC-ES ESL-1067, dated September 2016, table 3, and converted for use with CSA A23.3-14 Annex D.
2 See figure 1 of this section.
3 For concrete over metal deck applications where the concrete thickness over the top flute is less than h_{min} in this table, see figure 6 and tables 43 and 44 of this section.
4 The carbon steel KWIK Bolt TZ is considered a ductile steel element as defined by CSA A23.3-14 Annex D section D.2.
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 A23.3-14 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.
7 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 ESL-1067 for additional information.

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

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. 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)	1-13/16 (46)	1,285 (5.8)	1,435 (6.5)	1,575 (7.0)	1,815 (8.1)	1,300 (5.8)	1,455 (6.5)	1,595 (7.1)	1,840 (8.2)
	2 (51)	2-5/16 (59)	1,765 (7.8)	1,970 (8.8)	2,160 (9.6)	2,495 (11.1)	2,380 (10.6)	2,660 (11.8)	2,915 (13.0)	3,365 (15.0)
	2-3/4 (70)	3-1/16 (78)	2,880 (12.8)	3,220 (14.3)	3,530 (15.7)	4,075 (18.1)	7,655 (34.0)	8,560 (38.1)	9,375 (41.7)	10,825 (48.2)
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)	3,855 (17.2)	4,310 (19.2)	4,725 (21.0)	5,455 (24.3)	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)	6,405 (28.5)	7,165 (31.9)	7,845 (34.9)	9,060 (40.3)	13,465 (59.9)	15,055 (67.0)	16,490 (73.4)	19,040 (84.7)
3/4	3-1/4 (83)	3-13/16 (97)	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)
	3-3/4 (95)	4-5/16 (110)	5,795 (25.8)	6,475 (28.8)	7,095 (31.6)	8,195 (36.4)	12,100 (53.8)	13,530 (60.2)	14,820 (65.9)	17,115 (76.1)
	4-3/4 (121)	5-9/16 (141)	7,480 (33.3)	8,360 (37.2)	9,160 (40.7)	10,575 (47.0)	17,395 (77.4)	19,450 (86.5)	21,305 (94.8)	24,600 (109.4)

Table 37 - Hilti KWIK Bolt TZ carbon steel factored resistance with concrete/pullout failure in cracked 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 (2,900 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)	1-13/16 (46)	910 (4.1)	1,020 (4.5)	1,115 (5.0)	1,290 (5.7)	910 (4.1)	1,020 (4.5)	1,115 (5.0)	1,290 (5.7)
	2 (51)	2-5/16 (59)	1,590 (7.1)	1,780 (7.9)	1,945 (8.7)	2,250 (10.0)	1,665 (7.4)	1,865 (8.3)	2,040 (9.1)	2,355 (10.5)
	2-3/4 (70)	3-1/16 (78)	2,220 (9.9)	2,480 (11.0)	2,720 (12.1)	3,140 (14.0)	5,360 (23.8)	5,990 (26.6)	6,560 (29.2)	7,580 (33.7)
1/2	2 (51)	2-3/8 (60)	1,665 (7.4)	1,865 (8.3)	2,040 (9.1)	2,355 (10.5)	1,665 (7.4)	1,865 (8.3)	2,040 (9.1)	2,355 (10.5)
	3-1/4 (83)	3-5/8 (92)	3,450 (15.3)	3,855 (17.1)	4,225 (18.8)	4,875 (21.7)	6,920 (30.8)	7,735 (34.4)	8,475 (37.7)	9,785 (43.5)
5/8	3-1/8 (79)	3-9/16 (90)	3,210 (14.3)	3,590 (16.0)	3,935 (17.5)	4,545 (20.2)	6,425 (28.6)	7,180 (31.9)	7,870 (35.0)	9,085 (40.4)
	4 (102)	4-7/16 (113)	4,710 (21.0)	5,270 (23.4)	5,770 (25.7)	6,665 (29.6)	9,425 (41.9)	10,535 (46.9)	11,545 (51.3)	13,330 (59.3)
3/4	3-1/4 (83)	3-13/16 (97)	3,460 (15.4)	3,865 (17.2)	4,235 (18.8)	4,890 (21.8)	6,920 (30.8)	7,735 (34.4)	8,475 (37.7)	9,785 (43.5)
	3-3/4 (95)	4-5/16 (110)	4,235 (18.8)	4,735 (21.1)	5,190 (23.1)	5,990 (26.6)	8,470 (37.7)	9,470 (42.1)	10,375 (46.2)	11,980 (53.3)
	4-3/4 (121)	5-9/16 (141)	6,090 (27.1)	6,805 (30.3)	7,455 (33.2)	8,610 (38.3)	12,175 (54.2)	13,615 (60.6)	14,915 (66.3)	17,220 (76.6)

