STRUCTURAL CALCULATIONS

FOR

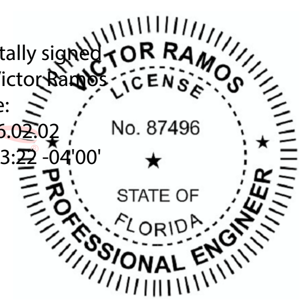
ALUMINUM CABLE RAILING
SHOP DRAWINGS

9601SW 67th AVENUE-PINECREST,
FL 33156

To the best of my knowledge and professional judgement all calculations contained herein have bee
reviewed, and conform to the recommendation of ASCE/SEI 7-22, ACI 318-19, AISC 360-16, and
the 2023 Florida Building Code, 8th Edition

Victor Ramos

Digitally signed by Victor Ramos
Date: 2026.02.02 10:03:22 -04'00'



BRC CONSULTANTS

7211 W 24 AVE, HIALEAH , FL 33016

Project Name: ALUMINUM CABLE RAILING

Project No.: ______ Sheet No.: ______

Calculated By: ______ Date: ______

Checked By: ______ Date: ______

INDEX

Horizontal Cable Railing Design
(Top, Bottom, Anchor Post, Intermediate Post)

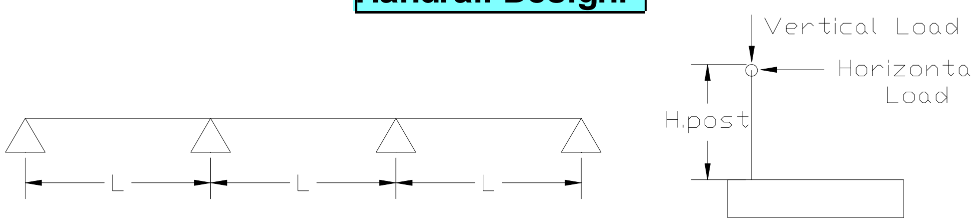
H=28 in

DESIGN INFORMATION:

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 (other than dwelling units include a load of 100 lbs applied vertically downward at the top of guardrail).
Concentrated horizontal load of 200 lbs applied on a 1 sq ft. area at any point in the system.

Handrail Design:



ALUMINUM POST ALLOWABLE STRESSES

2"x2"x1/4"

$B := 2$ in

$t := 0.25 = 0.250$ in

$b := B - 2t = 1.50$

$\frac{b}{t} = 6.00$ $\lambda_1 := 6.7$ $\lambda_2 := 10.5$ $\frac{b}{t} < \lambda_1$

SO

$\boxed{Fb_{PT.I} := 21200 = 21200.00}$ psi $\boxed{Fv_{PT.I} := 12700}$ psi

ALUMINUM TOP RAIL ALLOWABLE STRESSES

2"x1.5"x1/8"

$B := 1.5$ in

$t := 0.125 = 0.125$ in

$b := B - 2t = 1.25$

$\frac{b}{t} = 10.00$ $\lambda_1 := 20.8$ $\lambda_2 := 33$ $\frac{b}{t} < \lambda_1$

SO

$\boxed{Fb_{TR} := 21200 = 21200.00}$ psi $\boxed{Fv_{TR} := 12700}$ psi

General Data:

$L := 38.5$ Railing Span (in)

$H_{post} := 28$ Post Heigh (in)

General Loads:

$q_{wind} := 10.00$ 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

Top Railing Data:

2x1.5x1/8

$Fb_{TR} = 21200.00$ psi

$Fv_{TR} = 12700.00$ psi

$Sx_{TR} := 0.37$ For Vertical Loads $\left(in^3\right)$

$Sy_{TR} := 0.442$ For Horizontal Loads $\left(in^3\right)$

$A_{TR} := 0.813$ in^2

Cable Data:

$Fy_{cable} := 50000.00$ psi

$\phi_{cable} := 0.1875$ in

$E_{cable} := 16345000.00$ psi

Post Anchor Data:

2X2X1/4

$Fb_{PT} := 21200$ psi

$Fv_{PT} := 12700$ psi

$Sx_{PT} := 0.911$ For Railings Loads $\left(in^3\right)$

$Sy_{PT} := 0.911$ For Cable Loads $\left(in^3\right)$

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

Post Intermediate Data:

2X2X1/4

$Fb_{PT.I} = 21200.00$ psi

$Fv_{PT.I} = 12700.00$ psi

$Sx_{PT.I} := 0.911$ For Railings Loads $\left(in^3\right)$

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

Cable Design:

$L_{cable} := 38.5$ Maximum Cable Intermediate Post Span (in)

$s_{cable} := 3$ Cable spacing O.C.(in)

$L_T := 154$ Length of cable between anchor points (in)

$F_{ps} := 220$ Applied prestressing Force (lbs)

For Sphere Pass-Through Resistance with
w=50 psf through 2 cables & Vertical Maximum Deflection Plus Impact Factor=2

$$A_{cable} := \pi \cdot \frac{\phi_{cable}^{\ 2}}{4}$$ $\boxed{A_{cable} = 0.03}$ in^2

$$I_{cable} := 0.70\left(\pi \cdot \frac{\phi_{cable}^{\ 4}}{64}\right)$$ $\boxed{I_{cable} = 0.0000}$ in^4

$$\Delta_V := \left| \begin{array}{l} x \leftarrow 0.01 \\ \text{while } \dfrac{4 \cdot x \cdot E_{cable} \cdot A_{cable}}{L_{cable}} \cdot \dfrac{\sqrt{4 \cdot x^2 + L_{cable}^{\ 2}} - L_{cable}}{\sqrt{4 \cdot x^2 + L_{cable}^{\ 2}} + L_T - L_{cable}} + \dfrac{48 \cdot E_{cable} \cdot I_{cable} \cdot x}{L_{cable}^{\ 3}} + \dfrac{4 \cdot F_{ps} \cdot x}{L_{cable}} \le \dfrac{2 \cdot \left(50 \cdot \dfrac{\pi \cdot 4^2}{4 \cdot 144}\right)}{2 \cdot \cos\left(\operatorname{asin}\left(\dfrac{s_{cable} + 2 \cdot x}{4 + \phi_{cable}}\right)\right)} \\ \quad x \leftarrow x + 0.001 \end{array} \right.$$

$\boxed{\Delta_V = 0.40}$ in

$$P_{ef} := \frac{2\left(50 \cdot \dfrac{\pi \cdot 4^2}{4 \cdot 144}\right)}{2\cos\left(\operatorname{asin}\left(\dfrac{s_{cable} + 2 \cdot \Delta_V}{4 + \phi_{cable}}\right)\right)}$$ $\boxed{P_{ef} = 10.39}$ lbs

$$T_{cable} := \frac{P_{ef}}{2 \cdot \Delta_V} \cdot \sqrt{\Delta_V^{\ 2} + \frac{L_{cable}^{\ 2}}{4}}$$ $\boxed{T_{cable} = 249.96}$ lbs

Cable Section Required:

$$\phi_{cable.req} := \sqrt{4 \cdot \frac{\dfrac{T_{cable}}{0.9 \cdot Fy_{cable}}}{\pi}}$$ $\boxed{\phi_{cable.req} = 0.08}$ in

Section Provided:

$TENSION_{cable} := if(\phi_{cable} \ge \phi_{cable.req}, "O.K.", "N.G.")$ $\boxed{TENSION_{cable} = "O.K."}$

Top Railing Vertical Design:

Maximum Moment for Vertical Loads:

Concentrated Load = 200 lbs

$$M_{TR.200.V} := \frac{P_{200} \cdot L}{5}$$ $\boxed{M_{TR.200.V} = 1540.00}$ in − lb

Uniform Load = 50 plf

$M_{TR.50.V} := 0.1012 \cdot \left(\frac{q_{50}}{12} \right) \cdot L^2$ $\boxed{M_{TR.50.V} = 625.02}$ in – lb

$M_{TR.V} := \max(M_{TR.50.V}, M_{TR.200.V})$ $\boxed{M_{TR.V} = 1540.00}$ in – lb

Maximum Shear for Vertical Loads:

Concentrated Load = 200 lbs.

