August 31, 2021

Kevin Flatt
Fortress Railing Products
1720 North First Street
Garland, TX 75040

Project Number: 21-06-093

Re: Structural Connection Details
Fe26 2”, Fe26 3”, Al13 2”, & Al3 3” Connections to Wood Deck and Concrete
State of Oregon, United States of America

Mr. Flatt,

Per your request, Eclipse Engineering, P.C. (EEPC) designed the anchorage for the handrails mentioned above. We find that the following calculations meet or exceed the requirements of the 2018 IBC, ASCE7-16, 2019 OSSC, ICC-ESR-3178, and ICC-ESR-3027.

It is assumed the railing height will not exceed 3’-6”. 1-2 Family Dwellings is assumed to have a maximum force of 200 lbf. All Use Groups are assumed to have a maximum of 50 lbf/ft with an 8’-0” tributary length. The concrete has a designed strength of 2,500 psi with a thickness of 0’-4”. All wood fasteners are required to have a minimum 3x blocking underneath the posts. Please see the following documentation for details.

Eclipse Engineering has reviewed the anchorage of the handrails only. We take no responsibility for any other element of the structure or for the structure as a whole.

Please contact us with any questions.

Digitally signed by Scott Ratterman
Date: 2021.08.31 12:25:13-07'00'

REGISTERED PROFESSIONAL ENGINEER
08/31/2021
93867PE
OREGON
SEPTEMBER 11, 2018
SCOTT RATTERMAN
EXPIRES: 12/31/2022

Sincerely,
Eclipse Engineering, P.C.

