Steel Studio USA Guardrails

Stainless Steel Railing Design Calculations

Based on IBC 2006

Prepared for

Steel Studio USA Inc.

Mill Valley, California

Design Criteria: Date: 8/16/08

1. Railing live loads per International Building Code 2006:

   Guardrails

   50 plf uniform load in any direction on top rail
   200 pound concentrated load in any direction on top rail
   50 lb concentrated load over 1 ft^2 of infill area
   Concentrated load and uniform loads need not be assumed to act concurrently

   Railing deflections per ASTM E985

   Members designed per AISC, "Manual of Steel Construction: Allowable Stress Design", 9th Edition.

2. Stainless Steel Member sizes shall be as recommended in the calculation booklet
3. Stainless Steel alloys shall be as recommended in the calculation booklet
4. Weld filler to be E316L-XX, 70 ksi minimum tensile strength
5. Stainless steel fasteners to be minimum **Grade A2-70, Fu= 101 ksi**
6. Concrete strength is assumed to be **4,000 psi, normal weight**
7. Concrete slabs and other anchoring substrate designed by others
8. Standard Anchor Bolts to be ***Hilti Hit HY150*** Adhesive Anchors with 2-1/2" Minimum Edge Distance and 3-1/2" Minimum Embedment

Design Summary:

Recommended Post Spacing for the Horizontal Guardrail System as Shown in the Calculations: ***6'-0" Maximum***

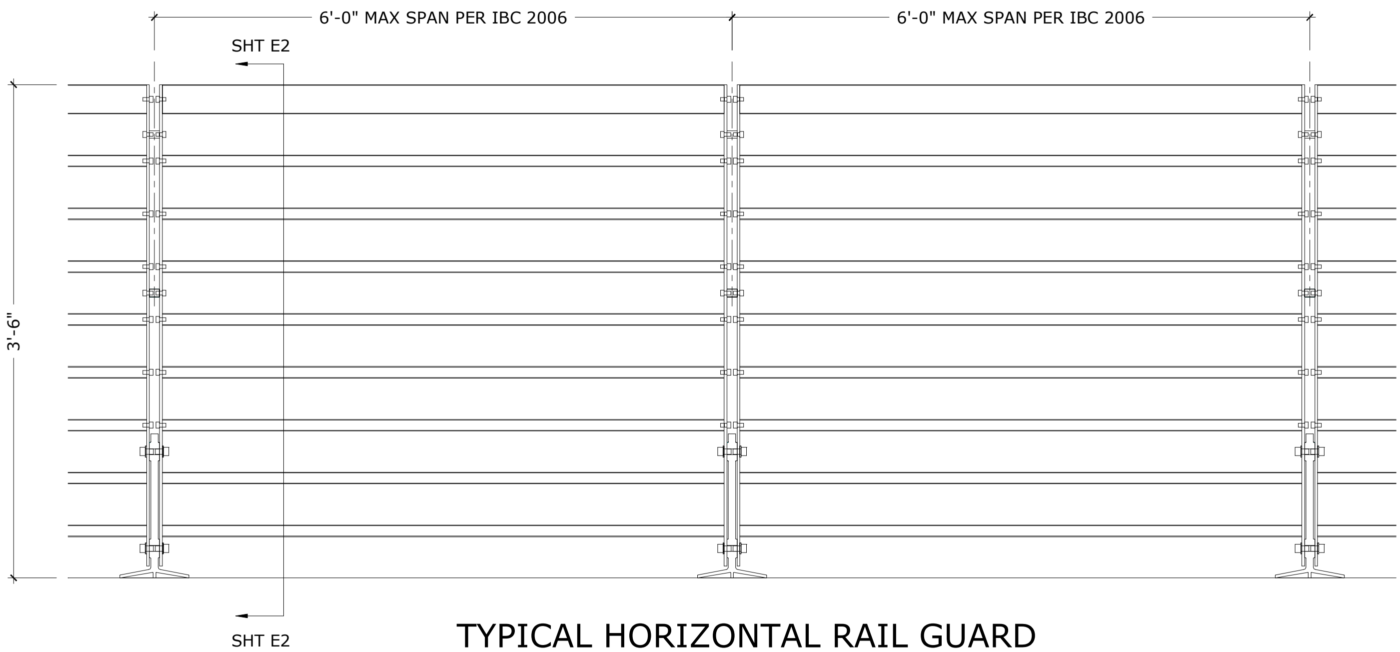
Recommended Post Spacing for the Vertical Guardrail System as Shown in the Calculations: ***6'-0" Maximum***

Recommended Post Spacing for the Glass Guardrail System as Shown in the Calculations: ***6'-0" Maximum***

6'-0" Maximum for Live Loads (IBC 2006), Maximum 27 PSF for Wind Loads
5'-6" Spans, Maximum 30 PSF for Wind Loads
5'-0" Spans, Maximum 33 PSF for Wind Loads
4'-6" Spans, Maximum 37 PSF for Wind Loads
4'-0" Spans, Maximum 41 PSF for Wind Loads

This Certification is limited to the structural design of structural components of this handrail system. It does NOT include responsibility for: • Structural design of misc. hardware (latches, hinges, etc.). • Concrete slabs and other masonry units designed by others • The manufacture, assembly, or installation of the system. • Quantities of materials or dimensional accuracy of drawings	Engineers Design Approval Stamp:

Elevation- Horizontal Rails	SHT E1



TYPICAL HORIZONTAL RAIL GUARD

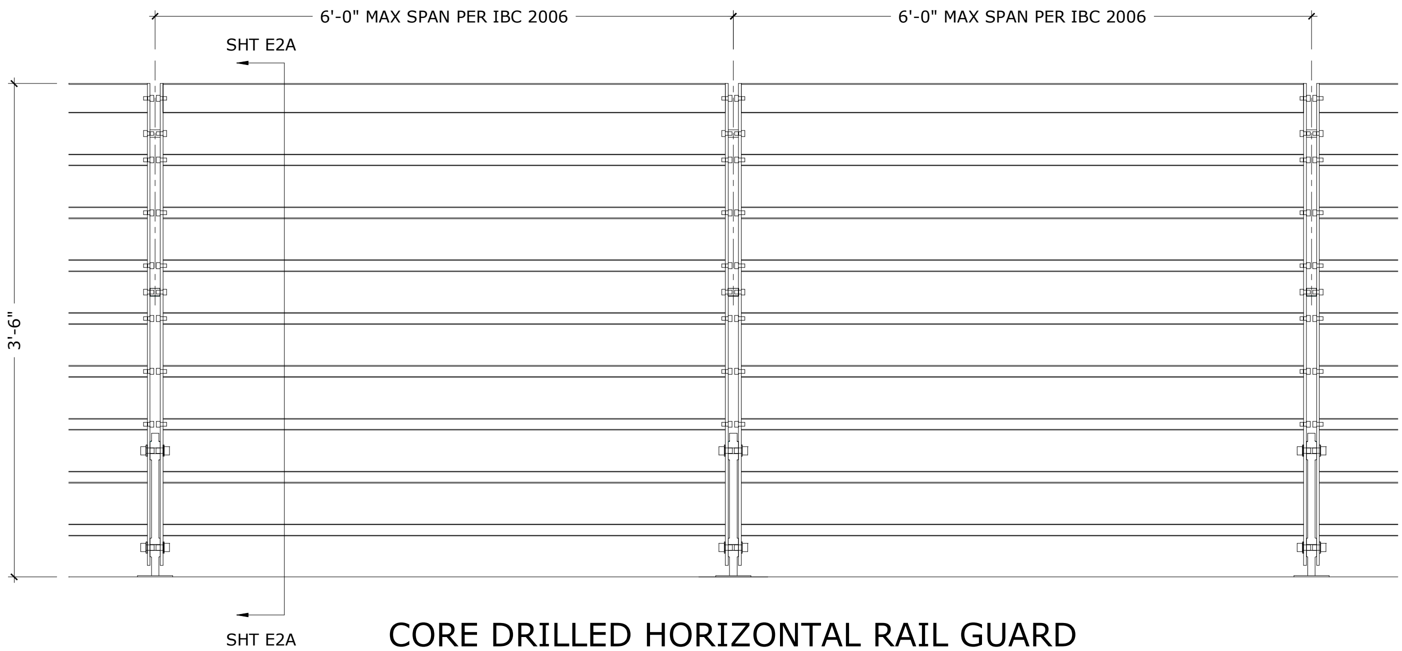
* ***Top Rail, See Sht 1-1A***
* ***Mid-Rail, See Sht 2-2A***
* ***Posts, See Sht 3***
* ***Anchorage, See Sht 4***
* ***Cast Post Stem & Base Plate, See Sht 7***

RICE
ENGINEERING

105 School Creek Trail
Luxemburg, WI 54217
Phone: (920)845-1042
Fax: (920)845-1048
www.rice-inc.com

Job No:	08-01-15C		
Engineer:	KEP	Sheet No:	E1
Date:	1/24/08	Rev:	8/15/08
Chk By:	MPM	Date:	8/15/08

Elevation- Horizontal Rails	SHT E1A



CORE DRILLED HORIZONTAL RAIL GUARD

* ***Top Rail, See Sht 1-1A***
* ***Mid-Rail, See Sht 2-2A***
* ***Posts, See Sht 3***
* ***Anchorage, See Sht 4A***
* ***Post Stem, See Sht 7A***