$V_{TR.200} := P_{200}$ $\boxed{V_{TR.200} = 200.00}$ lbs

Uniform Load = 50 plf.

$V_{TR.50} := 0.6 \cdot \left(\frac{q_{50}}{12} \cdot L \right)$ $\boxed{V_{TR.50} = 96.25}$ lbs

$V_{TR.V} := \max(V_{TR.200}, V_{TR.50})$ $\boxed{V_{TR.V} = 200.00}$ lbs

Maximum Axial for Cable Loads:

$P_{TR.V} := \frac{T_{cable} \cdot \mathrm{floor}\left(\frac{H_{post}}{s_{cable}} \right)}{2}$ $\boxed{P_{TR.V} = 1124.81}$ lbs.

***See Attached Axial and Bending Combined Calculations for Top Railing Vertical Loads

Top Railing Horizontal Design:

Maximum Moment for Horizontal Loads:

Concentrated Load = 200 lbs

$M_{TR.200.H} := \frac{P_{200} \cdot L}{5}$ $\boxed{M_{TR.200.H} = 1540.00}$ in – lb

Uniform Load = 50 plf

$M_{TR.50.H} := 0.1012 \cdot \left(\frac{q_{50}}{12} \right) \cdot L^2$ $\boxed{M_{TR.50.H} = 625.02}$ in – lb

For Wind Pressure

$M_{TR.wind} := 0.1012 \cdot \left(\frac{q_{wind}}{144} \right) \cdot \left(\frac{H_{post}}{2} \cdot L^2 \right)$ $\boxed{M_{TR.wind} = 145.84}$ in – lb

$M_{TR.H} := \max(M_{TR.200.H}, M_{TR.50.H}, M_{TR.wind})$ $\boxed{M_{TR.H} = 1540.00}$ in – lb

Maximum Shear for Horizontal Loads:

Concentrated Load = 200 lbs.

$V_{TR.200.H} := P_{200}$ $\boxed{V_{TR.200.H} = 200.00}$ lbs

Uniform Load = 50 plf

$V_{TR.50.H} := 0.6 \cdot \left(\frac{q_{50}}{12}\right) \cdot L$ $\boxed{V_{TR.50.H} = 96.25}$ lbs

For Wind Pressure

$V_{TR.wind} := 0.6 \cdot \left(\frac{q_{wind}}{144}\right) \cdot \left(\frac{H_{post}}{2}\right) \cdot L$ $\boxed{V_{TR.wind} = 22.46}$ lbs

$V_{TR.H} := \max\left(V_{TR.200.H}, V_{TR.50.H}, V_{TR.wind}\right)$ $\boxed{V_{TR.H} = 200.00}$ lbs

Maximum Axial for Cable Loads:

$P_{TR.H} := \frac{T_{cable} \cdot \mathrm{floor}\left(\frac{H_{post}}{s_{cable}}\right)}{2}$ $\boxed{P_{TR.H} = 1124.81}$ lbs.

***See Attached Axial and Bending Combined Calculations for Top Railing Horizontal Loads

Post Intermediate Design:

Maximum Reactions:

Concentrated Load = 200 lbs.

$R_{PTI.200} := P_{200}$ $\boxed{R_{PTI.200} = 200.00}$ lbs

Uniform Load = 50 plf

$R_{PTI.50} := 1.0 \cdot \left(\frac{q_{50}}{12}\right) \cdot L$ $\boxed{R_{PTI.50} = 160.42}$ lbs

For Wind Pressure

$R_{PTI.wind} := 1.0 \cdot \left(\frac{q_{wind}}{144}\right) \cdot H_{post} \cdot L$ $\boxed{R_{PTI.wind} = 74.86}$ lbs

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

Maximum Moment:

$M_{PTI} := R_{PTI} \cdot H_{post}$ $\boxed{M_{PTI} = 5600.00}$ in - lb

Maximum Shear:

$V_{PTI} := R_{PTI}$ | $V_{PTI} = 200.00$ lbs.

Section Required:

Bending Design: Section Modulus Required:

$$S_{PTI.xx} := \frac{M_{PTI}}{Fb_{PT.I}}$$ $S_{PTI.xx} = 0.26$ in^3

Shear Design: Area Required:

$$A_{PTI.xx} := \frac{1.5 \cdot V_{PTI}}{Fv_{PT.I}}$$ $A_{PTI.xx} = 0.02$ in^2

Post Intermediate Section Provided:

$BENDING_{PT.I} := if\left(S_{PTI.xx} \geq Sx_{PT.I}, "N.G", "OK"\right)$ | $BENDING_{PT.I} = "OK"$

$SHEAR_{PT.I} := if\left(A_{PTI.xx} \geq A_{PT.I}, "N.G", "OK"\right)$ | $SHEAR_{PT.I} = "OK"$

Post Anchor Along X-X Axis Design:

Maximum Reactions:

Concentrated Load = 200 lbs.

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

Uniform Load = 50 plf

$$R_{PT.50} := 1.0 \cdot \left(\frac{q_{50}}{12}\right) \cdot L$$ $R_{PT.50} = 160.42$ lbs

For Wind Pressure

$$R_{PT.wind} := 1.0 \cdot \left(\frac{q_{wind}}{144}\right) \cdot H_{post} \cdot L$$ $R_{PT.wind} = 74.86$ lbs

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

Maximum Moment:

$M_{PT.xx} := R_{PT.xx} \cdot H_{post}$ | $M_{PT.xx} = 5600.00$ in - lb

Maximum Shear:

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

Section Required:

Bending Design: Section Modulus Required:

$$S_{PT.xx} := \frac{M_{PT.xx}}{Fb_{PT}} \qquad S_{PT.xx} = 0.26 \text{ in}^3$$

Shear Design: Area Required:

$$A_{PT.xx} := \frac{1.5 \cdot V_{PT.xx}}{Fv_{PT}} \qquad A_{PT.xx} = 0.02 \text{ in}^2$$

Post Anchor Section Provided:

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

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

Post Anchor Along Y-Y Axis Design (Cable Tension):

Maximum Moment:

$$M_{PT.yy} := \frac{T_{cable} \cdot \mathrm{floor}\left(\frac{H_{post}}{s_{cable}}\right) \cdot H_{post}}{8} \qquad M_{PT.yy} = 7873.65 \quad \mathrm{in - lb}$$

Maximum Shear:

$$Vpost_{max.yy} := \frac{T_{cable} \cdot \mathrm{floor}\left(\frac{H_{post}}{s_{cable}}\right)}{2} \qquad Vpost_{max.yy} = 1124.81 \text{ lbs.}$$

Section Required:

Bending Design: Section Modulus Required:

$$S_{PT.yy} := \frac{M_{PT.yy}}{Fb_{PT}} \qquad S_{PT.yy} = 0.37 \text{ in}^3$$

Shear Design (Area Required)

$$A_{PT.yy} := \frac{1.5 \cdot Vpost_{max.yy}}{Fv_{PT}} \qquad A_{PT.yy} = 0.13 \text{ in}^2$$

Post Anchor Section Provided:

$$BENDING_{PT.yy} := \mathrm{if}\left(S_{PT.yy} \geq Sy_{PT}, \text{"N.G"}, \text{"OK"}\right) \qquad BENDING_{PT.yy} = \text{"OK"}$$

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

Post Anchor Combined Stress (Bending at Hpost/2)

