Eastern
Engineering Group

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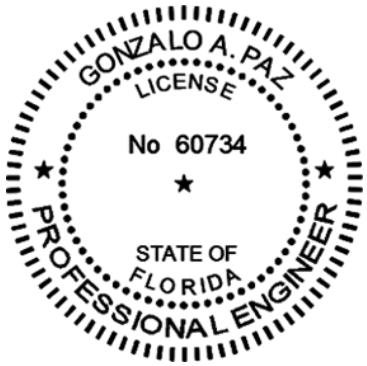
EVA VACCARO

Job. No: 25-0904

MISC. SHOP DRAWINGS

12940 SW 63rd Ave,
Pinecrest, FL 33156

STRUCTURAL CALCULATION



Digitally signed by Gonzalo A Paz
Date: 2025.07.18 15:32:59-04'00'

THIS ITEM HAS BEEN DIGITALLY SIGNED AND SEALED BY **GONZALO A. PAZ, PE** ON THE DATE ADJACENT TO THE SEAL.

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Prepared By:
☐ Gonzalo Paz , PE
Lic. No. 60734
CAN # 26655

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DESIGN CRITERIA:

Calculations based on:

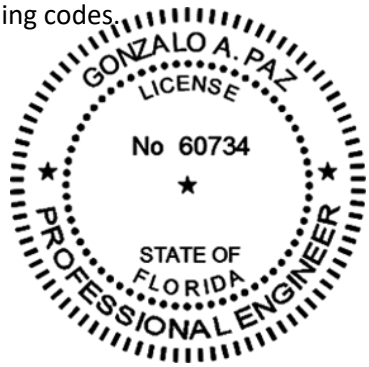
1. Florida Building Code 8th Edition 2023
2. Minimum Design Loads for Buildings and Other Structures ASCE 7-22
3. Building Code Requirements for Structural Concrete ACI 318-19
4. American Institute of Steel Construction AISC 360-16
5. Aluminum Design Manual 2020
6. Specifications for the Design of Cold-Formed Stainless Steel Structural Members SEI/ASCE8-02

CALCULATION INDEX:

I.	Wind load analysis	3-4
II.	Exterior railing at balconies	5-20
III.	Interior railing at stair	21-37
	Total Pages = 37	

CALCULATION STATEMENT:

To the best of my knowledge, ability, belief and professional judgment, I hereby attest that the manual calculations and computer-generated calculations are in compliance with the existing governing codes.



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WIND LOAD ANALYSIS

Wind for Others Structures & Opening Signs Design (ε<70%) ASCE 7-22

General Wind Data:

Miami Dade
Category II.....V=175 mph

$V := 175.00$ Wind Velocity (mph)

$K_{zt} := 1.00$ Topographic Factor

$K_d := 0.85$ Wind Directionality Factor (see table 26.6-1) ASCE 7-22 ....**Kd=0.85**

$G := 0.85$ Gust Factor (Rigid Structure)

$C_f := 1.80$ Net Force Coefficients Cf (see Figure 29.5-2)

	Flat-Side Members	Rounded Members
for ε<=0.1----------	2.0	1.2----------0.8
for 0.1 to 0.29----------	1.8	1.3----------0.9
for 0.3 to 0.7----------	1.6	1.5----------1.1

$\alpha := 11.50$

$zg := 1935.00$

Values for Terrain exposure constants α and zg:
Exposure B------ Value α =7.5 , Value zg=3,280
Exposure C------ Value α =9.8 , Value zg=2,460
Exposure D------ Value α =11.5 , Value zg=1,935

General Sign Data:

$Z := 14.33$ Height of Top of Sign (ft) conservative

$\varepsilon := 16.7$ Solidity Ratio of Sign (%)

Then

$Z := \text{if}(Z < 15, 15, Z)$

$K_z := 2.41\left(\frac{Z}{zg}\right)^{\frac{2}{\alpha}}$ $K_z = 1.04$

$q_z := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot V^2$ $q_z = 68.98$ psf

Allowable Design Wind Loads:

$p_z := 0.6\left(q_z \cdot G \cdot C_f\right)$ $p_z = 63.32$ Gross Wind per Actual Solid Area (psf)

$p_{z.EQ} := \max\left(p_z \cdot \frac{\varepsilon}{100}, 10\right)$ $p_{z.EQ} = 10.57$ Equivalent Wind in Overall Area (psf)

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EXTERIOR RAILING AT BALCONIES

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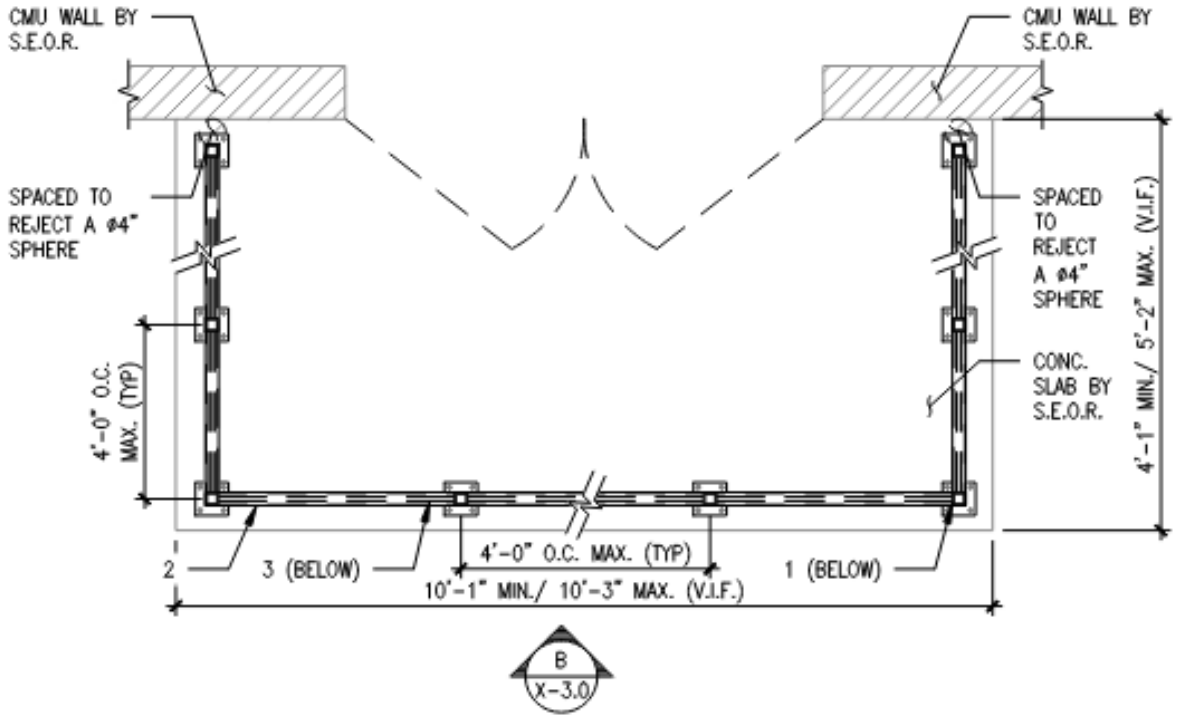
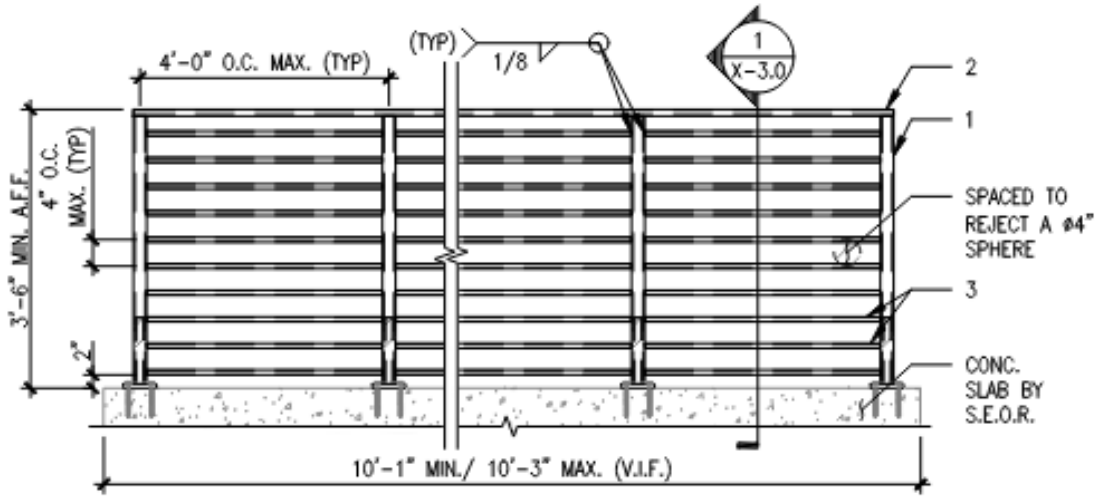


EXTERIOR RAILING AT BALCONIES PLAN VIEW (TYP)

A
X-3.0

SCALE: 1/2"=1'-0"



EXTERIOR RAILING AT BALCONIES ELEVATION (TYP)

B
X-3.0

SCALE: 1/2"=1'-0"

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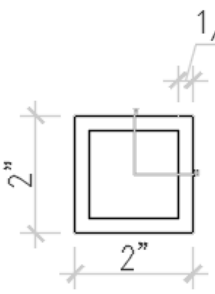
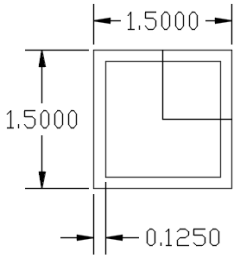
SECTION PROPERTIES

POST 2X2X1/4"
ALLOY 6061-T6



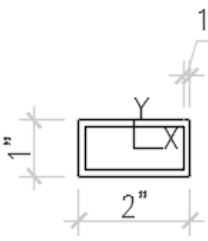
Area = 1.7500 in^2
Ixx = 0.9115 in^4
Iyy = 0.9115 in^4
Jz = 1.8229 in^4
Pxy = −0.0000 in^4
rxx = 0.7217 in
ryy = 0.7217 in
Sxx max = 0.9115 in^3
Sxx min = 0.9115 in^3
Syy max = 0.9115 in^3
Syy min = 0.9115 in^3