1 See 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 33. 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.
No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

Table 38 - Hilti KWIK Bolt TZ stainless steel design information in accordance with CSA A23.3-14[1]

Design parameter	Symbol	Units	Nominal anchor diameter												Ref
			3/8		1/2				5/8			3/4			A23.3-14
Nominal anchor diameter	d_a	in. (mm)	0.375 (9.5)		0.5 (12.7)				0.625 (15.9)			0.75 (19.1)			
Effective minimum embedment[2]	h_{ef}	in. (mm)	2 (51)		2 (51)		3-1/4 (83)		3-1/8 (79)	4 (102)		3-3/4 (95)		4-3/4 (121)	
Min. concrete thickness	h_{min}	in. (mm)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	6 (152)	8 (203)	8 (203)	
Critical edge distance	c_{ac}	in. (mm)	4-3/8 (111)	3-7/8 (98)	5-1/2 (140)	4-1/2 (114)	7-1/2 (191)	6 (152)	6-1/2 (165)	8-3/4 (222)	6-3/4 (171)	10 (254)	8 (203)	9 (229)	
Min. edge distance	c_{min}	in. (mm)	2-1/2 (64)		2-7/8 (73)		2-1/8 (54)		3-1/4 (83)	2-3/8 (60)		4-1/4 (108)		4 (102)	
	for s >	in. (mm)	5 (127)		5-3/4 (146)		5-1/4 (133)		5-1/2 (140)	5-1/2 (140)		10 (254)		8-1/2 (216)	
Min. anchor spacing	s_{min}	in. (mm)	2-1/4 (57)		2-7/8 (73)		2 (51)		2-3/4 (70)	2-3/8 (60)		5 (127)		4 (102)	
	for c >	in. (mm)	3-1/2 (89)		4-1/2 (114)		3-1/4 (83)		4-1/8 (105)	4-1/4 (108)		9-1/2 (241)		7 (178)	
Min. hole depth in concrete	h_o	in. (mm)	2-5/8 (67)		2-5/8 (67)		4 (102)		3-3/4 (98)	4-3/4 (121)		4-1/2 (117)		5-3/4 (146)	
Min. specified yield strength	f_{ya}	psi (N/mm^2)	92,000 (634)		92,000 (634)				92,000 (634)			76,125 (525)			
Min. specified ult. strength	f_{uta}	psi (N/mm^2)	115,000 (793)		115,000 (793)				115,000 (793)			101,500 (700)			
Effective tensile stress area	$A_{se,N}$	in^2 (mm^2)	0.052 (33.6)		0.101 (65.0)				0.162 (104.6)			0.237 (152.8)			
Steel embed. 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 (kN)	4,060 (18.1)		7,890 (35.1)				12,680 (56.4)			16,355 (72.8)			D.6.1.2
Factored steel resistance in shear	V_{sar}	lb (kN)	3,010 (13.4)		4,385 (19.5)				6,290 (28.0)			10,015 (44.5)			D.7.1.2
Factored steel resistance in shear, seismic	$V_{sar,eq}$	lb (kN)	1,800 (8.0)		4,385 (19.5)				5,960 (26.5)			8,215 (36.5)			
Coeff. for factored concrete breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10												D.6.2.2
Coeff. for factored concrete breakout resistance, cracked concrete	$k_{c,cr}$	-	7		10		7		7			10		7	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		2		1		1			1		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		0.85		1.00		1.00			1.00		1.00	D.5.3 (c)
Factored pullout resistance in 20 MPa uncracked concrete[6]	$N_{pr,uncr}$	lb (kN)	1,840 (8.2)		N/A		4,030 (17.9)		N/A			N/A		8,440 (37.5)	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete[6]	$N_{pr,cr}$	lb (kN)	1,635 (7.3)		1,885 (8.4)		NA		NA	4,095 (18.2)		5,685 (25.3)		NA	D.6.3.2
Factored seismic pullout resistance in 20 MPa cracked concrete[6]	$N_{pr,eq}$	lb (kN)	1,635 (7.3)		1,635 (7.3)		NA		NA	4,095 (18.2)		5,685 (25.3)		NA	D.6.3.2

1 Design information in this table is taken from ICC ES ESL-1067, dated September 2016, 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 TZ 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 cracked concrete ($k_{c,cr}$) or 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 ES-1067 for additional information.

