AL-FAROOQ CORPORATION
CONSULTING ENGINEERS & PRODUCT DEVELOPMENT

ALUVETRO.

September 9, 2020.

PRODUCT: SP300 : (PL1300) POSTLESS GLASS RAILING SYSTEM
(SMALL MISSILE IMPACT).

PERFORMANCE EVALUATION

JOB #: AFC 20-0093

PREPARED BY: CH

CHECKED BY: AL

C.A.N. 3538

ENG.: JALAL FAROOQ FLA. PE # 81223

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1 **Purpose and Scope of Submittal**.

The purpose of this performance evaluation is to evaluate the capacity of the system for new client requirements.

The new requirements are:

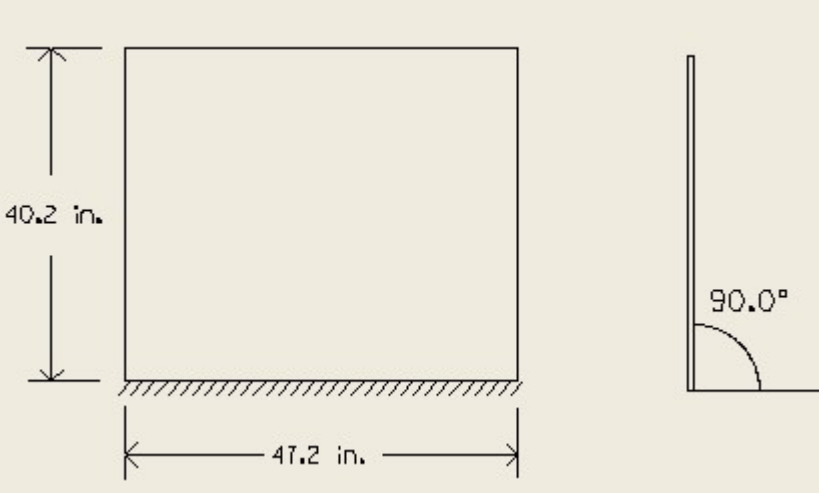
- Evaluate the capacity of new glass option: 3/8”FT + 0.060”SGP + 3/8”FT.
- Evaluate the capacity of 3 anchor options for 9-7/8” spacing.

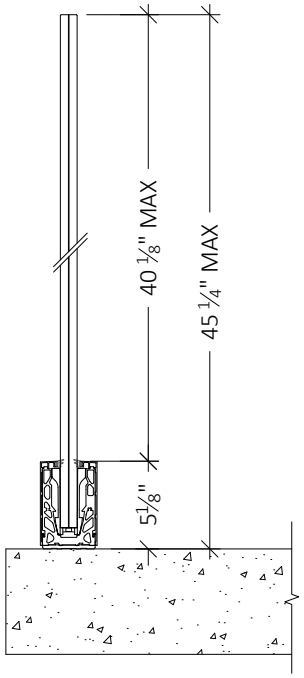
2 Glass Analysis.

Type of glass:

- 3/8” FT + 0.060” SGP interlayer + 3/8” FT. (3/4” thk nominal glass thickness).

The glass capacity is checked for the maximum size of 47-1/4” width and 40-1/8” free height





The maximum capacity of the glass is 161 psf.

See glass calculation on page GL-1.

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3 Anchors Capacities.

- TYPE D1: **3/8" DIA. HILTI HVU CAPSULE ADHESIVE ANCHORING SYSTEM.**
Directly into Concrete (f'c = 3000 psi.)
w/ 5-1/4" min. embedment, 9-7/8" spacing and 3-1/2" min. edge distance.

Shear Capacity into Substrate = 7387 * 1.00 * 0.27 = 1994 Lbs. see A-1
Tension Capacity into Substrate = 3255 * 1.00 * 0.67 = 2180 Lbs. see A-1
Bearing Capacity (0.444" thk. Aluminum 6063-T6) = 2622 Lbs. see A-2

Shear Capacity for Steel Bar (HAS-R 304/3016 SS rod) = 1875 Lbs. see A-1.1
Tension Capacity into Substrate = 3645 Lbs. see A-1.1

Critical Capacities: **Va = 1875 Lbs**. **Ta = 2180 Lbs**.

- TYPE D2: **3/8" DIA. HILTI HVU CAPSULE ADHESIVE ANCHORING SYSTEM.**
Directly into Concrete (f'c = 4000 psi.)
w/ 5-1/4" min. embedment, 9-7/8" spacing and 4-1/2" min. edge distance.

Shear Capacity into Substrate = 8655 * 1.00 * 0.37 = 3202 Lbs. see A-1
Tension Capacity into Substrate = 4185 * 1.00 * 0.74 = 3096 Lbs. see A-1
Bearing Capacity (0.444" thk. Aluminum 6063-T6) = 2622 Lbs. see A-2

Shear Capacity for Steel Bar (HAS-R 304/3016 SS rod) = 1875 Lbs. see A-1.1
Tension Capacity into Substrate = 3645 Lbs. see A-1.1

Critical Capacities: **Va = 1875 Lbs**. **Ta = 3096 Lbs**.

- TYPE E: **3/8" DIA. DEWALT SCREW-BOLT+.**
Directly into Concrete (f'c = 3000 psi.)
w/ 4-1/2" min. embedment, 9-7/8" spacing and 3-1/2" min. edge distance.

Shear Capacity into Substrate = 1735 * 0.75 * 0.82 = 1067 Lbs. see A-3
Tension Capacity into Substrate = 2985 * 0.71 * 0.96 = 2034 Lbs. see A-3
Bearing Capacity (0.444" thk. Aluminum 6063-T6) = 2622 Lbs. see A-2

Critical Capacities: **Va = 1067 Lbs**. **Ta = 2034 Lbs**.

- TYPE C: **3/8" DIA. SMS OR MACHINE BOLTS (MIN GRADE 5 CRS)**.
Into Steel Metal Structures: 3/8" thk min. (Fy = 36000 psi min.) w/ 1" min. edge distance.

Shear Capacity into Substrate = 1937 Lbs. see A-4
Tension Capacity into Substrate = 3719 Lbs. see A-4
Bearing Capacity in Steel (3/8" thk. A-36) = 2447 Lbs. see A-4
Bearing Capacity in Aluminum (0.44" thk. 6063-T6) = 2622 Lbs. see A-2

Critical Capacities: **Va = 1937 Lbs**. **Ta = 3719 Lbs**.

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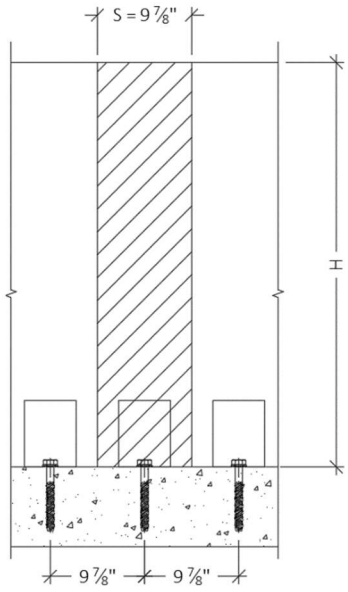
3.1 Anchors Calculations.

The maximum design wind loads have been calculated for different heights, 9-7/8” anchor spacing and different anchor types.



Pd : Design Pressure.
H : Railing Height.
S: Anchor Spacing.
e: lever arm.

V: Acting Shear.
T: Acting Tension.