Sean Smith, E.I.T.
Project Engineer

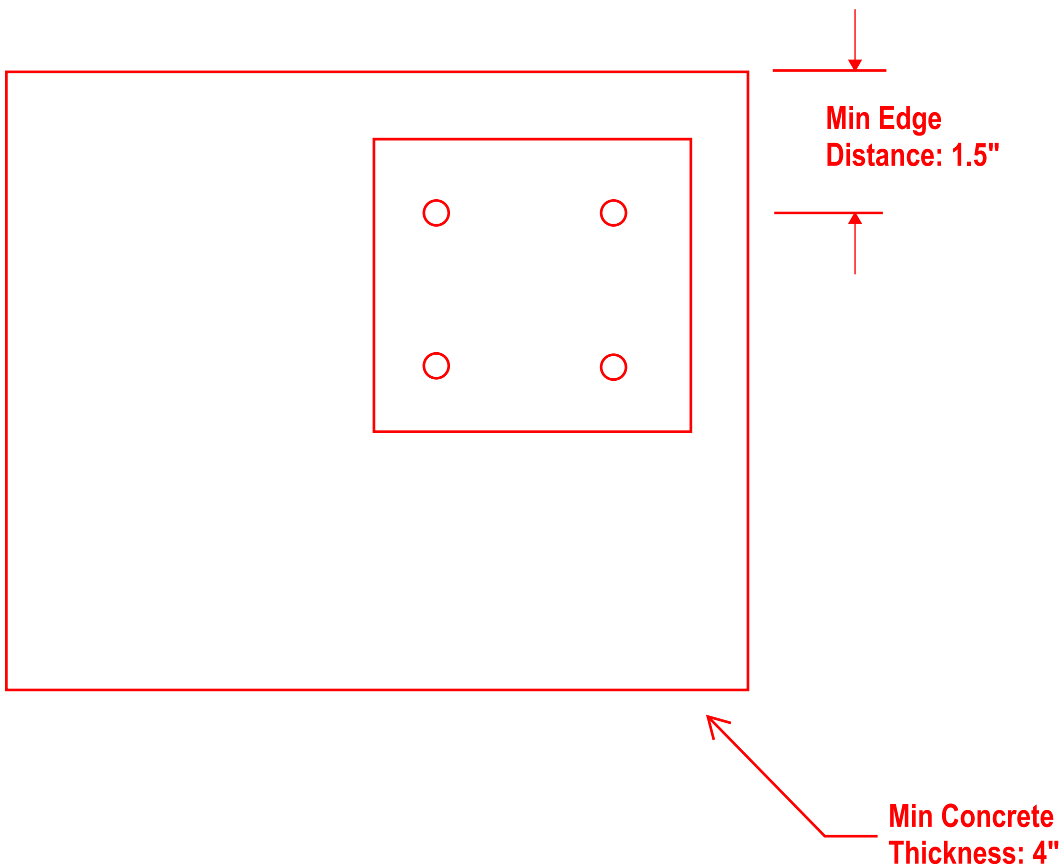
Guide for Anchor Selection

	1-2 Family Dwellings	All Use Groups	Equivalent Withdrawal Force
2" Fe26	ASSY VG CSK 3/8"X4" KWIK HUS EZ-SS 1/4"X2"	N/A	(Family) P = 1200 lb
3" Fe26	ASSY VG CSK 3/8"X4" KWIK HUS EZ-SS 1/4"X2"	ASSY VG CSK 3/8"X5.5" KWIK HUS EZ-SS 1/4"X2"	(Family) P = 925 lb (All) P = 1850 lb
Al13 Home 2"	ASSY VG CSK 3/8"X4" KWIK HUS EZ-SS 1/4"X2"	N/A	(Family) P = 851 lb
Al13 Home 3"	ASSY VG CSK 3/8"X4" KWIK HUS EZ-SS 1/4"X2"	N/A	(Family) P = 850 lb
Al13 Plus 3"	ASSY VG CSK 3/8"X4" KWIK HUS EZ-SS 1/4"X2"	ASSY VG CSK 3/8"X5.5" KWIK HUS EZ-SS 1/4"X2"	(Family) P = 850 lb (All) P = 1701 lb

Notes:

1) Concrete is designed for a minimum strength of 2,500 psi with minimum thickness of 4"
2) Minimum 3x blocking under screw posts

Concrete Anchor Layout



MISSOULA, MT
PH: (406) 721-5733
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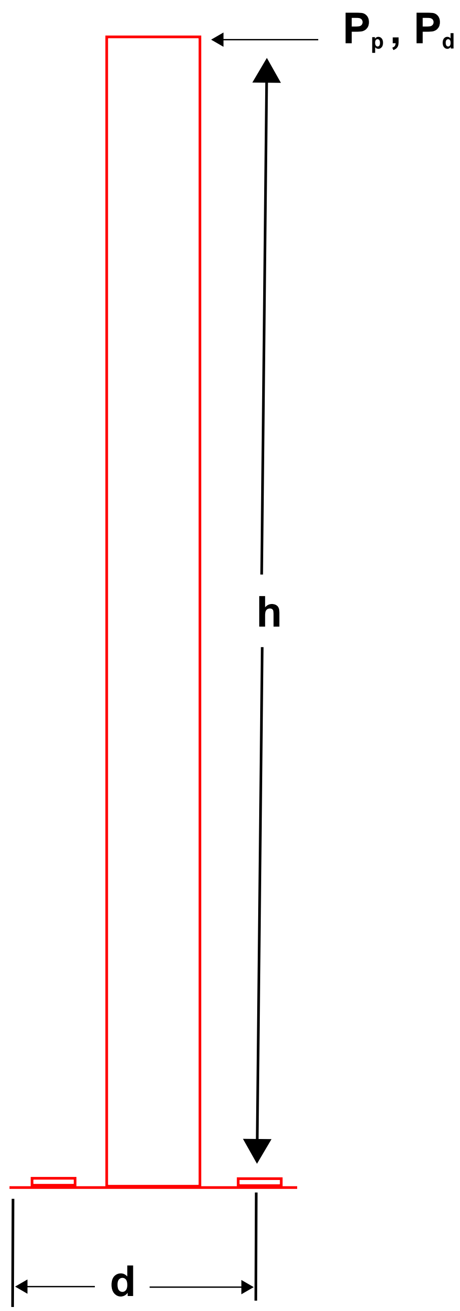
PH: (503) 395-1229

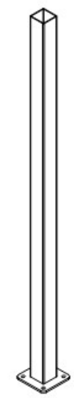
Anchorage Calculations for:

FORTRESS BUILDING PRODUCTS

Pepared for:
Kevin Flatt

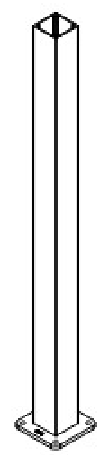

P_p , P_d
h
d

Railing Connection Fe26 2"



$h := 42\ in$	Height of Railing
$P := 200\ lb$	Maximum Point Load
$M := P \cdot h = 700\ ft \cdot lb$	Overturning Moment
$d := 3.5\ in$	Spacing of Screws
$n := 4$	Number of Screws
$T := \frac{M}{d} = 2400\ lb$	Tension force at Connection
$t := \frac{T}{\left(\frac{n}{2}\right)} = 1200\ lb$	Withdrawal Force per Screw