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Table 39 - Hilti KWIK Bolt TZ 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				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)
3/8	2	2-5/16	1,840	2,060	2,255	2,605	2,380	2,660	2,915	3,365
	(51)	(59)	(8.2)	(9.2)	(10.0)	(11.6)	(10.6)	(11.8)	(13.0)	(15.0)
1/2	2	2 3/8	2,025	2,260	2,480	2,860	2,025	2,260	2,480	2,860
	(51)	(60)	(9.0)	(10.1)	(11.0)	(12.7)	(9.0)	(10.1)	(11.0)	(12.7)
	3-1/4	3 5/8	4,030	4,505	4,935	5,700	9,885	11,050	12,105	13,975
	(83)	(92)	(17.9)	(20.0)	(22.0)	(25.4)	(44.0)	(49.2)	(53.8)	(62.2)
5/8	3-1/8	3-9/16	4,590	5,130	5,620	6,490	9,175	10,260	11,240	12,980
	(79)	(90)	(20.4)	(22.8)	(25.0)	(28.9)	(40.8)	(45.6)	(50.0)	(57.7)
	4	4-7/16	6,730	7,525	8,245	9,520	13,465	15,055	16,490	19,040
	(102)	(113)	(29.9)	(33.5)	(36.7)	(42.3)	(59.9)	(67.0)	(73.4)	(84.7)
3/4	3-3/4	4-5/16	6,050	6,765	7,410	8,555	12,100	13,530	14,820	17,115
	(95)	(110)	(26.9)	(30.1)	(33.0)	(38.1)	(53.8)	(60.2)	(65.9)	(76.1)
	4-3/4	5-9/16	8,440	9,435	10,335	11,935	17,395	19,450	21,305	24,600
	(121)	(141)	(37.5)	(42.0)	(46.0)	(53.1)	(77.4)	(86.5)	(94.8)	(109.4)

Table 40 - Hilti KWIK Bolt TZ stainless steel factored resistance with concrete/pullout failure in cracked 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)
3/8	2	2-5/16	1,635	1,830	2,005	2,315	1,665	1,865	2,040	2,355
	(51)	(59)	(7.3)	(8.1)	(8.9)	(10.3)	(7.4)	(8.3)	(9.1)	(10.5)
1/2	2	2 3/8	1,885	2,110	2,310	2,670	2,025	2,260	2,480	2,860
	(51)	(60)	(8.4)	(9.4)	(10.3)	(11.9)	(9.0)	(10.1)	(11.0)	(12.7)
	3-1/4	3 5/8	3,460	3,865	4,235	4,890	6,920	7,735	8,475	9,785
	(83)	(92)	(15.4)	(17.2)	(18.8)	(21.8)	(30.8)	(34.4)	(37.7)	(43.5)
5/8	3-1/8	3-9/16	3,210	3,590	3,935	4,545	6,425	7,180	7,870	9,085
	(79)	(90)	(14.3)	(16.0)	(17.5)	(20.2)	(28.6)	(31.9)	(35.0)	(40.4)
	4	4-7/16	4,095	4,575	5,015	5,790	9,425	10,535	11,545	13,330
	(102)	(113)	(18.2)	(20.4)	(22.3)	(25.7)	(41.9)	(46.9)	(51.3)	(59.3)
3/4	3-3/4	4-5/16	5,685	6,355	6,960	8,035	12,100	13,530	14,820	17,115
	(95)	(110)	(25.3)	(28.3)	(31.0)	(35.8)	(53.8)	(60.2)	(65.9)	(76.1)
	4-3/4	5-9/16	6,090	6,805	7,455	8,610	12,175	13,615	14,915	17,220
	(121)	(141)	(27.1)	(30.3)	(33.2)	(38.3)	(54.2)	(60.6)	(66.3)	(76.6)

1 See 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 19 to 26 as necessary. Compare to the steel values in table 34. 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 loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75.
For the 1/2-inch diameter by 2-inch effective embedment anchor, $\alpha_{N,seis}$ = 0.65.
No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