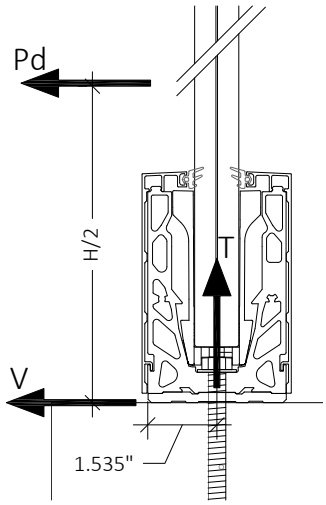
$V = Pd * H * S$
$T = V * H/2 / e$

$V / Va + T / Ta < 1$

$(Pd * H * S) / Va + (V * H/2 / e) / Ta < 1$

Solving for Pd:

$Pd = 1 / [(H * S) / Va + (H * S * H) / (2 * e * Ta)]$



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Railing Height (in)	DESIGN WIND LOAD Pd (psf) for 3/8" dia. Anchors							
	D1: Hilti f'c = 3000 psi		D2: Hilti f'c = 4000 psi		E: Screw-Bolt+		C: 3/8 Screw Grade 5	
	Va (lb)	Ta (lb)	Va	Ta	Va	Ta	Va	Ta
	1875	2180	1875	3096	1067	2034	1937	3719
	Pd (psf)		Pd (psf)		Pd (psf)		Pd (psf)	
36	68.5		93.7		60.4		110.4	
38	61.8		84.7		54.6		99.8	
40	56.0		76.9		49.6		90.7	
42	51.0		70.1		45.3		82.8	
44	46.6		64.2		41.5		75.8	
45.25	44.2		60.9		39.4		71.9	

Railing Height (in)	DESIGN WIND LOAD Pd (psf) for 1/2" dia. Anchors							
	A1: Hilti f'c = 3000 psi		A2: Hilti f'c = 4000 psi		B: Screw-Bolt+		F: 1/2 Screw Grade 5	
	Va (lb)	Ta (lb)	Va	Ta	Va	Ta	Va	Ta
	2227	2914	3276	3788	1193	2659	3263	6811
	Pd (psf)		Pd (psf)		Pd (psf)		Pd (psf)	
36	90.6		119.1		77.2		120.0	
38	81.7		107.4		69.9		120.0	
40	74.1		97.3		63.5		120.0	
42	67.5		88.6		58.0		120.0	
44	61.7		81.1		53.2		120.0	
45.25	58.5		76.8		50.5		120.0	

4 Summary.

The table above shows the maximum design load capacities for 9-7/8” spacing, different anchor options and different railing heights.

The maximum capacity of the glass is 161 psf for the maximum height.
It does not control the capacity of the system.

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ENG.: JALAL FAROOQ FLA. PE # 81223

Glass Load Resistance Report -- SP300

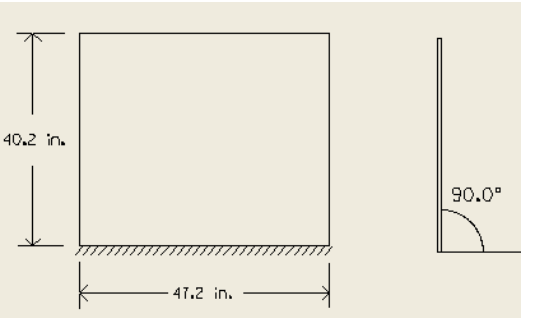
Friday, August 21, 2020

Glazing Information

Edge Supports: 1 Side
Glazing Angle: 90°
Lite Dimensions:
Unsupported Length: 40.2 in.
Supported Length: 47.2 in.

Project Details

Project Name: SP300
Location:
Comments: 3/8"FT+0.060"SGP+3/8"FT



Glass Construction (Rectangular)

Single Glazed Lite

Glass Type:	Fully Tempered
Nominal Thickness:	3/4 in.
Interlayer Type:	SentryGlas® Plus

Short Load Duration, Resistance, and Deflection Data

Load (~ 3 sec.):	161 psf
Load Resistance:	161 psf
Approximate center of edge deflection:	0.93 in.

Conclusion

Based on your design information, the load resistance is greater than or equal to the specified loading.

Statement of Compliance

Procedures followed in determining the resistance of this window glass are in accordance with ASTM E1300-09/12.

Disclaimer:

This software can be used to determine the load resistance of specified glass types exposed to uniform lateral loads of short or long duration subject to the following conditions:

- The glass is free of edge and surface damage and has been properly glazed in the opening in conformance with the manufacturer's recommendations.
- Procedures exist to determine load resistance for rectangular glass assemblies that are:
  a. Continuously supported along all four edges,
  b. Continuously supported along three edges,
  c. Continuously supported along two parallel edges, and
  d. Continuously supported along one edge.
- The software user has the responsibility of selecting the correct procedures for the required application from the software.
- The stiffness of members supporting any glass edge shall be sufficient that under design load, edge deflections shall not exceed L/175, where L denotes that length of the supported edge.
- The manufacturer states that the Safety Plus II 0.090 Polyurethane Large Missile Resistant interlayer is comparable to the PVB interlayer.
- The non-factored load values for laminated glass are representative of test data and calculations performed for an interlayer at a temperature of 50° C (122° F).

For other limiting conditions that may apply, refer to Section 5 of ASTM E1300 and local building codes.

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Prepared by: _____ on 8/21/2020

HVU Capsule Adhesive Anchoring System 3.2.7

Table 5 - Hilti HVU allowable and ultimate bond/concrete capacity for Hilti HAS rods in normal-weight concrete[1, 2]

Nominal anchor diameter	Embed. depth[3] in.	Adhesive capsule(s) required	HVU allowable bond/concrete capacity				HVU ultimate bond/concrete capacity			
			Tensile		Shear		Tensile		Shear	
			f'_c = 2,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 2,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 2,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 2,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)
3/8	3-1/2 (90)	(1) 3/8 x 3-1/2	2,085 (9.3)	2,595 (11.5)	3,335 (14.8)	4,710 (21.0)	8,345 (37.1)	10,380 (46.2)	10,000 (44.5)	14,120 (62.8)
	5-1/4 (133)	(2) 3/8 x 3-1/2	2,325 (10.3)	4,185 (18.6)	6,120 (27.2)	8,655 (38.5)	9,295 (41.3)	16,730 (74.4)	18,360 (81.7)	25,960 (115.5)
	7 (178)	(2) 3/8 x 3-1/2	4,405 (19.6)	4,895 (21.8)	9,420 (41.9)	13,330 (59.3)	17,630 (78.4)	19,590 (87.1)	28,260 (125.7)	39,980 (177.8)
1/2	4-1/4 (110)	(1) 1/2 x 4-1/4	3,250 (14.5)	4,735 (21.1)	5,450 (24.2)	7,280 (32.4)	12,990 (57.8)	18,940 (84.2)	15,440 (68.7)	21,840 (97.1)
	6-3/8 (162)	(1) 1/2 x 4-1/4 & (1) 3/8 x 3-1/2	4,890 (21.8)	5,455 (24.3)	9,455 (42.1)	13,375 (59.5)	19,565 (87.0)	21,815 (97.0)	28,360 (126.2)	40,120 (178.5)
	8-1/2 (216)	(2) 1/2 x 4-1/4	6,700 (29.8)	7,545 (33.6)	14,560 (64.8)	20,590 (91.6)	26,810 (119.3)	30,190 (134.3)	43,680 (194.3)	61,760 (274.7)
5/8	5 (125)	(1) 5/8 x 5	3,970 (17.7)	5,245 (23.3)	7,350 (32.7)	10,390 (46.2)	15,890 (70.7)	20,970 (93.3)	22,040 (98.0)	31,160 (138.6)
	7-1/2 (184)	(1) 5/8 x 5 & (1) 1/2 x 4-1/4	5,770 (25.7)	10,465 (46.6)	13,495 (60.0)	19,080 (84.9)	23,080 (102.7)	41,865 (186.2)	40,480 (180.1)	57,240 (254.6)
	10 (254)	(2) 5/8 x 5	11,700 (52.0)	12,835 (57.1)	20,775 (92.4)	29,375 (130.7)	46,795 (208.2)	51,340 (228.4)	62,320 (277.2)	88,120 (392.0)
3/4	6-5/8 (170)	(1) 3/4 x 6-5/8	6,080 (27.0)	8,615 (38.3)	12,270 (54.6)	17,355 (77.2)	24,330 (108.2)	34,470 (153.3)	36,800 (163.7)	52,060 (231.6)
	10 (254)	(1) 3/4 x 6-5/8 & (1) 1/2 x 4-1/4	9,110 (40.5)	14,835 (66.0)	22,755 (101.2)	32,180 (143.1)	36,445 (162.1)	59,350 (264.0)	68,260 (303.6)	96,540 (429.4)
	13-1/4 (337)	(2) 3/4 x 6-5/8	15,220 (67.7)	15,310 (68.1)	34,700 (154.4)	49,080 (218.3)	60,875 (270.8)	61,230 (272.4)	104,100 (463.1)	147,240 (655.0)
7/8	6-5/8 (170)	(1) 7/8 x 6-5/8	7,145 (31.8)	9,130 (40.6)	13,110 (58.3)	18,535 (82.4)	28,580 (127.1)	36,525 (162.5)	39,320 (174.9)	55,600 (247.3)
	10 (254)	(2) 3/4 x 6-5/8	10,475 (46.6)	18,970 (84.4)	24,575 (109.3)	34,755 (154.6)	41,905 (186.4)	75,870 (337.5)	73,720 (327.9)	104,260 (463.8)
	13-1/4 (337)	(2) 7/8 x 6-5/8	16,475 (73.3)	23,055 (102.6)	34,780 (154.7)	53,010 (235.8)	65,895 (293.1)	92,220 (410.2)	112,440 (500.2)	159,020 (707.4)
1	8-1/4 (210)	(1) 1 x 8-1/4	8,640 (38.4)	13,425 (59.7)	19,690 (87.6)	27,840 (123.8)	34,560 (153.7)	53,695 (238.8)	59,060 (262.7)	83,520 (371.5)
	12-3/8 (314)	(2) 7/8 x 6-5/8	14,665 (65.2)	23,450 (104.3)	36,170 (160.9)	51,150 (227.5)	58,665 (261.0)	93,800 (417.2)	108,500 (482.6)	153,440 (682.5)
	16-1/2 (419)	(2) 1 x 8-1/4	26,645 (118.5)	30,805 (137.0)	55,690 (247.7)	78,750 (350.3)	106,580 (474.1)	123,220 (548.1)	167,060 (743.1)	236,240 (1050.8)
1-1/4	12 (305)	(1) 1-1/4 x 12	19,175 (85.3)	23,920 (106.4)	38,615 (171.8)	54,610 (242.9)	76,740 (341.4)	95,680 (425.6)	115,840 (515.3)	163,820 (728.7)
	15 (381)	(1) 1-1/4 x 12 & (1) 1 x 8-1/4	24,750 (110.1)	26,855 (119.5)	53,960 (240.0)	76,315 (339.5)	99,000 (440.4)	107,420 (477.8)	161,880 (720.1)	228,940 (1018.4)
	18 (457)	(1) 1-1/4 x 12 & (2) 1 x 8-1/4	29,535 (131.4)	37,920 (168.7)	70,935 (315.5)	100,320 (446.2)	118,140 (525.5)	151,680 (674.7)	212,800 (946.6)	300,960 (1338.7)

