COVER SHEET
Structural Calculations for Spiral Stairs

Project:

SPIRAL STAIRS
AT
12715 ROLLING ROAD DRIVE
PINECREST FL 33156

R&D ENGINEERS

Research & Design Engineers, Inc.

13400 SW 134 AVE. #1
Miami, FL 33186
Tel: 786-293-1500
Fax: 786-293-4999

www.RnDEng.com
CA# 9857

CUETO ENGINEERING
SHOP DRAWING / SUBMITTAL REVIEW

[✓] APPROVED [ ] REJECTED
[ ] APPROVED AS NOTED [ ] REVISE & RESUBMIT

This submittal has been reviewed for design conformity and general compliance with Contract Documents. The Contractor is solely responsible for: confirming all dimensions and quantities; procedures, means, methods, techniques, and sequences of fabrication and construction; coordination of work for all trades; and full compliance with design documents.

By : Nestor A. Cueto, PE Date : 05/27/2025

Wayne A Sutherland Digitally signed by Wayne A Sutherland Date: 2025.06.03 16:43:36-04'00'

WAYNE A. SUTHERLAND LICENSE No 44353 STATE OF FLORIDA PROFESSIONAL ENGINEER

5/22/25

Wayne A. Sutherland, PE
Structural Civil
PE# 44353

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CHECK CENTER POLE ANCHOR BOLTS (BASED ON SIMPSON 5/8" Dia 4" Embedment into concrete)

$Live\_Load := 300 \cdot lb$ $Moment\_arm := 33 \cdot in$

$Moment := Live\_Load \cdot Moment\_arm = 825\ ft \cdot lb$

$Tension\_in\_bolts := \frac{Moment}{5.5 \cdot in} = 1800\ lb$

$Amount\_of\_bolts\_in\_tension := 2$

$Tension\_per\_bolt := \frac{Tension\_in\_bolts}{Amount\_of\_bolts\_in\_tension} = 900\ lb$

$Bolt\_tension\_capacity := 1640 \cdot lb$

$if(Bolt\_tension\_capacity > Tension\_per\_bolt, "OK", "NG") = "OK"$

CHECK CENTER POLE

ALLOWABLE STRESS (ALLOY 6061-T6)

$n_u := 1.95$ $n_y := 1.65$ $n_a := 1.20$ Factor of safety

$E := 10100 \cdot ksi$ $F_{tu} := 42.0ksi$ $F_{ty} := 35 \cdot ksi$ $F_{cy} := 35 \cdot ksi$

$F_y := \min(F_{cy}, F_{ty})$ $F_{tuw} := 24.0ksi$ $F_{tyw} := 20 \cdot ksi$ $F_{cyw} := 20 \cdot ksi$

SECTION PROPERTIES

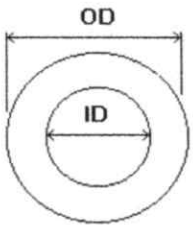
$OD := 5 \cdot in$ $ID := 4.75 \cdot in$ $t := \frac{OD - ID}{2}$ $t = 0.125 \cdot in$

$Area := \frac{3.142 \cdot (OD^2 - ID^2)}{4}$ $Area = 1.91 \cdot in^2$

$I := \frac{3.14 \cdot (OD^4 - ID^4)}{64}$ $I = 5.688 \cdot in^4$

$S := \frac{3.142 \cdot (OD^4 - ID^4)}{32 \cdot OD}$ $S = 2.277 \cdot in^3$

$R := \frac{ID}{2}$ $R = 2.38 \cdot in$



SECTION

MOMENT CAPACITY (NOT WITHIN 1" OF WELD) (SEE ALSO MOMENT CAPACITY AT WELD LOCATION)

TENSION IN EXTREME FIBRES OF ROUND TUBE:

$Moment = 825\ ft \cdot lb$

$f := \frac{Moment}{S}$ $f = 4.35 \cdot ksi$

$F_1 := \frac{1.17 \cdot F_{ty}}{n_y}$ $F_1 = 24.82 \cdot ksi$ $k_t := 1.0$

$F_2 := \frac{1.24 \cdot F_{tu}}{k_t \cdot n_u}$ $F_2 = 26.71 \cdot ksi$

$F := \min(F_1, F_2)$ $F = 24.82 \cdot ksi$

if(f < F, "The section is satisfactory for tension" , "N.G. For tension") = "The section is satisfactory for tension"