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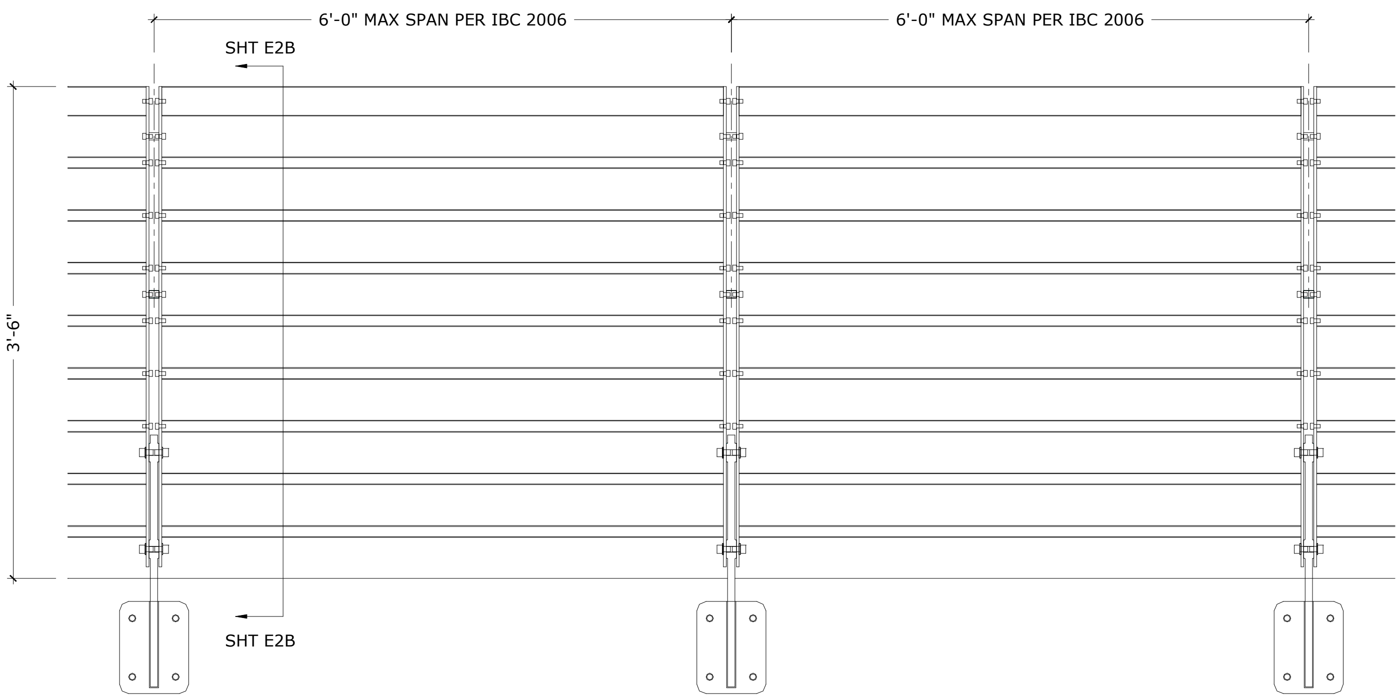
			Engineer: KEP	Sheet No: E1A
			Date: 1/24/08	Rev: 8/15/08
			Chk By: MPM	Date: 8/15/08

Elevation- Horizontal Rails	SHT E1B



SIDE MOUNTED HORIZONTAL RAIL GUARD

* ***Top Rail, See Sht 1-1A***
* ***Mid-Rail, See Sht 2-2A***
* ***Posts, See Sht 3***
* ***Anchorage, See Sht 4B***
* ***Post Stem & Side Plate, See Sht 7B***

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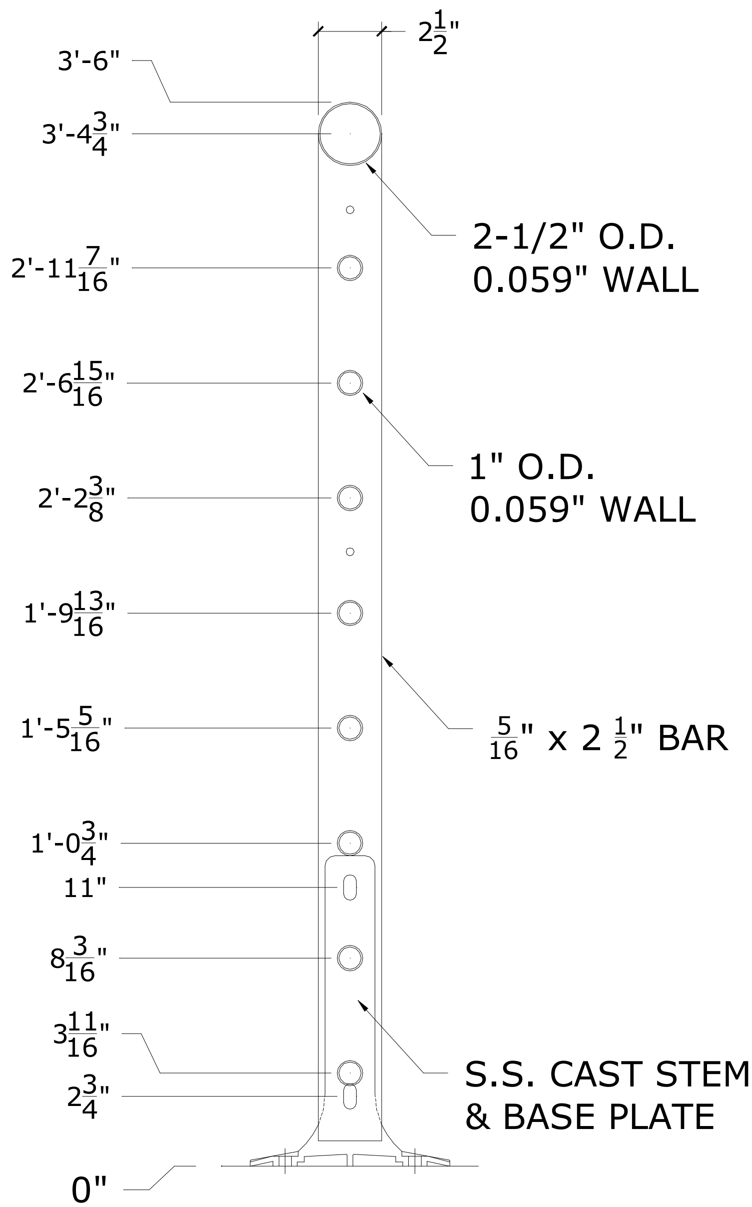
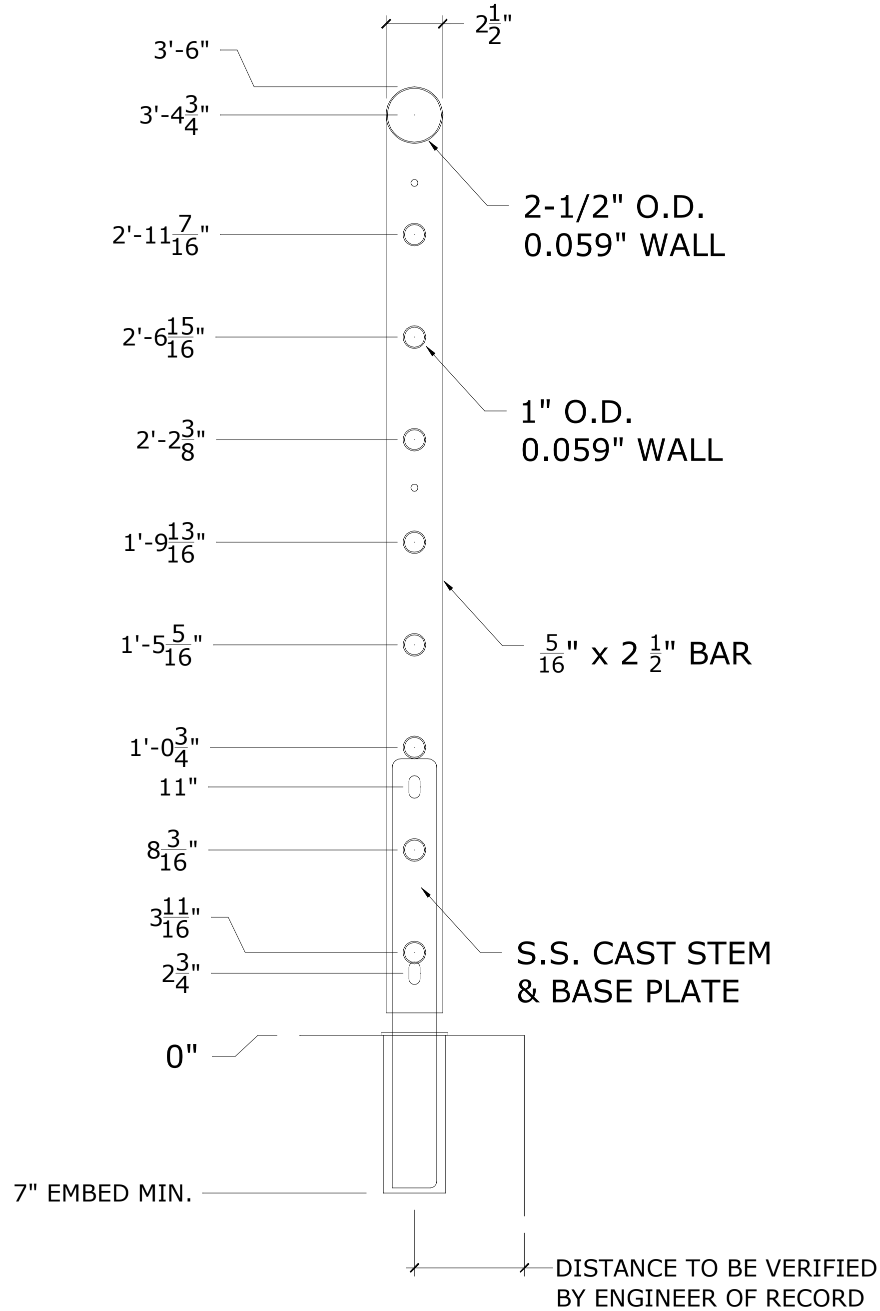
			Engineer: KEP	Sheet No: E1B
			Date: 1/24/08	Rev: 8/15/08
			Chk By: MPM	Date: 8/15/08