1 Influence factors for spacing and/or edge distance are applied to concrete/bond values above, and then compared to the steel value. The lesser of the values is to be used for the design.

2 Average ultimate concrete shear capacity based on Strength Design method.

3 Contact Hilti for the use of alternate embedment other than those tested and listed above.

3.2.7 HVU Capsule Adhesive Anchoring System

Table 6 - Allowable steel strength for carbon steel and stainless steel Hilti HAS rods[1]

Nominal anchor diameter	HAS-E ISO 898 Class 5.8		HAS-E B7 ASTM A193 B7		HAS-R Stainless AISI 304/316 SS	
	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8	2,640 (11.7)	1,360 (6.0)	4,555 (20.3)	2,345 (10.4)	3,645 (16.2)	1,875 (8.3)
1/2	4,700 (20.9)	2,420 (10.8)	8,100 (36.0)	4,170 (18.5)	6,480 (28.8)	3,335 (14.8)
5/8	7,340 (32.7)	3,780 (16.8)	12,655 (56.3)	6,520 (29.0)	10,125 (45.0)	5,215 (23.2)
3/4	10,570 (47.0)	5,445 (24.2)	18,225 (81.1)	9,390 (41.8)	12,390 (55.1)	6,385 (28.4)
7/8	14,385 (64.0)	7,410 (33.0)	24,805 (110.3)	12,780 (56.9)	16,865 (75.0)	8,690 (38.6)
1	18,790 (83.6)	9,680 (43.0)	32,400 (144.1)	16,690 (74.2)	22,030 (98.0)	11,350 (50.5)
1-1/4	29,360 (130.6)	15,125 (67.3)	50,620 (225.2)	26,080 (116.0)	34,425 (153.1)	17,735 (78.9)

1 Steel strength as defined in AISC Manual of Steel Construction (ASD):

Tensile = 0.33 x F_u x nominal area
Shear = 0.17 x F_u x nominal area

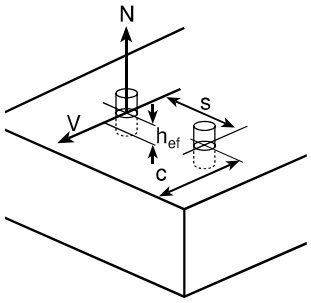
Table 7 - Ultimate steel strength for carbon steel and stainless steel Hilti HAS rods[1]

Nominal anchor diameter	HAS-E ISO 898 Class 5.8			HAS-E B7 ASTM A193 B7			HAS-R Stainless AISI 304/316 SS		
	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8	4,495 (20.0)	6,005 (26.7)	3,605 (16.0)	8,135 (36.2)	10,350 (43.4)	6,210 (27.6)	5,035 (22.4)	8,280 (36.8)	4,970 (22.1)
1/2	8,230 (36.6)	10,675 (47.5)	6,405 (28.5)	14,900 (66.3)	18,405 (79.0)	11,040 (49.1)	9,225 (41.0)	14,720 (65.5)	8,835 (39.3)
5/8	13,110 (58.3)	16,680 (74.2)	10,010 (44.5)	23,730 (105.6)	28,760 (125.7)	17,260 (76.8)	14,690 (65.3)	23,010 (102.4)	13,805 (61.4)
3/4	19,400 (86.3)	24,020 (106.9)	14,415 (64.1)	35,120 (156.2)	41,420 (185.7)	24,850 (110.5)	15,050 (66.9)	28,165 (125.3)	16,800 (75.2)
7/8	26,780 (119.1)	32,695 (145.4)	19,620 (87.3)	48,480 (215.7)	56,370 (256.9)	33,825 (150.5)	20,775 (92.4)	38,335 (170.5)	23,000 (102.3)
1	35,130 (156.3)	42,705 (190.0)	25,625 (114.0)	63,600 (282.9)	73,630 (337.0)	44,180 (196.5)	27,255 (121.2)	50,070 (222.7)	30,040 (133.6)
1-1/4	56,210 (250.0)	66,730 (296.8)	40,035 (178.1)	101,755 (452.6)	115,050 (511.8)	69,030 (307.1)	43,610 (194.0)	78,235 (348.0)	46,940 (208.8)

1 Steel strength as defined in AISC Manual of Steel Construction 2nd Ed. (LRFD):

Yield = F_y x tensile stress area
Tensile = 0.75 x F_u x nominal area
Shear = 0.45 x F_u x nominal area

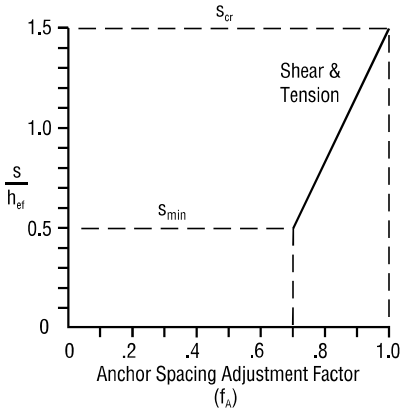
Figure 3 - Anchor spacing and edge distance in concrete



Spacing tension/shear $s_{min} = 0.5\ h_{ef}$ $s_{cr} = 1.5\ h_{ef}$ $f_A = 0.3(s/h_{ef}) + 0.55$ for $s_{cr} > s > s_{min}$
Edge distance tension $c_{min} = 0.5\ h_{ef}$ $c_{cr} = 1.5\ h_{ef}$ $f_{RN} = 0.4(c/h_{ef}) + 0.40$ for $c_{cr} > c > c_{min}$
Edge distance shear ⊥ toward edge $c_{min} = 0.5\ h_{ef}$ $c_{cr} = 2.0\ h_{ef}$ $f_{RV1} = 0.54(c/h_{ef}) - 0.09$ for $c_{cr} > c > c_{min}$
Edge distance shear II to or away from edge $c_{min} = 0.5\ h_{ef}$ $c_{cr} = 2.0\ h_{ef}$ $f_{RV2} = 0.36(c/h_{ef}) + 0.28$ for $c_{cr} > c > c_{min}$

Anchor spacing adjustment factors

s = Actual spacing
h_{ef} = Actual embedment
s_{min} = 0.5 h_{ef}
s_{cr} = 1.5 h_{ef}