Railing Connection Fe26 3"



$h := 42\ in$	Height of Railing
$d := 4.54\ in$	Spacing of Screws
$n := 4$	Number of Screws

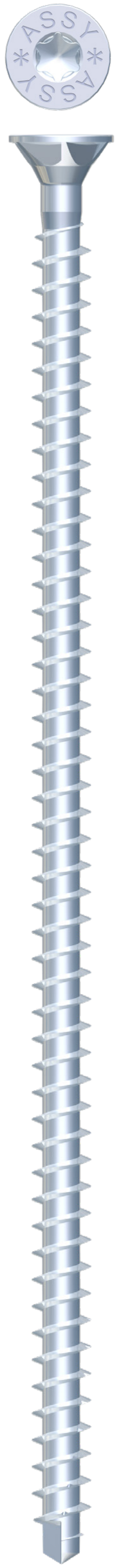
<u>For Distributed Load</u>

$P := 50\ \frac{lb}{ft}$	Continuous Load
$l := 8\ ft$	Trib Length
$P_d := P \cdot l = 400\ lb$	Shear Force given Trib length
$M_d := P_d \cdot h = 1400\ lb \cdot ft$	Maximum Distributed Moment
$T_d := \frac{M_d}{d} = 3700.44\ lb$	Tension for Distributed Load
$t_d := \frac{T_d}{0.5 \cdot n} = 1850.22\ lb$	Tension per screw

MTC Solutions - ASSY VG CSK 3/8"

$C_d := 1.4$	Duration Factor
$W := 280 \cdot \frac{lb}{in} \cdot C_d = 392 \ \frac{lb}{in}$	Withdrawal Limit
$\frac{t}{W} = 3.06 \ in$	Minimum Thread needed for 1-2 Family
$\frac{t_d}{W} = 4.72 \ in$	Minimum Thread Needed for All Use Groups

ASSY® VG CSK



The ASSY® VG Countersunk head (CSK) screw is the multipurpose fully threaded screw used in wood-to-wood, wood-to-steel and wood-to-concrete applications. All fully threaded screws are suitable for timber reinforcements. With the long threaded shank, high withdrawal capacities are achieved. Its self-tapping tip allows for more effective penetration and reduced spacing. Closer end- and edge-distances are possible, reducing the timber sizes required. The VG CSK screw is also suitable for use with the 90° cup and 45° wedge washer.

Countersunk Head

Drill bit tip

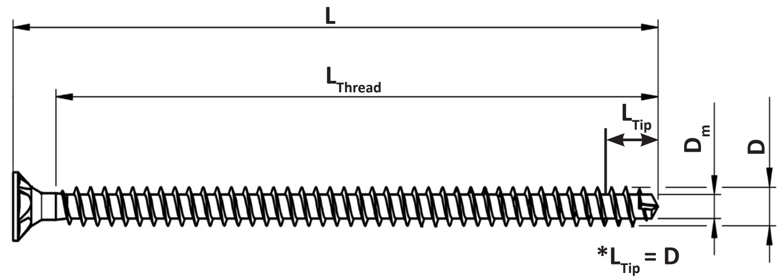
Self-tapping

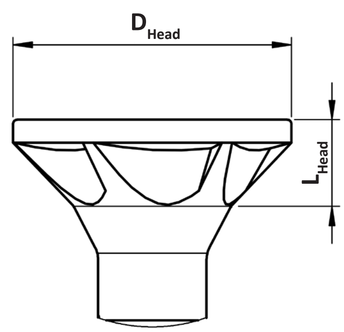
Fully Threaded

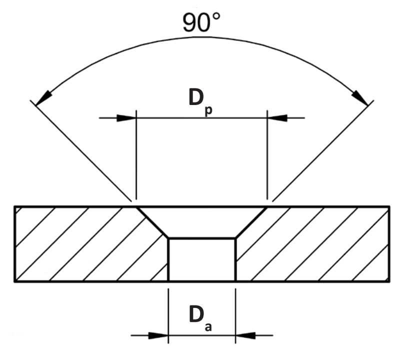
Diameters: 5/16”,3/8”, 1/2”