INSERT 1-1/2X1-1/2X1/8
ALLOY 6061-T6



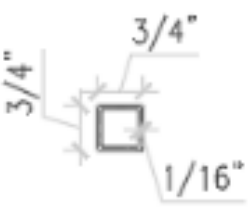
Area = 0.6874 in^2
Ixx = 0.2184 in^4
Iyy = 0.2184 in^4
Jz = 0.4368 in^4
Pxy = 0.0000 in^4
rxx = 0.5637 in
ryy = 0.5637 in
Sxx max = 0.2912 in^3
Sxx min = 0.2912 in^3
Syy max = 0.2912 in^3
Syy min = 0.2912 in^3

TOP & BOTTOM 1X2X1/8"
ALLOY 6061-T6



Area = 0.6875 in^2
Ixx = 0.1051 in^4
Iyy = 0.3317 in^4
Jz = 0.4368 in^4
Pxy = 0.0000 in^4
rxx = 0.3911 in
ryy = 0.6946 in
Sxx max = 0.2103 in^3
Sxx min = 0.2103 in^3
Syy max = 0.3317 in^3
Syy min = 0.3317 in^3

PICKETS 3/4"x3/4"x1/16"
(ALLOY 6063-T5)



Area = 0.1718 in^2
Ixx = 0.0137 in^4
Iyy = 0.0137 in^4
Jz = 0.0273 in^4
Pxy = −0.0000 in^4
rxx = 0.2818 in
ryy = 0.2818 in
Sxx max = 0.0364 in^3
Sxx min = 0.0364 in^3
Syy max = 0.0364 in^3
Syy min = 0.0364 in^3

Picket Horizontal Railing Design (Top, Bottom, Post)

Allowable Stresses for **Aluminum**				
	6063-T6 (psi)	6063-T5 (psi)	6061-T6 (psi)	6005-T5 (psi)
Fb	15000	9500	19000	19000
(Tubes & Shapes)	4800	4800	9000	8000
Fb	18000	11500	24000	24000
(Round & Oval)	5500	5500	10500	9000
Fv	8500	5500	12000	12000
Tubes, Shapes & Round	2800	2800	5000	4500
E	10100 ksi	10100 ksi	10100 ksi	10100 ksi

White bars apply to nonwelded members and to welded members at loc. fathers than 1.0 in from a weld
Shadded bars apply to within 1.0 in of a weld

Allowable Stress for Aluminum Welding:
Aluminum Filler Alloy 5356 Fv=7000 psi

Allowable Stress for Steel
Strong and Weak Axis Allowables Stress for Tube **Steel** Shape:
Fb=23760 psi, Fv=14400 psi for Fy=36 ksi E=29000 Ksi
Fb=33000 psi, Fv=20000 psi for Fy=50 ksi E=29000 Ks
Allowable Stress for Steel Welding:
Welding: E-70XX Fv=21000 psi

Allowable Stress for Stainless Steel
Strong and Weak Axis Allowables Stress for Tube Steel Shape:
Fb=16216 psi, Fv=9189 psi for (SS 304) Fy=30 ksi E=28000 Ksi
Fb=34730 psi, Fv=20838 psi for (S32304 Duplex SS) Fy=58 ksi E=28000 Ksi
Fb=62870 psi, Fv=37720 psi for (S17400-H1150) Fy=105 ksi E=28000 Ksi
Allowable Stress for Steel Welding:
Welding: E318 or E309 Fv=19200 psi

Allowable Stress for Wood
Strong and Weak Axis Allowables Stress for Lumber No.2 Non Dense (2"-4" thick):
Fb=1350 psi, Fv=175 psi for 2"-4" Wide E=1400 Ksi
Fb=1150 psi, Fv=175 psi for 5"-6" Wide E=1400 Ksi

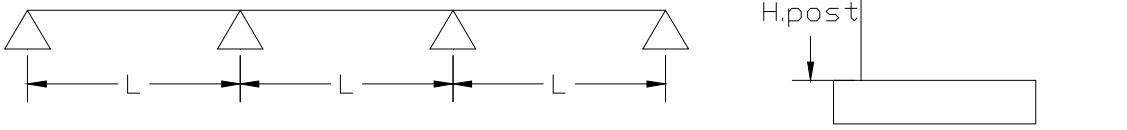
DESIGN INFORMATION:

Florida Building Code 2023
AISC Manual of Steel Construction 2017 ANSI/AISC 360-16, ANSI/AWC NDS—2018 NDS for Wood Construction, ASCE 7-22, AISC Design Guide 27 -Structural Stainless Steel, Aluminum Design Manual 2020

DESIGN LOADS:

Handrail Design Loads: Concentrated Load = 200 lbs. applied at any point in any direction.
Uniform Load = 50 plf applied in any direction (other than dwelling units).
Guardrail System Loads: Concentrated Load = 200 lbs. applied at any point in any direction at the top of the guardrail.
Concentrated horizontal load of 50 lbs applied on a 1 sq ft. area at any point in the system (FBC 1607.9.1.2 and Section 4.5.1.2 of ASCE 7).

Handrail Design:



General Data:

$L := 48.00$ Railing Span (in)

$H_{post} := 42.00$ Post Height (in)

$d_{picket} := 4.00$ Distance center/center of Picket (in)

General Loads:

$q_{wind} := 10.57$ Wind Pressure (psf)

$P_{200} := 200.00$ Single Concentrated Load (lbs) .....Railing P=200.00, Fence P=0.00

$q_{50} := 50.00$ Uniform Distributed Load (plf).....Railing q=50.00, Fence q=0.00

$P_{50} := 50.00$ Single Concentrated Load (lbs) .....Railing P=50.00, Fence P=0.00

Top Railing Data:

$Fb_{TR} := 19000.00$ psi

$Fv_{TR} := 5000.00$ psi

$Sx_{TR} := 0.2103$ Vertical Loads in^3

$A_{TR} := 0.6875$ in^2

$Sy_{TR} := 0.331$ Horizontal Loads in^3

Post Data:

$Fb_{PT} := 9000.00$ psi

$Fv_{PT} := 5000.00$ psi

$Sx_{PT} := 0.9115$ in^3

$A_{PT} := 1.75$ in^2

Picket Data:

$Fb_{PK} := 9000.00$ psi

$Fv_{PK} := 2800.00$ psi

$Sx_{PK} := 0.0364$ in^3

$A_{PK} := 0.1718$ in^2

Top Railing Design:

Actual Moment:

Concentrated Load = 200 lbs.

$$M_{TR.200} := \frac{P_{200} \cdot L}{5}$$

$M_{TR.200} = 1920.00$ in − lb

Uniform Load = 50 plf

$$M_{TR.50} := 0.1012 \cdot \left(\frac{q_{50}}{12}\right) \cdot L^2$$

$M_{TR.50} = 971.52$ in − lb

For Wind Pressure

$$M_{TR.wind} := 0.1012 \cdot \left(\frac{q_{wind}}{144}\right) \cdot \frac{d_{picket}}{2} \cdot L^2$$

$M_{TR.wind} = 34.23$ in − lb

$$M_{TR} := \max\left(M_{TR.200}, M_{TR.50}, M_{TR.wind}\right)$$

$M_{TR} = 1920.00$ in − lb

Actual Shear:

Concentrated Load = 200 lbs.

$$V_{TR.200} := P_{200} \text{ lbs}$$

$V_{TR.200} = 200.00$ lbs

Uniform Load = 50 plf

$$V_{TR.50} := 0.6 \cdot \left(\frac{q_{50}}{12}\right) \cdot L$$

$V_{TR.50} = 120.00$ lbs

For Wind Pressure

$$V_{TR.wind} := 0.6 \cdot \left(\frac{q_{wind}}{144}\right) \cdot \frac{d_{picket}}{2} \cdot L$$

$V_{TR.wind} = 4.23$ lbs

$$V_{TR} := \max\left(V_{TR.200}, V_{TR.50}, V_{TR.wind}\right)$$

$V_{TR} = 200.00$ lbs

Section Required:

Bending Design: Section Modulus Required

$$S_{TR.min} := \frac{M_{TR}}{Fb_{TR}}$$

$S_{TR.min} = 0.1$ in^3

Shear Design: Area Required

$$A_{TR.min} := \frac{1.5 \cdot V_{TR}}{Fv_{TR}}$$

$A_{TR.min} = 0.06$ in^2

Section Provided:

$$BENDING_{top} := \text{if}\left(S_{TR.min} \geq \min\left(Sx_{TR}, Sy_{TR}\right), \text{"N.G"}, \text{"OK"}\right)$$

$BENDING_{top} = \text{"OK"}$

$$SHEAR_{top} := \text{if}\left(A_{TR.min} \geq A_{TR}, \text{"N.G"}, \text{"OK"}\right)$$

$SHEAR_{top} = \text{"OK"}$

Post Design:

Actual Reaction:

Concentrated Load = 200 lbs.

$$R_{PT.200} := P_{200}$$ $R_{PT.200} = 200.00$ lbs

Uniform Load = 50 plf

$$R_{PT.50} := \left(\frac{q_{50}}{12}\right) \cdot L$$ $R_{PT.50} = 200.00$ lbs

For Wind Pressure

$$R_{PT.wind} := \left[\left(\frac{q_{wind}}{144}\right)\right] \cdot H_{post} \cdot L$$ $R_{PT.wind} = 147.98$ lbs

$$R_{PT} := \max\left(R_{PT.200}, R_{PT.50}, R_{PT.wind}\right)$$ $R_{PT} = 200.00$ lbs

Actual Moment:

$$M_{PT} := \max\left(\max\left(R_{PT.200}, R_{PT.50}\right) \cdot H_{post}, R_{PT.wind} \cdot \frac{H_{post}}{2}\right)$$ $M_{PT} = 8400.00$ in - lb

Actual Shear:

$$V_{PT} := R_{PT}$$ $V_{PT} = 200.00$ lbs.

