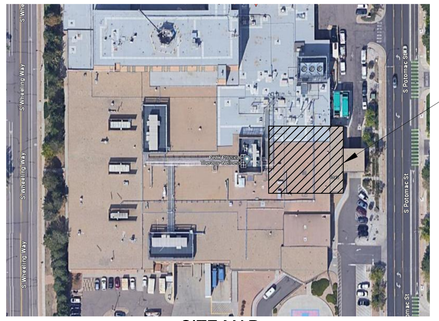
RSN:1827437
LT-24-2459794



SITE MAP
N.T.S.

In buildings provided with an Automatic Fire Sprinkler System, new or existing Fire Alarm Systems shall be connected to the exterior horn/strobe. (Aurora Fire Dept. Policy)

Code violations that are found during inspection are required to be corrected. Permit issuance does not grant approval of a code violation.

Field Inspection consultation is available upon request. Call 303-739-7420 to request a consultation

EXISTING PIPING

NEW PIPING

AURORA NOTES

1. OWNER IS RESPONSIBLE FOR PROVIDING HEAT, ABOVE 40 DEGREES FAHRENHEIT, ADEQUATE ENOUGH TO PREVENT FREEZING OF THE WET PIPE SPRINKLER PIPING.

2. ALL VALVES CONTROLLING THE WATER SUPPLY TO 20 OR MORE SPRINKLER HEADS MUST BE SUPERVISED. AT THE TIME OF FINAL INSPECTION, FIRE SAFETY SYSTEMS MUST BE SUPERVISED BY AN APPROVED UL-LISTED MONITORING AGENCY.

3. THE CONTRACTOR MUS PROVIDE ALL NESSASSARY TESTING EQUIPMENT AND PERFORM ALL TESTING REQUIRED BY THE LIFE SAFETY INSPECTOR.

4. ALL NEW OR EXISTING FIRE ALARM SYSTEMS MUST BE INTERCONNECTED WITH THE FLOW SWITCH OF THE FIRE SPRINKLER SYSTEMS OUTSIDE HORN & STROBE.

5. INSTALLATION OF THE INTERIOR ALARMS ACTIVATED BY THE FIRE SPRINKLER WATER FLOW WILL BE REQUIRED PER 2021 IFC, 903.4.2. APPROVED AUDIBLE DEVICES SHALL BE CONNECTED TO EVERY AUTOMATIC FIRE SPINKLER SYSTEM.

6. IMPORTANT: IN THE EVENT THAT A CONCEALED SPACE IS NOT SHOWN ON THE PLAN SUBMITTAL AND IS DISCOVERED IN THE FIELD, THE INSTALLING CONTRACTOR MUST COMPLY WTH 2019 NFPA 13, SECTION 9.3.17

7. ALL WATER SUPPLY VALVES AND WATER FLOW SWITCHES SHALL BE ELECTRICALLY SUPERVISED, IFC 2021, 903.4.

8. ELECTRICAL EXTERIOR HORN AND STROBE SHALL BE LISTED FOR OUTDOOR USE, IFC 903.4.2. OUTSIDE HORN AND STROBE WILL ACTIVATE UPON BOTH GENERAL ALARM AND FLOW SWITCH ACTIVATION. WHEN FIRE ALARM PANEL IS SILENCED, THE INTERIOR AND EXTERIOR STROBES WILL CONTINUE UNTIL FIRE ALARM PANEL IS RESET.

9. ALL CONTROL VALVE(S) WITHIN THE RISER ROOM MUST BE ACCESSIBLE, 2019 NFPA 13 SECTION 16.9.3.4

10.PRESSURE GAUGES ARE REQUIRED ON THE SYSTEM SIDE OF THE MAIN VALVE AND ON THE SUPPLY SIDE OF THE BACKFLOW PREVENTOR.

11. BOTH NEW AND EXISTING FIRE SPRINKLER SYSTEMS MUST BE EQUIPPED WITH APPROVED KNOX CAPS.

12. THE FIRE DEPARTMENT CONNECTION MUST BE LOCATED NOT LESS THAN 18 IN. AND NOT MORE THAN 4 FT ABOVE THE LEVEL OF THE ADJACENT GRADE OR ACCESS LEVEL. 2019 NFPA 13, SECTION A.16.12.5.1.2

GENERAL NOTES

1. THIS PROJECT CONSISTS OF REVISING THE EXISTING FIRE SPRINKLER SYSTEM FOR THE TENANT MODIFICATION. TENANT AREA IS 4,500 SQ FT.

2. TYPE OF CONSTRUCTION I-A.

3. BUILDING OCCUPANCY CLASSIFICATION PER THE 2021 IBC IS GROUP I-2.

4. SYSTEM #1 IS A WET PIPE FIRE SPRINKLER SYSTEM DESIGNED TO THE 2019 NFPA 13 EDITION.

5. ALL BRANCH LINE PIPING TO BE EDDYTHREAD OR SIMILIAR PIPE.

6. ALL MAIN PIPING TO BE EDDYFLOW OR SIMILAR PIPE.

7. ALL FITTINGS 1" THROUGH 2" TO BE DUCTILE/MALUABLE IRON THREADED FITTINGS.

8. ALL FITTINGS 2½" AND LARGER TO BE GROOVED TYPE FITTINGS.

9. ALL HANGERS TO BE IN ACCORDANCE WITH 2019 NFPA 13 EDITION.

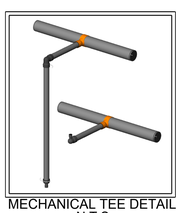
10. ALL MATERIAL TO MEET 2019 NFPA 13 EDITION.

11. MAXIMUM SQUARE FOOTAGE PER HEAD IS 225 SQ.FT.

12. SPRINKLER HEADS ARE NOT REQUIRED TO BE LOCATED IN THE CENTER OF CEILING TILES ALTHOUGH THE INTENT IS TO LOCATE AS CLOSE TO CENTER OR QUARTER POINT AS POSSIBLE.

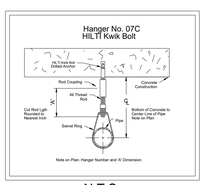
13. THE AUTHORITY HAVING JURISDICTION IS THE AURORA BUILDING DIVISION/LIFE SAFETY.

14. SCOPE OF WORK, REVISE THE EXISTING LIGHT HAZARD FIRE SPRINKLER SYSTEM TO ACCOMMODATE THE NEW TENANT IMPROVEMENT, THE NEWLY REVISED SPACE WILL BE LIGHT HAZARD AND WILL BE RELOCATING 27 PENDANTS, ADDING 2 PENDANTS WITH 17 PENDANTS TO REMAIN EXISTING AND 1 EXISTING OUTLET TO BE PLUGGED. ALL HEADS WILL BE SUPPLIED FROM A 1" OUTLET. DUE TO THE LIMITED ADDED DEMAND TO THE SYSTEM, NO HYDRAULIC CALCULATIONS SHALL BE REQUIRED. ALL WORK WILL BE DONE AS REQUIRED IN ACCORDANCE WITH THE 2021 IFC AND THE 2019 NFPA 13 EDITION.



MECHANICAL TEE DETAIL
N.T.S.

ARMOVER DETAIL
N.T.S.



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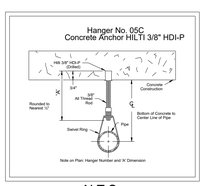

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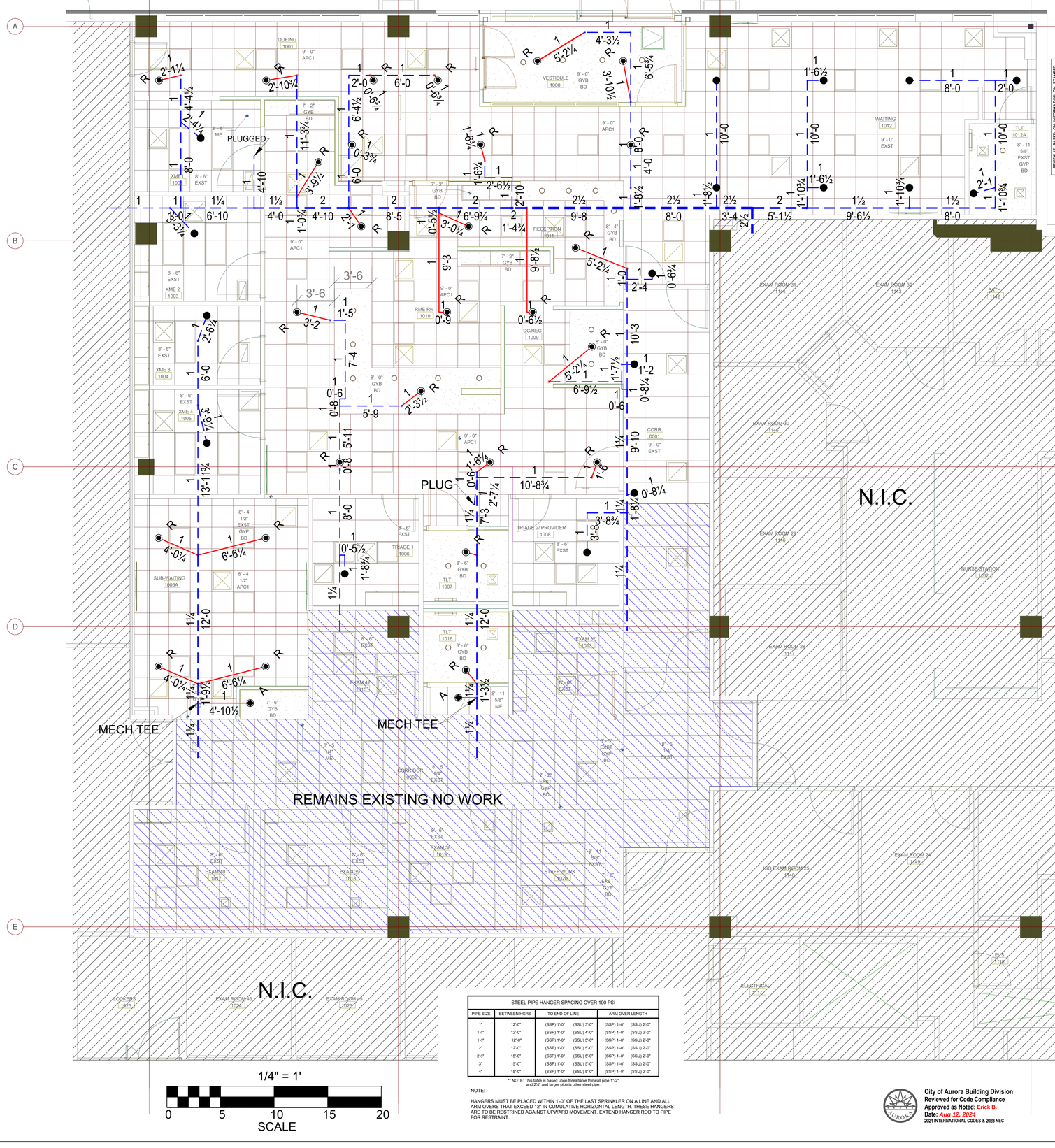


STEEL PIPE HANGER SPACING OVER 100 PSI					
PIPE SIZE	BETWEEN HGRS	TO END OF LINE		ARM OVER LENGTH	
1"	12'-0"	(SSP) 1'-0"	(SSU) 3'-0"	(SSP) 1'-0"	(SSU) 2'-0"
1¼"	12'-0"	(SSP) 1'-0"	(SSU) 4'-0"	(SSP) 1'-0"	(SSU) 2'-0"
1½"	12'-0"	(SSP) 1'-0"	(SSU) 5'-4"	(SSP) 1'-0"	(SSU) 2'-0"
2"	12'-0"	(SSP) 1'-0"	(SSU) 5'-0"	(SSP) 1'-0"	(SSU) 2'-0"
2½"	15'-0"	(SSP) 1'-0"	(SSU) 5'-0"	(SSP) 1'-0"	(SSU) 2'-0"
3"	15'-0"	(SSP) 1'-0"	(SSU) 5'-0"	(SSP) 1'-0"	(SSU) 2'-0"
4"	15'-0"	(SSP) 1'-0"	(SSU) 5'-0"	(SSP) 1'-0"	(SSU) 2'-0"

** NOTE: This table is based upon threadable thinwall pipe 1"-2", and 2½" and larger pipe is other steel pipe.

NOTE:

HANGERS MUST BE PLACED WITHIN 1'-0" OF THE LAST SPRINKLER ON A LINE AND ALL ARM OVERS THAT EXCEED 12" IN CUMULATIVE HORIZONTAL LENGTH. THESE HANGERS ARE TO BE RESTRINED AGAINST UPWARD MOVEMENT. EXTEND HANGER ROD TO PIPE FOR RESTRAINT.

City of Aurora Building Division
Project: *Fire Sprinkler*
Address: *1501 S. Potomac St.*
Occupancy Group: *IBC I-2*
Construction Type: *UBC I.F. R.-SPK*
RSN: *1827437*
Permit: *24-2459794*

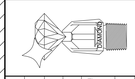
IMPORTANT
In localities subject to freezing conditions, it is the owner's responsibility to maintain adequate heat in all areas where water is trapped in enclosures for dry pipe, deluge, and other types of valves controlling water supplies to sprinkler systems.
This drawing and the hydraulic design application herein contained is the property of Diamond Fire Protection, Incorporated and is submitted for approval with the understanding that it will be returned to Diamond upon request, all information herein contained shall be treated as secret and confidential.
No reproduction or publication of any portion thereof shall be made without the express written consent of Diamond Fire Protection, Inc.

REVIEW IS BASED ON INFORMATION ON STAMPED PLANS AND SPECIFICATIONS SUBMITTED TO COMPLY WITH ALL APPLICABLE CODES AND ORDINANCES.
WRITTEN CORRECTIONS MUST BE MADE.
BRYAN A. EDELBERGER
NICET CERTIFICATION NO. 472644
NICET FIRE SPRINKLER LEVEL IV
CERTIFICATION EXPIRES - JUNE 01, 2027
8/14/2024
DATE SIGNED
BRYAN A. EDELBERGER, SET

AFF	CENTER OF PIPE ABOVE FLOOR
@	CENTER OF PIPE BELOW DECK
XX'-X"	CEILING HEIGHT
(XX'-X")	TOP OF STEEL ELEVATION

Sprinkler Legend

Symbol	Manufacturer	SIN	Model	Quantity	K-Factor	Type	Size	Response	Finish	Temperature	Note
●	Viking	VK462	MIRAGE	17	5.6	Pendent	½	Quick	White	155°F	EXISTING
◆R	Viking	VK462	MIRAGE	27	5.6	Pendent	½	Quick	White	155°F	RELOCATE
◆A	Viking	VK462	MIRAGE	2	5.6	Pendent	½	Quick	White	155°F	ADD
				Total = 46							



Scale:
1/8"=1'-0"
DRAWN BY:
BD
SUPERVISED BY:
BE
DATE:
07-16-2024
STATE REGISTRATION NO. 24-S-00659
DRAWING NO:
FP-1 OF 1
CONTRACT NO:
24-0401

DIAMOND FIRE PROTECTION CO., INC.
3360 S. PLATTE RIVER DRIVE - UNIT 101
ENGLEWOOD, CO 80110
PHONE 303.762.7570 FAX 303.762.7518

THE MEDICAL CENTER AURORA
1501 S. POTOMAC ST.
AURORA, CO 80012

DESCRIPTION: ER 1ST FLOOR
CONTRACT WITH: VERTIX BUILDERS
PLOTE DATE 07/16/24

City of Aurora Building Division
Reviewed for Code Compliance
Approved as Noted: Erick B.
Date: *Aug 12, 2024*
2021 INTERNATIONAL CODES & 2023 NEC

DIAMOND FIRE PROTECTION COMPANY, INC.
3360 S. Platte River Drive – Unit 101
Englewood, CO 80110-1216
Telephone 303-762-7570 Fax 303-762-7518

FIRE SPRINKLER MATERIAL DATA

FOR

THE MEDICAL CENTER OF AURORA
1501 S. PATOMAC STREET
AURORA, CO

EQUIPMENT SUBMITTAL

MATERIAL INDEX

Description	Mfg
Pipe	BMT
Fittings	Anvil
Sprinklers	Viking
Hangers	Caddy, Hilti

RSN:1827437
LT-24-2459794

BULL MOOSE TUBE

SCHEDULE 10 & 40 SPRINKLER PIPE SUBMITTAL DATA SHEET

APPROVALS AND SPECIFICATIONS

- ASTM A135, Grade A
- ASTM A795, Type E, Grade A
- Pressure rated to 300 psi
- Underwriters Laboratories—United States of America
- Underwriters Laboratories—Canada
- Factory Mutual
- NFPA-13
- NFPA-13R
- NFPA-14
- CIVIL DEFENSE APPROVAL—United Arab Emirates
- Made in the United States of America
- UL, ULC & FM listed for roll-groove, plain-end and welded joints for wet, dry, preaction and deluge sprinkler systems.
- LEED v4 Certified

FINISHES AND COATINGS

- Schedule 10 & 40 Sprinkler Pipe receives an OD mill coating of water-based paint which has corrosion protection expected with a painted carbon steel product, i.e. it would be expected to resist corrosion for an extended and indefinite period in a clean and dry environment and, as environmental conditions deteriorate, the corrosion protection would also diminish.
- Schedule 10 & 40 Sprinkler Pipe (black) receives an ID mill coating of Eddy Guard II MIC preventative coating. EG2 has been tested at independent laboratories to resist bacterial growth and maintain minimal bacterial count after multiple flushes (25) of the pipe.
- Schedule 10 & 40 Sprinkler Pipe when Hot Dip Galvanized by ASTM A123 and supplied by Bull Moose Tube is UL listed and FM approved.

PRODUCT IDENTIFICATION

- Every length of Bull Moose fire sprinkler pipe features large, easy-to-read, continuous stenciling, clearly identifying the manufacturer, type of pipe, size, and length.

	Nominal Pipe Size (inches)	1	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"	6"	8"
Schedule 10	O.D. (in)	1.315	1.660	1.900	2.375	2.875	3.500	4.500	6.625	8.625
	I.D. (in)	1.097	1.442	1.682	2.157	2.635	3.260	4.260	6.357	8.249
	Empty Weight (lb/ft)	1.410	1.810	2.090	2.640	3.530	4.340	5.620	9.290	16.940
	Water Filled Weight (lb/ft)	1.800	2.518	3.053	4.223	5.893	7.957	11.796	23.038	40.086
	C.R.R.*	15.27	9.91	7.76	6.27	4.92	3.54	2.50	1.158	1.805
	Pieces per Lift	91	61	61	37	30	19	19	10	7
Schedule 40	O.D. (in)	1.315	1.660	1.900	2.375	2.875	3.500	4.500		
	I.D. (in)	1.049	1.380	1.610	2.067	2.469	3.068	4.026		
	Empty Weight (lb/ft)	1.680	2.270	2.720	3.660	5.800	7.580	10.800		
	Water Filled Weight (lb/ft)	2.055	2.918	3.602	5.114	7.875	10.783	16.316		
	C.R.R.*	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
	Pieces per Lift	70	51	44	30	30	19	19		

*Calculated using Standard UL CRR formula, UL Fire Protection Directory, Category VIZY

SUBMITTAL INFORMATION

Project

Contractor Diamond Fire Protection

Engineer Buddy Davison

Specification Reference Pipe

Date

System Type

Locations

Comments

(X) Schedule 10 - Black ( ) Schedule 10 - Hot Dip Galvanized (X) Schedule 40 - Black ( ) Schedule 40 - Hot Dip Galvanized

BULLMOOSETUBE.COM
1819 Clarkson Road, Chesterfield, MO 63017
US: 800.325.4467 | Canada: 800.882.4666 | sales@BullMooseIndustries.com

RSN:1827437
LT-24-2459794

ASC Engineered Solutions

Elbows (Class 150 Standard)

☐ **Fig. 1102** 45° Elbow
☐ **Fig. 1103** 90° Street Elbow (Straight)
☐ **Fig.1103R** 90° Street Elbow (Reducing)

Fig. 1103R

Fig. 1102

Fig. 1103

c UL us LISTED

FM APPROVED

ASC Engineered Solutions™ offers the broadest line of malleable iron fitting sizes in both black and galvanized finishes. Every fitting is manufactured and tested to meet ASC's strict quality standards. All Anvil Class 150 Malleable Iron Fittings conform to ASME B16.3 and unions conform to ASME B16.39. All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

For Listings/Approval Details and Limitations, visit our website at www.asc-es.com or contact an ASC Engineered Solutions™ Representative.

See following page for standards and specifications.

Anvil Class 150/300 Malleable Iron Fittings conform to ASME B16.3 and Unions conform to ASME B16.39.

All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

Malleable Iron Threaded Pipe Unions Pressure - Temperature Ratings

Temperature	Pressure Class 150	Pressure Class 250	Pressure Class 300
°F/°C	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	500 34.5	600 41.4
200° 93.3°	265 18.3	455 31.4	550 37.9
250° 121.1°	225 15.5	405 27.9	505 34.8
300° 148.9°	185 12.8	360 24.8	460 31.7
350° 176.7°	150 10.3	315 21.7	415 28.6
400° 204.4°	110 7.6	270 18.6	370 25.5
450° 232.2°	75 5.2	225 15.5	325 22.4
500° 260.0°	– –	180 12.4	280 19.3
550° 287.8°	– –	130 9.0	230 15.9

Malleable Iron Threaded Fittings Pressure - Temperature Ratings

Temperature	Pressure Class 150	Pressure Class 300 Sizes ¼"–1" (6-25mm)	Pressure Class 300 Sizes 1¼"–2" (32-51mm)	Pressure Class 300 Sizes 2½"–3" (64-76mm)
°F/°C	PSI/bar	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	2000 137.9	1500 103.4	1000 68.9
200° 93.3°	265 18.3	1785 123.1	1350 93.1	910 62.7
250° 121.1°	225 15.5	1575 108.6	1200 82.7	825 56.9
300° 148.9°	185 12.8	1360 93.8	1050 72.4	735 50.7
350° 176.7°	150 10.3	1150 79.3	900 62.1	650 44.8
400° 204.4°	– –	935 64.5	750 51.7	560 38.6
450° 232.2°	– –	725 50.0	600 41.4	475 32.8
500° 260.0°	– –	510 35.2	450 31.0	385 26.5
550° 287.8°	– –	300 20.7	300 20.7	300 20.7

ANVIL
An ASC Engineered Solution

Note:
Unions with Copper or Copper Alloy seats are not intended for use where temperature exceeds 450°F.

PROJECT INFORMATION	APPROVAL STAMP
Project:	☐ Approved
Address:	☐ Approved as noted
Contractor:	☐ Not approved
Engineer:	Remarks:
Submittal Date:	
Notes 1:	
Notes 2:	

RSN:1827437
LT-24-2459794

ASC Engineered Solutions

Elbows (Class 150 Standard)
Fig. 1102, 1103, 1103R

Standards and Specifications

Malleable Iron Fittings

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3
Class 300/PN 50	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3

Malleable Iron Unions

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 250	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 300/PN 50	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39

Note:

* ASTM B633. Type I, SC 4, may be supplied as alternate zinc coating per applicable ASME B16 product standard.

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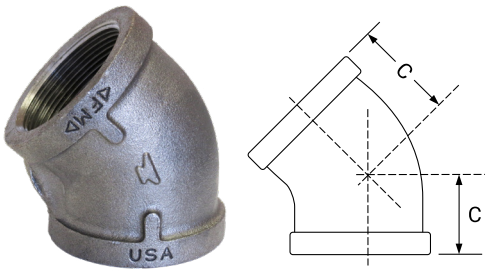
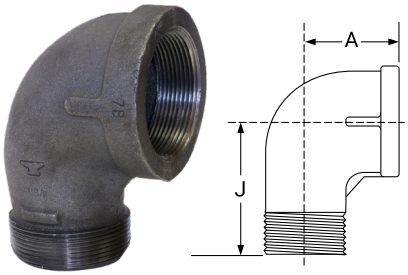
ASC Engineered Solutions

Fig. 1102
45° Elbow (Class 150 Standard)



Size	C	Unit Weight	
		Black	Galvanized
NPS/DN	In./mm	Lbs./kg	Lbs./kg
1/8 6	11/16 17	0.07 0.03	0.07 0.03
1/4 8	3/4 19	0.11 0.05	0.11 0.05
3/8 10	13/16 22	0.16 0.07	0.16 0.07
1/2 15	7/8 22	0.22 0.10	0.22 0.10
3/4 20	1 25	0.37 0.17	0.37 0.17
1 25	1 1/8 29	0.54 0.24	0.54 0.24
1 1/4 32	1 5/16 33	0.86 0.39	0.86 0.39
1 1/2 40	1 7/16 37	1.13 0.51	1.13 0.51
2 50	1 11/16 43	1.79 0.81	1.79 0.81
2 1/2 65	1 15/16 49	3.60 1.63	3.60 1.63
3 80	2 3/16 56	4.48 2.03	4.48 2.03
4 100	2 5/8 67	7.40 3.36	7.40 3.36
5 125	3 1/16 78	11.46 5.20	11.46 5.20
6 150	3 7/16 87	19.93 9.04	19.93 9.04

Fig. 1103, 1103R
90° Straight Street Elbow (Class 150 Standard)
90° Reducing Street Elbow (Class 150 Standard)



Size	A	J	Unit Weight	
			Black	Galv.
NPS/DN	In./mm	In./mm	Lbs./kg	Lbs./kg
1/8 6	11/16 17	1 25	0.06 0.03	0.06 0.03
1/4 8	13/16 22	1 3/16 30	0.10 0.05	0.10 0.05
3/8 10	15/16 24	1 7/16 37	0.17 0.08	0.17 0.08
1/2 15	1 1/8 29	1 5/8 41	0.28 0.13	0.28 0.13
3/4 20	1 5/16 33	1 7/8 48	0.41 0.19	0.41 0.19
1 25	1 1/2 38	2 1/8 54	0.62 0.28	0.62 0.28
1 1/4 32	1 3/4 44	2 7/16 62	1.09 0.49	1.09 0.49
1 1/2 40	1 15/16 49	2 11/16 68	1.44 0.65	1.44 0.65
2 50	2 1/4 57	3 1/4 83	2.85 1.29	2.85 1.29
2 1/2 65	2 11/16 68	3 7/8 98	4.00 1.81	4.00 1.81
3 80	3 1/16 78	4 1/2 114	6.06 2.75	6.06 2.75
4 100	3 13/16 98	5 11/16 144	10.53 4.78	10.53 4.78

Size	A	J	Unit Weight	
			Black	Galv.
NPS/DN	In./mm	In./mm	Lbs./kg	Lbs./kg
1/2 x 3/8 15 x 10	1 1/16 27	1 9/16 40	0.23 0.10	0.23 0.10
3/4 x 1/2 20 x 15	1 3/16 30	1 3/4 44	0.32 0.15	0.32 0.15
1 x 3/4 25 x 20	1 3/8 35	2 1/16 52	0.54 0.24	0.54 0.24
1 1/4 x 1 32 x 25	1 9/16 40	2 5/16 59	0.86 0.39	0.86 0.39
1 1/4 x 3/4 32 x 20	1 7/16 37	2 1/4 57	0.75 0.34	0.75 0.34
1 1/2 x 1 1/4 40 x 32	1 13/16 47	2 9/16 65	1.18 0.54	1.18 0.54
1 1/2 x 1 40 x 25	1 5/8 41	2 1/2 64	1.08 0.49	1.08 0.49
2 x 1 1/2 50 x 40	2 51	2 15/16 75	1.85 0.84	1.85 0.84

Note:

First size denotes female end.

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All elbows and tees 3/8" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

asc-es.com

Building connections that last™

RSN:1827437
LT-24-2459794

Engineered Solutions

Fig. 1102, 1103, 1103R Elbows (Class 150 Standard)

General Assembly of Threaded Fittings

1 Inspect both male and female components prior to assembly.

- Threads should be free from mechanical damage, dirt, chips and excess cutting oil.
- Clean or replace components as necessary.

2 Application of thread sealant

- Use a thread sealant that is fast drying, sets-up to a semi hard condition and is vibration resistant. Alternately, an anaerobic sealant may be utilized.
- Throroughly mix the thread sealant prior to application.
- Apply a thick even coat to the male threads only. Best application is achieved with a brush stiff enough to force sealant down to the root of the threads.

3 Joint Makeup

- For sizes up to and including 2" pipe, wrench tight makeup is considered three full turns past handtight. Handtight engagement for ½" through 2" thread varies from 4½ turns to 5 turns.
- For 2½" through 4" sizes, wrench tight makeup is considered two full turns past handtight. Handtight engagement for 2½" through 4" thread varies from 5½ turns to 6¾ turns.

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LT-24-2459794

ASC Engineered Solutions

Elbows (Class 300 XS/XH)

☐ **Fig. 1160** 45° Street Elbow
☐ **Fig. 1162** 45° Elbow

Fig. 1160

Fig. 1162

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ASC Engineered Solutions™ offers the broadest line of malleable iron fitting sizes in both black and galvanized finishes. Every fitting is manufactured and tested to meet ASC's strict quality standards. All Anvil Class 300 Malleable Iron Fittings conform to ASME B16.3 and unions conform to ASME B16.39. All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

For Listings/Approval Details and Limitations, visit our website at www.asc-es.com or contact an ASC Engineered Solutions™ Representative.

See following page for standards and specifications.

Malleable Iron Threaded Pipe Unions
Pressure - Temperature Ratings

Temperature	Pressure Class 150	Class 250	Class 300
°F/°C	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	500 34.5	600 41.4
200° 93.3°	265 18.3	455 31.4	550 37.9
250° 121.1°	225 15.5	405 27.9	505 34.8
300° 148.9°	185 12.8	360 24.8	460 31.7
350° 176.7°	150 10.3	315 21.7	415 28.6
400° 204.4°	110 7.6	270 18.6	370 25.5
450° 232.2°	75 5.2	225 15.5	325 22.4
500° 260.0°	– –	180 12.4	280 19.3
550° 287.8°	– –	130 9.0	230 15.9

Malleable Iron Threaded Fittings
Pressure - Temperature Ratings

Temperature	Pressure Class 150	Class 300 Sizes ¼"–1" (6-25mm)	Class 300 Sizes 1¼"–2" (32-51mm)	Class 300 Sizes 2½"–3" (64-76mm)
°F/°C	PSI/bar	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	2000 137.9	1500 103.4	1000 68.9
200° 93.3°	265 18.3	1785 123.1	1350 93.1	910 62.7
250° 121.1°	225 15.5	1575 108.6	1200 82.7	825 56.9
300° 148.9°	185 12.8	1360 93.8	1050 72.4	735 50.7
350° 176.7°	150 10.3	1150 79.3	900 62.1	650 44.8
400° 204.4°	– –	935 64.5	750 51.7	560 38.6
450° 232.2°	– –	725 50.0	600 41.4	475 32.8
500° 260.0°	– –	510 35.2	450 31.0	385 26.5
550° 287.8°	– –	300 20.7	300 20.7	300 20.7

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Note:
Unions with Copper or Copper Alloy seats are not intended for use where temperature exceeds 450°F.

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Project:	☐ Approved
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LT-24-2459794

ASC Engineered Solutions

Elbows (Class 300 XS/XH)
Fig. 1160, 1162

Standards and Specifications

Malleable Iron Fittings

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3
Class 300/PN 50	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3

Malleable Iron Unions

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 250	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 300/PN 50	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39

Note:

* ASTM B633. Type I, SC 4, may be supplied as alternate zinc coating per applicable ASME B16 product standard.

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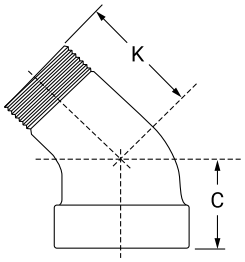
Fig. 1160
45° Street Elbow (Class 300 XS/XH)



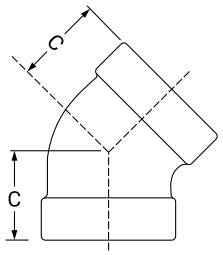
Size	C	K	Unit Weight Black
NPS/DN	In./mm	In./mm	Lbs./kg
½ 15	1 25	1⅜ 35	0.36 0.16
¾ 20	1⅛ 29	1⁹⁄₁₆ 40	0.54 0.24
1 25	1⁵⁄₁₆ 33	1¹³⁄₁₆ 47	0.85 0.39
1¼ 32	1½ 38	2⅛ 54	1.50 0.68
1½ 40	1¹¹⁄₁₆ 43	2⁵⁄₁₆ 59	2.06 0.93
2 50	2 51	2¹¹⁄₁₆ 68	3.34 1.51

Notes:

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

Fig. 1162
45° Elbow (Class 300 XS/XH)



Size	C	Unit Weight Black	Unit Weight Galv.
NPS/DN	In./mm	Lbs./kg	Lbs./kg
¼ 8	¹³⁄₁₆ 22	0.19 0.09	0.19 0.09
⅜ 10	⅞ 22	0.28 0.13	0.28 0.13
½ 15	1 25	0.43 0.20	0.43 0.20
¾ 20	1⅛ 29	0.66 0.30	0.66 0.30
1 25	1⁵⁄₁₆ 33	1.00 0.45	1.00 0.45
1¼ 32	1½ 38	1.67 0.76	1.67 0.76
1½ 40	1¹¹⁄₁₆ 43	2.15 0.98	2.15 0.98
2 50	2 51	3.40 1.54	3.40 1.54
2½ 65	2¼ 57	5.51 2.50	5.51 2.50
3 80	2½ 64	8.10 3.67	8.10 3.67
4 100	2¹³⁄₁₆ 73	13.41 6.08	13.41 6.08

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Fig. 1160, 1162 Elbows (Class 300 XS/XH)

General Assembly of Threaded Fittings

1 Inspect both male and female components prior to assembly.

- Threads should be free from mechanical damage, dirt, chips and excess cutting oil.
- Clean or replace components as necessary.

2 Application of thread sealant

- Use a thread sealant that is fast drying, sets-up to a semi hard condition and is vibration resistant. Alternately, an anaerobic sealant may be utilized.
- Throroughly mix the thread sealant prior to application.
- Apply a thick even coat to the male threads only. Best application is achieved with a brush stiff enough to force sealant down to the root of the threads.

3 Joint Makeup

- For sizes up to and including 2" pipe, wrench tight makeup is considered three full turns past handtight. Handtight engagement for ½" through 2" thread varies from 4½ turns to 5 turns.
- For 2½" through 4" sizes, wrench tight makeup is considered two full turns past handtight. Handtight engagement for 2½" through 4" thread varies from 5½ turns to 6¾ turns.

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Elbow & Tee (Class 150 Standard)

☐ **Fig. 1104** 45° Street Elbow
☐ **Fig. 1105** Straight Tee

Fig. 1104

Fig. 1105

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ASC Engineered Solutions™ offers the broadest line of malleable iron fitting sizes in both black and galvanized finishes. Every fitting is manufactured and tested to meet ASC's strict quality standards. All Anvil Class 150 Malleable Iron Fittings conform to ASME B16.3 and unions conform to ASME B16.39. All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

For Listings/Approval Details and Limitations, visit our website at www.asc-es.com or contact an ASC Engineered Solutions™ Representative.

See following page for standards and specifications.

Anvil Class 150/300 Malleable Iron Fittings conform to ASME B16.3 and Unions conform to ASME B16.39.

All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

Malleable Iron Threaded Pipe Unions Pressure - Temperature Ratings

Temperature	Pressure Class 150	Class 250	Class 300
°F/°C	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	500 34.5	600 41.4
200° 93.3°	265 18.3	455 31.4	550 37.9
250° 121.1°	225 15.5	405 27.9	505 34.8
300° 148.9°	185 12.8	360 24.8	460 31.7
350° 176.7°	150 10.3	315 21.7	415 28.6
400° 204.4°	110 7.6	270 18.6	370 25.5
450° 232.2°	75 5.2	225 15.5	325 22.4
500° 260.0°	– –	180 12.4	280 19.3
550° 287.8°	– –	130 9.0	230 15.9

Malleable Iron Threaded Fittings Pressure - Temperature Ratings

Temperature	Class 150	Pressure Class 300 Sizes ¼"–1" (6-25mm)	Sizes 1¼"–2" (32-51mm)	Sizes 2½"–3" (64-76mm)
°F/°C	PSI/bar	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	2000 137.9	1500 103.4	1000 68.9
200° 93.3°	265 18.3	1785 123.1	1350 93.1	910 62.7
250° 121.1°	225 15.5	1575 108.6	1200 82.7	825 56.9
300° 148.9°	185 12.8	1360 93.8	1050 72.4	735 50.7
350° 176.7°	150 10.3	1150 79.3	900 62.1	650 44.8
400° 204.4°	– –	935 64.5	750 51.7	560 38.6
450° 232.2°	– –	725 50.0	600 41.4	475 32.8
500° 260.0°	– –	510 35.2	450 31.0	385 26.5
550° 287.8°	– –	300 20.7	300 20.7	300 20.7

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Note:
Unions with Copper or Copper Alloy seats are not intended for use where temperature exceeds 450°F.

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LT-24-2459794

Engineered Solutions

Elbow & Tee (Class 150 Standard)
Fig. 1104, 1105

Standards and Specifications

Malleable Iron Fittings

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3
Class 300/PN 50	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3

Malleable Iron Unions

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 250	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 300/PN 50	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39

Note:

* ASTM B633. Type I, SC 4, may be supplied as alternate zinc coating per applicable ASME B16 product standard.

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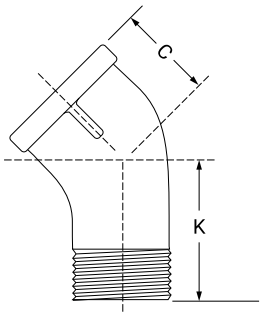
Fig. 1104
45° Street Elbow (Class 150 Standard)



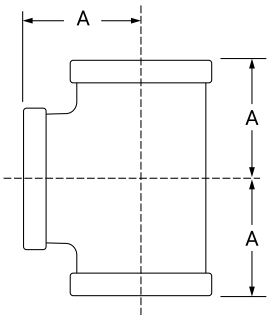
Size	C	K	Unit Weight	
			Black	Galvanized
NPS/DN	In./mm	In./mm	Lbs./kg	Lbs./kg
1/8 6	11/16 17	7/8 22	0.06 0.03	0.06 0.03
1/4 8	3/4 19	15/16 24	0.10 0.05	0.10 0.05
3/8 10	13/16 22	1 25	0.14 0.06	0.14 0.06
1/2 15	7/8 22	1 1/8 29	0.20 0.09	0.20 0.09
3/4 20	1 25	1 5/16 33	0.33 0.15	0.33 0.15
1 25	1 1/8 29	1 7/16 37	0.52 0.24	0.52 0.24
1 1/4 32	1 5/16 33	1 11/16 43	0.85 0.39	0.85 0.39
1 1/2 40	1 7/16 37	1 7/8 48	1.22 0.55	1.22 0.55
2 50	1 11/16 43	2 1/4 57	1.92 0.87	1.92 0.87

Notes:

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All elbows and tees 3/8" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

Fig. 1105
Straight Tee (Class 150 Standard)



Size	A	Unit Weight	
		Black	Galvanized
NPS/DN	In./mm	Lbs./kg	Lbs./kg
1/8 6	11/16 17	0.09 0.04	0.09 0.04
1/4 8	13/16 22	0.15 0.07	0.15 0.07
3/8 10	15/16 24	0.23 0.10	0.23 0.10
1/2 15	1 1/8 29	0.41 0.19	0.41 0.19
3/4 20	1 5/16 33	0.60 0.27	0.60 0.27
1 25	1 1/2 38	0.90 0.41	0.90 0.41
1 1/4 32	1 3/4 44	1.31 0.59	1.31 0.59
1 1/2 40	1 15/16 49	1.73 0.78	1.73 0.78
2 50	2 1/4 57	2.52 1.14	2.52 1.14
2 1/2 65	2 11/16 68	4.90 2.22	4.90 2.22
3 80	3 1/16 78	7.13 3.23	7.13 3.23
3 1/2 90	3 7/16 87	9.00 4.08	9.00 4.08
4 100	3 13/16 98	11.32 5.13	11.32 5.13
5 125	4 1/2 114	19.42 8.81	19.42 8.81
6 150	5 1/8 130	25.50 11.56	25.50 11.56

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Fig. 1104, 1105 Elbow & Tee (Class 150 Standard)

General Assembly of Threaded Fittings

1 Inspect both male and female components prior to assembly.

- Threads should be free from mechanical damage, dirt, chips and excess cutting oil.
- Clean or replace components as necessary.

2 Application of thread sealant

- Use a thread sealant that is fast drying, sets-up to a semi hard condition and is vibration resistant. Alternately, an anaerobic sealant may be utilized.
- Throroughly mix the thread sealant prior to application.
- Apply a thick even coat to the male threads only. Best application is achieved with a brush stiff enough to force sealant down to the root of the threads.

3 Joint Makeup

- For sizes up to and including 2" pipe, wrench tight makeup is considered three full turns past handtight. Handtight engagement for ½" through 2" thread varies from 4½ turns to 5 turns.
- For 2½" through 4" sizes, wrench tight makeup is considered two full turns past handtight. Handtight engagement for 2½" through 4" thread varies from 5½ turns to 6¾ turns.

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ASC Engineered Solutions

Reducing Elbow (Class 150 Standard)
Fig. 1101R

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ASC Engineered Solutions™ offers the broadest line of malleable iron fitting sizes in both black and galvanized finishes. Every fitting is manufactured and tested to meet ASC's strict quality standards. All Anvil Class 150 Malleable Iron Fittings conform to ASME B16.3 and unions conform to ASME B16.39. All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

For Listings/Approval Details and Limitations, visit our website at www.asc-es.com or contact an ASC Engineered Solutions™ Representative.

See following page for standards and specifications.

Anvil Class 150/300 Malleable Iron Fittings conform to ASME B16.3 and Unions conform to ASME B16.39.

All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

Malleable Iron Threaded Pipe Unions
Pressure - Temperature Ratings

Temperature	Pressure		
	Class 150	Class 250	Class 300
°F/°C	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	500 34.5	600 41.4
200° 93.3°	265 18.3	455 31.4	550 37.9
250° 121.1°	225 15.5	405 27.9	505 34.8
300° 148.9°	185 12.8	360 24.8	460 31.7
350° 176.7°	150 10.3	315 21.7	415 28.6
400° 204.4°	110 7.6	270 18.6	370 25.5
450° 232.2°	75 5.2	225 15.5	325 22.4
500° 260.0°	– –	180 12.4	280 19.3
550° 287.8°	– –	130 9.0	230 15.9

Malleable Iron Threaded Fittings
Pressure - Temperature Ratings

Temperature	Pressure			
	Class 150	Class 300		
		Sizes ¼"–1" (6-25mm)	Sizes 1¼"–2" (32-51mm)	Sizes 2½"–3" (64-76mm)
°F/°C	PSI/bar	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	2000 137.9	1500 103.4	1000 68.9
200° 93.3°	265 18.3	1785 123.1	1350 93.1	910 62.7
250° 121.1°	225 15.5	1575 108.6	1200 82.7	825 56.9
300° 148.9°	185 12.8	1360 93.8	1050 72.4	735 50.7
350° 176.7°	150 10.3	1150 79.3	900 62.1	650 44.8
400° 204.4°	– –	935 64.5	750 51.7	560 38.6
450° 232.2°	– –	725 50.0	600 41.4	475 32.8
500° 260.0°	– –	510 35.2	450 31.0	385 26.5
550° 287.8°	– –	300 20.7	300 20.7	300 20.7

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Note:
Unions with Copper or Copper Alloy seats are not intended for use where temperature exceeds 450°F.

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Project:	☐ Approved
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Reducing Elbow (Class 150 Standard)
Fig. 1101R

Standards and Specifications

Malleable Iron Fittings

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3
Class 300/PN 50	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3

Malleable Iron Unions

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 250	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 300/PN 50	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39

Note:

* ASTM B633. Type I, SC 4, may be supplied as alternate zinc coating per applicable ASME B16 product standard.