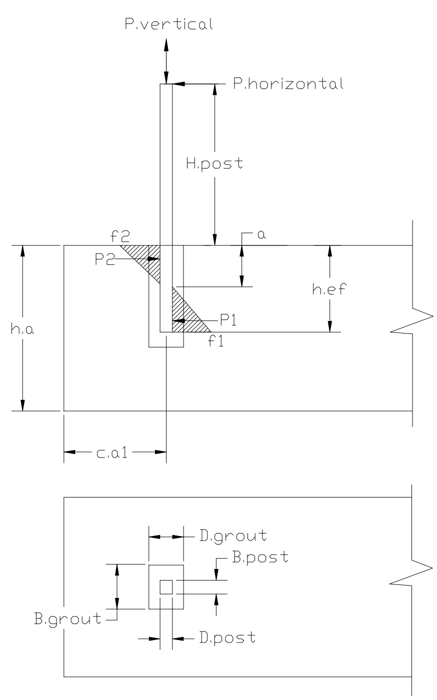
$$fb_{PT.xx.0.5H} := \frac{M_{PT.xx}}{2Sx_{PT}}$$ $fb_{PT.xx.0.5H} = 3073.55$ psi

$$fb_{PT.yy} := \frac{M_{PT.yy}}{Sy_{PT}}$$ $fb_{PT.yy} = 8642.86$ psi

$$IE_{PT} := \frac{fb_{PT.xx.0.5H}}{Fb_{PT}} + \frac{fb_{PT.yy}}{Fb_{PT}}$$ $IE_{PT} = 0.55$

$$COMBINED_{PT} := \left| \begin{array}{l} \text{"N.G."} \\ \text{"OK"} \quad \text{if } 1 \geq IE_{PT} \end{array} \right.$$ $COMBINED_{PT} = \text{"OK"}$

Post Anchorage to Concrete:



Post Data:

$B_{post} := 2$ Post Width (in)

$D_{post} := 2$ Post Depth (in)

$h_{ef} := 4.5$ Post Embedment (in)

$C_{a1} := 6$ Minimum Edge Distance (in)

Grout Size Data:

$B_{grout} := 4$ Equivalent Grout Width (in)

$D_{grout} := 4$ Equivalent Grout Depth (in)

$f'c_{grout} := 10000.00$ Grout Strength (psi)

Concrete Slab Data:

$f'c_{concrete} := 4000$ Concrete Strength (psi)

$d_o := 4$ Hold diameter (Grout Diameter) (in)

$h_a := 12$ Concrete Slab Deep (in)

Equivalent Maximum Horizontal Load at Top Railing Height (Pd)

$Pd := R_{PT.xx}$ $Pd = 200.00$ lbs

Arm Effect:

$$a := \frac{2 \cdot h_{ef}^{2} + 3 \cdot H_{post} \cdot h_{ef}}{3 \cdot h_{ef} + 6.H_{post}}$$ $a = 2.31$ in

$$P_2 := \frac{Pd \cdot a^2}{h_{ef} \cdot (2 \cdot a - h_{ef})}$$ $P_2 = 2117.91$ lbs

$P_1 := P_2 - Pd$ $P_1 = 1917.91$ lbs

$M_{external} := Pd \cdot (H_{post} + a)$ $M_{external} = 6061.16$ lbs − in

$$M_{internal} := P_2 \cdot \frac{2}{3} \cdot a + P_1 \cdot \frac{2}{3} \cdot (h_{ef} - a)$$ $M_{internal} = 6061.16$ lbs − in

$Vu := 1.6 \cdot (\max(P_1, P_2))$ $Vu = 3388.65$ lbs

Stress Analysis Between Post and Grout:

$$f_{2.grout} := 1.6 \cdot \frac{2 \cdot P_2}{a \cdot B_{post}}$$ $\boxed{f_{2.grout} = 1469.63}$ psi

$$f_{1.grout} := 1.6 \cdot \frac{2.P_1}{(h_{ef} - a) \cdot B_{post}}$$ $\boxed{f_{1.grout} = 1398.52}$ psi

Bearing Stress for Grout :

$$Fp_{grout} := \left[0.65 \cdot (0.85 f'c_{grout})\right] \cdot 1.5$$ $\boxed{Fp_{grout} = 8287.50}$ psi

$$Stress_{grout} := \left| \begin{array}{l} \text{"N.G."} \\ \text{"O.K."} \quad \text{if } \max(f_{1.grout}, f_{2.grout}) \le Fp_{grout} \end{array} \right.$$

$\boxed{Stress_{grout} = \text{"O.K."}}$

Stress Analysis Between Grout and Concrete:

$$f_{2.concrete} := 1.6 \cdot \frac{2 \cdot P_2}{a \cdot B_{grout}}$$ $\boxed{f_{2.concrete} = 734.81}$ psi

$$f_{1.concrete} := 1.6 \cdot \frac{2.P_1}{(h_{ef} - a) \cdot B_{grout}}$$ $\boxed{f_{1.concrete} = 699.26}$ psi

Bearing Stress for Concrete :

$$Fp_{concrete} := \left[0.65 \cdot (0.85 \cdot f'c_{concrete})\right] \cdot 1.5$$ $\boxed{Fp_{concrete} = 3315.00}$ psi

$$Stress_{concrete} := \left| \begin{array}{l} \text{"N.G."} \\ \text{"O.K."} \quad \text{if } \max(f_{1.concrete}, f_{2.concrete}) \le Fp_{concrete} \end{array} \right.$$

$\boxed{Stress_{concrete} = \text{"O.K."}}$

Shear Analysis-Concrete Breakout Strength:

$$A_{Vco} := 4.5 \cdot C_{a1}^{\ 2}$$ $\boxed{A_{Vco} = 162}$ in2

$$A_{Vc} := \left| \begin{array}{l} 2 \cdot (1.5 \cdot C_{a1}) \cdot h_a \quad \text{if } h_a < 1.5 \cdot C_{a1} \\ 2 \cdot (1.5 \cdot C_{a1}) \cdot (1.5 \cdot C_{a1}) \quad \text{if } h_a \ge 1.5 \cdot C_{a1} \end{array} \right.$$ $\boxed{A_{Vc} = 162.00}$ in2

$\psi_{ed.V} := 1.00$ Modification factor for edge effect

$\psi_{c.V} := 1$ Modification Factor in No cracked concrete at service loads
ψc.v=1.4
Modification Factor in cracked concrete with
ψc.v=1 w/ No supplementary reinforcement.
ψc.v=1.2 w/ Supplementary reinforcement of a No 4 Bar between the anchor and the edge.
ψc.v=1.4 w/ Supplementary reinforcement of No 4 Bar and stirrups spaced at not more than 4 in

$l_e := \text{if}\left(h_{ef} > 8 \cdot d_o, 8 \cdot d_o, h_{ef}\right)$ $l_e = 4.50$ in

$$V_b := 7 \cdot \left[\left(\frac{l_e}{d_o}\right)^{0.2} \sqrt{d_o} \cdot \sqrt{f'c_{concrete}} \cdot C_{a1}^{\;1.5}\right]$$ $V_b = 13323.41$ lbs.

$$V_{cb} := \frac{A_{Vc}}{A_{Vco}} \cdot \psi_{ed.V} \cdot \psi_{c.V} \cdot V_b$$ $V_{cb} = 13323.41$ lbs.

$\phi := 0.7$ Conditions
ϕ=0.75 w/ Supplementary reinforcement are crossing concrete failure prism.
ϕ=0.70 w/ No supplementary reinforcement are crossing concrete failure prism.