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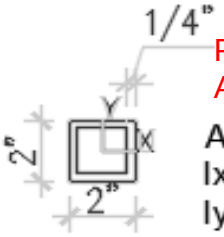
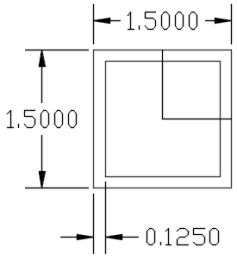


POST 2X2X1/4
ALLOY 6061-T6

Area = 1.7500 in^2
Ixx = 0.9115 in^4
Iyy = 0.9115 in^4
Jz = 1.8229 in^4
Pxy = -0.0000 in^4
rxx = 0.7217 in
ryy = 0.7217 in
Sxx max = 0.9115 in^3
Sxx min = 0.9115 in^3
Syy max = 0.9115 in^3
Syy min = 0.9115 in^3

INSERT 1-1/2X1-1/2X1/8
ALLOY 6061-T6



Area = 0.6874 in^2
Ixx = 0.2184 in^4
Iyy = 0.2184 in^4
Jz = 0.4368 in^4
Pxy = 0.0000 in^4
rxx = 0.5637 in
ryy = 0.5637 in
Sxx max = 0.2912 in^3
Sxx min = 0.2912 in^3
Syy max = 0.2912 in^3
Syy min = 0.2912 in^3

Maximum moment at base of posts
Maximum force = 200# (0.2 kips)
H max = 42"

Post maximum height from top without insert and weld affected. H_pw_{max}
Alloy 6061-T6 --- Fb = 9 ksi, Sx = 0.9115 cu.in
H_pw_{max} = 9 ksi * 0.9112 cu.in / 0.20 k = 41 inches

Post maximum height from top without insert and not weld affected. H_pnw_{max}
Alloy 6061-T6 --- Fb = 19 ksi, Sx = 0.8392 cu.in
H_pnw_{max} = 19 ksi * 0.9112 cu.in / 0.20k = 86.56 inches > 43.5" --- OK

Assuming post an insert to be snug fit, the action moment will be taken by both post and insert accordingly to its inertia as both are Aluminum with the same E.

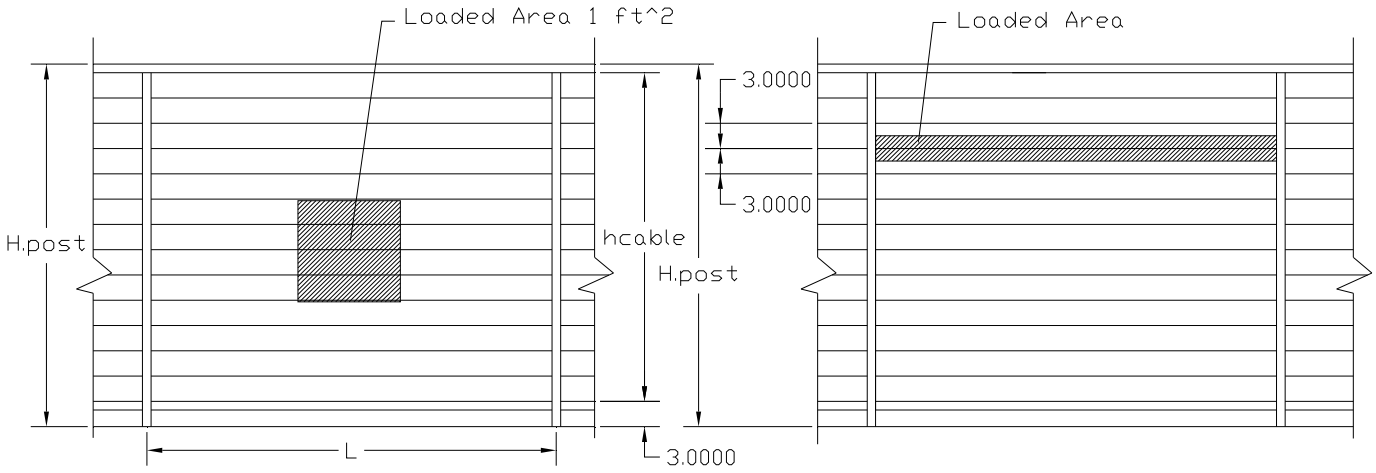
Post Inertia = 0.9115 in^4, Insert Inertia = 0.2184 in^4, Total Inertia = 1.1299 in^4.
Load distribution ------Post= 0.814; Insert = 0.192

Maximum moment at end of weld affected area = .20*42 = 8.4 K-in

Post Moment = 8.4 * 0.814 = 6.837 K-in,
fb post = 6.837/ 0.9115 = 7.51 ksi < 9.0 ksi ---- OK

Insert Moment = 8.4 * 0.192 = 1.6128 K-in,
fb insert = 1.6128/ 0.2912= 5.528 ksi < 9.0 ksi ---- OK

Picket Design:



Assume three pickets acting simultaneously

$$\omega_{picket} := \frac{P_{50}}{12} \cdot \frac{1}{3}$$

$\omega_{picket} = 1.39$ $\frac{lbs}{in}$

$$q_{picket} := \max(10, q_{wind})$$

$q_{picket} = 10.57$ psf

$$M_{PK} := \max\left(6 \cdot \omega_{picket} \cdot \frac{L}{2} - \omega_{picket} \cdot 18, \frac{q_{picket} \cdot d_{picket} \cdot L^2}{144 \cdot 8}\right)$$

$M_{PK} = 175.00$ in-lb

$$V_{PK} := \max\left[12 \cdot \omega_{picket} \cdot \frac{(L - 6)}{L}, \frac{q_{picket} \cdot d_{picket} \cdot L}{144 \cdot 2}\right]$$

$V_{PK} = 14.58$ lb

Section Required:

Bending Design: Section Modulus Required:

$$S_{PK.min} := \frac{M_{PK}}{Fb_{PK}}$$

$S_{PK.min} = 0.019$ in^3

Shear Design: Area Required:

$$A_{PK.min} := \frac{1.5 \cdot V_{PK}}{Fv_{PK}}$$

$A_{PK.min} = 0.008$ in^2

Section Provided:

$$BENDING_{picket} := \text{if}(S_{PK.min} \geq Sx_{PK}, \text{"N.G"}, \text{"OK"})$$

$BENDING_{picket} = \text{"OK"}$

$$SHEAR_{picket} := \text{if}(A_{PK.min} \geq A_{PK}, \text{"N.G"}, \text{"OK"})$$

$SHEAR_{picket} = \text{"OK"}$

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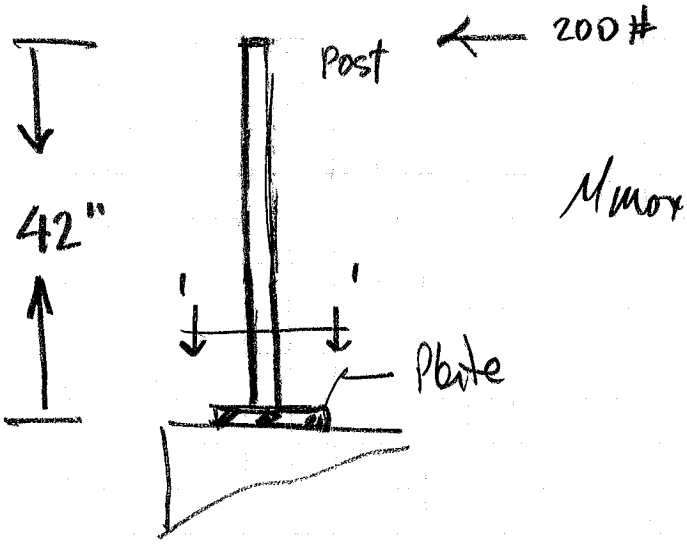
PROJ. NAME: _____

PROJ No.: _____ DATE: _____

DESIGNED BY: _____ PAGE: _____

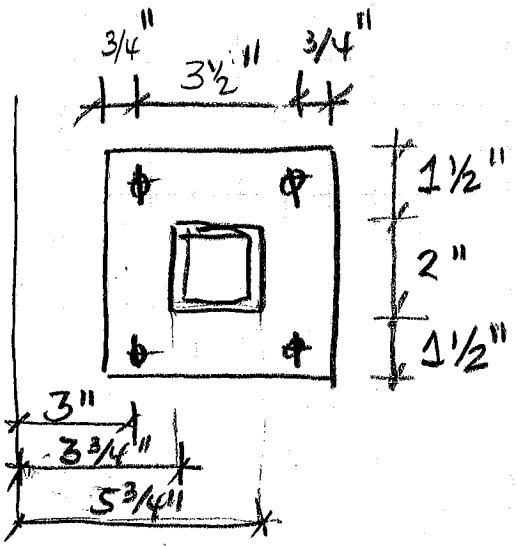
REVIEWED BY: R.L. OR G.P.

Post Connection

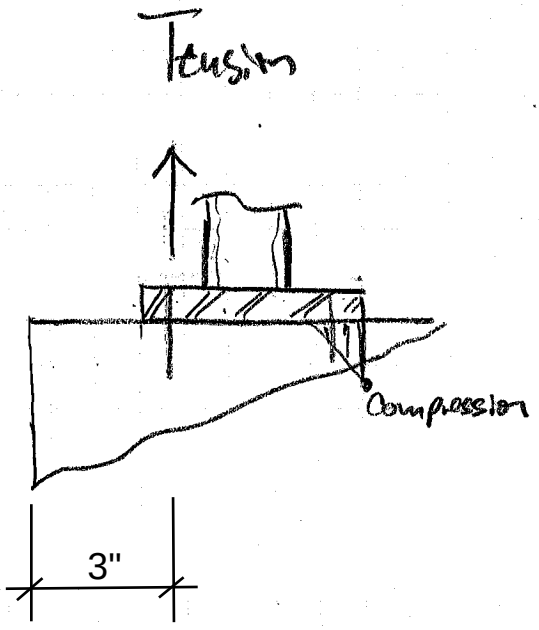


$M_{max} = 200\# \times 42 = 8400\ \#\text{-in.}$

Transv. Section



Section 1-1



Connection Force Resultant from Statics Analysis

Connection to concrete

Data Input:

$n := 2.00$ Number of Anchor Bolts in Tension due to Bending Only

$d := 4.25$ Distance from Tension Force to Outermost Compression Fiber (in)