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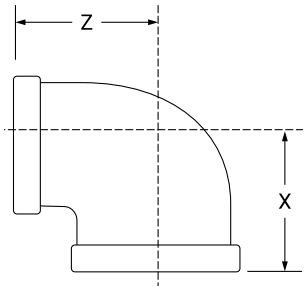
ASC Engineered Solutions

Reducing Elbow (Class 150 Standard)
Fig. 1101R



Size		X	Z	Unit Weight	
				Black	Galvanized
NPS/DN	NPS/DN	In./mm	In./mm	Lbs./kg	Lbs./kg
1/4 8	1/8 6	3/4 19	3/4 19	0.10 0.05	0.10 0.05
3/8 10	1/8 6	13/16 22	7/8 22	0.12 0.05	0.12 0.05
	1/4 8	7/8 22	15/16 24	0.14 0.06	0.14 0.06
1/2 15	1/4 8	1 25	1 25	0.19 0.09	0.19 0.09
	3/8 10	1 1/16 27	1 1/16 27	0.22 0.10	0.22 0.10
3/4 20	1/4 8	1 1/8 29	1 1/8 29	0.26 0.12	0.26 0.12
	3/8 10	1 1/8 29	1 1/8 29	0.29 0.13	0.29 0.13
	1/2 15	1 3/16 30	1 1/4 32	0.38 0.17	0.38 0.17
1 25	3/8 10	1 3/16 30	1 1/4 32	0.41 0.19	0.41 0.19
	1/2 15	1 1/4 32	1 3/8 35	0.46 0.21	0.46 0.21
	3/4 20	1 3/8 35	1 7/16 37	0.56 0.25	0.56 0.25
1 1/4 32	1/2 15	1 3/8 35	1 9/16 40	0.61 0.28	0.61 0.28
	3/4 20	1 7/16 37	1 5/8 41	0.71 0.32	0.71 0.32

Size		X	Z	Unit Weight	
				Black	Galvanized
NPS/DN	NPS/DN	In./mm	In./mm	Lbs./kg	Lbs./kg
1 1/4 32	1 25	1 9/16 40	1 11/16 43	0.87 0.39	0.87 0.39
1 1/2 40	3/4 20	1 1/2 38	1 3/4 44	0.83 0.38	0.83 0.38
	1 25	1 5/8 41	1 13/16 47	1.02 0.46	1.02 0.46
	1 1/4 32	1 13/16 47	1 7/8 48	1.17 0.53	1.17 0.53
2 50	3/4 20	1 5/8 41	2 51	1.30 0.59	1.30 0.59
	1 25	1 3/4 44	2 51	1.35 0.61	1.35 0.61
	1 1/4 32	1 7/8 48	2 1/8 54	1.53 0.69	1.53 0.69
	1 1/2 40	2 51	2 1/8 54	1.75 0.79	1.75 0.79
2 1/2 65	1 1/2 40	2 3/16 56	2 1/2 64	2.50 1.13	2.50 1.13
	2 50	2 7/16 62	2 5/8 67	2.98 1.35	2.98 1.35
3 80	2 50	2 9/16 65	2 15/16 75	3.75 1.70	3.75 1.70
	2 1/2 65	2 13/16 73	3 76	4.30 1.95	4.30 1.95
4 100	3 80	3 5/16 84	3 5/8 92	7.87 3.57	7.87 3.57

Notes:

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All elbows and tees 3/8" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

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Fig. 1101R Reducing Elbow (Class 150 Standard)

General Assembly of Threaded Fittings

1 Inspect both male and female components prior to assembly.

- Threads should be free from mechanical damage, dirt, chips and excess cutting oil.
- Clean or replace components as necessary.

2 Application of thread sealant

- Use a thread sealant that is fast drying, sets-up to a semi hard condition and is vibration resistant. Alternately, an anaerobic sealant may be utilized.
- Throroughly mix the thread sealant prior to application.
- Apply a thick even coat to the male threads only. Best application is achieved with a brush stiff enough to force sealant down to the root of the threads.

3 Joint Makeup

- For sizes up to and including 2" pipe, wrench tight makeup is considered three full turns past handtight. Handtight engagement for ½" through 2" thread varies from 4½ turns to 5 turns.
- For 2½" through 4" sizes, wrench tight makeup is considered two full turns past handtight. Handtight engagement for 2½" through 4" thread varies from 5½ turns to 6¾ turns.

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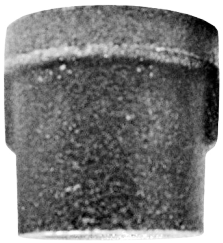
Reducer (Class 150 Standard)
Fig. 1125



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ASC Engineered Solutions™ offers the broadest line of malleable iron fitting sizes in both black and galvanized finishes. Every fitting is manufactured and tested to meet ASC's strict quality standards. All Anvil Class 150 Malleable Iron Fittings conform to ASME B16.3 and unions conform to ASME B16.39. All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

For Listings/Approval Details and Limitations, visit our website at www.asc-es.com or contact an ASC Engineered Solutions™ Representative.

See following page for standards and specifications.

Malleable Iron Threaded Pipe Unions
Pressure - Temperature Ratings

Temperature	Pressure Class 150	Class 250	Class 300
°F/°C	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	500 34.5	600 41.4
200° 93.3°	265 18.3	455 31.4	550 37.9
250° 121.1°	225 15.5	405 27.9	505 34.8
300° 148.9°	185 12.8	360 24.8	460 31.7
350° 176.7°	150 10.3	315 21.7	415 28.6
400° 204.4°	110 7.6	270 18.6	370 25.5
450° 232.2°	75 5.2	225 15.5	325 22.4
500° 260.0°	– –	180 12.4	280 19.3
550° 287.8°	– –	130 9.0	230 15.9

Malleable Iron Threaded Fittings
Pressure - Temperature Ratings

Temperature	Pressure Class 150	Class 300 Sizes ¼"–1" (6-25mm)	Class 300 Sizes 1¼"–2" (32-51mm)	Class 300 Sizes 2½"–3" (64-76mm)
°F/°C	PSI/bar	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	2000 137.9	1500 103.4	1000 68.9
200° 93.3°	265 18.3	1785 123.1	1350 93.1	910 62.7
250° 121.1°	225 15.5	1575 108.6	1200 82.7	825 56.9
300° 148.9°	185 12.8	1360 93.8	1050 72.4	735 50.7
350° 176.7°	150 10.3	1150 79.3	900 62.1	650 44.8
400° 204.4°	– –	935 64.5	750 51.7	560 38.6
450° 232.2°	– –	725 50.0	600 41.4	475 32.8
500° 260.0°	– –	510 35.2	450 31.0	385 26.5
550° 287.8°	– –	300 20.7	300 20.7	300 20.7

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Note:
Unions with Copper or Copper Alloy seats are not intended for use where temperature exceeds 450°F.

PROJECT INFORMATION	APPROVAL STAMP
Project:	☐ Approved
Address:	☐ Approved as noted
Contractor:	☐ Not approved
Engineer:	Remarks:
Submittal Date:	
Notes 1:	
Notes 2:	

RSN:1827437
LT-24-2459794

ASC Engineered Solutions

Reducer (Class 150 Standard)
Fig. 1125

Standards and Specifications

Malleable Iron Fittings

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3
Class 300/PN 50	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3

Malleable Iron Unions

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 250	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 300/PN 50	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39

Note:

* ASTM B633. Type I, SC 4, may be supplied as alternate zinc coating per applicable ASME B16 product standard.

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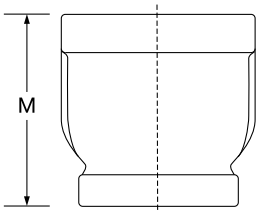
ASC Engineered Solutions

Reducer (Class 150 Standard)
Fig. 1125



Size		M	Unit Weight	
			Black	Galvanized
NPS/DN	NPS/DN	In./mm	Lbs./kg	Lbs./kg
¼ 8	⅛ 6	1 25	0.07 0.03	0.07 0.03
⅜ 10	⅛ 6	1 ⅛ 29	0.11 0.05	0.11 0.05
	¼ 8		0.11 0.05	0.11 0.05
½ 15	⅛ 6	1 ¼ 32	0.14 0.06	0.14 0.06
	¼* 8		0.15 0.07	0.15 0.07
	⅜ 10		0.17 0.08	0.17 0.08
¾ 20	⅛ 6	1 7/16 37	0.24 0.11	0.24 0.11
	¼ 8		0.22 0.10	0.22 0.10
	⅜ 10		0.25 0.11	0.25 0.11
	½* 15		0.27 0.12	0.27 0.12
1 25	¼ 8	1 11/16 43	0.35 0.16	0.35 0.16
	⅜ 10		0.35 0.16	0.35 0.16

Size		M	Unit Weight	
			Black	Galvanized
NPS/DN	NPS/DN	In./mm	Lbs./kg	Lbs./kg
1 25	½ 15	1 11/16 43	0.39 0.18	0.39 0.18
	¾* 20		0.43 0.20	0.43 0.20
1 ¼ 32	½ 15	2 1/16 52	0.61 0.28	0.61 0.28
	¾ 20		0.64 0.29	0.64 0.29
	1 25		0.68 0.31	0.68 0.31
1 ½ 40	½ 15	2 5/16 59	0.78 0.35	0.78 0.35
	¾ 20		0.88 0.40	0.88 0.40
	1 25		0.88 0.40	0.88 0.40
	1 ¼ 32		0.90 0.41	0.90 0.41
2 50	½ 15	2 13/16 73	1.30 0.59	1.30 0.59
	¾ 20		1.34 0.61	1.34 0.61
	1 25		1.40 0.63	1.40 0.63

Notes:

*Sizes ½ x ¼, ¾ x ½ and 1 x ¾ do not have bands at the reducing end.

See first page for pressure-temperature ratings. Galvanized weights may vary.
Please contact your ASC Engineered Solutions™ Representative if you need verification.

All Elbows & Tees ⅜" (10 DN) and Larger are 100% Gas Tested at a Minimum of 100 PSI. (6.9 bar)

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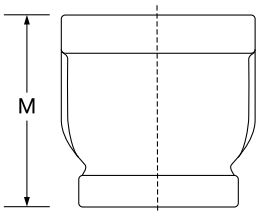
ASC Engineered Solutions

Reducer (Class 150 Standard)
Fig. 1125

(Continued)



Size		M	Unit Weight		Size		M	Unit Weight	
			Black	Galvanized				Black	Galvanized
NPS/DN	NPS/DN	In./mm	Lbs./kg	Lbs./kg	NPS/DN	NPS/DN	In./mm	Lbs./kg	Lbs./kg
2 50	1¼ 32	2 13/16 73	1.53 0.69	1.53 0.69	3½ 90	2 50	4 102	4.32 1.96	4.32 1.96
	1½ 40		1.55 0.70	1.55 0.70		2½ 65		4.72 2.14	4.72 2.14
2½ 65	1 25	3¼ 83	2.12 0.96	2.12 0.96		3 80		4.99 2.26	4.99 2.26
	1¼ 32		2.09 0.95	2.09 0.95		1½ 40		4.90 2.22	4.90 2.22
	1½ 40		2.09 0.95	2.09 0.95		2 50		5.10 2.31	5.10 2.31
	2 50		2.51 1.14	2.51 1.14	4 100	2½ 65	4 3/8 111	5.93 2.69	5.93 2.69
3 80	1 25	3 11/16 94	3.16 1.43	3.16 1.43		3 80		6.55 2.97	6.55 2.97
	1¼ 32		2.99 1.36	2.99 1.36		3½ 90		6.30 2.86	6.30 2.86
	1½ 40		3.30 1.50	3.30 1.50	5 125	4 100	4 9/16 116	9.57 4.34	9.57 4.34
	2 50		3.25 1.47	3.25 1.47	6 150	4 100	4 13/16 124	10.30 4.67	10.30 4.67
	2½ 65		3.31 1.50	3.31 1.50					

Notes:

*Sizes ½ x ¼, ¾ x ½ and 1 x ¾ do not have bands at the reducing end.

See first page for pressure–temperature ratings. Galvanized weights may vary.
Please contact your ASC Engineered Solutions™ Representative if you need verification.

All Elbows & Tees ⅜" (10 DN) and Larger are 100% Gas Tested at a Minimum of 100 PSI. (6.9 bar)

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Fig. 1125 Reducer (Class 150 Standard)

General Assembly of Threaded Fittings

1 Inspect both male and female components prior to assembly.

- Threads should be free from mechanical damage, dirt, chips and excess cutting oil.
- Clean or replace components as necessary.

2 Application of thread sealant

- Use a thread sealant that is fast drying, sets-up to a semi hard condition and is vibration resistant. Alternately, an anaerobic sealant may be utilized.
- Throroughly mix the thread sealant prior to application.
- Apply a thick even coat to the male threads only. Best application is achieved with a brush stiff enough to force sealant down to the root of the threads.

3 Joint Makeup

- For sizes up to and including 2" pipe, wrench tight makeup is considered three full turns past handtight. Handtight engagement for ½" through 2" thread varies from 4½ turns to 5 turns.
- For 2½" through 4" sizes, wrench tight makeup is considered two full turns past handtight. Handtight engagement for 2½" through 4" thread varies from 5½ turns to 6¾ turns.

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ASC Engineered Solutions

Couplings & Cap (Class 150 Standard)

- ☐ **Fig. 1121** Right Hand Coupling
- ☐ **Fig. 1122** Right & Left Coupling
- ☐ **Fig. 1124** Cap

Fig. 1122

Fig. 1121

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Fig. 1124

ASC Engineered Solutions™ offers the broadest line of malleable iron fitting sizes in both black and galvanized finishes. Every fitting is manufactured and tested to meet ASC's strict quality standards. All Anvil Class 150 Malleable Iron Fittings conform to ASME B16.3 and unions conform to ASME B16.39. All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

For Listings/Approval Details and Limitations, visit our website at www.asc-es.com or contact an ASC Engineered Solutions™ Representative.

See following page for standards and specifications.

Malleable Iron Threaded Pipe Unions Pressure - Temperature Ratings

Temperature	Pressure		
	Class 150	Class 250	Class 300
°F/°C	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	500 34.5	600 41.4
200° 93.3°	265 18.3	455 31.4	550 37.9
250° 121.1°	225 15.5	405 27.9	505 34.8
300° 148.9°	185 12.8	360 24.8	460 31.7
350° 176.7°	150 10.3	315 21.7	415 28.6
400° 204.4°	110 7.6	270 18.6	370 25.5
450° 232.2°	75 5.2	225 15.5	325 22.4
500° 260.0°	– –	180 12.4	280 19.3
550° 287.8°	– –	130 9.0	230 15.9

Malleable Iron Threaded Fittings Pressure - Temperature Ratings

Temperature	Pressure			
	Class 150	Class 300		
		Sizes ¼"–1" (6-25mm)	Sizes 1¼"–2" (32-51mm)	Sizes 2½"–3" (64-76mm)
°F/°C	PSI/bar	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	2000 137.9	1500 103.4	1000 68.9
200° 93.3°	265 18.3	1785 123.1	1350 93.1	910 62.7
250° 121.1°	225 15.5	1575 108.6	1200 82.7	825 56.9
300° 148.9°	185 12.8	1360 93.8	1050 72.4	735 50.7
350° 176.7°	150 10.3	1150 79.3	900 62.1	650 44.8
400° 204.4°	– –	935 64.5	750 51.7	560 38.6
450° 232.2°	– –	725 50.0	600 41.4	475 32.8
500° 260.0°	– –	510 35.2	450 31.0	385 26.5
550° 287.8°	– –	300 20.7	300 20.7	300 20.7

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Note:
Unions with Copper or Copper Alloy seats are not intended for use where temperature exceeds 450°F.

PROJECT INFORMATION	APPROVAL STAMP
Project:	☐ Approved
Address:	☐ Approved as noted
Contractor:	☐ Not approved
Engineer:	Remarks:
Submittal Date:	
Notes 1:	
Notes 2:	

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LT-24-2459794

ASC Engineered Solutions

Couplings & Cap (Class 150 Standard)
Fig. 1121, 1122, 1124

Standards and Specifications

Malleable Iron Fittings

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3
Class 300/PN 50	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3

Malleable Iron Unions

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 250	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 300/PN 50	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39

Note:

* ASTM B633. Type I, SC 4, may be supplied as alternate zinc coating per applicable ASME B16 product standard.

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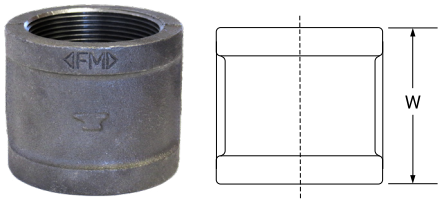
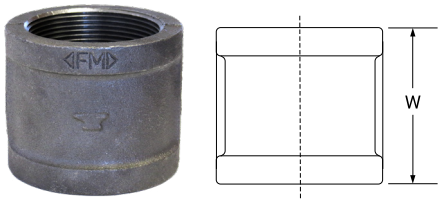
Fig. 1121
Coupling (Class 150 Standard)



Size	W	Unit Weight		Size	W	Unit Weight	
		Black	Galvanized			Black	Galvanized
NPS/DN	In./mm	Lbs./kg	Lbs./kg	NPS/DN	In./mm	Lbs./kg	Lbs./kg
1/8*	15/16	0.06	0.06	1 1/4	1 15/16	0.75	0.75
6	24	0.03	0.03	32	49	0.34	0.34
1/4	1 1/16	0.09	0.09	1 1/2	2 1/8	1.00	1.00
8	27	0.04	0.04	40	54	0.45	0.45
3/8	1 3/16	0.13	0.13	2	2 1/2	1.45	1.45
10	30	0.06	0.06	50	64	0.66	0.66
1/2	1 5/16	0.20	0.20	2 1/2	2 7/8	2.40	2.40
15	33	0.09	0.09	65	73	1.09	1.09
3/4	1 1/2	0.30	0.30	3	3 3/16	3.30	3.30
20	38	0.14	0.14	80	81	1.50	1.50
1	1 11/16	0.48	0.48	4	3 11/16	5.72	5.72
25	43	0.22	0.22	100	94	2.59	2.59

Fig. 1122
Right & Left Coupling
(Class 150 Standard)



Size	W	Unit Weight		Size	W	Unit Weight	
		Black	Galvanized			Black	Galvanized
NPS/DN	In./mm	Lbs./kg	Lbs./kg	NPS/DN	In./mm	Lbs./kg	Lbs./kg
1/2	1 5/16	0.20	0.20	1 1/4	1 15/16	0.75	0.75
15	33	0.09	0.09	32	49	0.34	0.34
3/4	1 1/2	0.30	0.30	1 1/2	2 1/8	1.00	1.00
20	38	0.14	0.14	40	54	0.45	0.45
1	1 11/16	0.48	0.48	2	2 1/2	1.45	1.45
25	43	0.22	0.22	50	64	0.66	0.66

Note:

*Offered in steel only.

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All Elbows & Tees 3/8" (10 DN) and Larger are 100% Gas Tested at a Minimum of 100 PSI. (6.9 bar)

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Fig. 1124
Cap (Class 150 Standard)

Size	Unit Weight		Size	Unit Weight	
	Black	Galvanized		Black	Galvanized
NPS/DN	Lbs./kg	Lbs./kg	NPS/DN	Lbs./kg	Lbs./kg
½ 15	0.12 0.05	0.12 0.05	2½ 65	1.75 0.79	1.75 0.79
¾ 20	0.22 0.10	0.22 0.10	3 80	2.62 1.19	2.62 1.19
1 25	0.38 0.17	0.38 0.17	3½ 90	3.19 1.45	3.19 1.45
1¼ 32	0.58 0.26	0.58 0.26	4 100	4.54 2.06	4.54 2.06
1½ 40	0.73 0.33	0.73 0.33	5 125	6.45 2.93	6.45 2.93
2 50	1.13 0.51	1.13 0.51	6 150	10.00 4.54	10.00 4.54

Note:

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All Elbows & Tees ⅜" (10 DN) and Larger are 100% Gas Tested at a Minimum of 100 PSI. (6.9 bar)

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Fig. 1121, 1122, 1124 Couplings & Cap (Class 150 Standard)

General Assembly of Threaded Fittings

1 Inspect both male and female components prior to assembly.

- Threads should be free from mechanical damage, dirt, chips and excess cutting oil.
- Clean or replace components as necessary.

2 Application of thread sealant

- Use a thread sealant that is fast drying, sets-up to a semi hard condition and is vibration resistant. Alternately, an anaerobic sealant may be utilized.
- Throroughly mix the thread sealant prior to application.
- Apply a thick even coat to the male threads only. Best application is achieved with a brush stiff enough to force sealant down to the root of the threads.

3 Joint Makeup

- For sizes up to and including 2" pipe, wrench tight makeup is considered three full turns past handtight. Handtight engagement for ½" through 2" thread varies from 4½ turns to 5 turns.
- For 2½" through 4" sizes, wrench tight makeup is considered two full turns past handtight. Handtight engagement for 2½" through 4" thread varies from 5½ turns to 6¾ turns.

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Tee & Cross (Class 150 Standard)

☐ **Fig. 1106** Street or Service Tee (Straight)
☐ **Fig. 1106R** Street or Service Tee (Reducing)
☐ **Fig.1107** Cross

Fig. 1106

Fig. 1106R

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Fig. 1107

ASC Engineered Solutions™ offers the broadest line of malleable iron fitting sizes in both black and galvanized finishes. Every fitting is manufactured and tested to meet ASC's strict quality standards. All Anvil Class 150 Malleable Iron Fittings conform to ASME B16.3 and unions conform to ASME B16.39. All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

For Listings/Approval Details and Limitations, visit our website at www.asc-es.com or contact an ASC Engineered Solutions™ Representative.

See following page for standards and specifications.

Anvil Class 150/300 Malleable Iron Fittings conform to ASME B16.3 and Unions conform to ASME B16.39.

All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

Malleable Iron Threaded Pipe Unions
Pressure - Temperature Ratings

Temperature	Pressure		
	Class 150	Class 250	Class 300
°F/°C	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	500 34.5	600 41.4
200° 93.3°	265 18.3	455 31.4	550 37.9
250° 121.1°	225 15.5	405 27.9	505 34.8
300° 148.9°	185 12.8	360 24.8	460 31.7
350° 176.7°	150 10.3	315 21.7	415 28.6
400° 204.4°	110 7.6	270 18.6	370 25.5
450° 232.2°	75 5.2	225 15.5	325 22.4
500° 260.0°	– –	180 12.4	280 19.3
550° 287.8°	– –	130 9.0	230 15.9

Malleable Iron Threaded Fittings
Pressure - Temperature Ratings

Temperature	Pressure			
	Class 150	Class 300		
		Sizes ¼"–1" (6-25mm)	Sizes 1¼"–2" (32-51mm)	Sizes 2½"–3" (64-76mm)
°F/°C	PSI/bar	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	2000 137.9	1500 103.4	1000 68.9
200° 93.3°	265 18.3	1785 123.1	1350 93.1	910 62.7
250° 121.1°	225 15.5	1575 108.6	1200 82.7	825 56.9
300° 148.9°	185 12.8	1360 93.8	1050 72.4	735 50.7
350° 176.7°	150 10.3	1150 79.3	900 62.1	650 44.8
400° 204.4°	– –	935 64.5	750 51.7	560 38.6
450° 232.2°	– –	725 50.0	600 41.4	475 32.8
500° 260.0°	– –	510 35.2	450 31.0	385 26.5
550° 287.8°	– –	300 20.7	300 20.7	300 20.7

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Note:
Unions with Copper or Copper Alloy seats are not intended for use where temperature exceeds 450°F.

PROJECT INFORMATION	APPROVAL STAMP
Project:	☐ Approved
Address:	☐ Approved as noted
Contractor:	☐ Not approved
Engineer:	Remarks:
Submittal Date:	
Notes 1:	
Notes 2:	

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ASC Engineered Solutions

Tee & Cross (Class 150 Standard)
Fig. 1106, 1106R, 1107

Standards and Specifications

Malleable Iron Fittings

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3
Class 300/PN 50	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3

Malleable Iron Unions

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 250	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 300/PN 50	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39

Note:

* ASTM B633. Type I, SC 4, may be supplied as alternate zinc coating per applicable ASME B16 product standard.

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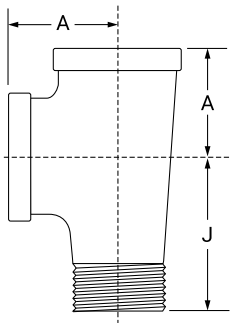
Fig. 1106, 1106R

Straight Street or Service Tee (Class 150 Standard)
Reducing Street or Service Tee (Class 150 Standard)



Size	A	J	Unit Weight	
			Black	Galvanized
NPS/DN	In./mm	In./mm	Lbs./kg	Lbs./kg
1/4 8	1 3/16 30	1 3/16 30	0.15 0.07	0.15 0.07
3/8 10	1 5/16 33	1 7/16 37	0.24 0.11	0.24 0.11
1/2 15	1 1/8 29	1 5/8 41	0.34 0.15	0.34 0.15
3/4 20	1 5/16 33	1 7/8 48	0.61 0.28	0.61 0.28
1 25	1 1/2 38	2 1/8 54	0.96 0.44	0.96 0.44
1 1/4 32	1 3/4 44	2 7/16 62	1.39 0.63	1.39 0.63
1 1/2 40	1 15/16 49	2 11/16 68	1.93 0.88	1.93 0.88
2 50	2 1/4 57	3 1/4 83	3.16 1.43	3.16 1.43

Size female run x male run x outlet	Run		Outlet	Unit Weight	
	A	J	A	Black	Galvanized
NPS/DN	In./mm	In./mm	In./mm	Lbs./kg	Lbs./kg
1 1/4 x 1 x 1 1/4 32 x 25 x 32	1 3/4 44	2 5/16 59	1 3/4 44	1.34 0.61	1.34 0.61

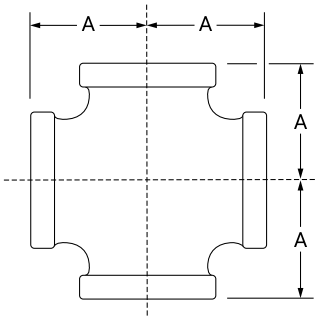
Notes:

See first page for pressure-temperature ratings. Galvanized weights may vary.
Please contact your ASC Engineered Solutions™ Representative if you need verification.

All elbows and tees 3/8" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

Fig. 1107

Cross (Class 150 Standard)



Size	A	Unit Weight	
		Black	Galvanized
NPS/DN	In./mm	Lbs./kg	Lbs./kg
1/8 6	11/16 17	0.12 0.05	0.12 0.05
1/4 8	13/16 22	0.18 0.08	0.18 0.08
3/8 10	15/16 24	0.28 0.13	0.28 0.13
1/2 15	1 1/8 29	0.42 0.19	0.42 0.19
3/4 20	1 5/16 33	0.69 0.31	0.69 0.31
1 25	1 1/2 38	1.12 0.51	1.12 0.51
1 1/4 32	1 3/4 44	1.44 0.65	1.44 0.65
1 1/2 40	1 15/16 49	1.98 0.90	1.98 0.90
2 50	2 1/4 57	3.30 1.50	3.30 1.50
2 1/2 65	2 11/16 68	5.90 2.68	5.90 2.68
3 80	3 1/16 78	7.94 3.60	7.94 3.60
4 100	3 13/16 98	13.50 6.12	13.50 6.12

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Fig. 1106, 1106R, 1107 Tee & Cross (Class 150 Standard)

General Assembly of Threaded Fittings

1 Inspect both male and female components prior to assembly.

- Threads should be free from mechanical damage, dirt, chips and excess cutting oil.
- Clean or replace components as necessary.

2 Application of thread sealant

- Use a thread sealant that is fast drying, sets-up to a semi hard condition and is vibration resistant. Alternately, an anaerobic sealant may be utilized.
- Throroughly mix the thread sealant prior to application.
- Apply a thick even coat to the male threads only. Best application is achieved with a brush stiff enough to force sealant down to the root of the threads.

3 Joint Makeup

- For sizes up to and including 2" pipe, wrench tight makeup is considered three full turns past handtight. Handtight engagement for ½" through 2" thread varies from 4½ turns to 5 turns.
- For 2½" through 4" sizes, wrench tight makeup is considered two full turns past handtight. Handtight engagement for 2½" through 4" thread varies from 5½ turns to 6¾ turns.

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ASC Engineered Solutions

Reducing Tee (Class 150 Standard)
Fig. 1105R

c UL us LISTED FM APPROVED

ASC Engineered Solutions™ offers the broadest line of malleable iron fitting sizes in both black and galvanized finishes. Every fitting is manufactured and tested to meet ASC's strict quality standards. All Anvil Class 150 Malleable Iron Fittings conform to ASME B16.3 and unions conform to ASME B16.39. All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

For Listings/Approval Details and Limitations, visit our website at www.asc-es.com or contact an ASC Engineered Solutions™ Representative.

See following page for standards and specifications.

Malleable Iron Threaded Pipe Unions
Pressure - Temperature Ratings

Temperature	Pressure		
	Class 150	Class 250	Class 300
°F/°C	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	500 34.5	600 41.4
200° 93.3°	265 18.3	455 31.4	550 37.9
250° 121.1°	225 15.5	405 27.9	505 34.8
300° 148.9°	185 12.8	360 24.8	460 31.7
350° 176.7°	150 10.3	315 21.7	415 28.6
400° 204.4°	110 7.6	270 18.6	370 25.5
450° 232.2°	75 5.2	225 15.5	325 22.4
500° 260.0°	– –	180 12.4	280 19.3
550° 287.8°	– –	130 9.0	230 15.9

Malleable Iron Threaded Fittings
Pressure - Temperature Ratings

Temperature	Pressure			
	Class 150	Class 300		
		Sizes ¼"–1" (6-25mm)	Sizes 1¼"–2" (32-51mm)	Sizes 2½"–3" (64-76mm)
°F/°C	PSI/bar	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	2000 137.9	1500 103.4	1000 68.9
200° 93.3°	265 18.3	1785 123.1	1350 93.1	910 62.7
250° 121.1°	225 15.5	1575 108.6	1200 82.7	825 56.9
300° 148.9°	185 12.8	1360 93.8	1050 72.4	735 50.7
350° 176.7°	150 10.3	1150 79.3	900 62.1	650 44.8
400° 204.4°	– –	935 64.5	750 51.7	560 38.6
450° 232.2°	– –	725 50.0	600 41.4	475 32.8
500° 260.0°	– –	510 35.2	450 31.0	385 26.5
550° 287.8°	– –	300 20.7	300 20.7	300 20.7

ANVIL
An ASC Engineered Solution

Note:
Unions with Copper or Copper Alloy seats are not intended for use where temperature exceeds 450°F.

PROJECT INFORMATION	APPROVAL STAMP
Project:	☐ Approved
Address:	☐ Approved as noted
Contractor:	☐ Not approved
Engineer:	Remarks:
Submittal Date:	
Notes 1:	
Notes 2:	

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ASC Engineered Solutions

Reducing Tee (Class 150 Standard)
Fig. 1105R

Standards and Specifications

Malleable Iron Fittings

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3
Class 300/PN 50	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3

Malleable Iron Unions

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 250	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 300/PN 50	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39

Note:

* ASTM B633. Type I, SC 4, may be supplied as alternate zinc coating per applicable ASME B16 product standard.

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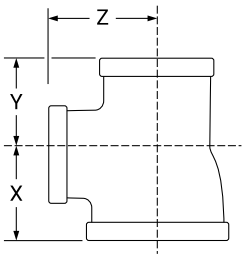
ASC Engineered Solutions

Reducing Tee (Class 150 Standard)
Fig. 1105R



Size			X	Y	Z	Unit Weight	
						Black	Galv.
NPS/DN	NPS/DN	NPS/DN	In./mm	In./mm	In./mm	Lbs./kg	Lbs./kg
1/8 6	1/8 6	1/4 8	3/4 19	3/4 19	3/4 19	0.12 0.05	0.12 0.05
1/4 8	1/4 8	1/8 6	3/4 19	3/4 19	3/4 19	0.13 0.06	0.13 0.06
		3/8 10	15/16 24	15/16 24	7/8 22	0.19 0.09	0.19 0.09
3/8 10	1/4 8	1/4 8	7/8 22	13/16 22	15/16 24	0.19 0.09	0.19 0.09
		3/8 10	15/16 24	15/16 24	15/16 24	0.21 0.10	0.21 0.10
	3/8 10	1/4 8	7/8 22	7/8 22	15/16 24	0.21 0.10	0.21 0.10
		1/2 15	1 1/16 27	1 1/16 27	1 1/16 27	0.27 0.12	0.27 0.12
1/2 15	1/4 8	1/2 15	1 1/8 29	15/16 24	1 1/8 29	0.29 0.13	0.29 0.13
	3/8 10	3/8 10	1 1/16 27	1 25	1 1/16 27	0.28 0.13	0.28 0.13
		1/2 15	1 1/8 29	1 1/16 27	1 1/8 29	0.33 0.15	0.33 0.15
	1/2 15	1/4 8	1 25	1 25	1 25	0.27 0.12	0.27 0.12
		3/8 10	1 1/16 27	1 1/16 27	1 1/16 27	0.30 0.14	0.3 0.14
		3/4 20	1 1/4 32	1 1/4 32	1 3/16 30	0.45 0.20	0.45 0.20
		1 25	1 3/8 35	1 3/8 35	1 1/4 32	0.55 0.25	0.55 0.25
	1/4 8	3/4 20	1 5/16 33	1 1/8 29	1 5/16 33	0.45 0.20	0.45 0.20
	3/8 10	3/8 10	1 1/8 29	15/16 24	1 1/8 29	0.36 0.16	– –
		3/4 20	1 5/16 33	1 1/8 29	1 5/16 33	0.46 0.21	0.46 0.21
	1/2 15	1/2 15	1 3/16 30	1 1/8 29	1 1/4 32	0.43 0.20	0.43 0.20
		3/4 20	1 5/16 33	1 1/4 32	1 5/16 33	0.51 0.23	0.51 0.23
3/4 20		1/4 8	1 1/16 27	1 1/16 27	1 1/8 29	0.38 0.17	0.38 0.17
	3/4 20	3/8 10	1 1/8 29	1 1/8 29	1 1/8 29	0.42 0.19	0.42 0.19
		1/2 15	1 3/16 22	1 3/16 30	1 1/4 32	0.47 0.21	0.47 0.21
		1 25	1 7/16 37	1 7/16 37	1 3/8 35	0.62 0.28	0.62 0.28
		1 1/4 32	1 5/8 41	1 5/8 41	1 7/16 37	0.90 0.41	0.90 0.41
	1/4 8	1 25	1 1/2 38	1 5/16 33	1 1/2 38	0.69 0.31	0.69 0.31
	1/2 15	1/2 15	1 1/4 32	1 1/8 29	1 3/8 35	0.70 0.32	0.70 0.32
1 25		3/4 20	1 3/8 35	1 1/4 32	1 7/16 37	0.56 0.25	0.56 0.25
		1 25	1 1/2 38	1 3/8 35	1 1/2 38	0.76 0.34	0.76 0.34

Notes:

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All elbows and tees 3/8" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

See additional sizes on following page.

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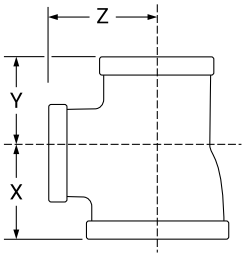
ASC Engineered Solutions

Reducing Tee (Class 150 Standard)
Fig. 1105R

(Continued)



Size			X	Y	Z	Unit Weight	
						Black	Galv.
NPS/DN	NPS/DN	NPS/DN	In./mm	In./mm	In./mm	Lbs./kg	Lbs./kg
1 25	¾ 20	½ 15	1 ¼ 32	1 3/16 30	1 3/8 35	0.59 0.27	0.59 0.27
		¾ 20	1 3/8 35	1 5/16 33	1 7/16 37	0.74 0.34	0.74 0.34
		1 25	1 ½ 38	1 7/16 37	1 ½ 38	0.78 0.35	0.78 0.35
	1 25	¼ 8	1 1/8 29	1 1/8 29	1 ¼ 44	0.53 0.24	0.53 0.24
		⅜ 10	1 3/16 30	1 3/16 30	1 ¼ 32	0.60 0.27	0.60 0.27
		½ 15	1 ¼ 32	1 ¼ 32	1 3/8 35	0.70 0.32	0.70 0.32
		¾ 20	1 3/8 35	1 3/8 35	1 7/16 37	0.82 0.37	0.82 0.37
		1 ¼ 32	1 11/16 43	1 11/16 43	1 9/16 40	0.92 0.42	0.92 0.42
		1 ½ 40	1 13/16 47	1 13/16 46	1 5/8 41	1.19 0.54	1.19 0.54
		2 50	2 51	2 51	1 ¾ 44	1.63 0.74	1.63 0.74
1 ¼ 32	½ 15	1 25	1 9/16 40	1 3/8 35	1 11/16 43	0.87 0.39	0.87 0.39
		1 ¼ 32	1 ¾ 44	1 9/16 40	1 ¾ 44	1.04 0.47	1.04 0.47
	¾ 20	¾ 20	1 7/16 37	1 5/16 33	1 5/8 41	0.86 0.39	0.86 0.39
		1 25	1 9/16 40	1 7/16 37	1 11/16 43	0.91 0.41	0.91 0.41
1 ¼ 32	¾ 20	1 ¼ 32	1 ¾ 44	1 5/8 41	1 ¾ 44	1.04 0.47	1.04 0.47
	1 25	½ 15	1 3/8 35	1 ¼ 32	1 9/16 40	0.76 0.34	0.76 0.34
		¾ 20	1 7/16 37	1 3/8 35	1 5/8 41	0.87 0.39	0.87 0.39
		1 25	1 9/16 40	1 ½ 38	1 11/16 43	1.11 0.50	1.11 0.50
		1 ¼ 32	1 ¾ 44	1 11/16 43	1 ¾ 44	1.13 0.51	1.13 0.51
1 ¼ 32	1 25	⅜ 10	1 ¼ 32	1 ¼ 32	1 7/16 37	0.86 0.39	0.86 0.39
		½ 15	1 3/8 35	1 3/8 35	1 9/16 40	0.98 0.44	0.98 0.44
		¾ 20	1 7/16 37	1 7/16 37	1 5/8 41	1.07 0.49	1.07 0.49
		1 25	1 9/16 40	1 9/16 40	1 11/16 43	1.18 0.54	1.18 0.54
		1 ½ 40	1 7/8 48	1 7/8 48	1 13/16 47	1.45 0.66	1.45 0.66
		2 50	2 1/8 54	2 1/8 54	1 7/8 48	1.70 0.77	1.70 0.77
1 ½ 40	½ 15	1 ¼ 32	1 ½ 40	1 15/16 49	1 11/16 43	1.33 0.60	1.33 0.60
	¾ 20	¾ 20	1 ½ 38	1 5/16 33	1 ¾ 44	1.00 0.45	1.00 0.45
		1 ½ 40	1 15/16 49	1 ¾ 44	1 15/16 49	1.41 0.64	1.41 0.64

Notes:

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

See additional sizes on previous and following page.

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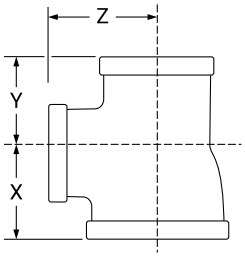
ASC Engineered Solutions

Reducing Tee (Class 150 Standard)
Fig. 1105R

(Continued)



Size			X	Y	Z	Unit Weight	
						Black	Galv.
NPS/DN	NPS/DN	NPS/DN	In./mm	In./mm	In./mm	Lbs./kg	Lbs./kg
		1 25	1 5/8 41	1 1/2 38	1 13/16 47	1.14 0.52	1.14 0.52
	1 25	1 1/4 32	1 13/16 47	1 11/16 43	1 7/8 48	1.30 0.59	1.30 0.59
		1 1/2 40	1 15/16 49	1 13/16 47	1 15/16 49	1.50 0.68	1.50 0.68
		1/2 15	1 7/16 37	1 3/8 35	1 11/16 43	1.05 0.48	1.05 0.48
		3/4 20	1 1/2 38	1 7/16 37	1 3/4 44	1.08 0.49	1.08 0.49
	1 1/4 32	1 25	1 5/8 41	1 9/16 40	1 13/16 47	1.26 0.57	1.26 0.57
1 1/2 40		1 1/4 32	1 13/16 47	1 3/4 44	1 7/8 48	1.52 0.69	1.52 0.69
		1 1/2 40	1 15/16 49	1 7/8 48	1 15/16 49	1.50 0.68	1.50 0.68
		1/2 15	1 7/16 37	1 7/16 37	1 11/16 43	1.19 0.54	1.19 0.54
		3/4 20	1 1/2 38	1 1/2 38	1 3/4 44	1.60 0.73	1.60 0.73
	1 1/2 40	1 25	1 5/8 41	1 5/8 41	1 13/16 47	1.45 0.66	1.45 0.66
		1 1/4 32	1 13/16 47	1 13/16 47	1 7/8 48	1.45 0.66	1.45 0.66
		2 50	2 3/16 56	2 3/16 56	2 51	1.86 0.84	1.86 0.84
2 50	1/2 15	2 50	2 1/4 57	1 7/8 48	2 1/4 57	2.15 0.98	2.15 0.98

Size			X	Y	Z	Unit Weight	
						Black	Galv.
NPS/DN	NPS/DN	NPS/DN	In./mm	In./mm	In./mm	Lbs./kg	Lbs./kg
	3/4 20	2 50	2 1/4 57	1 15/16 49	2 1/4 57	2.00 0.91	2.00 0.91
	1 25	2 50	2 1/4 57	2 51	2 1/4 57	2.14 0.97	2.14 0.97
		1 1/4 32	1 7/8 48	1 3/4 44	2 1/8 54	1.72 0.78	1.72 0.78
	1 1/4 32	1 1/2 40	2 51	1 7/8 48	2 3/16 56	1.85 0.84	1.85 0.84
		2 50	2 1/4 57	2 1/8 54	2 1/4 57	2.20 1.00	2.20 1.00
		1 25	1 3/4 44	1 5/8 41	2 51	1.57 0.71	1.57 0.71
2 50	1 1/2 40	1 1/4 32	1 7/8 48	1 13/16 47	2 1/8 54	1.76 0.80	1.76 0.80
		1 1/2 40	2 51	1 15/16 49	2 3/16 56	1.95 0.88	1.95 0.88
		2 50	2 1/4 57	2 3/16 56	2 1/4 57	2.24 1.02	2.24 1.02
		1/2 15	1 1/2 38	1 1/2 38	1 7/8 48	1.65 0.75	1.65 0.75
		3/4 20	1 5/8 41	1 5/8 41	2 51	1.87 0.85	1.87 0.85
	2 50	1 25	1 3/4 44	1 3/4 44	2 51	1.76 0.80	1.76 0.80
		1 1/4 32	1 7/8 48	1 7/8 48	2 1/8 54	2.35 1.07	2.35 1.07
		1 1/2 40	2 51	2 51	2 3/16 56	2.55 1.16	2.55 1.16

Notes:

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All elbows and tees 3/8" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

See additional sizes on previous and following page.