Wood/Wood, Wood/Steel,
Wood/Concrete

Code Approved: ICC, CCMC
& LARR







Item#	Box size	D	L		L_{Thread}		D_{Head}	D_m	D_p	D_a	L_{Head}	Bit
#	pieces	in. [mm]	in.	[mm]	in.	[mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	
14080080000	75	5/16 [8]	**3-1/8**	[80]	**2-1/2**	[61]	**0.591** [15]	**0.196** [5]	**0.748** [19]	**0.354** [9]	**0.181** [4.6]	**AW 40**
14080120000	75		**4-3/4**	[120]	**4**	[103]						
14080140000	75		**5-1/2**	[140]	**4-7/8**	[123]						
14080160000	75		**6-1/4**	[160]	**5-5/8**	[143]						
14080180000	75		**7-1/8**	[180]	**6-3/8**	[163]						
14080200000	75		**7-7/8**	[200]	**7-1/4**	[183]						
14080220000	75		**8-5/8**	[220]	**8**	[203]						
14080240000	75		**9-1/2**	[240]	**8-3/4**	[223]						
14080260000	75		**10-1/4**	[260]	**9-5/8**	[243]						
14080280000	75		**11**	[280]	**10-3/8**	[263]						
14080300000	75		**11-7/8**	[300]	**11-1/8**	[283]						

ASSY® VG CSK

1-2 Family Dwellings

All Use Groups

Item#	Box size	D	L		L_{Thread}		D_{Head}	D_m	D_p	D_a	L_{Head}	Bit
#	pieces	in. [mm]	in.	[mm]	in.	[mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	
14100100000	50	3/8 [10]	**4**	[100]	**3**	[77]	0.728 [18.5]	0.244 [6.2]	0.944 [24]	0.433 [11]	0.255 [6.5]	AW 50
14100140000	50		**5-1/2**	[140]	**4-7/8**	[125]						
14100160000	50		**6-1/4**	[160]	**5-3/4**	[145]						
14100180000	50		**7-1/8**	[180]	**6-1/2**	[165]						
14100200000	50		**7-7/8**	[200]	**7-1/4**	[185]						
14100220000	50		**8-5/8**	[220]	**8-1/8**	[205]						
14100240000	50		**9-1/2**	[240]	**8-7/8**	[225]						
14100260000	50		**10-1/4**	[260]	**9-5/8**	[245]						
14100280000	50		**11**	[280]	**10-3/8**	[265]						
14100300000	50		**11-7/8**	[300]	**11-1/4**	[285]						
14100320000	50		**12-5/8**	[320]	**12**	[305]						
14100340000	50		**13-3/8**	[340]	**12-3/4**	[325]						
14100360000	50		**14-1/4**	[360]	**13-5/8**	[345]						
14100380000	50		**15**	[380]	**14-3/8**	[365]						
14100400000	50		**15-3/4**	[400]	**15-1/8**	[385]						
14100430000	25		**16-7/8**	[430]	**16-3/8**	[415]						
14100480000	25		**19**	[480]	**18-1/4**	[465]						
14100530000	25		**20-7/8**	[530]	**20-1/8**	[512]						
14100580000	25		**22-7/8**	[580]	**22-1/8**	[562]						
14100650000	25		**25-5/8**	[650]	**24-7/8**	[632]						
14100700000	25		**27-5/8**	[700]	**26-7/8**	[682]						
14100750000	25		**29-1/2**	[750]	**28-7/8**	[732]						
14100800000	25		**31-1/2**	[800]	**30-3/4**	[782]						

Item#	Box size	D	L		L_{Thread}		D_{Head}	D_m	D_p	D_a	L_{Head}	Bit
#	pieces	in. [mm]	in.	[mm]	in.	[mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	in. [mm]	
14120120000	50	1/2 [12]	**4-3/4**	[120]	**4-1/8**	[105]	0.885 [22.5]	0.280 [7.1]	1.024 [26]	0.512 [13]	0.264 [6.7]	AW 50
14120140000	50		**5-1/2**	[140]	**4-7/8**	[125]						
14120160000	50		**6-1/4**	[160]	**5-3/4**	[145]						
14120180000	50		**7-1/8**	[180]	**6-1/2**	[165]						
14120200000	50		**7-7/8**	[200]	**7-1/4**	[185]						
14120220000	50		**8-5/8**	[220]	**8-1/8**	[205]						
14120240000	50		**9-1/2**	[240]	**8-7/8**	[225]						
14120260000	50		**10-1/4**	[260]	**9-5/8**	[245]						
14120280000	50		**11**	[280]	**10-3/8**	[265]						
14120300000	50		**11-7/8**	[300]	**11-1/4**	[285]						
14120380000	50		**15**	[380]	**14-3/8**	[365]						
14120480000	25		**19**	[480]	**18-1/4**	[465]						
14120600000	25		**23-5/8**	[600]	**23**	[585]						