COMPRESSION IN EXTREME FIBRES ROUND TUBE:

$R_b := \frac{OD - t}{2}$ $R_b = 2.44 \cdot in$

$\frac{R_b}{t} = 19.5$

$S_1 := 29$ $S_2 := 81$ $\Phi_{cp} := 0.8$

$$F_b := \begin{cases} f \leftarrow \frac{1.17 \cdot F_{cy}}{n_y} & \text{if } \frac{R_b}{t} \le S_1 \\ f \leftarrow \left(39.3 - 2.70 \cdot \sqrt{\frac{R_b}{t}}\right) \cdot ksi & \text{if } S_1 < \frac{R_b}{t} < S_2 \\ f \leftarrow \left[\frac{\Phi_{cp} \cdot \pi^2 \cdot E}{16 \cdot \left(\frac{R_b}{t}\right) \cdot \left(1 + \frac{\sqrt{\frac{R_b}{t}}}{35}\right)^2}\right] \cdot \frac{1}{n_y} & \text{if } \frac{R_b}{t} > S_1 \end{cases}$$

$F_b = 24.82 \cdot ksi$

$Moment\_capacity := F_b \cdot S = 4708.5 \, ft \cdot lb$

if(Moment < Moment_capacity, "Section is O.K" , "N.G") = "Section is O.K"

MOMENT CAPACITY AT WELD LOCATION (Mw)

$$F_{b\_weld} := \begin{cases} f \leftarrow 10.5 \cdot ksi & \text{if } \frac{R_b}{t} \le S_1 \\ f \leftarrow \left(39.3 - 1.39 \cdot \sqrt{\frac{R_b}{t}}\right) \cdot ksi & \text{if } S_1 < \frac{R_b}{t} < S_2 \\ f \leftarrow \left[\frac{\Phi_{cp} \cdot \pi^2 \cdot E}{16 \cdot \left(\frac{R_b}{t}\right) \cdot \left(1 + \frac{\sqrt{\frac{R_b}{t}}}{35}\right)^2}\right] \cdot \frac{1}{n_y} & \text{if } \frac{R_b}{t} > S_1 \end{cases}$$

$F_{b\_weld} = 10.50 \cdot ksi$

if(f < F, "The section is satisfactory for tension" , "N.G. For tension") = "The section is satisfactory for tension"

$Moment = 825 \, ft \cdot lb$

$Moment\_capacity_{weld} := F_{b\_weld} \cdot S$ $Moment\_capacity_{weld} = 1992.1 \, ft \cdot lb$

$\text{if}(Moment\_capacity_{weld} > Moment, \text{"Section is O.K"} , \text{"N.G"}) = \text{"Section is O.K"}$

CHECK RAILING POST **ALLOY 6061-T6**

$Fcy := 35 \frac{kip}{in^2}$ $Fsy := 20ksi$ $Fty := 35ksi$ $E := 10100ksi$

FACTOR OF SAFETY: $ny := 1.65$

SECTION PROPERTIES

$B := 2.25 \cdot in$ $D := 2.25 \cdot in$ $T := 0.12 \cdot in$ $L := 42in$

$Bi := B - 2 \cdot T$ $Di := D - 2 \cdot T$

$Bi = 2.01 \cdot in$ $Di = 2.01 \cdot in$

$Area := B \cdot D - Bi \cdot Di$ $Area = 1.02 \cdot in^2$

$$Ix := \frac{B \cdot D^3}{12} - \frac{Bi \cdot Di^3}{12} \qquad Ix = 0.78 \cdot in^4$$

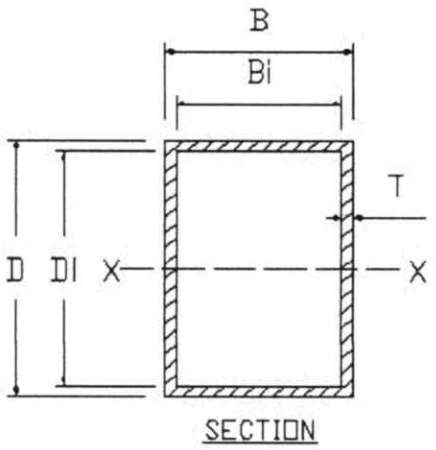
$$Iy := \frac{D \cdot B^3}{12} - \frac{Di \cdot Bi^3}{12} \qquad Iy = 0.78 \cdot in^4$$

$$J := \frac{2 \cdot T \cdot T \cdot (B - T)^2 \cdot (D - T)^2}{B \cdot T + D \cdot T - T^2 - T^2} \qquad J = 1.16 \cdot in^4$$

$$C := \frac{D}{2} \qquad C = 1.13 \cdot in$$

$$Sc := \frac{Ix}{C} \qquad Sc = 0.69 \cdot in^3$$

$$Fc := \frac{Fcy}{ny} \qquad Fc = 21.21 \cdot ksi$$



RAIL POST

TENSION IN RECTANGULAR TUBE $$Ft := \frac{Fty}{ny} \qquad Ft = 21.21 \cdot ksi$$

COMPRESSION IN RECTANGULAR TUBE (POST)