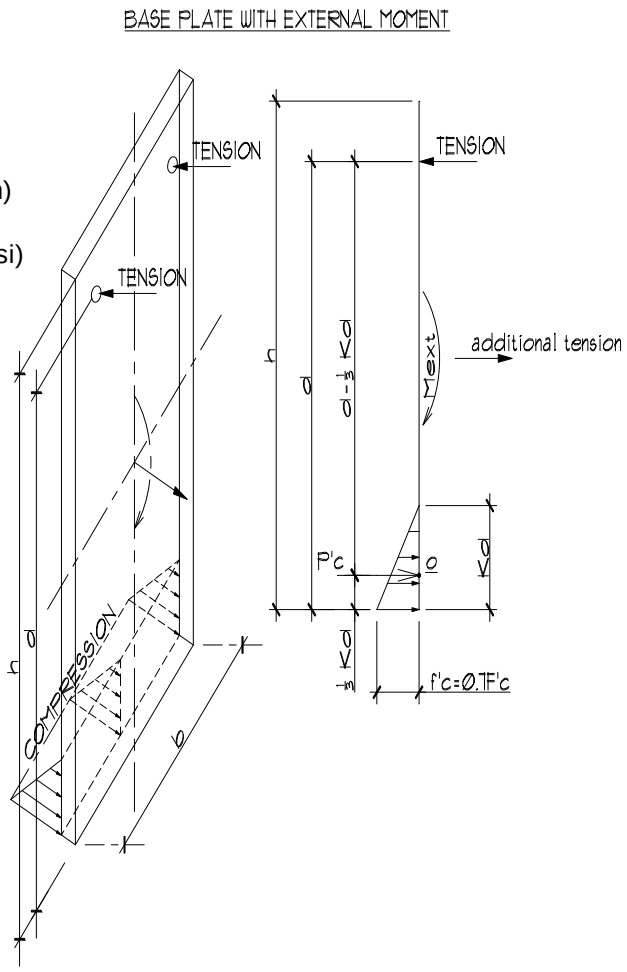
$h := 5.00$ High plate (in)

$b := 5.00$ Width of Compression Area (Post Section) (in)

$f'_c := 3000.00$ Maximum Concrete Compressive Strength (psi)

$M_{ext} := 8400.00$ External Cantilever End Moment (lbs-in)

$P_{ext} := 0.00$ Additional Tension (lbs-in)



Analysis:

Compression Force:

$$C_{force} = \left(\frac{1}{2}\right)\cdot 0.7\cdot f'_c\cdot kd\cdot b$$

Sum of Moments about Compression Force:

$$\left[0 = C_{force}\cdot\left[d - \left(\frac{1}{3}\right)\cdot kd\right] - M_{ext} + P_{ext}\cdot\left(d - \frac{h}{2}\right)\right]$$

Calculation of kd:

$x := 1$ (Required Iteration Initial Guess)

Given

$$-\frac{1}{6}\cdot 0.7\cdot f'_c\cdot x^2\cdot b + \left(\frac{1}{2}\right)\cdot(x)\cdot 0.7\cdot f'_c\cdot b\cdot d - M_{ext} + P_{ext}\cdot\left(d - \frac{h}{2}\right) = 0$$

$kd := Find(x)$

Height of Compression Prism: $kd = 0.3883$ in

Tension in Bolts:

$$T_{bolt} := if\left[kd > 0, \frac{\left(\frac{1}{2}\right)\cdot 0.7\cdot f'_c\cdot kd\cdot b}{n} + \frac{P_{ext}}{2\cdot n}, \frac{M_{ext}}{n(2.d - h)} + \frac{P_{ext}}{2\cdot n}\right]$$

Tension per Bolt: $T_{bolt} = 1019.3$ lbs

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

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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

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PROJ. NAME: _____
PROJ No.: _____ DATE: _____
DESIGNED BY: _____ PAGE: _____
REVIEWED BY: R.L. OR G.P.

3/8" 4 → 5/8
5 → 3/8 = 3.5
4×4

Using 3/8" Screw Bolt +

with 3.25" Embedment Allowable
T = 2035 #
S = 1735 #

with 4½" Emb. Allowable.
T = 2985 #
S = 1735 #

Tension factors

w/ 3" Edge Distance. E.D. = 3" | factor for 3¼ Emb = 0.77
for 4½ Emb = 0.67

w/ 3½ Spacing @ = 3½" | factor for 3¼ Emb = 0.77
for 4½ Emb = 0.70

Allowable Tension for
3¼ Embedment = 1050 #
4½ Embedment = 1400 #

Shear factors

E.D. = 3" | factor for 3¼ = 0.61
" 4½ = 0.64

@ = 3½ | factor for 3¼ = 0.62
" 4½ = 0.63

Allowable Shear for
3¼ Emb = 656 #
4½ Emb = 699 #

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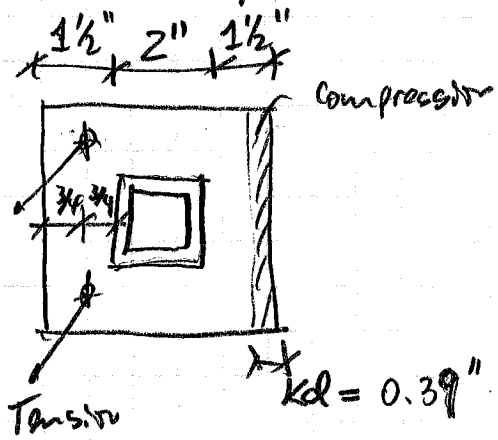
Actual Tension = 1019 # ≤ 1400 # (OK)

Actual Shear = 200/4 = 50 # ≤ 699 # (OK)

Combine $\frac{1019}{1400} + \frac{50}{699} = 0.8 \leq 1.00$ K

Max Compresion = 2040 #



$M_{plate\ due\ to\ Tens.}$ = 2040 * 0.75"
= 1530 #-in

$M_{plate\ due\ to\ comp.}$ = 2040 * (1.5" − 0.39/3)
= 2795 #-in

Using 5/8" Plate (Fb = 9000 psi) Alloy 6061 T6

$M_{allowable} = \frac{0.625^2 * 5"}{6} * 9000 = 2929$ #-in

Mallowable ≥ Mmax actual = 2795 (OK)

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INTERIOR RAILING AT STAIR

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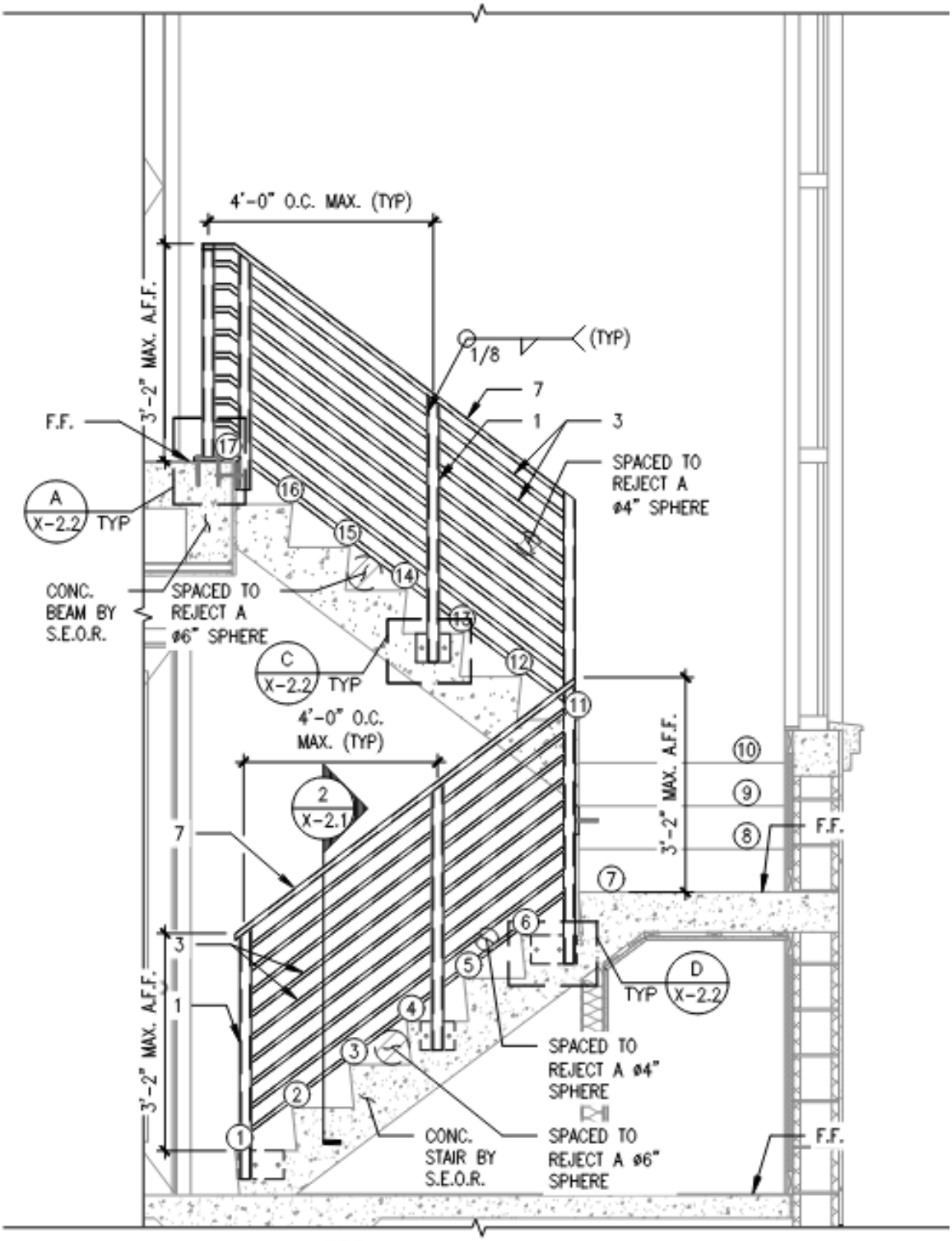

1 X-2.1 RAILING AT STAIR SECTION (TYP)

SCALE: 1/2"=1'-0"