$\phi \cdot V_{cb} = 9326.39$ lbs

$BREAKOUT_{shear} := \text{if}\left(Vu > \phi \cdot V_{cb}, \text{"N.G."}, \text{"OK"}\right)$ $BREAKOUT_{shear} = \text{"OK"}$

Shear Analysis-Concrete Burst-Out Strength:

$$C_{a1c} := \begin{vmatrix} C_{a1} \\ \text{"N/A"} \quad \text{if } h_a < C_{a1} \end{vmatrix}$$ $C_{a1c} = 6.00$ in

Total Cone Area for Failure Plane

$$A_{cone.total} := \sqrt{2} \cdot C_{a1c} \cdot \pi \cdot \left(C_{a1c} - \frac{D_{grout}}{2} + \frac{B_{grout}}{2}\right)$$ $A_{cone.total} = 159.94$ in^2

Cone Area for Failure Plane at Post

$$A_{cone.post} := \sqrt{2} \cdot \left(\frac{B_{grout}}{2}\right)^2 \cdot \pi$$ $A_{cone.post} = 17.77$ in^2

Final Cone Area for Failure Plane

$$A_{cone.final} := \frac{A_{cone.total} - A_{cone.post}}{2}$$

$A_{cone.final} = 71.09$ in^2

Final Area for Failure Plane

$$V_{cone.cb} := 4 \cdot \sqrt{f'c_{concrete}} \cdot A_{cone.final}$$

$V_{cone.cb} = 17983.53$ lbs

$\phi_{B.O} := 0.75$

Conditions
ϕ=0.75 for Any Condition

$\phi_{B.O} \cdot V_{cone.cb} = 13487.64$ lbs

$$BURSTOUT_{shear} := if\left(Vu > \phi_{B.O} \cdot V_{cone.cb}, \text{"N.G."}, \text{"OK"}\right)$$

$BURSTOUT_{shear} = \text{"OK"}$

Horizontal Cable Railing Design
(Top, Bottom, Anchor Post, Intermediate Post)

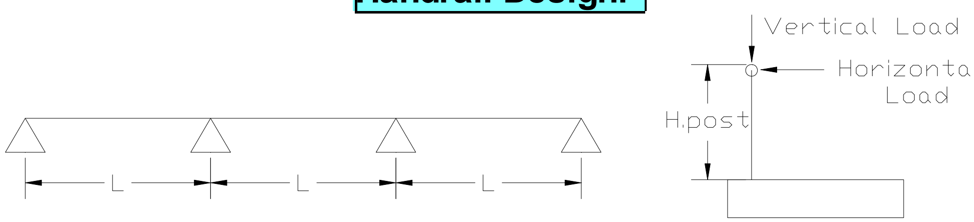
H=26 in

DESIGN INFORMATION:

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 (other than dwelling units include a load of 100 lbs applied vertically downward at the top of guardrail).
Concentrated horizontal load of 200 lbs applied on a 1 sq ft. area at any point in the system.

Handrail Design:



ALUMINUM POST ALLOWABLE STRESSES

2"x2"x1/4"

$B := 2$ in

$t := 0.25 = 0.250$ in

$b := B - 2t = 1.50$

$\frac{b}{t} = 6.00$ $\quad \lambda_1 := 6.7$ $\quad \lambda_2 := 10.5$ $\quad \frac{b}{t} < \lambda_1$

SO

$\boxed{Fb_{PT.I} := 21200 = 21200.00}$ psi $\quad \boxed{Fv_{PT.I} := 12700}$ psi

ALUMINUM TOP RAIL ALLOWABLE STRESSES

2"x1.5"x1/8"

$B := 1.5$ in

$t := 0.125 = 0.125$ in

$b := B - 2t = 1.25$

$\frac{b}{t} = 10.00$ $\quad \lambda_1 := 20.8$ $\quad \lambda_2 := 33$ $\quad \frac{b}{t} < \lambda_1$

SO

$\boxed{Fb_{TR} := 21200 = 21200.00}$ psi $\quad \boxed{Fv_{TR} := 12700}$ psi

General Data:

$L := 47$ Railing Span (in)

$H_{post} := 26$ Post Heigh (in)

General Loads:

$q_{wind} := 10.00$ 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

Top Railing Data:

2x1.5x1/8

$Fb_{TR} = 21200.00$ psi

$Fv_{TR} = 12700.00$ psi

$Sx_{TR} := 0.37$ For Vertical Loads $\left(in^3\right)$

$Sy_{TR} := 0.442$ For Horizontal Loads $\left(in^3\right)$

$A_{TR} := 0.813$ in^2

Cable Data:

$Fy_{cable} := 50000.00$ psi

$\phi_{cable} := 0.1875$ in

$E_{cable} := 16345000.00$ psi

Post Anchor Data:

2X2X1/4

$Fb_{PT} := 21200$ psi

$Fv_{PT} := 12700$ psi

$Sx_{PT} := 0.911$ For Railings Loads $\left(in^3\right)$

$Sy_{PT} := 0.911$ For Cable Loads $\left(in^3\right)$

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

Post Intermediate Data:

2X2X1/4

$Fb_{PT.I} = 21200.00$ psi

$Fv_{PT.I} = 12700.00$ psi

$Sx_{PT.I} := 0.911$ For Railings Loads $\left(in^3\right)$

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

Cable Design:

$L_{cable} := 47$ Maximum Cable Intermediate Post Span (in)

$s_{cable} := 3$ Cable spacing O.C.(in)

$L_T := 140$ Length of cable between anchor points (in)

$F_{ps} := 280$ Applied prestressing Force (lbs)

For Sphere Pass-Through Resistance with
w=50 psf through 2 cables & Vertical Maximum Deflection Plus Impact Factor=2

$$A_{cable} := \pi\cdot\frac{\phi_{cable}^{\,2}}{4}$$ $\boxed{A_{cable} = 0.03}$ in^2

$$I_{cable} := 0.70\left(\pi\cdot\frac{\phi_{cable}^{\,4}}{64}\right)$$ $\boxed{I_{cable} = 0.0000}$ in^4

$$\Delta_V := \left|\begin{array}{l} x \leftarrow 0.01 \\ \text{while } \dfrac{4\cdot x\cdot E_{cable}\cdot A_{cable}}{L_{cable}}\cdot\dfrac{\sqrt{4\cdot x^2 + L_{cable}^{\,2}} - L_{cable}}{\sqrt{4\cdot x^2 + L_{cable}^{\,2}} + L_T - L_{cable}} + \dfrac{48\cdot E_{cable}\cdot I_{cable}\cdot x}{L_{cable}^{\,3}} + \dfrac{4\cdot F_{ps}\cdot x}{L_{cable}} \le \dfrac{2\cdot\left(50\cdot\dfrac{\pi\cdot 4^2}{4\cdot 144}\right)}{2\cdot\cos\left(\operatorname{asin}\left(\dfrac{s_{cable} + 2\cdot x}{4 + \phi_{cable}}\right)\right)} \\ \quad x \leftarrow x + 0.001 \end{array}\right.$$

$\boxed{\Delta_V = 0.40}$ in

$$P_{ef} := \frac{2\left(50\cdot\dfrac{\pi\cdot 4^2}{4\cdot 144}\right)}{2\cos\left(\operatorname{asin}\left(\dfrac{s_{cable} + 2\cdot\Delta_V}{4 + \phi_{cable}}\right)\right)}$$ $\boxed{P_{ef} = 10.29}$ lbs

$$T_{cable} := \frac{P_{ef}}{2\cdot\Delta_V}\cdot\sqrt{\Delta_V^{\,2} + \frac{L_{cable}^{\,2}}{4}}$$ $\boxed{T_{cable} = 305.22}$ lbs

Cable Section Required:

$$\phi_{cable.req} := \sqrt{4\cdot\frac{\dfrac{T_{cable}}{0.9\cdot Fy_{cable}}}{\pi}}$$ $\boxed{\phi_{cable.req} = 0.09}$ in

Section Provided:

$TENSION_{cable} := \text{if}\left(\phi_{cable} \ge \phi_{cable.req}, \text{"O.K."}, \text{"N.G."}\right)$ $\boxed{TENSION_{cable} = \text{"O.K."}}$