See also calculations for capacity at location of weld

$$Sr := \frac{L \cdot Sc}{0.5 \cdot \sqrt{Iy \cdot J}} \qquad Sr = 61.06$$

$$Bc := Fcy \cdot \left[1 + \left(\frac{\frac{Fcy}{ksi}}{2250} \right)^{0.5} \right] \qquad Bc = 39.37 \cdot ksi$$

$$Dc := \frac{Bc}{10} \cdot \left(\frac{Bc}{E} \right)^{0.5} \qquad Dc = 0.25 \cdot ksi$$

$$S1 := \left(\frac{Bc - Fcy}{1.6 \cdot Dc} \right)^2 \qquad S1 = 123.24$$

$$Cc := 0.41 \cdot \frac{Bc}{Dc} \qquad Cc = 65.67$$

$$S2 := \left(\frac{Cc}{1.6} \right)^2 \qquad S2 = 1.68 \times 10^3$$

$$F(Sr) := \begin{cases} Fc \leftarrow \dfrac{Fcy}{ny} & \text{if } Sr < S1 \\ Fc \leftarrow \dfrac{1}{ny}\cdot\left(Bc - 1.6Dc\cdot\sqrt{\dfrac{L\cdot Sc}{0.5\cdot\sqrt{Iy\cdot J}}}\right) & \text{if } S1 < Sr < S2 \\ Fc \leftarrow \dfrac{\pi^2\cdot E}{2.56\cdot ny\cdot\left(\dfrac{L\cdot Sc}{0.5\cdot\sqrt{Iy\cdot J}}\right)} & \text{if } Sr > S2 \end{cases}$$

$F(Sr) = 21.21\cdot ksi$ $\quad F2 := F(Sr)$

COMPRESSION IN COMPONENT (POST)

$bt := \dfrac{Bi}{T}$ $\quad bt = 16.75$

$$Bp := Fcy\cdot\left[1 + \frac{\left(\frac{Fcy}{ksi}\right)^{\frac{1}{3}}}{11.4}\right]$$

$$Dp := \frac{Bp}{10}\cdot\left(\frac{Bp}{E}\right)^{0.5} \qquad Cp := 0.41\cdot\frac{Bp}{Dp}$$

$nu := 1.95$ $\quad kc := 1.12$

$$S1p := \frac{Bp - Fcy}{1.6\cdot Dp} \qquad S1p = 20.87$$

$k1 := 0.35$ $\quad k2 := 2.27$

$$S2p := \frac{k1\cdot Bp}{1.6\cdot Dp} \qquad S2p = 32.76$$

$$F(bt) := \begin{cases} Fp \leftarrow \dfrac{Fcy}{ny} & \text{if } bt < S1p \\ Fp \leftarrow \dfrac{1}{ny}\cdot\left(Bp - 1.6\cdot Dp\cdot\dfrac{Bi}{T}\right) & \text{if } S1p < bt < S2p \\ Fp \leftarrow \dfrac{k2\cdot\sqrt{Bp\cdot E}}{ny\cdot 1.6\cdot\dfrac{Bi}{T}} & \text{if } bt > S2p \end{cases}$$

$F(bt) = 21.21\cdot ksi$ $\quad F3 := F(bt)$

COMPRESSION IN WEB (POST) $\quad dt := \dfrac{Di}{T}$ $\quad dt = 16.75$

$$Bbr := 1.3\cdot Fcy\cdot\left[1 + \frac{\left(\frac{Fcy}{ksi}\right)^{\frac{1}{3}}}{7}\right] \qquad Dbr := \frac{Bbr}{20}\cdot\left(6\cdot\frac{Bbr}{E}\right)^{0.5} \qquad Cbr := \frac{2\cdot Bbr}{3\cdot Dbr}$$