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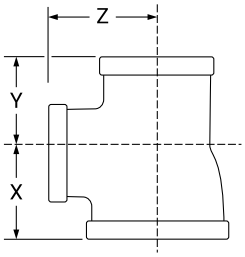
ASC Engineered Solutions

Reducing Tee (Class 150 Standard)
Fig. 1105R

(Continued)



Size			X	Y	Z	Unit Weight	
						Black	Galv.
NPS/DN	NPS/DN	NPS/DN	In./mm	In./mm	In./mm	Lbs./kg	Lbs./kg
2 50	2 50	2½ 65	2⅝ 67	2⅝ 67	2⅜ 60	3.50 1.59	3.50 1.59
	1½ 40	2 50	2⅜ 60	2³⁄₁₆ 56	2⅝ 67	3.43 1.56	3.43 1.56
		2½ 65	2¹¹⁄₁₆ 68	2½ 64	2¹¹⁄₁₆ 68	3.80 1.72	3.80 1.72
	2 50	2 50	2⅜ 60	2¼ 57	2⅝ 67	3.28 1.49	3.28 1.49
		2½ 65	2¹¹⁄₁₆ 68	2⅝ 67	2¹¹⁄₁₆ 68	4.10 1.86	4.10 1.86
2½ 65	2½ 65	¾ 20	1¾ 44	1¾ 44	2⁵⁄₁₆ 59	2.72 1.23	2.72 1.23
		1 25	1⅞ 48	1⅞ 48	2⅜ 60	2.85 1.29	2.85 1.29
		1¼ 32	2¹⁄₁₆ 52	2¹⁄₁₆ 52	2⁷⁄₁₆ 62	3.36 1.52	3.36 1.52
		1½ 40	2³⁄₁₆ 56	2³⁄₁₆ 56	2½ 64	3.46 1.57	3.46 1.57
		2 50	2⅜ 60	2⅜ 60	2⅝ 67	3.65 1.66	3.65 1.66
		3 80	3 76	3 76	2¹³⁄₁₆ 73	5.82 2.64	5.82 2.64
3 80	2 50	2 50	2½ 64	2¼ 57	2⅞ 73	4.50 2.04	4.50 2.04
		3 80	3⅛ 79	2⅞ 73	3⅛ 79	5.80 2.63	5.80 2.63

Size			X	Y	Z	Unit Weight	
						Black	Galv.
NPS/DN	NPS/DN	NPS/DN	In./mm	In./mm	In./mm	Lbs./kg	Lbs./kg
3 80	2½ 65	2 50	2½ 64	2⅜ 60	2⅞ 73	4.80 2.18	4.80 2.18
		2½ 65	2¹³⁄₁₆ 73	2¹¹⁄₁₆ 68	3 76	5.80 2.63	5.80 2.63
	3 80	¾ 20	1⅞ 48	1⅞ 48	2⅝ 67	4.03 1.83	4.03 1.83
		1 25	2 51	2 51	2⅝ 67	4.13 1.87	4.13 1.87
		1¼ 32	2³⁄₁₆ 56	2³⁄₁₆ 56	2¾ 70	4.50 2.04	4.50 2.04
		1½ 40	2⁵⁄₁₆ 59	2⁵⁄₁₆ 59	2¹³⁄₁₆ 73	5.18 2.35	5.18 2.35
		2 50	2½ 64	2½ 64	2⅞ 73	5.70 2.59	5.70 2.59
		2½ 65	2¹³⁄₁₆ 73	2¹³⁄₁₆ 73	3 76	6.09 2.76	6.09 2.76
4 100	3 80	4 100	3¹³⁄₁₆ 98	3⅝ 92	3¹³⁄₁₆ 98	10.40 4.72	10.40 4.72
	4 100	1½ 40	2½ 65	2½ 65	3⅜ 86	7.47 3.39	7.47 3.39
		2 50	2¾ 70	2¾ 70	3⁷⁄₁₆ 87	8.39 3.80	8.39 3.80
		2½ 65	3¹⁄₁₆ 78	3¹⁄₁₆ 78	3½ 89	9.60 4.35	9.60 4.35
		3 80	3⁵⁄₁₆ 84	3⁵⁄₁₆ 84	3⅝ 92	11.02 5.00	11.02 5.00

Notes:

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

See additional sizes on previous page.

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41 of 109
RSN:1827437
LT-24-2459794

Engineered Solutions

Fig. 1105R Reducing Tee (Class 150 Standard)

General Assembly of Threaded Fittings

1 Inspect both male and female components prior to assembly.

- Threads should be free from mechanical damage, dirt, chips and excess cutting oil.
- Clean or replace components as necessary.

2 Application of thread sealant

- Use a thread sealant that is fast drying, sets-up to a semi hard condition and is vibration resistant. Alternately, an anaerobic sealant may be utilized.
- Throroughly mix the thread sealant prior to application.
- Apply a thick even coat to the male threads only. Best application is achieved with a brush stiff enough to force sealant down to the root of the threads.

3 Joint Makeup

- For sizes up to and including 2" pipe, wrench tight makeup is considered three full turns past handtight. Handtight engagement for ½" through 2" thread varies from 4½ turns to 5 turns.
- For 2½" through 4" sizes, wrench tight makeup is considered two full turns past handtight. Handtight engagement for 2½" through 4" thread varies from 5½ turns to 6¾ turns.

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ASC Engineered Solutions

Class 125 (Standard)
Fig. 3387 Cored Plug

c UL us LISTED FM APPROVED

For Listings/Approval Details and Limitations, visit our website at www.asc-es.com or contact an ASC Engineered Solutions™ Sales Representative.

Material Specifications

Dimensions: ASME B16.4

Material: ASTM A126

Finish: Black or Hot Dip Galvanized per ASTM A153 Class A

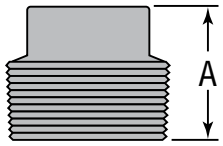
Threads: NPT per ASME B1.20.1

Agency Approvals: All cast iron threaded fittings are UL/ULC Listed and FM Approved.

▲ Pressure – Temperature Ratings in accordance with ASME B16.4 Class 125

Figure 3387 Cored Plug

Nominal Size	Maximum Working Pressure ▲	Dimension A	Approx Wt. Each
In. (mm)	psi (kPa)	In. (mm)	Lbs. (kg)
½* 15	300 2065	0.94 23.87	0.10 0.05
¾ 20	300 2065	1.07 27.17	0.17 0.08
1 25	300 2065	1.25 31.75	0.28 0.13
1¼ 32	300 2065	1.36 34.54	0.44 0.20
1½ 40	300 2065	1.45 36.83	0.62 0.28
2 50	300 2065	1.56 39.62	0.91 0.41



▲ – Working Pressure Ratings are for reference only and based on Sch. 40 pipe. For the latest UL/ULC, and FM pressure ratings versus pipe schedule, please visit asc-es.com or contact your local ASC Engineering Solutions™ Representative.

*Part supplied as Solid Plug.

SCI An ASC Engineered Solution

PROJECT INFORMATION	APPROVAL STAMP
Project:	☐ Approved
Address:	☐ Approved as noted
Contractor:	☐ Not approved
Engineer:	Remarks:
Submittal Date:	
Notes 1:	
Notes 2:	

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LT-24-2459794

ASC Engineered Solutions

Locknut & Flange (Class 150 Standard)

☐ **Fig. 1134** Hex Locknut
☐ **Fig. 1190** Floor Flange (Ductile Iron)

Fig. 1190

Fig. 1134

c UL us LISTED

FM APPROVED

ASC Engineered Solutions™ offers the broadest line of malleable iron fitting sizes in both black and galvanized finishes. Every fitting is manufactured and tested to meet ASC's strict quality standards. All Anvil Class 150 Malleable Iron Fittings conform to ASME B16.3 and unions conform to ASME B16.39. All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

For Listings/Approval Details and Limitations, visit our website at www.asc-es.com or contact an ASC Engineered Solutions™ Representative.

See following page for standards and specifications.

Malleable Iron Threaded Pipe Unions
Pressure - Temperature Ratings

Temperature	Pressure		
	Class 150	Class 250	Class 300
°F/°C	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	500 34.5	600 41.4
200° 93.3°	265 18.3	455 31.4	550 37.9
250° 121.1°	225 15.5	405 27.9	505 34.8
300° 148.9°	185 12.8	360 24.8	460 31.7
350° 176.7°	150 10.3	315 21.7	415 28.6
400° 204.4°	110 7.6	270 18.6	370 25.5
450° 232.2°	75 5.2	225 15.5	325 22.4
500° 260.0°	– –	180 12.4	280 19.3
550° 287.8°	– –	130 9.0	230 15.9

Malleable Iron Threaded Fittings
Pressure - Temperature Ratings

Temperature	Pressure			
	Class 150	Class 300		
		Sizes ¼"–1" (6-25mm)	Sizes 1¼"–2" (32-51mm)	Sizes 2½"–3" (64-76mm)
°F/°C	PSI/bar	PSI/bar	PSI/bar	PSI/bar
-20°–150° -28.9°–65.6°	300 20.7	2000 137.9	1500 103.4	1000 68.9
200° 93.3°	265 18.3	1785 123.1	1350 93.1	910 62.7
250° 121.1°	225 15.5	1575 108.6	1200 82.7	825 56.9
300° 148.9°	185 12.8	1360 93.8	1050 72.4	735 50.7
350° 176.7°	150 10.3	1150 79.3	900 62.1	650 44.8
400° 204.4°	– –	935 64.5	750 51.7	560 38.6
450° 232.2°	– –	725 50.0	600 41.4	475 32.8
500° 260.0°	– –	510 35.2	450 31.0	385 26.5
550° 287.8°	– –	300 20.7	300 20.7	300 20.7

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Note:
Unions with Copper or Copper Alloy seats are not intended for use where temperature exceeds 450°F.

PROJECT INFORMATION	APPROVAL STAMP
Project:	☐ Approved
Address:	☐ Approved as noted
Contractor:	☐ Not approved
Engineer:	Remarks:
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Notes 2:	

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LT-24-2459794

ASC Engineered Solutions

Hex Locknut & Floor Flange (Class 150 Standard)
Fig. 1134, 1190

Standards and Specifications

Malleable Iron Fittings

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3
Class 300/PN 50	ASME B16.3	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.3

Malleable Iron Unions

	Dimensions	Material	Galvanizing*	Thread	Pressure Rating
Class 150/PN 20	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 250	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39
Class 300/PN 50	ASME B16.39	ASTM A197	ASTM A153	ASME B1 20.1	ASME B16.39

Note:

* ASTM B633. Type I, SC 4, may be supplied as alternate zinc coating per applicable ASME B16 product standard.

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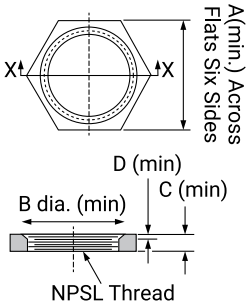
Fig. 1134
Hex Locknut (Class 150 Standard)



Size	Minimum Dimensions				Unit Weight	
	A	B	C	D	Black	Galv.
NPS/DN	In./mm	In./mm	In./mm	In./mm	Lbs./kg	Lbs./kg
•¼ 8	.840 21	.660 17	.250 6	.060 2	0.02 0.01	0.02 0.01
•⅜ 10	1.000 25	.770 20	.280 7	.060 2	0.04 0.02	0.04 0.02
•½ 15	1.180 30	.970 25	.310 8	.060 2	0.06 0.03	0.06 0.03
¾ 20	1.430 36	1.230 31	.340 9	.060 2	0.08 0.04	0.08 0.04
1 25	1.750 44	1.500 38	.380 10	.060 2	0.14 0.06	0.14 0.06
1¼ 32	2.100 53	1.860 47	.420 11	.060 2	0.21 0.10	0.21 0.10
1½ 40	2.350 60	2.120 54	.470 12	.060 2	0.24 0.11	0.24 0.11
2 50	2.880 73	2.630 67	.530 13	.090 2	0.40 0.18	0.40 0.18

Notes:

For additional sizes larger than 2" (50 DN) see Cast Iron page 52.

Not to be used for pressure service.

Supplied in steel only.

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

Fig. 1190
Ductile Iron Floor Flange (Class 150 Standard)

Size	Diam. of Flange	Diam. of Bolt Circle	No. of Holes	Dia. of Holes	Unit Weight	
					Black	Galv.
NPS/DN	In./mm	In./mm	In./mm	In./mm	Lbs./kg	Lbs./kg
¼ 8	2 3/16 56	1 7/8 48	4	¼ 6	0.39 0.18	0.39 0.18
⅜ 10	3 76	2 51	4	¼ 6	0.43 0.20	0.43 0.20
½ 15	3½ 89	2½ 64	4	¼ 6	0.56 0.25	0.56 0.25
¾ 20	3½ 89	2½ 64	4	¼ 6	0.60 0.27	0.60 0.27
1 25	4 102	3 76	4	¼ 6	0.84 0.38	0.84 0.38
1¼ 32	4 102	3 76	4	¼ 6	0.90 0.41	0.90 0.41
1½ 40	4½ 114	3½ 89	4	5/16 8	1.20 0.54	1.20 0.54
2 50	5½ 140	4¼ 108	4	5/16 8	2.03 0.92	2.03 0.92

Notes:

Structural use only.

See first page for pressure-temperature ratings. Galvanized weights may vary. Please contact your ASC Engineered Solutions™ Representative if you need verification.

All elbows and tees ⅜" (10 DN) and larger are 100% gas tested at a minimum of 100 PSI (6.9 bar).

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Fig. 1134, 1190 Hex Locknut & Floor Flange (Class 150 Standard)

General Assembly of Threaded Fittings

1 Inspect both male and female components prior to assembly.

- Threads should be free from mechanical damage, dirt, chips and excess cutting oil.
- Clean or replace components as necessary.

2 Application of thread sealant

- Use a thread sealant that is fast drying, sets-up to a semi hard condition and is vibration resistant. Alternately, an anaerobic sealant may be utilized.
- Throroughly mix the thread sealant prior to application.
- Apply a thick even coat to the male threads only. Best application is achieved with a brush stiff enough to force sealant down to the root of the threads.

3 Joint Makeup

- For sizes up to and including 2" pipe, wrench tight makeup is considered three full turns past handtight. Handtight engagement for ½" through 2" thread varies from 4½ turns to 5 turns.
- For 2½" through 4" sizes, wrench tight makeup is considered two full turns past handtight. Handtight engagement for 2½" through 4" thread varies from 5½ turns to 6¾ turns.

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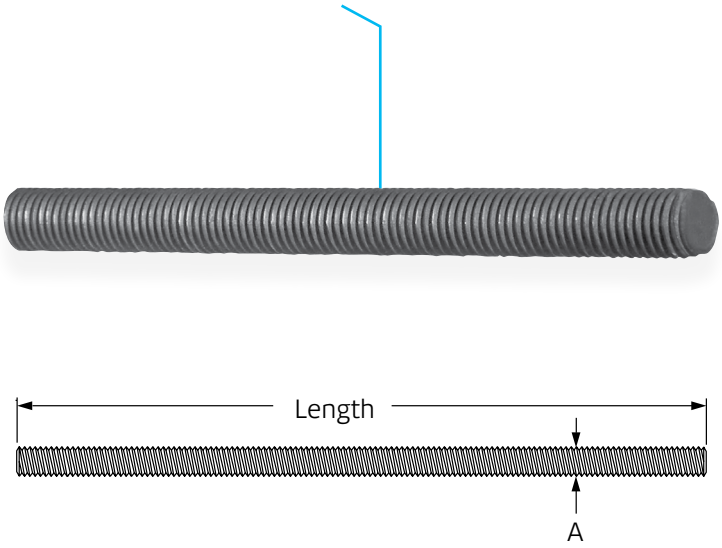
Continuous Threaded Rod
Fig. 146 (Formerly Afcon Fig. 650)



Size Range: ¼" through 1½" stocked in six, ten, and twelve foot lengths. Other even foot lengths can be furnished to order.

Material: Carbon steel or Stainless Steel Gr 304

Threads: National Coarse (USS), rod threaded complete length.

Finish: ☐ Plain or ☐ Zinc Plated (Hot-Dip Galvanized optional)

Maximum Temperature: Zinc Plated 450˚F, Stainless Steel 650˚ F

Approvals: Complies with MSS SP-58.

Ordering: Specify rod diameter and length, figure number,name and finish.

Note: The acceptability of galvanized coatings at temperatures above 450˚F is at the discretion of the end user.

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Fig. 146: Dimensions (in) • **Loads** (lbs) • **Weight** (lbs)

Rod Size A	Threads per Inch	Max Load 650˚ F	Weight per Ft.
¼	20	240	0.12
⅜	16	730	0.30
½	13	1,350	0.53
⅝	11	2,160	0.84
¾	10	3,230	1.20
⅞	9	4,480	1.70
1	8	5,900	2.30
1¼	7	9,500	3.60
1½	6	13,800	5.10

PROJECT INFORMATION	APPROVAL STAMP
Project:	☐ Approved
Address:	☐ Approved as noted
Contractor:	☐ Not approved
Engineer:	Remarks:
Submittal Date:	
Notes 1:	
Notes 2:	

MIRAGE® STANDARD AND QR CONCEALED PENDENT SPRINKLER VK462 AND HP SPRINKLER VK463 (K5.6)

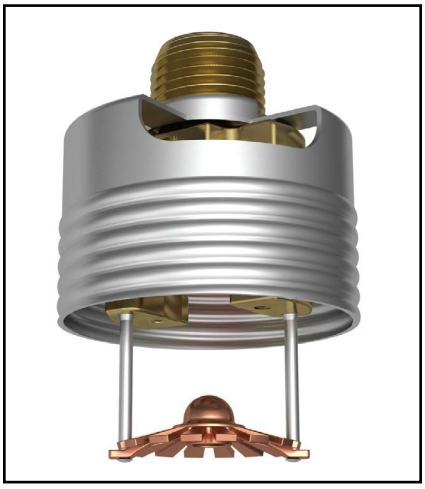
TECHNICAL DATA

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com
Visit the Viking website for the latest edition of this technical data page www.vikinggroupinc.com

1. DESCRIPTION

Viking Mirage® Standard and Quick Response Concealed Pendent Sprinkler VK462 and HP Sprinkler VK463 are thermosensitive glass-bulb spray sprinklers designed for installation on concealed pipe systems where the appearance of a smooth ceiling is desired.

The sprinkler is pre-assembled with a threaded adapter for installation with a low-profile cover assembly that provides up to ½" (12.7 mm) of vertical adjustment. The two-piece design allows installation and testing of the sprinkler prior to installation of the cover plate. The "The "push-on" and "thread-on" designs of the concealed cover plate assemblies allow easy installation of the cover plate after the system has been tested and the ceiling finish has been applied. The cover assembly can be removed and reinstalled, allowing temporary removal of ceiling panels without taking the sprinkler system out of service or removing the sprinkler. The Electroless Nickel PTFE (ENT) coating has been investigated for installation in corrosive environments and is listed and approved as indicated in the Approval Charts. The ENT finish is only available for the sprinkler assembly, the cover plate is not plated.



WARNING: Cancer and Reproductive Harm-
www.P65Warnings.ca.gov

2. LISTINGS AND APPROVALS

cULus Listed: Category VNIV

FM Approval: Class 2015

NYC Approved: MEA 89-92-E, Volume 32

VdS Approved: Certificate G4080021

LPCB Approved: Ref. No. 096e/12

CE Certified: Standard EN 12259-1, EC-certificate of conformity 0832-CPD-2032

China Approval: Approved according to China GB Standard

Refer to the Approval Charts and Design Criteria listing and approval requirements that must be followed.

3. TECHNICAL DATA

Specifications:
Available since 2006.
Minimum Operating Pressure: 7 psi (0.5 bar)*
Maximum Working Pressure: Sprinkler VK463 is rated for use with water working pressures ranging from the minimum 7 psi (0.5 bar) up to 250 psi (17.2 bar) for high-pressure systems. High-pressure (HP) sprinklers can be identified by locating "250" stamped on the deflector. Sprinkler VK462 is rated to a maximum 175 psi (12 bar) wwp.
Factory tested hydrostatically to 500 psi (34.5 bar)
Thread size: 1/2" (15 mm) NPT
Nominal K-Factor: 5.6 U.S. (80.6 metric**)
Glass-bulb fluid temperature rated to -65°F (-55°C)
Patents Pending

* cULus Listing, FM Approval, and NFPA 13 installs require a minimum of 7 psi (0.5 bar). The minimum operating pressure for LPCB and CE Approvals ONLY is 5 psi (0.35 bar).

** Metric K-factor measurement shown is when pressure is measured in Bar. When pressure is measured in kPa, divide the metric K-factor shown by 10.0.

Material Standards:
Sprinkler Body: Brass UNS-C84400
Deflector: Phosphor Bronze UNS-C51000
Deflector Pins: Stainless Steel Alloy
Bulb: Glass, nominal 3 mm diameter
Pip Cap and Insert Assembly: Copper UNS-C11000 and Stainless Steel UNS-S30400
Button: Brass UNS-C36000
Screws: 18-8 Stainless Steel
Belleville Spring Sealing Assembly: Nickel Alloy, coated on both sides with PTFE Tape
Yoke: Phosphor Bronze UNS-C51000
Cover Adapter: Cold Rolled Steel UNS-G10080, Finish: Clear Chromate over Zinc Plating

Cover Assembly Materials:
Cover: Copper UNS-C11000 or Stainless Steel UNS-S30400
Base: Brass UNS-C26000 or UNS-C26800
Springs: Nickel Alloy
Solder: Eutectic

Ordering Information: The sprinkler and cover plate must be ordered separately. Refer to Tables 1 and 2.

VIKING®

TECHNICAL DATA

MIRAGE® STANDARD AND QR CONCEALED PENDENT SPRINKLER VK462 AND HP SPRINKLER VK463 (K5.6)

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com
Visit the Viking website for the latest edition of this technical data page www.vikinggroupinc.com

4. INSTALLATION
Refer to appropriate NFPA Installation Standards.

5. OPERATION
During fire conditions, when the temperature around the sprinkler approaches its operating temperature, the cover plate detaches. Continued heating of the exposed sprinkler causes the heat-sensitive liquid in the glass bulb to expand and the bulb to shatter, releasing the yoke, pip-cap and sealing spring assembly. Water flowing through the sprinkler orifice strikes the sprinkler deflector, forming a uniform spray pattern to extinguish or control the fire.

6. INSPECTIONS, TESTS AND MAINTENANCE
Refer to NFPA 25 for Inspection, Testing and Maintenance requirements.

7. AVAILABILITY
Viking Sprinklers VK462 and VK463 are available through a network of domestic and international distributors. See The Viking Corporation web site for the closest distributor or contact The Viking Corporation.

8. GUARANTEE
For details of warranty, refer to Viking's current list price schedule or contact Viking directly.

TABLE 1: SPRINKLER ORDERING INFORMATION

Instructions:
(1) Select a Sprinkler Base Part Number
(2) Add the suffix for the desired Finish
(3) Add the suffix for the desired Sprinkler Temperature Rating
(4) Order a cover plate (refer to Table 2)

Example:
13503AE = 200 °F (93 °C) Temperature Rated Sprinkler with a standard Brass finish.

SIN	Sprinkler Base Part Number[8]	Size		1: Finishes		2: Temperature Ratings				
		NPT Inch	BSPT mm	Description	Suffix[1]	Sprinkler Temperature Classification	Nominal Rating	Bulb Color	Max. Ambient Ceiling Temperature[2]	Suffix
VK462	13503	1/2	--	Brass	A	Ordinary	155 °F (68 °C)	Red	100 °F (38 °C)	B
VK462	21356[7,9]	--	15	ENT [3,4]	JN	Intermediate	175 °F (79 °C)	Yellow	150 °F (65 °C)	D
VK463	13667	1/2	--			Intermediate	200 °F (93 °C)	Green	150 °F (65 °C)	E

Accessories

Sprinkler Wrenches and tools (see Figure 1):
A. Heavy Duty Part Number: 14047W/B[5] (available since 2006)
B. Head Cabinet Wrench Part Number: 14031[6] (available since 2006)
C. Optional Concealed Cover Plate Installer Tool Part Number: 14412[10] (available since 2007)
D. Optional Large Concealed Cover Plate Installer Tool Part No. 14867[10] (available since 2007)

Sprinkler Cabinet:
Holds up to 6 sprinklers: Part number 01731A (available since 1971).

Footnotes

1. Where a dash (-) is shown in the Finish suffix designation, insert the desired Temperature Rating suffix. See example above.
2. Based on NFPA 13, NFPA 13R, and NFPA 13D. Other limits may apply, depending on fire loading, sprinkler location, and other requirements of the Authority Having Jurisdiction. Refer to specific installation standards.
3. UL Listed as corrosion resistant.
4. The corrosion resistant coatings have passed the standard corrosion test required by the approving agencies indicated in the Approval Chart. These tests cannot and do not represent all possible corrosive environments. Prior to installation, verify through the end-user that the coatings are compatible with or suitable for the proposed environment. For automatic sprinklers, the ENT coating is applied to all exposed exterior surfaces, including the waterway.
5. Requires a ½" ratchet (not available from Viking).
6. Also optional for removal of the protective cap. Ideal for sprinkler cabinets.
7. Not available with ENT finish. See approval charts for more information.
8. See approval charts for more information.
9. Approved according to China GB Standard.
10. The installer tool is for push-on style cover plates only.

VIKING®

TECHNICAL DATA

MIRAGE® STANDARD AND QR CONCEALED PENDENT SPRINKLER VK462 AND HP SPRINKLER VK463 (K5.6)

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com
Visit the Viking website for the latest edition of this technical data page www.vikinggroupinc.com

TABLE 2: COVER PLATE ORDERING INFORMATION

Instructions:
(1) Select a Cover Plate Base Part Number
(2) Add the suffix for the desired Finish
(3) Add the suffix for the required Cover Plate Nominal Rating.

Example:
23190MC/W = 165 °F (74 °C) Temperature Rated, 2-3/4" (70 mm) diameter, Thread-On style Round Cover Plate with a Painted White finish.

1: Select a Cover Plate Base Part Number[3]						2: Select a Finish	
Thread-On Style			Push-On Style				
Base Part Number	Size Inch (mm)	Type	Base Part Number	Size Inch (mm)	Type	Description	Suffix[5]
23190	2-3/4 (70)	Round	23447	2-3/4 (70)	Round	Polished Chrome	F
23174	3-5/16 (84)	Round	23463	3-5/16 (84)	Round	Brushed Chrome	F-/B
23179	3-5/16 (84)	Square	23482	3-5/16 (84)	Square	Bright Brass	B
23193[4]	2-3/4 (70)	Stainless Steel Round	23455[4]	2-3/4 (70)	Stainless Steel Round	Antique Brass	B-/A
						Brushed Brass	B-/B
23183[4]	3-5/16 (84)	Stainless Steel Round	23473[4]	3-5/16 (84)	Stainless Steel Round	Brushed Copper	E-/B
						Painted White	M-/W
23174-/CR	3-5/16 (84)	Clean Room	23463-/CR	3-5/16 (84)	Clean Room	Painted Ivory	M-/I
						Painted Black	M-/B
23183CR[4]	3-5/16 (84)	Stainless Steel Round Clean Room	23473CR[4]	3-5/16 (84)	Stainless Steel Round Clean Room		

3: Temperature Rating Matrix[1,2]				
Cover Plate Nominal Rating (Required)	Temperature Classification	Sprinkler Nominal Rating	Sprinkler Maximum Ambient Ceiling Temperature[2]	Suffix
UL: 135 °F (57 °C) FM: 139° F (59 °C)	Ordinary	155 °F (68 °C)	100 °F (38 °C)	**A**
165 °F (74 °C)	Intermediate	175 °F (79 °C)	150 °F (65 °C)	**C**
165 °F (74 °C)	Intermediate	200 °F (93 °C)	150 °F (65 °C)	**C**

Footnotes

1. The sprinkler temperature rating is stamped on the deflector.
2. Based on NFPA-13. Other limits may apply, depending on fire loading, sprinkler location, and other requirements of the Authority Having Jurisdiction. Refer to specific installation standards.
3. Part number shown is the base part number. For complete part number, refer to current Viking price list schedule.
4. Stainless Steel versions are not available with any finishes or paint.
5. Where a dash (-) is shown in the Finish suffix designation, insert the desired Temperature Rating suffix. See example above.

TECHNICAL DATA

MIRAGE® STANDARD AND QR CONCEALED PENDENT SPRINKLER VK462 AND HP SPRINKLER VK463 (K5.6)

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com
Visit the Viking website for the latest edition of this technical data page www.vikinggroupinc.com

Approval Chart 1 (UL)

Mirage® Concealed Pendent Sprinklers VK462 and VK463

Sprinkler Temperature Rating
Cover Plate Temperature Rating
AW1 Cover Plate Finish KEY

Sprinkler Base Part No.[1]	SIN	Thread Size		Nominal K-factor		Maximum Water Working Pressure	Listings and Approvals[4] (Refer also to Design Criteria)					
		NPT Inch	BSPT mm	U.S.	metric[2]		cULus[5]	NYC	VdS[7]	LPCB	CE	China Approval
Standard Response Applications												
13503A	VK462	1/2"	--	5.6	80.6	175 psi (12 bar)	--	--	AY1, CZ1	AY1, BZ1	AY1, CZ1[8]	--
21356A[12]	VK462	--	15	5.6	80.6	175 psi (12 bar)	--	--	–	--	--	AY1, CZ1
Quick Response Applications												
13503A	VK462	1/2"	15	5.6	80.6	175 psi (12 bar)	AV1, BX1, AS2, BT2	AV1, BX1[6]	–	–	--	--
13503JN[11]	VK462	1/2"	15	5.6	80.6	175 psi (12 bar)	AV1, BX1, AS2, BT2	AV1, BX1[6]	–	–	--	--
21356A[12]	VK462	--	15	5.6	80.6	175 psi (12 bar)	AY1, CZ1	--	–	–	--	--
13667A	VK463	1/2"	15	5.6	80.6	250 psi (17.2 bar)[3]	AV1, BX1	AV1, BX1[6]	--	--	--	--
13667JN[11]	VK463	1/2"	15	5.6	80.6	250 psi (17.2 bar)[3]	AV1, BX1	AV1, BX1[6]	--	--	--	--

Approved Sprinkler Temperature Rating Codes	Approved Cover Plate Temperature Rating Codes	Approved Cover Plate Finish Codes
A = 155 °F (68 °C) B = 175 °F (79 °C) C = 200 °F (93 °C)	S - 135 °F (57 °C) cover 23193, 23445 or 23183, 23473 (large diameter) T - 165 °F (74 °C) cover 23193, 23445 or 23183, 23473 (large diameter) V - 135 °F (57 °C) cover 23190, 23447, 23174, 23463 (large diameter), or 23179, 23482 (square cover plate) X - 165 °F (74 °C) cover 23190, 23447, or 23174, 23463 (large diameter) Y - 135 °F (57 °C) cover 23190, 23447 *LPCB Approved as 139 °F (59 °C)* Z - 165 °F (74 °C) cover 23190, 23447	1 - Polished Chrome, Brushed Chrome, Bright Brass, Antique Brass, Brushed Brass, Brushed Copper, Painted White, Painted Ivory, or Painted Black 2 - Stainless Steel

Footnotes

1. Part number shown is the base part number. For complete part number, refer to current Viking price list schedule.
2. Metric K-factor measurement shown is when pressure is measured in Bar. When pressure is measured in kPa, divide the metric K-factor shown by 10.0.
3. The Water Working Pressure rating is stamped on the deflector.
4. This chart shows the listings and approvals available at the time of printing. Other approvals may be in process. Check with the manufacturer for any additional approvals.
5. Listed by Underwriter's Laboratories for use in the U.S. and Canada.
6. Accepted for use, City of New York Department of Buildings, MEA Number 89-92-E, Vol. 32.
7. VdS Approved, standards VdS 2344:2005-12, VdS 2100-25:2008-01, and EN 12259-1:1999 + A1:2001 + A2:2004 + A3:2006, Certificate G4080021.
8. CE Certified, Standard EN 12259-1, EC-certificate of conformity 0832-CPD-2032.
9. The 135/139 °F cover has an orange label. The 165 °F (74 °C) cover has a white label.
10. Painted finish consists of Polyester Baked Enamel. Other paint colors are available on request with the same listings as the standard paint colors. Listings and approvals apply for any paint manufacturer. Contact Viking for additional information.
11. cULus Listed as corrosion resistant.
12. Approved according to China GB Standard.

NOTE: Custom colors are indicated on a label inside the cover assembly. Refer to Figure 1.

TECHNICAL DATA

MIRAGE® STANDARD AND QR CONCEALED PENDENT SPRINKLER VK462 AND HP SPRINKLER VK463 (K5.6)

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com
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DESIGN CRITERIA - UL

(Also refer to Approval Chart 1)

cULus Listing Requirements:

Mirage® Concealed Pendent Sprinklers VK462 and VK463 are cULus Listed as quick response for installation in accordance with the latest edition of NFPA 13 for standard coverage pendent spray sprinklers as indicated below.

- For hazard occupancies up to and including Ordinary Hazard, Group II.
- Protection areas and maximum spacing shall be in accordance with the tables provided in NFPA 13. Maximum spacing allowed is 15 ft. (4.6 m).
- Minimum spacing allowed is 6 ft. (1.8 m) unless baffles are installed in accordance with NFPA 13.
- Minimum distance from walls is 4 in. (102 mm).
- Maximum distance from walls shall be no more than one-half of the allowable distance between sprinklers. The distance shall be measured perpendicular to the wall.
- The sprinkler obstruction rules contained in NFPA 13 for standard coverage pendent spray sprinklers must be followed.
- Venting is required.
- Concealed sprinklers must NOT be installed in positive pressure plenums.

VdS Approval Requirements:

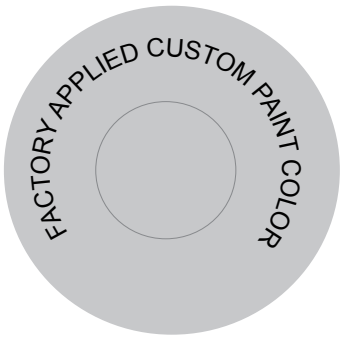
Concealed sprinklers must be installed in neutral or negative pressure plenums only.

VdS does not allow the installation of concealed sprinklers in false ceiling where the void above also contains a water based active fire protection system.

Steps of installation:

1. Prepare the sprinkler key.
2. Remove the plastic cover.
3. Hold the sprinkler with the wrench and fasten it.
4. Replace the plastic cover and do not remove until the cover is installed.

IMPORTANT: Always refer to Bulletin Form No. F_091699 - Care and Handling of Sprinklers. Also refer to Form No. F_080614 for general care, installation, and maintenance information. Viking sprinklers are to be installed in accordance with the latest edition of Viking technical data, the appropriate standards of NFPA, LPCB, APSAD, VdS or other similar organizations, and also with the provisions of governmental codes, ordinances, and standards, whenever applicable.



All custom color painted cover plates will have an identifying label affixed to the inside of the cover that indicates the custom color and will have a representative sample (a paint dot) of the paint on the label.

Figure 1: Identification of Custom Paint for Concealed Covers

Figure 2: Square Cover Assembly

VIKING®

TECHNICAL DATA

MIRAGE® STANDARD AND QR CONCEALED PENDENT SPRINKLER VK462 AND HP SPRINKLER VK463 (K5.6)

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Approval Chart 2 (FM)

Mirage® Standard Response Concealed Pendent Sprinkler VK462

Sprinkler Temperature Rating
Cover Plate Temperature Rating
AW1 ← Cover Plate Finish KEY

Sprinkler Base Part No.[1]	SIN	Thread Size		Nominal K-Factor		Maximum Water Working Pressure	FM Approvals[3] (Refer also to Design Criteria below.)
		NPT Inch	BSPT mm	U.S.	metric[2]		
13503A	VK462	1/2"	15	5.6	80.6	175 psi (12 bar)	AW1, BX1, AY2, BZ2
21356A[6]	VK462	--	15	5.6	80.6	175 psi (12 bar)	AU1, CV1

Approved Sprinkler Temperature Rating Codes	Approved Cover Plate Temperature Rating Codes	Approved Cover Plate Finish Codes
A - 155 °F (68 °C) B - 175 °F (79 °C) and 200 °F (93 °C) C - 200 °F (93 °C)	U - 139 °F (59 °C) cover 23190, 23447 V - 165 °F (74 °C) cover 23190, 23447 W - 139 °F (59 °C) cover 23190, 23447, or 23174, 23463 (large diameter), or 23179, 23482 (square cover plate) X - 165 °F (74 °C) cover 23190, 23447, 23174, 23463 (large diameter), or 23179, 23482 (square cover plate) Y - 139 °F (59 °C) cover, 23183, 23473 or 23193, 23455 Z - 165 °F (74 °C) cover 23183, 23473 or 23193, 23455	1 - Polished Chrome, Brushed Chrome, Bright Brass, Antique Brass, Brushed Brass, Brushed Copper, Painted White, Painted Ivory, or Painted Black 2 - Stainless Steel

Footnotes

1. Part number shown is the base part number. For complete part number, refer to current Viking price list schedule.
2. Metric K-factor measurement shown is when pressure is measured in Bar. When pressure is measured in kPa, divide the metric K-factor shown by 10.0.
3. This chart shows the FM Approvals available at the time of printing. Other approvals may be in process. Check with the manufacturer for any additional approvals.
4. The 139 °F (59 °C) cover has an orange label. The 165 °F (74 °C) cover has a white label.
5. Painted finish consists of Polyester Baked Enamel. Other paint colors are available on request with the same listings as the standard paint colors. Listings and approvals apply for any paint manufacturer. Contact Viking for additional information.
6. Approved according to China GB Standard.

NOTE: Custom colors are indicated on a label inside the cover assembly. Refer to Figure 1.

DESIGN CRITERIA - FM

(Also refer to Approval Chart 2 above.)

FM Approval Requirements:

Viking Concealed Pendent Sprinkler VK462 is FM Approved as a standard response **Non-Storage** concealed pendent sprinkler as indicated in the FM Approval Guide. For specific application and installation requirements, reference the latest applicable FM Loss Prevention Data Sheets (including Data Sheet 2-0). FM Global Loss Prevention Data Sheets contain guidelines relating to, but not limited to: minimum water supply requirements, hydraulic design, ceiling slope and obstructions, minimum and maximum allowable spacing, and deflector distance below the ceiling.

NOTE: The FM installation guidelines may differ from cULus and/or NFPA criteria.

IMPORTANT: Always refer to Bulletin Form No. F_091699 - Care and Handling of Sprinklers. Also refer to Form No. F_080614 for general care, installation, and maintenance information. Viking sprinklers are to be installed in accordance with the latest edition of Viking technical data, the appropriate standards of NFPA, FM Global, LPCB, APSAD, VdS or other similar organizations, and also with the provisions of governmental codes, ordinances, and standards, whenever applicable.

TECHNICAL DATA

MIRAGE® STANDARD AND QR CONCEALED PENDENT SPRINKLER VK462 AND HP SPRINKLER VK463 (K5.6)

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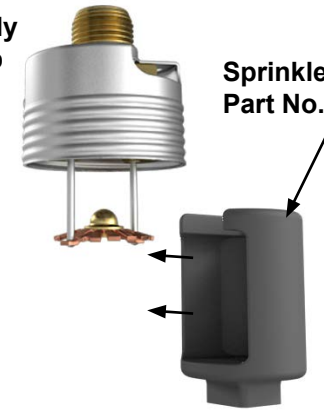
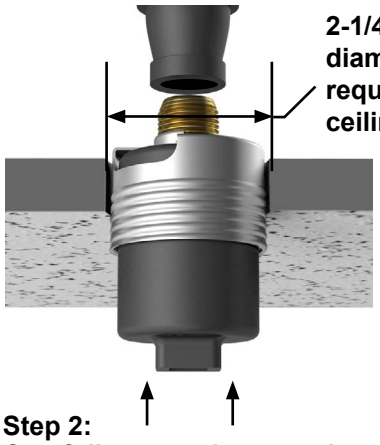
Sprinkler and Adapter Assembly
- Protective cap removed
- Use wrench 14047W/B**



Step 1:
Carefully slide the wrench sideways around the deflector and pins



Step 2:
Carefully press the wrench upward and turn slightly to ensure engagement with the sprinkler wrench flats.

NEVER install the sprinkler by applying the installation wrench across the frame arms. DO NOT overtighten. Use only the designated sprinkler wrenches, Viking Part Numbers 14047W/B or 14031**. A leak tight seal should be achieved by turning the sprinkler clockwise 1 to 1-1/2 turns beyond finger tight.**

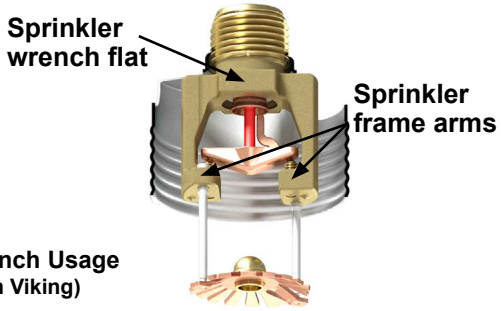
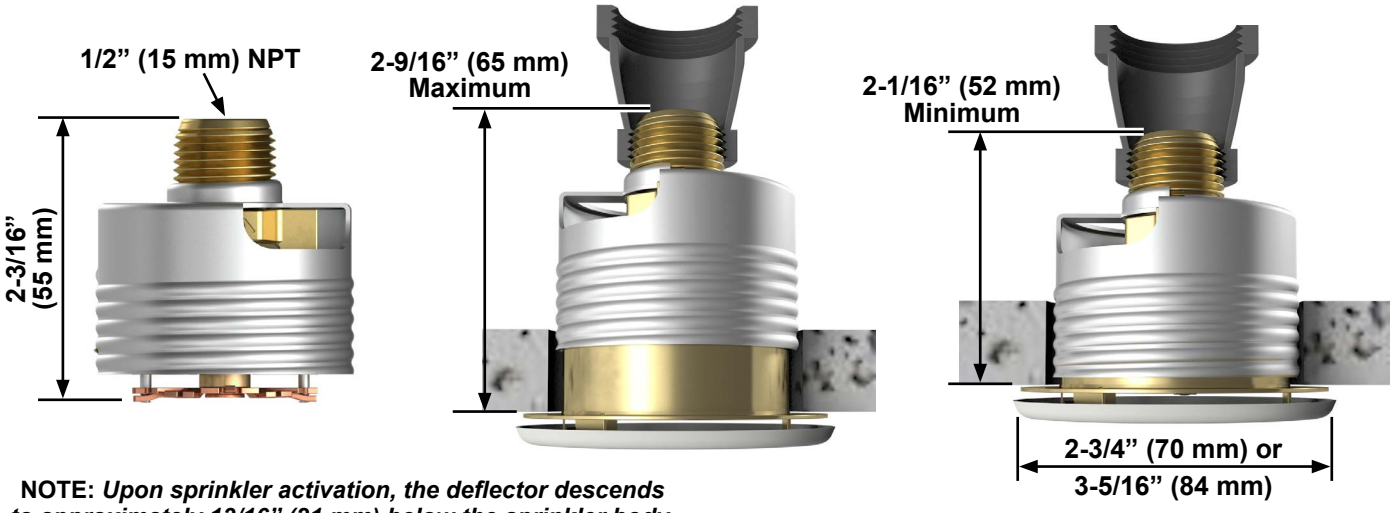


Figure 3: Sprinkler Installation and Proper Wrench Usage
** A 1/2” ratchet is required (Not available from Viking)



NOTE: ***Upon sprinkler activation, the deflector descends to approximately 13/16” (21 mm) below the sprinkler body.***

Figure 4: Sprinkler Dimensions and Cover Installation

BULLETIN

CARE AND HANDLING OF SPRINKLERS

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

SPRINKLERS ARE FRAGILE - HANDLE WITH CARE!

General Handling and Storage:

- Store sprinklers in a cool, dry place.
- Protect sprinklers during storage, transport, handling, and after installation.
- Use the original shipping containers. DO NOT place sprinklers loose in boxes, bins, or buckets.
- Keep sprinklers separated at all times. DO NOT allow metal parts to contact sprinkler operating elements.

For Pre-Assembled Drops:

- Protect sprinklers during handling and after installation.
- For recessed assemblies, use the protective sprinkler cap (Viking Part Number 10364).

Sprinklers with Protective Shields or Caps:

- DO NOT remove shields or caps until after sprinkler installation and there no longer is potential for mechanical damage to the sprinkler operating elements.
- **Sprinkler shields or caps MUST be removed BEFORE placing the system in service!**
- Remove the sprinkler shield by carefully pulling it apart where it is snapped together.
- Remove the cap by turning it slightly and pulling it off the sprinkler.

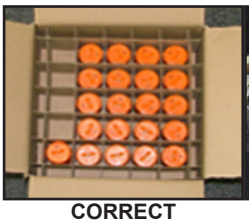
Sprinkler Installation:

- DO NOT use the sprinkler deflector or operating element to start or thread the sprinkler into a fitting.
- **Use only the designated sprinkler head wrench!** Refer to the current sprinkler technical data page to determine the correct wrench for the model of sprinkler used.
- DO NOT install sprinklers onto piping at the floor level.
- Install sprinklers after the piping is in place to prevent mechanical damage.
- DO NOT allow impacts such as hammer blows directly to sprinklers or to fittings, pipe, or couplings in close proximity to sprinklers. Sprinklers can be damaged from direct or indirect impacts.
- DO NOT attempt to remove drywall, paint, etc., from sprinklers.
- **Take care not to over-tighten the sprinkler and/or damage its operating parts!**

  Maximum Torque:
  1/2" NPT: 14 ft-lbs. (19.0 N-m)
  3/4" NPT: 20 ft-lbs. (27.1 N-m)
  1" NPT: 30 ft-lbs. (40.7 N-m)

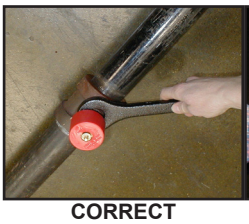
CORRECT
(Original container used)

INCORRECT
(Placed loose in box)



CORRECT
(Protected with caps)

INCORRECT
(Protective caps not used)



CORRECT
(Piping is in place at the ceiling)

INCORRECT
(Sprinkler at floor level)

CORRECT
(Special installation wrenches)

INCORRECT
(Designated wrench not used)

WARNING: Cancer and Reproductive Harm- www.P65Warnings.ca.gov

⚠ WARNING

Any sprinkler with a loss of liquid from the glass bulb or damage to the fusible element should be destroyed. Never install sprinklers that have been dropped, damaged, or exposed to temperatures exceeding the maximum ambient temperature allowed. Sprinklers that have been painted in the field must be replaced per NFPA 13. Protect sprinklers from paint and paint overspray in accordance with the installation standards. Do not clean sprinklers with soap and water, ammonia, or any other cleaning fluid. Do not use adhesives or solvents on sprinklers or their operating elements.