SURFACE MOUNT HORIZONTAL RAIL SECTION

Section- Horizontal Rails	SHT E2A



CORE DRILLED HORIZONTAL RAIL SECTION

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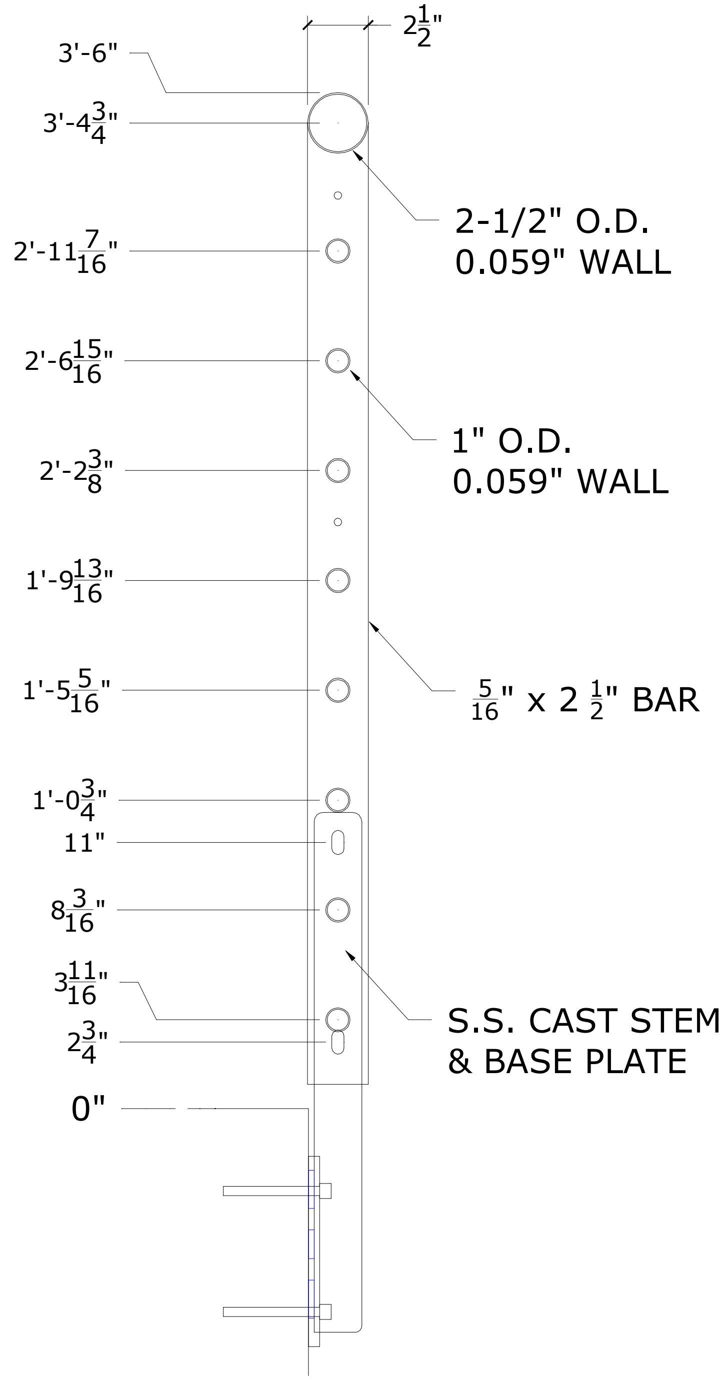
			Engineer: KEP	Sheet No: E2A
			Date: 1/24/08	Rev: 8/15/08
			Chk By: MPM	Date: 8/15/08

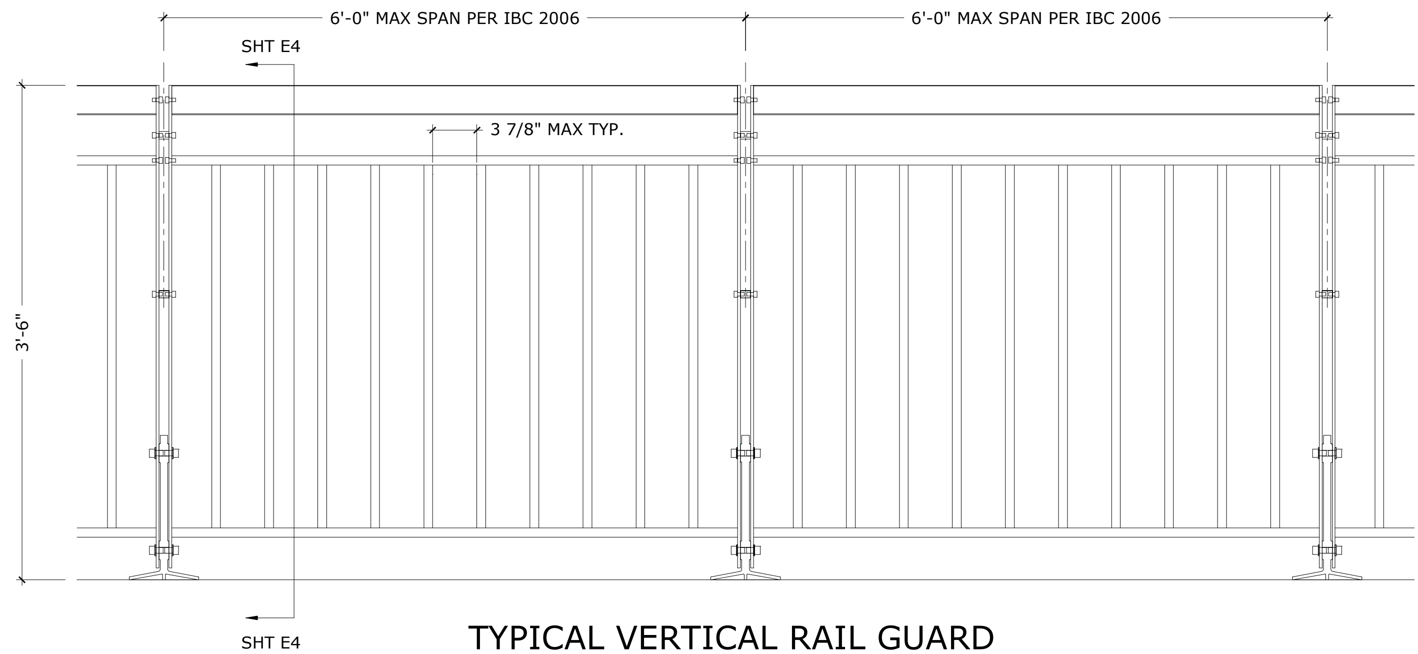
Section- Horizontal Rails	SHT E2B



SIDE MOUNTED HORIZONTAL RAIL SECTION

RICE ***ENGINEERING***	105 School Creek Trail Luxemburg, WI 54217 Phone: (920)845-1042 Fax: (920)845-1048 www.rice-inc.com	Steel Studio USA	Job No: 08-01-15C	
			Engineer: KEP	Sheet No: E2B
			Date: 1/24/08	Rev: 8/15/08
			Chk By: MPM	Date: 8/15/08

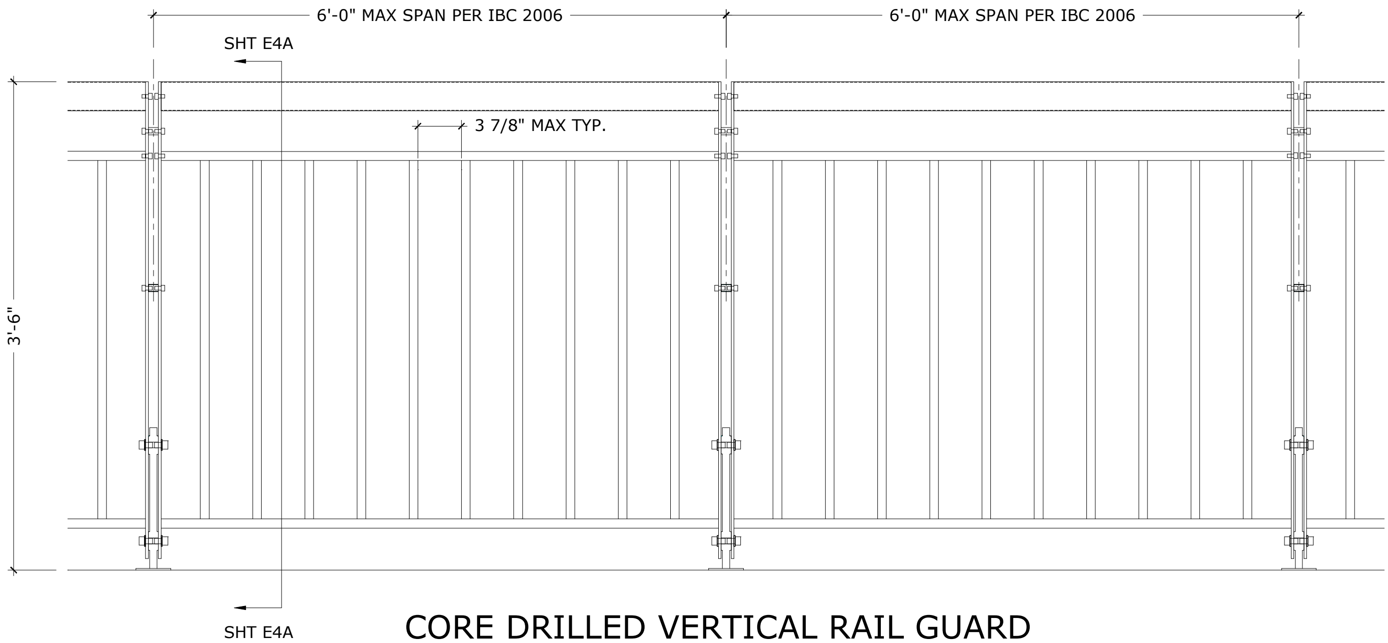
Elevation- Vertical Rails	SHT E3



TYPICAL VERTICAL RAIL GUARD

* ***Top Rail, See Sht 1-1A***
* ***Picket Infill System, See Sht 2B***
* ***Posts, See Sht 3***
* ***Anchorage, See Sht 4***
* ***Cast Post Stem & Base Plate, See Sht 7***

Elevation- Vertical Rails	SHT E3A



CORE DRILLED VERTICAL RAIL GUARD

* ***Top Rail, See Sht 1-1A***
* ***Picket Infill System, See Sht 2B***
* ***Posts, See Sht 3***
* ***Anchorage, See Sht 4A***
* ***Post Stem, See Sht 7A***