Table 41 - Hilti KWIK Bolt TZ 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 embedment in. (mm)	Nominal embedment in. (mm)	Loads according to Figure 4			Loads according to Figure 5		
			Tension - N_r		Shear - V_r	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)	1-13/16 (46)	740 (3.3)	910 (4.0)	1,115 (5.0)	700 (3.1)	855 (3.8)	1,175 (5.2)
	2 (51)	2-5/16 (59)	1,285 (5.7)	1,575 (7.0)	1,360 (6.0)	1,180 (5.2)	1,445 (6.4)	1,815 (8.1)
	2-3/4 (70)	3-1/16 (78)	1,965 (8.7)	2,405 (10.7)	1,730 (7.7)	n/a	n/a	n/a
1/2	2 (51)	2-3/8 (60)	1,285 (5.7)	1,575 (7.0)	1,655 (7.4)	1,190 (5.3)	1,460 (6.5)	1,650 (7.3)
	3-1/4 (83)	3-5/8 (92)	2,360 (10.5)	2,890 (12.9)	2,590 (11.5)	2,155 (9.6)	2,640 (11.7)	2,515 (11.2)
5/8	3-1/8 (79)	3-9/16 (90)	1,805 (8.0)	2,210 (9.8)	2,935 (13.1)	2,600 (11.6)	3,180 (14.1)	3,000 (13.3)
	4 (102)	4-7/16 (113)	3,330 (14.8)	4,080 (18.1)	3,580 (15.9)	n/a	n/a	n/a
3/4	3-1/4 (83)	3-13/16 (97)	2,705 (12.0)	3,315 (14.7)	3,085 (13.7)	n/a	n/a	n/a
	3-3/4 (95)	4-5/16 (110)	2,720 (12.1)	3,330 (14.8)	3,945 (17.5)	n/a	n/a	n/a

Table 42 - Hilti KWIK Bolt TZ 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)	Loads according to Figure 4			Loads according to Figure 5		
			Tension - N_r		Shear - V_r	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)	1-13/16 (46)	625 (2.8)	765 (3.4)	1,115 (5.0)	585 (2.6)	720 (3.2)	1,175 (5.2)
	2 (51)	2-5/16 (59)	935 (4.2)	1,145 (5.1)	1,360[8] (6.0)	1,060 (4.7)	1,300 (5.8)	1,815[8] (8.1)
	2-3/4 (70)	3-1/16 (78)	1,585 (7.1)	1,940 (8.6)	1,730 (7.7)	n/a	n/a	n/a
1/2	2 (51)	2-3/8 (60)	935 (4.2)	1,145 (5.1)	1,910 (8.5)	845 (3.8)	1,035 (4.6)	1,650 (7.3)
	3-1/4 (83)	3-5/8 (92)	1,675 (7.5)	2,050 (9.1)	3,150 (14.0)	1,920 (8.5)	2,350 (10.5)	2,515 (11.2)
5/8	3-1/8 (79)	3-9/16 (90)	1,280 (5.7)	1,565 (7.0)	2,935[8] (13.1)	1,845 (8.2)	2,260 (10.1)	3,000[8] (13.3)
	4 (102)	4-7/16 (113)	2,970 (13.2)	3,635 (16.2)	3,850[8] (17.1)	n/a	n/a	n/a
3/4	3-1/4 (83)	3-13/16 (97)	1,920 (8.5)	2,350 (10.5)	3,085[8] (13.7)	n/a	n/a	n/a
	3-3/4 (95)	4-5/16 (110)	2,025 (9.0)	2,480 (11.0)	3,945[8] (17.5)	n/a	n/a	n/a

1 See 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 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 27 and 28 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.
See section 3.1.8 for additional information on seismic applications.

8 For the following anchor sizes, an additional factor for seismic shear must be applied to the cracked concrete tabular values for seismic shear conditions:
3/8-in diameter with 1-1/2" effective embedment - $\alpha_{v,seis}$ = 0.77, 3/8-inch diameter with 2" and 2 3/4" effective embedment - $\alpha_{v,seis}$ = 0.63
5/8-inch diameter - $\alpha_{v,seis}$ = 0.94
3/4-inch diameter with 3-1/4" effective embedment - $\alpha_{v,seis}$ = 0.80, 3/4-inch diameter with 3-3/4" effective embedment - $\alpha_{v,seis}$ = 0.86