Refer to the appropriate technical data page and NFPA standards for complete care, handling, installation, and maintenance instructions. For additional product and system information Viking data pages and installation instructions are available on the Viking Web site at www.vikinggroupinc.com.

VIKING | BULLETIN | CARE AND HANDLING OF SPRINKLERS

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PROTECTIVE SPRINKLER SHIELDS AND CAPS

General Handling and Storage:

Many Viking sprinklers are available with a plastic protective cap or shield temporarily covering the operating elements. The snap-on shields and caps are factory installed and are intended to help protect the operating elements from mechanical damage during shipping, storage, and installation. NOTE: It is still necessary to follow the care and handling instructions on the appropriate sprinkler technical data sheets* when installing sprinklers with bulb shields or caps.

WHEN TO REMOVE THE SHIELDS AND CAPS:

NOTE: SHIELDS AND CAPS MUST BE REMOVED FROM SPRINKLERS BEFORE PLACING THE SYSTEM IN SERVICE!

Remove the shield or cap from the sprinkler only after checking all of the following:

- The sprinkler has been installed*.
- The wall or ceiling finish work is completed where the sprinkler is installed and there no longer is a potential for mechanical damage to the sprinkler operating elements.

SHIELDS AND CAPS MUST BE REMOVED FROM SPRINKLERS BEFORE PLACING THE SYSTEM IN SERVICE!

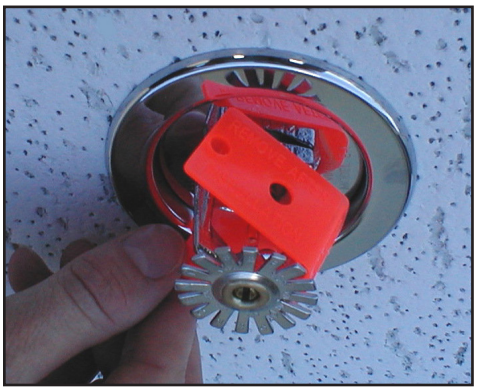

Figure 1: Sprinkler shield being removed from a pendent sprinkler.

Figure 2: Sprinkler cap being removed from a pendent sprinkler.

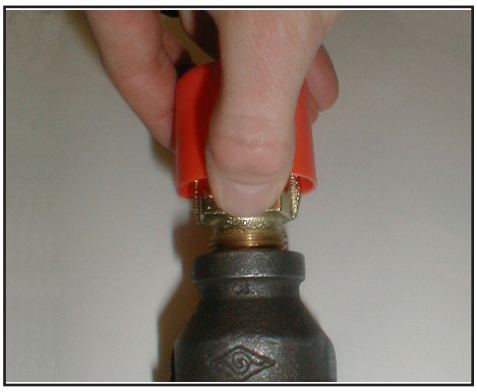

Figure 3: Sprinkler cap being removed from and upright sprinkler.

HOW TO REMOVE SHIELDS AND CAPS:

No tools are necessary to remove the shields or caps from sprinklers. DO NOT use any sharp objects to remove them! **Take care not to cause mechanical damage to sprinklers when removing the shields or caps.** When removing caps from fusible element sprinklers, use care to prevent dislodging ejector springs or damaging fusible elements. NOTE: Squeezing the sprinkler cap excessively could damage sprinkler fusible elements.

- To remove the shield, simply pull the ends of the shield apart where it is snapped together. Refer to Figure 1.
- To remove the cap, turn it slightly and pull it off the sprinkler. Refer to Figures 2 and 3.

NOTICE Refer to the current sprinkler technical data page to determine the correct sprinkler wrench for the model of sprinkler used.

WARNING Never install sprinklers that have been dropped, damaged, or exposed to temperatures in excess of the maximum ambient temperature allowed.

*** Refer to the appropriate current technical data pages for complete care, handling, and installation instructions. Data pages are included with each shipment from Viking or Viking distributors. They can also be found on the Web site at www.vikinggroupinc.com.**

BULLETIN

CARE AND HANDLING OF SPRINKLERS

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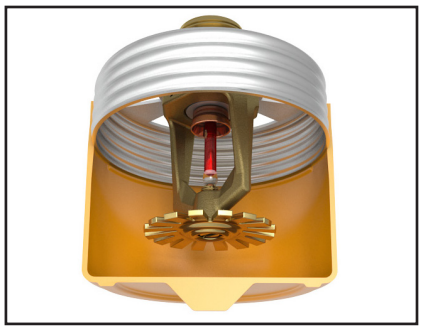
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

CAUTION CONCEALED COVER ASSEMBLIES ARE FRAGILE!
TO ASSURE SATISFACTORY PERFORMANCE OF THE PRODUCT, HANDLE WITH CARE.



Concealed Sprinkler and Adapter Assembly with Protective Cap

Concealed Sprinkler and Adapter Assembly (Protective Cap Removed)

Cover Plate Assembly (Pendent Cover 12381 shown)

GENERAL HANDLING AND STORAGE INSTRUCTIONS:

- Do not store in temperatures exceeding 100 °F (38 °C). Avoid direct sunlight and confined areas subject to heat.
- Protect sprinklers and cover assemblies during storage, transport, handling, and after installation.
  -- Use original shipping containers.
  -- Do not place sprinklers or cover assemblies loose in boxes, bins, or buckets.
- Keep the sprinkler bodies covered with the protective sprinkler cap any time the sprinklers are shipped or handled, during testing of the system, and while ceiling finish work is being completed.
- Use only the designated Viking recessed sprinkler wrench (refer to the appropriate sprinkler data page) to install these sprinklers. **NOTE:** The protective cap is temporarily removed during installation and then placed back on the sprinkler for protection until finish work is completed.
- Do not over-tighten the sprinklers into fittings during installation.
- Do not use the sprinkler deflector to start or thread the sprinklers into fittings during installation.
- Do not attempt to remove drywall, paint, etc., from the sprinklers.
- Remove the plastic protective cap from the sprinkler before attaching the cover plate assembly. **PROTECTIVE CAPS MUST BE REMOVED FROM SPRINKLERS BEFORE PLACING THE SYSTEM IN SERVICE!**

Refer to the appropriate current technical data pages for complete care, handling, and installation instructions. Data pages are included with each shipment from Viking or Viking distributors. They can also be found on the Web site at www.vikinggroupinc.com.

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BULLETIN

CARE AND HANDLING OF SPRINKLERS

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USE THE FOLLOWING PRECAUTIONS WHEN HANDLING WAX-COATED SPRINKLERS

Many of Viking's sprinklers are available with factory-applied wax coating for corrosion resistance. These sprinklers MUST receive appropriate care and handling to avoid damaging the wax coating and to assure satisfactory performance of the product.

General Handling and Storage of Wax-Coated Sprinklers:

- Store the sprinklers in a cool, dry place (in temperatures below the maximum ambient temperature allowed for the sprinkler temperature rating. Refer to Table 1 below.)
- Store containers of wax-coated sprinklers separate from other sprinklers.
- Protect the sprinklers during storage, transport, handling, and after installation.
- Use original shipping containers.
- Do not place sprinklers in loose boxes, bins, or buckets.

Installation of Wax-Coated Sprinklers:

Use only the special sprinkler head wrench designed for installing wax-coated Viking sprinklers (any other wrench may damage the unit).

- Take care not to crack the wax coating on the units.
- For touching up the wax coating after installation, wax is available from Viking in bar form. Refer to Table 1 below. The coating MUST be repaired after sprinkler installation to protect the corrosion-resistant properties of the sprinkler.
- Use care when locating sprinklers near fixtures that can generate heat. Do not install sprinklers where they would be exposed to temperatures exceeding the maximum recommended ambient temperature for the temperature rating used.
- Inspect the coated sprinklers frequently soon after installation to verify the integrity of the corrosion resistant coating. Thereafter, inspect representative samples of the coated sprinklers in accordance with NFPA 25. Close up visual inspections are necessary to determine whether the sprinklers are being affected by corrosive conditions.

TABLE 1

Sprinkler Temperature Rating (Fusing Point)	Wax Part Number	Wax Melting Point	Maximum Ambient Ceiling Temperature[1]	Wax Color
155 °F (68 °C) / 165 °F (74 °C)	02568A	148 °F (64 °C)	100 °F (38 °C)	Light Brown
175 °F (79 °C)	04146A	161 °F (71 °C)	150 °F (65 °C)	Brown
200 °F (93 °C)	04146A	161 °F (71 °C)	150 °F (65 °C)	Brown
220 °F (104 °C)	02569A	170 °F (76 °C)	150 °F (65 °C)	Dark Brown
286 °F (141 °C)	02569A	170 °F (76 °C)	150 °F (65 °C)	Dark Brown

[1] Based on NFPA-13. Other limits may apply, depending on fire loading, sprinkler location, and other requirements of the Authority Having Jurisdiction. Refer to specific installation standards.

⚠WARNING Never install sprinklers that have been dropped, damaged, or exposed to temperatures in excess of the maximum ambient temperature allowed.

Refer to the appropriate current technical data pages for complete care, handling, and installation instructions. Data pages are included with each shipment from Viking or Viking distributors. They can also be found on the Web site at www.vikinggroupinc.com.

TECHNICAL DATA — SPRINKLER OVERVIEW

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

1. DESCRIPTION

Viking fire sprinklers consist of a threaded frame with a specific waterway or orifice size and a deflector for distributing water in a specified pattern. A closed or sealed sprinkler refers to a complete assembly, including the thermosensitive operating element. An open sprinkler does not use an operating element and is open at all times. The distribution of water is intended to extinguish a fire or to control its spread.

Viking sprinklers are available in several models and styles. Refer to specific sprinkler technical data pages for available styles, finishes, temperature ratings, thread sizes, and nominal K-Factors for the particular model selected.

2. LISTINGS AND APPROVALS

Refer to the Approval Charts on the appropriate sprinkler technical data page(s) and/or approval agency listings.

WARNING: Cancer and Reproductive Harm- www.P65Warnings.ca.gov

3. TECHNICAL DATA

Pressure Ratings:

Maximum allowable water working pressure is 175 psig (12 Bar) unless rated and specified for high water working pressure [250 psig (17.2 bar)].

Sprinkler Identification:

Viking sprinklers are identified and marked with the word “Viking”, the sprinkler identification number (SIN) consisting of “VK” plus a three digit number*, the model letter, and the year of manufacture.

Available Finishes:

Viking sprinklers are available in several decorative finishes. Some models are available with corrosion-resistant coatings or are fabricated from non-corrosive material. Refer to the sprinkler technical data page for additional information.

Available Temperature Ratings:

Viking sprinklers are available in several temperature ratings that relate to a specific temperature classification. Applicable installation rules mandate the use and limitations of each temperature classification. In selecting the appropriate temperature classification, the maximum expected ceiling temperature must be known. When there is doubt as to the maximum temperature at the sprinkler location, a maximum-reading thermometer should be used to determine the temperature under conditions that would show the highest readings to be expected. In addition, recognized installation rules may require a higher temperature classification, depending upon sprinkler location, occupancy classification, commodity classification, storage height, and other hazards. In all cases, the maximum expected ceiling temperature dictates the lowest allowable temperature classification. Sprinklers located immediately adjacent to a heat source may require a higher temperature rating.

K-Factors:

Viking sprinklers are available in several orifice sizes with related K-Factors. The orifice is a tapered waterway and, therefore, the K-Factor given is nominal. Nominal U.S. K-Factors are provided in accordance with the 1999 edition of NFPA 13, Section 3-2.3. Refer to the specific data page for appropriate K-Factor information.

Available Styles:

Viking sprinklers are available for installation in several positions as indicated by a stamping on the deflector. The deflector style dictates the appropriate installation position of the sprinkler; it breaks the solid stream of water issuing from the sprinkler orifice to form a specific spray pattern. The following list indicates the various styles and identification of Viking sprinklers.

UPRIGHT SPRINKLER: A sprinkler intended to be installed with the deflector above the frame so water flows upward through the orifice, striking the deflector and forming an umbrella-shaped spray pattern downward. Marked “SSU” (Standard Sprinkler Upright) or “UPRIGHT” on the deflector.

PENDENT SPRINKLER: A sprinkler intended to be oriented with the deflector below the frame so water flows downward through the orifice, striking the deflector and forming an umbrella-shaped spray pattern downward. Marked “SSP” (Standard Sprinkler Pendent) or “PENDENT” on the deflector.

Viking Technical Data may be found on The Viking Corporation’s Web site at http://www.vikinggroupinc.com. The Web site may include a more recent edition of this Technical Data Page.

CONVENTIONAL SPRINKLER: An “old style” sprinkler intended to be installed with the deflector in either the upright or pendent position. The deflector provides a spherical type pattern with 40 to 60 percent of the water initially directed downward and a proportion directed upward. Must be installed in accordance with installation rules for conventional or old style sprinklers. DO NOT USE AS A REPLACEMENT FOR STANDARD SPRAY SPRINKLERS. Marked “C U/P” (Conventional Upright/Pendent) on the deflector.

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

VERTICAL SIDEWALL (VSW) SPRINKLER: A sprinkler intended for installation near the wall and ceiling. The deflector provides a water spray pattern outward in a quarter-spherical pattern and can be installed in the upright or pendent position with the flow arrow in the direction of discharge. Marked “SIDEWALL” on the deflector with an arrow and the word “FLOW”. (Note: Some vertical sidewall sprinklers can only be installed in the upright or pendent position—in this case, the sprinkler will also be marked “UPRIGHT” or “PENDENT”.)

HORIZONTAL SIDEWALL (HSW) SPRINKLER: A sprinkler intended for installation near the wall and ceiling. The special deflector provides a water spray pattern outward in a quarter-spherical pattern. Most of the water is directed away from the nearby wall with a small portion directed at the wall behind the sprinkler. The top of the deflector is oriented parallel with the ceiling or roof. The flow arrows point in the direction of discharge. Marked “SIDEWALL” and “TOP” with an arrow and the word “FLOW”.

EXTENDED COVERAGE (EC) SPRINKLER: A spray sprinkler designed to discharge water over an area having the maximum dimensions indicated in the individual listings. Maximum area of coverage, minimum flow rate, orifice size, and nominal K-Factor are specified in the individual listings. EC sprinklers are intended for Light-Hazard occupancies with smooth, flat, horizontal ceilings unless otherwise specified. In addition to the above markings, the sprinkler is marked “EC”.

QUICK RESPONSE (QR) SPRINKLER: A spray sprinkler with a fast- actuating operating element. The use of quick response sprinklers may be limited due to occupancy and hazard. Refer to the Authority Having Jurisdiction (AHJ) prior to installing.

QUICK RESPONSE EXTENDED COVERAGE (QREC) SPRINKLER: A spray sprinkler designed to discharge water over an area having the maximum dimensions indicated in the individual listing. This is a sprinkler with an operating element that meets the criteria for quick response. QREC sprinklers are only intended for Light Hazard occupancies. The sprinkler is marked “QREC”.

FLUSH SPRINKLER: A decorative spray sprinkler intended for installation with a concealed piping system. The unit is mounted flush with the ceiling or wall, with the fusible link exposed. Upon actuation, the deflector extends beyond the ceiling or wall to distribute water discharge. The sprinkler is marked “SSP”, “PEND”, or “SIDEWALL” and “TOP”.

CONCEALED SPRINKLER: A decorative spray sprinkler intended for installation with a concealed piping system. The sprinkler is hidden from view by a cover plate installed flush with the ceiling or wall. During fire conditions, the cover plate detaches, and upon sprinkler actuation, the deflector extends beyond the ceiling or wall to distribute water discharge. The sprinkler is marked “SSP”, “PEND”, or “SIDEWALL” and “TOP”.

RECESSED SPRINKLER: A spray sprinkler assembly intended for installation with a concealed piping system. The assembly consists of a sprinkler installed in a decorative adjustable recessed escutcheon that minimizes the protrusion of the sprinkler beyond the ceiling or wall without adversely affecting the sprinkler distribution or sensitivity. Refer to the appropriate technical data page for allowable sprinkler models, temperature ratings, and occupancy classifications. DO NOT RECESS ANY SPRINKLER NOT LISTED FOR USE WITH THE ESCUTCHEON.

CORROSION-RESISTANT SPRINKLER: A special service sprinkler with non-corrosive protective coatings, or that is fabricated from non-corrosive material, for use in atmospheres that would normally corrode sprinklers.

DRY SPRINKLER: A special-service sprinkler intended for installation on dry pipe systems or wet pipe systems where the sprinkler is subject to freezing temperatures. The unit consists of a sprinkler permanently secured to an extension nipple with a sealed inlet end to prevent water from entering the nipple until the sprinkler operates. The unit MUST be installed in a tee fitting. Dry upright sprinklers are marked with the “B” dimension [distance from the face of the fitting (tee) to the top of the deflector]. Dry pendent and sidewall sprinklers are marked with the “A” dimension [the distance from the face of fitting (tee) to the finished surface of the ceiling or wall].

LARGE DROP SPRINKLER: A type of special application sprinkler used to provide fire control of specific high-challenge fire hazards. Large drop sprinklers are designed to produce an umbrella-shaped spray pattern downward with a higher percentage of “large” water droplets than standard spray sprinklers. The sprinkler has an extra-large orifice with a nominal K-Factor of 11.2. Marked “HIGH CHALLENGE” and “UPRIGHT”.

EARLY SUPPRESSION FAST-RESPONSE (ESFR) SPRINKLER: A sprinkler intended to provide fire suppression of specific high-challenge fire hazards through the use of a fast response fusible link, 14.0, 16.8, or 25.2 nominal K-Factor, and special deflector. ESFR sprinklers are designed to produce high-momentum water droplets in a hemispherical pattern below the deflector. This permits penetration of the fire plume and direct wetting of the burning fuel surface while cooling the atmosphere early in the development of a high-challenge fire. Marked “ESFR” and “UPRIGHT” or “PEND”.

INTERMEDIATE LEVEL/RACK STORAGE SPRINKLER: A standard spray sprinkler assembly designed to protect its operating element from the spray of sprinklers installed at higher elevations. The assembly consists of a standard or large orifice upright or pendent sprinkler with an integral upright or pendent water shield and guard assembly. Use only those sprinklers that have been tested and listed for use with the assembly. Refer to the technical data page for allowable sprinkler models.

RESIDENTIAL SPRINKLER: A sprinkler intended for use in the following occupancies: one- and two-family dwellings with the fire protection sprinkler system installed in accordance with NFPA 13D; residential occupancies up to four stories in height with the fire protection system installed in accordance with NFPA 13R; and where allowed by the Authority Having Jurisdiction in residential portions of any occupancy with the fire protection system installed in accordance with NFPA 13.

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Residential sprinklers have a unique distribution pattern and utilize a “fast response” heat sensitive operating element. They enhance survivability in the room of fire origin and are designed to provide a life safety environment for a minimum of ten minutes. For this reason, residential sprinklers must not be used to replace standard sprinklers unless tested for and approved by the Authority Having Jurisdiction. In addition to standard markings, the unit is identified as “RESIDENTIAL SPRINKLER” or “RES”.

4. INSTALLATION

Refer to appropriate NFPA Installation Standards.

5. OPERATION

Refer to the appropriate sprinkler technical data page(s).

6. INSPECTIONS, TESTS AND MAINTENANCE

Refer to NFPA 25 for Inspection, Testing and Maintenance requirements.

7. AVAILABILITY

Viking sprinklers are available through a network of domestic and international distributors. See The Viking Corporation web site for the closest distributor or contact The Viking Corporation.

8. GUARANTEE

For details of warranty, refer to Viking’s current list price schedule or contact Viking directly.

IMPORTANT: Always refer to Bulletin Form No. F_091699 - Care and Handling of Sprinklers and the appropriate sprinkler general care, installation, and maintenance guide. Viking sprinklers are to be installed in accordance with the latest edition of Viking technical data, the appropriate standards of NFPA, FM Global, LPCB, APSAD, VdS or other similar organizations, and also with the provisions of governmental codes, ordinances, and standards, whenever applicable. The sprinkler technical data page may contain installation requirements specific for the sprinkler model selected. The use of certain types of sprinklers may be limited due to occupancy and hazard. Refer to the Authority Having Jurisdiction prior to installation.

VIKING®

BULLETIN

REGULATORY AND HEALTH WARNINGS

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com
Visit the Viking website for the latest edition of this technical data page www.vikinggroupinc.com

1. DESCRIPTION

Regulatory and Health Warnings applying to materials used in the manufacture and construction of fire protection products are provided herin as they relate to legally mandated jurisdictional regions.

⚠ WARNING

STATE OF CALIFORNIA, USA

Installing or servicing fire protection products such as sprinklers, valves, piping etc. can expose you to chemicals including, but not limited to, lead, nickel, butadiene, titaninum dioxide, chromium, carbon black, and acrylonitrile which are known to the State of California to cause cancer or birth defects or other reproductive harm.

For more information, go to **www.P65Warnings.ca.gov**

2. WARRANTY TERMS AND CONDITIONS

For details of warranty, refer to Viking's current list price schedule at **www.vikinggroupinc.com** or contact Viking directly.

RSN:1827437
LT-24-2459794

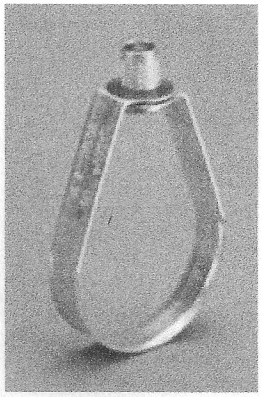
CADDY®

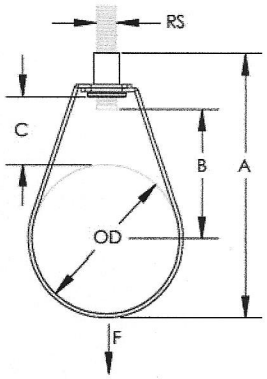
115 Standard Duty Loop Hanger

Features

- Flared edges help prevent any sharp surfaces from coming into contact with the pipe (1/2" to 4" sizes)
- Retained insert nut helps ensure the loop hanger and insert nut stay together
- Recommended for the suspension of stationary non-insulated pipe lines
- Manufactured to use the minimum rod size permitted by NFPA® for fire sprinkler piping
- Conforms with Federal Specification WW-H-171 (Type 10), Manufacturers Standardization Society (MSS) SP-58 and SP-69 (Type 10)

The 115 Standard Duty Loop Hanger, part of the CADDY® line of fasteners and supports from ERICO, is ideal for suspending stationary, non-insulated pipe lines, including CPVC pipes, in fire sprinkler systems. A knurled insert nut helps simplify vertical adjustments and flared edges on the base (1/2" to 4" sizes) help protect pipes from coming into contact with any sharp edges of the hanger.





Material: Steel
Finish: Pre-galvanized

FM APPROVED c UL us

Part Number	Pipe Size	Outer Diameter OD	Rod Size RS	A	B	C	Static Load F
1150050EG	1/2"	0.840"	3/8"	2 13/16"	1 1/8"	1"	300 lb
1150075EG	3/4"	1.050"	3/8"	3"	1 3/16"	15/16"	300 lb
1150100EG	1"	1.315"	3/8"	3 1/4"	1 3/8"	15/16"	300 lb
1150125EG	1 1/4"	1.660"	3/8"	3 9/16"	1 1/2"	15/16"	300 lb
1150150EG	1 1/2"	1.900"	3/8"	3 13/16"	1 5/8"	15/16"	300 lb
1150200EG	2"	2 3/8"	3/8"	4 1/4"	1 7/8"	15/16"	300 lb
1150250EG	2 1/2"	2 7/8"	3/8"	5 9/16"	2 13/16"	1 9/16"	525 lb
1150300EG	3"	3 1/2"	3/8"	6 9/16"	3 1/2"	1 15/16"	525 lb
1150350EG	3 1/2"	4"	3/8"	7 1/16"	3 3/4"	1 15/16"	585 lb
1150400EG	4"	4 1/2"	3/8"	7 9/16"	4"	1 15/16"	650 lb
1150500EG	5"	5 9/16"	1/2"	9 13/16"	4 3/4"	2 1/4"	1,000 lb
1150600EG	6"	6 5/8"	1/2"	11 5/16"	6 5/16"	3 5/16"	1,000 lb
1150800EG	8"	8 5/8"	1/2"	12 7/8"	6 7/8"	2 7/8"	1,000 lb

Surge Restraint

Features

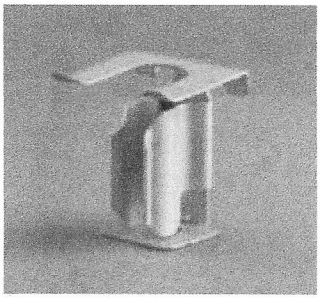
- Surge restraint for 115 standard duty loop hangers

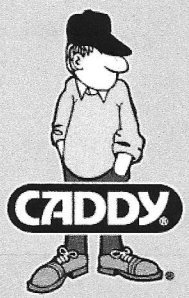
Specifications

Material: Steel
Finish: CADDY® ARMOUR

UL

Part Number	Pipe Size
SR6	1/2" – 2"





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WARNING
ERICO products shall be installed and used only as indicated in ERICO's product instruction sheets and training materials. Instruction sheets are available at www.erico.com and from your ERICO customer service representative. Improper installation, misuse, misapplication or other failure to completely follow ERICO's instructions and warnings may cause product malfunction, property damage, serious bodily injury and death.

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ERICO®

RSN:1827437
LT-24-2459794

HILTI ANCHORS FOR ATTACHMENTS TO HOLLOW CORE CONCRETE PANELS

INTRODUCTION

Hollow core concrete panels are used in many types of structures including office buildings, hotels, multi family residential units and others. The ease of jobsite construction makes hollow core concrete panels a convenient base material between floors of multi story structures. Other building elements, including partitons, supports, mechanical and electrical equipment, plumbing and other piping must be attached to or hung from these panels. Hilti provides a variety of anchoring systems for reliable connection to hollow core concrete panels. Hilti systems include several screw anchors (KH-EZ, KH-EZ P, KH-EZ I, and KH-EZ E), internally threaded flush anchors (HDI-P TZ, HDI-P) and adhesive anchors (HIT HY-270).

This document is a supplement to the Hilti North American Product Technical Guide, Volume 2, Anchor Fastening Technical Guide, Edition 19 (PTG Ed. 19). Please refer to the publication in its entirety, which is available at www.hilti.com or www.hilti.ca, for complete details including data development, product specifications, general suitability, installation, corrosion and spacing and edge distance guidelines.

KWIK HUS-EZ AND KWIK HUS-EZ P SCREW ANCHOR PRODUCT DESCRIPTION

KWIK HUS EZ carbon steel anchors

Anchor System		Features and Benefits
	Carbon Steel 1/4"-3/8" KWIK HUS-EZ	• OSHA 1926.1153 Table 1 compliant installation options including the Hilti SafeSet™ hollow drill bit technology • Easy installation using impact tool or torque wrench • Product and length identification marks facilitate quality control after installation • Through fixture installation improves productivity and accurate installation • Thread design enables quality setting and exceptional load values in wide variety of base material strengths • ¼” diameter available in hex head and pan head styles • Anchor is fully removable • Anchor diameter is same as drill bit diameter. No special diameter bit required
	Carbon Steel 1/4" KWIK HUS EZ P	

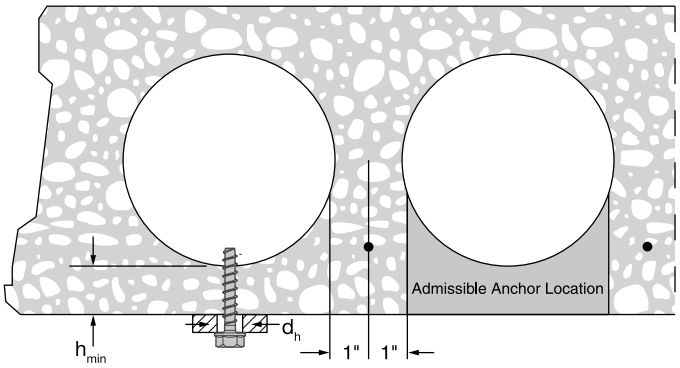
INSTALLATION PARAMETERS

Table 1 — KWIK HUS-EZ and KWIK HUS-EZ P specifications

Setting information	Symbol	Units	Nominal anchor diameter		
			1/4		3/8
Head style			Hex head	Pan head	Hex head
Nominal bit diameter	d_{bit}	in.	1/4		3/8
Minimum base material thickness	h_{min}	in.	1-1/8		
Minimum Fixture hole diameter	d_h	in.	3/8		1/2
Minimum anchor spacing	s_{min}	in.	4-1/8		
Minimum edge distance	c_{min}	in.	3-3/4		
Installation torque[1]	T_{inst}	ft-lb (Nm)	18 (24)		19 (26)
Maximum impact wrench torque rating[2]	$T_{impact, max}$	ft-lb (Nm)	114 (155)		
Wrench or Torx bit size		in.	7/16	T30	9/16

1 T_{inst} is the maximum installation torque that may be applied with a torque wrench.
2 Because of variability in measurement procedures, the published torque of an impact tool may not correlate properly with the above setting torques. Over torquing can damage the anchor and/or reduce its holding capacity.

Figure 1 — Installation of Hilti KWIK HUS-EZ (KH-EZ) and KWIK HUS-EZ P (KH-EZ P) in hollow core concrete panels



DESIGN INFORMATION

Table 2 — Hilti KWIK HUS-EZ (KH-EZ) and KWIK HUS-EZ P (KH-EZ P) loads in hollow core concrete panels[1,2]

Anchor Diameter (inches)	Min. effective embedment h_{ef} (inches)	Allowable loads, lb (kN)[3]				Ultimate load lb (kN)			
		Tension		Shear		Tension		Shear	
1/4	1-1/8	400	(1.8)	610	(2.7)	1600	(7.1)	2440	(10.9)
	1-3/8	525	(2.3)	770	(3.4)	2100	(9.3)	3080	(13.7)
3/8	1-1/8	435	(1.9)	890	(4.0)	1740	(7.7)	3560	(15.8)
	1-3/8	590	(2.6)	1405	(6.3)	2360	(10.5)	5620	(25.0)

1 The admissable anchor location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm admissable anchor location.
2 Minimum compressive strength of prestressed concrete is 7,000 psi. Published results represent the average results conducted in local base materials. Due to variations in materials and dimensional configurations, on-site testing is required to determine the actual performance
3 Allowable loads calculated with a factor of safety of 4.

ORDERING INFORMATION

Description	Hole Diameter	Total Length without Anchor Head	Qty (pcs) / Box
KH-EZ 1/4"x1-7/8"	1/4"	1-7/8"	100
KH-EZ 1/4"x2-5/8"	1/4"	2-5/8"	100
KH-EZ 1/4"x3"	1/4"	3"	100
KH-EZ 1/4"x3-1/2"	1/4"	3-1/2"	100
KH-EZ 1/4"x4"	1/4"	4"	100
KH-EZ P 1/4"x1-7/8”	1/4"	1-7/8"	100
KH-EZ P 1/4"x2-5/8"	1/4"	2-5/8"	100
KH-EZ 3/8"x1-7/8"	3/8"	1-7/8"	50
KH-EZ 3/8"x2-1/8"	3/8"	2-1/8"	50
KH-EZ 3/8"x3"	3/8"	3"	50
KH-EZ 3/8"x3-1/2"	3/8"	3-1/2"	50
KH-EZ 3/8"x4"	3/8"	4"	50
KH-EZ 3/8"x5"	3/8"	5"	30

KWIK HUS-EZ I AND KWIK HUS-EZ E SCREW ANCHOR PRODUCT DESCRIPTION

KWIK HUS EZ I and KWIK HUS-EZ E carbon steel anchors

Anchor System		Features and Benefits
	Carbon Steel 1/4", 3/8" KWIK HUS-EZ I	• OSHA 1926.1153 Table 1 compliant installation options including the Hilti SafeSet™ hollow drill bit technology • Easy installation using impact tool or torque wrench • Product and length identification marks facilitate quality control after installation • Thread design enables quality setting and exceptional load values in wide variety of base material strengths • 1/4" diameter available in internally and externally threaded head styles • Anchor is fully removable • Anchor diameter is same as drill bit diameter. No special diameter bit required
	Carbon Steel 1/4" KWIK HUS EZ E	

INSTALLATION PARAMETERS

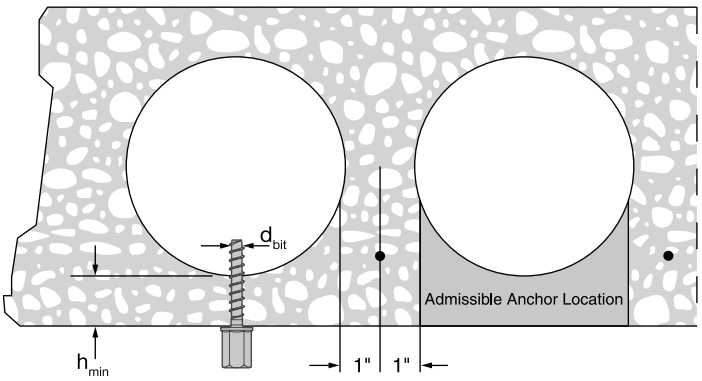
Table 3 — KWIK HUS-EZ I and KWIK HUS-EZ E specifications

Setting information	Symbol	Units	Nominal anchor diameter			
			1/4			3/8
Head style			KH-EZ E	KH-EZ I		
Nominal bit diameter	d_{bit}	in.	1/4			3/8
Threaded rod diameter	d_{rod}	in.	N/A	1/4	3/8	1/2
Minimum base material thickness	h_{min}	in.	1-1/8			
Minimum anchor spacing	s_{min}		4-1/8			
Minimum edge distance	c_{min}		3-3/4			
Installation torque[1]	T_{inst}	ft-lb (N-m)	18 (24)			40 (54)
Maximum impact wrench torque rating[2]	$T_{impact, max}$	ft-lb (Nm)	114 (155)			
Wrench size		in.	1/2	3/8	1/2	11/16

1 T_{inst} is the maximum installation torque that may be applied with a torque wrench.

2 Because of variability in measurement procedures, the published torque of an impact tool may not correlate properly with the above setting torques.
Over torquing can damage the anchor and/or reduce its holding capacity.

Figure 2 — Installation of Hilti KWIK HUS-EZ I (KH-EZ I) and KWIK HUS-EZ E (KH-EZ E) in hollow core concrete panels



RSN:1827437
LT-24-2459794

DESIGN INFORMATION

Table 4 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E loads in hollow core concrete panels[1,2]

Anchor Diameter (inches)	Hanger rod size	Min. effective embedment h_{ef} (inches)	Allowable loads, lb (kN)				Ultimate load lb (kN)			
			Tension[3]		Shear[3]		Tension		Shear	
1/4	14-20 UNC	1-1/8	400	(1.8)	215	(1.0)	1600	(7.1)	860	(3.8)
		1-3/8	525	(2.3)	585	(2.6)	2100	(9.3)	2340	(10.4)
	3/8-16 UNC	1-1/8	400	(1.8)	295	(1.3)	1600	(7.1)	1180	(5.2)
		1-3/8	525	(2.3)	665	(3.0)	2100	(9.3)	2660	(11.8)
3/8	1/2-13 UNC	1-1/8	435	(1.9)	370	(1.6)	1740	(7.7)	1480	(6.6)
		1-3/8	590	(2.6)	985	(4.4)	2360	(10.5)	3940	(17.5)

1 The admissable anchor location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm admissable anchor location.
2 Minimum compressive strength of prestressed concrete is 7,000 psi. Published results represent the average results conducted in local base materials. Due to variations in materials and dimensional configurations, on-site testing is required to determine the actual performance
3 Allowable loads calculated with a factor of safety of 4.

ORDERING INFORMATION

Description	Thread diameter	Thread length	Drill bit diameter	Qty/box
KWIK HUS-EZ 1/4x1-5/8 I 1/4	1/4	3/8	1/4	100
KWIK HUS-EZ 1/4x2-1/2 I 1/4	1/4	3/8	1/4	100
KWIK HUS-EZ 1/4x1-5/8 I 3/8	3/8	7/16	1/4	100
KWIK HUS-EZ 1/4x2-1/2 I 3/8	3/8	7/16	1/4	100
KWIK HUS-EZ 1/4x1-5/8 E 3/8	3/8	1	1/4	100
KWIK HUS-EZ 3/8x2-1/8 I 1/2	1/2	1/2	3/8	100

HDI-P DROP-IN ANCHORS
PRODUCT DESCRIPTION

HDI-P Drop-in Anchors

Anchor System	Features and Benefits
HDI-P Drop-in Anchor	• Optimized anchor length to allow reliable fastenings in hollow core panels, precast plank and post tensioned slabs • Shallow drilling enables fast installation • Lip provides flush installation, consistent anchor depth and easy rod alignment • HSD-G 3/8 setting tool with hand guard leaves mark on flange when anchor is set properly to enable inspection and verification of proper expansion

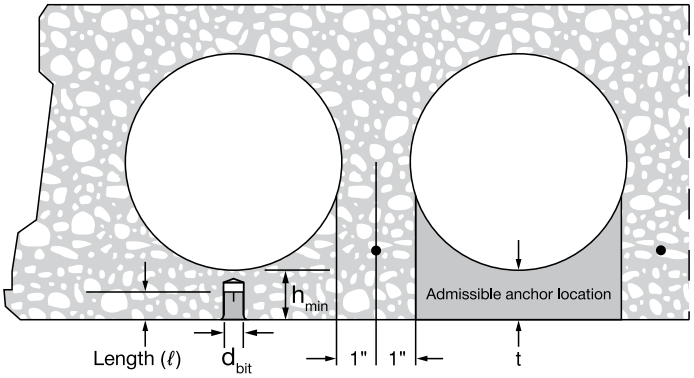
INSTALLATION PARAMETERS

Table 5 — HDI-P specifications

Setting information	Symbol	Units	Nominal anchor diameter		
			1/4	3/8	1/2
Nominal bit diameter	d_{bit}	in.	3/8	1/2	5/8
Threaded rod diameter	d_{rod}	in.	1/4	3/8	1/2
Minimum base material thickness	h_{min}	in.	1-3/8		
Anchor length	ℓ	in. (mm)	5/8 (15.9)	3/4 (19.1)	1 (25.4)
Hole depth in base material	h_0	in. (mm)	5/8 (15.9)	3/4 (19.1)	1 (25.4)
Minimum anchor spacing	s_{min}	in.	4-1/8		
Minimum edge distance	c_{min}	in.	3-3/4		

1 The Admissible Anchor Location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm Admissible Anchor Location.
2 Minimum compressive strength of hollow core panels is 7,000 psi at the time of installation. The minimum thickness h_{min} is 1-3/8 inches.

Figure 3 — Installation of Hilti HDI-P in hollow core concrete panels



DESIGN INFORMATION

Table 6 — Hilti HDI-P loads in hollow core concrete panels[1,2]

Nominal Anchor Diameter (inches)	Length in. (mm)		Nominal Bit Diameter in.	Allowable loads, lb (kN)[3]				Ultimate loads lb (kN)			
				Tension		Shear		Tension		Shear	
1/4	5/8	(15.9)	3/8	310	(1.4)	455	(2.0)	1,550	(6.9)	2,275	(10.1)
3/8	3/4	(19.1)	1/2	420	(1.9)	800	(3.6)	2,100	(9.3)	4,000	(17.8)
1/2	1	(25.4)	5/8	620	(2.8)	1100	(4.9)	3,100	(13.8)	5,500	(24.5)

1 The admissable anchor location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm admissable anchor location.
2 Minimum compressive strength of prestressed concrete is 7,000 psi. Published results represent the average results conducted in local base materials. Due to variations in materials and dimensional configurations, on-site testing is required to determine the actual performance.
3 Allowable loads calculated with a factor of safety of 5.

ORDERING INFORMATION

HDI-P anchor

Description	Bit diameter	Qty / box
HDI-P 1/4	3/8	100
HDI-P 3/8	1/2	100
HDI-P 1/2	5/8	50

Setting tools for HDI-P anchors HDI

Description
HST-P 1/4 Hand Setting Tool
HST-P 3/8 Hand Setting Tool
HSD-G 3/8 Hand Setting Tool with hand guard
HST-P 1/2 Hand Setting Tool

HDI-P TZ FLUSH ANCHORS
PRODUCT DESCRIPTION

HDI-P TZ Flush anchors

Anchor System		Features and Benefits
	Carbon steel HDI-P TZ	• Flush anchor anchor with optimized length for reliable fastenings in post-tensioned cable concrete slabs • Suitable for uncracked and cracked concrete including seismic areas • Productive installation with HDI-P TZ automatic setting tool with hammer drill • Used with Hilti Dust Removal System (DRS) for compliance with Table 1 of OSHA 1926.1153 regulations for silica dust exposure • Shallow drilling for fast installations • Easy installation with Auto Setting Tool • Lip provides flush installation, consistent anchor depth, and easy rod alignment • Auto Setting Tool includes stop drill bit and setting tool, no tool change necessary
	Auto-setting tool HDI-P TZ	
	Hand-setting tool HDI-P TZ	

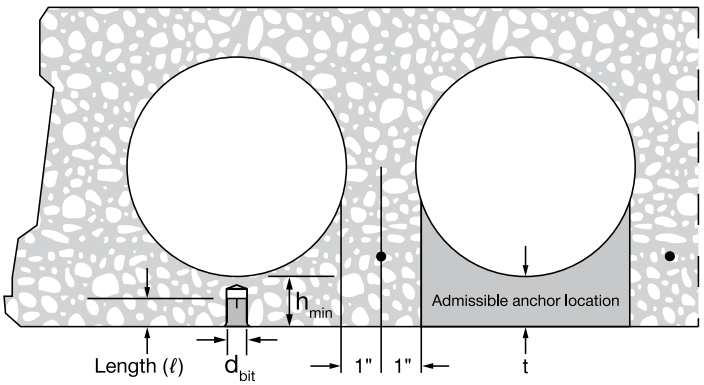
INSTALLATION PARAMETERS

Table 7 — HDI-P TZ Specifications

Setting information	Symbol	Unit	Nominal anchor size / internal thread dia. (in)
			3/8
Nominal bit diameter	d_{bit}	in.	9/16
Threaded rod diameter	d_{rod}	in.	3/8
Minimum base material thickness	h_{min}	in.	1-3/8
Anchor length	ℓ	in. (mm)	3/4 (19.1)
Hole depth in base material	h_0	in. (mm)	3/4 (19)
Minimum anchor spacing	s_{min}	in.	8
Minimum edge distance	c_{min}	in.	8

1 The Admissible Anchor Location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm Admissible Anchor Location.
2 Minimum compressive strength of hollow core panels is 7,000 psi at the time of installation. The minimum thickness h_{min} is 1-3/8 inches.

Figure 4 — Installation HDI-P TZ in hollow core concrete panels



DESIGN INFORMATION

Table 8 — Hilti HDI-P TZ loads in hollow core concrete panels[1,2]

Nominal Anchor Diameter (inches)	Length in. (mm)	Nominal Bit Diameter in.	Allowable loads, lb (kN)[3]		Ultimate loads lb (kN)	
			Tension	Shear	Tension	Shear
3/8	3/4 (19.1)	9/16	475 (2.1)	700 (3.1)	1,900 (8.5)	2,800 (12.5)

1 The admissable anchor location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm admissable anchor location.
2 Minimum compressive strength of prestressed concrete is 7,000 psi. Published results represent the average results conducted in local base materials. Due to variations in materials and dimensional configurations, on-site testing is required to determine the actual performance.
3 Allowable loads calculated with a factor of safety of 4.