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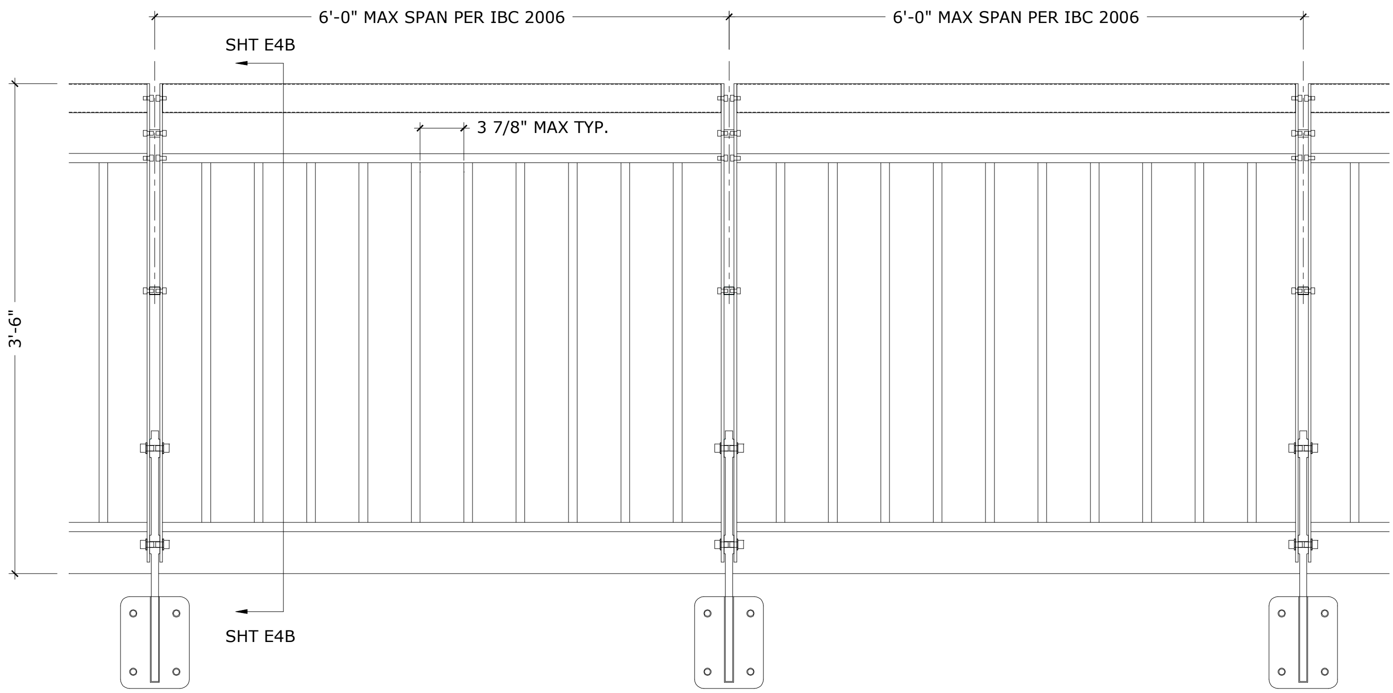
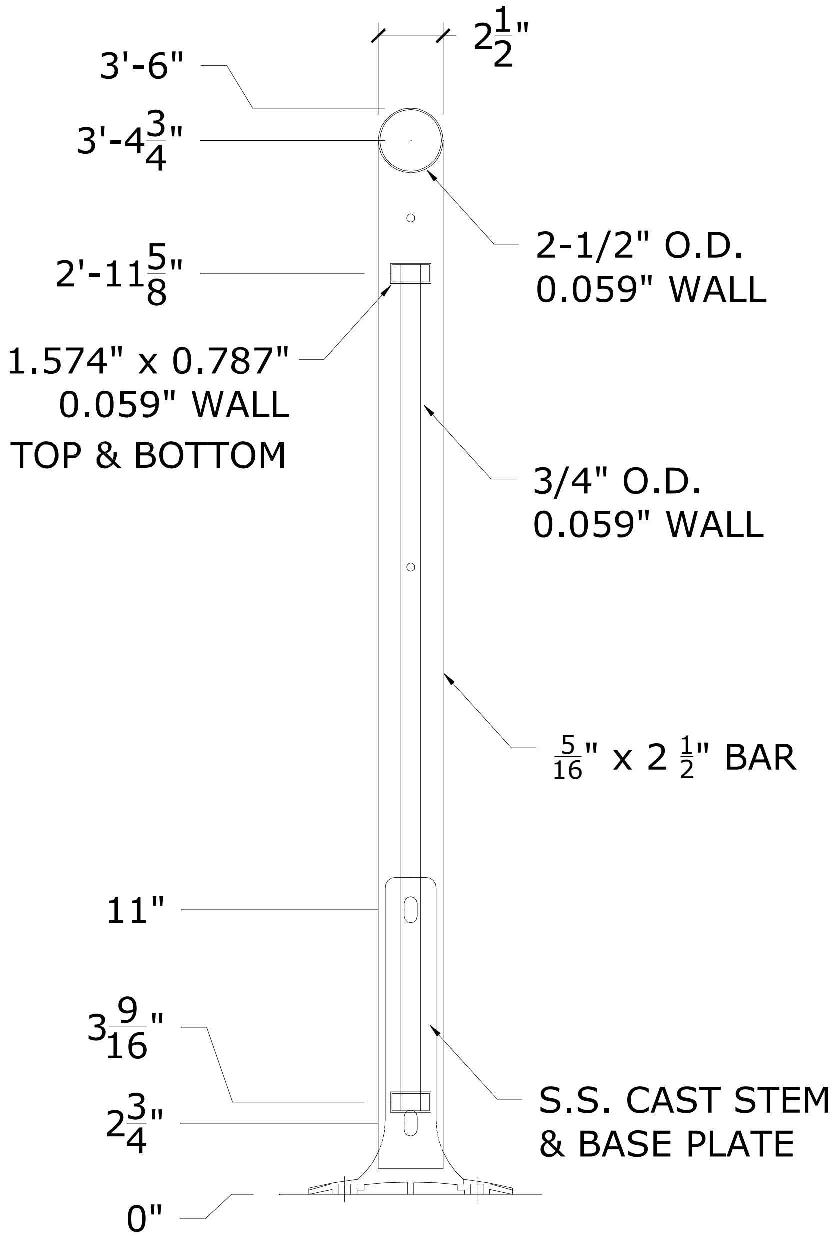
Job No:	08-01-15C		
Engineer:	KEP	Sheet No:	E3A
Date:	1/24/08	Rev:	8/15/08
Chk By:	MPM	Date:	8/15/08

Elevation- Vertical Rails	SHT E3B



SIDE MOUNTED VERTICAL RAIL GUARD

* ***Top Rail, See Sht 1-1A***
* ***Picket Infill System, See Sht 2B***
* ***Posts, See Sht 3***
* ***Anchorage, See Sht 4B***
* ***Post Stem & Side Plate, See Sht 7B***



SURFACE MOUNT VERTICAL RAIL SECTION

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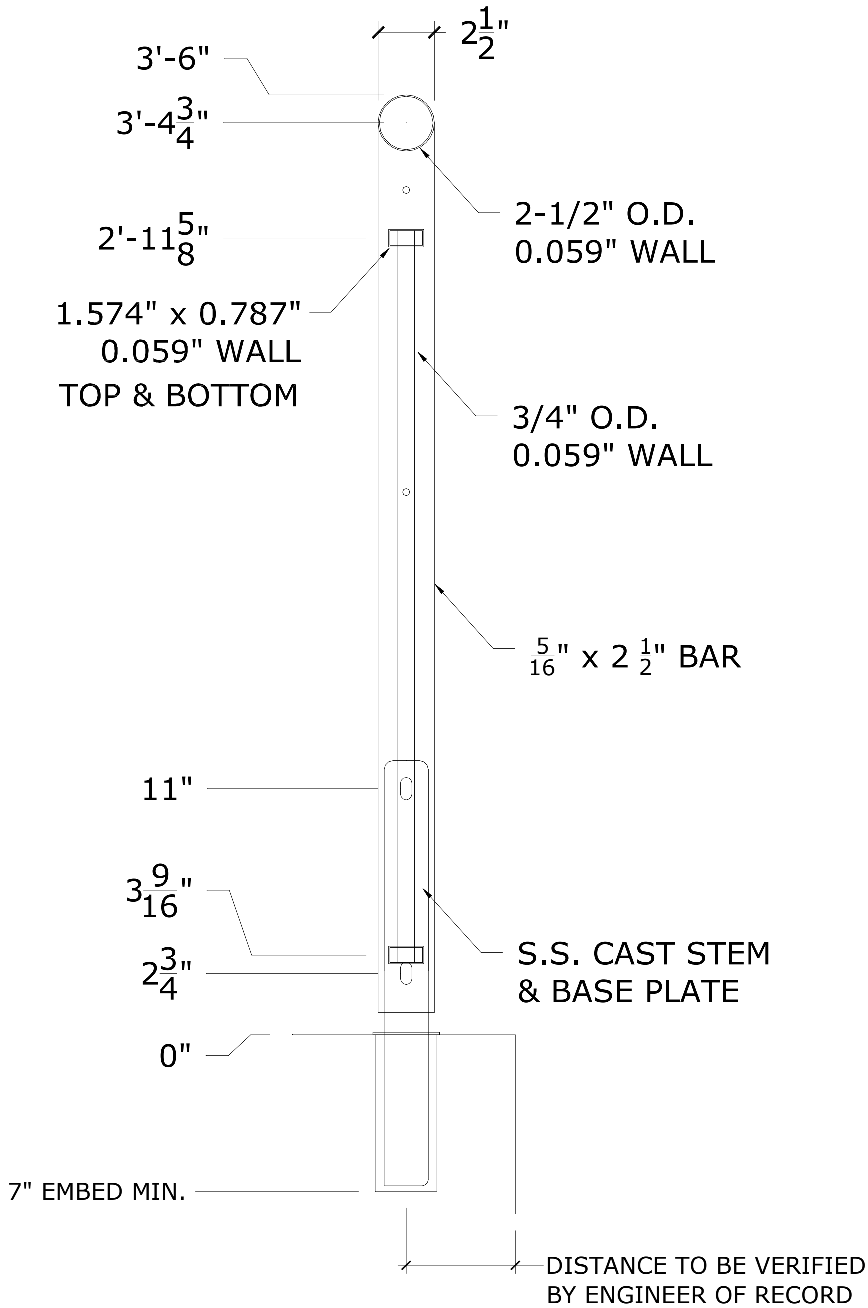
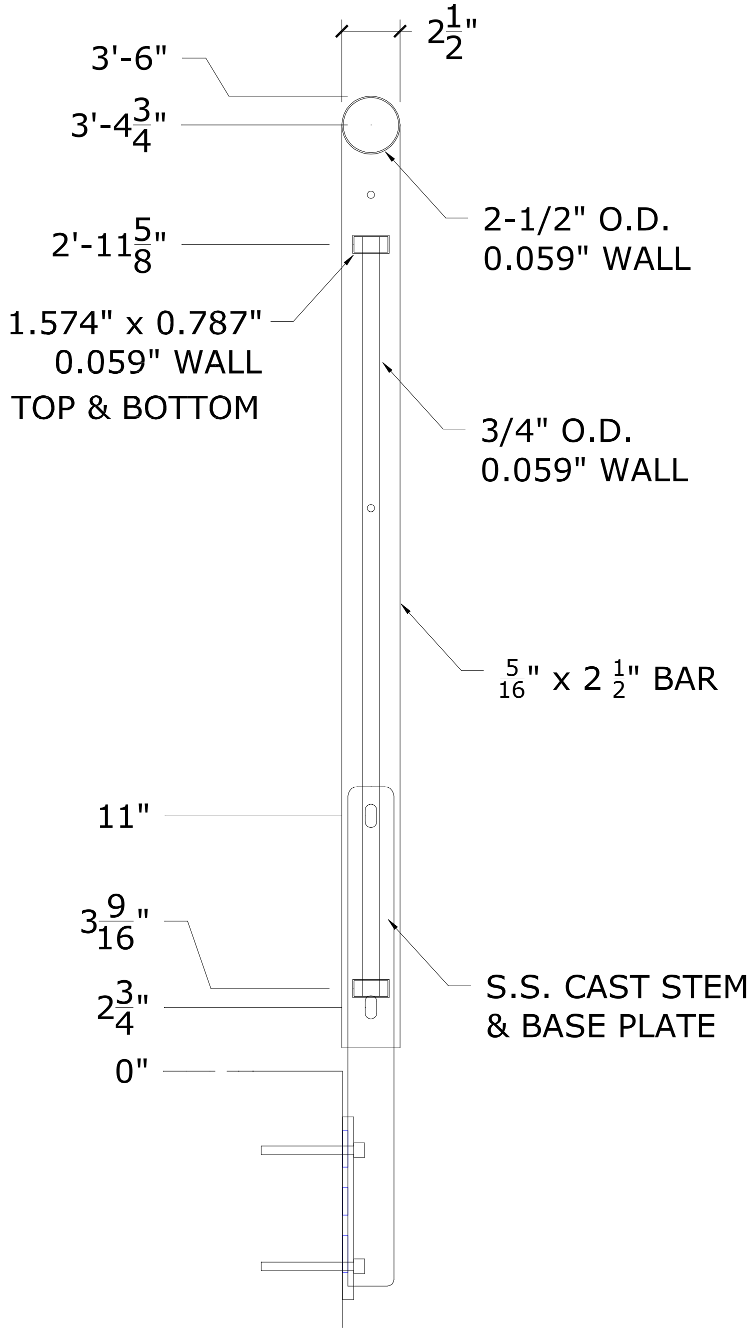
Steel Studio USA