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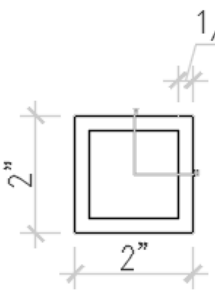
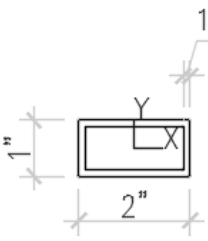
SECTION PROPERTIES



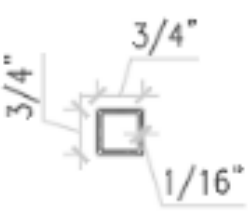
POST 2X2X1/4"
ALLOY 6061-T6

Area = 1.7500 in^2
Ixx = 0.9115 in^4
Iyy = 0.9115 in^4
Jz = 1.8229 in^4
Pxy = −0.0000 in^4
rxx = 0.7217 in
ryy = 0.7217 in
Sxx max = 0.9115 in^3
Sxx min = 0.9115 in^3
Syy max = 0.9115 in^3
Syy min = 0.9115 in^3



TOP & BOTTOM 1X2X1/8"
ALLOY 6061-T6

Area = 0.6875 in^2
Ixx = 0.1051 in^4
Iyy = 0.3317 in^4
Jz = 0.4368 in^4
Pxy = 0.0000 in^4
rxx = 0.3911 in
ryy = 0.6946 in
Sxx max = 0.2103 in^3
Sxx min = 0.2103 in^3
Syy max = 0.3317 in^3
Syy min = 0.3317 in^3



PICKETS $\frac{3}{4}$"x$\frac{3}{4}$"x$\frac{1}{16}$"
(ALLOY 6063-T5)

Area = 0.1718 in^2
Ixx = 0.0137 in^4
Iyy = 0.0137 in^4
Jz = 0.0273 in^4
Pxy = −0.0000 in^4
rxx = 0.2818 in
ryy = 0.2818 in
Sxx max = 0.0364 in^3
Sxx min = 0.0364 in^3
Syy max = 0.0364 in^3
Syy min = 0.0364 in^3

Picket Horizontal Railing Design (Top, Bottom, Post)

Allowable Stresses for **Aluminum**				
	6063-T6 (psi)	6063-T5 (psi)	6061-T6 (psi)	6005-T5 (psi)
Fb	15000	9500	19000	19000
(Tubes & Shapes)	4800	4800	9000	8000
Fb	18000	11500	24000	24000
(Round & Oval)	5500	5500	10500	9000
Fv	8500	5500	12000	12000
Tubes, Shapes & Round	2800	2800	5000	4500
E	10100 ksi	10100 ksi	10100 ksi	10100 ksi

White bars apply to nonwelded members and to welded members at loc. fathers than 1.0 in from a weld
Shadded bars apply to within 1.0 in of a weld

Allowable Stress for Aluminum Welding:
Aluminum Filler Alloy 5356 Fv=7000 psi

Allowable Stress for Steel
Strong and Weak Axis Allowables Stress for Tube **Steel** Shape:
Fb=23760 psi, Fv=14400 psi for Fy=36 ksi E=29000 Ksi
Fb=33000 psi, Fv=20000 psi for Fy=50 ksi E=29000 Ks

Allowable Stress for Steel Welding:
Welding: E-70XX Fv=21000 psi

Allowable Stress for Stainless Steel
Strong and Weak Axis Allowables Stress for Tube Steel Shape:
Fb=16216 psi, Fv=9189 psi for (SS 304) Fy=30 ksi E=28000 Ksi
Fb=34730 psi, Fv=20838 psi for (S32304 Duplex SS) Fy=58 ksi E=28000 Ksi
Fb=62870 psi, Fv=37720 psi for (S17400-H1150) Fy=105 ksi E=28000 Ksi

Allowable Stress for Steel Welding:
Welding: E318 or E309 Fv=19200 psi

Allowable Stress for Wood
Strong and Weak Axis Allowables Stress for Lumber No.2 Non Dense (2"-4" thick):
Fb=1350 psi, Fv=175 psi for 2"-4" Wide E=1400 Ksi
Fb=1150 psi, Fv=175 psi for 5"-6" Wide E=1400 Ksi

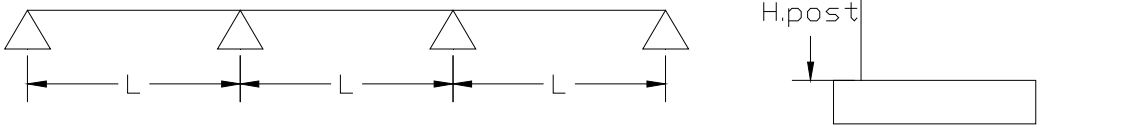
DESIGN INFORMATION:

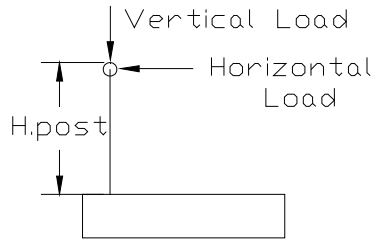
Florida Building Code 2023
AISC Manual of Steel Construction 2017 ANSI/AISC 360-16, ANSI/AWC NDS—2018 NDS for Wood Construction, ASCE 7-22, AISC Design Guide 27 -Structural Stainless Steel, Aluminum Design Manual 2020

DESIGN LOADS:

Handrail Design Loads: Concentrated Load = 200 lbs. applied at any point in any direction.
Uniform Load = 50 plf applied in any direction (other than dwelling units).
Guardrail System Loads: Concentrated Load = 200 lbs. applied at any point in any direction at the top of the guardrail.
Concentrated horizontal load of 50 lbs applied on a 1 sq ft. area at any point in the system (FBC 1607.9.1.2 and Section 4.5.1.2 of ASCE 7).

Handrail Design:





General Data:

$L := 48.00$ Railing Span (in)

$H_{post} := 38.00$ Post Height (in)

$d_{picket} := 4.00$ Distance center/center of Picket (in)

General Loads:

$q_{wind} := 0.00$ Wind Pressure (psf)

$P_{200} := 200.00$ Single Concentrated Load (lbs) .....Railing P=200.00, Fence P=0.00

$q_{50} := 50.00$ Uniform Distributed Load (plf).....Railing q=50.00, Fence q=0.00

$P_{50} := 50.00$ Single Concentrated Load (lbs) .....Railing P=50.00, Fence P=0.00

Top Railing Data:

$Fb_{TR} := 19000.00$ psi

$Fv_{TR} := 5000.00$ psi

$Sx_{TR} := 0.2103$ Vertical Loads in^3

$A_{TR} := 0.6875$ in^2

$Sy_{TR} := 0.331$ Horizontal Loads in^3

Post Data:

$Fb_{PT} := 9000.00$ psi

$Fv_{PT} := 5000.00$ psi

$Sx_{PT} := 0.9115$ in^3

$A_{PT} := 1.75$ in^2

Picket Data:

$Fb_{PK} := 9000.00$ psi

$Fv_{PK} := 2800.00$ psi

$Sx_{PK} := 0.0364$ in^3

$A_{PK} := 0.1718$ in^2

Top Railing Design:

Actual Moment:

Concentrated Load = 200 lbs.

$$M_{TR.200} := \frac{P_{200} \cdot L}{5}$$

$M_{TR.200} = 1920.00$ in − lb

Uniform Load = 50 plf

$$M_{TR.50} := 0.1012 \cdot \left(\frac{q_{50}}{12}\right) \cdot L^2$$

$M_{TR.50} = 971.52$ in − lb

For Wind Pressure

$$M_{TR.wind} := 0.1012 \cdot \left(\frac{q_{wind}}{144}\right) \cdot \frac{d_{picket}}{2} \cdot L^2$$

$M_{TR.wind} = 0$ in − lb

$$M_{TR} := \max\left(M_{TR.200}, M_{TR.50}, M_{TR.wind}\right)$$

$M_{TR} = 1920.00$ in − lb

Actual Shear:

Concentrated Load = 200 lbs.

$$V_{TR.200} := P_{200} \text{ lbs}$$

$V_{TR.200} = 200.00$ lbs

Uniform Load = 50 plf

$$V_{TR.50} := 0.6 \cdot \left(\frac{q_{50}}{12}\right) \cdot L$$

$V_{TR.50} = 120.00$ lbs

For Wind Pressure

$$V_{TR.wind} := 0.6 \cdot \left(\frac{q_{wind}}{144}\right) \cdot \frac{d_{picket}}{2} \cdot L$$

$V_{TR.wind} = 0.00$ lbs

$$V_{TR} := \max\left(V_{TR.200}, V_{TR.50}, V_{TR.wind}\right)$$

$V_{TR} = 200.00$ lbs

Section Required:

Bending Design: Section Modulus Required

$$S_{TR.min} := \frac{M_{TR}}{Fb_{TR}}$$

$S_{TR.min} = 0.1$ in^3

Shear Design: Area Required

$$A_{TR.min} := \frac{1.5 \cdot V_{TR}}{Fv_{TR}}$$

$A_{TR.min} = 0.06$ in^2

Section Provided:

$$BENDING_{top} := \text{if}\left(S_{TR.min} \geq \min\left(Sx_{TR}, Sy_{TR}\right), \text{"N.G"}, \text{"OK"}\right)$$

$BENDING_{top} = \text{"OK"}$

$$SHEAR_{top} := \text{if}\left(A_{TR.min} \geq A_{TR}, \text{"N.G"}, \text{"OK"}\right)$$

$SHEAR_{top} = \text{"OK"}$

Post Design:

Actual Reaction:

Concentrated Load = 200 lbs.

$$R_{PT.200} := P_{200}$$ $R_{PT.200} = 200.00$ lbs

Uniform Load = 50 plf

$$R_{PT.50} := \left(\frac{q_{50}}{12}\right)\cdot L$$ $R_{PT.50} = 200.00$ lbs

For Wind Pressure

$$R_{PT.wind} := \left[\left(\frac{q_{wind}}{144}\right)\right]\cdot H_{post}\cdot L$$ $R_{PT.wind} = 0.00$ lbs

$$R_{PT} := \max\left(R_{PT.200}, R_{PT.50}, R_{PT.wind}\right)$$ $R_{PT} = 200.00$ lbs

Actual Moment:

$$M_{PT} := \max\left(\max\left(R_{PT.200}, R_{PT.50}\right)\cdot H_{post}, R_{PT.wind}\cdot\frac{H_{post}}{2}\right)$$ $M_{PT} = 7600.00$ in - lb

Actual Shear:

$$V_{PT} := R_{PT}$$ $V_{PT} = 200.00$ lbs.