ORDERING INFORMATION

HDI-P TZ anchor

Description	Bit diameter (inches)	Qty/box
HDI-P TZ 3/8"	9/16	100

Setting tools for HDI-P TZ anchors

Description
Auto setting tool HDI-P TZ 3/8"
Setting tool HST HDI-P TZ 3/8"x20

HIT-HY 270 ANCHORS
PRODUCT DESCRIPTION

HIT-HY 270 Adhesive Anchor System

Anchor System		Features and Benefits
	Hilti HIT-HY 270 Cartridge	• Injectable two-component hybrid adhesive mortar • Fast cure adhesive for quick installation time • Mixing nozzle provides proper mix ratio
	Hilti HAS Threaded rods	
	HIT-SC Screen	

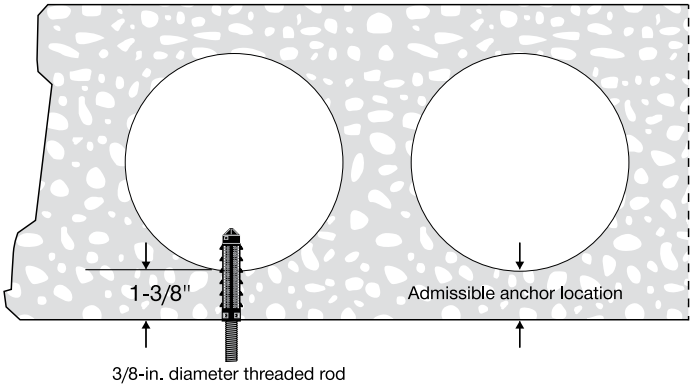
INSTALLATION PARAMETERS

Table 10 — Hilti Installation specifications for HAS threaded rod in hollowcore concrete panels

Setting information	Symbol	Unit	Nominal anchor size (in)
			3/8
Nominal bit diameter	d_o	in.	5/8
Screen size	HIT-SC	mm.	16x50
Depth Drilled	h_0	in.	Through drill
Installation torque	T_{inst}	ft.-lb (Nm)	2.2 (3)
Diameter of fixture hole	d_h	in.	7/16

1 The Admissible Anchor Location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm Admissible Anchor Location.
2 Minimum compressive strength of hollow core panels is 7,000 psi at the time of installation. The minimum thickness h_{min} is 1-3/8 inches.
3 Allowable loads calculated with a 5:1 factor-of-safety.

Figure 5 — Hilti HIT-HY 270 adhesive installed in hollow core concrete[1,2]



3/8-in. diameter threaded rod
in combination with HIT-SC 16 x 50 mm

1 Representation of the tested conditions for which allowable adhesive bond loads are applicable. Refer to footnotes of tables 10 and 11 for more information on requirements and restrictions on the admissible anchor installation.
2 Minimum edge distance is 6-inches.
Minimum spacing is:
- 8-inches along the length of each hollow core section.
- One anchor per hollow core section (left and right on page), 6-inches minimum between adjacent hollow core sections.

DESIGN INFORMATION

Table 11 — Hilti HIT-HY 270 loads for threaded rods in hollow core concrete panels[1,4,5,6,7]

Nominal Anchor Diameter (inches)	Effective embedment in. (mm)[2]		Nominal Bit Diameter in.	Allowable loads, lb (kN)[3]				Ultimate loads lb (kN)			
				Tension		Shear		Tension		Shear	
3/8	2	(19.1)	5/8	450	(2.0)	560	(2.5)	2,250	(10.0)	2,800	(12.5)

1 All values are for anchor installed in hollow core concrete with minimum compressive strength of 7,000 psi. Due to variations in materials and dimensional configurations, on-site testing is required to determine the actual performance of the anchor. Allowable loads are calculated using a safety factor of 5.

2 Tabulated embedment depth is limited by the plastic HIT-SC 16x50 mm screens. See figure 5.

3 The required concrete thickness is the thickness for which values are available and installation is recommended. Anchors shall be installed along the centerline of the hollow core or along the line of minimum thickness. Verify these requirements with the hollow core plank supplier before installation. The required thickness is measured from the inner to the outer side of hollow core panel. See figure 5.

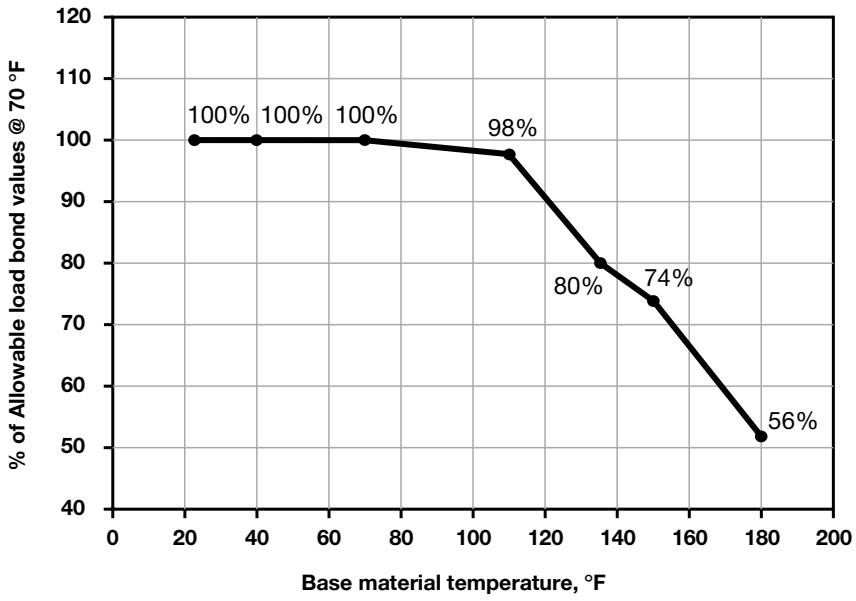
4 Tabulated allowable loads must be the lesser of the adjusted bond values tabulated and the steel values in table 3 of Section 3.2.5 of Hilti Product Technical Guide Volume 2, Ed. 19.

5 Allowable loads shall be adjusted for increased base material temperature in accordance with Figure 6.

6 The adhesive gel and cure times shall be identical to the values adopted for masonry.

7 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

Figure 6 — Influence of in-service base material temperature on bond loads for HIT-HY 270



ORDERING INFORMATION

HIT-HY 270 with mesh screen

Product Description
HIT-HY 270 Adhesive
HIT-SC 16 x 50 mm screen
HAS-E 3/8 threaded rod

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 or www.hilti.ca. 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.

The following excerpt are pages from the North American Product Technical Guide, Volume 2: Anchor Fastening, Edition 22.

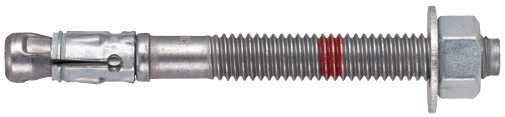
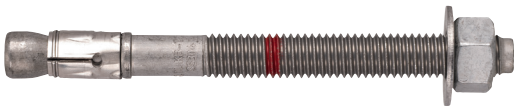
Please refer to the publication in its entirety for complete details on this product including data development, product specifications, general suitability, installation, corrosion and spacing and edge distance guidelines.
US&CA: https://submittals.us.hilti.com/PTGVol2/

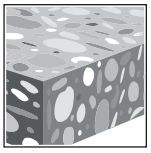
To consult directly with a team member regarding our anchor fastening products, contact Hilti's team of technical support specialists between the hours of 7:00am – 6:00pm CST.
US: 877-749-6337 or HNATechnicalServices@hilti.com
CA: 1-800-363-4458, ext. 6 or CATechnicalServices@hilti.com

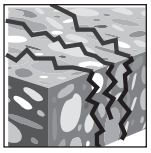
3.3.5 KWIK BOLT TZ2 EXPANSION ANCHOR

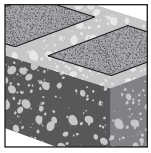
PRODUCT DESCRIPTION

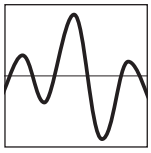
KWIK BOLT TZ2 Expansion anchor

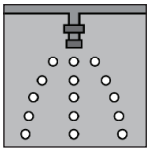
Anchor System	Features and Benefits
 Carbon steel KB-TZ2  Stainless Steel 304/316 KB-TZ2	• IFU provides multiple installation methods including no hole cleaning with hammer drill, Hilti Dust Removal System (DRS) for virtually dustless installation (OSHA 1926.1153 Table 1 compliant) and core drilling installation. • More 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 help facilitate quality control after installation. • Maximized thread lengths and multiple embedment depths to accommodate various base plate thicknesses. • Mechanical expansion allows immediate load application. • Raised impact section (dog point) helps protect threads from damage during installation. • Bolt meets ductility requirements of ACI 318 Section 2.3. • Functional coatings and profile on expansion wedges provide increased reliability.


Uncracked concrete


Cracked concrete


Grout-filled concrete masonry


Seismic Design Categories A-F


Fire sprinkler listings

Profis Engineering design software

Hollow Drill Bit and Adaptive Torque Tool (AT)

Approvals/ Listings

ICC-ES (International Code Council) • 2021 International Building Code / International Residential Code (IBC/IRC) • 2015 National Building Code of Canada (NBC-C)	ESR-4266 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193 ESR-4561 in grout-filled CMU per ICC-ES AC01 ELC-4266 in concrete per CSA A23.3 / ACI 355.2
City of Los Angeles	2020 LABC Supplement (within ESR-4266 & ESR-4561)
Florida Building Code	2020 FBC Supplement with HVHZ (within ESR-4266 & ESR-4561)
FM (Factory Mutual) — Carbon steel KB-TZ2 only	Pipe hanger components for automatic sprinkler systems 3/8 (up to 4-inch nominal pipe diameter) 1/2[1] (up to 8-inch nominal pipe diameter) 3/4 (up to 12-inch nominal pipe diameter)
UL and cUL (Underwriters Laboratory) — Carbon steel KB-TZ2 only	Pipe hanger equipment for fire protection services 3/8 (up to 4-inch nominal pipe diameter) 1/2[1] (up to 8-inch nominal pipe diameter) 5/8 & 3/4 (up to 12-inch nominal pipe diameter)
ANSI/MSS SP-58-2018	Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information.

ICC ES™ CITY LA DBS

FM APPROVED

CLASSIFIED C UL US LISTED
Pipe Hanger 757G

1 1/2-inch dia. with 1-1/2-inch effective embedment does not have FM or UL certification.

MATERIAL SPECIFICATIONS

Carbon steel with electroplated zinc-nickel plating

- Carbon steel anchor components plated in accordance with ASTM F1941 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 carbon or stainless steel.
- Nuts and bolts are finished with a proprietary coating. Only Hilti KB-TZ2 nuts can be used with KB-TZ2 bolts.
- Carbon steel bolts are manufactured from carbon steel.

Stainless steel

- 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 stainless steel.
- Nuts and bolts are finished with a proprietary coating. Only Hilti KB-TZ2 nuts can be used with KB-TZ2 bolts.
- Stainless steel 304 bolts are manufactured from AISI Type 304 stainless steel.
- Stainless steel 316 bolts are manufactured from AISI Type 316 stainless steel.

INSTALLATION PARAMETERS

Table 1 — Hilti KB-TZ2 setting information for installation in concrete and grout-filled concrete masonry units (CMU)[1]

Setting information		Symbol	Units	Nominal anchor diameter (in)																
				1/4	3/8			1/2				5/8			3/4			1		
Nominal bit diameter		d_o	in.	1/4	3/8			1/2				5/8			3/4			1		
Effective minimum embedment		h_{ef}	in.	1-1/2	1-1/2	2	2-1/2	1-1/2 [2]	2	2-1/2	3-1/4	2-3/4	3-1/4	4	3-1/4	3-3/4	4-3/4	4	5-3/4	
			(mm)	(38)	(38)	(51)	(64)	(38)	(51)	(64)	(83)	(70)	(83)	(102)	(83)	(95)	(121)	(102)	(146)	
Nominal minimum embedment		h_{nom}	in.	1-3/4	1-7/8	2-1/2	3	2 2)	2-1/2	3	3-3/4	3-1/4	3-3/4	4-1/2	4	4-1/2	5-1/2	4-5/8	6-3/8	
			(mm)	(44)	(48)	(64)	(76)	(51)	(64)	(76)	(95)	(83)	(95)	(114)	(102)	(114)	(140)	(117)	(162)	
Min. hole depth		h_o	in.	2	2	2-3/4	3-1/4	2-1/4 [2]	2-3/4	3-1/4	4-1/4	3-3/4	4-1/4	4-3/4	4-1/4	4-3/4	5-3/4	5	6-3/4	
			(mm)	(51)	(51)	(70)	(83)	(57)	(70)	(83)	(108)	(95)	(108)	(121)	(108)	(121)	(146)	(127)	(171)	
Fixture hole diameter		d_h	in.	5/16	7/16			9/16				11/16			13/16			1-1/8		
			(mm)	(7.9)	(11.1)			(14.3)				(17.5)			(20.6)			(28.6)		
Concrete	Installation torque Carbon steel	$T_{inst,conc}$	ft-lb	4	30			50				40			110			185		
			(Nm)	(5)	(41)			(68)				(54)			(149)			(251)		
	Installation torque Stainless steel	$T_{inst,conc}$	ft-lb	6	30			40				60			125			185		
			(Nm)	(8)	(41)			(54)				(81)			(169)			(251)		
Grout-filled CMU	Installation torque Carbon steel	$T_{inst,CMU}$	ft-lb	4	15			25				30			50			N/A		
			(Nm)	(5)	(20)			(34)				(41)			(68)			N/A		
	Installation torque Stainless steel	$T_{inst,CMU}$	ft-lb	6	15			25				35			50			N/A		
			(Nm)	(8)	(20)			(34)				(48)			(68)			N/A		

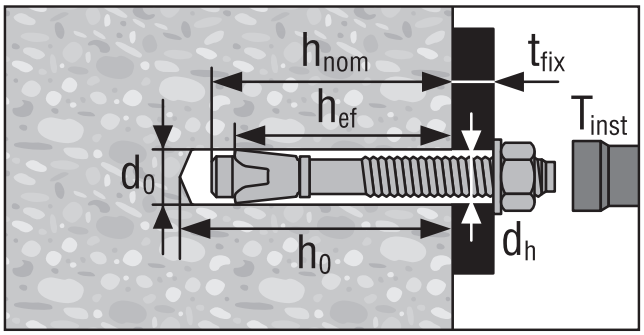
1 Shaded cells are not applicable for installations in grout-filled CMU.
2 Design information for h_{ef} = 1-1/2 is only applicable to carbon steel (CS) KB-TZ2 bolts.

Hilti KWIK Bolt TZ2 Fracture Load (lb)[1]

Nominal Anchor Diameter (in)	Carbon Steel	Stainless Steel
1/4	2920	2920
3/8	6490	6180
1/2	11240	11870
5/8	17535	18835
3/4	25335	$f_{uta} \geq 105$, $f_y \geq 84$ [2]
1	$f_{uta} \geq 88$, $f_y \geq 75$ [2]	$f_{uta} \geq 99.9$, $f_y \geq 65$ [2]

1 Bolt fracture loads are determined by testing in a universal tensile machine for quality control at the manufacturing facility. These loads are not intended for design use.
2 All 3/4-in. stainless steel, all 1-in. carbon steel and all 1-in. stainless steel material strengths specified by the tensile and yield strengths expressed in (ksi). Bolt fracture loads not applicable for these models.

Figure 1 — Hilti KWIK Bolt TZ 2 specifications



DESIGN INFORMATION IN CONCRETE PER ACI 318

ACI 318 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 ICC-ES ESR-4266 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables refer to section 3.1.8. Data tables from ESR-4266 are not contained in this section but can be found at www.icc-es.org or at www.hilti.com

Table 2 — Hilti Carbon Steel KB-TZ2 design strength based on concrete failure modes in uncracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
1/4	1-1/2 (38)	1 3/4 (44)	945 (4.2)	980 (4.4)	1,040 (4.6)	1,125 (5.0)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
3/8	1-1/2 (38)	1 7/8 (48)	1,435 (6.4)	1,570 (7.0)	1,815 (8.1)	2,220 (9.9)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
	2 (51)	2 1/2 (64)	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)
	2-1/2 (64)	3 (76)	2,715 (12.1)	2,895 (12.9)	3,205 (14.3)	3,690 (16.4)	6,640 (29.5)	7,275 (32.4)	8,400 (37.4)	10,290 (45.8)
1/2	1-1/2 (38)	2 (51)	1,610 (7.2)	1,765 (7.9)	2,040 (9.1)	2,495 (11.1)	1,735 (7.7)	1,900 (8.5)	2,195 (9.8)	2,690 (12.0)
	2 (51)	2 1/2 (64)	2,480 (11.0)	2,720 (12.1)	3,140 (14.0)	3,845 (17.1)	2,675 (11.9)	2,930 (13.0)	3,380 (15.0)	4,140 (18.4)
	2-1/2 (64)	3 (76)	3,085 (13.7)	3,375 (15.0)	3,900 (17.3)	4,775 (21.2)	6,640 (29.5)	7,275 (32.4)	8,400 (37.4)	10,290 (45.8)
	3-1/4 (83)	3 3/4 (95)	4,570 (20.3)	5,005 (22.3)	5,780 (25.7)	7,080 (31.5)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	2-3/4 (70)	3 1/4 (83)	3,495 (15.5)	3,830 (17.0)	4,425 (19.7)	5,420 (24.1)	7,660 (34.1)	8,395 (37.3)	9,690 (43.1)	11,870 (52.8)
	3-1/4 (83)	3 3/4 (95)	4,570 (20.3)	5,005 (22.3)	5,780 (25.7)	7,080 (31.5)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
	4 (102)	4 1/2 (114)	5,845 (26.0)	6,405 (28.5)	7,395 (32.9)	9,060 (40.3)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-1/4 (83)	4 (102)	5,140 (22.9)	5,630 (25.0)	6,505 (28.9)	7,965 (35.4)	11,075 (49.3)	12,130 (54.0)	14,005 (62.3)	17,155 (76.3)
	3-3/4[5] (95)	4 1/2 (114)	6,370 (28.3)	6,980 (31.0)	8,060 (35.9)	9,870 (43.9)	13,725 (61.1)	15,035 (66.9)	17,360 (77.2)	21,265 (94.6)
	4-3/4 (121)	5 1/2 (140)	8,075 (35.9)	8,845 (39.3)	10,215 (45.4)	12,510 (55.6)	17,390 (77.4)	19,050 (84.7)	22,000 (97.9)	26,945 (119.9)
1	4 (102)	4 5/8 (117)	7,020 (31.2)	7,690 (34.2)	8,880 (39.5)	10,875 (48.4)	15,120 (67.3)	16,565 (73.7)	19,125 (85.1)	23,425 (104.2)
	5-3/4 (146)	6 3/8 (162)	10,755 (47.8)	11,780 (52.4)	13,605 (60.5)	16,660 (74.1)	23,165 (103.0)	25,375 (112.9)	29,300 (130.3)	35,885 (159.6)

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 15 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 For core drilled installations of 3/4" anchors installed at 3-3/4" effective embedment, apply a reduction factor of 0.89 to the design tension strength.

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Table 3 — Hilti Carbon Steel KB-TZ2 design strength based on concrete failure modes in cracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4,5]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
1/4	1-1/2	1 3/4	280	300	340	395	1,095	1,195	1,385	1,695
	(38)	(44)	(1.2)	(1.3)	(1.5)	(1.8)	(4.9)	(5.3)	(6.2)	(7.5)
3/8	1-1/2	1 7/8	1,255	1,375	1,585	1,940	1,350	1,480	1,710	2,090
	(38)	(48)	(5.6)	(6.1)	(7.1)	(8.6)	(6.0)	(6.6)	(7.6)	(9.3)
	2	2 1/2	1,930	2,115	2,440	2,990	2,080	2,275	2,630	3,220
	(51)	(64)	(8.6)	(9.4)	(10.9)	(13.3)	(9.3)	(10.1)	(11.7)	(14.3)
	2-1/2	3	2,185	2,390	2,765	3,385	4,705	5,155	5,950	7,285
	(64)	(76)	(9.7)	(10.6)	(12.3)	(15.1)	(20.9)	(22.9)	(26.5)	(32.4)
1/2	1-1/2	2	1,435	1,570	1,815	2,220	1,545	1,690	1,950	2,390
	(38)	(51)	(6.4)	(7.0)	(8.1)	(9.9)	(6.9)	(7.5)	(8.7)	(10.6)
	2	2 1/2	1,930	2,115	2,440	2,990	2,080	2,275	2,630	3,220
	(51)	(64)	(8.6)	(9.4)	(10.9)	(13.3)	(9.3)	(10.1)	(11.7)	(14.3)
	2-1/2	3	2,700	2,955	3,415	4,180	5,810	6,365	7,350	9,000
	(64)	(76)	(12.0)	(13.1)	(15.2)	(18.6)	(25.8)	(28.3)	(32.7)	(40.0)
	3-1/4	3 3/4	3,235	3,545	4,095	5,015	6,970	7,640	8,820	10,800
	(83)	(95)	(14.4)	(15.8)	(18.2)	(22.3)	(31.0)	(34.0)	(39.2)	(48.0)
5/8	2-3/4	3 1/4	3,110	3,410	3,935	4,820	6,705	7,345	8,480	10,385
	(70)	(83)	(13.8)	(15.2)	(17.5)	(21.4)	(29.8)	(32.7)	(37.7)	(46.2)
	3-1/4	3 3/4	4,000	4,380	5,060	6,195	8,615	9,435	10,895	13,345
	(83)	(95)	(17.8)	(19.5)	(22.5)	(27.6)	(38.3)	(42.0)	(48.5)	(59.4)
	4	4 1/2	4,420	4,840	5,590	6,845	9,520	10,430	12,040	14,750
	(102)	(114)	(19.7)	(21.5)	(24.9)	(30.4)	(42.3)	(46.4)	(53.6)	(65.6)
3/4	3-1/4	4	4,000	4,380	5,060	6,195	8,615	9,435	10,895	13,345
	(83)	(102)	(17.8)	(19.5)	(22.5)	(27.6)	(38.3)	(42.0)	(48.5)	(59.4)
	3-3/4	4 1/2	4,955	5,430	6,270	7,680	10,675	11,695	13,505	16,540
	(95)	(114)	(22.0)	(24.2)	(27.9)	(34.2)	(47.5)	(52.0)	(60.1)	(73.6)
	4-3/4	5 1/2	5,745	6,055	6,580	7,405	15,220	16,670	19,250	23,575
	(121)	(140)	(25.6)	(26.9)	(29.3)	(32.9)	(67.7)	(74.2)	(85.6)	(104.9)
1	4	4 5/8	5,460	5,980	6,905	8,460	11,760	12,880	14,875	18,220
	(102)	(117)	(24.3)	(26.6)	(30.7)	(37.6)	(52.3)	(57.3)	(66.2)	(81.0)
	5-3/4	6 3/8	7,675	8,410	9,710	11,890	20,270	22,205	25,640	31,400
	(146)	(162)	(34.1)	(37.4)	(43.2)	(52.9)	(90.2)	(98.8)	(114.1)	(139.7)

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 17 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.73. No reduction needed for seismic shear. See Section 3.1.8 for additional information on seismic applications.

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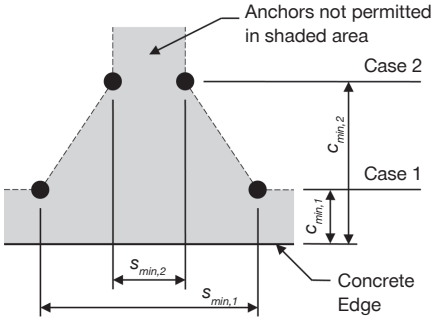
Table 4 — Hilti Carbon Steel KB-TZ2 design strength based on steel failure per ACI 318 Ch. 17 [1,2]

Nominal anchor diameter in.	Effective embedment depth in. (mm)	Tensile [3] ΦN_{sa} lb (kN)	Shear [4] ΦV_{sa} lb (kN)	Seismic Shear [5] ΦV_{sa} lb (kN)
1/4	1-1/2 (38)	2,190 (9.7)	875 (3.9)	875 (3.9)
3/8	1-1/2 (38)	4,870 (21.7)	2,095 (9.3)	2,095 (9.3)
3/8	2 (51) | 2-1/2 (64)	4,870 (21.7)	2,200 (9.8)	2,200 (9.8)
1/2	1-1/2 (38) | 2 (51)	8,430 (37.5)	3,600 (16.0)	3,600 (16.0)
1/2	2-1/2 (64) | 3-1/4 (83)	8,430 (37.5)	4,470 (19.9)	4,470 (19.9)
5/8	2-3/4 (70) | 3-1/4 (83) | 4 (102)	13,150 (58.5)	6,665 (29.6)	6,665 (29.6)
3/4	3-1/4 (83) | 3-3/4 (95) | 4-3/4 (121)	19,000 (84.5)	8,975 (39.9)	8,975 (39.9)
1 (25.4)	4 (102)	31,025 (138.0)	12,215 (54.3)	8,975 (39.9)
1 (25.4)	5-3/4 (146)	31,025 (138.0)	14,875 (66.2)	8,975 (39.9)

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KB-TZ2 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 Ch. 17.
4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17. See Section 3.1.8 for additional information on seismic applications.

Figure 2



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

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

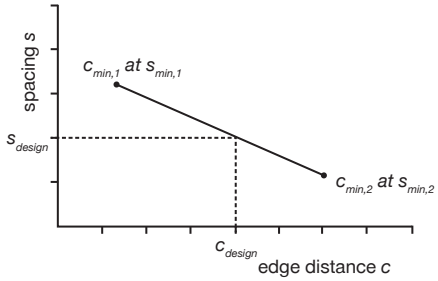


Table 5 — Hilti KB-TZ2 carbon steel installation parameters [1]

Setting information	Symbol	Units	Nominal Anchor diameter (in.)														
			1/4	3/8			1/2				5/8			3/4		1	
Effective embedment	h_{ef}	in.	1-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	3 1/4	2-3/4	3-1/4	4	3-1/4	3-3/4	4-3/4	4	5-3/4
		(mm)	(38)	(38)	(51)	(64)	(38)	(51)	(64)	(83)	(70)	(83)	(102)	(83)	(95)	(121)	(102)	(146)
Min. member thickness	h_{min}	in.	3-1/4	3-1/4	4	5	3-1/2	4	5	5-1/2	5	5-1/2	6	5-1/2	6	8	8	10
		(mm)	(83)	(83)	(102)	(127)	(89)	(102)	(127)	(140)	(127)	(140)	(152)	(140)	(152)	(203)	(203)	(254)
Case 1	$c_{min,1}$	in.	1-1/2	5	2-1/2	2-1/2	8	2-3/4	2-3/4	2-1/4	4-1/2	3-1/2	2-3/4	5	4	3-1/2	8	3
		(mm)	(38)	(127)	(64)	(64)	(203)	(70)	(70)	(57)	(114)	(89)	(70)	(127)	(102)	(89)	(203)	(76)
	for $s_{min,1} \geq$	in.	1-1/2	8	6	5	12	5-1/2	9-3/4	5-1/4	6-1/2	5-1/2	7-1/4	10	5-3/4	5-1/2	8	6-3/4
		(mm)	(38)	(203)	(152)	(127)	(305)	(140)	(248)	(133)	(165)	(140)	(184)	(254)	(146)	(140)	(203)	(171)
Case 2	$c_{min,2}$	in.	1-1/2	8	3-1/2	4	8	10	8	4-3/4	5-1/2	7	4-1/4	6	7-1/4	4-3/4	8	3-3/4
		(mm)	(38)	(203)	(89)	(102)	(203)	(254)	(203)	(121)	(140)	(178)	(108)	(152)	(184)	(121)	(203)	(95)
	for $s_{min,2} \geq$	in.	1-1/2	5	2-1/4	2	12	3-1/2	3	2	4-1/2	2-3/4	2-1/4	4-1/2	3-3/4	3-3/4	8	4-3/4
			(38)	(127)	(57)	(51)	(305)	(89)	(76)	(51)	(114)	(70)	(57)	(114)	(95)	(95)	(203)	(121)

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

Table 6 — Load adjustment factors for Carbon Steel 1/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

1/4-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear [3] f_{AV}	⊥ Toward edge f_{RV}	∥ To edge f_{RV}	Concrete thickness factor in shear [4] f_{HV}
Effective Embedment h_{ef}	in.		1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2
	(mm)		(38)	(38)	(38)	(38)	(38)	(38)
Nominal Embedment h_{nom}	in.		1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4
	(mm)		(44)	(44)	(44)	(44)	(44)	(44)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2	(38)	0.67	0.42	0.56	0.23	0.42	n/a
	2	(51)	0.72	0.51	0.58	0.35	0.51	n/a
	2-1/2	(64)	0.78	0.63	0.60	0.49	0.63	n/a
	3	(76)	0.83	0.75	0.63	0.65	0.75	n/a
	3-1/4	(83)	0.86	0.81	0.64	0.73	0.81	0.74
	3-1/2	(89)	0.89	0.88	0.65	0.82	0.88	0.76
	4	(102)	0.94	1.00	0.67	1.00	1.00	0.82
	5	(127)	1.00		0.71			0.91
	6	(152)			0.75			1.00
	7	(178)			0.79			
	8	(203)			0.83			
	9	(229)			0.88			
	> 12	(305)			1.00			

3.3.5

Table 7 — Load adjustment factors for Carbon Steel 1/4-in. diameter KB-TZ2 in cracked concrete [1,2]

1/4-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}	Edge distance factor in tension f_{RN}	Spacing factor in shear [3] f_{AV}	⊥ Toward edge f_{RV}	∥ To edge f_{RV}	Concrete thickness factor in shear [4] f_{HV}
Effective Embedment h_e	in.		1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2
	(mm)		(38)	(38)	(38)	(38)	(38)	(38)
Nominal Embedment h_{nom}	in.		1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4
	(mm)		(44)	(44)	(44)	(44)	(44)	(44)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2	(38)	0.67	0.75	0.57	0.29	0.59	n/a
	2	(51)	0.72	0.91	0.60	0.45	0.91	n/a
	2-1/2	(64)	0.78	1.00	0.62	0.63	1.00	n/a
	3	(76)	0.83		0.65	0.83		n/a
	3-1/4	(83)	0.86		0.66	0.94		0.80
	3-1/2	(89)	0.89		0.67	1.00		0.83
	4	(102)	0.94		0.70			0.89
	5	(127)	1.00		0.75			0.99
	6	(152)			0.80			1.00
	7	(178)			0.84			
	8	(203)			0.89			
	9	(229)			0.94			
	> 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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

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Table 8 — Load adjustment factors for Carbon Steel 3/8-in. diameter KB-TZ2 in uncracked concrete [1,2]

3/8-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2
		(mm)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)
Nominal Embedment h_{nom}		in.	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3
		(mm)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2	(51)	n/a	n/a	0.63	n/a	n/a	n/a	n/a	n/a	0.54	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	0.69	0.65	n/a	n/a	n/a	n/a	0.59	0.55	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	n/a	0.71	0.67	n/a	0.60	0.51	n/a	0.60	0.55	n/a	0.43	0.18	n/a	0.60	0.37	n/a	n/a	n/a
	3	(76)	n/a	0.75	0.70	n/a	0.69	0.58	n/a	0.61	0.56	n/a	0.57	0.24	n/a	0.69	0.48	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.77	0.72	n/a	0.74	0.61	n/a	0.62	0.57	n/a	0.64	0.27	n/a	0.74	0.54	0.66	n/a	n/a
	3-1/2	(89)	n/a	0.79	0.73	n/a	0.80	0.65	n/a	0.63	0.58	n/a	0.72	0.30	n/a	0.80	0.61	0.68	n/a	n/a
	4	(102)	n/a	0.83	0.77	n/a	0.91	0.73	n/a	0.65	0.59	n/a	0.87	0.37	n/a	0.91	0.73	0.73	0.78	n/a
	5	(127)	1.00	0.92	0.83	1.00	1.00	0.91	0.67	0.69	0.61	1.00	1.00	0.52	1.00	1.00	0.91	0.82	0.87	0.66
	6	(152)	1.00	1.00	0.90	1.00		1.00	0.70	0.73	0.63	1.00		0.68	1.00		1.00	0.89	0.96	0.72
	8	(203)	1.00		1.00	1.00			0.77	0.80	0.67	1.00		1.00	1.00			1.00	1.00	0.83
	12	(305)							0.90	0.96	0.76									1.00
	18	(457)							1.00	1.00	0.89									
	> 24	(610)									1.00									

Table 9 — Load adjustment factors for Carbon Steel 3/8-in. diameter KB-TZ2 in cracked concrete [1,2]

3/8-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2
		(mm)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)
Nominal Embedment h_{nom}		in.	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3
		(mm)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2	(51)	n/a	n/a	0.63	n/a	n/a	n/a	n/a	n/a	0.54	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	0.69	0.65	n/a	n/a	n/a	n/a	0.58	0.55	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	n/a	0.71	0.67	n/a	0.87	0.75	n/a	0.59	0.55	n/a	0.40	0.18	n/a	0.80	0.37	n/a	n/a	n/a
	3	(76)	n/a	0.75	0.70	n/a	1.00	0.85	n/a	0.61	0.56	n/a	0.52	0.24	n/a	1.00	0.48	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.77	0.72	n/a	1.00	0.90	n/a	0.62	0.57	n/a	0.59	0.27	n/a	1.00	0.55	0.78	n/a	n/a
	3-1/2	(89)	n/a	0.79	0.73	n/a	1.00	0.95	n/a	0.63	0.58	n/a	0.66	0.31	n/a	1.00	0.61	0.81	n/a	n/a
	4	(102)	n/a	0.83	0.77	n/a		1.00	n/a	0.64	0.59	n/a	0.81	0.37	n/a		0.75	0.86	0.76	n/a
	5	(127)	1.00	0.92	0.83	1.00			0.73	0.68	0.61	1.00	1.00	0.52	1.00		1.00	0.96	0.85	0.66
	6	(152)	1.00	1.00	0.90	1.00			0.78	0.72	0.63	1.00		0.69	1.00			1.00	0.93	0.72
	8	(203)	1.00		1.00	1.00			0.87	0.79	0.67	1.00		1.00	1.00				1.00	0.83
	12	(305)							1.00	0.93	0.76									1.00
	18	(457)								1.00	0.89									
	> 24	(610)									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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

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Table 10 — Load adjustment factors for Carbon Steel 1/2-in. diameter KB-TZ2 in uncracked concrete [1,2]

1/2-in. KB-TZ2 uncracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear [3] f_{AV}				Edge distance in shear ⊥ Toward edge f_{RV}				Edge distance in shear ∥ To edge f_{RV}				Concrete thickness factor in shear [4] f_{HV}			
Effective Embedment h_{ef}	in.	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4
	(mm)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)
Nominal Embedment h_{nom}	in.	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4
	(mm)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)																									
2	(51)	n/a	n/a	n/a	0.60	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.53	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2-1/4	(57)	n/a	n/a	n/a	0.62	n/a	n/a	n/a	0.30	n/a	n/a	n/a	0.54	n/a	n/a	n/a	0.11	n/a	n/a	n/a	0.21	n/a	n/a	n/a	n/a
2-3/4	(70)	n/a	n/a	n/a	0.64	n/a	0.51	0.44	0.33	n/a	n/a	n/a	0.55	n/a	0.35	0.23	0.14	n/a	0.51	0.44	0.29	n/a	n/a	n/a	n/a
3	(76)	n/a	n/a	0.70	0.65	n/a	0.55	0.47	0.35	n/a	n/a	0.57	0.55	n/a	0.40	0.26	0.16	n/a	0.55	0.47	0.33	n/a	n/a	n/a	n/a
3-1/4	(83)	n/a	n/a	0.72	0.67	n/a	0.59	0.50	0.37	n/a	n/a	0.57	0.55	n/a	0.45	0.30	0.19	n/a	0.59	0.50	0.37	0.52	n/a	n/a	n/a
3-1/2	(89)	n/a	0.79	0.73	0.68	n/a	0.64	0.53	0.38	n/a	0.61	0.58	0.56	n/a	0.51	0.33	0.21	n/a	0.64	0.53	0.38	0.54	n/a	n/a	n/a
4	(102)	n/a	0.83	0.77	0.71	n/a	0.73	0.59	0.42	n/a	0.62	0.59	0.57	n/a	0.62	0.40	0.25	n/a	0.73	0.59	0.42	0.58	0.70	n/a	n/a
4-3/4	(121)	n/a	0.90	0.82	0.74	n/a	0.86	0.70	0.48	n/a	0.64	0.61	0.58	n/a	0.80	0.52	0.33	n/a	0.86	0.70	0.48	0.63	0.76	n/a	n/a
5	(127)	n/a	0.92	0.83	0.76	n/a	0.91	0.74	0.50	n/a	0.65	0.61	0.58	n/a	0.87	0.56	0.35	n/a	0.91	0.74	0.50	0.65	0.78	0.67	n/a
5-1/4	(133)	n/a	0.94	0.85	0.77	n/a	0.95	0.78	0.53	n/a	0.66	0.62	0.59	n/a	0.93	0.61	0.38	n/a	0.95	0.78	0.53	0.66	0.80	0.69	n/a
5-1/2	(140)	n/a	0.96	0.87	0.78	n/a	1.00	0.81	0.55	n/a	0.67	0.63	0.59	n/a	1.00	0.65	0.41	n/a	1.00	0.81	0.55	0.68	0.82	0.71	0.61
6	(152)	n/a	1.00	0.90	0.81	n/a	1.00	0.89	0.60	n/a	0.68	0.64	0.60	n/a	1.00	0.74	0.46	n/a	1.00	0.89	0.60	0.71	0.85	0.74	0.63
8	(203)	n/a		1.00	0.91	1.00	1.00	1.00	0.80	n/a	0.74	0.68	0.63	1.00	1.00	1.00	0.72	1.00	1.00	1.00	0.80	0.82	0.98	0.85	0.73
9-3/4	(248)	n/a		1.00	1.00		1.00		0.98	n/a	0.80	0.72	0.66		1.00		0.96		1.00		0.98	0.90	1.00	0.94	0.81
10	(254)	n/a					1.00		1.00	n/a	0.80	0.73	0.67		1.00		1.00		1.00		1.00	0.91		0.95	0.82
12	(305)	1.00								0.75	0.86	0.77	0.70									1.00		1.00	0.89
24	(610)									1.00	1.00	1.00	0.90												1.00
> 30	(762)												1.00												

3.3.5

Table 11 — Load adjustment factors for Carbon Steel 1/2-in. diameter KB-TZ2 in cracked concrete [1,2]

1/2-in. KB-TZ2 cracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear [3] f_{AV}				Edge distance in shear ⊥ Toward edge f_{RV}				Edge distance in shear ∥ To edge f_{RV}				Concrete thickness factor in shear [4] f_{HV}			
Effective Embedment h_{ef}	in.	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4	1-1/2	2	2-1/2	3-1/4
	(mm)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)	(38)	(51)	(64)	(83)
Nominal Embedment h_{nom}	in.	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4	2	2-1/2	3	3-3/4
	(mm)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)	(51)	(64)	(76)	(95)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)																									
2	(51)	n/a	n/a	n/a	0.60	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.54	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2-1/4	(57)	n/a	n/a	n/a	0.62	n/a	n/a	n/a	0.61	n/a	n/a	n/a	0.54	n/a	n/a	n/a	0.12	n/a	n/a	n/a	0.24	n/a	n/a	n/a	n/a
2-3/4	(70)	n/a	n/a	n/a	0.64	n/a	0.93	0.80	0.68	n/a	n/a	n/a	0.55	n/a	0.50	0.19	0.16	n/a	0.93	0.38	0.33	n/a	n/a	n/a	n/a
3	(76)	n/a	n/a	0.70	0.65	n/a	1.00	0.85	0.71	n/a	n/a	0.56	0.55	n/a	0.57	0.21	0.19	n/a	1.00	0.43	0.38	n/a	n/a	n/a	n/a
3-1/4	(83)	n/a	n/a	0.72	0.67	n/a	1.00	0.90	0.75	n/a	n/a	0.56	0.56	n/a	0.64	0.24	0.21	n/a	1.00	0.48	0.42	0.76	n/a	n/a	n/a
3-1/2	(89)	n/a	0.79	0.73	0.68	n/a	1.00	0.95	0.79	n/a	0.63	0.57	0.56	n/a	0.72	0.27	0.24	n/a	1.00	0.54	0.47	0.79	n/a	n/a	n/a
4	(102)	n/a	0.83	0.77	0.71	n/a	1.00	1.00	0.86	n/a	0.65	0.58	0.57	n/a	0.88	0.33	0.29	n/a	1.00	0.66	0.58	0.85	0.78	n/a	n/a
4-3/4	(121)	n/a	0.90	0.82	0.74	n/a	1.00	1.00	0.98	n/a	0.68	0.59	0.59	n/a	1.00	0.43	0.37	n/a	1.00	0.85	0.75	0.92	0.85	n/a	n/a
5	(127)	n/a	0.92	0.83	0.76	n/a	1.00	1.00	1.00	n/a	0.69	0.60	0.59	n/a	1.00	0.46	0.40	n/a	1.00	0.92	0.81	0.95	0.87	0.63	n/a
5-1/4	(133)	n/a	0.94	0.85	0.77	n/a	1.00	1.00		n/a	0.70	0.60	0.60	n/a	1.00	0.49	0.43	n/a	1.00	0.99	0.87	0.97	0.90	0.65	n/a
5-1/2	(140)	n/a	0.96	0.87	0.78	n/a	1.00	1.00		n/a	0.71	0.61	0.60	n/a	1.00	0.53	0.47	n/a	1.00	1.00	0.93	0.99	0.92	0.66	0.63
6	(152)	n/a	1.00	0.90	0.81	n/a	1.00	1.00		n/a	0.73	0.62	0.61	n/a	1.00	0.60	0.53	n/a	1.00	1.00	1.00	1.00	0.96	0.69	0.66
8	(203)	n/a		1.00	0.91	1.00	1.00	1.00		n/a	0.81	0.66	0.65	1.00	1.00	0.93	0.82	1.00	1.00	1.00			1.00	0.80	0.76
9-3/4	(248)	n/a		1.00	1.00		1.00			n/a	0.87	0.69	0.68		1.00	1.00	1.00		1.00					0.88	0.84
10	(254)	n/a					1.00			n/a	0.88	0.70	0.68		1.00				1.00					0.89	0.85
12	(305)	1.00								1.00	0.96	0.74	0.72											0.98	0.94
24	(610)										1.00	0.98	0.94											1.00	1.00
> 30	(762)											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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

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Table 12 — Load adjustment factors for Carbon Steel 5/8-in. diameter KB-TZ2 in uncracked concrete [1,2]

5/8-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4
		(mm)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)
Nominal Embedment h_{nom}		in.	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2
		(mm)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/4	(57)	n/a	0.62	n/a	n/a	n/a	0.38	n/a	0.53	n/a	n/a	n/a	0.10	n/a	n/a	0.20	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.64	0.61	n/a	n/a	0.42	n/a	0.54	0.54	n/a	n/a	0.13	n/a	n/a	0.27	n/a	n/a	n/a
	3	(76)	n/a	0.65	0.63	n/a	0.30	0.44	n/a	0.54	0.55	n/a	0.13	0.15	n/a	0.27	0.30	n/a	n/a	n/a
	3-1/2	(89)	n/a	0.68	0.65	n/a	0.33	0.48	n/a	0.55	0.56	n/a	0.17	0.19	n/a	0.33	0.38	n/a	n/a	n/a
	4	(102)	0.74	0.71	0.67	0.40	0.37	0.51	0.57	0.56	0.56	0.25	0.21	0.23	0.40	0.37	0.47	n/a	n/a	n/a
	4-1/2	(114)	0.77	0.73	0.69	0.45	0.40	0.56	0.58	0.57	0.57	0.30	0.24	0.28	0.45	0.40	0.56	n/a	n/a	n/a
	5	(127)	0.80	0.76	0.71	0.50	0.43	0.60	0.58	0.57	0.58	0.35	0.29	0.33	0.50	0.43	0.60	0.58	n/a	n/a
	5-1/2	(140)	0.83	0.78	0.73	0.55	0.48	0.64	0.59	0.58	0.59	0.41	0.33	0.38	0.55	0.48	0.64	0.61	0.56	n/a
	6	(152)	0.86	0.81	0.75	0.60	0.52	0.69	0.60	0.59	0.59	0.46	0.38	0.43	0.60	0.52	0.69	0.63	0.59	0.62
	6-1/2	(165)	0.89	0.83	0.77	0.65	0.57	0.74	0.61	0.59	0.60	0.52	0.42	0.48	0.65	0.57	0.74	0.66	0.61	0.64
	7	(178)	0.92	0.86	0.79	0.70	0.61	0.80	0.62	0.60	0.61	0.59	0.47	0.54	0.70	0.61	0.80	0.68	0.64	0.67
	7-1/4	(184)	0.94	0.87	0.80	0.73	0.63	0.83	0.62	0.61	0.61	0.62	0.50	0.57	0.73	0.63	0.83	0.70	0.65	0.68
	12	(305)	1.00	1.00	1.00	1.00	1.00	1.00	0.70	0.67	0.69	1.00	1.00	1.00	1.00	1.00	1.00	0.89	0.83	0.87
	24	(610)							0.90	0.85	0.88							1.00	1.00	1.00
	> 36	(914)							1.00	1.00	1.00									