Job No:	08-01-15C		
Engineer:	KEP	Sheet No:	E4
Date:	1/24/08	Rev:	8/15/08
Chk By:	MPM	Date:	8/15/08



CORE DRILLED VERTICAL RAIL SECTION

Section- Vertical Rails	SHT E4B



SIDE MOUNTED VERTICAL RAIL SECTION

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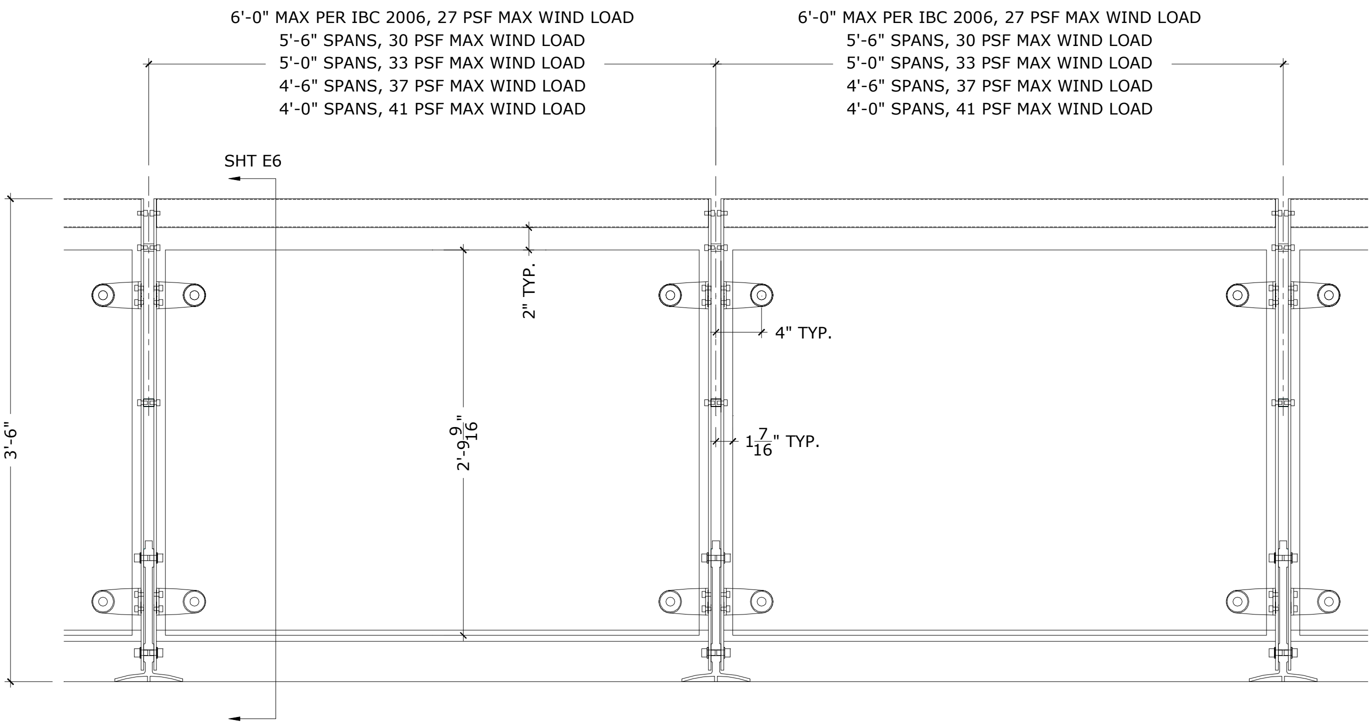
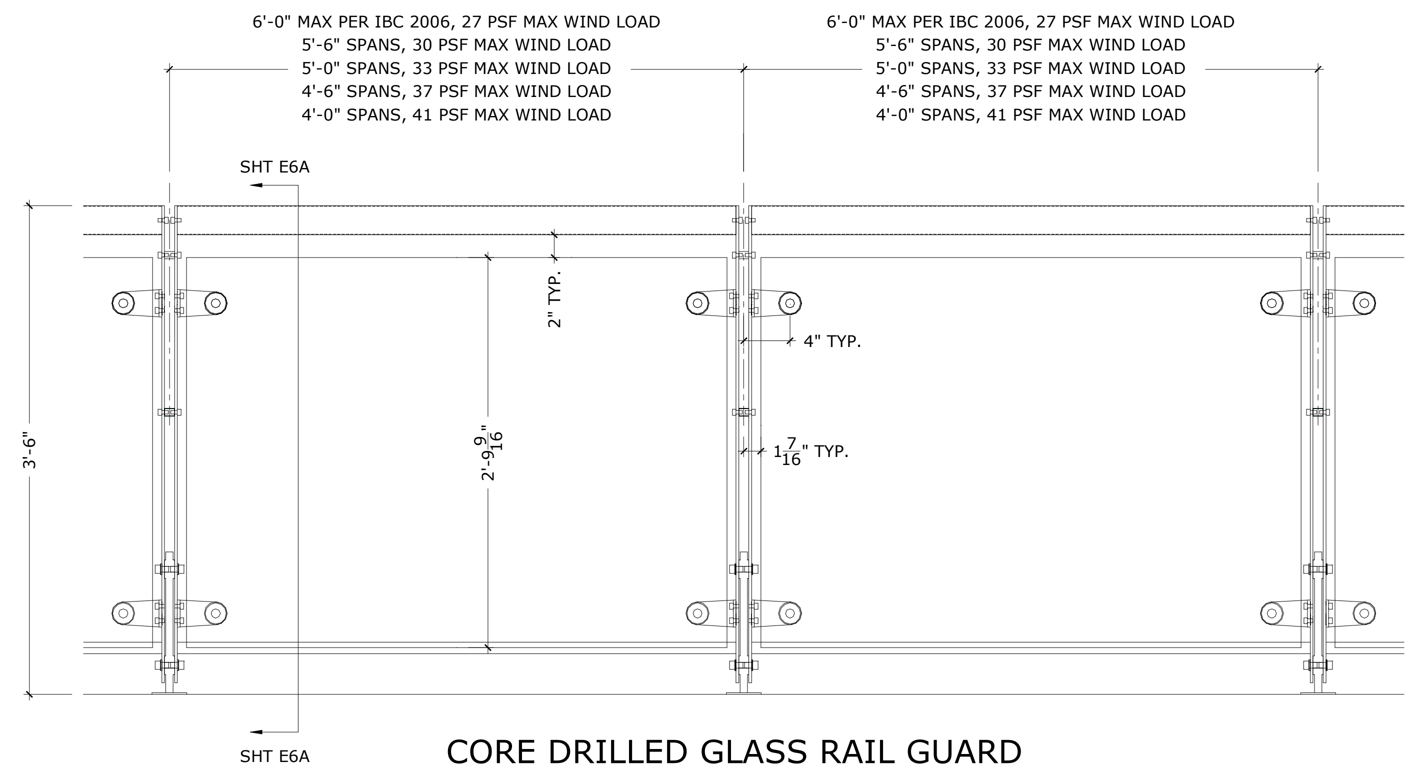
			Engineer:	KEP	Sheet No:	E4B
			Date:	1/24/08	Rev:	8/15/08
			Chk By:	MPM	Date:	8/15/08