Section Required:

Bending Design: Section Modulus Required:

$$S_{PT.min} := \frac{M_{PT}}{Fb_{PT}}$$ $S_{PT.min} = 0.84$ in^3

Shear Design: Area Required:

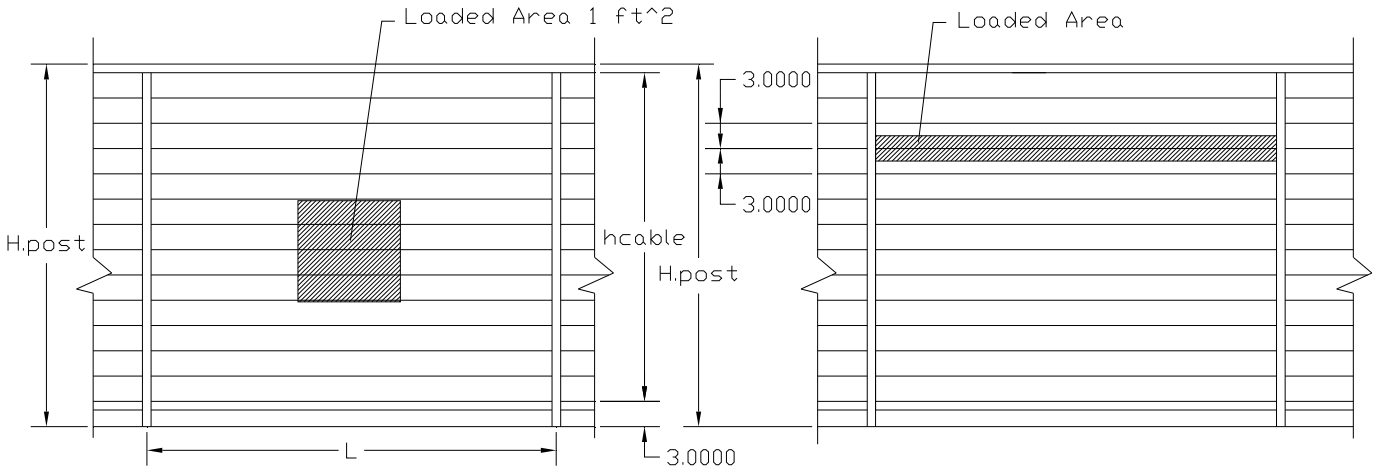
$$A_{PT.min} := \frac{1.5\cdot V_{PT}}{Fv_{PT}}$$ $A_{PT.min} = 0.06$ in^2

Section Provided:

$$BENDING_{post} := \text{if}\left(S_{PT.min} \geq Sx_{PT}, \text{"N.G"}, \text{"OK"}\right)$$ $BENDING_{post} = \text{"OK"}$

$$SHEAR_{post} := \text{if}\left(A_{PT.min} \geq A_{PT}, \text{"N.G"}, \text{"OK"}\right)$$ $SHEAR_{post} = \text{"OK"}$

Picket Design:



Assume three pickets acting simultaneously

$$\omega_{picket} := \frac{P_{50}}{12} \cdot \frac{1}{3}$$

$\omega_{picket} = 1.39$ $\frac{lbs}{in}$

$$q_{picket} := \max(10, q_{wind})$$

$q_{picket} = 10.00$ psf

$$M_{PK} := \max\left(6 \cdot \omega_{picket} \cdot \frac{L}{2} - \omega_{picket} \cdot 18, \frac{q_{picket} \cdot d_{picket} \cdot L^2}{144 \cdot 8}\right)$$

$M_{PK} = 175.00$ in-lb

$$V_{PK} := \max\left[12 \cdot \omega_{picket} \cdot \frac{(L - 6)}{L}, \frac{q_{picket} \cdot d_{picket} \cdot L}{144 \cdot 2}\right]$$

$V_{PK} = 14.58$ lb

Section Required:

Bending Design: Section Modulus Required:

$$S_{PK.min} := \frac{M_{PK}}{Fb_{PK}}$$

$S_{PK.min} = 0.019$ in^3

Shear Design: Area Required:

$$A_{PK.min} := \frac{1.5 \cdot V_{PK}}{Fv_{PK}}$$

$A_{PK.min} = 0.008$ in^2

Section Provided:

$$BENDING_{picket} := if(S_{PK.min} \geq Sx_{PK}, "N.G", "OK")$$

$BENDING_{picket} = "OK"$

$$SHEAR_{picket} := if(A_{PK.min} \geq A_{PK}, "N.G", "OK")$$

$SHEAR_{picket} = "OK"$

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SIDE CONNECTION DESIGN

LOADS:

Mpost= 8400#-in (CONSERVATIVE)
Vpost= 200#

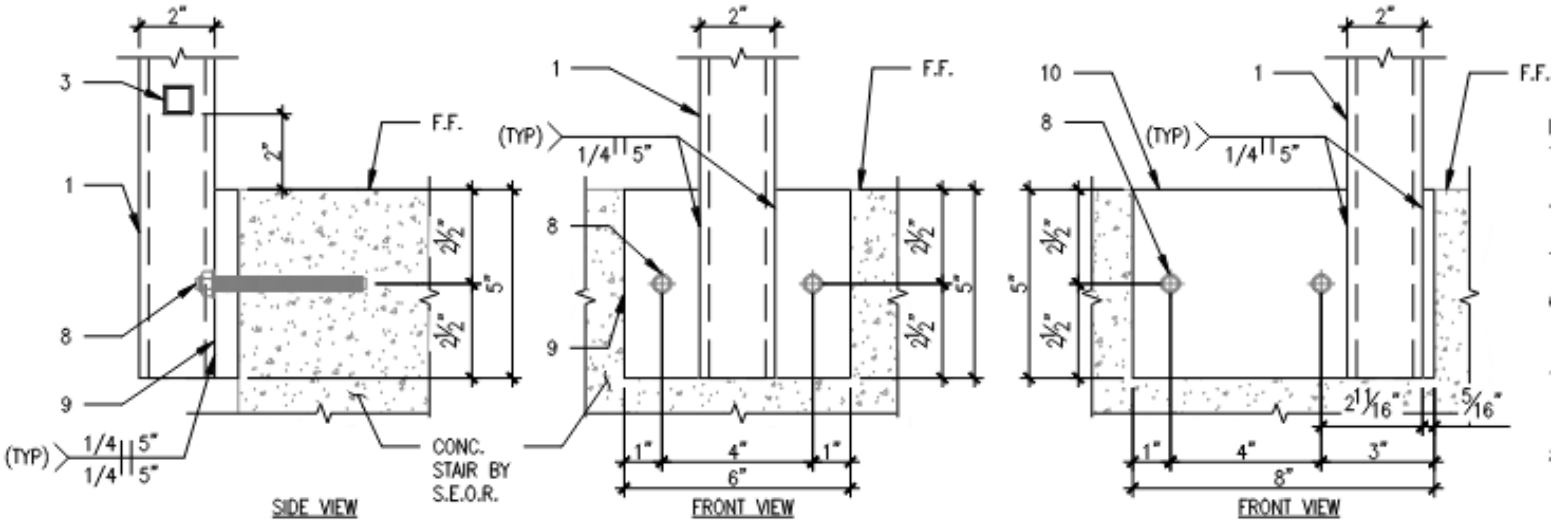
LOADS PROCESSING:

Tper anchor= 1508.4# (see spreadsheet printout)

Sper anchor= 200#/2anchor= 100#

*USING ø 3/8" S.S.THREADED ROD W/ C6+ EPOXY BY RED HEAD ASTM A307, W/ 3-3/8 MIN. EMBEDMENT, 2.5" MIN. EDGE DISTANCE AND 4" SPACING.

- For bolts calculations, see spreadsheet printout



SKETCH

Connection Force Resultant from Statics Analysis

Connection to concrete

Data Input:

$n := 2.00$ Number of Anchor Bolts in Tension due to Bending Only

$d := 3.00$ Distance from Tension Force to Outermost Compression Fiber (in)

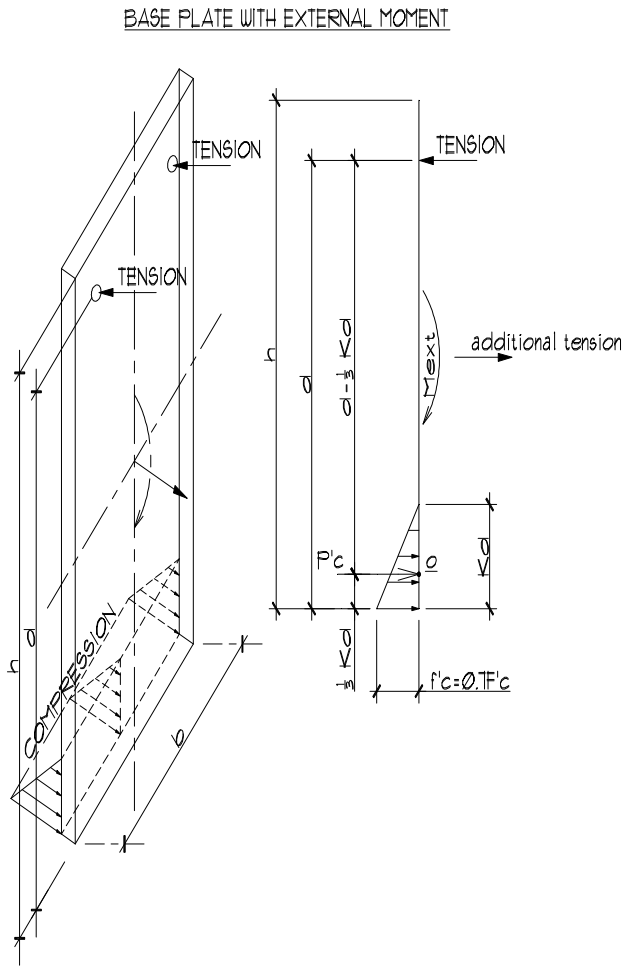
$h := 5.00$ High plate (in)