Table 13 — Load adjustment factors for Carbon Steel 5/8-in. diameter KB-TZ2 in cracked concrete [1,2]

5/8-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4
		(mm)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)
Nominal Embedment h_{nom}		in.	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2
		(mm)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2-1/4	(57)	n/a	0.62	n/a	n/a	n/a	0.56	n/a	0.54	n/a	n/a	n/a	0.10	n/a	n/a	0.20	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.64	0.61	n/a	n/a	0.61	n/a	0.55	0.54	n/a	n/a	0.13	n/a	n/a	0.27	n/a	n/a	n/a
	3	(76)	n/a	0.65	0.63	n/a	0.71	0.64	n/a	0.55	0.55	n/a	0.16	0.15	n/a	0.32	0.31	n/a	n/a	n/a
	3-1/2	(89)	n/a	0.68	0.65	n/a	0.79	0.69	n/a	0.56	0.56	n/a	0.20	0.19	n/a	0.41	0.39	n/a	n/a	n/a
	4	(102)	0.74	0.71	0.67	0.98	0.86	0.75	0.58	0.57	0.56	0.31	0.25	0.24	0.62	0.50	0.47	n/a	n/a	n/a
	4-1/2	(114)	0.77	0.73	0.69	1.00	0.94	0.81	0.59	0.57	0.57	0.37	0.30	0.28	0.74	0.60	0.56	n/a	n/a	n/a
	5	(127)	0.80	0.76	0.71	1.00	1.00	0.87	0.60	0.58	0.58	0.43	0.35	0.33	0.87	0.70	0.66	0.62	n/a	n/a
	5-1/2	(140)	0.83	0.78	0.73	1.00	1.00	0.93	0.61	0.59	0.59	0.50	0.40	0.38	1.00	0.81	0.76	0.65	0.60	n/a
	6	(152)	0.86	0.81	0.75		1.00	1.00	0.61	0.60	0.60	0.57	0.46	0.43		0.92	0.87	0.68	0.63	0.62
	6-1/2	(165)	0.89	0.83	0.77		1.00		0.62	0.61	0.60	0.64	0.52	0.49		1.00	0.98	0.71	0.66	0.64
	7	(178)	0.92	0.86	0.79		1.00		0.63	0.62	0.61	0.72	0.58	0.55		1.00	1.00	0.73	0.68	0.67
	7-1/4	(184)	0.94	0.87	0.80				0.64	0.62	0.62	0.76	0.61	0.58				0.74	0.69	0.68
	12	(305)	1.00	1.00	1.00				0.73	0.70	0.69	1.00	1.00	1.00				0.96	0.89	0.87
	24	(610)							0.96	0.90	0.88							1.00	1.00	1.00
	> 36	(914)							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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 14 — Load adjustment factors for Carbon Steel 3/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

3/4-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment 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 Embedment h_{nom}		in.	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2
		(mm)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3-1/2	(89)	n/a	n/a	n/a	n/a	n/a	0.50	n/a	n/a	n/a	n/a	n/a	0.16	n/a	n/a	0.32	n/a	n/a	n/a
	3-3/4	(95)	n/a	0.67	0.63	n/a	n/a	0.52	n/a	0.56	0.55	n/a	n/a	0.18	n/a	n/a	0.36	n/a	n/a	n/a
	4	(102)	n/a	0.68	0.64	n/a	0.44	0.54	n/a	0.56	0.56	n/a	0.24	0.20	n/a	0.44	0.40	n/a	n/a	n/a
	4-1/2	(114)	0.73	0.70	0.66	n/a	0.48	0.57	0.56	0.57	0.56	n/a	0.29	0.24	n/a	0.48	0.47	n/a	n/a	n/a
	4-3/4	(121)	0.74	0.71	0.67	n/a	0.49	0.59	0.57	0.58	0.57	n/a	0.31	0.26	n/a	0.49	0.51	n/a	n/a	n/a
	5	(127)	0.76	0.72	0.68	0.42	0.51	0.61	0.57	0.58	0.57	0.27	0.33	0.28	0.42	0.51	0.55	n/a	n/a	n/a
	5-1/2	(140)	0.78	0.74	0.69	0.46	0.55	0.65	0.58	0.59	0.58	0.31	0.39	0.32	0.46	0.55	0.64	0.55	n/a	n/a
	5-3/4	(146)	0.79	0.76	0.70	0.48	0.58	0.67	0.58	0.59	0.58	0.33	0.41	0.34	0.48	0.58	0.67	0.57	n/a	n/a
	6	(152)	0.81	0.77	0.71	0.50	0.60	0.69	0.58	0.60	0.58	0.35	0.44	0.36	0.50	0.60	0.69	0.58	0.62	n/a
	7	(178)	0.86	0.81	0.75	0.58	0.70	0.78	0.60	0.61	0.60	0.45	0.55	0.46	0.58	0.70	0.78	0.62	0.67	n/a
	7-1/4	(184)	0.87	0.82	0.75	0.60	0.73	0.81	0.60	0.62	0.60	0.47	0.58	0.48	0.60	0.73	0.81	0.63	0.68	n/a
	8	(203)	0.91	0.86	0.78	0.67	0.80	0.89	0.61	0.63	0.61	0.54	0.68	0.56	0.67	0.80	0.89	0.67	0.72	0.67
	9	(229)	0.96	0.90	0.82	0.75	0.90	1.00	0.63	0.64	0.63	0.65	0.81	0.67	0.75	0.90	1.00	0.71	0.76	0.71
	10	(254)	1.00	0.94	0.85	0.83	1.00		0.64	0.66	0.64	0.76	0.94	0.78	0.83	1.00		0.75	0.80	0.75
	11	(279)		0.99	0.89	0.92			0.65	0.68	0.66	0.88	1.00	0.90	0.92			0.78	0.84	0.79
	12	(305)		1.00	0.92	1.00			0.67	0.69	0.67	1.00		1.00	1.00			0.82	0.88	0.82
	16	(406)			1.00				0.72	0.76	0.73							0.94	1.00	0.95
	18	(457)							0.75	0.79	0.75							1.00		1.00
	24	(610)							0.83	0.89	0.84									
	> 36	(914)							1.00	1.00	1.00									

Table 15 — Load adjustment factors for Carbon Steel 3/4-in. diameter KB-TZ2 in cracked concrete [1,2]

3/4-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment 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 Embedment h_{nom}		in.	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2
		(mm)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3-1/2	(89)	n/a	n/a	n/a	n/a	n/a	0.63	n/a	n/a	n/a	n/a	n/a	0.13	n/a	n/a	0.26	n/a	n/a	n/a
	3-3/4	(95)	n/a	0.67	0.63	n/a	n/a	0.65	n/a	0.56	0.55	n/a	n/a	0.15	n/a	n/a	0.29	n/a	n/a	n/a
	4	(102)	n/a	0.68	0.64	n/a	0.78	0.68	n/a	0.56	0.55	n/a	0.22	0.16	n/a	0.44	0.32	n/a	n/a	n/a
	4-1/2	(114)	0.73	0.70	0.66	n/a	0.85	0.73	0.58	0.57	0.56	n/a	0.26	0.19	n/a	0.52	0.39	n/a	n/a	n/a
	4-3/4	(121)	0.74	0.71	0.67	n/a	0.88	0.75	0.58	0.57	0.56	n/a	0.28	0.21	n/a	0.57	0.42	n/a	n/a	n/a
	5	(127)	0.76	0.72	0.68	1.00	0.91	0.77	0.59	0.58	0.56	0.37	0.31	0.23	0.74	0.61	0.45	n/a	n/a	n/a
	5-1/2	(140)	0.78	0.74	0.69	1.00	0.98	0.83	0.59	0.58	0.57	0.43	0.35	0.26	0.85	0.71	0.52	0.61	n/a	n/a
	5-3/4	(146)	0.79	0.76	0.70	1.00	1.00	0.85	0.60	0.59	0.57	0.46	0.38	0.28	0.91	0.76	0.56	0.63	n/a	n/a
	6	(152)	0.81	0.77	0.71	1.00	1.00	0.88	0.60	0.59	0.57	0.49	0.40	0.30	0.97	0.81	0.59	0.64	0.60	n/a
	7	(178)	0.86	0.81	0.75		1.00	0.99	0.62	0.61	0.59	0.61	0.51	0.37	1.00	1.00	0.75	0.69	0.65	n/a
	7-1/4	(184)	0.87	0.82	0.75			1.00	0.62	0.61	0.59	0.64	0.54	0.39	1.00	1.00	0.79	0.71	0.66	n/a
	8	(203)	0.91	0.86	0.78				0.64	0.62	0.60	0.75	0.62	0.46			0.91	0.74	0.70	0.63
	9	(229)	0.96	0.90	0.82				0.65	0.64	0.61	0.89	0.74	0.54			1.00	0.79	0.74	0.67
	10	(254)	1.00	0.94	0.85				0.67	0.65	0.62	1.00	0.87	0.64				0.83	0.78	0.70
	11	(279)		0.99	0.89				0.69	0.67	0.64		1.00	0.74				0.87	0.82	0.74
	12	(305)		1.00	0.92				0.71	0.68	0.65			0.84				0.91	0.85	0.77
	16	(406)			1.00				0.77	0.74	0.70			1.00				1.00	0.98	0.89
	18	(457)							0.81	0.77	0.72								1.00	0.94
	24	(610)							0.91	0.86	0.80									1.00
	> 36	(914)							1.00	1.00	0.94									

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

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Table 16 — Load adjustment factors for Carbon Steel 1-in. diameter KB-TZ2 in uncracked concrete [1,2]

1-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear ⊥ Toward edge f_{RV}		Edge distance in shear ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Effective Embedment h_{ef}	in.	4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4
	(mm)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)
Nominal Embedment h_{nom}	in.	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8
	(mm)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3 (76)	n/a	n/a	n/a	0.292	n/a	n/a	n/a	0.081	n/a	0.162	n/a	n/a
	3-3/4 (95)	n/a	n/a	n/a	0.321	n/a	n/a	n/a	0.113	n/a	0.227	n/a	n/a
	4 (102)	n/a	n/a	n/a	0.331	n/a	n/a	n/a	0.125	n/a	0.250	n/a	n/a
	4-1/4 (108)	n/a	n/a	n/a	0.341	n/a	n/a	n/a	0.137	n/a	0.274	n/a	n/a
	4-3/4 (121)	n/a	0.638	n/a	0.362	n/a	0.549	n/a	0.162	n/a	0.324	n/a	n/a
	5 (127)	n/a	0.645	n/a	0.372	n/a	0.552	n/a	0.175	n/a	0.349	n/a	n/a
	6 (152)	n/a	0.674	n/a	0.415	n/a	0.563	n/a	0.230	n/a	0.415	n/a	n/a
	6-3/4 (171)	n/a	0.696	n/a	0.449	n/a	0.570	n/a	0.274	n/a	0.449	n/a	n/a
	8 (203)	0.833	0.732	0.727	0.508	0.621	0.583	0.620	0.354	0.727	0.508	0.696	n/a
	10 (254)	0.917	0.790	0.909	0.625	0.652	0.604	0.867	0.494	0.909	0.625	0.778	0.645
	12 (305)	1.000	0.848	1.000	0.750	0.682	0.625	1.000	0.650	1.000	0.750	0.853	0.707
	18 (457)		1.000		1.000	0.773	0.688		1.000		1.000	1.000	0.866
	24 (610)					0.864	0.750						1.000
	36 (914)					1.000	0.875						
	> 48 (1219)						1.000						

Table 17 — Load adjustment factors for Carbon Steel 1-in. diameter KB-TZ2 in cracked concrete [1,2]

1-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear ⊥ Toward edge f_{RV}		Edge distance in shear ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Effective Embedment h_{ef}	in.	4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4	4	5-3/4
	(mm)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)
Nominal Embedment h_{nom}	in.	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8
	(mm)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3 (76)	n/a	n/a	n/a	0.542	n/a	n/a	n/a	0.081	n/a	0.162	n/a	n/a
	3-3/4 (95)	n/a	n/a	n/a	0.596	n/a	n/a	n/a	0.113	n/a	0.226	n/a	n/a
	4 (102)	n/a	n/a	n/a	0.614	n/a	n/a	n/a	0.124	n/a	0.249	n/a	n/a
	4-1/4 (108)	n/a	n/a	n/a	0.633	n/a	n/a	n/a	0.136	n/a	0.272	n/a	n/a
	4-3/4 (121)	n/a	0.638	n/a	0.671	n/a	0.549	n/a	0.161	n/a	0.322	n/a	n/a
	5 (127)	n/a	0.645	n/a	0.690	n/a	0.552	n/a	0.174	n/a	0.348	n/a	n/a
	6 (152)	n/a	0.674	n/a	0.770	n/a	0.562	n/a	0.228	n/a	0.457	n/a	n/a
	6-3/4 (171)	n/a	0.696	n/a	0.833	n/a	0.570	n/a	0.273	n/a	0.545	n/a	n/a
	8 (203)	0.833	0.732	1.000	0.943	0.619	0.583	0.606	0.352	1.000	0.703	0.691	n/a
	10 (254)	0.917	0.790		1.000	0.649	0.604	0.847	0.491		0.983	0.773	0.644
	12 (305)	1.000	0.848			0.679	0.625	1.000	0.646		1.000	0.846	0.706
	18 (457)		1.000			0.769	0.687		1.000			1.000	0.864
	24 (610)					0.858	0.749						0.998
	36 (914)					1.000	0.874						1.000
	> 48 (1219)						0.998						

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 18 — Hilti Stainless Steel KB-TZ2 design strength based on concrete failure modes in uncracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
1/4	1-1/2 (38)	1 3/4 (44)	705 (3.1)	760 (3.4)	850 (3.8)	995 (4.4)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
3/8	1-1/2 (38)	1 7/8 (48)	1,435 (6.4)	1,570 (7.0)	1,815 (8.1)	2,220 (9.9)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
	2 (51)	2 1/2 (64)	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)
	2-1/2 (64)	3 (76)	2,720 (12.1)	2,910 (12.9)	3,235 (14.4)	3,760 (16.7)	6,640 (29.5)	7,275 (32.4)	8,400 (37.4)	10,290 (45.8)
1/2	2 (51)	2 1/2 (64)	2,195 (9.8)	2,390 (10.6)	2,725 (12.1)	3,285 (14.6)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	2-1/2 (64)	3 (76)	2,605 (11.6)	2,855 (12.7)	3,295 (14.7)	4,040 (18.0)	6,640 (29.5)	7,275 (32.4)	8,400 (37.4)	10,290 (45.8)
	3-1/4 (83)	3 3/4 (95)	3,575 (15.9)	3,915 (17.4)	4,520 (20.1)	5,540 (24.6)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	2-3/4 (70)	3 1/4 (83)	2,655 (11.8)	2,910 (12.9)	3,360 (14.9)	4,115 (18.3)	7,660 (34.1)	8,395 (37.3)	9,690 (43.1)	11,870 (52.8)
	3-1/4 (83)	3 3/4 (95)	3,910 (17.4)	4,220 (18.8)	4,765 (21.2)	5,645 (25.1)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
	4 (102)	4 1/2 (114)	5,235 (23.3)	5,700 (25.4)	6,525 (29.0)	7,895 (35.1)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-1/4 (83)	4 (102)	4,570 (20.3)	5,005 (22.3)	5,780 (25.7)	7,080 (31.5)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
	3-3/4[6] (95)	4 1/2 (114)	6,370 (28.3)	6,980 (31.0)	8,060 (35.9)	9,870 (43.9)	13,725 (61.1)	15,035 (66.9)	17,360 (77.2)	21,265 (94.6)
	4-3/4 (121)	5 1/2 (140)	8,075 (35.9)	8,845 (39.3)	10,215 (45.4)	12,510 (55.6)	17,390 (77.4)	19,050 (84.7)	22,000 (97.9)	26,945 (119.9)
1	4 (102)	4 5/8 (117)	7,020 (31.2)	7,690 (34.2)	8,880 (39.5)	10,875 (48.4)	15,120 (67.3)	16,565 (73.7)	19,125 (85.1)	23,425 (104.2)
	5-3/4 (146)	6 3/8 (162)	12,100 (53.8)	13,255 (59.0)	15,305 (68.1)	18,745 (83.4)	26,060 (115.9)	28,545 (127.0)	32,965 (146.6)	40,370 (179.6)

Table 19 — Hilti Stainless Steel KB-TZ2 design strength based on concrete failure modes in cracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4,5]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension (lesser of concrete breakout / pullout) - ΦN_n				Shear (lesser of concrete breakout or pryout) - ΦV_n			
			f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.1 MPa) lb (kN)
1/4	1-1/2 (38)	1 3/4 (44)	300 (1.3)	330 (1.5)	380 (1.7)	465 (2.1)	1,095 (4.9)	1,195 (5.3)	1,385 (6.2)	1,695 (7.5)
3/8	1-1/2 (38)	1 7/8 (48)	1,255 (5.6)	1,375 (6.1)	1,585 (7.1)	1,940 (8.6)	1,350 (6.0)	1,480 (6.6)	1,710 (7.6)	2,090 (9.3)
	2 (51)	2 1/2 (64)	1,930 (8.6)	2,115 (9.4)	2,440 (10.9)	2,990 (13.3)	2,080 (9.3)	2,275 (10.1)	2,630 (11.7)	3,220 (14.3)
	2-1/2 (64)	3 (76)	2,185 (9.7)	2,390 (10.6)	2,765 (12.3)	3,385 (15.1)	4,705 (20.9)	5,155 (22.9)	5,950 (26.5)	7,285 (32.4)
1/2	2 (51)	2 1/2 (64)	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)
	2-1/2 (64)	3 (76)	2,700 (12.0)	2,955 (13.1)	3,415 (15.2)	4,180 (18.6)	5,810 (25.8)	6,365 (28.3)	7,350 (32.7)	9,000 (40.0)
	3-1/4[8] (83)	3 3/4 (95)	3,235 (14.4)	3,545 (15.8)	4,095 (18.2)	5,015 (22.3)	6,970 (31.0)	7,640 (34.0)	8,820 (39.2)	10,800 (48.0)
5/8	2-3/4 (70)	3 1/4 (83)	3,110 (13.8)	3,410 (15.2)	3,935 (17.5)	4,820 (21.4)	6,705 (29.8)	7,345 (32.7)	8,480 (37.7)	10,385 (46.2)
	3-1/4 (83)	3 3/4 (95)	4,000 (17.8)	4,380 (19.5)	5,060 (22.5)	6,195 (27.6)	8,615 (38.3)	9,435 (42.0)	10,895 (48.5)	13,345 (59.4)
	4 (102)	4 1/2 (114)	4,420 (19.7)	4,840 (21.5)	5,590 (24.9)	6,845 (30.4)	9,520 (42.3)	10,430 (46.4)	12,040 (53.6)	14,750 (65.6)
3/4	3-1/4 (83)	4 (102)	4,000 (17.8)	4,380 (19.5)	5,060 (22.5)	6,195 (27.6)	8,615 (38.3)	9,435 (42.0)	10,895 (48.5)	13,345 (59.4)
	3-3/4[7] (95)	4 1/2 (114)	4,955 (22.0)	5,430 (24.2)	6,270 (27.9)	7,680 (34.2)	10,675 (47.5)	11,695 (52.0)	13,505 (60.1)	16,540 (73.6)
	4-3/4 (121)	5 1/2 (140)	5,715 (25.4)	6,260 (27.8)	7,230 (32.2)	8,855 (39.4)	15,220 (67.7)	16,670 (74.2)	19,250 (85.6)	23,575 (104.9)
1	4 (102)	4 5/8 (117)	6,240 (27.8)	6,835 (30.4)	7,895 (35.1)	9,665 (43.0)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
	5-3/4 (146)	6 3/8 (162)	9,410 (41.9)	10,310 (45.9)	11,905 (53.0)	14,580 (64.9)	20,270 (90.2)	22,205 (98.8)	25,640 (114.1)	31,400 (139.7)

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 22 to 33 as necessary. Compare to the steel values in Table 20. 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, except for the 3/4 bolts where $\alpha_{V,seis}$ = 0.81. See Section 3.1.8 for additional information on seismic applications.
6 For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.89 to the design tension strength.
7 For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.81 to the design tension strength.
8 For core drilled installations of 1/2" anchors installed at 3-1/4 effective embedment, apply a reduction factor of 0.85 to the design tension strength.

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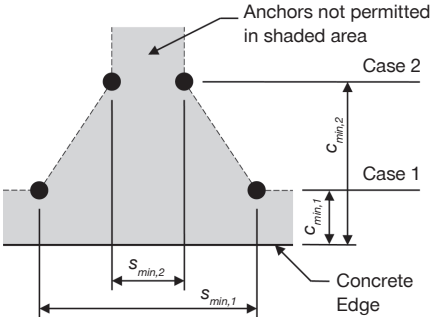
Table 20 — Hilti Stainless Steel KB-TZ2 design strength based on steel failure per ACI 318 Ch. 17 [1,2]

Nominal anchor diameter in.	Effective embedment depth in. (mm)			Tensile [3] ΦN_{sa} lb (kN)	Shear [4] ΦV_{sa} lb (kN)	Seismic Shear [5] ΦV_{sa} lb (kN)
1/4	1-1/2 (38)			2,190 (9.7)	950 (4.2)	720 (3.2)
3/8	1-1/2 (38)			4,635 (20.6)	3,000 (13.3)	3,000 (13.3)
3/8	2 (51)		2-1/2 (64)	4,635 (20.6)	3,175 (14.1)	3,175 (14.1)
1/2	2 (51)	2-1/2 (64)	3-1/4 (83)	8,905 (39.6)	5,425 (24.1)	5,425 (24.1)
5/8	2-3/4 (70)	3-1/4 (83)	4 (102)	14,125 (62.8)	8,030 (35.7)	8,030 (35.7)
3/4	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	18,035 (80.2)	10,765 (47.9)	8,755 (38.9)
1 (25.4)	4 (102)			35,215 (156.6)	14,920 (66.4)	8,755 (38.9)
1 (25.4)	5-3/4 (146)			35,215 (156.6)	20,410 (90.8)	8,755 (38.9)

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KB-TZ2 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 Ch. 17.
4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17. See Section 3.1.8 for additional information on seismic applications.

Figure 3



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

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

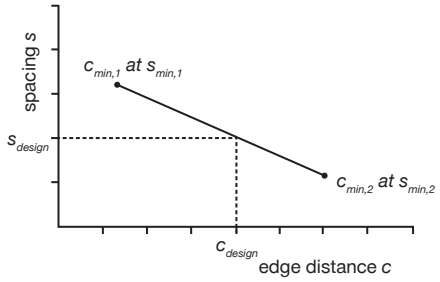


Table 21 — Hilti KB-TZ2 stainless steel installation parameters[1]

Setting information	Symbol	Units	Nominal Anchor diameter (in.)													
			1/4	3/8			1/2			5/8			3/4			1	
Effective embedment	h_{ef}	in.	1-1/2	1-1/2	2	2-1/2	2	2-1/2	3 1/4	2-3/4	3-1/4	4	3-1/4	3-3/4	4-3/4	4	5-3/4
		(mm)	(38)	(38)	(51)	(64)	(51)	(64)	(83)	(70)	(83)	(102)	(83)	(95)	(121)	(102)	(146)
Min. member thickness	h_{min}	in.	3-1/4	3-1/4	4	5	4	5	5-1/2	5	5-1/2	6	5-1/2	6	8	8	10
		(mm)	(83)	(83)	(102)	(127)	(102)	(127)	(140)	(127)	(140)	(152)	(140)	(152)	(203)	(203)	(254)
Case 1	$c_{min,1}$	in.	1-1/2	5	2-1/2	2-1/2	2-3/4	2-1/2	2-1/4	4	3-1/4	2-1/4	5	4	3 3/4	3-3/4	3
		(mm)	(38)	(127)	(64)	(64)	(70)	(64)	(57)	(102)	(83)	(57)	(127)	(102)	(95)	(95)	(76)
	for $s_{min,1} \geq$	in.	1-1/2	8	5	5	5-1/2	4-1/2	5-1/4	7	5-1/2	7	11	7-1/2	5 3/4	10	6-3/4
		(mm)	(38)	(203)	(127)	(127)	(140)	(114)	(133)	(178)	(140)	(178)	(279)	(191)	(146)	(254)	(171)
Case 2	$c_{min,2}$	in.	1-1/2	8	4	3-1/2	4-1/8	4-1/2	4-1/2	5-1/2	4	4-1/4	8	6	5-1/4	4-1/4	3-3/4
		(mm)	(38)	(203)	(102)	(89)	(105)	(114)	(114)	(140)	(102)	(108)	(203)	(152)	(133)	(108)	(95)
	for $s_{min,2} \geq$	in.	1-1/2	5	2-1/4	2-1/4	2-3/4	2-1/2	2	5-1/2	2-3/4	3	5	4	4	5	4-3/4
		(mm)	(38)	(127)	(57)	(57)	(70)	(64)	(51)	(140)	(70)	(76)	(127)	(102)	(102)	(127)	(121)

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

Table 22 — Load adjustment factors for Stainless Steel 1/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

1/4-in. KB-TZ2 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}	∥ To edge f_{RV}	
Effective Embedment h_{ef}	in.	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	
	(mm)	(38)	(38)	(38)	(38)	(38)	(38)	
Nominal Embedment h_{nom}	in.	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	
	(mm)	(44)	(44)	(44)	(44)	(44)	(44)	
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2 (38)		0.67	0.42	0.56	0.23	0.42	n/a
	2 (51)		0.72	0.51	0.58	0.35	0.51	n/a
	2-1/2 (64)		0.78	0.63	0.60	0.49	0.63	n/a
	3 (76)		0.83	0.75	0.63	0.65	0.75	n/a
	3-1/4 (83)		0.86	0.81	0.64	0.73	0.81	0.74
	3-1/2 (89)		0.89	0.88	0.65	0.82	0.88	0.76
	4 (102)		0.94	1.00	0.67	1.00	1.00	0.82
	5 (127)		1.00		0.71			0.91
	6 (152)				0.75			1.00
	7 (178)				0.79			
	8 (203)				0.83			
	9 (229)				0.88			
	> 12 (305)				1.00			

3.3.5

Table 23 — Load adjustment factors for Stainless Steel 1/4-in. diameter KB-TZ2 in cracked concrete [1,2]

1/4-in. KB-TZ2 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}	∥ To edge f_{RV}	
Effective Embedment h_{ef}	in.	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	
	(mm)	(38)	(38)	(38)	(38)	(38)	(38)	
Nominal Embedment h_{nom}	in.	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	
	(mm)	(44)	(44)	(44)	(44)	(44)	(44)	
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	1-1/2 (38)		0.67	0.75	0.57	0.29	0.59	n/a
	2 (51)		0.72	0.91	0.60	0.45	0.91	n/a
	2-1/2 (64)		0.78	1.00	0.62	0.63	1.00	n/a
	3 (76)		0.83		0.65	0.83		n/a
	3-1/4 (83)		0.86		0.66	0.94		0.80
	3-1/2 (89)		0.89		0.67	1.00		0.83
	4 (102)		0.94		0.70			0.89
	5 (127)		1.00		0.75			0.99
	6 (152)				0.80			1.00
	7 (178)				0.84			
	8 (203)				0.89			
	9 (229)				0.94			
	> 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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

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Table 24 — Load adjustment factors for Stainless Steel 3/8-in. diameter KB-TZ2 in uncracked concrete [1,4]

3/8-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2
		(mm)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)
Nominal Embedment h_{nom}		in.	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3
		(mm)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)
Spacing (s) / Edge Distance (c_{ar}) / Concrete Thickness (h) - in. (mm)	2-1/4	(57)	n/a	0.69	0.65	n/a	n/a	n/a	n/a	0.57	0.55	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	n/a	0.71	0.67	n/a	0.48	0.68	n/a	0.58	0.55	n/a	0.31	0.18	n/a	0.48	0.37	n/a	n/a	n/a
	3	(76)	n/a	0.75	0.70	n/a	0.55	0.77	n/a	0.59	0.56	n/a	0.40	0.24	n/a	0.55	0.48	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.77	0.72	n/a	0.59	0.81	n/a	0.60	0.57	n/a	0.45	0.27	n/a	0.59	0.54	0.69	n/a	n/a
	3-1/2	(89)	n/a	0.79	0.73	n/a	0.64	0.86	n/a	0.61	0.58	n/a	0.51	0.30	n/a	0.64	0.61	0.72	n/a	n/a
	4	(102)	n/a	0.83	0.77	n/a	0.73	0.97	n/a	0.62	0.59	n/a	0.62	0.37	n/a	0.73	0.74	0.77	0.70	n/a
	5	(127)	1.00	0.92	0.83	1.00	0.91	1.00	0.69	0.65	0.61	1.00	0.87	0.52	1.00	0.91	1.00	0.86	0.78	0.66
	6	(152)	1.00	1.00	0.90	1.00	1.00		0.72	0.68	0.63	1.00	1.00	0.68	1.00	1.00		0.94	0.85	0.72
	8	(203)	1.00		1.00	1.00			0.80	0.74	0.67	1.00		1.00	1.00			1.00	0.98	0.83
	10	(254)							0.87	0.80	0.71								1.00	0.93
	12	(305)							0.94	0.86	0.76									1.00
	18	(457)							1.00	1.00	0.89									
	> 24	(610)									1.00									

Table 25 — Load adjustment factors for Stainless Steel 3/8-in. diameter KB-TZ2 in cracked concrete [1,4]

3/8-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2
		(mm)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)	(38)	(51)	(64)
Nominal Embedment h_{nom}		in.	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3	1-7/8	2-1/2	3
		(mm)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)	(48)	(64)	(76)
Spacing (s) / Edge Distance (c_{ar}) / Concrete Thickness (h) - in. (mm)	2-1/4	(57)	n/a	0.69	0.65	n/a	n/a	n/a	n/a	0.58	0.55	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/2	(64)	n/a	0.71	0.67	n/a	0.87	0.75	n/a	0.59	0.55	n/a	0.40	0.18	n/a	0.80	0.37	n/a	n/a	n/a
	3	(76)	n/a	0.75	0.70	n/a	1.00	0.85	n/a	0.61	0.56	n/a	0.52	0.24	n/a	1.00	0.48	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.77	0.72	n/a	1.00	0.90	n/a	0.62	0.57	n/a	0.59	0.27	n/a	1.00	0.55	0.78	n/a	n/a
	3-1/2	(89)	n/a	0.79	0.73	n/a	1.00	0.95	n/a	0.63	0.58	n/a	0.66	0.31	n/a	1.00	0.61	0.81	n/a	n/a
	4	(102)	n/a	0.83	0.77	n/a	1.00	1.00	n/a	0.64	0.59	n/a	0.81	0.37	n/a	1.00	0.75	0.86	0.76	n/a
	5	(127)	1.00	0.92	0.83	1.00			0.73	0.68	0.61	1.00	1.00	0.52	1.00		1.00	0.96	0.85	0.66
	6	(152)	1.00	1.00	0.90	1.00			0.78	0.72	0.63	1.00		0.69	1.00			1.00	0.93	0.72
	8	(203)	1.00		1.00	1.00			0.87	0.79	0.67	1.00		1.00	1.00				1.00	0.83
	10	(254)							0.96	0.86	0.72									0.93
	12	(305)							1.00	0.93	0.76									1.00
	18	(457)								1.00	0.89									
	> 24	(610)									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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 26 — Load adjustment factors for Stainless Steel 1/2-in. diameter KB-TZ2 in uncracked concrete [1,2]

1/2-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4
		(mm)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)
Nominal Embedment h_{nom}		in.	2-1/2	3	3-3/4	2-1/2	3	3-3/4	2-1/2	3	3-3/4	2-1/2	3	3-3/4	2-1/2	3	3-3/4	2-1/2	3	3-3/4
		(mm)	(64)	(76)	(95)	(64)	(76)	(95)	(64)	(76)	(95)	(64)	(76)	(95)	(64)	(76)	(95)	(64)	(76)	(95)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2	(51)	n/a	n/a	0.60	n/a	n/a	n/a	n/a	n/a	0.54	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	n/a	0.62	n/a	n/a	0.40	n/a	n/a	0.54	n/a	n/a	0.12	n/a	n/a	0.24	n/a	n/a	n/a
	2-1/2	(64)	n/a	n/a	0.63	n/a	0.45	0.42	n/a	n/a	0.55	n/a	0.20	0.14	n/a	0.40	0.28	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.68	0.64	0.51	0.48	0.44	n/a	0.56	0.55	0.35	0.23	0.16	0.51	0.46	0.33	n/a	n/a	n/a
	3	(76)	0.75	0.70	0.65	0.55	0.51	0.46	0.59	0.57	0.55	0.40	0.26	0.19	0.55	0.51	0.37	n/a	n/a	n/a
	4	(102)	0.83	0.77	0.71	0.73	0.64	0.56	0.62	0.59	0.57	0.62	0.40	0.29	0.73	0.64	0.56	0.70	n/a	n/a
	4-1/8	(105)	0.84	0.78	0.71	0.75	0.66	0.57	0.63	0.59	0.57	0.65	0.42	0.30	0.75	0.66	0.57	0.71	n/a	n/a
	4-1/2	(114)	0.88	0.80	0.73	0.82	0.72	0.61	0.64	0.60	0.58	0.74	0.48	0.34	0.82	0.72	0.61	0.74	n/a	n/a
	4-3/4	(121)	0.90	0.82	0.74	0.86	0.76	0.64	0.64	0.61	0.59	0.80	0.52	0.37	0.86	0.76	0.64	0.76	n/a	n/a
	5	(127)	0.92	0.83	0.76	0.91	0.80	0.67	0.65	0.61	0.59	0.87	0.56	0.40	0.91	0.80	0.67	0.78	0.67	n/a
	5-1/4	(133)	0.94	0.85	0.77	0.95	0.84	0.70	0.66	0.62	0.60	0.93	0.61	0.43	0.95	0.84	0.70	0.80	0.69	n/a
	5-1/2	(140)	0.96	0.87	0.78	1.00	0.88	0.73	0.67	0.63	0.60	1.00	0.65	0.46	1.00	0.88	0.73	0.82	0.71	0.63
	6	(152)	1.00	0.90	0.81		0.96	0.80	0.68	0.64	0.61		0.74	0.53		0.96	0.80	0.85	0.74	0.66
	8	(203)		1.00	0.91		1.00	1.00	0.74	0.68	0.64		1.00	0.81		1.00	1.00	0.98	0.85	0.76
	12	(305)			1.00				0.86	0.77	0.72			1.00				1.00	1.00	0.93
	18	(457)							1.00	0.91	0.83									1.00
	24	(610)								1.00	0.93									
	> 30	(762)									1.00									

3.3.5

Table 27 — Load adjustment factors for Stainless Steel 1/2-in. diameter KB-TZ2 in cracked concrete [1,2]

1/2-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4	2	2-1/2	3-1/4
		(mm)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)	(51)	(64)	(83)
Nominal Embedment h_{nom}		in.	2-1/2	3	3-3/4	2-1/2	3	3-3/4	2-1/2	3	3-3/4	2-1/2	3	3-3/4	2-1/2	3	3-3/4	2-1/2	3	3-3/4
		(mm)	(64)	(76)	(95)	(64)	(76)	(95)	(64)	(76)	(95)	(64)	(76)	(95)	(64)	(76)	(95)	(64)	(76)	(95)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	2	(51)	n/a	n/a	0.60	n/a	n/a	n/a	n/a	n/a	0.54	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2-1/4	(57)	n/a	n/a	0.62	n/a	n/a	0.61	n/a	n/a	0.54	n/a	n/a	0.12	n/a	n/a	0.24	n/a	n/a	n/a
	2-1/2	(64)	n/a	n/a	0.63	n/a	0.75	0.65	n/a	n/a	0.55	n/a	0.16	0.14	n/a	0.33	0.29	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.68	0.64	0.93	0.80	0.68	n/a	0.55	0.55	0.62	0.19	0.16	0.93	0.38	0.33	n/a	n/a	n/a
	3	(76)	0.75	0.70	0.65	1.00	0.85	0.71	0.63	0.56	0.55	0.71	0.21	0.19	1.00	0.43	0.38	n/a	n/a	n/a
	4	(102)	0.83	0.77	0.71	1.00	1.00	0.86	0.68	0.58	0.57	1.00	0.33	0.29	1.00	0.66	0.58	0.84	n/a	n/a
	4-1/8	(105)	0.84	0.78	0.71	1.00	1.00	0.88	0.68	0.58	0.58	1.00	0.34	0.30	1.00	0.69	0.61	0.85	n/a	n/a
	4-1/2	(114)	0.88	0.80	0.73		1.00	0.94	0.70	0.59	0.58		0.39	0.34		0.79	0.69	0.89	n/a	n/a
	4-3/4	(121)	0.90	0.82	0.74			0.98	0.71	0.59	0.59		0.43	0.37		0.85	0.75	0.91	n/a	n/a
	5	(127)	0.92	0.83	0.76			1.00	0.72	0.60	0.59		0.46	0.40		0.92	0.81	0.94	0.63	n/a
	5-1/4	(133)	0.94	0.85	0.77				0.73	0.60	0.60		0.49	0.43		0.99	0.87	0.96	0.65	n/a
	5-1/2	(140)	0.96	0.87	0.78				0.74	0.61	0.60		0.53	0.47		1.00	0.93	0.98	0.66	0.63
	6	(152)	1.00	0.90	0.81				0.76	0.62	0.61		0.60	0.53			1.00	1.00	0.69	0.66
	8	(203)		1.00	0.91				0.85	0.66	0.65		0.93	0.82					0.80	0.76
	12	(305)			1.00				1.00	0.74	0.72		1.00	1.00					0.98	0.94
	18	(457)								0.86	0.83								1.00	1.00
	24	(610)								0.98	0.94									
	> 30	(762)								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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

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Table 28 — Load adjustment factors for Stainless Steel 5/8-in. diameter KB-TZ2 in uncracked concrete [1,2]

5/8-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4
		(mm)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)
Nominal Embedment h_{nom}		in.	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2
		(mm)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)
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	0.38	n/a	n/a	n/a	n/a	n/a	0.10	n/a	n/a	0.20	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.64	n/a	n/a	n/a	0.42	n/a	0.55	n/a	n/a	n/a	0.13	n/a	n/a	0.27	n/a	n/a	n/a
	3	(76)	n/a	0.65	0.63	n/a	n/a	0.44	n/a	0.56	0.55	n/a	n/a	0.15	n/a	n/a	0.30	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.67	0.64	n/a	0.56	0.46	n/a	0.56	0.55	n/a	0.22	0.17	n/a	0.45	0.34	n/a	n/a	n/a
	4	(102)	n/a	0.71	0.67	0.40	0.65	0.51	n/a	0.58	0.56	0.25	0.31	0.23	0.40	0.61	0.47	n/a	n/a	n/a
	4-1/4	(108)	n/a	0.72	0.68	0.43	0.67	0.53	n/a	0.58	0.57	0.28	0.34	0.26	0.43	0.67	0.51	n/a	n/a	n/a
	5	(127)	n/a	0.76	0.71	0.50	0.77	0.60	n/a	0.59	0.58	0.35	0.43	0.33	0.50	0.77	0.60	0.58	n/a	n/a
	5-1/2	(140)	0.83	0.78	0.73	0.55	0.85	0.64	0.59	0.60	0.59	0.41	0.49	0.38	0.55	0.85	0.64	0.61	0.65	n/a
	6	(152)	0.86	0.81	0.75	0.60	0.92	0.69	0.60	0.61	0.59	0.46	0.56	0.43	0.60	0.92	0.69	0.63	0.67	0.62
	7	(178)	0.92	0.86	0.79	0.70	1.00	0.80	0.62	0.63	0.61	0.59	0.71	0.54	0.70	1.00	0.80	0.68	0.73	0.67
	8	(203)	0.98	0.91	0.83	0.80		0.91	0.63	0.65	0.63	0.72	0.87	0.66	0.80		0.91	0.73	0.78	0.71
	10	(254)	1.00	1.00	0.92	1.00		1.00	0.67	0.69	0.66	1.00	1.00	0.92	1.00		1.00	0.82	0.87	0.80
	12	(305)			1.00				0.70	0.73	0.69			1.00				0.89	0.95	0.87
	24	(610)							0.90	0.95	0.88							1.00	1.00	1.00
	> 36	(914)							1.00	1.00	1.00									

Table 29 — Load adjustment factors for Stainless Steel 5/8-in. diameter KB-TZ2 in cracked concrete [1,2]

5/8-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment h_{ef}		in.	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4	2-3/4	3-1/4	4
		(mm)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)	(70)	(83)	(102)
Nominal Embedment h_{nom}		in.	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2	3-1/4	3-3/4	4-1/2
		(mm)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)	(83)	(95)	(114)
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	0.56	n/a	n/a	n/a	n/a	n/a	0.10	n/a	n/a	0.20	n/a	n/a	n/a
	2-3/4	(70)	n/a	0.64	n/a	n/a	n/a	0.61	n/a	0.55	n/a	n/a	n/a	0.13	n/a	n/a	0.27	n/a	n/a	n/a
	3	(76)	n/a	0.65	0.63	n/a	n/a	0.64	n/a	0.55	0.55	n/a	n/a	0.15	n/a	n/a	0.31	n/a	n/a	n/a
	3-1/4	(83)	n/a	0.67	0.64	n/a	0.75	0.66	n/a	0.55	0.55	n/a	0.18	0.17	n/a	0.37	0.35	n/a	n/a	n/a
	4	(102)	n/a	0.71	0.67	0.98	0.86	0.75	n/a	0.57	0.56	0.31	0.25	0.24	0.62	0.50	0.47	n/a	n/a	n/a
	4-1/4	(108)	n/a	0.72	0.68	1.00	0.90	0.78	n/a	0.57	0.57	0.34	0.27	0.26	0.68	0.55	0.52	n/a	n/a	n/a
	5	(127)	n/a	0.76	0.71	1.00	1.00	0.87	n/a	0.58	0.58	0.43	0.35	0.33	0.87	0.70	0.66	0.62	n/a	n/a
	5-1/2	(140)	0.83	0.78	0.73	1.00		0.93	0.61	0.59	0.59	0.50	0.40	0.38	1.00	0.81	0.76	0.65	0.60	n/a
	6	(152)	0.86	0.81	0.75			1.00	0.61	0.60	0.60	0.57	0.46	0.43		0.92	0.87	0.68	0.63	0.62
	7	(178)	0.92	0.86	0.79				0.63	0.62	0.61	0.72	0.58	0.55		1.00	1.00	0.73	0.68	0.67
	8	(203)	0.98	0.91	0.83				0.65	0.63	0.63	0.88	0.71	0.67				0.78	0.73	0.71
	10	(254)	1.00	1.00	0.92				0.69	0.67	0.66	1.00	0.99	0.93				0.87	0.81	0.80
	12	(305)			1.00				0.73	0.70	0.69		1.00	1.00				0.96	0.89	0.87
	24	(610)							0.96	0.90	0.88							1.00	1.00	1.00
	> 36	(914)							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 Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 30 — Load adjustment factors for Stainless Steel 3/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