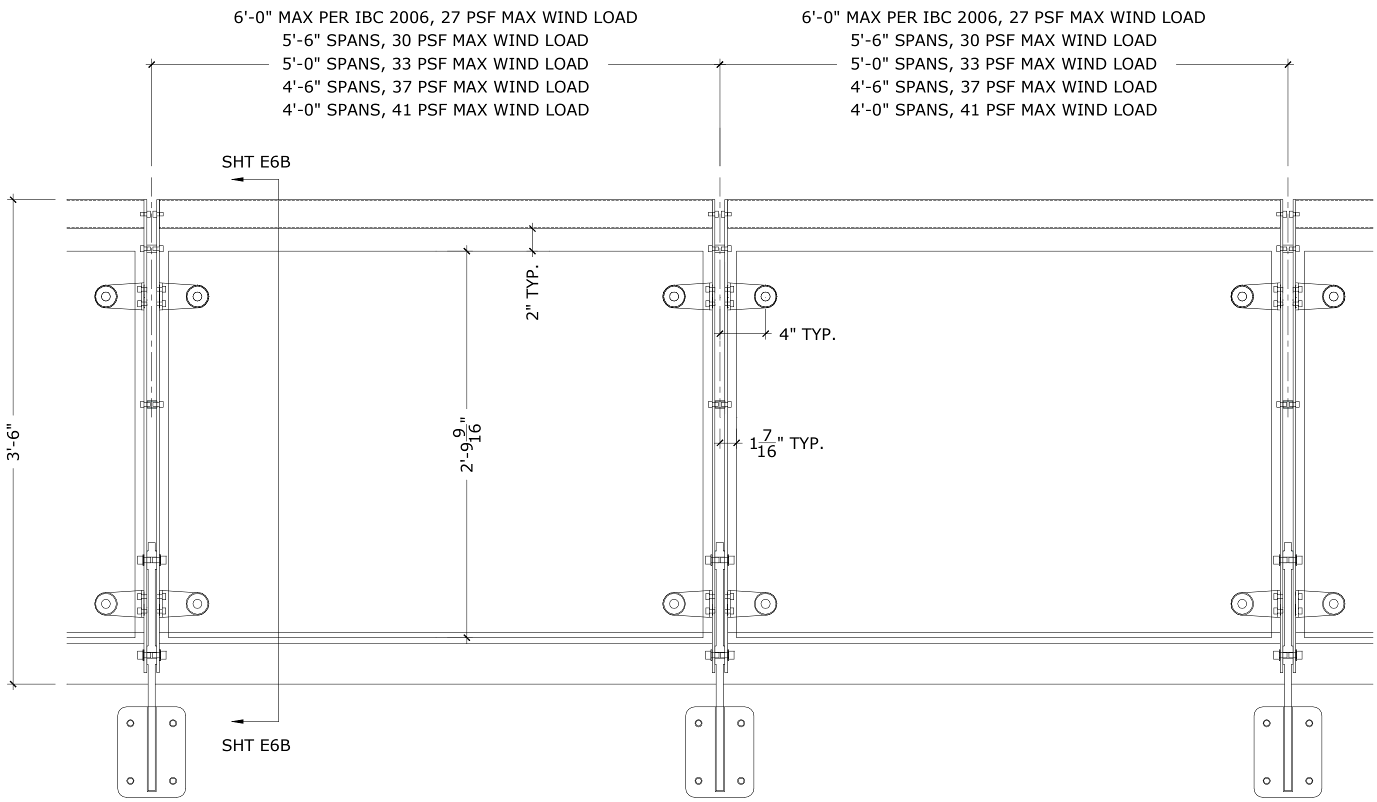
TYPICAL GLASS RAIL GUARD

* ***Top Rail, See Sht 1-1A***
* ***Posts, See Sht 3***
* ***Glass & Glass Brackets, See Shts 5-5E***
* ***Anchorage, See Shts 4 & 6***
* ***Cast Post Stem & Base Plate, See Sht 7***



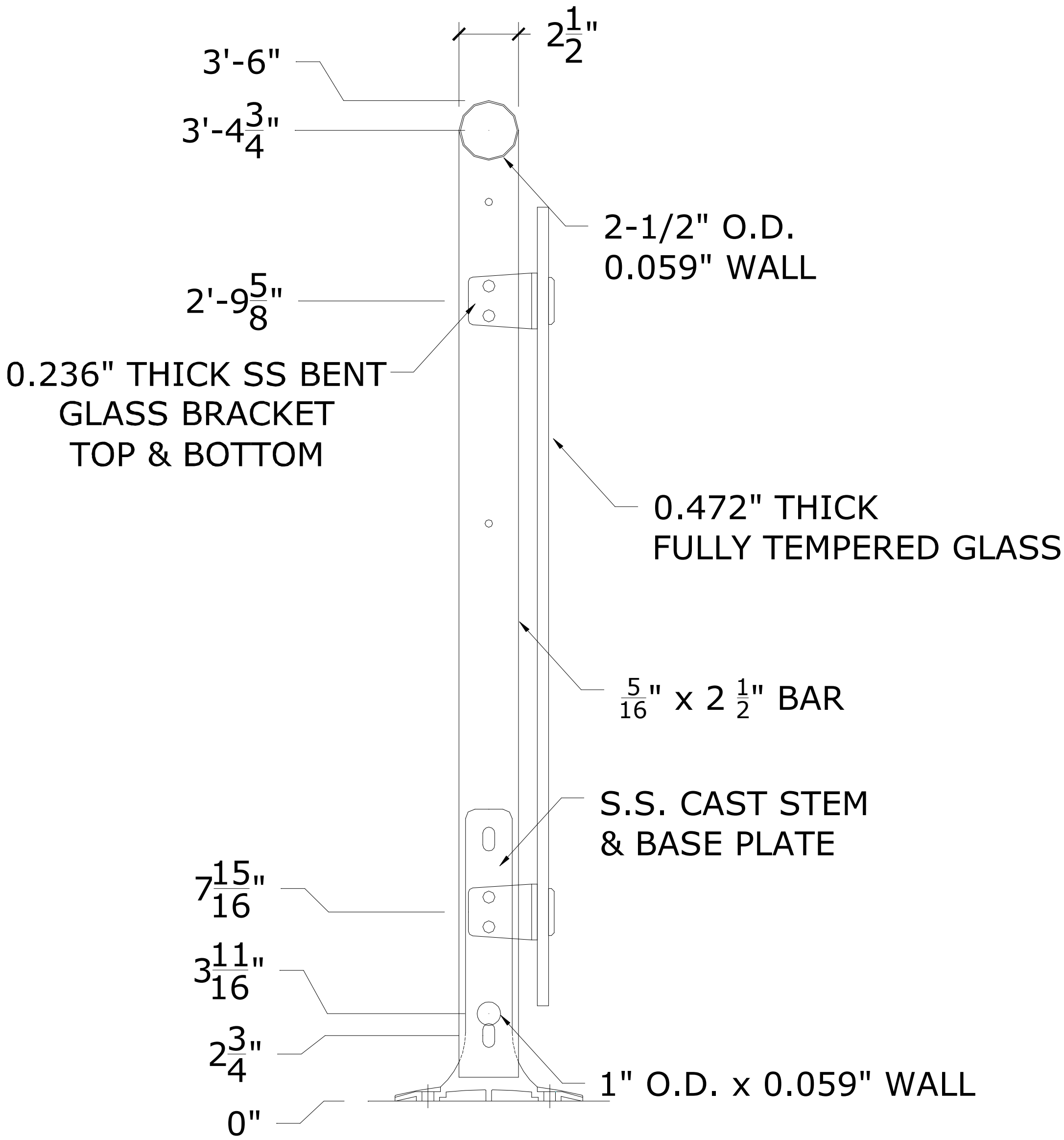
CORE DRILLED GLASS RAIL GUARD

* ***Top Rail, See Sht 1-1A***
* ***Posts, See Sht 3***
* ***Glass & Glass Brackets, See Shts 5-5E***
* ***Anchorage, See Shts 4A & 6A***
* ***Post Stem, See Sht 7A***