Edge distance adjustment factors

c = Actual edge distance
h_{ef} = Actual embedment
c_{min} = 0.5 h_{ef} Tension and shear
c_{cr} = 1.5 h_{ef} Tension
= 2.0 h_{ef} Shear
⊥ = Perpendicular to edge
II = Parallel to edge

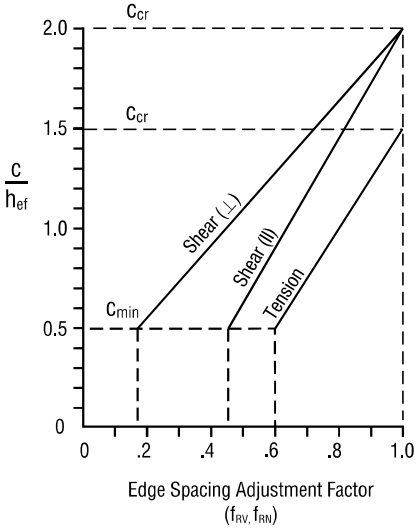


Table 11 - Hilti HVU load adjustment factors for 3/8-in. diameter anchors

Anchor diameter		3/8-in. diameter											
Adjustment factor		Spacing tension/shear f_A			Edge distance tension f_{RN}			Edge distance shear (⊥ toward edge) f_{RV1}			Edge distance shear (II to or away from edge) f_{RV2}		
Embedment Depth, in.		3-1/2	5-1/4	7	3-1/2	5-1/4	7	3-1/2	5-1/4	7	3-1/2	5-1/4	7
Spacing (s)/Edge distance (c), in.	1-3/4	0.70			0.60			0.18			0.46		
	2	0.72			0.63			0.22			0.49		
	2-5/8	0.78	0.70		0.70	0.60		0.32	0.18		0.55	0.46	
	3	0.81	0.72		0.74	0.63		0.37	0.22		0.59	0.49	
	3-1/2	0.85	0.75	0.70	0.80	0.67	0.60	0.45	0.27	0.18	0.64	0.52	0.46
	4	0.89	0.78	0.72	0.86	0.70	0.63	0.53	0.32	0.22	0.69	0.55	0.49
	4-1/2	0.94	0.81	0.74	0.91	0.74	0.66	0.60	0.37	0.26	0.74	0.59	0.51
	5-1/4	1.00	0.85	0.78	1.00	0.80	0.70	0.72	0.45	0.32	0.82	0.64	0.55
	6		0.89	0.81		0.86	0.74	0.84	0.53	0.37	0.90	0.69	0.59
	7		0.95	0.85		0.93	0.80	1.00	0.63	0.45	1.00	0.76	0.64
	7-7/8		1.00	0.89		1.00	0.85		0.72	0.52		0.82	0.69
	8-1/2			0.89			0.86		0.78	0.57		0.86	0.72
	9			0.91			0.89		0.84	0.60		0.90	0.74
	10			0.94			0.91		0.94	0.68		0.97	0.79
	10-1/2			0.96			0.94		1.00	0.72		1.00	0.82
	12			0.98			0.97			0.84			0.90
	13			1.00			1.00			0.91			0.95
	14									1.00			1.00

3.2.7 HVU Capsule Adhesive Anchoring System

Table 12 - Hilti HVU load adjustment factors for 1/2-in. diameter anchors

Anchor diameter		1/2-in. diameter											
Adjustment factor		Spacing tension/shear f_A			Edge distance tension f_{RN}			Edge distance shear (⊥ toward edge) f_{RV1}			Edge distance shear (II to or away from edge) f_{RV2}		
Embedment depth, in.		4-1/4	6-3/8	8-1/2	4-1/4	6-3/8	8-1/2	4-1/4	6-3/8	8-1/2	4-1/4	6-3/8	8-1/2
Spacing (s)/Edge distance (c), in.	2-1/8	0.70			0.60			0.18			0.46		
	3	0.76			0.68			0.29			0.53		
	3-3/16	0.78	0.70		0.70	0.60		0.32	0.18		0.55	0.46	
	3-1/2	0.80	0.71		0.73	0.62		0.35	0.21		0.58	0.48	
	4	0.83	0.74		0.78	0.65		0.42	0.25		0.62	0.51	
	4-1/4	0.85	0.75	0.70	0.80	0.67	0.60	0.45	0.27	0.18	0.64	0.52	0.46
	5	0.90	0.79	0.73	0.87	0.71	0.64	0.55	0.33	0.23	0.70	0.56	0.49
	5-1/2	0.94	0.81	0.74	0.92	0.75	0.66	0.61	0.38	0.26	0.75	0.59	0.51
	6	0.97	0.83	0.76	0.96	0.78	0.68	0.67	0.42	0.29	0.79	0.62	0.53
	6-3/8	1.00	0.85	0.78	1.00	0.80	0.70	0.72	0.45	0.32	0.82	0.64	0.55
	7		0.88	0.80		0.84	0.73	0.80	0.50	0.35	0.87	0.68	0.58
	8		0.93	0.83		0.90	0.78	0.93	0.59	0.42	0.96	0.73	0.62
	8-1/2		0.95	0.85		0.93	0.80	1.00	0.63	0.45	1.00	0.76	0.64
	9		0.97	0.87		0.96	0.82		0.67	0.48		0.79	0.66
	9-9/16		1.00	0.89		1.00	0.85		0.72	0.52		0.82	0.69
	10			0.90			0.87		0.76	0.55		0.84	0.70
	10-1/2			0.92			0.89		0.80	0.58		0.87	0.72
	12			0.97			0.96		0.93	0.67		0.96	0.79
	12-3/4			1.00			1.00		1.00	0.72		1.00	0.82
	14									0.80			0.87
	16									0.93			0.96
	17									1.00			1.00

Spacing tension/shear
$s_{min} = 0.5\ h_{ef}$ $s_{cr} = 1.5\ h_{ef}$
$f_A = 0.3(s/h_{ef}) + 0.55$
for $s_{cr} > s > s_{min}$

Edge distance tension
$c_{min} = 0.5\ h_{ef}$ $c_{cr} = 1.5\ h_{ef}$
$f_{RN} = 0.4(c/h_{ef}) + 0.40$
for $c_{cr} > c > c_{min}$

Edge distance shear
⊥ toward edge
$c_{min} = 0.5\ h_{ef}$ $c_{cr} = 2.0\ h_{ef}$
$f_{RV1} = 0.54(c/h_{ef}) - 0.09$
for $c_{cr} > c > c_{min}$

Edge distance shear
II to or away from edge
$c_{min} = 0.5\ h_{ef}$ $c_{cr} = 2.0\ h_{ef}$
$f_{RV2} = 0.36(c/h_{ef}) + 0.28$
for $c_{cr} > c > c_{min}$

Table 13 - Hilti HVU load adjustment factors for 5/8-in. and 3/4-in. diameter anchors