Top Railing Vertical Design:

Maximum Moment for Vertical Loads:

Concentrated Load = 200 lbs

$$M_{TR.200.V} := \frac{P_{200}\cdot L}{5}$$ $\boxed{M_{TR.200.V} = 1880.00}$ in − lb

Uniform Load = 50 plf

$$M_{TR.50.V} := 0.1012 \cdot \left(\frac{q_{50}}{12}\right) \cdot L^2$$ $\boxed{M_{TR.50.V} = 931.46}$ in − lb

$$M_{TR.V} := \max\left(M_{TR.50.V}, M_{TR.200.V}\right)$$ $\boxed{M_{TR.V} = 1880.00}$ in − lb

Maximum Shear for Vertical Loads:

Concentrated Load = 200 lbs.

$$V_{TR.200} := P_{200}$$ $\boxed{V_{TR.200} = 200.00}$ lbs

Uniform Load = 50 plf.

$$V_{TR.50} := 0.6 \cdot \left(\frac{q_{50}}{12} \cdot L\right)$$ $\boxed{V_{TR.50} = 117.50}$ lbs

$$V_{TR.V} := \max\left(V_{TR.200}, V_{TR.50}\right)$$ $\boxed{V_{TR.V} = 200.00}$ lbs

Maximum Axial for Cable Loads:

$$P_{TR.V} := \frac{T_{cable} \cdot \mathrm{floor}\left(\frac{H_{post}}{s_{cable}}\right)}{2}$$ $\boxed{P_{TR.V} = 1220.89}$ lbs.

***See Attached Axial and Bending Combined Calculations for Top Railing Vertical Loads

Top Railing Horizontal Design:

Maximum Moment for Horizontal Loads:

Concentrated Load = 200 lbs

$$M_{TR.200.H} := \frac{P_{200} \cdot L}{5}$$ $\boxed{M_{TR.200.H} = 1880.00}$ in − lb

Uniform Load = 50 plf

$$M_{TR.50.H} := 0.1012 \cdot \left(\frac{q_{50}}{12}\right) \cdot L^2$$ $\boxed{M_{TR.50.H} = 931.46}$ in − lb

For Wind Pressure

$$M_{TR.wind} := 0.1012 \cdot \left(\frac{q_{wind}}{144}\right) \cdot \left(\frac{H_{post}}{2} \cdot L^2\right)$$ $\boxed{M_{TR.wind} = 201.82}$ in − lb

$$M_{TR.H} := \max\left(M_{TR.200.H}, M_{TR.50.H}, M_{TR.wind}\right)$$ $\boxed{M_{TR.H} = 1880.00}$ in − lb

Maximum Shear for Horizontal Loads:

Concentrated Load = 200 lbs.

$V_{TR.200.H} := P_{200}$ $\boxed{V_{TR.200.H} = 200.00}$ lbs

Uniform Load = 50 plf

$V_{TR.50.H} := 0.6 \cdot \left(\frac{q_{50}}{12}\right) \cdot L$ $\boxed{V_{TR.50.H} = 117.5}$ lbs

For Wind Pressure

$V_{TR.wind} := 0.6 \cdot \left(\frac{q_{wind}}{144}\right) \cdot \left(\frac{H_{post}}{2}\right) \cdot L$ $\boxed{V_{TR.wind} = 25.46}$ lbs

$V_{TR.H} := \max\left(V_{TR.200.H}, V_{TR.50.H}, V_{TR.wind}\right)$ $\boxed{V_{TR.H} = 200.00}$ lbs

Maximum Axial for Cable Loads:

$$P_{TR.H} := \frac{T_{cable} \cdot \mathrm{floor}\left(\frac{H_{post}}{s_{cable}}\right)}{2}$$ $\boxed{P_{TR.H} = 1220.89}$ lbs.

***See Attached Axial and Bending Combined Calculations for Top Railing Horizontal Loads

Post Intermediate Design:

Maximum Reactions:

Concentrated Load = 200 lbs.

$R_{PTI.200} := P_{200}$ $\boxed{R_{PTI.200} = 200.00}$ lbs

Uniform Load = 50 plf

$R_{PTI.50} := 1.0 \cdot \left(\frac{q_{50}}{12}\right) \cdot L$ $\boxed{R_{PTI.50} = 195.83}$ lbs

For Wind Pressure

$R_{PTI.wind} := 1.0 \cdot \left(\frac{q_{wind}}{144}\right) \cdot H_{post} \cdot L$ $\boxed{R_{PTI.wind} = 84.86}$ lbs

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

Maximum Moment:

$M_{PTI} := R_{PTI} \cdot H_{post}$ $\boxed{M_{PTI} = 5200.00}$ in - lb

Maximum Shear:

$V_{PTI} := R_{PTI}$ $\boxed{V_{PTI} = 200.00}$ lbs.

Section Required:

Bending Design: Section Modulus Required:

$S_{PTI.xx} := \frac{M_{PTI}}{Fb_{PT.I}}$ $\boxed{S_{PTI.xx} = 0.25}$ in^3

Shear Design: Area Required:

$A_{PTI.xx} := \frac{1.5 \cdot V_{PTI}}{Fv_{PT.I}}$ $\boxed{A_{PTI.xx} = 0.02}$ in^2

Post Intermediate Section Provided:

$BENDING_{PT.I} := if(S_{PTI.xx} \geq Sx_{PT.I}, \text{"N.G"}, \text{"OK"})$ $\boxed{BENDING_{PT.I} = \text{"OK"}}$

$SHEAR_{PT.I} := if(A_{PTI.xx} \geq A_{PT.I}, \text{"N.G"}, \text{"OK"})$ $\boxed{SHEAR_{PT.I} = \text{"OK"}}$

Post Anchor Along X-X Axis Design:

Maximum Reactions:

Concentrated Load = 200 lbs.

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

Uniform Load = 50 plf

$R_{PT.50} := 1.0 \cdot \left(\frac{q_{50}}{12}\right) \cdot L$ $\boxed{R_{PT.50} = 195.83}$ lbs

For Wind Pressure

$R_{PT.wind} := 1.0 \cdot \left(\frac{q_{wind}}{144}\right) \cdot H_{post} \cdot L$ $\boxed{R_{PT.wind} = 84.86}$ lbs

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

Maximum Moment:

$M_{PT.xx} := R_{PT.xx} \cdot H_{post}$ $\boxed{M_{PT.xx} = 5200.00}$ in - lb

Maximum Shear:

$V_{PT.xx} := R_{PT.xx}$ $\boxed{V_{PT.xx} = 200.00}$ lbs.

Section Required:

Bending Design: Section Modulus Required:

$$S_{PT.xx} := \frac{M_{PT.xx}}{Fb_{PT}}$$ $S_{PT.xx} = 0.25$ in^3

Shear Design: Area Required:

$$A_{PT.xx} := \frac{1.5 \cdot V_{PT.xx}}{Fv_{PT}}$$ $A_{PT.xx} = 0.02$ in^2

Post Anchor Section Provided:

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

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

Post Anchor Along Y-Y Axis Design (Cable Tension):

Maximum Moment:

$$M_{PT.yy} := \frac{T_{cable} \cdot floor\left(\frac{H_{post}}{s_{cable}}\right) \cdot H_{post}}{8}$$ $M_{PT.yy} = 7935.76$ in − lb

Maximum Shear:

$$Vpost_{max.yy} := \frac{T_{cable} \cdot floor\left(\frac{H_{post}}{s_{cable}}\right)}{2}$$ $Vpost_{max.yy} = 1220.89$ lbs.