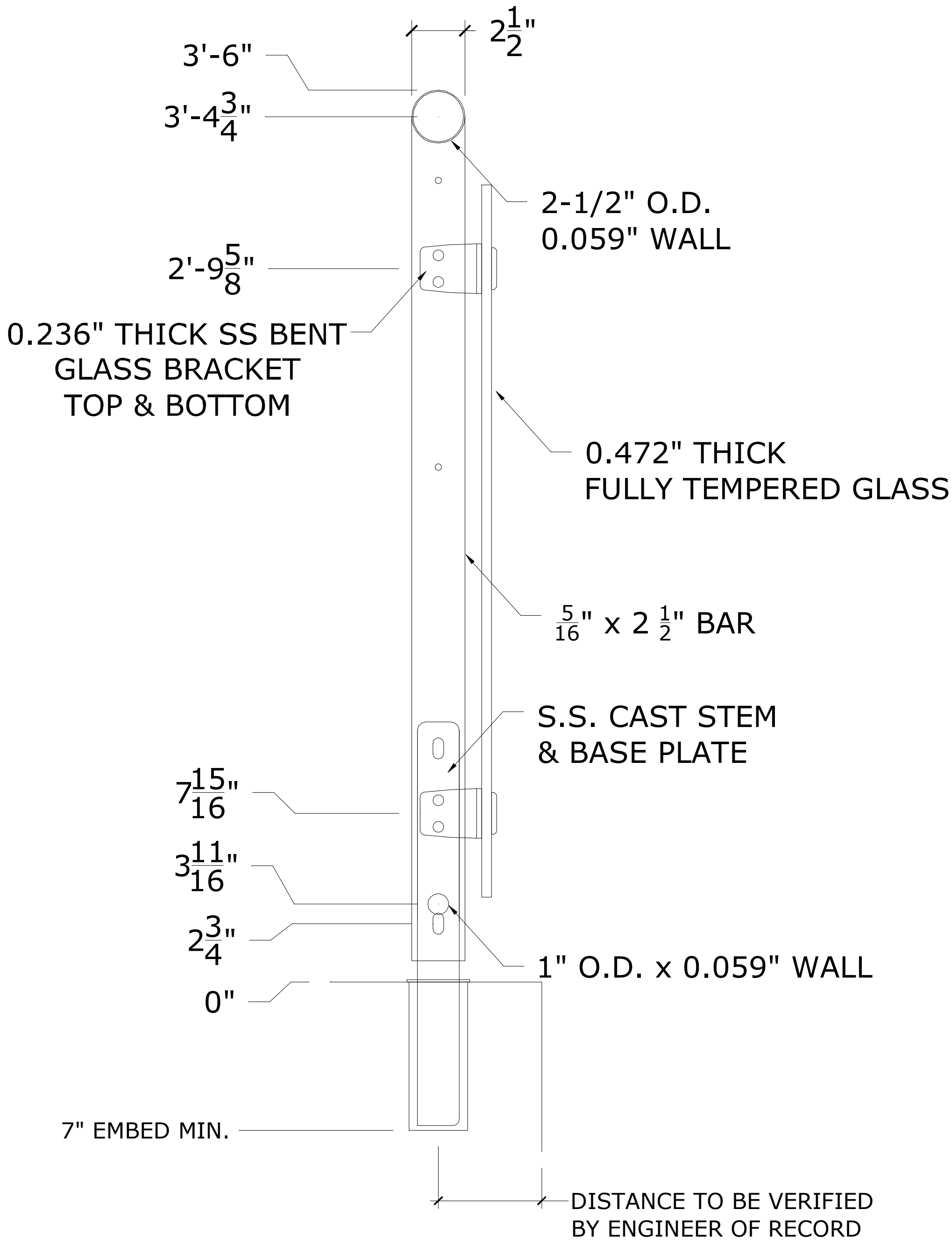


SIDE MOUNTED GLASS RAIL GUARD

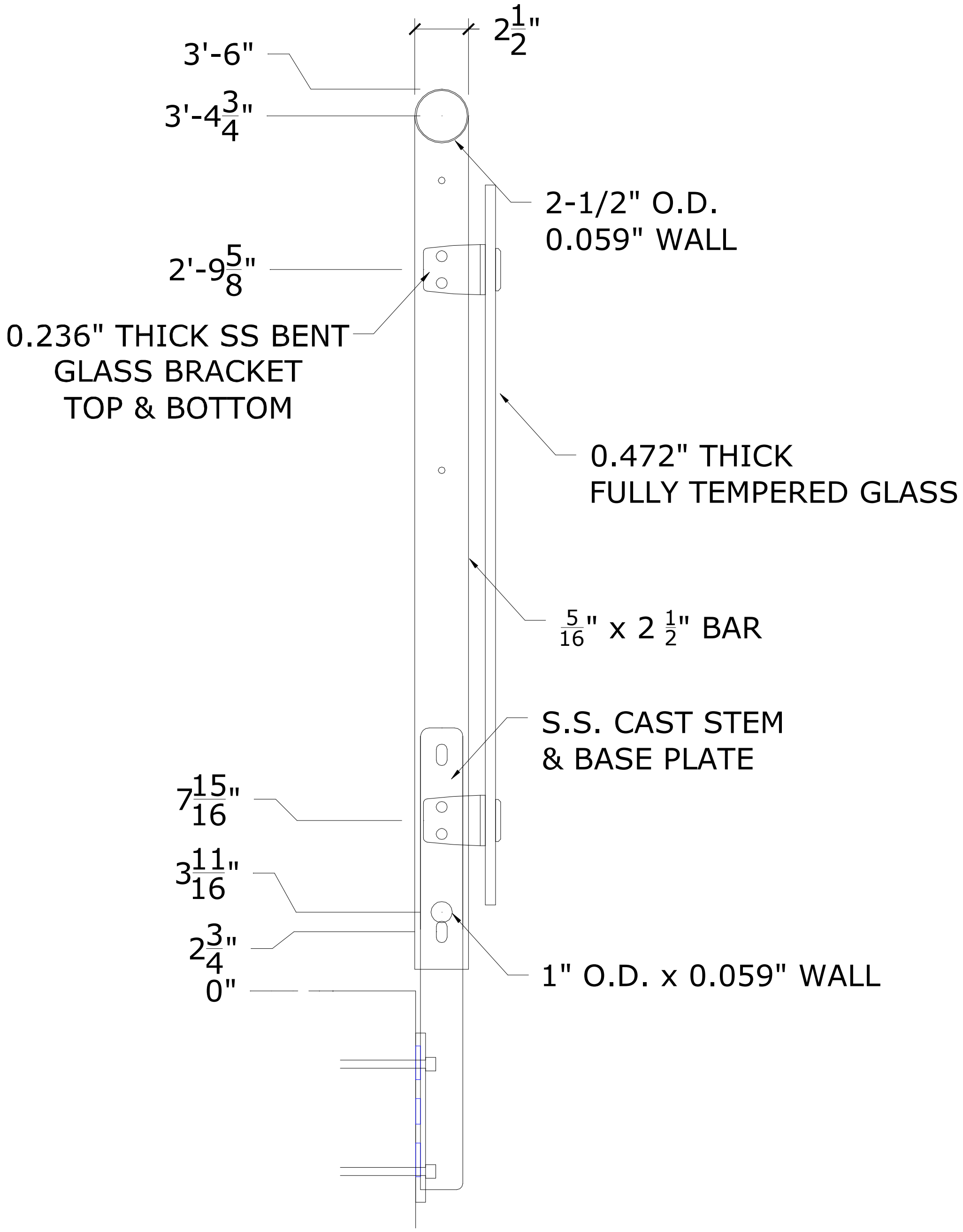
* ***Top Rail, See Sht 1-1A***
* ***Posts, See Sht 3***
* ***Glass & Glass Brackets, See Shts 5-5E***
* ***Anchorage, See Shts 4B & 6B***
* ***Post Stem & Side Plate, See Sht 7B***



SURFACE MOUNT GLASS RAIL SECTION



CORE DRILLED GLASS RAIL SECTION



SIDE MOUNTED GLASS RAIL SECTION

Pipe Handrail

These calculations are based on emperical test data performed by Julius Blum & Co., Inc.

Top Rail Analysis	SHT 1

Input Variables:

$F_H := 50$ $\frac{lb}{ft}$ Load Case 1 (Uniform Load)

$F_V := 0$ $\frac{lb}{ft}$ Optional vertical uniform load

$P := 200$ lb Load Case 2 (Point Load)

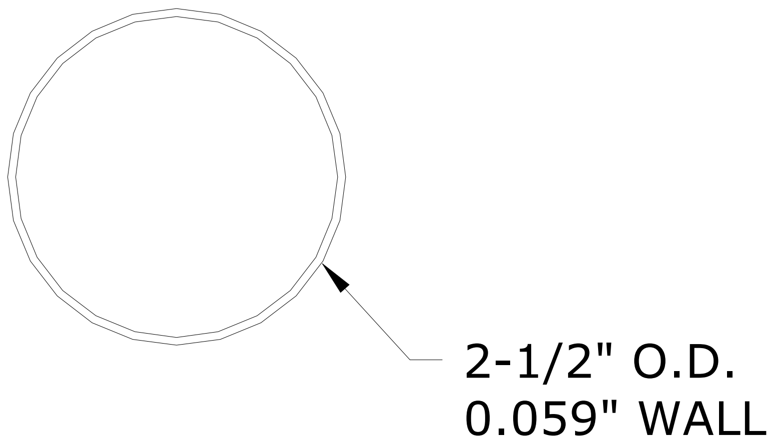
$L := 72$ in ***MAX POST SPACING (cl to cl)***

Number of Railing Spans:

- [x] 1 span
- [ ] 2 span
- [ ] 3 or more spans

Railing Section:

- [x] 2-1/2" O.D. x 0.059" Wall
- [ ] 1 1/4" Schd. 80
- [ ] 1 1/2" Schd. 40
- [ ] 1 1/2" Schd. 80
- [ ] 1 1/2" tube
- [ ] 2" Schd. 40
- [ ] 2" Schd. 80



Railing Temper:

- [ ] 6063-T5
- [ ] 6063-T6
- [x] Stainless Steel (304A or 316A)

- [x] *4/3 increase allowed*

All calculations below this line are automatic

Railing Properties

Ixr=	0.337
Iyr=	0.337
Sxr=	0.27
Syr=	0.27
R=	1.25
t=	0.059

<u>Computational Factors</u>

$K_1 := (8 \cdot q1) + (8 \cdot q2) + (9.5 \cdot q3)$ $K_1 = 8$

$K_2 := (4 \cdot q1) + (5 \cdot q2) + (5 \cdot q3)$ $K_2 = 4$

$K_3 := (48 \cdot q1) + (66 \cdot q2) + (87 \cdot q3)$ $K_3 = 48$

$I_{xtotr} := I_{xr}$

$I_{ytotr} := I_{yr}$

Railing Analysis:

Case 1 Uniform Load:

$L_{br} := L$

$$E_r := \begin{cases} 28000000 & \text{if } S_r = 1 \\ 10100000 & \text{otherwise} \end{cases}$$

Top Rail Analysis	SHT 1A

$$\Delta_{yr1} := \left[\frac{5\cdot\left(\frac{F_H}{12}\right)\cdot L^4}{384\cdot E_r\cdot I_{ytotr}}\right]$$ $\Delta_{yr1} = 0.155$ in Modeled as a simple span

$$\Delta_{xr1} := \left[\frac{5\cdot\left(\frac{F_V}{12}\right)\cdot L^4}{384\cdot E_r\cdot I_{xtotr}}\right]$$ $\Delta_{xr1} = 0$ in

$$\Delta_{allr} := \frac{L}{120}$$ $\Delta_{allr} = 0.6$ in

$$M_{yrmax} := \frac{\frac{F_H}{12}\cdot L^2}{K_1}$$ $M_{yrmax} = 2700$ lb·in

$$M_{xrmax} := \frac{\frac{F_V}{12}\cdot L^2}{K_1}$$ $M_{xrmax} = 0$ lb·in

$F_{bry1} := 0.66\cdot(35000)$ $F_{bry1} = 23100$ psi

$F_{brx1} := F_{bry1}$ $F_{brx1} = 23100$ psi

$$f_{bry1} := \frac{M_{yrmax}\cdot\left[I_{yr}\cdot(1 + 1.8S_r)\right]}{S_{yr}\cdot I_{ytotr}}$$ $f_{bry1} = 28000$ psi

$$f_{brx1} := \frac{M_{xrmax}\cdot\left[I_{xr}\cdot(1 + 1.8\cdot S_r)\right]}{S_{xr}\cdot I_{xtotr}}$$ $f_{brx1} = 0$ psi

Case 1 Point Load:

$$\Delta_{y3r} := \frac{P\cdot L^3}{K_3\cdot E_r\cdot I_{ytotr}}$$ $\Delta_{y3r} = 0.165$ in

$$\Delta_{y4r} := \frac{P\cdot L^3}{K_3\cdot E_r\cdot I_{xtotr}}$$ $\Delta_{y4r} = 0.165$ in

$$M_{yrmax2} := \frac{P\cdot L}{K_2}$$ $M_{yrmax2} = 3600$ lb·in

$$M_{xrmax2} := \frac{P\cdot L}{K_2}$$ $M_{xrmax2} = 3600$ lb·in

$$f_{bry2} := \frac{M_{yrmax2}\cdot I_{yr}}{S_{yr}\cdot I_{ytotr}}$$

$$f_{brx2} := \frac{M_{xrmax2}\cdot I_{xr}}{S_{xr}\cdot I_{xtotr}}$$ $f_{brx2} = 13333$ psi

$f_{bry2} = 13333$ psi

$$F_{bry} := \begin{cases} (F_{bry1}\cdot 1.34) & \text{if IBC} = 1 \\ F_{bry1} & \text{otherwise} \end{cases}$$

Calculation Results:

$$Int_{r1} := \left(\frac{f_{brx1}}{F_{brx1}}\right) + \left(\frac{f_{bry1}}{F_{bry}}\right)$$

$$Int_{r2} := \max\left[\left(\frac{f_{brx2}}{F_{brx1}}\right), \left(\frac{f_{bry2}}{F_{bry1}}\right)\right]$$

$$Rail := \begin{cases} \text{"HANDRAIL OK"} & \text{if } \max(Int_{r1}, Int_{r2}) \le 1.07 \\ \text{"HANDRAIL OVERSTRESSED"} & \text{otherwise} \end{cases}$$

$Int_{r1} = 0.9$ $Int_{r2} = 0.58$ Rail = "HANDRAIL OK"

Pipe Handrail

These calculations are based on emperical test data performed by Julius Blum & Co., Inc.