$b := 6.00$ Width of Compression Area (Post Section) (in)

$f'_c := 3000.00$ Maximum Concrete Compressive Strength (psi)

$M_{ext} := 8400.00$ External Cantilever End Moment (lbs-in)

$P_{ext} := 200.00$ Additional Tension (lbs-in)



Analysis:

Compression Force:

$$C_{force} = \left(\frac{1}{2}\right)\cdot 0.7\cdot f'_c\cdot kd\cdot b$$

Sum of Moments about Compression Force:

$$\left[0 = C_{force}\cdot\left[d - \left(\frac{1}{3}\right)\cdot kd\right] - M_{ext} + P_{ext}\cdot\left(d - \frac{h}{2}\right)\right]$$

Calculation of kd:

$x := 1$ (Required Iteration Initial Guess)

Given

$$-\frac{1}{6}\cdot 0.7\cdot f'_c\cdot x^2\cdot b + \left(\frac{1}{2}\right)\cdot(x)\cdot 0.7\cdot f'_c\cdot b\cdot d - M_{ext} + P_{ext}\cdot\left(d - \frac{h}{2}\right) = 0$$

$kd := Find(x)$

Height of Compression Prism: $kd = 0.463$ in

Tension in Bolts:

$$T_{bolt} := if\left[kd > 0, \frac{\left(\frac{1}{2}\right)\cdot 0.7\cdot f'_c\cdot kd\cdot b}{n} + \frac{P_{ext}}{2\cdot n}, \frac{M_{ext}}{n(2.d - h)} + \frac{P_{ext}}{2\cdot n}\right]$$

Tension per Bolt: $T_{bolt} = 1508.4$ lbs

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Concrete		3000
Diameter		Ø 3/8
Embed		3 3/8
Steel Strength		ASTM A307
Spacing=		4.00
Edge Dist.=		2.50
Double Edge Dist		Yes
by Design	Tbolt =	1508.40
	Vbolt =	100.00
by Manuf.	T =	2080.00
	V =	1040.00

Threaded Rod and Rebar Installation in Solid Concrete Edge / Spacing Distance Load Factor Summary[1,2]

LOAD FACTOR		DISTANCE FROM EDGE OF CONCRETE
Critical Edge Distance—Tension		
100% Tension Load	→	0.75 x Anchor Embedment
Minimum Edge Distance—Tension		
70% Tension Load	→	0.25 x Anchor Embedment
Critical Edge Distance—Shear		
100% Shear Load	→	1.25 x Anchor Embedment
Minimum Edge Distance—Shear		
10% Shear Load	→	0.25 x Anchor Embedment

LOAD FACTOR		DISTANCE FROM ANOTHER ANCHOR
Critical Spacing—Tension		
100% Tension Load	→	1.25 x Anchor Embedment
Minimum Spacing—Tension		
80% Tension Load	→	0.25 x Anchor Embedment
Critical Spacing—Shear		
100% Shear Load	→	1.25 x Anchor Embedment
Minimum Spacing—Shear		
25% Shear Load	→	0.25 x Anchor Embedment

Find interpolated value of 'B' for the given value of 'A' from table of data below:

Tension

	Edge Dist.	2 1/2
0.75 x Embed	2.53125	1
	2.5	**0.99**
0.25 x Embed	0.84375	0.7

Tension

	Spacing=	4
1.25 x Embed	4.21875	1
	4	**0.98**
0.25 x Embed	0.84375	0.75

Shear

	Edge Dist.	2 1/2
1.25 x Embed	4.21875	1
	2.5	**0.29**
0.25 x Embed	0.84375	0.1

Shear

	Spacing=	4
1.25 x Embed	4.21875	1
	4	**0.95**
0.25 x Embed	0.84375	0.3

Tallow & Vallow	Tallow=	2023.00	>	Tbolt	**O.K.**
	Vallow=	291.00	>	Vbolt	**O.K.**

Combine	$= (\frac{T_{bolt}}{T_{allow}})^{\frac{5}{3}} + (\frac{V_{bolt}}{V_{allow}})^{\frac{5}{3}} =$	0.78	<	1.00	**O.K.**

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Threaded Rod Allowable Tension Loads Installed in Solid Concrete

THREADED ROD DIA. (In.)	MIN. EMBEDMENT DEPTH (In.)	ALLOWABLE TENSION LOAD BASED ON CONCRETE STRENGTH			ALLOWABLE TENSION LOAD BASED ON STEEL STRENGTH		
		3000	5000	7000	ASTM A307	ASTM A193GR	ASTM F593
Ø 3/8	1 1/2	790.0	945.0	1100.0	**2080.0**	4340.0	3995.0
	3 3/8	**2910.0**	3080.0	3245.0	**2080.0**	4340.0	3995.0
Ø 1/2	2	1520.0	1755.0	1990.0	3730.0	7780.0	7155.0
	4 1/2	5000.0	5825.0	6650.0	3730.0	7780.0	7155.0
Ø 5/8	2 1/2	2145.0	2500.0	2855.0	5870.0	12230.0	11250.0
	5 5/8	6225.0	7255.0	8280.0	5870.0	12230.0	11250.0
Ø 3/4	3	3010.0	3395.0	3775.0	8490.0	17690.0	14860.0
	6 3/4	9160.0	10675.0	12185.0	8490.0	17690.0	14860.0
Ø 7/8	3 1/2	3750.0	4335.0	4915.0	11600.0	25510.0	20835.0
	7 7/8	13895.0	17585.0	21275.0	11600.0	25510.0	20835.0
Ø 1	4	4435.0	5100.0	5760.0	15180.0	31620.0	26560.0
	9	15565.0	18465.0	21365.0	15180.0	31620.0	26560.0
Ø 1 1/4	5	8675.0	9235.0	9795.0	23800.0	49580.0	34670.0
	11 1/4	19455.0	22665.0	25875.0	23800.0	49580.0	34670.0

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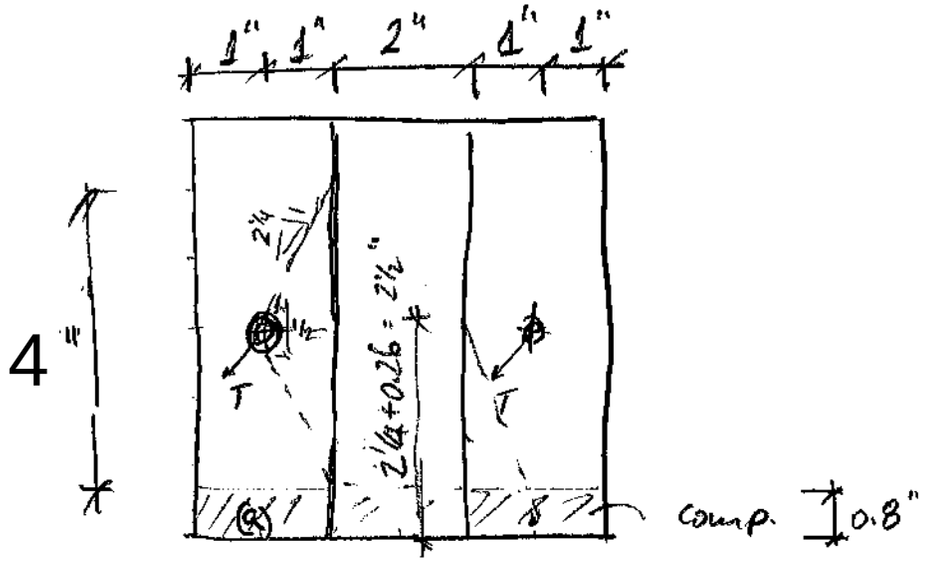
Threaded Rod Allowable Shear Loads Installed in Solid Concrete

THREADED ROD DIA. (In.)	MIN. EMBEDMENT DEPTH (In.)	ALLOWABLE TENSION LOAD BASED ON CONCRETE STRENGTH	ALLOWABLE TENSION LOAD BASED ON STEEL STRENGTH		
		3000	ASTM A307	ASTM A193GR	ASTM F593
Ø 3/8	1 1/2	N/A	**1040.0**	2170.0	1995.0
	3 3/8	**1300**	**1040.0**	2170.0	1995.0
Ø 1/2	2	N/A	1870.0	3895.0	3585.0
	4 1/2	2855	1870.0	3895.0	3585.0
Ø 5/8	2 1/2	N/A	2940.0	6125.0	5635.0
	5 5/8	4575	2940.0	6125.0	5635.0
Ø 3/4	3	N/A	4250.0	8855.0	7440.0
	6 3/4	6430	4250.0	8855.0	7440.0
Ø 7/8	3 1/2	N/A	5800.0	12760.0	10730.0
	7 7/8	8030	5800.0	12760.0	10730.0
Ø 1	4	N/A	7590.0	15810.0	13285.0
	9	9630	7590.0	15810.0	13285.0
Ø 1 1/4	5	N/A	11900.0	24790.0	18840.0
	11 1/4	16270	11900.0	24790.0	18840.0

Plate Design



- Plate Moment due to Tension = 1508.4 # x 1" = 1508.4 #-in.

b = 4" assuming thk = 5/8"

$S_x = 5/8^2 \times 4 / 6 = 0.26$ in³

$f_b = 1508.4 / 0.26 = 5792.26$ Psi ≤ 9000 psi (OK)

- Plate Moment due to compression = $\left(\frac{1508.4 \text{ (a)} \times 2}{3}\right) * 1" = 1005.6$ #-in. (b = 2½")

$S_x = 5/8^2 \times \frac{2.5}{6} = 0.163$ in³.