Anchor diameter		5/8-in. diameter												3/4-in. diameter											
Adjustment factor		Spacing tension/shear f_A			Edge distance tension f_{RN}			Edge distance shear (⊥ toward edge) f_{RV1}			Edge distance shear (II to or away from edge) f_{RV2}			Spacing tension/shear f_A			Edge distance tension f_{RN}			Edge distance shear (⊥ toward edge) f_{RV1}			Edge distance shear (II to or away from edge) f_{RV2}		
Embedment depth, in.		5	7-1/2	10	5	7-1/2	10	5	7-1/2	10	5	7-1/2	10	6-5/8	10	13-1/4	6-5/8	10	13-1/4	6-5/8	10	13-1/4	6-5/8	10	13-1/4
Spacing (s)/Edge distance (c), in.	2-1/2	0.70			0.60			0.18			0.46														
	3-5/16	0.75			0.67			0.27			0.52			0.70			0.60			0.18			0.46		
	3-3/4	0.78	0.70		0.70	0.60		0.32	0.18		0.55	0.46		0.72			0.63			0.22			0.48		
	4	0.79	0.71		0.72	0.61		0.34	0.20		0.57	0.47		0.73			0.64			0.24			0.50		
	4-1/2	0.82	0.73		0.76	0.64		0.40	0.23		0.60	0.50		0.75			0.67			0.28			0.52		
	5	0.85	0.75	0.70	0.80	0.67	0.60	0.45	0.27	0.18	0.64	0.52	0.46	0.78	0.70		0.70	0.60		0.32	0.18		0.55	0.46	
	5-1/2	0.88	0.77	0.72	0.84	0.69	0.62	0.50	0.31	0.21	0.68	0.54	0.48	0.80	0.72		0.73	0.62		0.36	0.21		0.58	0.48	
	6	0.91	0.79	0.73	0.88	0.72	0.64	0.56	0.34	0.23	0.71	0.57	0.50	0.82	0.73		0.76	0.64		0.40	0.23		0.61	0.50	
	6-5/8	0.95	0.82	0.75	0.93	0.75	0.67	0.63	0.39	0.27	0.76	0.60	0.52	0.85	0.75	0.70	0.80	0.67	0.60	0.45	0.27	0.18	0.64	0.52	0.46
	7	0.97	0.83	0.76	0.96	0.77	0.68	0.67	0.41	0.29	0.78	0.62	0.53	0.87	0.76	0.71	0.82	0.68	0.61	0.48	0.29	0.20	0.66	0.53	0.47
	7-1/2	1.00	0.85	0.78	1.00	0.80	0.70	0.72	0.45	0.32	0.82	0.64	0.55	0.89	0.78	0.72	0.85	0.70	0.63	0.52	0.32	0.22	0.69	0.55	0.48
	8		0.87	0.79		0.83	0.72	0.77	0.49	0.34	0.86	0.66	0.57	0.91	0.79	0.73	0.88	0.72	0.64	0.56	0.34	0.24	0.71	0.57	0.50
	9		0.91	0.82		0.88	0.76	0.88	0.56	0.40	0.93	0.71	0.60	0.96	0.82	0.75	0.94	0.76	0.67	0.64	0.40	0.28	0.77	0.60	0.52
	9-15/16		0.95	0.85		0.93	0.80	0.98	0.63	0.45	1.00	0.76	0.64	1.00	0.85	0.78	1.00	0.80	0.70	0.72	0.45	0.32	0.82	0.64	0.55
	10		0.95	0.85		0.93	0.80	1.00	0.63	0.45		0.76	0.64		0.85	0.78		0.80	0.70	0.73	0.45	0.32	0.82	0.64	0.55
	11-1/4		1.00	0.89		1.00	0.85		0.72	0.52		0.82	0.69		0.89	0.80		0.85	0.74	0.83	0.52	0.37	0.89	0.69	0.59
	12			0.91			0.88		0.77	0.56		0.86	0.71		0.91	0.82		0.88	0.76	0.89	0.56	0.40	0.93	0.71	0.61
	13			0.94			0.92		0.85	0.61		0.90	0.75		0.94	0.84		0.92	0.79	0.97	0.61	0.44	0.99	0.75	0.63
	13-1/4			0.95			0.93		0.86	0.63		0.92	0.76		0.95	0.85		0.93	0.80	1.00	0.63	0.45	1.00	0.76	0.64
	15			1.00			1.00		1.00	0.72		1.00	0.82		1.00	0.89		1.00	0.85		0.72	0.52		0.82	0.69
	18									0.88			0.93			0.96			0.94		0.88	0.64		0.93	0.77
	20									1.00			1.00			1.00			1.00		1.00	0.73		1.00	0.82
	22																					0.81			0.88
	24																					0.89			0.93
	26-1/2																					1.00			1.00

AL-FAROOQ CORPORATION
9360 SW 72nd ST., SUITE 220
MIAMI, FL 33173
305-264-8100

REV 8/21/2020

FASTENER CHART BASED ON 2015 ADM -

D = 3/8" **de= 2D =** 0.596
Shank (in) = 0.298 Ω = 3

BEARING CAPACITIES (Lbs)			
	Fu=22000	Fu=30000	Fu=38000
t (in)	6063-T5	6063-T6	6005-T5
0.44	1923	**2622**	3322

D = 1/2" **de= 2D =** 0.81
Shank (in) = 0.405 Ω = 3

BEARING CAPACITIES (Lbs)			
	Fu=22000	Fu=30000	Fu=38000
t (in)	6063-T5	6063-T6	6005-T5
0.44	2614	**3564**	4514

Rn = (de)(t)(Fu)/Ω = BEARING CAPACITY (Lbs.)
2015 ADM

Allowable Load Capacities for Screw-Bolt+ in Normal-Weight Concrete[1,2,3,4,5]

Nominal Anchor Diameter in.	Minimum Nominal Embedment Depth in. (mm)	Minimum Concrete Compressive Strength									
		f'c = 2,500 psi (17.3 MPa)		f'c = 3,000 psi (20.7 MPa)		f'c = 4,000 psi (27.6 MPa)		f'c = 6,000 psi (41.4 MPa)		f'c = 8,000 psi (55.2 MPa)	
		Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)	Tension lbs (kN)	Shear lbs (kN)
1/4	1 (25)	330 (1.5)	415 (1.8)	350 (1.6)	440 (2.0)	385 (1.7)	480 (2.1)	430 (1.9)	520 (2.3)	430 (1.9)	520 (2.3)
	1-5/8 (41)	710 (3.2)	415 (1.8)	750 (3.3)	440 (2.0)	815 (3.6)	480 (2.1)	815 (3.6)	520 (2.3)	815 (3.6)	520 (2.3)
	2-1/2 (64)	915 (4.1)	505 (2.2)	965 (4.3)	535 (2.4)	1,050 (4.7)	585 (2.6)	1,070 (4.8)	635 (2.8)	1,070 (4.8)	635 (2.8)
3/8	1-1/2 (38)	660 (2.9)	890 (4.0)	720 (3.2)	975 (4.3)	835 (3.7)	1,125 (5.0)	1,020 (4.5)	1,375 (6.1)	1,020 (4.5)	1,590 (7.1)
	2 (51)	920 (4.1)	1,080 (4.8)	1,005 (4.5)	1,185 (5.3)	1,160 (5.2)	1,365 (6.1)	1,180 (5.2)	1,585 (7.1)	1,365 (6.1)	1,585 (7.1)
	3-1/4 (83)	1,855 (8.3)	1,580 (7.0)	2,035 (9.1)	1,735 (7.7)	2,265 (10.1)	2,000 (8.9)	2,265 (10.1)	2,140 (9.5)	2,590 (11.5)	2,140 (9.5)
	4-1/2 (114)	2,725 (12.1)	1,580 (7.0)	2,985 (13.3)	1,735 (7.7)	3,450 (15.3)	2,000 (8.9)	3,770 (16.8)	2,140 (9.5)	3,770 (16.8)	2,140 (9.5)
1/2	1-3/4 (44)	710 (3.2)	1,495 (6.7)	780 (3.5)	1,640 (7.3)	900 (4.0)	1,895 (8.4)	1,100 (4.9)	2,320 (10.3)	1,100 (4.9)	2,675 (11.9)
	2-1/2 (64)	1,670 (7.4)	2,010 (8.9)	1,830 (8.1)	2,200 (9.8)	2,115 (9.4)	2,540 (11.3)	2,115 (9.4)	2,885 (12.8)	2,115 (9.4)	2,885 (12.8)
	4-1/4 (108)	3,315 (14.7)	2,350 (10.5)	3,630 (16.1)	2,575 (11.5)	4,120 (18.3)	2,970 (13.2)	4,120 (18.3)	3,380 (15.0)	4,120 (18.3)	3,380 (15.0)
	5-1/2 (140)	3,935 (17.5)	2,350 (10.5)	4,310 (19.2)	2,575 (11.5)	4,975 (22.1)	2,970 (13.2)	5,330 (23.7)	3,380 (15.0)	5,330 (23.7)	3,380 (15.0)
5/8	2-1/2 (64)	1,435 (6.4)	2,655 (11.8)	1,570 (7.0)	2,910 (12.9)	1,815 (8.1)	3,355 (14.9)	2,220 (9.9)	4,110 (18.3)	2,220 (9.9)	4,295 (19.1)
	3-1/4 (83)	2,440 (10.9)	3,015 (13.4)	2,670 (11.9)	3,305 (14.7)	3,085 (13.7)	3,815 (17.0)	3,085 (13.7)	4,295 (19.1)	3,085 (13.7)	4,295 (19.1)
	5 (127)	3,615 (16.1)	3,420 (15.2)	3,960 (17.6)	3,745 (16.7)	4,570 (20.3)	4,325 (19.2)	4,825 (21.5)	4,870 (21.7)	5,570 (24.8)	4,870 (21.7)
	6-1/4 (159)	5,130 (22.8)	3,420 (15.2)	5,620 (25.0)	3,745 (16.7)	6,490 (28.9)	4,325 (19.2)	7,945 (35.3)	4,870 (21.7)	7,945 (35.3)	4,870 (21.7)
3/4	2-1/2 (64)	1,510 (6.7)	2,905 (12.9)	1,655 (7.4)	3,180 (14.1)	1,910 (8.5)	3,675 (16.3)	2,340 (10.4)	4,500 (20.0)	2,340 (10.4)	5,195 (23.1)
	4-1/4 (108)	2,975 (13.2)	4,265 (19.0)	3,260 (14.5)	4,670 (20.8)	3,765 (16.7)	5,395 (24.0)	4,435 (19.7)	6,070 (27.0)	5,125 (22.8)	6,070 (27.0)
	5 (127)	4,755 (21.2)	4,265 (19.0)	5,210 (23.2)	4,670 (20.8)	6,015 (26.8)	5,395 (24.0)	7,365 (32.8)	6,070 (27.0)	7,365 (32.8)	6,070 (27.0)
	6-1/4 (159)	5,125 (22.8)	4,265 (19.0)	5,615 (25.0)	4,670 (20.8)	6,480 (28.8)	5,395 (24.0)	7,940 (35.3)	6,070 (27.0)	7,940 (35.3)	6,070 (27.0)