Section Required:

Bending Design: Section Modulus Required:

$$S_{PT.yy} := \frac{M_{PT.yy}}{Fb_{PT}}$$ $S_{PT.yy} = 0.37$ in^3

Shear Design (Area Required)

$$A_{PT.yy} := \frac{1.5 \cdot Vpost_{max.yy}}{Fv_{PT}}$$ $A_{PT.yy} = 0.14$ in^2

Post Anchor Section Provided:

$BENDING_{PT.yy} := if\left(S_{PT.yy} \geq Sy_{PT}, "N.G", "OK"\right)$ $BENDING_{PT.yy} = "OK"$

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

Post Anchor Combined Stress (Bending at Hpost/2)

$$fb_{PT.xx.0.5H} := \frac{M_{PT.xx}}{2Sx_{PT}}$$

$fb_{PT.xx.0.5H} = 2854.01$ psi

$$fb_{PT.yy} := \frac{M_{PT.yy}}{Sy_{PT}}$$

$fb_{PT.yy} = 8711.05$ psi

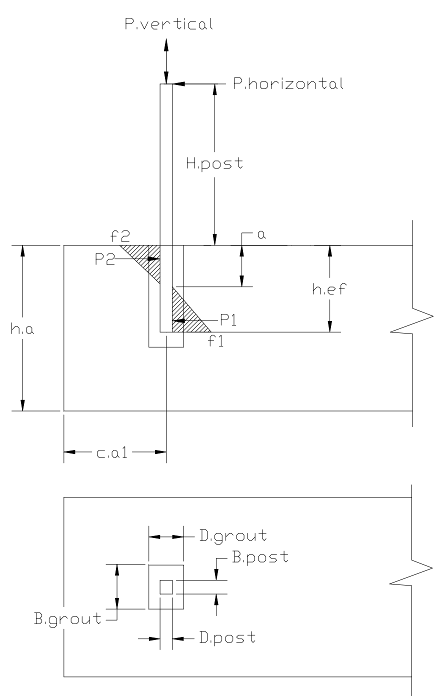
$$IE_{PT} := \frac{fb_{PT.xx.0.5H}}{Fb_{PT}} + \frac{fb_{PT.yy}}{Fb_{PT}}$$

$IE_{PT} = 0.55$

$$COMBINED_{PT} := \begin{vmatrix} \text{"N.G."} \\ \text{"OK"} \quad \text{if } 1 \geq IE_{PT} \end{vmatrix}$$

$COMBINED_{PT} = \text{"OK"}$

Post Anchorage to Concrete:



Post Data:

$B_{post} := 2$ Post Width (in)

$D_{post} := 2$ Post Depth (in)

$h_{ef} := 4.5$ Post Embedment (in)

$C_{a1} := 6$ Minimum Edge Distance (in)

Grout Size Data:

$B_{grout} := 4$ Equivalent Grout Width (in)

$D_{grout} := 4$ Equivalent Grout Depth (in)

$f'c_{grout} := 10000.00$ Grout Strength (psi)

Concrete Slab Data:

$f'c_{concrete} := 4000$ Concrete Strength (psi)

$d_o := 4$ Hold diameter (Grout Diameter) (in)

$h_a := 12$ Concrete Slab Deep (in)

Equivalent Maximum Horizontal Load at Top Railing Height (Pd)

$Pd := R_{PT.xx}$ $Pd = 200.00$ lbs

Arm Effect:

$$a := \frac{2 \cdot h_{ef}^{2} + 3 \cdot H_{post} \cdot h_{ef}}{3 \cdot h_{ef} + 6.H_{post}}$$ $a = 2.31$ in

$$P_2 := \frac{Pd \cdot a^2}{h_{ef} \cdot (2 \cdot a - h_{ef})}$$ $P_2 = 1984.66$ lbs

$P_1 := P_2 - Pd$ $P_1 = 1784.66$ lbs

$M_{external} := Pd \cdot (H_{post} + a)$ $M_{external} = 5661.95$ lbs − in

$M_{internal} := P_2 \cdot \frac{2}{3} \cdot a + P_1 \cdot \frac{2}{3} \cdot (h_{ef} - a)$ $M_{internal} = 5661.95$ lbs − in

$Vu := 1.6 \cdot (\max(P_1, P_2))$ $Vu = 3175.46$ lbs

Stress Analysis Between Post and Grout:

$$f_{2.grout} := 1.6 \cdot \frac{2 \cdot P_2}{a \cdot B_{post}}$$ $f_{2.grout} = 1374.81$ psi

$$f_{1.grout} := 1.6 \cdot \frac{2.P_1}{(h_{ef} - a) \cdot B_{post}}$$ $f_{1.grout} = 1303.70$ psi

Bearing Stress for Grout :

$$Fp_{grout} := [0.65 \cdot (0.85 f'c_{grout})] \cdot 1.5$$ $Fp_{grout} = 8287.50$ psi

$$Stress_{grout} := \begin{vmatrix} \text{"N.G."} \\ \text{"O.K."} \quad \text{if } \max(f_{1.grout}, f_{2.grout}) \le Fp_{grout} \end{vmatrix}$$

$Stress_{grout} = \text{"O.K."}$

Stress Analysis Between Grout and Concrete:

$$f_{2.concrete} := 1.6 \cdot \frac{2 \cdot P_2}{a \cdot B_{grout}}$$ $f_{2.concrete} = 687.41$ psi

$$f_{1.concrete} := 1.6 \cdot \frac{2.P_1}{(h_{ef} - a) \cdot B_{grout}}$$ $f_{1.concrete} = 651.85$ psi

Bearing Stress for Concrete :

$$Fp_{concrete} := [0.65 \cdot (0.85 \cdot f'c_{concrete})] \cdot 1.5$$ $Fp_{concrete} = 3315.00$ psi

$$Stress_{concrete} := \begin{vmatrix} \text{"N.G."} \\ \text{"O.K."} \quad \text{if } \max(f_{1.concrete}, f_{2.concrete}) \le Fp_{concrete} \end{vmatrix}$$

$Stress_{concrete} = \text{"O.K."}$

Shear Analysis-Concrete Breakout Strength:

$$A_{Vco} := 4.5 \cdot C_{a1}^{\ 2}$$ $A_{Vco} = 162$ in^2

$$A_{Vc} := \begin{vmatrix} 2 \cdot (1.5 \cdot C_{a1}) \cdot h_a \quad \text{if } h_a < 1.5 \cdot C_{a1} \\ 2 \cdot (1.5 \cdot C_{a1}) \cdot (1.5 \cdot C_{a1}) \quad \text{if } h_a \ge 1.5 \cdot C_{a1} \end{vmatrix}$$ $A_{Vc} = 162.00$ in^2

$\psi_{ed.V} := 1.00$ Modification factor for edge effect

$\psi_{c.V} := 1$ Modification Factor in No cracked concrete at service loads
ψc.v=1.4
Modification Factor in cracked concrete with
ψc.v=1 w/ No supplementary reinforcement.
ψc.v=1.2 w/ Supplementary reinforcement of a No 4 Bar between the anchor and the edge.
ψc.v=1.4 w/ Supplementary reinforcement of No 4 Bar and stirrups spaced at not more than 4 in

$l_e := \text{if}\left(h_{ef} > 8 \cdot d_o, 8 \cdot d_o, h_{ef}\right)$ $l_e = 4.50$ in

$$V_b := 7 \cdot \left[\left(\frac{l_e}{d_o}\right)^{0.2} \sqrt{d_o} \cdot \sqrt{f'c_{concrete}} \cdot C_{a1}^{\ 1.5}\right]$$ $V_b = 13323.41$ lbs.

$$V_{cb} := \frac{A_{Vc}}{A_{Vco}} \cdot \psi_{ed.V} \cdot \psi_{c.V} \cdot V_b$$ $V_{cb} = 13323.41$ lbs.

$\phi := 0.7$ Conditions
ϕ=0.75 w/ Supplementary reinforcement are crossing concrete failure prism.
ϕ=0.70 w/ No supplementary reinforcement are crossing concrete failure prism.