$f_b = 1005.6$ #-in / 0.163 in³

= 6169.33 psi ≤ 9000 psi (OK)

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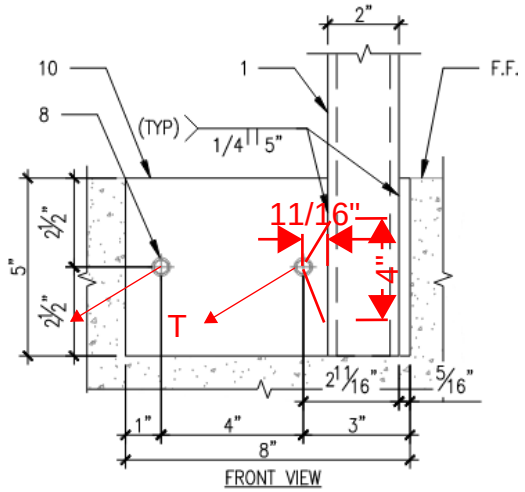
SIDE EXCENTRIC CONNECTION DESIGN



LOADS:

Mpost= 8 400#-in (CONSERVATIVE)
Vpost= 200#

LOADS PROCESSING:

Sper anchor= 200#/2anchor= 100#

Tper anchor= M/0.9*d = 8 400#-in/0.9*5 = 1867#

*USING ø 1/2" S.S.THREADED ROD W/ A7+ EPOXY BY RED HEAD ASTM A307, W/ 4-1/2 MIN. EMBEDMENT, 2" MIN. EDGE DISTANCE AND 4" SPACING.

- For bolts calculations, see spreadsheet printout

CHECK PLATE:

LOADS:

T=1867#LRFD

LOADS PROCESSING:

Mdue tension= TxEcc=1867#x0.688"=1283.56#-in
Mallow=(1.5xSxxFy)/Ω = 1.5(4"x0.625in^2/6)x15000psi/1.65=3551.14#-in

Mdue tension< Mallow OK

Using plate 5x8x5/8" Aluminum Plate

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Concrete		3000
Diameter		Ø 3/8
Embed		3 3/8
Steel Strength		ASTM A307
Spacing=		4.00
Edge Dist.=		2.50
Double Edge Dist		No
by Design	Tbolt =	1867.00
	Vbolt =	100.00
by Manuf.	T =	2080.00
	V =	1040.00

Threaded Rod and Rebar Installation in Solid Concrete Edge / Spacing Distance Load Factor Summary[1,2]

LOAD FACTOR		DISTANCE FROM EDGE OF CONCRETE
Critical Edge Distance—Tension		
100% Tension Load	→	0.75 x Anchor Embedment
Minimum Edge Distance—Tension		
70% Tension Load	→	0.25 x Anchor Embedment
Critical Edge Distance—Shear		
100% Shear Load	→	1.25 x Anchor Embedment
Minimum Edge Distance—Shear		
10% Shear Load	→	0.25 x Anchor Embedment

LOAD FACTOR		DISTANCE FROM ANOTHER ANCHOR
Critical Spacing—Tension		
100% Tension Load	→	1.25 x Anchor Embedment
Minimum Spacing—Tension		
80% Tension Load	→	0.25 x Anchor Embedment
Critical Spacing—Shear		
100% Shear Load	→	1.25 x Anchor Embedment
Minimum Spacing—Shear		
25% Shear Load	→	0.25 x Anchor Embedment

Find interpolated value of 'B' for the given value of 'A' from table of data below:

Tension

	Edge Dist.	2 1/2
0.75 x Embed	2.53125	1
	2.5	**0.99**
0.25 x Embed	0.84375	0.7

Tension

	Spacing=	4
1.25 x Embed	4.21875	1
	4	**0.98**
0.25 x Embed	0.84375	0.75

Shear

	Edge Dist.	2 1/2
1.25 x Embed	4.21875	1
	2.5	**0.54**
0.25 x Embed	0.84375	0.1

Shear

	Spacing=	4
1.25 x Embed	4.21875	1
	4	**0.95**
0.25 x Embed	0.84375	0.3

Tallow & Vallow	Tallow=	2034.00	>	Tbolt	**O.K.**
	Vallow=	537.00	>	Vbolt	**O.K.**

Combine	$= (\frac{T_{bolt}}{T_{allow}})^{\frac{5}{3}} + (\frac{V_{bolt}}{V_{allow}})^{\frac{5}{3}} =$	0.93	<	1.00	**O.K.**

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Threaded Rod Allowable Tension Loads Installed in Solid Concrete

THREADED ROD DIA. (In.)	MIN. EMBEDMENT DEPTH (In.)	ALLOWABLE TENSION LOAD BASED ON CONCRETE STRENGTH			ALLOWABLE TENSION LOAD BASED ON STEEL STRENGTH		
		3000	5000	7000	ASTM A307	ASTM A193GR	ASTM F593
Ø 3/8	1 1/2	790.0	945.0	1100.0	**2080.0**	4340.0	3995.0
	3 3/8	**2910.0**	3080.0	3245.0	**2080.0**	4340.0	3995.0
Ø 1/2	2	1520.0	1755.0	1990.0	3730.0	7780.0	7155.0
	4 1/2	5000.0	5825.0	6650.0	3730.0	7780.0	7155.0
Ø 5/8	2 1/2	2145.0	2500.0	2855.0	5870.0	12230.0	11250.0
	5 5/8	6225.0	7255.0	8280.0	5870.0	12230.0	11250.0
Ø 3/4	3	3010.0	3395.0	3775.0	8490.0	17690.0	14860.0
	6 3/4	9160.0	10675.0	12185.0	8490.0	17690.0	14860.0
Ø 7/8	3 1/2	3750.0	4335.0	4915.0	11600.0	25510.0	20835.0
	7 7/8	13895.0	17585.0	21275.0	11600.0	25510.0	20835.0
Ø 1	4	4435.0	5100.0	5760.0	15180.0	31620.0	26560.0
	9	15565.0	18465.0	21365.0	15180.0	31620.0	26560.0
Ø 1 1/4	5	8675.0	9235.0	9795.0	23800.0	49580.0	34670.0
	11 1/4	19455.0	22665.0	25875.0	23800.0	49580.0	34670.0

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Threaded Rod Allowable Shear Loads Installed in Solid Concrete

THREADED ROD DIA. (In.)	MIN. EMBEDMENT DEPTH (In.)	ALLOWABLE TENSION LOAD BASED ON CONCRETE STRENGTH	ALLOWABLE TENSION LOAD BASED ON STEEL STRENGTH		
		3000	ASTM A307	ASTM A193GR	ASTM F593
Ø 3/8	1 1/2	N/A	**1040.0**	2170.0	1995.0
	3 3/8	**1300**	**1040.0**	2170.0	1995.0
Ø 1/2	2	N/A	1870.0	3895.0	3585.0
	4 1/2	2855	1870.0	3895.0	3585.0
Ø 5/8	2 1/2	N/A	2940.0	6125.0	5635.0
	5 5/8	4575	2940.0	6125.0	5635.0
Ø 3/4	3	N/A	4250.0	8855.0	7440.0
	6 3/4	6430	4250.0	8855.0	7440.0
Ø 7/8	3 1/2	N/A	5800.0	12760.0	10730.0
	7 7/8	8030	5800.0	12760.0	10730.0
Ø 1	4	N/A	7590.0	15810.0	13285.0
	9	9630	7590.0	15810.0	13285.0
Ø 1 1/4	5	N/A	11900.0	24790.0	18840.0
	11 1/4	16270	11900.0	24790.0	18840.0

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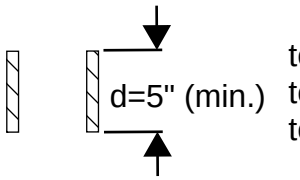
SIDE CONNECTION DESIGN

CHECK WELDING



te = 0.707*w
te = 0.707*(1/4")
te = 0.17675

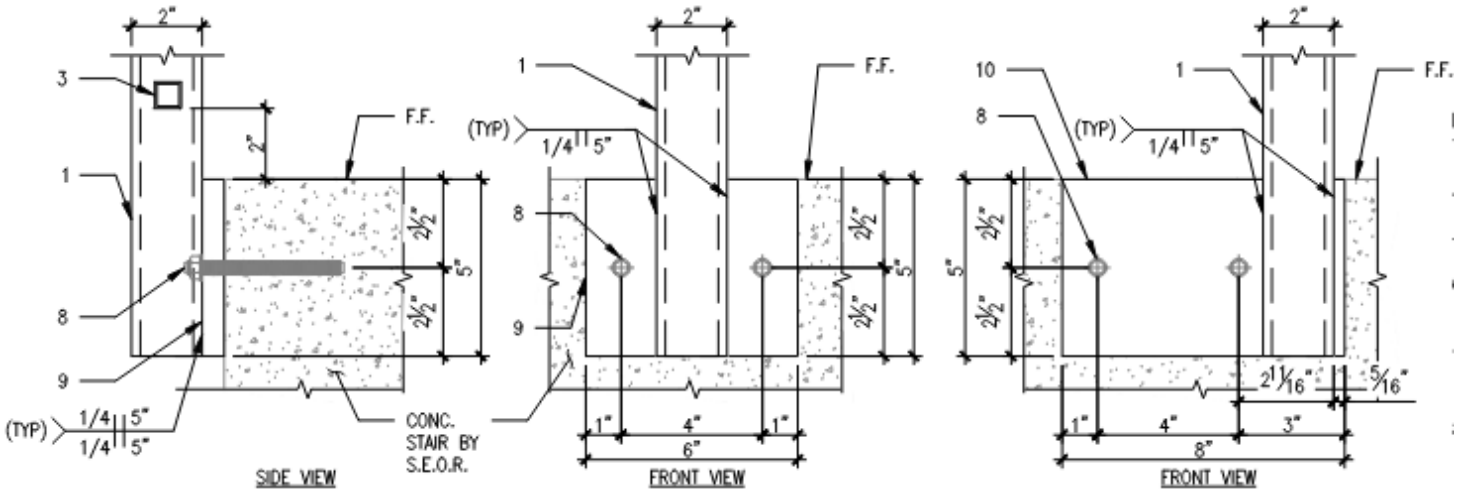
Using 1/4" fillet weld

$Sw = (d^2/3) * te$
$Sw = (5^2/3) * 0.17675$
$Sw = 1.4729\ in^3$

M = 200# * 48in
M = 9600 #-in (conservative)

Fv = 7000psi < fv = M/Sw

$fv = 9600\ \#\text{-in} / 1.4729\ in^3 = 6517.75psi < 7000psi$ (OK)



SKETCH