1. Tabulated load values are for anchors installed in uncracked concrete. Concrete compressive strength must be at the specified minimum at the time of installation.
2. Allowable load capacities are calculated using an applied safety factor 4.0.
3. Allowable load capacities must be multiplied by reduction factors when anchor spacing or edge distances are less than critical distances.
4. Linear interpolation may be used to determine allowable loads for intermediate embedments and compressive strengths.
5. Anchors may be used in lightweight concrete provided the allowable load capacities are multiplied by a reduction factor of 0.60.

LOAD ADJUSTMENT FACTORS FOR NORMAL-WEIGHT CONCRETE

Edge Distance Reduction Factors - Tension (F_{NC})

Diameter (in)		1/4			3/8				1/2				5/8				3/4			
Nominal Embedment h_{nom} (in)		1	1-5/8	2-1/2	1-1/2	2	3-1/4	4-1/2	1-3/4	2-1/2	4-1/4	5-1/2	2-1/2	3-1/4	5	6-1/4	2-1/2	4-1/4	5	6-1/4
Min. Edge Distance c_{min} (in)		1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4
Edge Distance (inches)	1-1/2	1.00	0.77	0.64	0.85	0.74	0.59	0.55	-	-	-	-	-	-	-	-	-	-	-	-
	1-3/4	1.00	0.83	0.67	0.93	0.79	0.62	0.57	0.87	0.71	0.58	0.54	0.73	0.65	0.56	0.53	0.73	0.59	0.56	0.53
	2	1.00	0.88	0.71	1.00	0.84	0.65	0.59	0.94	0.76	0.60	0.56	0.78	0.68	0.58	0.54	0.78	0.61	0.58	0.54
	2-1/4	1.00	0.94	0.75	1.00	0.89	0.68	0.61	1.00	0.80	0.63	0.57	0.82	0.71	0.60	0.56	0.82	0.63	0.60	0.56
	2-1/2	1.00	1.00	0.78	1.00	0.95	0.71	0.63	1.00	0.84	0.65	0.59	0.87	0.75	0.62	0.57	0.87	0.66	0.62	0.57
	2-3/4	1.00	1.00	0.82	1.00	1.00	0.74	0.65	1.00	0.88	0.67	0.61	0.91	0.78	0.64	0.59	0.91	0.68	0.64	0.59
	3	1.00	1.00	0.86	1.00	1.00	0.77	0.67	1.00	0.92	0.69	0.62	0.96	0.81	0.66	0.60	0.96	0.70	0.66	0.60
	3-1/2	1.00	1.00	0.93	1.00	1.00	0.83	0.71	1.00	1.00	0.74	0.65	1.00	0.87	0.69	0.63	1.00	0.75	0.69	0.63
	4	1.00	1.00	1.00	1.00	1.00	0.88	0.75	1.00	1.00	0.78	0.69	1.00	0.94	0.73	0.66	1.00	0.79	0.73	0.66
	4-1/2	1.00	1.00	1.00	1.00	1.00	0.94	0.79	1.00	1.00	0.82	0.72	1.00	1.00	0.77	0.69	1.00	0.84	0.77	0.69
	5	1.00	1.00	1.00	1.00	1.00	1.00	0.84	1.00	1.00	0.87	0.75	1.00	1.00	0.81	0.72	1.00	0.89	0.81	0.72
	5-1/2	1.00	1.00	1.00	1.00	1.00	1.00	0.88	1.00	1.00	0.91	0.79	1.00	1.00	0.85	0.75	1.00	0.93	0.85	0.75
	6	1.00	1.00	1.00	1.00	1.00	1.00	0.92	1.00	1.00	0.96	0.82	1.00	1.00	0.89	0.78	1.00	0.98	0.89	0.78
	6-1/2	1.00	1.00	1.00	1.00	1.00	1.00	0.96	1.00	1.00	1.00	0.85	1.00	1.00	0.92	0.81	1.00	1.00	0.92	0.81
	7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.88	1.00	1.00	0.96	0.84	1.00	1.00	0.96	0.84
	7-1/2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.92	1.00	1.00	1.00	0.87	1.00	1.00	1.00	0.87
	8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	1.00	0.90	1.00	1.00	1.00	0.90
	8-1/2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	0.93	1.00	1.00	1.00	0.93
	9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.96	1.00	1.00	1.00	0.96
	9-1/2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	0.99
	10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Spacing Reduction Factors - Tension (F_{NS})

Diameter (in)		1/4			3/8				1/2				5/8				3/4			
Nominal Embedment h_{nom} (in)		1	1-5/8	2-1/2	1-1/2	2	3-1/4	4-1/2	1-3/4	2-1/2	4-1/4	5-1/2	2-1/2	3-1/4	5	6-1/4	2-1/2	4-1/4	5	6-1/4
Minimum Spacing s_{min} (in)		1-1/2	1-1/2	1-1/2	2	2	2	2	2-3/4	2-3/4	2-3/4	2-3/4	2-3/4	2-3/4	2-3/4	2-3/4	3	3	3	3
Spacing Distance (inches)	1-1/2	0.89	0.73	0.66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1-3/4	0.94	0.77	0.68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	1.00	0.80	0.70	0.88	0.77	0.67	0.63	-	-	-	-	-	-	-	-	-	-	-	-
	2-1/4	1.00	0.83	0.72	0.93	0.80	0.69	0.64	-	-	-	-	-	-	-	-	-	-	-	-
	2-1/2	1.00	0.86	0.74	0.97	0.83	0.70	0.65	-	-	-	-	-	-	-	-	-	-	-	-
	2-3/4	1.00	0.89	0.76	1.00	0.86	0.72	0.66	0.92	0.78	0.67	0.64	0.80	0.73	0.65	0.63	-	-	-	-
	3	1.00	0.92	0.78	1.00	0.89	0.74	0.67	0.95	0.80	0.68	0.65	0.83	0.74	0.66	0.64	0.83	0.69	0.66	0.64
	3-1/2	1.00	0.99	0.82	1.00	0.94	0.77	0.70	1.00	0.85	0.71	0.67	0.88	0.78	0.68	0.65	0.88	0.71	0.68	0.65
	4	1.00	1.00	0.86	1.00	1.00	0.80	0.72	1.00	0.89	0.73	0.68	0.92	0.81	0.70	0.67	0.93	0.74	0.71	0.67
	4-1/2	1.00	1.00	0.90	1.00	1.00	0.83	0.74	1.00	0.93	0.75	0.70	0.97	0.85	0.72	0.68	0.97	0.76	0.73	0.69
	5	1.00	1.00	0.94	1.00	1.00	0.86	0.76	1.00	0.98	0.78	0.72	1.00	0.88	0.75	0.70	1.00	0.79	0.75	0.70
	5-1/2	1.00	1.00	0.97	1.00	1.00	0.89	0.78	1.00	1.00	0.80	0.74	1.00	0.92	0.77	0.72	1.00	0.81	0.77	0.72
	6	1.00	1.00	1.00	1.00	1.00	0.93	0.81	1.00	1.00	0.82	0.75	1.00	0.95	0.79	0.73	1.00	0.84	0.79	0.73
	6-1/2	1.00	1.00	1.00	1.00	1.00	0.96	0.83	1.00	1.00	0.85	0.77	1.00	0.98	0.81	0.75	1.00	0.86	0.81	0.75
	7	1.00	1.00	1.00	1.00	1.00	0.99	0.85	1.00	1.00	0.87	0.79	1.00	1.00	0.83	0.76	1.00	0.89	0.83	0.77
	7-1/2	1.00	1.00	1.00	1.00	1.00	1.00	0.87	1.00	1.00	0.90	0.81	1.00	1.00	0.85	0.78	1.00	0.91	0.85	0.78
	8	1.00	1.00	1.00	1.00	1.00	1.00	0.90	1.00	1.00	0.92	0.83	1.00	1.00	0.87	0.80	1.00	0.94	0.87	0.80
	8-1/2	1.00	1.00	1.00	1.00	1.00	1.00	0.92	1.00	1.00	0.94	0.84	1.00	1.00	0.89	0.81	1.00	0.96	0.89	0.81
	9	1.00	1.00	1.00	1.00	1.00	1.00	0.94	1.00	1.00	0.97	0.86	1.00	1.00	0.91	0.83	1.00	0.99	0.91	0.83
	9-1/2	1.00	1.00	1.00	1.00	1.00	1.00	0.96	1.00	1.00	0.99	0.88	1.00	1.00	0.93	0.84	1.00	1.00	0.93	0.85
	10	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	0.90	1.00	1.00	0.95	0.86	1.00	1.00	0.95	0.86
	10-1/2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.91	1.00	1.00	0.97	0.88	1.00	1.00	0.97	0.88
	11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.93	1.00	1.00	0.99	0.89	1.00	1.00	0.99	0.89
	11-1/2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	1.00	0.91	1.00	1.00	1.00	0.91
	12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	0.92	1.00	1.00	1.00	0.93
	13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.96	1.00	1.00	1.00	0.96
	14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	0.99
	15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Edge Distance Reduction Factors - Shear (F_{VC})