$\phi \cdot V_{cb} = 9326.39$ lbs

$BREAKOUT_{shear} := \text{if}\left(Vu > \phi \cdot V_{cb}, \text{"N.G."}, \text{"OK"}\right)$ $BREAKOUT_{shear} = \text{"OK"}$

Shear Analysis-Concrete Burst-Out Strength:

$$C_{a1c} := \begin{vmatrix} C_{a1} \\ \text{"N/A"} \quad \text{if } h_a < C_{a1} \end{vmatrix}$$ $C_{a1c} = 6.00$ in

Total Cone Area for Failure Plane

$$A_{cone.total} := \sqrt{2} \cdot C_{a1c} \cdot \pi \cdot \left(C_{a1c} - \frac{D_{grout}}{2} + \frac{B_{grout}}{2}\right)$$ $A_{cone.total} = 159.94$ in^2

Cone Area for Failure Plane at Post

$$A_{cone.post} := \sqrt{2} \cdot \left(\frac{B_{grout}}{2}\right)^2 \cdot \pi$$ $A_{cone.post} = 17.77$ in^2

Final Cone Area for Failure Plane

$$A_{cone.final} := \frac{A_{cone.total} - A_{cone.post}}{2}$$

$A_{cone.final} = 71.09$ in^2

Final Area for Failure Plane

$$V_{cone.cb} := 4 \cdot \sqrt{f'c_{concrete}} \cdot A_{cone.final}$$

$V_{cone.cb} = 17983.53$ lbs

$\phi_{B.O} := 0.75$

Conditions
ϕ=0.75 for Any Condition

$\phi_{B.O} \cdot V_{cone.cb} = 13487.64$ lbs

$$BURSTOUT_{shear} := if\left(Vu > \phi_{B.O} \cdot V_{cone.cb}, \text{"N.G."}, \text{"OK"}\right)$$

$BURSTOUT_{shear} = \text{"OK"}$

Weld Design For POST-TOP

MATERIALS:

Welding: Aluminum Filler Alloy 5183

Weld and Section Data:

$F_v := 14.4$ Allowable Stress for Welding (ksi)

$b := 2$ Width of POST (in)

$d := 2$ Depth of POST (in)

Load Data:

$M_{weld} := 0$ Moment (Kips-ft)

$V_{weld} := 1.221$ Shear (Kips)

$P_{weld} := 0.00$ Tension or Compression (Kips)

$T_{weld} := 0.00$ Torsional Moment (kips-ft)

Check Weld Section :

$$t_e := \left| \begin{array}{l} x \leftarrow 0.00001 \\ \text{while } \sqrt{\left[\dfrac{P_{weld}}{2(b+d)\cdot x} + \dfrac{M_{weld}\cdot 12}{\left(b\cdot d + \dfrac{d^2}{3}\right)\cdot x}\right]^2 + \left[\dfrac{1.5V_{weld}}{2(b+d)\cdot x} + \dfrac{T_{weld}\cdot 12\cdot\sqrt{\left(\dfrac{b}{2}\right)^2 + \left(\dfrac{d}{2}\right)^2}}{\dfrac{(b+d)^3}{6}\cdot x}\right]^2} \geq F_v \\ \quad x \leftarrow x + 0.01 \end{array} \right.$$

$t_e = 0.02$ in

$S_{weld} := \left(b\cdot d + \dfrac{d^2}{3}\right)\cdot t_e$ $S_{weld} = 0.11$ in^3

$A_{weld} := 2\cdot(d + b)\cdot t_e$ $A_{weld} = 0.16$ in^2

$J_{weld} := \dfrac{(b+d)^3}{6}\cdot t_e$ $J_{weld} = 0.21$ in^3

Check Bending Stress :

$$f_b := \frac{M_{weld} \cdot (12)}{S_{weld}}$$ $f_b = 0.00$ ksi

Check Shear Stress :

$$f_v := \frac{1.5V_{weld}}{A_{weld}} + \frac{T_{weld} \cdot 12 \cdot \sqrt{\left(\frac{b}{2}\right)^2 + \left(\frac{d}{2}\right)^2}}{J_{weld}}$$ $f_v = 11.44$ ksi

Check Tension Stress :

$$f_a := \frac{P_{weld}}{A_{weld}}$$ $f_a = 0.00$ Ksi

Check Combined Stress :

$$f_{weld} := \sqrt{(f_b + f_a)^2 + f_v^{\,2}}$$ $f_{weld} = 11.44$ ksi

$$STRESS := \begin{array}{|l} \text{"N.G."} \\ \text{"OK"} \quad \text{if } F_v \ge f_{weld} \end{array}$$ $STRESS = \text{"OK"}$

$$W_{weld} := \begin{array}{|l} \text{"1/8"} \quad \text{if } \frac{t_e}{0.707} \le 0.125 \\ \text{"3/16"} \quad \text{if } 0.125 < \frac{t_e}{0.707} \le 0.1875 \\ \text{" 1/4"} \quad \text{if } 0.25 < \frac{t_e}{0.707} \le 0.25 \\ \text{"1/2"} \quad \text{if } 0.375 < \frac{t_e}{0.707} \le 0.50 \\ \text{"5/8"} \quad \text{if } 0.50 < \frac{t_e}{0.707} \le 0.625 \\ \text{"3/4"} \quad \text{if } 0.625 < \frac{t_e}{0.707} \le 0.750 \\ \text{"1"} \quad \text{if } 0.75 < \frac{t_e}{0.707} \le 1.00 \end{array}$$ $W_{weld} = \text{"1/8"}$