$Bbr = 66.76\cdot ksi$ $\quad Dbr = 0.66\cdot ksi$

$$F(dt) := \begin{cases} Fp \leftarrow \dfrac{1.3 \cdot Fcy}{ny} & \text{if } dt < S1p \\ Fp \leftarrow \dfrac{1}{ny} \cdot \left(Bbr - 0.67 \cdot Dbr \cdot \dfrac{Di}{T} \right) & \text{if } S1p < dt < S2p \\ Fp \leftarrow \dfrac{k2 \cdot \sqrt{Bbr \cdot E}}{ny \cdot 0.67 \cdot \dfrac{Di}{T}} & \text{if } dt > S2p \end{cases}$$

$F(dt) = 27.58 \cdot ksi$ $F4 := F(dt)$ $F := (Ft \;\; F2 \;\; F3 \;\; F4)$

$Fdesign := \min(F)$ $Fdesign = 21.21 \cdot ksi$

WEB SHEAR (POST)

$$Bs := Fsy \cdot \left[1 + \frac{\left(\dfrac{Fsy}{ksi} \right)^{\frac{1}{3}}}{8.7} \right]$$

$$Ds := \frac{Bs}{10} \cdot \left(\frac{Bs}{E} \right)^{0.5}$$

$$Cs := 0.41 \cdot \frac{Bs}{Ds}$$

$Bs = 26.24 \cdot ksi$ $Ds = 0.13 \cdot ksi$ $Cs = 80.44$

$$S1s := \frac{Bs - Fsy}{1.25 \cdot Ds}$$

$S1s = 37.32$

$$S2s := \frac{Cs}{1.25}$$

$S2s = 64.35$

$$F(dt) := \begin{cases} Fs \leftarrow \dfrac{Fsy}{ny} & \text{if } dt < S1s \\ Fs \leftarrow \dfrac{1}{ny} \cdot \left(Bs - 1.25 \cdot Ds \cdot \dfrac{Di}{T} \right) & \text{if } S1p < dt < S2p \\ Fs \leftarrow \dfrac{\pi^2 \cdot E}{ny \cdot \left(1.25 \cdot \dfrac{Di}{T} \right)} & \text{if } dt > S2p \end{cases}$$

$F(dt) = 12.12 \cdot ksi$ $Fs := F(dt)$

AREA OF WEB $Aw := Di \cdot T$ $Aw = 0.24 \cdot in^2$ $V := Fs \cdot Aw$ $V = 2.92 \cdot kip$

MAXIMUM HORIZONTAL LOAD BASED ON SHEAR CAPACITY

$Wv := 2 \cdot V$ $Wv = 5.85 \cdot kip$

MAXIMUM ALLOWABLE MOMENT

$M := Fdesign \cdot Sc$ $M = 14623.0 \cdot lb \cdot in$

CHECK APPLIED MOMENT

$Pa := 200lb$

$Ma := Pa \cdot L$ $Ma = 8400.0 \cdot lb \cdot in$

$\text{if}(Ma > M, \text{"N.G."}, \text{"O.K."}) = \text{"O.K."}$

RAILING CAPACITY (AT WITHIN 1" OF WELD) **ALLOY 6061-T6**

$Fcyw := 20\frac{kip}{in^2}$ $Fsyw := 12ksi$ $Ftyw := 20ksi$ $Fc := \frac{Fcyw}{ny}$ $Fc = 12.12 \cdot ksi$

TENSION IN RECTANGULAR TUBE (AT WELD LOCATION)

$Ft := \frac{Ftyw}{ny}$ $Ft = 12.12 \cdot ksi$

COMPRESSION IN RECTANGULAR TUBE (AT WELD LOCATION)

$Sr := \frac{L \cdot Sc}{0.5 \cdot \sqrt{Iy \cdot J}}$ $Sr = 61.06$

$Bc := Fcyw \cdot \left[1 + \left(\frac{\frac{Fcyw}{ksi}}{2250}\right)^{0.5}\right]$ $Bc = 21.89 \cdot ksi$

$Dc := \frac{Bc}{10} \cdot \left(\frac{Bc}{E}\right)^{0.5}$ $Dc = 0.10 \cdot ksi$