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Table 43 - Hilti KWIK Bolt TZ carbon steel factored resistance in the top of uncracked concrete over metal deck[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 = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
3/8	1-1/2 (38)	1-13/16 (46)	1,285 (5.7)	1,575 (7.0)	1,300 (5.8)	1,595 (7.1)
	2 (51)	2-5/16 (59)	1,765 (7.9)	2,160 (9.6)	2,380 (10.6)	2,915 (13.0)
1/2	2 (51)	2-3/8 (60)	2,380 (10.6)	2,915 (13.0)	2,380 (10.6)	2,915 (13.0)

Table 44 - Hilti KWIK Bolt TZ carbon steel factored resistance in the top of cracked concrete over metal deck[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 = 30 MPa (4,350 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)
3/8	1-1/2 (38)	1-13/16 (46)	910 (4.0)	1,115 (5.0)	910 (4.0)	1,115 (5.0)
	2 (51)	2-5/16 (59)	1,590 (7.1)	1,945 (8.7)	1,665 (7.4)	2,040 (9.1)
1/2	2 (51)	2-3/8 (60)	1,665 (7.4)	2,040 (9.1)	1,665 (7.4)	2,040 (9.1)

1 See 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 19 to 26 as necessary. Compare to the steel values in table 33. 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.
No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

DESIGN INFORMATION IN MASONRY

Table 45 – Allowable tensile loads for carbon steel and stainless steel Hilti KB-TZ anchors in the face of grout-filled concrete masonry walls[1,3,4,5,6]

Nominal anchor diameter	Nominal embedment		Allowable tensile capacity at s_{cr} and c_{cr}		Spacing				Edge distance				
					Critical spacing, s_{cr}		Minimum spacing, s_{min} [2]		Load multiplier at s_{min}	Critical edge distance, c_{cr}		Minimum edge distance, c_{min}		Load multiplier at c_{min}
in.	in.	(mm)	lb	(kN)	in.	(mm)	in.	(mm)		in.	(mm)	in.	(mm)	
3/8	2-5/16	(59)	515	(2.3)	9-1/4	(235)	3	(76)	0.49	12	(305)	4	(102)	0.70
1/2	2-3/8	(60)	565	(2.5)	9-1/2	(241)	4	(102)	0.49					0.85
	3-5/8	(92)	735	(3.3)	14-1/2	(368)			0.59					1.00
5/8	3-9/16	(90)	790	(3.5)	14-1/4	(362)	5	(127)	0.66					0.89
	4-7/16	(113)	870	(3.9)	17-3/4	(451)			0.60					1.00
3/4	4-5/16	(110)	1,060	(4.7)	17-1/4	(438)	6	(152)	0.45					0.80
	5-9/16	(141)	1,165	(5.2)	22-1/4	(565)			0.41					0.85

Table 46 – Allowable shear loads for carbon steel and stainless steel Hilti KB-TZ anchors in the face of grout-filled concrete masonry walls[1,3,4,5,6]

Nominal anchor diameter	Nominal embedment		Allowable shear capacity at s_{cr} and c_{cr}		Spacing				Edge distance					
					Critical spacing, s_{cr}		Minimum spacing, s_{min} [2]		Load multi-plier at s_{min}	Critical edge distance, c_{cr}		Minimum edge distance, c_{min}		⊥ load multiplier at c_{min}	∥ load multiplier at c_{min}
in.	in.	(mm)	lb	(kN)	in.	(mm)	in.	(mm)		in.	(mm)	in.	(mm)		
3/8	2-5/16	(59)	625	(2.8)	9-1/4	(235)	3	(76)	0.5	12	(305)	4	(102)	0.81	1.00
1/2	2-3/8	(60)	940	(4.2)	9-1/2	(241)	4	(102)						0.45	0.85
	3-5/8	(92)	1,055	(4.7)	14-1/2	(368)								0.41	0.88
5/8	3-9/16	(90)	1,615	(7.2)	14-1/4	(362)	5	(127)						0.40	0.87
	4-7/16	(113)	1,860	(8.3)	17-3/4	(451)								0.38	0.90
3/4	4-5/16	(110)	1,615	(7.2)	17-1/4	(438)	6	(152)						0.40	0.87
	5-9/16	(141)	1,860	(8.3)	22-1/4	(565)								0.38	0.90

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 2015 IBC Section 2103.3, 2012 IBC Section 2103.13, or 2009 and 2006 IBC Section 2103.12. Mortar must comply with 2015 IBC Section 2103.2, 2012 IBC Section 2103.9, or 2009 and 2006 IBC Section 2103.8. 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 7.