TABLE 3—REFERENCE WITHDRAWAL DESIGN VALUES (W)[2,3] (lbf/in)

NOMINAL FASTENER DIAMETER (inch)	FOR SPECIFIC GRAVITIES (SG) AND EQUIVALENT SPECIFIC GRAVITIES (ESG) OF:[4]				
	Sawn Lumber and Glulam				PSL
	SG = 0.55	SG = 0.49	SG = 0.42	SG = 0.35	ESG ≥ 0.50
W_{90} - For screws driven into the side grain of the main member, such that the screws are oriented perpendicular to the grain and loaded in direct withdrawal[1]:					
$^1/_4$	230	202	169	137	156
$^5/_{16}$	279	248	212	176	179
$^3/_8$	317	280	237	188	211
$^1/_2$	331	297	251	209	223
W_{45} - For screws driven into the side grain of the main member, such that the screws are oriented at 45 degrees to the grain and loaded along the axis of the screw:					
$^1/_4$	197	173	145	118	156
$^5/_{16}$	239	212	182	151	179
$^3/_8$	272	240	203	163	211
$^1/_2$	284	254	215	179	223

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N.

[1] Values must be multiplied by all adjustment factors applicable to wood screws, in accordance with the NDS.
[2] SWG ASSYplus VG and VG 4 screws must be installed and used in dry in-service conditions, such that the wet service factor, C_M, is 1.0 in accordance with the NDS.
[3] Reference withdrawal design values are to be multiplied by the length of thread penetration into the main member. Main member penetration must be at least 8 times the nominal diameter. Thread length does not include the length of the tip.
[4] The specific gravity used for design purposes must be the assigned specific gravity for sawn lumber per Table 12.3.3A of the NDS (Table 11.3.3A of the NDS for the 2012 IBC, Table 11.3.2A of the NDS for the 2009 IBC) or the applicable Specific Gravity for Fastener Design for glulam, given in Section 5 of the NDS Supplement; and the equivalent specific gravity (ESG) must be the equivalent specific gravity given in the applicable ICC-ES evaluation report on the PSL product.

TABLE 4—REFERENCE HEAD PULL-THROUGH DESIGN VALUES (W_H)[1,2,3] (lbf)

NOMINAL FASTENER DIAMETER (inch)	HEAD TYPE	MINIMUM SIDE MEMBER THICKNESS, t_s (inches)	FOR SPECIFIC GRAVITIES (SG) AND EQUIVALENT SPECIFIC GRAVITIES (ESG) OF:[4]				
			Sawn Lumber				PSL
			SG = 0.55	SG = 0.49	SG = 0.42	SG = 0.35	ESG ≥ 0.50
$^5/_{16}$	Countersunk, Countersunk Milling Pocket	$1^3/_8$	414	350	281	216	398
$^3/_8$	Countersunk, Countersunk Milling Pocket		474	408	334	266	491
$^1/_2$	Countersunk, Countersunk Milling Pocket		474	408	334	266	491

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N.

[1]Tabulated head pull-through design values, W_H, must be multiplied by all adjustment factors applicable to wood screw withdrawal, in accordance with the NDS.
[2]Design values apply to connections with minimum side member thicknesses, t_s, as given above.
[3]SWG ASSYplus VG and VG 4 screws must be installed and used in dry in-service conditions, such that the wet service factor, C_M, is 1.0 in accordance with the NDS.
[4]The specific gravity (SG) used for design purposes must be the assigned specific gravity for sawn lumber per Table 12.3.3A of the NDS (Table 11.3.3A of the NDS for the 2012 IBC, Table 11.3.2A of the NDS for the 2009 IBC) or the applicable Specific Gravity for Fastener Design for glulam, given in Section 5 of the NDS Supplement; and the equivalent specific gravity (ESG) must be the equivalent specific gravity given in the applicable ICC-ES evaluation report on PSL product.