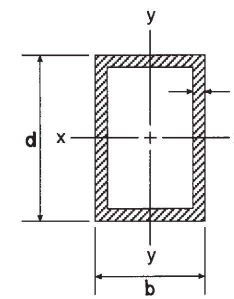


Table 24
RECTANGULAR TUBES

Designation	Width b in.	Depth d in.	Thickness t in.	Weight lb/ft	Area A in²	Axis x-x I_x in⁴	Axis x-x S_x in³	Axis x-x r_x in.	Axis y-y I_y in⁴	Axis y-y S_y in³	Axis y-y r_y in.	J in⁴
RT 1 × 1 1/2 × 1/8	1.000	1.500	0.125	0.662	0.563	0.159	0.212	0.532	0.0811	0.162	0.380	0.161
RT 1 × 2 × 1/8	1.000	2.000	0.125	0.809	0.688	0.332	0.332	0.695	0.105	0.210	0.391	0.245
RT 1 × 2 1/2 × 1/8	1.000	2.500	0.125	0.956	0.813	0.590	0.472	0.852	0.129	0.258	0.399	0.332
RT 1 × 3 × 1/8	1.000	3.000	0.125	1.10	0.938	0.950	0.633	1.01	0.153	0.307	0.404	0.422
RT 1 × 4 × 1/8	1.000	4.000	0.125	1.40	1.19	2.04	1.02	1.31	0.201	0.403	0.412	0.605
RT 1 1/4 × 2 × 1/8	1.250	2.000	0.125	0.882	0.750	0.387	0.387	0.718	0.180	0.288	0.489	0.371
RT 1 1/4 × 2 1/2 × 1/8	1.250	2.500	0.125	1.03	0.875	0.678	0.543	0.881	0.219	0.351	0.501	0.510
RT 1 1/4 × 3 × 1/8	1.250	3.000	0.125	1.18	1.00	1.08	0.720	1.04	0.259	0.415	0.509	0.654
RT 1 1/2 × 1 3/4 × 1/8	1.500	1.750	0.125	0.882	0.750	0.318	0.364	0.652	0.248	0.331	0.575	0.416
RT 1 1/2 × 2 × 1/8	1.500	2.000	0.125	0.956	0.813	0.442	0.442	0.737	0.278	0.370	0.585	0.511
RT 1 1/2 × 2 × 1/4	1.500	2.000	0.250	1.76	1.50	0.719	0.719	0.692	0.438	0.583	0.540	0.798
RT 1 1/2 × 2 1/2 × 1/8	1.500	2.500	0.125	1.10	0.938	0.767	0.613	0.904	0.337	0.449	0.599	0.711
RT 1 1/2 × 3 × 1/8	1.500	3.000	0.125	1.25	1.06	1.21	0.806	1.07	0.396	0.528	0.611	0.919
RT 1 1/2 × 3 × 3/16	1.500	3.000	0.188	1.82	1.55	1.68	1.12	1.04	0.533	0.711	0.586	1.24
RT 1 1/2 × 4 × 1/8	1.500	4.000	0.125	1.54	1.31	2.51	1.25	1.38	0.515	0.686	0.626	1.35
RT 1 1/2 × 6 × 1/8	1.500	6.000	0.125	2.13	1.81	7.20	2.40	1.99	0.752	1.00	0.644	2.25
RT 1 3/4 × 2 × 1/8	1.750	2.000	0.125	1.03	0.875	0.497	0.497	0.753	0.401	0.458	0.677	0.663
RT 1 3/4 × 2 1/4 × 1/8	1.750	2.250	0.125	1.10	0.938	0.661	0.588	0.840	0.442	0.506	0.687	0.795
RT 1 3/4 × 2 1/2 × 1/8	1.750	2.500	0.125	1.18	1.00	0.855	0.684	0.925	0.484	0.553	0.696	0.931
RT 1 3/4 × 2 3/4 × 1/8	1.750	2.750	0.125	1.25	1.06	1.08	0.785	1.01	0.525	0.600	0.703	1.07
RT 1 3/4 × 3 × 1/8	1.750	3.000	0.125	1.32	1.13	1.34	0.892	1.09	0.566	0.647	0.710	1.21
RT 1 3/4 × 3 1/2 × 1/8	1.750	3.500	0.125	1.47	1.25	1.96	1.12	1.25	0.649	0.742	0.721	1.50
RT 1 3/4 × 4 × 1/8	1.750	4.000	0.125	1.62	1.38	2.74	1.37	1.41	0.732	0.836	0.730	1.80
RT 1 3/4 × 4 1/2 × 1/8	1.750	4.500	0.125	1.76	1.50	3.69	1.64	1.57	0.814	0.931	0.737	2.11
RT 1 3/4 × 5 × 1/8	1.750	5.000	0.125	1.91	1.63	4.83	1.93	1.72	0.897	1.03	0.743	2.41
RT 1 3/4 × 5 × 3/16	1.750	5.000	0.188	2.82	2.40	6.91	2.76	1.70	1.23	1.41	0.717	3.33
RT 1 3/4 × 6 × 1/8	1.750	6.000	0.125	2.21	1.88	7.74	2.58	2.03	1.06	1.21	0.753	3.04

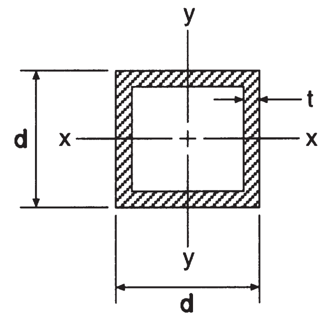


Table 23
SQUARE TUBES

Designation	Depth width d in.	Thickness t in.	Weight lb/ft	Area A in^2	Axis x-x, y-y I_x, I_y in^4	S_x, S_y in^3	r_x, r_y in.	J in^4
RT 1 × 1 × .065	1.000	0.065	0.286	0.243	0.0356	0.0712	0.383	0.0531
RT 1 × 1 × .095	1.000	0.095	0.404	0.344	0.0475	0.0949	0.371	0.0704
RT 1 × 1 × .125	1.000	0.125	0.515	0.438	0.0570	0.114	0.361	0.0837
RT 1.25 × 1.25 × .065	1.250	0.065	0.362	0.308	0.0723	0.116	0.485	0.108
RT 1.25 × 1.25 × .095	1.250	0.095	0.516	0.439	0.0982	0.157	0.473	0.146
RT 1.25 × 1.25 × .125	1.250	0.125	0.662	0.563	0.120	0.192	0.462	0.178
RT 1.375 × 1.375 × .125	1.375	0.125	0.735	0.625	0.164	0.239	0.513	0.244
RT 1.5 × 1.5 × .065	1.500	0.065	0.439	0.373	0.128	0.171	0.586	0.192
RT 1.5 × 1.5 × .078	1.500	0.078	0.522	0.444	0.150	0.200	0.581	0.224
RT 1.5 × 1.5 × .095	1.500	0.095	0.628	0.534	0.176	0.235	0.575	0.263
RT 1.5 × 1.5 × .125	1.500	0.125	0.809	0.688	0.218	0.291	0.564	0.325
RT 1.5 × 1.5 × .250	1.500	0.250	1.47	1.25	0.339	0.451	0.520	0.488
RT 1.75 × 1.75 × .125	1.750	0.125	0.956	0.813	0.360	0.411	0.665	0.536
RT 2 × 2 × .095	2.000	0.095	0.851	0.724	0.439	0.439	0.779	0.657
RT 2 × 2 × .125	2.000	0.125	1.10	0.938	0.552	0.552	0.767	0.824
RT 2 × 2 × .156	2.000	0.156	1.35	1.15	0.657	0.657	0.755	0.978
RT 2 × 2 × .188	2.000	0.188	1.60	1.36	0.754	0.754	0.744	1.12
RT 2 × 2 × .250	2.000	0.250	2.06	1.75	0.911	0.911	0.722	1.34
RT 2.25 × 2.25 × .125	2.250	0.125	1.25	1.06	0.802	0.713	0.869	1.20
RT 2.5 × 2.5 × .125	2.500	0.125	1.40	1.19	1.12	0.896	0.971	1.67
RT 2.5 × 2.5 × .188	2.500	0.188	2.04	1.74	1.56	1.25	0.947	2.32
RT 2.5 × 2.5 × .250	2.500	0.250	2.65	2.25	1.92	1.54	0.924	2.85
RT 2.75 × 2.75 × .125	2.750	0.125	1.54	1.31	1.51	1.10	1.07	2.26
RT 2.75 × 2.75 × .188	2.750	0.188	2.27	1.93	2.12	1.54	1.05	3.16
RT 3 × 3 × .095	3.000	0.095	1.30	1.10	1.55	1.04	1.19	2.33
RT 3 × 3 × .125	3.000	0.125	1.69	1.44	1.98	1.32	1.17	2.97
RT 3 × 3 × .188	3.000	0.188	2.49	2.11	2.80	1.87	1.15	4.18
RT 3 × 3 × .250	3.000	0.250	3.23	2.75	3.49	2.33	1.13	5.20
RT 3 × 3 × .375	3.000	0.375	4.63	3.94	4.61	3.08	1.08	6.78
RT 3.5 × 3.5 × .125	3.500	0.125	1.98	1.69	3.21	1.83	1.38	4.81
RT 3.5 × 3.5 × .250	3.500	0.250	3.82	3.25	5.76	3.29	1.33	8.58
RT 3.5 × 3.5 × .375	3.500	0.375	5.51	4.69	7.74	4.42	1.28	11.4
RT 4 × 4 × .125	4.000	0.125	2.28	1.94	4.85	2.43	1.58	7.27
RT 4 × 4 × .188	4.000	0.188	3.37	2.87	6.96	3.48	1.56	10.4
RT 4 × 4 × .250	4.000	0.250	4.41	3.75	8.83	4.41	1.53	13.2
RT 4 × 4 × .375	4.000	0.375	6.39	5.44	12.0	6.02	1.49	17.9
RT 4 × 4 × .500	4.000	0.500	8.23	7.00	14.6	7.29	1.44	21.4