3/4-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment 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 Embedment h_{nom}		in.	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2
		(mm)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3-3/4	(95)	n/a	n/a	n/a	n/a	n/a	0.47	n/a	n/a	n/a	n/a	n/a	0.18	n/a	n/a	0.36	n/a	n/a	n/a
	4	(102)	n/a	0.68	0.64	n/a	0.44	0.48	n/a	0.56	0.56	n/a	0.24	0.20	n/a	0.44	0.40	n/a	n/a	n/a
	4-1/2	(114)	n/a	0.70	0.66	n/a	0.48	0.52	n/a	0.57	0.56	n/a	0.29	0.24	n/a	0.48	0.47	n/a	n/a	n/a
	5	(127)	0.76	0.72	0.68	0.42	0.51	0.55	0.57	0.58	0.57	0.27	0.33	0.28	0.42	0.51	0.55	n/a	n/a	n/a
	5-1/4	(133)	0.77	0.73	0.68	0.44	0.53	0.57	0.57	0.58	0.57	0.29	0.36	0.30	0.44	0.53	0.57	n/a	n/a	n/a
	5-1/2	(140)	0.78	0.74	0.69	0.46	0.55	0.59	0.58	0.59	0.58	0.31	0.39	0.32	0.46	0.55	0.59	0.55	n/a	n/a
	5-3/4	(146)	0.79	0.76	0.70	0.48	0.58	0.61	0.58	0.59	0.58	0.33	0.41	0.34	0.48	0.58	0.61	0.57	n/a	n/a
	6	(152)	0.81	0.77	0.71	0.50	0.60	0.63	0.58	0.60	0.58	0.35	0.44	0.36	0.50	0.60	0.63	0.58	0.62	n/a
	7	(178)	0.86	0.81	0.75	0.58	0.70	0.70	0.60	0.61	0.60	0.45	0.55	0.46	0.58	0.70	0.70	0.62	0.67	n/a
	7-1/2	(191)	0.88	0.83	0.76	0.63	0.75	0.75	0.60	0.62	0.61	0.49	0.61	0.51	0.63	0.75	0.75	0.65	0.69	n/a
	8	(203)	0.91	0.86	0.78	0.67	0.80	0.80	0.61	0.63	0.61	0.54	0.68	0.56	0.67	0.80	0.80	0.67	0.72	0.67
	9	(229)	0.96	0.90	0.82	0.75	0.90	0.90	0.63	0.64	0.63	0.65	0.81	0.67	0.75	0.90	0.90	0.71	0.76	0.71
	10	(254)	1.00	0.94	0.85	0.83	1.00	1.00	0.64	0.66	0.64	0.76	0.94	0.78	0.83	1.00	1.00	0.75	0.80	0.75
	11	(279)	1.00	0.99	0.89	0.92			0.65	0.68	0.66	0.88	1.00	0.90	0.92			0.78	0.84	0.79
	12	(305)		1.00	0.92	1.00			0.67	0.69	0.67	1.00		1.00	1.00			0.82	0.88	0.82
	16	(406)			1.00				0.72	0.76	0.73							0.94	1.00	0.95
	18	(457)							0.75	0.79	0.75							1.00		1.00
	24	(610)							0.83	0.89	0.84									
	> 36	(914)							1.00	1.00	1.00									

3.3.5

Table 31 — Load adjustment factors for Stainless Steel 3/4-in. diameter KB-TZ2 in cracked concrete [1,2]

3/4-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}			Edge distance factor in tension f_{RN}			Spacing factor in shear [3] f_{AV}			Edge distance in shear ⊥ Toward edge f_{RV}			Edge distance in shear ∥ To edge f_{RV}			Concrete thickness factor in shear [4] f_{HV}		
Effective Embedment 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 Embedment h_{nom}		in.	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2	4	4-1/2	5-1/2
		(mm)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)	(102)	(114)	(140)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3-3/4	(95)	n/a	n/a	n/a	n/a	n/a	0.65	n/a	n/a	n/a	n/a	n/a	0.15	n/a	n/a	0.29	n/a	n/a	n/a
	4	(102)	n/a	0.68	0.64	n/a	0.78	0.68	n/a	0.56	0.55	n/a	0.22	0.16	n/a	0.44	0.32	n/a	n/a	n/a
	4-1/2	(114)	n/a	0.70	0.66	n/a	0.85	0.73	n/a	0.57	0.56	n/a	0.26	0.19	n/a	0.52	0.39	n/a	n/a	n/a
	5	(127)	0.76	0.72	0.68	1.00	0.91	0.77	0.59	0.58	0.56	0.37	0.31	0.23	0.74	0.61	0.45	n/a	n/a	n/a
	5-1/4	(133)	0.77	0.73	0.68	1.00	0.95	0.80	0.59	0.58	0.56	0.40	0.33	0.24	0.79	0.66	0.49	n/a	n/a	n/a
	5-1/2	(140)	0.78	0.74	0.69	1.00	0.98	0.83	0.59	0.58	0.57	0.43	0.35	0.26	0.85	0.71	0.52	0.61	n/a	n/a
	5-3/4	(146)	0.79	0.76	0.70	1.00	1.00	0.85	0.60	0.59	0.57	0.46	0.38	0.28	0.91	0.76	0.56	0.63	n/a	n/a
	6	(152)	0.81	0.77	0.71	1.00	1.00	0.88	0.60	0.59	0.57	0.49	0.40	0.30	0.97	0.81	0.59	0.64	0.60	n/a
	7	(178)	0.86	0.81	0.75	1.00		0.99	0.62	0.61	0.59	0.61	0.51	0.37	1.00	1.00	0.75	0.69	0.65	n/a
	7-1/2	(191)	0.88	0.83	0.76	1.00		1.00	0.63	0.61	0.59	0.68	0.56	0.41	1.00		0.83	0.72	0.67	n/a
	8	(203)	0.91	0.86	0.78	1.00			0.64	0.62	0.60	0.75	0.62	0.46	1.00		0.91	0.74	0.70	0.63
	9	(229)	0.96	0.90	0.82				0.65	0.64	0.61	0.89	0.74	0.54			1.00	0.79	0.74	0.67
	10	(254)	1.00	0.94	0.85				0.67	0.65	0.62	1.00	0.87	0.64				0.83	0.78	0.70
	11	(279)	1.00	0.99	0.89				0.69	0.67	0.64		1.00	0.74				0.87	0.82	0.74
	12	(305)		1.00	0.92				0.71	0.68	0.65			0.84				0.91	0.85	0.77
	16	(406)			1.00				0.77	0.74	0.70			1.00				1.00	0.98	0.89
	18	(457)							0.81	0.77	0.72								1.00	0.94
	24	(610)							0.91	0.86	0.80									1.00
	> 36	(914)							1.00	1.00	0.94									

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

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Table 32 — Load adjustment factors for Stainless Steel 1-in. diameter KB-TZ2 in uncracked concrete [1,4]

1-in. KB-TZ2 uncracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear ⊥ Toward edge f_{RV}		Edge distance in shear ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Effective Embedment h_{ef}	in.		4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75
	(mm)		(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)
Nominal Embedment h_{nom}	in.		4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8
	(mm)		(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3	(76)	n/a	n/a	n/a	0.302	n/a	n/a	n/a	0.085	n/a	0.170	n/a	n/a
	3-3/4	(95)	n/a	n/a	0.393	0.332	n/a	n/a	0.199	0.119	0.393	0.238	n/a	n/a
	4	(102)	n/a	n/a	0.409	0.342	n/a	n/a	0.219	0.131	0.409	0.262	n/a	n/a
	4-1/4	(108)	n/a	n/a	0.425	0.352	n/a	n/a	0.240	0.144	0.425	0.287	n/a	n/a
	4-3/4	(121)	n/a	0.638	0.458	0.373	n/a	0.551	0.284	0.170	0.458	0.339	n/a	n/a
	5	(127)	0.708	0.645	0.475	0.384	0.576	0.554	0.306	0.183	0.475	0.366	n/a	n/a
	6	(152)	0.750	0.674	0.545	0.429	0.591	0.565	0.403	0.241	0.545	0.429	n/a	n/a
	6-3/4	(171)	0.781	0.696	0.614	0.464	0.602	0.573	0.481	0.287	0.614	0.464	n/a	n/a
	8	(203)	0.833	0.732	0.727	0.525	0.621	0.586	0.620	0.371	0.727	0.525	0.696	n/a
	10	(254)	0.917	0.790	0.909	0.645	0.652	0.608	0.867	0.518	0.909	0.645	0.778	0.656
	12	(305)	1.000	0.848	1.000	0.774	0.682	0.629	1.000	0.681	1.000	0.774	0.853	0.718
	18	(457)		1.000		1.000	0.773	0.694		1.000		1.000	1.000	0.880
	24	(610)					0.864	0.758						1.000
	36	(914)					1.000	0.887						
	> 48	(1219)						1.000						

Table 33 — Load adjustment factors for Stainless Steel 1-in. diameter KB-TZ2 in cracked concrete [1,4]

1-in. KB-TZ2 cracked concrete			Spacing factor in tension f_{AN}		Edge distance factor in tension f_{RN}		Spacing factor in shear [3] f_{AV}		Edge distance in shear ⊥ Toward edge f_{RV}		Edge distance in shear ∥ To edge f_{RV}		Concrete thickness factor in shear [4] f_{HV}	
Effective Embedment h_{ef}	in.		4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75	4.00	5.75
	(mm)		(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)	(102)	(146)
Nominal Embedment h_{nom}	in.		4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8	4-5/8	6-3/8
	(mm)		(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)	(117)	(162)
Spacing (s) / Edge Distance (c_a) / Concrete Thickness (h) - in. (mm)	3	(76)	n/a	n/a	n/a	0.542	n/a	n/a	n/a	0.081	n/a	0.162	n/a	n/a
	3-3/4	(95)	n/a	n/a	0.721	0.596	n/a	n/a	0.170	0.113	0.340	0.226	n/a	n/a
	4	(102)	n/a	n/a	0.750	0.614	n/a	n/a	0.188	0.124	0.375	0.249	n/a	n/a
	4-1/4	(108)	n/a	n/a	0.779	0.633	n/a	n/a	0.205	0.136	0.411	0.272	n/a	n/a
	4-3/4	(121)	n/a	0.638	0.840	0.671	n/a	0.549	0.243	0.161	0.485	0.322	n/a	n/a
	5	(127)	0.708	0.645	0.871	0.690	0.568	0.552	0.262	0.174	0.524	0.348	n/a	n/a
	6	(152)	0.750	0.674	1.000	0.770	0.582	0.562	0.344	0.228	0.689	0.457	n/a	n/a
	6-3/4	(171)	0.781	0.696		0.833	0.592	0.570	0.411	0.273	0.822	0.545	n/a	n/a
	8	(203)	0.833	0.732		0.943	0.609	0.583	0.530	0.352	1.000	0.703	0.661	n/a
	10	(254)	0.917	0.790		1.000	0.636	0.604	0.741	0.491		0.983	0.739	0.644
	12	(305)	1.000	0.848			0.664	0.625	0.974	0.646		1.000	0.809	0.706
	18	(457)		1.000			0.746	0.687	1.000	1.000			0.991	0.864
	24	(610)					0.828	0.749					1.000	0.998
	36	(914)					0.991	0.874						1.000
	> 48	(1219)					1.000	0.998						

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, f_{AV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, f_{HV}, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

Table 34 — Hilti Carbon Steel KB-TZ2 in the soffit of uncracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations [1,2,3,4,5,6]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Installation per Figure 4				Installation per Figure 5			
			Min. conc. thickness [8] in. (mm)	Tension - ΦN_n		Shear - ΦV_n	Min. conc. thickness [8] in. (mm)	Tension - ΦN_n		Shear - ΦV_n
				f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)
1/4	1-1/2 (38)	1-3/4 (44)	2-1/2 (64)	775 (3.4)	820 (3.6)	1,060 (4.7)	2-1/4 (57)	620 (2.8)	655 (2.9)	730 (3.2)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	1,205 (5.4)	1,285 (5.7)	880 (3.9)	2-1/4 (57)	645 (2.9)	685 (3.0)	1,540 (6.9)
	2 (51)	2-1/2 (64)	2-1/2 (64)	1,705 (7.6)	1,830 (8.1)	1,380 (6.1)	2-1/4 (57)	1,615 (7.2)	1,730 (7.7)	1,630 (7.3)
	2-1/2 (64)	3 (76)	2-1/2 (64)	1,945 (8.7)	2,155 (9.6)	1,380 (6.1)	N/A	N/A	N/A	N/A
1/2	1-1/2 (38)	2 (51)	2-1/2 (64)	1,205 (5.4)	1,390 (6.2)	1,165 (5.2)	2-1/4 (57)	1,180 (5.2)	1,365 (6.1)	1,740 (7.7)
	2 (51)	2-1/2 (64)	2-1/2 (64)	1,790 (8.0)	2,015 (9.0)	1,470 (6.5)	2-1/4 (57)	1,235 (5.5)	1,395 (6.2)	2,065 (9.2)
	2-1/2 (64)	3 (76)	2-1/2 (64)	2,435 (10.8)	2,645 (11.8)	2,135 (9.5)	N/A	N/A	N/A	N/A
	3-1/4 (83)	3-3/4 (95)	2-1/2 (64)	3,065 (13.6)	3,390 (15.1)	2,755 (12.3)	3-1/4 (83)	1,730 (7.7)	1,915 (8.5)	2,250 (10.0)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	2,870 (12.8)	3,315 (14.7)	2,480 (11.0)	3-1/4 (83)	1,925 (8.6)	2,225 (9.9)	2,655 (11.8)
	4 (102)	4-1/2 (114)	2-1/2 (64)	3,780 (16.8)	4,365 (19.4)	3,025 (13.5)	N/A	N/A	N/A	N/A
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	2,470 (11.0)	2,730 (12.1)	2,655 (11.8)	N/A	N/A	N/A	N/A
	3-3/4[9] (95)	4-1/2 (114)	3-1/4 (83)	3,115 (13.9)	3,405 (15.1)	5,110 (22.7)	N/A	N/A	N/A	N/A

Table 35 — Hilti Carbon Steel KB-TZ2 in the soffit of cracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations [1,2,3,4,5,6,7]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Installation per Figure 4				Installation per Figure 5			
			Min. conc. thickness [8] in. (mm)	Tension - ΦN_n		Shear - ΦV_n	Min. conc. thickness [8] in. (mm)	Tension - ΦN_n		Shear - ΦV_n
				f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)		f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)
1/4	1-1/2 (38)	1-3/4 (44)	2-1/2 (64)	230 (1.0)	260 (1.2)	1,060 (4.7)	2-1/4 (57)	185 (0.8)	205 (0.9)	730 (3.2)
3/8	1-1/2 (38)	1-7/8 (48)	2-1/2 (64)	1,055 (4.7)	1,220 (5.4)	880 (3.9)	2-1/4 (57)	565 (2.5)	650 (2.9)	1,540 (6.9)
	2 (51)	2-1/2 (64)	2-1/2 (64)	1,490 (6.6)	1.705 (7.6)	1,380 (6.1)	2-1/4 (57)	1,385 (6.2)	1,580 (7.0)	1,630 (7.3)
	2-1/2 (64)	3 (76)	2-1/2 (64)	1,565 (7.0)	1.695 (7.5)	1,380 (6.1)	N/A	N/A	N/A	N/A
1/2	1-1/2 (38)	2 (51)	2-1/2 (64)	1,075 (4.8)	1.230 (5.5)	1,165 (5.2)	2-1/4 (57)	960 (4.3)	1,100 (4.9)	1,740 (7.7)
	2 (51)	2-1/2 (64)	2-1/2 (64)	1,390 (6.2)	1.600 (7.1)	1,470 (6.5)	2-1/4 (57)	960 (4.3)	1,110 (4.9)	2,065 (9.2)
	2-1/2 (64)	3 (76)	2-1/2 (64)	2,130 (9.5)	2,435 (10.9)	2,135 (9.5)	N/A	N/A	N/A	N/A
	3-1/4 (83)	3-3/4 (95)	2-1/2 (64)	2,170 (9.7)	2,435 (10.8)	2,755 (12.3)	3-1/4 (83)	1,230 (5.5)	1,380 (6.1)	2,250 (10.0)
5/8	2-3/4 (70)	3-1/4 (83)	2-1/2 (64)	2,555 (11.4)	2,950 (13.1)	2,480 (11.0)	3-1/4 (83)	1,715 (7.6)	1,980 (8.8)	2,655 (11.8)
	4 (102)	4-1/2 (114)	2-1/2 (64)	2,855 (12.7)	3,300 (14.7)	3,025 (13.5)	N/A	N/A	N/A	N/A
3/4	3-1/4 (83)	4 (102)	2-1/2 (64)	2,160 (9.6)	2,395 (10.7)	2,655 (11.8)	N/A	N/A	N/A	N/A
	3-3/4 (95)	4-1/2 (114)	3-1/4 (83)	2,425 (10.8)	2,735 (12.2)	5,110 (22.7)	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 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 of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.73. See Section 3.1.8 for additional information on seismic applications.
8 Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 4 and 5.
9 For core drilled installations of 3/4" anchors installed at 3-3/4" effective embedment, apply a reduction factor of 0.89 to the design tension strength of anchors installed in uncracked concrete.

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Figure 4 — Installation of Hilti KB-TZ2 carbon steel in the soffit of concrete over metal deck floor and roof assemblies – W deck[2]

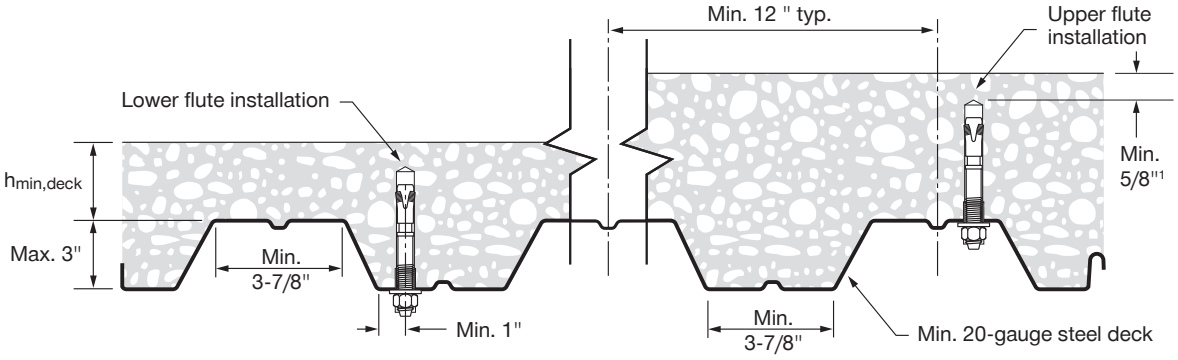
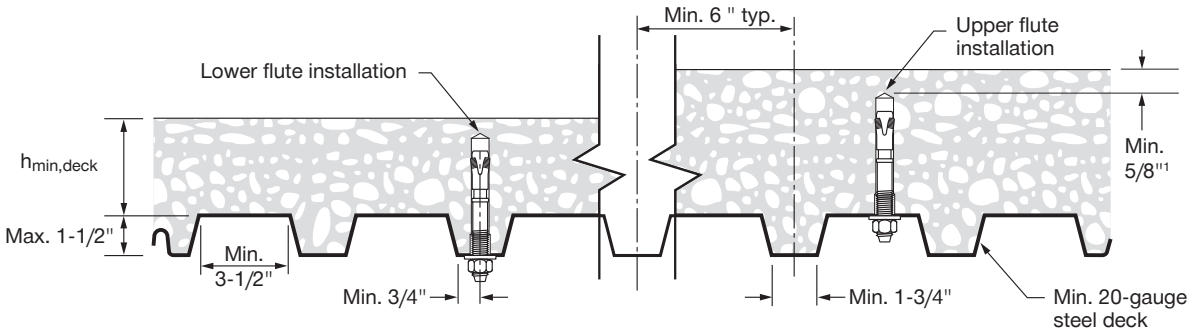


Figure 5 — Installation of Hilti KB-TZ2 carbon steel in the soffit of concrete over metal deck floor and roof assemblies – B deck



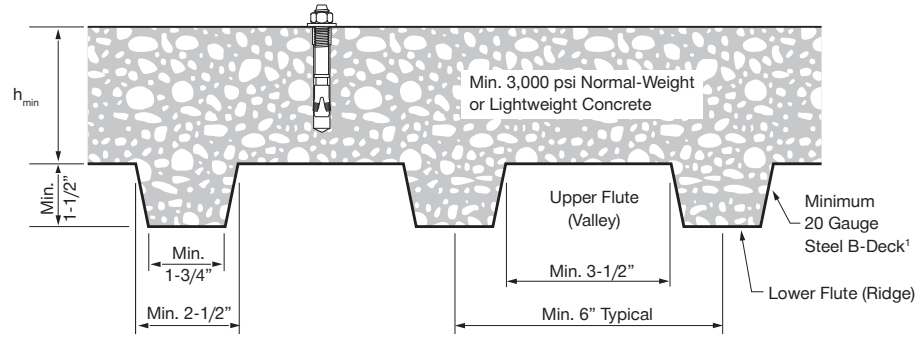
1 5/8" clearance between the bottom of the drilled hole and the concrete surface is only applicable for upper flute installations. Refer to Tables 34 and 35 for minimum concrete thicknesses for installations into the lower flute.
2 For flute widths greater or equal to 4-1/2", the shear strength may be increased. Refer to ESR-4266 for more information.

Table 36 — Hilti KB-TZ2 carbon steel anchors setting information for installation on the top of concrete-filled profile steel deck asseblies according to figure 6 [1,2,3]

Design information	Symbol	Units	Nominal anchor diameter (in)			
			1/4	3/8		1/2
Effective minimum embedment	h_{ef}	in.	1-1/2	1-1/2	2	2
Nominal minimum embedment	h_{nom}	in.	1-3/4	1-7/8	2-1/2	2-1/2
Minimum hole depth	h_0	in.	2	2	2-1/2	2-3/4
Minimum concrete thickness [4]	$h_{min,deck}$	in.	2-1/2	2-1/2	2-1/2	3-2/4
Critical edge distance	$c_{ac,deck,top}$	in.	5	8	4-1/2	6
Minimum edge distance	$c_{min,deck,top}$	in.	3	16		7-1/2
Minimum spacing	$s_{min,deck,top}$	in.	3	8		9
Required installation torque	T_{inst}	ft-lb	4	30		50

1 Installation must comply with Figure 6 of this report.
2 Design capacity shall be based on calculations according to values in Tables 2 and 3 of this report.
3 Applicable for $h_{min,deck}$ < 4-in. For $h_{min,deck}$ ≥ 4-in, use setting information in Tables 1 and 5 of this section.
4 Minimun concrete thickness refers to concrete thickness above the upper flute. See Figure 6.

Figure 6 — KB-TZ2 Installation in the top of concrete filled profile steel deck assemblies



1 1-1/2-in B-deck as a minimum profile size. Other deck profiles meeting the B-deck minimum dimensions are also permitted

DESIGN DATA IN CONCRETE PER CSA A23.3

CSA A23.3 Annex D Design

Limit State Design of anchors is described in the provisions of CSA A23.3 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. Tables 37, 38, 42 and 43 in this section contains the Limit State Design tables that are based on the published loads in ICC-ES Evaluation Report ESR 4266 and converted for use with CSA A23.3 Annex D. Tables 40, 41, 45 and 46 are Hilti Simplified Design Tables which are pre-factored resistance tables based on the design parameters and variables in Tables 37, 38, 42 and 43. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

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

Table 37 — Hilti KB-TZ2 carbon steel tension design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations[1]

Design parameter	Symbol	Units	Nominal anchor diameter (in.)																Ref
			1/4	3/8			1/2				5/8			3/4			1		A23.3
Effective min. embedment [2]	h_{ef}	in. (mm)	1-1/2 (38)	1-1/2 (38)	2 (51)	2-1/2 (64)	1-1/2 (38)	2 (51)	2-1/2 (64)	3-1/4 (83)	2-3/4 (70)	3-1/4 (83)	4 (102)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	4 (102)	5-3/4 (146)	
Min. concrete thickness	h_{min}	in. (mm)	See Table 5																
Minimum edge distance	c_{min}	in. (mm)	See Table 5																
Minimum anchor spacing	s_{min}	in. (mm)	See Table 5																
Tension, steel failure modes																			
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85	0.85			0.85				0.85			0.85			0.85		8.4.3
Resistance modification factor for tension, steel failure modes[3]	R	-	0.80	0.80			0.80				0.80			0.80			0.80		D.5.3
Min. specified yield strength	f_{ya}	psi (N/mm^2)	100,900 (696)	100,900 (696)			96,300 (664)				87,000 (600)			84,700 (584)			75,000 (517)		
Min. specified ult. strength	f_{ut}	psi (N/mm^2)	122,400 (844)	126,200 (870)			114,000 (786)				106,700 (736)			105,900 (730)			88,000 (607)		
Effective tensile stress area	$A_{se,N}$	in^2 (mm^2)	0.024 (15.4)	0.051 (33.2)			0.099 (63.6)				0.164 (106.0)			0.239 (154.4)			0.470 (303.2)		
Factored steel resistance in tension	N_{sar}	lb (kN)	1,985 (8.8)	4,420 (19.7)			7,645 (34.0)				11,925 (53.0)			17,230 (76.6)			28,145 (125.2)		D.6.1.2
Tension, concrete failure modes																			
Anchor category	-	-	3	1			1				1			1			1		D.5.3 (c)
Concrete material resistance factor	Φ_c	-	0.65	0.65			0.65				0.65			0.65			0.65		8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [5]	R	-	0.75	1.00			1.00				1.00			1.00			1.00		D.5.3 (c)
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10.0	10.0	10.0	10.0	11.3	11.3	10.0	10.0	10.0	10.0	10.0	11.3	11.3[7]	10.0	11.3	10.0	D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	-	7.1	8.8	8.8	7.1	10.0	8.8	8.8	7.1	8.8	8.8	7.1	8.8	8.8	8.8	8.8	8.8	D.6.2.2
Modification factor for anchor resistance, tension, uncracked conc. [4]	$\Psi_{c,N}$	-	1.0	1.0			1.0				1.0			1.0			1.0		
Critical edge distance	c_{ac}	in. (mm)	4 (102)	5 (127)	4-3/8 (111)	5-1/2 (140)	8 (203)	5-1/2 (140)	6-3/4 (171)	10 (254)	10 (254)	11-1/2 (292)	8-3/4 (222)	12 (305)	10 (254)	9 (229)	11 (279)	16 (406)	
Factored pullout resistance in 20 MPa uncracked concrete [6]	$N_{pr,uncr}$	lb (kN)	1,055 (4.7)	N/A	N/A	2,865 (12.7)	N/A	N/A	N/A	N/A	3,770 (16.8)	N/A	6,300 (28.0	N/A	N/A	N/A	N/A	N/A	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete [6]	$N_{pr,cr}$	lb (kN)	325 (1.4)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6,000 (26.7)	N/A	8,275 (36.8)	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete, seismic [6]	$N_{pr,eq}$	lb (kN)	325 (1.4)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5,880 (26.1)	N/A	8,275 (36.8)	D.6.3.2
Normalization factor, uncracked concrete	n_{uncr}	-	0.20	0.22	0.24	0.35	0.50	0.42	0.29	0.35	0.50	0.48	0.50	0.35	0.31	0.39	N/A	0.38	
Normalization factor, cracked concrete, seismic	n_{cr}	-	0.39	0.50	0.46	0.28	0.47	0.50	0.48	0.40	0.50	0.47	0.50	0.36	0.42	0.29	N/A	0.50	

1 Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 4 and 6, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB-TZ2 carbon steel anchor is considered a ductile steel element as defined by CSA A23.3 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 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 For all design cases, $\Psi_{c,P}$ = 1.0. Tabular value for pullout strength is for a concrete compressive strength of 2,900 psi (20.0 M Pa). Pullout strength for concrete compressive strength greater than 2,900 psi (20.2 MPa) may be increased by multiplying the tabular pullout strength by $(f'_c / 2{,}900)^n$ for psi, or $(f'_c / 20.2)^n$ for MPa,
7 For core drilled installation $k_{c,uncr}$ = 10.0 for 3/4“ diameter installed at 3-3/4“ effective embedment.

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Table 38 — Hilti KB-TZ2 carbon steel shear design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations [1]

Design parameter	Symbol	Units	Nominal anchor diameter (in.)																Ref
			1/4	3/8			1/2				5/8			3/4			1		A23.3
Anchor O.D.	d_a	in.	0.25	0.375			0.5				0.625			0.75			1.00		
		(mm)	(6.4)	(9.5)			(12.7)				(15.9)			(19.1)			(25.4)		
Effective min. embedment [2]	h_{ef}	in.	1-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	3-1/4	2-3/4	3-1/4	4	3-1/4	3-3/4	4-3/4	4	5-3/4	
		(mm)	(38)	(38)	(51)	(64)	(38)	(51)	(64)	(83)	(70)	(83)	(102)	(83)	(95)	(121)	(102)	(146)	
Shear, steel failure modes																			
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85	0.85			0.85				0.85			0.85			0.85		8.4.3
Resistance modification factor for shear, steel failure modes [3]	R	-	0.75	0.75			0.75				0.75			0.75			0.75		D.5.3
Factored steel resistance in shear	V_{sar}	lb	855	2,055			3,530				6,540			8,800			11,980	14,550	D.7.1.2
		(kN)	(3.8)	(9.1)			(15.7)				(29.1)			(39.1)			(53.3)	(64.7)	
Factored steel resistance in shear, seismic	$V_{sar,eq}$	lb	855	2,055			3,530				6,540			8,800			8,800		
		(kN)	(3.8)	(9.1)			(15.7)				(29.1)			(39.1)			(39.1)		
Shear, concrete failure modes																			
Concrete material resistance factor	Φ_c	-	0.65	0.65			0.65				0.65			0.65			0.65		8.4.2
Resistance modification factor for shear, concrete failure modes [4]	R	-	1.00	1.00			1.00				1.00			1.00			1.00		D.5.3
Load bearing length of anchor in shear	ℓ_e	in.	1-1/2	1-1/2	2	2-1/2	1-1/2	2	2-1/2	3-1/4	2-3/4	3-1/4	4	3-1/4	3-3/4	4-3/4	4	5-3/4	
		(mm)	(38)	(38)	(51)	(64)	(38)	(51)	(64)	(83)	(70)	(83)	(102)	(83)	(95)	(121)	(102)	(146)	
Effectiveness factor for pryout	k_{cp}	-	1.0	1.0	1.0	2.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	

1 Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 4 and 6, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB-TZ2 carbon steel anchor is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

Table 39 — Steel resistance for Hilti KB-TZ2 carbon steel anchors [1,2]

Nominal anchor diameter in.	Effective embedment depth in. (mm)			Tensile [3] ΦN_{sar} lb (kN)	Shear [4] ΦV_{sar} lb (kN)	Seismic Shear [5] $\Phi V_{sar,eq}$ lb (kN)
1/4	1-1/2 (38)			1,985 (8.8)	855 (3.8)	855 (3.8)
3/8	1-1/2 (38)			4,420 (19.7)	2,055 (9.1)	2,055 (9.1)
3/8	2 (51)	2-1/2 (64)		4,420 (19.7)	2,160 (9.6)	2,160 (9.6)
1/2	1-1/2 (38)	2 (51)		7,645 (34.0)	3,530 (15.7)	3,530 (15.7)
1/2	2-1/2 (64)	3-1/4 (83)		7,645 (34.0)	4,385 (19.5)	4,385 (19.5)
5/8	2-3/4 (70)	3-1/4 (83)	4 (102)	11,925 (53.0)	6,540 (29.1)	6,540 (29.1)
3/4	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	17,230 (76.6)	8,800 (39.1)	8,800 (39.1)
1	4 (102)			28,145 (125.2)	11,980 (53.3)	8,800 (39.1)
1	5-3/4 (146)			28,145 (125.2)	14,550 (64.7)	8,800 (39.1)

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Hilti KB-TZ2 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 Annex D.
4 Shear determined by static shear tests with $V_{sar} < 0.6\ A_{se,V}\ \Phi_s\ f_{ut}$a R as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \le 0.60\ A_{se,V}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D. See Section 3.1.8 for additional information on seismic applications.

Table 40 — Hilti KB-TZ2 carbon steel factored resistance based on concrete failure modes in uncracked concrete, applicable for both hammer and core drilled installations [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1 1/2 (38)	1 3/4 (44)	1,055 (4.7)	1,105 (4.9)	1,145 (5.1)	1,210 (5.4)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
3/8	1 1/2 (38)	1 7/8 (48)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
	2 (51)	2 1/2 (64)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)
	2 1/2 (64)	3 (76)	2,865 (12.7)	3,095 (13.8)	3,300 (14.7)	3,650 (16.2)	3,305 (14.7)	3,695 (16.4)	4,050 (18.0)	4,675 (20.8)
1/2	1 1/2 (38)	2 (51)	1,735 (7.7)	1,940 (8.6)	2,125 (9.5)	2,455 (10.9)	1,735 (7.7)	1,940 (8.6)	2,125 (9.5)	2,455 (10.9)
	2 (51)	2 1/2 (64)	2,675 (11.9)	2,990 (13.3)	3,275 (14.6)	3,780 (16.8)	2,675 (11.9)	2,990 (13.3)	3,275 (14.6)	3,780 (16.8)
	2 1/2 (64)	3 (76)	3,305 (14.7)	3,695 (16.4)	4,050 (18.0)	4,675 (20.8)	3,305 (14.7)	3,695 (16.4)	4,050 (18.0)	4,675 (20.8)
	3 1/4 (83)	3 3/4 (95)	4,900 (21.8)	5,480 (24.4)	6,005 (26.7)	6,930 (30.8)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
5/8	2 3/4 (70)	3 1/4 (83)	3,770 (16.8)	4,215 (18.7)	4,615 (20.5)	5,330 (23.7)	7,630 (33.9)	8,530 (37.9)	9,345 (41.6)	10,790 (48.0)
	3 1/4 (83)	3 3/4 (95)	4,900 (21.8)	5,480 (24.4)	6,005 (26.7)	6,930 (30.8)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
	4 (102)	4 1/2 (114)	6,300 (28.0)	7,045 (31.3)	7,720 (34.3)	8,910 (39.6)	13,385 (59.5)	14,965 (66.6)	16,395 (72.9)	18,930 (84.2)
3/4	3 1/4 (83)	4 (102)	4,900 (21.8)	5,480 (24.4)	6,005 (26.7)	6,930 (30.8)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
	3 3/4[6] (95)	4 1/2 (114)	6,865 (30.5)	7,675 (34.1)	8,405 (37.4)	9,710 (43.2)	13,730 (61.1)	15,350 (68.3)	16,815 (74.8)	19,415 (86.4)
	4 3/4 (121)	5 1/2 (140)	8,660 (38.5)	9,685 (43.1)	10,605 (47.2)	12,250 (54.5)	17,320 (77.0)	19,365 (86.1)	21,215 (94.4)	24,495 (109.0)
1	4 (102)	4 5/8 (117)	7,560 (33.6)	8,455 (37.6)	9,260 (41.2)	10,695 (47.6)	15,125 (67.3)	16,910 (75.2)	18,525 (82.4)	21,390 (95.1)
	5 3/4 (146)	6 3/8 (162)	11,535 (51.3)	12,895 (57.4)	14,125 (62.8)	16,310 (72.6)	23,070 (102.6)	25,790 (114.7)	28,255 (125.7)	32,625 (145.1)

Table 41 — Hilti KB-TZ2 carbon steel factored resistance based on concrete failure modes in cracked concrete, applicable for both hammer and core drilled installations [1,2,3,4,5]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1 1/2 (38)	1 3/4 (44)	325 (1.4)	350 (1.6)	380 (1.7)	425 (1.9)	1,090 (4.9)	1,220 (5.4)	1,335 (5.9)	1,545 (6.9)
3/8	1 1/2 (38)	1 7/8 (48)	1,350 (6.0)	1,510 (6.7)	1,655 (7.4)	1,915 (8.5)	1,350 (6.0)	1,510 (6.7)	1,655 (7.4)	1,915 (8.5)
	2 (51)	2 1/2 (64)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)
	2 1/2 (64)	3 (76)	2,350 (10.4)	2,625 (11.7)	2,875 (12.8)	3,320 (14.8)	2,350 (10.4)	2,625 (11.7)	2,875 (12.8)	3,320 (14.8)
1/2	1 1/2 (38)	2 (51)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
	2 (51)	2 1/2 (64)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)
	2 1/2 (64)	3 (76)	2,910 (12.9)	3,255 (14.5)	3,565 (15.9)	4,115 (18.3)	2,910 (12.9)	3,255 (14.5)	3,565 (15.9)	4,115 (18.3)
	3 1/4 (83)	3 3/4 (95)	3,480 (15.5)	3,890 (17.3)	4,260 (19.0)	4,920 (21.9)	6,960 (31.0)	7,780 (34.6)	8,525 (37.9)	9,845 (43.8)
5/8	2 3/4 (70)	3 1/4 (83)	3,355 (14.9)	3,755 (16.7)	4,110 (18.3)	4,750 (21.1)	6,715 (29.9)	7,505 (33.4)	8,225 (36.6)	9,495 (42.2)
	3 1/4 (83)	3 3/4 (95)	4,315 (19.2)	4,820 (21.5)	5,285 (23.5)	6,100 (27.1)	8,625 (38.4)	9,645 (42.9)	10,565 (47.0)	12,200 (54.3)
	4 (102)	4 1/2 (114)	4,750 (21.1)	5,310 (23.6)	5,820 (25.9)	6,720 (29.9)	9,505 (42.3)	10,625 (47.3)	11,640 (51.8)	13,440 (59.8)
3/4	3 1/4 (83)	4 (102)	4,315 (19.2)	4,820 (21.5)	5,285 (23.5)	6,100 (27.1)	8,625 (38.4)	9,645 (42.9)	10,565 (47.0)	12,200 (54.3)
	3 3/4 (95)	4 1/2 (114)	5,345 (23.8)	5,975 (26.6)	6,545 (29.1)	7,335 (33.6)	10,690 (47.6)	11,955 (53.2)	13,095 (58.2)	15,120 (67.3)
	4 3/4 (121)	5 1/2 (140)	6,000 (26.7)	6,400 (28.5)	6,745 (30.0)	7,335 (32.6)	15,240 (67.8)	17,040 (75.8)	18,670 (83.0)	21,555 (95.9)
1	4 (102)	4 5/8 (117)	5,890 (26.2)	6,585 (29.3)	7,215 (32.1)	8,330 (37.0)	11,780 (52.4)	13,170 (58.6)	14,425 (64.2)	16,660 (74.1)
	5 3/4 (146)	6 3/8 (162)	8,275 (36.8)	9,250 (41.1)	10,135 (45.1)	11,700 (52.0)	20,300 (90.3)	22,695 (101.0)	24,865 (110.6)	28,710 (127.7)

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 17 as necessary. Compare to the steel values in Table 39. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: For sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.73. No reduction needed for seismic shear. See Section 3.1.8 for additional information on seismic applications.
6 For core drilled installations of 3/4" anchors installed at 3-3/4" effective embedment, apply a reduction factor of 0.89 to the design tension strength

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Table 42 — Hilti KB-TZ2 stainless steel tension design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations [1]

Design parameter	Symbol	Units	Nominal anchor diameter (in.)															Ref
			1/4	3/8			1/2			5/8			3/4			1		A23.3
Effective min. embedment [2]	h_{ef}	in. (mm)	1-1/2 (38)	1-1/2 (38)	2 (51)	2-1/2 (64)	2 (51)	2-1/2 (64)	3-1/4 (83)	2-3/4 (70)	3-1/4 (83)	4 (102)	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	4 (102)	5-3/4 (146)	
Min. concrete thickness	h_{min}	in. (mm)	See Table 19															
Minimum edge distance	c_{min}	in. (mm)	See Table 19															
Minimum anchor spacing	s_{min}	in. (mm)	See Table 19															
Tension, steel failure modes																		
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85	0.85			0.85			0.85			0.85			0.85		8.4.3
Resistance modification factor for tension, steel failure modes [3]	R	-	0.80	0.80			0.80			0.80			0.80			0.80		
Min. specified yield strength	f_{ya}	psi (N/mm^2)	100,900 (696)	96,300 (664)			96,300 (664)			91,600 (632)			84,100 (580)			65,000 (448)		
Min. specified ult. strength	f_{ut}	psi (N/mm^2)	122,400 (844)	120,100 (828)			120,400			114,600 (790)			100,500 (693)			99,900 (689)		
Effective tensile stress area	$A_{se,N}$	in^2 (mm^2)	0.024 (15.4)	0.051 (33.2)			0.099 (63.6)			0.164 (106.0)			0.239 (154.4)			0.470 (303.2)		
Factored steel resistance in tension	N_{sar}	lb (kN)	2,050 (9.1)	4,210 (18.7)			8,070 (35.9)			12,810 (57.0)			16,350 (72.7)			31,930 (142.0)		D.6.1.2
Tension, concrete failure modes																		
Anchor category	-	-	3	1			1			1			1			1		D.5.3 (c)
Concrete material resistance factor	Φ_c	-	0.65	0.65			0.65			0.65			0.65			0.65		8.4.2
Resistance modification factor for tension and shear, concrete failure modes, Condition B [5]	R	-	0.75	1.00			1.00			1.00			1.00			1.00		D.5.3 (c)
Coeff. for factored conc. breakout resistance, uncracked concrete	$k_{c,uncr}$	-	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	11.3[7]	10.0	11.3	11.3	D.6.2.2
Coeff. for factored conc. breakout resistance, cracked concrete	$k_{c,cr}$	-	7.1	8.8	8.8	7.1	7.1	8.8	7.1	8.8	8.8	7.1	8.8	8.8[7]	8.8	10.0	8.8	D.6.2.2
Modification factor for anchor resistance, tension, uncracked conc. [4]	$\Psi_{c,N}$	-	1.0	1.0			1.0			1.0			1.0			1.0		
Critical edge distance	c_{ac}	in. (mm)	4 (102)	4-1/2 (114)	5-1/2 (140)	4-1/8 (105)	5-1/2 (140)	6-1/4 (159)	7-1/2 (191)	10 (254)	7 (178)	9 (229)	12 (305)	10 (254)	10 (254)	11 (279)	15-1/2 (394)	
Factored pullout resistance in 20 MPa uncracked concrete [6]	$N_{pr,uncr}$	lb (kN)	810 (3.6)	N/A	N/A	2,875 (12.8)	2,355 (10.5)	2,810 (12.5)	3,855 (17.1)	2,860 (12.7)	4,165 (18.5)	5,615 (25.0)	N/A	N/A	N/A	N/A	N/A	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete [6]	$N_{pr,cr}$	lb (kN)	360 (1.6)	N/A	N/A	N/A	N/A	N/A	N/A[8]	N/A	N/A	N/A	N/A	N/A	6,160 (27.4)	N/A	N/A	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete, seismic [6]	$N_{pr,eq}$	lb (kN)	360 (1.6)	N/A	N/A	N/A	N/A	N/A	N/A[8]	N/A	N/A	N/A	N/A	N/A	6,160 (27.4)	N/A	N/A	D.6.3.2
Normalization factor, uncracked concrete	n_{uncr}	-	0.39	N/A	N/A	0.37	0.46	0.50	0.50	0.50	0.42	0.47	N/A	N/A	0.30	N/A	N/A	
Normalization factor, cracked concrete, seismic	n_{cr}	-	0.50	N/A	N/A	N/A	N/A	N/A	0.50	N/A	N/A	N/A	N/A	N/A	0.50	N/A	N/A	

1 Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 5 and 7, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB-TZ2 stainless steel anchor is considered a ductile steel element as defined by CSA A23.3 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 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 For all design cases, $\Psi_{c,P}$ = 1.0. Tabular value for pullout strength is for a concrete compressive strength of 2,900 psi (20.0 MPa). Pullout strength for concrete compressive strength greater than 2,900 psi (20.2 MPa) may be increased by multiplying the tabular pullout strength by $(f'_c / 2{,}900)n$ for psi, or $(f'_c / 20.2)^n$ for MPa.
7 For core drilled installation $k_{c,uncr}$ = 10.0 and $k_{c,cr}$ = 7.1 for 3/4“ diameter installed at 3-3/4“ effective embedment
8 For core drilled installation, $N_{p,c}r$ = 4245 lb (18.9 kN) and $N_{p,eq}$ = 4245 lb (18.9 kN) for 1/2-inch diameter anchors installed at 3-3/4 inches (95 mm) effective embedment.