4 Allowable loads or applied loads may be modified for the 2009 and 2006 IBC, due to short-term wind or seismic loads. See Table 47.

5 Embedment depth must be measured from the outside face of the concrete masonry unit.

6 For intermediate edge distances and spacings, allowable loads may be determined by linearly interpolating between the allowable loads at the two tabulated edge distances.

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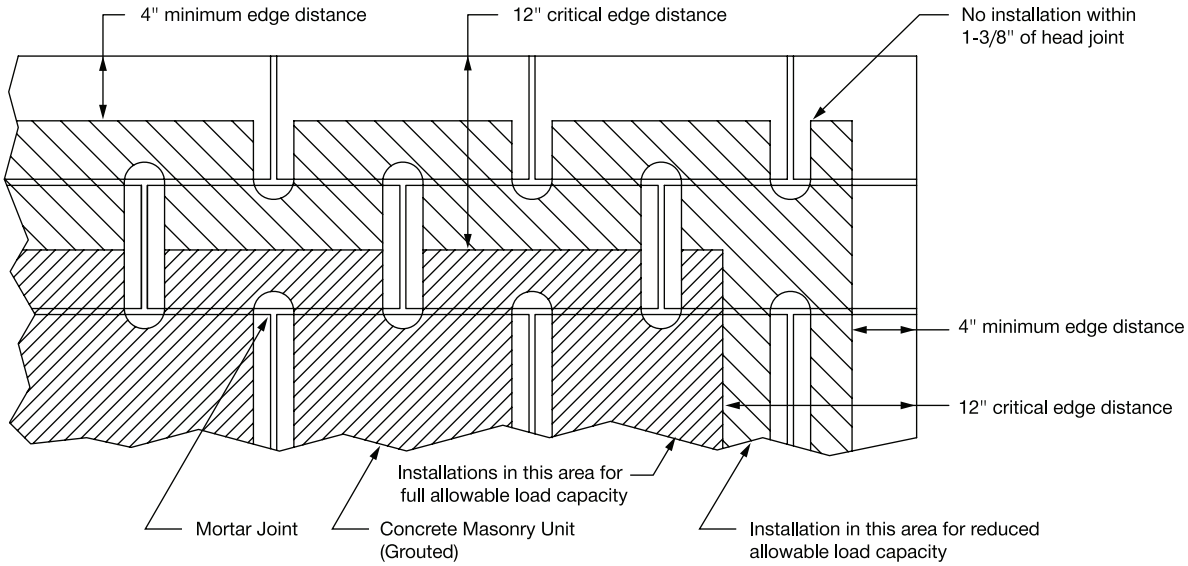
Figure 7 – Acceptable locations (shaded areas) for Hilti KWIK Bolt TZ anchors in grout-filled concrete masonry



Anchor installation is restricted to shaded areas

Table 47 - Alternative basic load combination adjustment factors under the 2009 or 2006 IBC[1,2,3]

Modification factor for alternate basic load combinations		Modification factor for allowable loads for short-term loading conditions	
Tension	Shear	Tension	Shear
0.75	0.75	1.33	1.33

1 When using the basic load combinations in accordance with IBC Section 1605.3.1, allowable loads must not be increased for wind or seismic loading.

2 When using the alternative basic load combinations in the 2009 or 2006 IBC Section 1605.3.2 that include wind or seismic loads, the allowable loads for anchors may be increased by the tabulated factors found in the right half of the table. Alternatively, the basic load combinations may be reduced by multiplying them by the factors found on the left half of the table. For example, the alternate basic loads for wind or seismic loading may be multiplied by 0.75 or divided by 1.33, as applicable. For the 2015 and 2012 IBC, the allowable loads or load combinations must not be adjusted.

3 The above modification factors are applicable under the 2009 or 2006 IBC only, for Tables 45 and 46 for seismic and wind loads.

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.

3.3.5.6 ORDERING INFORMATION[1]

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

1 All dimensions in inches

Table 44 - 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 ½	2	2 ½	3	3 ½	4	4 ½	5	5 ½	6	6 ½	7	7 ½	8	8 ½	9	9 ½	10	11	12	13	14	15
	Up to but not including	2	2 ½	3	3 ½	4	4 ½	5	5 ½	6	6 ½	7	7 ½	8	8 ½	9	9 ½	10	11	12	13	14	15	16

Figure 8 — Bolt head with length identification mark and KWIK Bolt TZ head notch embossment