TABLE 5—CONNECTION GEOMETRY REQUIREMENTS[1]

CONDITION		MINIMUM DIMENSION (in terms of nominal screw diameter, D)	
		LATERALLY LOADED SCREWS	**AXIALLY LOADED SCREWS**
Screws Installed Perpendicular to the Surface of the Wood Member			
End distance		7D (10.5D in D-Fir)	5D (7.5D in D-Fir)
Edge distance	Lateral Loading parallel to grain	3D	-
	Lateral Loading perpendicular to grain	7D	-
	Axial Load on fastener	-	3D
Spacing between fasteners in a row		7D (10.5D in D-Fir)	5D (7.5D in D-Fir)
Spacing between rows[2]	Loading parallel to grain	4D	-
	Loading perpendicular to grain	5D	-
	Axial Load on fastener	-	2.5D
Screws Installed at an Incline[3]			
End distance, a_{AXIAL}		5D (7.5D in D-Fir)[4]	
Edge distance, e_{AXIAL}		3D	
Spacing between fasteners in a row, $S_{P\ AXIAL}$		5D (7.5D in D-Fir)	
Spacing between rows of fasteners, $S_{Q\ AXIAL}$		2.5D	

[1] End distances, edge distances and screw spacing must be sufficient to prevent splitting of the wood, or as required by this table, whichever is the more restrictive.
[2]Within a row, fasteners may be staggered up to 2D to further reduce the potential for splitting.
[3]See Figures 4 and 5.
[4]End distance must also be sufficient to ensure that the screw is fully embedded in the wood member.

TABLE 6—RECOMMENDED DIAMETER OF PREDRILLED HOLES[1] (inch)

NOMINAL FASTENER DIAMETER (inch)	APPLICABLE LOAD CONDITION AND SPECIFIC GRAVITY		
	Screws Subject to Lateral Load		**Screws Loaded Axially**
	SG ≤ 0.5	**SG > 0.5 and PSL**	**0.35 ≤ SG ≤ 0.55 and PSL**
$^{1}/_{4}$	$^{5}/_{32}$	$^{5}/_{32}$	$^{5}/_{32}$
$^{5}/_{16}$	$^{13}/_{64}$	$^{7}/_{32}$	$^{13}/_{64}$
$^{3}/_{8}$	$^{15}/_{64}$	$^{1}/_{4}$	$^{15}/_{64}$
$^{1}/_{2}$	$^{17}/_{64}$	$^{5}/_{16}$	$^{17}/_{64}$

For **SI:** 1 inch = 25.4 mm.

BY INSPECTION ASSY VGS CSK 3/8" MEETS THE MINIMUM LOAD REQUIREMENTS www.hilti.com

Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Aug 31, 2021	Date:	8/31/2021
Fastening point:			

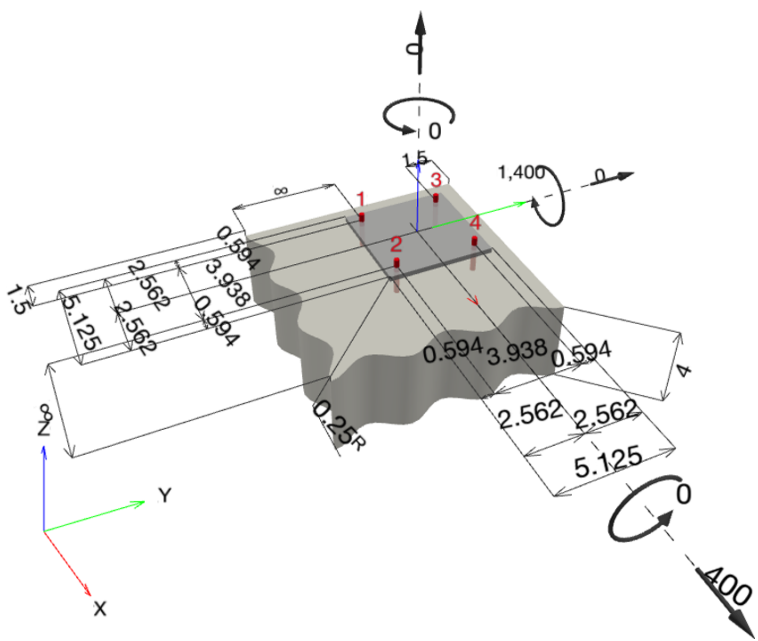
Specifier's comments:

1 Input data

Anchor type and diameter:	**KWIK HUS-EZ (KH-EZ)-SS316 1/4 (1 5/8)**
Item number:	2245630 KH-EZ SS316 1/4"x2"
Effective embedment depth:	$h_{ef,act}$ = 1.190 in., h_{nom} = 1.625 in.
Material:	AISI 316
Evaluation Service Report:	ESR-3027
Issued I Valid:	1/1/2021 | 12/1/2021
Proof:	Design Method ACI 318-19 / Mech
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.250 in.
Anchor plate[R] :	l_x x l_y x t = 5.125 in. x 5.125 in. x 0.250 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 2500, f_c' = 2,500 psi; h = 4.000 in.
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present
	edge reinforcement: none or < No. 4 bar

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



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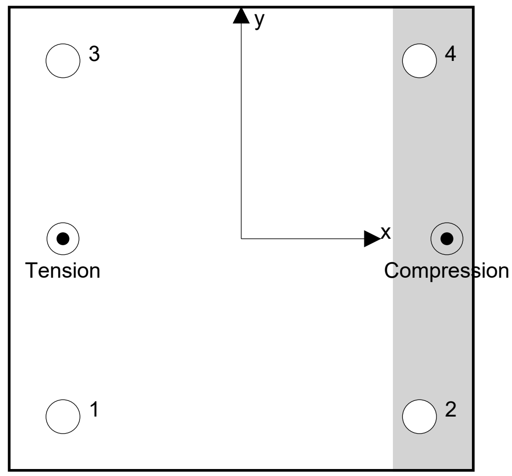
Company:		Page:	2
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Aug 31, 2021	Date:	8/31/2021
Fastening point:			

1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	$N = 0; V_x = 400; V_y = 0;$ $M_x = 0; M_y = 1,400; M_z = 0;$	no	55

2 Load case/Resulting anchor forces



Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	165	100	100	0
2	0	100	100	0
3	165	100	100	0
4	0	100	100	0

max. concrete compressive strain:	0.03 [‰]
max. concrete compressive stress:	148 [psi]
resulting tension force in (x/y)=(-1.969/0.000):	330 [lb]
resulting compression force in (x/y)=(2.272/0.000):	330 [lb]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

3 Tension load

	Load N_{ua} [lb]	Capacity ϕ N_n [lb]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	165	4,590	4	OK
Pullout Strength*	165	314	53	OK
Concrete Breakout Failure**	330	1,021	33	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value   refer to ICC-ES ESR-3027

$\phi\ N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.04	153,000

Calculations

N_{sa} [lb]
6,120

Results

N_{sa} [lb]	ϕ_{steel}	$\phi\ N_{sa}$ [lb]	N_{ua} [lb]
6,120	0.750	4,590	165

3.2 Pullout Strength

$N_{pn,f'_c} = N_{p,2500}\ \lambda_a\ (f_c'/2500)^{0.1}$ refer to ICC-ES ESR-3027

$\phi\ N_{pn,f'_c} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

f'_c [psi]	λ_a	$N_{p,2500}$ [lb]
2,500	1.000	570

Calculations

$(f_c'/2500)^{0.1}$
1.000

Results

N_{pn,f'_c} [lb]	$\phi_{concrete}$	$\phi\ N_{pn,f'_c}$ [lb]	N_{ua} [lb]
570	0.550	314	165

Company:		Page:	4
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Aug 31, 2021	Date:	8/31/2021
Fastening point:			

3.3 Concrete Breakout Failure

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ ACI 318-19 Eq. (17.6.2.1b)

$\phi\ N_{cbg} \geq N_{ua}$ ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$ ACI 318-19 Eq. (17.6.2.2.1)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
1.190	0.000	0.000	1.500	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
4.760	17	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
22.52	12.74	1.000	1.000	0.952	1.000	1,103

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [lb]	N_{ua} [lb]
1,856	0.550	1,021	330

4 Shear load

	Load V_{ua} [lb]	Capacity $\phi\ V_n$ [lb]	Utilization $\beta_V = V_{ua}/\phi\ V_n$	Status
Steel Strength*	100	1,190	9	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	400	2,711	15	OK
Concrete edge failure in direction y+**	400	1,051	39	OK

* highest loaded anchor   **anchor group (relevant anchors)

4.1 Steel Strength

V_{sa} = ESR value   refer to ICC-ES ESR-3027

$\phi\ V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.04	153,000

Calculations

V_{sa} [lb]
1,830

Results

V_{sa} [lb]	ϕ_{steel}	$\phi\ V_{sa}$ [lb]	V_{ua} [lb]
1,830	0.650	1,190	100

4.2 Pryout Strength

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b\right]$ ACI 318-19 Eq. (17.7.3.1b)