Table 43 — Hilti KB-TZ2 stainless steel shear design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations[1]

Design parameter	Symbol	Units	Nominal anchor diameter (in.)														Ref
			1/4	3/8			1/2			5/8			3/4			1		A23.3
Anchor O.D.	d_a	in.	0.25	0.375			0.5			0.625			0.75			1.00		
		(mm)	(6.4)	(9.5)			(12.7)			(15.9)			(19.1)			(25.4)		
Effective min. embedment [2]	h_{ef}	in.	1-1/2	1-1/2	2	2-1/2	2	2-1/2	3-1/4	2-3/4	3-1/4	4	3-1/4	3-3/4	4-3/4	4	5-3/4	
		(mm)	(38)	(38)	(51)	(64)	(51)	(64)	(83)	(70)	(83)	(102)	(83)	(95)	(121)	(102)	(146)	
Shear, steel failure modes																		
Steel embed. material resistance factor for reinforcement	Φ_s	-	0.85	0.85			0.85			0.85			0.85			0.85		8.4.3
Resistance modification factor for shear, steel failure modes [3]	R	-	0.75	0.75			0.75			0.75			0.75			0.75		
Factored steel resistance in shear	V_{sar}	lb	930	2,940	3,115		5,320			7,875			10,555			14,635	20,020	D.7.1.2
		(kN)	(4.1)	(13.1)	(13.9)		(23.7)			(35.0)			(47.0)			(65.1)	(89.1)	
Factored steel resistance in shear, seismic	$V_{sar,eq}$	lb	710	2,940	3,115		5,320			7,875			8,585			8,585		
		(kN)	(3.2)	(13.1)	(13.9)		(23.7)			(35.0)			(38.2)			(38.2)		
Shear, concrete failure modes																		
Concrete material resistance factor	Φ_c	-	0.65	0.65			0.65			0.65			0.65			0.65		8.4.2
Resistance modification factor for shear, concrete failure modes [4]	R	-	0.75	1.00			1.00			1.00			1.00			1.00		D.5.3 (c)
Load bearing length of anchor in shear	ℓ_e	in.	1-1/2	1-1/2	2	2-1/2	2	2-1/2	3-1/4	2-3/4	3-1/4	4	3-1/4	3-3/4	4-3/4	4	5-3/4	
		(mm)	(38)	(38)	(51)	(64)	(51)	(64)	(83)	(70)	(83)	(102)	(83)	(95)	(121)	(102)	(146)	
Effectiveness factor for pryout	k_{cp}	-	1.0	1.0	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	

1 Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 5 and 7, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB-TZ2 stainless steel anchor is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

Table 44 — Steel resistance for Hilti KB-TZ2 stainless steel anchors [1,2]

Nominal anchor diameter in.	Effective embedment depth in. (mm)			Tensile [3] N_{sar} lb (kN)	Shear [4] V_{sar} lb (kN)	Seismic Shear [5] $V_{sar,eq}$ lb (kN)
1/4	1-1/2 (38)			2,050 (9.1)	930 (4.1)	710 (3.2)
3/8	1-1/2 (38)			4,210 (18.7)	2,940 (13.1)	2,940 (13.1)
3/8	2 (51)	2-1/2 (64)		4,210 (18.7)	3,115 (13.9)	3,115 (13.9)
1/2	2 (51)	2-1/2 (64)	3-1/4 (83)	8,070 (35.9)	5,320 (23.7)	5,320 (23.7)
5/8	2-3/4 (70)	3-1/4 (83)	4 (102)	12,810 (57.0)	7,875 (35.0)	7,875 (35.0)
3/4	3-1/4 (83)	3-3/4 (95)	4-3/4 (121)	16,350 (72.7)	10,555 (47.0)	8,585 (38.2)
1	4 (102)			31,930 (142.0)	14,635 (65.1)	8,585 (38.2)
1	5-3/4 (146)			31,930 (142.0)	20,020 (89.1)	8,585 (38.2)

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Hilti KB-TZ2 stainless steel anchors are to be considered ductile steel elements.
3 Tensile Nsar = Ase,N fs futa R as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with Vsar < 0.6 Ase,V fs futa R as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with Vsar,eq < 0.60 Ase,V fs futa R as noted in CSA A23.3 Annex D. See Section 3.1.8 for additional information on seismic applications.

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Table 45 — Hilti KB-TZ2 stainless steel factored resistance based on concrete failure modes in uncracked concrete, applicable for both hammer and core drilled installations [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1 1/2 (38)	1 3/4 (44)	810 (3.6)	885 (3.9)	950 (4.2)	1,065 (4.7)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
3/8	1 1/2 (38)	1 7/8 (48)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)	1,535 (6.8)	1,720 (7.6)	1,880 (8.4)	2,175 (9.7)
	2 (51)	2 1/2 (64)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)
	2 1/2 (64)	3 (76)	2,875 (12.8)	3,125 (13.9)	3,340 (14.9)	3,715 (16.5)	6,615 (29.4)	7,395 (32.9)	8,100 (36.0)	9,355 (41.6)
1/2	2 (51)	2 1/2 (64)	2,355 (10.5)	2,610 (11.6)	2,835 (12.6)	3,240 (14.4)	2,365 (10.5)	2,645 (11.8)	2,900 (12.9)	3,345 (14.9)
	2-1/2 (64)	3 (76)	2,810 (12.5)	3,140 (14.0)	3,440 (15.3)	3,975 (17.7)	6,615 (29.4)	7,395 (32.9)	8,100 (36.0)	9,355 (41.6)
	3 1/4 (83)	3 3/4 (95)	3,855 (17.1)	4,310 (19.2)	4,720 (21.0)	5,450 (24.2)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
5/8	2 3/4 (70)	3 1/4 (83)	2,860 (12.7)	3,200 (14.2)	3,505 (15.6)	4,045 (18.0)	7,630 (33.9)	8,530 (37.9)	9,345 (41.6)	10,790 (48.0)
	3 1/4 (83)	3 3/4 (95)	4,165 (18.5)	4,575 (20.3)	4,935 (22.0)	5,570 (24.8)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
	4 (102)	4 1/2 (114)	5,615 (25.0)	6,235 (27.7)	6,795 (30.2)	7,775 (34.6)	13,385 (59.5)	14,965 (66.6)	16,395 (72.9)	18,930 (84.2)
3/4	3 1/4 (83)	4 (102)	4,900 (21.8)	5,480 (24.4)	6,005 (26.7)	6,930 (30.8)	9,805 (43.6)	10,960 (48.8)	12,005 (53.4)	13,865 (61.7)
	3 3/4[6] (95)	4 1/2 (114)	6,865 (30.5)	7,675 (34.1)	8,405 (37.4)	9,710 (43.2)	13,730 (61.1)	15,350 (68.3)	16,815 (74.8)	19,415 (86.4)
	4 3/4 (121)	5 1/2 (140)	8,660 (38.5)	9,685 (43.1)	10,605 (47.2)	12,250 (54.5)	17,320 (77.0)	19,365 (86.1)	21,215 (94.4)	24,495 (109.0)
1	4 (102)	4 5/8 (117)	7,560 (33.6)	8,455 (37.6)	9,260 (41.2)	10,695 (47.6)	15,125 (67.3)	16,910 (75.2)	18,525 (82.4)	21,390 (95.1)
	5 3/4 (146)	6 3/8 (162)	13,035 (58.0)	14,570 (64.8)	15,965 (71.0)	18,435 (82.0)	26,070 (116.0)	29,145 (129.6)	31,925 (142.0)	36,865 (164.0)

Table 46 — Hilti KB-TZ2 stainless steel factored resistance based on concrete failure modes in cracked concrete, applicable for both hammer and core drilled installations [1,2,3,4]

Nominal anchor diameter in.	Effective embedment in. (mm)	Nominal embedment in. (mm)	Tension - N_r				Shear - V_r			
			f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)	f'_c = 20 MPa (2,900 psi) lb (kN)	f'_c = 25 MPa (3,625 psi) lb (kN)	f'_c = 30 MPa (4,350 psi) lb (kN)	f'_c = 40 MPa (5,800 psi) lb (kN)
1/4	1 1/2 (38)	1 3/4 (44)	470 (2.1)	525 (2.3)	575 (2.6)	665 (3.0)	820 (3.6)	915 (4.1)	1,000 (4.5)	1,155 (5.1)
3/8	1 1/2 (38)	1 7/8 (48)	1,350 (6.0)	1,510 (6.7)	1,655 (7.4)	1,915 (8.5)	1,350 (6.0)	1,510 (6.7)	1,655 (7.4)	1,915 (8.5)
	2 (51)	2 1/2 (64)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)	2,080 (9.3)	2,330 (10.4)	2,550 (11.3)	2,945 (13.1)
	2 1/2 (64)	3 (76)	2,350 (10.4)	2,625 (11.7)	2,875 (12.8)	3,320 (14.8)	4,695 (20.9)	5,250 (23.4)	5,750 (25.6)	6,640 (29.5)
1/2	2 (51)	2 1/2 (64)	1,680 (7.5)	1,880 (8.4)	2,060 (9.2)	2,375 (10.6)	1,680 (7.5)	1,880 (8.4)	2,060 (9.2)	2,375 (10.6)
	2-1/2 (64)	3 (76)	2,910 (12.9)	3,255 (14.5)	3,565 (15.9)	4,115 (18.3)	5,820 (25.9)	6,505 (28.9)	7,130 (31.7)	8,230 (36.6)
	3 1/4[8] (83)	3 3/4 (95)	3,480 (15.5)	3,890 (17.3)	4,260 (19.0)	4,920 (21.9)	6,960 (31.0)	7,780 (34.6)	8,525 (37.9)	9,845 (43.8)
5/8	2 3/4 (70)	3 1/4 (83)	3,355 (14.9)	3,755 (16.7)	4,110 (18.3)	4,750 (21.1)	6,715 (29.9)	7,505 (33.4)	8,225 (36.6)	9,495 (42.2)
	3 1/4 (83)	3 3/4 (95)	4,315 (19.2)	4,820 (21.5)	5,285 (23.5)	6,100 (27.1)	8,625 (38.4)	9,645 (42.9)	10,565 (47.0)	12,200 (54.3)
	4 (102)	4 1/2 (114)	4,750 (21.1)	5,310 (23.6)	5,820 (25.9)	6,720 (29.9)	9,505 (42.3)	10,625 (47.3)	11,640 (51.8)	13,440 (59.8)
3/4	3 1/4 (83)	4 (102)	4,315 (19.2)	4,820 (21.5)	5,285 (23.5)	6,100 (27.1)	8,625 (38.4)	9,645 (42.9)	10,565 (47.0)	12,200 (54.3)
	3 3/4[7] (95)	4 1/2 (114)	5,345 (23.8)	5,975 (26.6)	6,545 (29.1)	7,560 (33.6)	10,690 (47.6)	11,955 (53.2)	13,095 (58.2)	15,120 (67.3)
	4 3/4 (121)	5 1/2 (140)	6,160 (27.4)	6,890 (30.6)	7,545 (33.6)	8,715 (38.8)	15,240 (67.8)	17,040 (75.8)	18,670 (83.0)	21,555 (95.9)
1	4 (102)	4 5/8 (117)	6,690 (29.8)	7,480 (33.3)	8,195 (36.5)	9,465 (42.1)	13,385 (59.5)	14,965 (66.6)	16,395 (72.9)	18,930 (84.2)
	5 3/4 (146)	6 3/8 (162)	10,150 (45.2)	11,350 (50.5)	12,430 (55.3)	14,355 (63.9)	20,300 (90.3)	22,695 (101.0)	24,865 (110.6)	28,710 (127.7)

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 22 to 33 as necessary. Compare to the steel values in Table 43. 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, except for the 3/4 bolts where $\alpha_{V,seis}$ = 0.81. See Section 3.1.8 for additional information on seismic applications.
6 For core drilled installations of 3/4" anchors installed at 3-3/4" effective embedment, apply a reduction factor of 0.89 to the design tension strength.
7 For core drilled installations of 3/4" anchors installed at 3-3/4" effective embedment, apply a reduction factor of 0.81 to the design tension strength.
8 Fore core drilled installations of 1/2" anchors installed at 3-1/4" effective embedment, apply a reduction factor of 0.85 to the design tension strength.

Table 47 — Hilti KB-TZ2 carbon steel factored resistance in the soffit of uncracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations[1,2,3,4,5,6]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Installation per Figure 4				Installation per Figure 5			
		Min. conc. thickness [8] in. (mm)	Tension - N_r		Shear - V_r	Min. conc. thickness [8] 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)	$f'_c \geq$ 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)	$f'_c \geq$ 20 MPa (2,900 psi) lb (kN)
1/4	1-3/4 (44)	2-1/2 (64)	835 (3.7)	905 (4.0)	1,040 (4.6)	2-1/4 (57)	670 (3.0)	725 (3.2)	715 (3.2)
3/8	1-7/8 (48)	2-1/2 (64)	1,195 (5.3)	1,310 (5.8)	865 (3.8)	2-1/4 (57)	640 (2.8)	700 (3.1)	1,510 (6.7)
	2-1/2 (64)	2-1/2 (64)	1,690 (7.5)	1,865 (8.3)	1,350 (6.0)	2-1/4 (57)	1600 (7.1)	1,765 (7.9)	1,595 (7.1)
	3 (76)	2-1/2 (64)	1,925 (8.6)	2,215 (9.9)	1,350 (6.0)	N/A	N/A	N/A	N/A
1/2	2 (51)	2-1/2 (64)	1,185 (5.3)	1,450 (6.4)	1,140 (5.1)	2-1/4 (57)	1,160 (5.2)	1,420 (6.3)	1,710 (7.6)
	2-1/2 (64)	2-1/2 (64)	1,760 (7.8)	2,090 (9.3)	1,440 (6.4)	2-1/4 (57)	1,220 (5.4)	1,445 (6.4)	2,025 (9.0)
	3-1/4 (83)	2-1/2 (64)	2,410 (10.7)	2,710 (12.1)	2,095 (9.3)	N/A	N/A	N/A	N/A
	3-3/4 (95)	2-1/2 (64)	3,030 (13.5)	3,490 (15.5)	2,700 (12.0)	3-1/4 (83)	1,710 (7.6)	1,975 (8.8)	2,210 (9.8)
5/8	3-1/4 (83)	2-1/2 (64)	2,820 (12.5)	3,455 (15.4)	2,430 (10.8)	3-1/4 (83)	1,890 (8.4)	2,315 (10.3)	2,605 (11.6)
	4-1/2 (114)	2-1/2 (64)	3,715 (16.5)	4,550 (20.2)	2,965 (13.2)	N/A	N/A	N/A	N/A
3/4	4 (102)	2-1/2 (64)	2,440 (10.9)	2,815 (12.5)	2,605 (11.6)	N/A	N/A	N/A	N/A
	4-1/2[9] (114)	3-1/4 (83)	3,085 (13.7)	3,495 (15.5)	5,015 (22.3)	N/A	N/A	N/A	N/A

3.3.5

Table 48 — Hilti KB-TZ2 carbon steel factored resistance in the soffit of cracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations [1,2,3,4,5,6,7]

Nominal anchor diameter in.	Nominal embedment in. (mm)	Installation per Figure 4				Installation per Figure 5			
		Min. conc. thickness [8] in. (mm)	Tension - N_r		Shear - V_r	Min. conc. thickness [8] 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)	$f'_c \geq$ 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)	$f'_c \geq$ 20 MPa (2,900 psi) lb (kN)
1/4	1-3/4 (44)	2-1/2 (64)	250 (1.1)	290 (1.3)	1,040 (4.6)	2-1/4 (57)	195 (0.9)	230 (1.0)	715 (3.2)
3/8	1-7/8 (48)	2-1/2 (64)	1,040 (4.6)	1,270 (5.6)	865 (3.8)	2-1/4 (57)	555 (2.5)	680 (3.0)	1,510 (6.7)
	2-1/2 (64)	2-1/2 (64)	1,470 (6.5)	1,770 (7.9)	1,350 (6.0)	2-1/4 (57)	1,365 (6.1)	1,645 (7.3)	1,595 (7.1)
	3 (76)	2-1/2 (64)	1,550 (6.9)	1,735 (7.7)	1,350 (6.0)	N/A	N/A	N/A	N/A
1/2	2 (51)	2-1/2 (64)	1,055 (4.7)	1,275 (5.7)	1,140 (5.1)	2-1/4 (57)	945 (4.2)	1,160 (5.1)	1,710 (7.6)
	2-1/2 (64)	2-1/2 (64)	1,365 (6.1)	1,670 (7.4)	1,440 (6.4)	2-1/4 (57)	945 (4.2)	1,160 (5.2)	2,025 (9.0)
	3-1/4 (83)	2-1/2 (64)	2,095 (9.3)	2,545 (11.3)	2,095 (9.3)	N/A	N/A	N/A	N/A
	3-3/4 (95)	2-1/2 (64)	2,140 (9.5)	2,520 (11.2)	2,700 (12.0)	3-1/4 (83)	1,210 (5.4)	1,425 (6.3)	2,210 (9.8)
5/8	3-1/4 (83)	2-1/2 (64)	2,510 (11.2)	3,075 (13.7)	2,430 (10.8)	3-1/4 (83)	1,685 (7.5)	2,060 (9.2)	2,605 (11.6)
	4-1/2 (114)	2-1/2 (64)	2,810 (12.5)	3,440 (15.3)	2,965 (13.2)	N/A	N/A	N/A	N/A
3/4	4 (102)	2-1/2 (64)	2,135 (9.5)	2,470 (11.0)	2,605 (11.6)	N/A	N/A	N/A	N/A
	4-1/2 (114)	3-1/4 (83)	2,400 (10.7)	2,700 (12.0)	5,015 (22.3)	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 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 of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 h_{ef} where $\alpha_{N,seis}$ = 0.73. See Section 3.1.8 for additional information on seismic applications.
8 Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 4 and 5.
9 For core drilled installations of 3/4" anchors installed at 4-1/2" nominal embedment, apply a reduction factor of 0.89 to the design tension strength of anchors installed in uncracked concrete.

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Table 49 — Allowable tensile loads for Hilti KB-TZ2 carbon steel and stainless steel anchors in the face of grout-filled concrete masonry unit (CMU) 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[2], s_{min}		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)	
1/4	1-3/4	(44)	145	(0.6)	6	(152)	3	(76)	0.62	12	(305)	4	(102)	0.87
3/8	1-7/8	(48)	405	(1.8)	6	(152)			0.49					0.80
	3	(76)	590	(2.6)	10	(254)			0.58					0.93
1/2	2-1/2	(64)	500	(2.2)	8	(203)	4	(102)	0.59					0.94
	3-3/4	(95)	640	(2.8)	13	(330)			0.78					1.00
5/8	3-1/4	(83)	890	(4.0)	11	(279)	5	(127)	0.66	20	(508)			0.96
	4-1/2	(114)	940	(4.2)	16	(406)			0.61					0.96
3/4	4	(102)	1,245	(5.5)	13	(330)	6	(152)	0.49					0.75
	5-1/2	(140)	1,385	(6.2)	19	(483)			0.45					0.82

Table 50 — Allowable shear loads for Hilti KB-TZ2 carbon steel and stainless steel anchors in the face of grout-filled concrete masonry unit (CMU) 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 multiplier at s_{min}	Critical edge distance, c_{cr}		Minimum edge distance, c_{min}		Perpendicular load reduction factor at c_{min}	Parallel load reduction factor at c_{min}
in.	in.	(mm)	lb	(kN)	in	(mm)	in	(mm)		in	(mm)	in	(mm)		
1/4	1-3/4	(44)	320	(1.4)	6	(152)	3	(76)	0.73	12	(305)	4	(102)	1.00	1.00
3/8	1-7/8	(48)	585	(2.6)	6	(152)								0.76	0.99
	3	(76)	695	(3.1)	10	(254)									
1/2	2-1/2	(64)	1,045	(4.7)	8	(203)	4	(102)						0.50	0.83
	3-3/4	(95)			13	(330)									
5/8	3-1/4	(83)	1,735	(7.7)	11	(279)	5	(127)		20	(508)			0.36	0.75
	4-1/2	(114)	2,050	(9.1)	16	(406)								0.35	0.85
3/4	4	(102)	1,735	(7.7)	13	(330)	6	(152)						0.36	0.75
	5-1/2	(140)	2,050	(9.1)	19	(483)								0.35	0.85

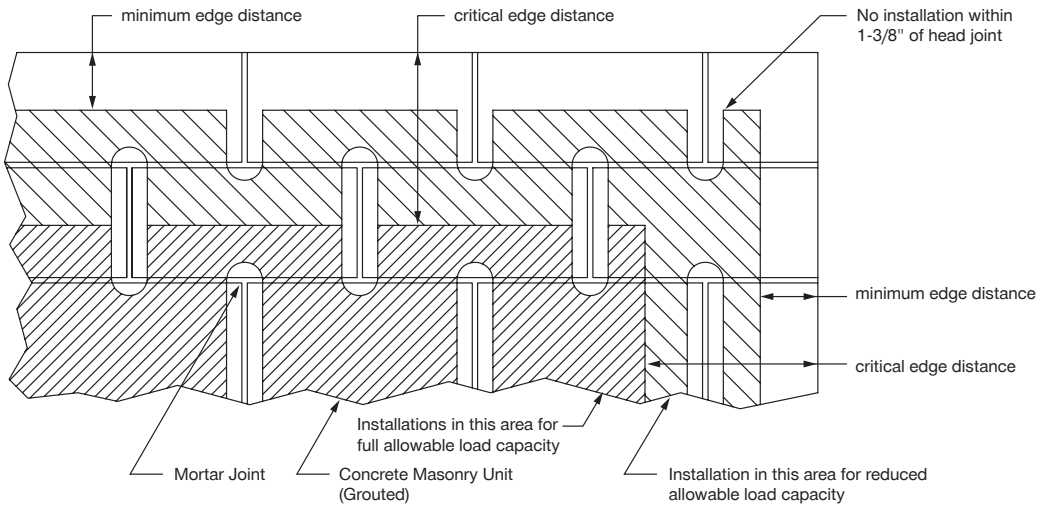
1 Values valid for anchors installed in face shells of Type 1, Grade N, lightweight, medium-weight, or normal-weight concrete masonry units conforming to ASTM C90. The masonry units must be fully grouted with coarse grout conforming to 2018 and 2015 IBC Section 2103.3, 2012 IBC Section 2103.13, or 2009 IBC Section 2103.12. Mortar must comply with 2018 and 2015 IBC Section 2103.2.1, 2012 IBC Section 2103.9, or 2009 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 effective embedment. 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 in accordance with Figure 6.
4 Embedment depth must be measured from the outside face of the concrete masonry unit.
5 For intermediate edge and spacing distances, allowable loads may be determined by linearly interpolating between the allowable loads at the two tabulated edge or spacing distances.
6 The tabulated allowable loads have been calculated based on a safety factor of 5.0.

Table 51 — Allowable tensile and shear loads for Hilti KB-TZ2 carbon and stainless steel anchors in the top of grout-filled concrete masonry walls [1,3,4,5,6]

Nominal anchor diameter	Nominal embedment		Minimum edge distance from edge of wall, C_{min}		Minimum spacing,[2] s_{min}		Minimum end distance C_{end}		Allowable tensile capacity		Allowable shear capacity			
											Parallel to edge of masonry wall		Perpendicular to edge of masonry wall	
in.	in.	(mm)	in	(mm)	in	(mm)	in	(mm)	lb	(kN)	lb	(kN)	lb	(kN)
3/8	1-7/8	(48)	1-3/4	(44)	6	(152)	12	(305)	300	(1.3)	325	(1.4)	175	(0.8)
	3	(76)			10	(254)	12	(305)	395	(1.8)	475	(2.1)	220	(1.0)
1/2	2-1/2	(64)			8	(203)	12	(305)	385	(1.7)	500	(2.2)	195	(0.9)
	3-3/4	(95)			13	(330)	12	(305)	485	(2.2)	610	(2.7)	240	(1.1)
5/8	3-1/4	(83)	2-3/4	(70)	11	(279)	12	(305)	620	(2.8)	930	(4.1)	410	(1.8)
	4-1/2	(114)			16	(406)	12	(305)	865	(3.8)	1240	(5.5)	465	(2.1)

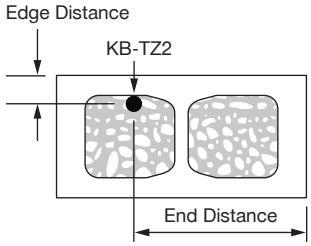
1 Values valid for anchors installed in face shells of Type 1, Grade N, lightweight, medium-weight, or normal-weight concrete masonry units conforming to ASTM C90. The masonry units must be fully grouted with coarse grout conforming to 2018 and 2015 IBC Section 2103.3, 2012 IBC Section 2103.13, or 2009 IBC Section 2103.12. Mortar must comply with 2018 and 2015 IBC Section 2103.2.1, 2012 IBC Section 2103.9, or 2009 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 effective embedment. 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 head joint in accordance with Figure 6.
4 Embedment depth must be measured from the outside face of the concrete masonry unit.
5 For intermediate edge and spacing distances, allowable loads may be determined by linearly interpolating between the allowable loads at the two tabulated edge or spacing distances.
6 The tabulated allowable loads have been calculated based on a safety factor of 5.0.

Figure 7 — Acceptable locations (shaded areas) for Hilti KB-TZ2 anchors in the face of grout-filled CMU walls



Anchor installation is restricted to shaded areas

Figure 8 — Edge and end distances for the Hilti KB-TZ2 anchors installed in the top of grout-filled CMU walls



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INSTALLATION INSTRUCTIONS

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

ORDERING INSTRUCTIONS

Table 52 — Hilti KB-TZ2 carbon steel product portfolio

Description	Length (in)	Length ident. letter	Thread length (in)	Nominal embed. 1 (in)	Min. fixture thickness 1 (in)	Max. fixture thickness 1 (in)	Nominal embed. 2 (in)	Min. fixture thickness 2 (in)	Max. fixture thickness 2 (in)	Nominal embed. 3 (in)	Min. fixture thickness 3 (in)	Max. fixture thickness 3 (in)	Nominal embed. 4 (in)	Min. fixture thickness 4 (in)	Max. fixture thickness 4 (in)	Package quantity
KB-TZ2 1/4 x 2-1/8	2-1/8	B	7/8	1-3/4	0	1/8	-	-	-	-	-	-	-	-	-	100
KB-TZ2 1/4 x 2-1/2	2-1/2	C	1-1/4	1-3/4	0	1/2	-	-	-	-	-	-	-	-	-	100
KB-TZ2 1/4 x 3-1/4	3-1/4	D	2	1-3/4	0	1-1/4	-	-	-	-	-	-	-	-	-	100
KB-TZ2 1/4 x 4-1/2	4-1/2	G	3	1-3/4	1/8	2-1/2	-	-	-	-	-	-	-	-	-	100
KB-TZ2 3/8 x 2-1/2	2-1/2	C	1	1-7/8	0	1/4	-	-	-	-	-	-	-	-	-	50
KB-TZ2 3/8 x 3	3	D	1 1/2	1-7/8	0	3/4	2-1/2	0	1/4	-	-	-	-	-	-	50
KB-TZ2 3/8 x 3-1/2	3-1/2	Ω	2	1-7/8	0	1-1/4	2-1/2	0	3/4	3	0	1/4	-	-	-	50
KB-TZ2 3/8 x 3-3/4	3-3/4	E	2-1/4	1-7/8	0	1-1/2	2-1/2	0	1	3	0	1/2	-	-	-	50
KB-TZ2 3/8 x 5	5	H	3-1/2	1-7/8	0	2-3/4	2-1/2	0	2-1/4	3	0	1-3/4	-	-	-	50
KB-TZ2 3/8 x 7	7	L	4-7/8	1-7/8	1/2	4-3/4	2-1/2	0	4-1/4	3	0	3-3/4	-	-	-	50
KB-TZ2 1/2 x 3	3	D	1-1/8	2	1/4	1/2	2-1/2	0	0	-	-	-	-	-	-	20
KB-TZ2 1/2 x 3-3/4	3-3/4	E	1-5/8	2	1/2	1-1/4	2-1/2	0	3/4	3	0	1/4	-	-	-	20
KB-TZ2 1/2 x 4-1/2	4-1/2	G	2-3/8	2	1/2	2	2-1/2	0	1-1/2	3	0	1	3-3/4	0	1/4	20
KB-TZ2 1/2 x 5-1/2	5-1/2	I	3-3/8	2	1/2	3	2-1/2	0	2-1/2	3	0	2	3-3/4	0	1-1/4	20
KB-TZ2 1/2 x 7	7	L	4-3/4	2	5/8	4-1/2	2-1/2	1/8	4	3	0	3-1/2	3-3/4	0	2-3/4	20
KB-TZ2 1/2 x 8-1/2	8-1/2	O	4-7/8	2	2	6	2-1/2	1-1/2	5-1/2	3	1	5	3-3/4	1/4	4-1/4	20
KB-TZ2 1/2 x 10	10	R	4-7/8	2	3-1/2	7-1/2	2-1/2	3	7	3	2-1/2	6-1/2	3-3/4	1-3/4	5-3/4	20
KB-TZ2 5/8 x 4-1/4	4-1/4	F	2-1/4	3-1/4	0	3/8	-	-	-	-	-	-	-	-	-	15
KB-TZ2 5/8 x 4-3/4	4-3/4	G	2-3/4	3-1/4	0	7/8	3-3/4	0	3/8	-	-	-	-	-	-	15
KB-TZ2 5/8 x 5-1/2	5-1/2	I	3-1/2	3-1/4	0	1-5/8	3-3/4	0	1-1/8	4-1/2	0	3/8	-	-	-	15
KB-TZ2 5/8 x 6	6	J	4	3-1/4	0	2-1/8	3-3/4	0	1-5/8	4-1/2	0	7/8	-	-	-	15
KB-TZ2 5/8 x 7	7	L	4-7/8	3-1/4	0	3-1/8	3-3/4	0	2-5/8	4-1/2	0	1-7/8	-	-	-	15
KB-TZ2 5/8 x 8-1/2	8-1/2	O	6-1/2	3-1/4	0	4-5/8	3-3/4	0	4-1/8	4-1/2	0	3-3/8	-	-	-	15
KB-TZ2 5/8 x 10	10	R	7-1/8	3-1/4	1/8	6-1/8	3-3/4	0	5-5/8	4-1/2	0	4-7/8	-	-	-	15
KB-TZ2 3/4 x 4-3/4	4-3/4	G	2-1/2	4	0	1/8	-	-	-	-	-	-	-	-	-	10
KB-TZ2 3/4 x 5-1/2	5-1/2	I	3-1/4	4	0	7/8	4-1/2	0	3/8	-	-	-	-	-	-	10
KB-TZ2 3/4 x 6-1/4	6-1/4	J	3-1/4	4	0	1-5/8	4-1/2	0	1-1/8	5-1/2	0	1/8	-	-	-	10
KB-TZ2 3/4 x 7	7	L	4	4	0	2-3/8	4-1/2	0	1-7/8	5-1/2	0	7/8	-	-	-	10
KB-TZ2 3/4 x 8	8	N	5	4	0	3-3/8	4-1/2	0	2-7/8	5-1/2	0	1-7/8	-	-	-	10
KB-TZ2 3/4 x 9	9	P	6	4	0	4-3/8	4-1/2	0	3-7/8	5-1/2	0	2-7/8	-	-	-	10
KB-TZ2 3/4 x 10	10	R	7	4	0	5-3/8	4-1/2	0	4-7/8	5-1/2	0	3-7/8	-	-	-	10
KB-TZ2 1x6-1/2	6-1/2	K	2 1/2	4 5/8	0	1-1/8	6-3/8	-	-	-	-	-	-	-	-	10
KB-TZ2 1x8	8	N	3 7/8	4 5/8	0	2-5/8	6-3/8	0	7/8	-	-	-	-	-	-	10
KB-TZ2 1x9	9	P	3 7/8	4 5/8	7/8	3-5/8	6-3/8	0	1-7/8	-	-	-	-	-	-	10
KB-TZ2 1x10-1/2	10-1/2	R	6	4 5/8	3/8	5-1/8	6-3/8	0	3-3/8	-	-	-	-	-	-	10
KB-TZ2 1x12	12	T	6	4 5/8	1-7/8	6-5/8	6-3/8	1/8	4-7/8	-	-	-	-	-	-	10

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Table 53 — Hilti KB-TZ2 SS304 product portfolio

Description	Length (in)	Length ident. letter	Thread length (in)	Nominal embed. 1 (in)	Min. fixture thickness 1 (in)	Max. fixture thickness 1 (in)	Nominal embed. 2 (in)	Min. fixture thickness 2 (in)	Max. fixture thickness 2 (in)	Nominal embed. 3 (in)	Min. fixture thickness 3 (in)	Max. fixture thickness 3 (in)	Package quantity
KB-TZ2 1/4x2-1/8 SS304	2-1/8	B	7/8	1-3/4	0	1/8	-	-	-	-	-	-	100
KB-TZ2 1/4x2-1/2 SS304	2-1/2	C	1 1/4	1-3/4	0	1/2	-	-	-	-	-	-	100
KB-TZ2 1/4x3-1/4 SS304	3-1/4	D	2	1-3/4	0	1-1/4	-	-	-	-	-	-	100
KB-TZ2 1/4x4-1/2 SS304	4-1/2	G	3	1-3/4	1/8	2-1/2	-	-	-	-	-	-	100
KB-TZ2 3/8x2-1/2 SS304	2-1/2	C	1	1-7/8	0	1/4	-	-	-	-	-	-	50
KB-TZ2 3/8x3 SS304	3	D	1 1/2	1-7/8	0	3/4	2-1/2	0	1/4	-	-	-	50
KB-TZ2 3/8x3-1/2 SS304	3-1/2	Ω	2	1-7/8	0	1-1/4	2-1/2	0	3/4	3	0	1/4	50
KB-TZ2 3/8x3-3/4 SS304	3-3/4	E	2 1/4	1-7/8	0	1-1/2	2-1/2	0	1	3	0	1/2	50
KB-TZ2 3/8x5 SS304	5	H	3 1/2	1-7/8	0	2-3/4	2-1/2	0	2-1/4	3	0	1-3/4	50
KB-TZ2 3/8x7 SS304	7	L	4 7/8	1-7/8	1/2	4-3/4	2-1/2	0	4-1/4	3	0	3-3/4	50
KB-TZ2 1/2x3-3/4 SS304	3-3/4	E	1 5/8	2-1/2	0	3/4	3	0	1/4	-	-	-	20
KB-TZ2 1/2x4-1/2 SS304	4-1/2	G	2 3/8	2-1/2	0	1-1/2	3	0	1	3-3/4	0	1/4	20
KB-TZ2 1/2x5-1/2 SS304	5-1/2	I	3 3/8	2-1/2	0	2-1/2	3	0	2	3-3/4	0	1-1/4	20
KB-TZ2 1/2x7 SS304	7	L	4 3/4	2-1/2	1/8	4	3	0	3-1/2	3-3/4	0	2-3/4	20
KB-TZ2 5/8x4-1/4 SS304	4-1/4	F	2 1/4	3-1/4	0	3/8	-	-	-	-	-	-	15
KB-TZ2 5/8x4-3/4 SS304	4-3/4	G	2 3/4	3-1/4	0	7/8	3-3/4	0	3/8	-	-	-	15
KB-TZ2 5/8x6 SS304	6	J	4	3-1/4	0	2-1/8	3-3/4	0	1-5/8	4-1/2	0	7/8	15
KB-TZ2 5/8x7 SS304	7	L	4 7/8	3-1/4	0	3-1/8	3-3/4	0	2-5/8	4-1/2	0	1-7/8	15
KB-TZ2 5/8x8-1/2 SS304	8-1/2	O	6 1/2	3-1/4	0	4-5/8	3-3/4	0	4-1/8	4-1/2	0	3-3/8	15
KB-TZ2 5/8x10 SS304	10	R	7 1/8	3-1/4	1/8	6-1/8	3-3/4	0	5-5/8	4-1/2	0	4-7/8	15
KB-TZ2 3/4x4-3/4 SS304	4-3/4	G	1 3/4	4	0	1/8	-	-	-	-	-	-	10
KB-TZ2 3/4x5-1/2 SS304	5-1/2	I	2 1/2	4	0	7/8	4-1/2	0	3/8	-	-	-	10
KB-TZ2 3/4x6-1/4 SS304	6-1/4	J	3 1/4	4	0	1-5/8	4-1/2	0	1-1/8	5-1/2	0	1/8	10
KB-TZ2 3/4x7 SS304	7	L	4	4	0	2-3/8	4-1/2	0	1-7/8	5-1/2	0	7/8	10
KB-TZ2 3/4x8 SS304	8	N	5	4	0	3-3/8	4-1/2	0	2-7/8	5-1/2	0	1-7/8	10
KB-TZ2 3/4x9 SS304	9	P	6	4	0	4-3/8	4-1/2	0	3-7/8	5-1/2	0	2-7/8	10
KB-TZ2 3/4x10 SS304	10	R	7	4	0	5-3/8	4-1/2	0	4-7/8	5-1/2	0	3-7/8	10
KB-TZ2 3/4x12 SS304	12	T	7	4	1-5/8	7-3/8	4-1/2	1-1/8	6-7/8	5-1/2	1/8	5-7/8	10
KB-TZ2 1x6-1/2 SS304	6-1/2	K	2 1/2	4-5/8	0	7/8	6-3/8	-	-	-	-	-	10
KB-TZ2 1x8 SS304	8	N	3 7/8	4-5/8	0	2-3/8	6-3/8	0	7/8	-	-	-	10
KB-TZ2 1x9 SS304	9	P	3 7/8	4-5/8	1	3-3/8	6-3/8	0	1-7/8	-	-	-	10
KB-TZ2 1x10-1/2 SS304	10-1/2	R	6	4 5/8	1/2	4-7/8	6-3/8	0	3-3/8	-	-	-	10
KB-TZ2 1x12 SS304	12	T	6	4 5/8	2	6-3/8	6-3/8	1/4	4-7/8	-	-	-	10

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Table 54 — Hilti KB-TZ2 SS316 product portfolio

Description	Length (in)	Length ident. letter	Thread length (in)	Nominal embed. 1 (in)	Min. fixture thickness 1 (in)	Max. fixture thickness 1 (in)	Nominal embed. 2 (in)	Min. fixture thickness 2 (in)	Max. fixture thickness 2 (in)	Nominal embed. 3 (in)	Min. fixture thickness 3 (in)	Max. fixture thickness 3 (in)	Package quantity
KB-TZ2 1/4x2-1/2 SS316	2-1/2	C	1-1/4	1-3/4	0	1/2	-	-	-	-	-	-	100
KB-TZ2 1/4x3-1/4 SS316	3-1/4	D	2	1-3/4	0	1-1/4	-	-	-	-	-	-	100
KB-TZ2 1/4x4-1/2 SS316	4-1/2	G	3	1-3/4	1/8	2-1/2	-	-	-	-	-	-	100
KB-TZ2 3/8x2-1/2 SS316	2-1/2	C	1	1-7/8	0	1/4	-	-	-	-	-	-	50
KB-TZ2 3/8x3 SS316	3	D	1-1/2	1-7/8	0	3/4	2-1/2	0	1/4	-	-	-	50
KB-TZ2 3/8x3-1/2 SS316	3-1/2	Ω	2	1-7/8	0	1-1/4	2-1/2	0	3/4	3	0	1/4	50
KB-TZ2 3/8x3-3/4 SS316	3-3/4	E	2-1/4	1-7/8	0	1-1/2	2-1/2	0	1	3	0	1/2	50
KB-TZ2 3/8x5 SS316	5	H	3-1/2	1-7/8	0	2-3/4	2-1/2	0	2-1/4	3	0	1-3/4	50
KB-TZ2 3/8x7 SS316	7	L	4-7/8	1-7/8	1/2	4-3/4	2-1/2	0	4-1/4	3	0	3-3/4	50
KB-TZ2 1/2x3-3/4 SS316	3-3/4	E	1-5/8	2-1/2	0	3/4	3	0	1/4	-	-	-	20
KB-TZ2 1/2x4-1/2 SS316	4-1/2	G	2-3/8	2-1/2	0	1-1/2	3	0	1	3-3/4	0	1/4	20
KB-TZ2 1/2x5-1/2 SS316	5-1/2	I	3-3/8	2-1/2	0	2-1/2	3	0	2	3-3/4	0	1-1/4	20
KB-TZ2 1/2x7 SS316	7	L	4-3/4	2-1/2	1/8	4	3	0	3-1/2	3-3/4	0	2-3/4	20
KB-TZ2 1/2x8-1/2 SS316	8-1/2	O	4-7/8	2-1/2	1-1/2	5-1/2	3	1	5	3-3/4	1/4	4-1/4	20
KB-TZ2 1/2x10 SS316	10	R	4-7/8	2-1/2	3	7	3	2-1/2	6-1/2	3-3/4	1-3/4	5-3/4	20
KB-TZ2 5/8x4-1/4 SS316	4-1/4	F	2-1/4	3-1/4	0	3/8	-	-	-	-	-	-	15
KB-TZ2 5/8x4-3/4 SS316	4-3/4	G	2-3/4	3-1/4	0	7/8	3-3/4	0	3/8	-	-	-	15
KB-TZ2 5/8x6 SS316	6	J	4	3-1/4	0	2-1/8	3-3/4	0	1-5/8	4-1/2	0	7/8	15
KB-TZ2 5/8x7 SS316	7	L	4-7/8	3-1/4	0	3-1/8	3-3/4	0	2-5/8	4-1/2	0	1-7/8	15
KB-TZ2 5/8x8-1/2 SS316	8-1/2	O	6-1/2	3-1/4	0	4-5/8	3-3/4	0	4-1/8	4-1/2	0	3-3/8	15
KB-TZ2 5/8x10 SS316	10	R	7-1/8	3-1/4	1/8	6-1/8	3-3/4	0	5-5/8	4-1/2	0	4-7/8	15
KB-TZ2 3/4x4-3/4 SS316	4-3/4	G	1-3/4	4	0	1/8	-	-	-	-	-	-	10
KB-TZ2 3/4x5-1/2 SS316	5-1/2	I	2-1/2	4	0	7/8	4-1/2	0	3/8	-	-	-	10
KB-TZ2 3/4x6-1/4 SS316	6-1/4	J	3-1/4	4	0	1-5/8	4-1/2	0	1-1/8	5-1/2	0	1/8	10
KB-TZ2 3/4x7 SS316	7	L	4	4	0	2-3/8	4-1/2	0	1-7/8	5-1/2	0	7/8	10
KB-TZ2 3/4x8 SS316	8	N	5	4	0	3-3/8	4-1/2	0	2-7/8	5-1/2	0	1-7/8	10
KB-TZ2 3/4x9 SS316	9	P	6	4	0	4-3/8	4-1/2	0	3-7/8	5-1/2	0	2-7/8	10
KB-TZ2 3/4x10 SS316	10	R	7	4	0	5-3/8	4-1/2	0	4-7/8	5-1/2	0	3-7/8	10
KB-TZ2 3/4x12 SS316	12	T	7	4	1-5/8	7-3/8	4-1/2	1-1/8	6-7/8	5-1/2	1/8	5-7/8	10
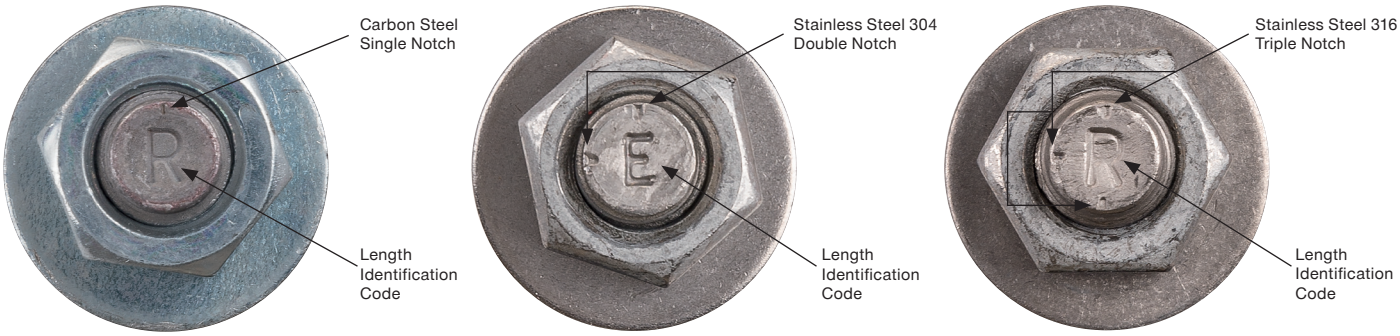
Figure 9 — Anchor head with length identification code and KB-TZ2 head notch embossment