Diameter (in)		1/4			3/8				1/2				5/8				3/4			
Nominal Embedment h_{nom} (in)		1	1-5/8	2-1/2	1-1/2	2	3-1/4	4-1/2	1-3/4	2-1/2	4-1/4	5-1/2	2-1/2	3-1/4	5	6-1/4	2-1/2	4-1/4	5	6-1/4
Min. Edge Distance c_{min}(in)		1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4
Edge Distance (inches)	1-1/2	0.58	0.63	0.59	0.40	0.37	0.31	0.32	-	-	-	-	-	-	-	-	-	-	-	-
	1-3/4	0.68	0.73	0.69	0.46	0.43	0.36	0.38	0.35	0.31	0.30	0.31	0.27	0.26	0.25	0.26	0.26	0.22	0.22	0.23
	2	0.78	0.84	0.78	0.53	0.49	0.41	0.43	0.41	0.35	0.35	0.36	0.30	0.29	0.29	0.30	0.30	0.25	0.26	0.27
	2-1/4	0.87	0.94	0.88	0.59	0.55	0.46	0.48	0.46	0.40	0.39	0.40	0.34	0.33	0.32	0.33	0.33	0.28	0.29	0.30
	2-1/2	0.97	1.00	0.98	0.66	0.61	0.51	0.54	0.51	0.44	0.43	0.45	0.38	0.36	0.36	0.37	0.37	0.31	0.32	0.33
	2-3/4	1.00	1.00	1.00	0.73	0.67	0.56	0.59	0.56	0.49	0.48	0.49	0.42	0.40	0.40	0.41	0.41	0.34	0.35	0.37
	3	1.00	1.00	1.00	0.79	0.73	0.61	0.64	0.61	0.53	0.52	0.54	0.46	0.44	0.43	0.45	0.44	0.38	0.39	0.40
	3-1/2	1.00	1.00	1.00	0.92	0.85	0.72	0.75	0.71	0.62	0.61	0.63	0.53	0.51	0.50	0.52	0.52	0.44	0.45	0.47
	4	1.00	1.00	1.00	1.00	0.97	0.82	0.86	0.81	0.71	0.69	0.72	0.61	0.58	0.57	0.59	0.59	0.50	0.51	0.53
	4-1/2	1.00	1.00	1.00	1.00	1.00	0.92	0.97	0.91	0.80	0.78	0.81	0.68	0.66	0.65	0.67	0.67	0.56	0.58	0.60
	5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.89	0.87	0.90	0.76	0.73	0.72	0.74	0.74	0.63	0.64	0.66
	5-1/2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.95	0.99	0.84	0.80	0.79	0.82	0.82	0.69	0.71	0.73
	6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.91	0.88	0.86	0.89	0.89	0.75	0.77	0.80
	6-1/2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.95	0.93	0.97	0.96	0.81	0.84	0.86
	7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.88	0.90	0.93
	7-1/2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.94	0.96	1.00
	8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Spacing Reduction Factors - Shear (F_{VS})

Diameter (in)		1/4			3/8				1/2				5/8				3/4			
Nominal Embedment h_{nom} (in)		1	1-5/8	2-1/2	1-1/2	2	3-1/4	4-1/2	1-3/4	2-1/2	4-1/4	5-1/2	2-1/2	3-1/4	5	6-1/4	2-1/2	4-1/4	5	6-1/4
Minimum Spacing s_{min} (in)		1-1/2	1-1/2	1-1/2	2	2	2	2	2-3/4	2-3/4	2-3/4	2-3/4	2-3/4	2-3/4	2-3/4	2-3/4	3	3	3	3
Spacing Distance (inches)	1-1/2	0.60	0.60	0.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1-3/4	0.61	0.62	0.61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	0.63	0.64	0.63	0.59	0.58	0.57	0.57	-	-	-	-	-	-	-	-	-	-	-	-
	2-1/4	0.65	0.66	0.65	0.60	0.59	0.58	0.58	-	-	-	-	-	-	-	-	-	-	-	-
	2-1/2	0.66	0.67	0.66	0.61	0.60	0.59	0.59	-	-	-	-	-	-	-	-	-	-	-	-
	2-3/4	0.68	0.69	0.68	0.62	0.61	0.59	0.60	0.59	0.58	0.58	0.58	0.57	0.57	0.57	0.57	-	-	-	-
	3	0.69	0.71	0.70	0.63	0.62	0.60	0.61	0.60	0.59	0.59	0.59	0.58	0.57	0.57	0.57	0.57	0.56	0.56	0.57
	3-1/2	0.73	0.74	0.73	0.65	0.64	0.62	0.63	0.62	0.60	0.60	0.60	0.59	0.59	0.58	0.59	0.59	0.57	0.57	0.58
	4	0.76	0.78	0.76	0.68	0.66	0.64	0.64	0.64	0.62	0.62	0.62	0.60	0.60	0.60	0.60	0.60	0.58	0.59	0.59
	4-1/2	0.79	0.81	0.79	0.70	0.68	0.65	0.66	0.65	0.63	0.63	0.63	0.61	0.61	0.61	0.61	0.61	0.59	0.60	0.60
	5	0.82	0.85	0.83	0.72	0.70	0.67	0.68	0.67	0.65	0.64	0.65	0.63	0.62	0.62	0.62	0.62	0.60	0.61	0.61
	5-1/2	0.86	0.88	0.86	0.74	0.72	0.69	0.70	0.69	0.66	0.66	0.66	0.64	0.63	0.63	0.64	0.64	0.61	0.62	0.62
	6	0.89	0.92	0.89	0.76	0.74	0.70	0.71	0.70	0.68	0.67	0.68	0.65	0.65	0.64	0.65	0.65	0.63	0.63	0.63
	6-1/2	0.92	0.95	0.92	0.79	0.76	0.72	0.73	0.72	0.69	0.69	0.69	0.66	0.66	0.66	0.66	0.66	0.64	0.64	0.64
	7	0.95	0.99	0.96	0.81	0.78	0.74	0.75	0.74	0.71	0.70	0.71	0.68	0.67	0.67	0.67	0.67	0.65	0.65	0.66
	7-1/2	0.99	1.00	0.99	0.83	0.80	0.76	0.77	0.75	0.72	0.72	0.72	0.69	0.68	0.68	0.69	0.69	0.66	0.66	0.67
	8	1.00	1.00	1.00	0.85	0.82	0.77	0.79	0.77	0.74	0.73	0.74	0.70	0.69	0.69	0.70	0.70	0.67	0.67	0.68
	9	1.00	1.00	1.00	0.90	0.87	0.81	0.82	0.80	0.77	0.76	0.77	0.73	0.72	0.72	0.72	0.72	0.69	0.69	0.70
	10	1.00	1.00	1.00	0.94	0.91	0.84	0.86	0.84	0.80	0.79	0.80	0.75	0.74	0.74	0.75	0.75	0.71	0.71	0.72
	11	1.00	1.00	1.00	0.98	0.95	0.87	0.89	0.87	0.82	0.82	0.83	0.78	0.77	0.76	0.77	0.77	0.73	0.74	0.74
	12	1.00	1.00	1.00	1.00	0.99	0.91	0.93	0.91	0.85	0.85	0.86	0.80	0.79	0.79	0.80	0.80	0.75	0.76	0.77
	13	1.00	1.00	1.00	1.00	1.00	0.94	0.96	0.94	0.88	0.88	0.89	0.83	0.82	0.81	0.82	0.82	0.77	0.78	0.79
	14	1.00	1.00	1.00	1.00	1.00	0.98	1.00	0.97	0.91	0.90	0.92	0.85	0.84	0.84	0.85	0.85	0.79	0.80	0.81
	15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.94	0.93	0.95	0.88	0.86	0.86	0.87	0.87	0.81	0.82	0.83
	16	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.96	0.98	0.91	0.89	0.88	0.90	0.90	0.83	0.84	0.85
	17	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.93	0.91	0.91	0.92	0.92	0.86	0.86	0.88
	18	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.96	0.94	0.93	0.95	0.94	0.88	0.89	0.90
	19	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.96	0.95	0.97	0.97	0.90	0.91	0.92
	20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.98	1.00	0.99	0.92	0.93	0.94
	21	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.94	0.95	0.97
	22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.96	0.97	0.99
	23	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.99	1.00
	24	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