$\phi\ V_{cpg} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$ ACI 318-19 Eq. (17.6.2.2.1)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
1	1.190	0.000	0.000	1.500

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	4.760	17	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
46.99	12.74	1.000	1.000	0.952	1.000	1,103

Results

V_{cpg} [lb]	$\phi_{concrete}$	$\phi\ V_{cpg}$ [lb]	V_{ua} [lb]
3,873	0.700	2,711	400

4.3 Concrete edge failure in direction y+

$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V}\ \psi_{ed,V}\ \psi_{c,V}\ \psi_{h,V}\ \psi_{parallel,V}\ V_b$ ACI 318-19 Eq. (17.7.2.1b)

$\phi\ V_{cbg} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Vc} see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)

$A_{Vc0} = 4.5\ c_{a1}^2$ ACI 318-19 Eq. (17.7.2.1.3)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{e'_V}{1.5c_{a1}}}\right) \leq 1.0$ ACI 318-19 Eq. (17.7.2.3.1)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ ACI 318-19 Eq. (17.7.2.4.1b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ ACI 318-19 Eq. (17.7.2.6.1)

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2} \sqrt{d_a}\right) \lambda_a \sqrt{f'_c}\ c_{a1}^{1.5}$ ACI 318-19 Eq. (17.7.2.2.1a)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
1.500	1.500	0.000	1.000	4.000

l_e [in.]	λ_a	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
1.190	1.000	0.250	2,500	2.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
17.30	10.13	1.000	1.000	1.000	439

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi\ V_{cbg}$ [lb]	V_{ua} [lb]
1,501	0.700	1,051	400

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.527	0.381	5/3	55	OK

$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} <= 1$

6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2018, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://submittals.us.hilti.com/PROFISAnchorDesignGuide/
- Hilti post-installed anchors shall be installed in accordance with the Hilti Manufacturer's Printed Installation Instructions (MPII). Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

7 Installation data

Anchor type and diameter: KWIK HUS-EZ (KH-EZ)-SS316 1/4 (1 5/8)

Profile: no profile

Item number: 2245630 KH-EZ SS316 1/4"x2"

Hole diameter in the fixture: d_f = 0.375 in.

Maximum installation torque: 216 in.lb

Plate thickness (input): 0.250 in.

Hole diameter in the base material: 0.250 in.

Recommended plate thickness: not calculated

Hole depth in the base material: 1.836 in.

Drilling method: Hammer drilled

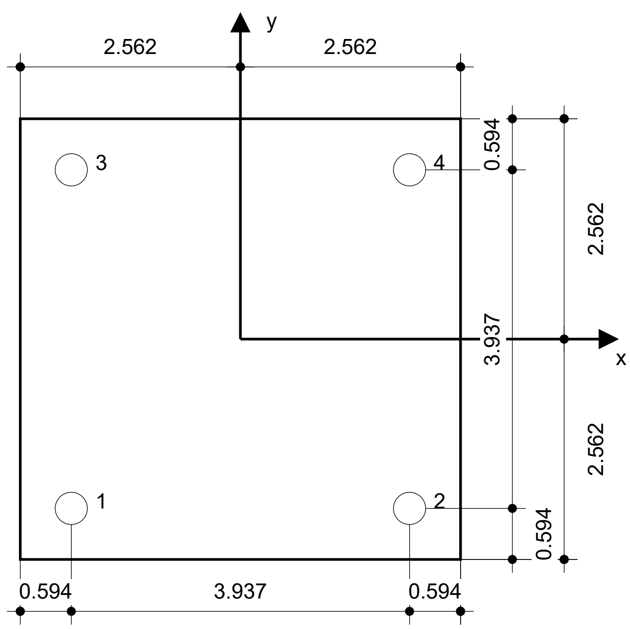
Minimum thickness of the base material: 3.250 in.

Cleaning: Manual cleaning of the drilled hole according to instructions for use is required.

Hilti KH-EZ-SS316 screw anchor with 1.625 in embedment, 1/4 (1 5/8), Stainless steel, installation per ESR-3027

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Manual blow-out pump	• Torque wrench



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-1.969	-1.969	1.500	-	-	5.437
2	1.969	-1.969	5.437	-	-	5.437
3	-1.969	1.969	1.500	-	-	1.500
4	1.969	1.969	5.437	-	-	1.500

8 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
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