$S1 := \left(\frac{Bc - Fcyw}{1.6 \cdot Dc}\right)^2$ $S1 = 133.82$

$Cc := 0.41 \cdot \frac{Bc}{Dc}$ $Cc = 88.08$

$S2 := \left(\frac{Cc}{1.6}\right)^2$ $S2 = 3.03 \times 10^3$

$$F(Sr) := \begin{cases} Fc \leftarrow \frac{Fcyw}{ny} & \text{if } Sr < S1 \\ Fc \leftarrow \frac{1}{ny} \cdot \left(Bc - 1.6Dc \cdot \sqrt{\frac{L \cdot Sc}{0.5 \cdot \sqrt{Iy \cdot J}}}\right) & \text{if } S1 < Sr < S2 \\ Fc \leftarrow \frac{\pi^2 \cdot E}{2.56 \cdot ny \cdot \left(\frac{L \cdot Sc}{0.5 \cdot \sqrt{Iy \cdot J}}\right)} & \text{if } Sr > S2 \end{cases}$$

$F(Sr) = 12.12 \cdot ksi$ $F2 := F(Sr)$

COMPRESSION IN COMPONENT (POST) (AT WELD LOCATION)

$bt := \frac{Bi}{T}$ $bt = 16.75$

$Bp := Fcyw \cdot \left[1 + \frac{\left(\frac{Fcyw}{ksi}\right)^{\frac{1}{3}}}{11.4}\right]$

$Dp := \frac{Bp}{10} \cdot \left(\frac{Bp}{E}\right)^{0.5}$ $Cp := 0.41 \cdot \frac{Bp}{Dp}$

$nu := 1.95$ $kc := 1.12$

$$S1p := \frac{Bp - Fcyw}{1.6 \cdot Dp} \qquad S1p = 24.28$$

$k1 := 0.35 \qquad k2 := 2.27$

$$S2p := \frac{k1 \cdot Bp}{1.6 \cdot Dp} \qquad S2p = 44.18$$

$$F(bt) := \begin{cases} Fp \leftarrow \dfrac{Fcyw}{ny} & \text{if } bt < S1p \\ Fp \leftarrow \dfrac{1}{ny} \cdot \left(Bp - 1.6 \cdot Dp \cdot \dfrac{Bi}{T} \right) & \text{if } S1p < bt < S2p \\ Fp \leftarrow \dfrac{k2 \cdot \sqrt{Bp \cdot E}}{ny \cdot 1.6 \cdot \dfrac{Bi}{T}} & \text{if } bt > S2p \end{cases}$$

$F(bt) = 12.12 \cdot ksi \qquad F3 := F(bt)$

COMPRESSION IN WEB (POST) (AT WELD LOCATION)

$$Bbr := 1.3 \cdot Fcyw \cdot \left[1 + \frac{\left(\dfrac{Fcyw}{ksi} \right)^{\frac{1}{3}}}{7} \right] \qquad Dbr := \frac{Bbr}{20} \cdot \left(6 \cdot \frac{Bbr}{E} \right)^{0.5} \qquad Cbr := \frac{2 \cdot Bbr}{3 \cdot Dbr}$$

$Bbr = 36.08 \cdot ksi \qquad Dbr = 0.26 \cdot ksi$

$$F(dt) := \begin{cases} Fp \leftarrow \dfrac{1.3 \cdot Fcyw}{ny} & \text{if } dt < S1p \\ Fp \leftarrow \dfrac{1}{ny} \cdot \left(Bbr - 0.67 \cdot Dbr \cdot \dfrac{Di}{T} \right) & \text{if } S1p < dt < S2p \\ Fp \leftarrow \dfrac{k2 \cdot \sqrt{Bbr \cdot E}}{ny \cdot 0.67 \cdot \dfrac{Di}{T}} & \text{if } dt > S2p \end{cases}$$

$F(dt) = 15.76 \cdot ksi$

$Fdesign := \min(Ft, F2, F3, F4) \qquad Fdesign = 12.12 \cdot ksi$

WEB SHEAR (POST)

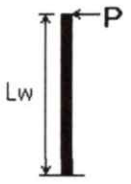
$$Bs := Fsyw \cdot \left[1 + \frac{\left(\dfrac{Fsyw}{ksi} \right)^{\frac{1}{3}}}{8.7} \right] \qquad Ds := \frac{Bs}{10} \cdot \left(\frac{Bs}{E} \right)^{0.5} \qquad Cs := 0.41 \cdot \frac{Bs}{Ds}$$