TABLE 20.3: Fastener Capacity

SAE Grade 5 Steel for Diameters up thru 9/16" (UNC Threads) ASTM A 449 Steel for Diameters 5/8" and Over (UNC Threads)															
Nominal Fastener Diameter & Threads per Inch	D Nominal Thread Diameter (in)	A(S) Tensile Stress Area (in2)	A(R) Thread Root Area (in2)	Allowable Tension (lbs)	Allowable Shear		Allowable Bearing (lbs)			Minimum Material Thickness (lbs) to Equal Tensile Capacity of Fastener (in)			Maximum Tensile Load (lbs) for Available 3/8" Plate Thickness		
					Single (lbs)	Double (lbs)	1/8" Steel A36	1/8" Aluminum 6063-T5	1/8" Aluminum 6063-T6	A36	6063-T5	6063-T6	3/8" Steel A36	3/8" Aluminum 6063-T5	3/8" Aluminum 6063-T6
#6-32	0.1380	0.0091	0.0078	363	180	360	900	253	345	0.1602	0.3046	0.2268	363	363	363
#8-32	0.1640	0.0140	0.0124	560	286	573	1,070	301	410	0.2079	> 3/8"	0.2953	560	522	560
#10-24	0.1900	0.0175	0.0151	701	350	700	1,240	348	475	0.2246	> 3/8"	0.3001	701	643	701
#12-24	0.2160	0.0242	0.0214	967	493	986	1,409	396	540	0.2594	> 3/8"	0.3619	967	734	967
1/4-20	0.2500	0.0318	0.0280	1,273	646	1,291	1,631	458	625	0.2745	> 3/8"	> 3/8"	1,273	865	1,179
5/16-18	0.3125	0.0524	0.0469	2,517	1,299	2,599	2,039	573	781	0.3144	> 3/8"	> 3/8"	2,517	1,303	1,776
3/8-16	0.3750	0.0775	0.0699	3,719	1,937	3,874	2,447	688	938	0.3518	> 3/8"	> 3/8"	3,719	1,572	2,144
7/16-14	0.4375	0.1063	0.0961	5,103	2,664	5,328	2,855	802	1,094	> 3/8"	> 3/8"	> 3/8"	4,937	1,873	2,554
1/2-13	0.5000	0.1419	0.1292	6,811	3,581	7,162	3,263	917	1,250	> 3/8"	> 3/8"	> 3/8"	5,642	2,140	2,918
9/16-12	0.5625	0.1819	0.1664	8,733	4,611	9,222	3,670	1,031	1,406	> 3/8"	> 3/8"	> 3/8"	6,444	2,444	3,333
5/8-11	0.6250	0.2260	0.2071	10,848	5,738	11,477	4,078	1,146	1,563	> 3/8"	> 3/8"	> 3/8"	7,148	2,711	3,697
3/4-10	0.7500	0.3345	0.3091	16,054	8,565	17,130	4,894	1,375	1,875	> 3/8"	> 3/8"	> 3/8"	8,612	3,266	4,454
7/8-9	0.8750	0.4617	0.4285	22,163	11,876	23,753	5,709	1,604	2,188	> 3/8"	> 3/8"	> 3/8"	10,158	3,853	5,254
1-8	1.0000	0.6057	0.5630	29,076	15,601	31,203	6,525	1,833	2,500	> 3/8"	> 3/8"	> 3/8"	11,696	4,437	6,050

SAE Grade 5 Steel (Spaced Threads)															
Nominal Fastener Diameter & Threads per Inch	D Nominal Thread Diameter (in)	K Basic Minor Diameter (in)	A(R) Thread Root Area (in2)	Allowable Tension (lbs)	Allowable Shear		Allowable Bearing (lbs)			Minimum Material Thickness (lbs) to Equal Tensile Capacity of Fastener (in)			Maximum Tensile Load (lbs) for Available 3/8" Plate Thickness		
					Single (lbs)	Double (lbs)	1/8" Steel A36	1/8" Aluminum 6063-T5	1/8" Aluminum 6063-T6	A36	6063-T5	6063-T6	3/8" Steel A36	3/8" Aluminum 6063-T5	3/8" Aluminum 6063-T6
#6-20	0.1380	0.0990	0.0077	308	178	356	900	253	345	0.1358	0.1907	0.1543	308	308	308
#8-18	0.1640	0.1160	0.0106	423	244	488	1,070	301	410	0.1569	0.2175	0.1758	423	423	423
#10-16	0.1900	0.1350	0.0143	573	331	661	1,240	348	475	0.1834	0.2517	0.2028	573	573	573
#12-14	0.2160	0.1570	0.0194	774	447	894	1,409	396	540	0.2182	0.2995	0.2380	774	774	774
1/4-14	0.2500	0.1850	0.0269	1,075	621	1,242	1,631	458	625	0.2617	0.3593	0.2696	1,075	1,075	1,075
5/16-12	0.3125	0.2360	0.0437	2,100	1,212	2,425	2,039	573	781	0.3407	> 3/8"	0.3430	2,100	1,681	2,100
3/8-12	0.3750	0.2990	0.0702	3,370	1,946	3,892	2,447	688	938	> 3/8"	> 3/8"	> 3/8"	2,773	2,017	2,751

	SAE Grade 5 (≤ 9/16")	ASTM A449 (≥ 5/8")
F_U (Min. Ultimate Tensile Strength)	120,000 psi	120,000 psi
F_T (Allow. Tensile Stress, D≤1/4")	40,000 psi	N/A
F_T (Allow. Tensile Stress, D> 1/4")	48,000 psi	48,000 psi
F_V (Allowable Shear Strass; D≤1/4")	23,094 psi	N/A
F_V (Allowable Shear Strass; D>1/4")	27,713 psi	27,713 psi

For All Diameters	Effective Area (UNC Threads)	Effective Area (Spaced Threads)
$F_T = F_U/SF$	$A(R) = \pi\ (D-1.2269/N)^2 / 4$	$A(R) = \pi K^2/4$
Allowable Tension = $F_T[A(S)]$	$A(S) = \pi\ (D-0.9743/N)^2 / 4$	$A(S) = \pi K^2/4$
$F_V = Fu / (SF \times sq\ rt\ (3))$		
Allowable Single Shear = $F_V[A(R)]$		

NOTE 5:

1. Values are taken from AISC, ASTM, IFI, SAE and AA documents. K values for spaced threads are taken as the minimum values in IFI Fastener Handbook, 6th Ed.

2. Safety Factor used for fasteners with diameters 1/4" or less is 3.0, Safety Factor used for fasteners with diameters 5/16" or greater is 2.5.

3. Fasteners with diameters of 5/8" or greater are fabricated from carbon steel complying with ASTM A449 Type

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