$Bs = 15.16 \cdot ksi \qquad Ds = 0.06 \cdot ksi \qquad Cs = 105.83$

$$S1s := \frac{Bs - Fsyw}{1.25 \cdot Ds} \qquad S1s = 43.02$$

$$S2s := \frac{Cs}{1.25} \qquad S2s = 84.67$$

$$F(dt) := \begin{cases} Fs \leftarrow \dfrac{Fsyw}{ny} & \text{if } dt < S1s \\ Fs \leftarrow \dfrac{1}{ny}\cdot\left(Bs - 1.25\cdot Ds\cdot\dfrac{Di}{T}\right) & \text{if } S1p < dt < S2p \\ Fs \leftarrow \dfrac{\pi^2\cdot E}{ny\cdot\left(1.25\cdot\dfrac{Di}{T}\right)} & \text{if } dt > S2p \end{cases}$$



RAIL POST

$F(dt) = 7.27\cdot ksi$ $Fs := F(dt)$

AREA OF WEB $Aw := Di\cdot T$ $Aw = 0.24\cdot in^2$ $V := Fs\cdot Aw$ $V = 1.75\cdot kip$

MAXIMUM HORIZONTAL LOAD BASED ON SHEAR CAPACITY (AT WELD LOCATION)

$Wv := 2\cdot V$ $Wv = 3.51\cdot kip$

MAXIMUM ALLOWABLE MOMENT (AT WITHIN 1" OF WELD)

$Mw := Fdesign\cdot Sc$ $Mw = 8356.0\cdot lb\cdot in$

CHECK APPLIED MOMENT

$Pa := 200lb$ $Lw := 40in$ $Ma := Pa\cdot Lw$ $Ma = 8000.0\cdot lb\cdot in$

$if(Ma > Mw, " ADD INSERT", "O.K.") = "O.K."$

TREAD CALCULATION

$D := 5\cdot in$ $x1 := 30\cdot in$ $x2 := 6\cdot in$

$PL := 300\cdot lb$

$e := x1 - \dfrac{D}{2} - x2 = 21.5\cdot in$

$M := e\cdot PL = 537.5\,ft\cdot lb$

TREAD TO POLE WELD CONNECTION

$L_w := 4.75\cdot in$ Length of weld

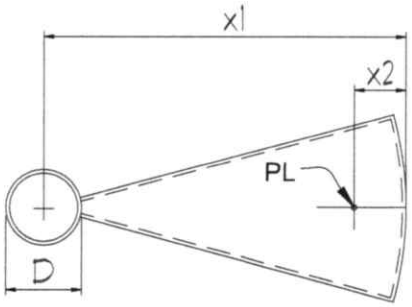
$Amount\_of\_Lines\_of\_Welds := 2$ (weld at each side of plate)

$I := \dfrac{L_w^3}{12} = 8.93\cdot in^3$ $c := \dfrac{L_w}{2} = \dfrac{L_w}{2} = 2.38\cdot in$

$S := \dfrac{I}{c} = 3.76\cdot in^2$ $fm := \dfrac{PL\cdot e}{S} = 1715.2\cdot\dfrac{lb}{in}$

$F_m := \dfrac{fm}{Amount\_of\_Lines\_of\_Welds} = 857.6\cdot\dfrac{lb}{in}$

$F_v := \dfrac{PL}{(Amount\_of\_Lines\_of\_Welds)\cdot L_w} = 31.58\cdot\dfrac{lb}{in}$



$F_r := \sqrt{F_m^{\,2} + F_v^{\,2}} = 858.2 \cdot \frac{lb}{in}$

Weld size: $D := \frac{3}{16} \cdot in$

Length of weld: $L_w = 4.75 \cdot in$

$Throat\_area := (0.707 \cdot D) \cdot Amount\_of\_Lines\_of\_Welds = 0.27 \cdot in$ per inch of weld

$Shear\_stress\_in\_weld := \frac{F_r}{Throat\_area} = 3.24 \cdot ksi$

$Allowable\_shear\_stress := 5 \cdot ksi$

$if(Allowable\_shear\_stress > Shear\_stress\_in\_weld, "OK", "NG") = "OK"$

CHECK BENDING CAPACITY OF TREADS

$M = 537.5\,ft \cdot lb$ $b := 0.125 \cdot in$ $d := 4.75 \cdot in$

$F_b := 12 \cdot ksi$

$S_{required} := \frac{M}{F_b} = 0.54 \cdot in^3$

$S := \frac{b \cdot d^2}{6} \cdot (2) = 0.94 \cdot in^3$

$if\left(S > S_{required}, "OK", "NG"\right) = "OK"$