Mid Rail Analysis	SHT 2

Input Variables:

$F_H := 0 \quad \frac{lb}{ft}$ Load Case 1 (Uniform Load)

$F_V := 0 \quad \frac{lb}{ft}$ Optional vertical uniform load

$P := 50 \quad lb$ Load Case 2 (Point Load)

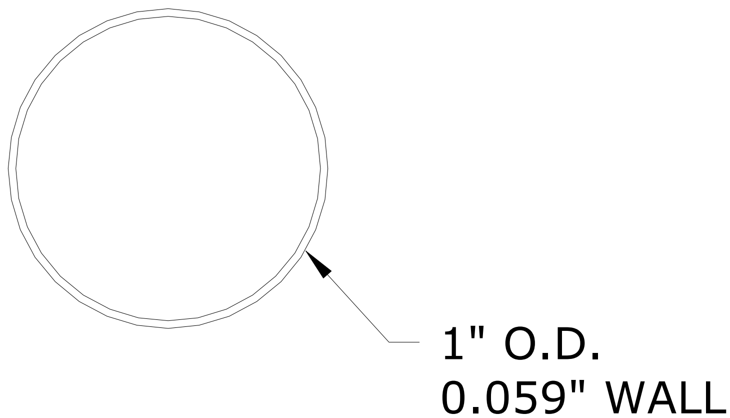
$L := 72 \quad in$ ***MAX POST SPACING (cl to cl)***

Number of Railing Spans:

1 span ☑

2 span ☐

3 or more spans ☐



Railing Section:

☑ 1" O.D. x 0.059" Wall

☐ 1 1/4" Schd. 80

☐ 1 1/2" Schd. 40

☐ 1 1/2" Schd. 80

☐ 1 1/2" tube

☐ 2" Schd. 40

☐ 2" Schd. 80

Railing Temper:

☐ 6063-T5

☐ 6063-T6

☑ Stainless Steel (304A or 316A)

All calculations below this line are automatic

Railing Properties

Ixr=	0.019
Iyr=	0.019
Sxr=	0.039
Syr=	0.039
R=	0.5
t=	0.059

Computational Factors

$K_1 := (8 \cdot q1) + (8 \cdot q2) + (9.5 \cdot q3) \qquad K_1 = 8$

$K_2 := (4 \cdot q1) + (5 \cdot q2) + (5 \cdot q3) \qquad K_2 = 4$

$K_3 := (48 \cdot q1) + (66 \cdot q2) + (87 \cdot q3) \qquad K_3 = 48$

$I_{xtotr} := I_{xr}$

$I_{ytotr} := I_{yr}$

Railing Analysis:

$L_{br} := L$

$E_r := \begin{cases} 28000000 & \text{if } S_r = 1 \\ 10100000 & \text{otherwise} \end{cases}$

Mid Rail Analysis	SHT 2A

Case 1 Uniform Load:

$\Delta_{yr1} := \left[\dfrac{5\cdot\left(\frac{F_H}{12}\right)\cdot L^4}{384\cdot E_r\cdot I_{ytotr}}\right]$ $\Delta_{yr1} = 0$ in Modeled as a simple span

$\Delta_{xr1} := \left[\dfrac{5\cdot\left(\frac{F_V}{12}\right)\cdot L^4}{384\cdot E_r\cdot I_{xtotr}}\right]$ $\Delta_{xr1} = 0$ in

$\Delta_{allr} := \dfrac{L}{120}$ $\Delta_{allr} = 0.6$ in Per ASTM Specification E985

$M_{yrmax} := \dfrac{\frac{F_H}{12}\cdot L^2}{K_1}$ $M_{yrmax} = 0$ lb·in

$M_{xrmax} := \dfrac{\frac{F_V}{12}\cdot L^2}{K_1}$ $M_{xrmax} = 0$ lb·in

$F_{bry1} := 0.66\cdot(35000)$ $F_{bry1} = 23100$ psi

$F_{brx1} := F_{bry1}$ $F_{brx1} = 23100$ psi

$f_{bry1} := \dfrac{M_{yrmax}\cdot\left[I_{yr}\cdot\left(1 + 1.8S_r\right)\right]}{S_{yr}\cdot I_{ytotr}}$ $f_{bry1} = 0$ psi

$f_{brx1} := \dfrac{M_{xrmax}\cdot\left[I_{xr}\cdot\left(1 + 1.8\cdot S_r\right)\right]}{S_{xr}\cdot I_{xtotr}}$ $f_{brx1} = 0$ psi

Case 1 Point Load:

$\Delta_{y3r} := \dfrac{P\cdot L^3}{K_3\cdot E_r\cdot I_{ytotr}}$ $\Delta_{y3r} = 0.731$ in

$\Delta_{y4r} := \dfrac{P\cdot L^3}{K_3\cdot E_r\cdot I_{xtotr}}$ $\Delta_{y4r} = 0.731$ in

$M_{yrmax2} := \dfrac{P\cdot L}{K_2}$ $M_{yrmax2} = 900$ lb·in

$M_{xrmax2} := \dfrac{P\cdot L}{K_2}$ $M_{xrmax2} = 900$ lb·in

$f_{bry2} := \dfrac{M_{yrmax2}\cdot I_{yr}}{S_{yr}\cdot I_{ytotr}}$

$f_{brx2} := \dfrac{M_{xrmax2}\cdot I_{xr}}{S_{xr}\cdot I_{xtotr}}$

$f_{brx2} = 23077$ psi

$f_{bry2} = 23077$ psi

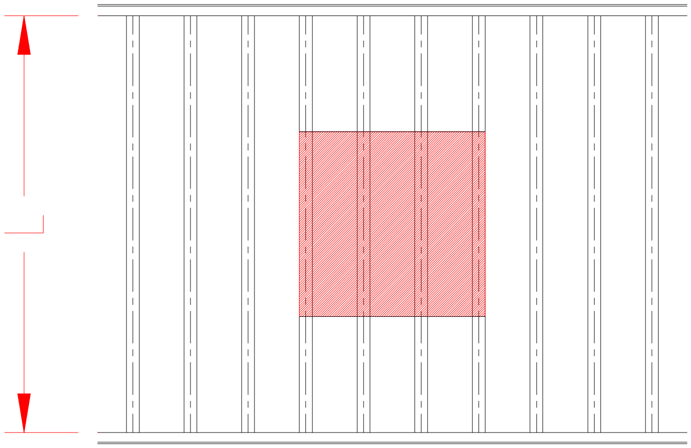
Calculation Results:

$Int_{r1} := \left(\dfrac{f_{brx1}}{F_{brx1}}\right) + \left(\dfrac{f_{bry1}}{F_{bry1}}\right)$ $Int_{r2} := \max\left[\left(\dfrac{f_{brx2}}{F_{brx1}}\right), \left(\dfrac{f_{bry2}}{F_{bry1}}\right)\right]$

$Rail := \begin{cases} \text{"HANDRAIL OK"} & \text{if } \max\left(Int_{r1}, Int_{r2}\right) \le 1.07 \\ \text{"HANDRAIL OVERSTRESSED"} & \text{otherwise} \end{cases}$

Rail = "HANDRAIL OK"

$Int_{r1} = 0$ $Int_{r2} = 1$



Pipe Picket Infill Analysis	SHT 2B

Pipe Properties:

Input D: 0.75 in.

Input t: 0.059 in.

==========================

A_m= 0.407716 in^2

P_m= 2.263518 in.

J= 0.017 in^4

I= 0.0077 in^4

S= 0.020534 in^3

S_r= 5.855932

Tube Properties:

Input B: 0.787 in.
Input D: 1.574 in.
Input t: 0.059 in.
Input L_b: 4.5 in.

=========================

A_m= 1.10292 in^2

A= 0.264674 in^2

P_m= 4.486 in.

J= 0.064 in^4

I_x= 0.083666 in^4

I_y= 0.027607 in^4

S_x= 0.10631 in^3

S_y= 0.070157 in^3

Chk Pickets:

$L := 30.819$ in $\quad A := \frac{L-12}{2} \quad C := A$

$A = 9.41$ in

$B := 12$ in

$C = 9.41$ in

$I_y := 0.0077$ in^4

$S_x := 0.0205$ in^3

$S_r := 5.86$

$Load := 50$ psf

$Trib := 4.5$ in

$w := \frac{Load \cdot Trib}{144}$ $\quad w = 1.56$ pli

$R1 := \frac{w \cdot B}{2 \cdot L} \cdot (2C + B)$ $\quad R1 = 9.38$ lb

$M := R1 \cdot \left(A + \frac{R1}{2w}\right)$ $\quad M = 116.34$ lb·in

$f_b := \frac{M}{S_x}$ $\quad \boxed{f_b = 5675}$ psi

$S_r = 5.86$

$F_b := 0.66(35000)$ $\quad \boxed{F_b = 23100}$ psi

Use 3/4" O.D. x 0.059" Wall S.S. Pipe 304A Minimum

Chk Intermediate and Bottom Rails:

Input: $I_{x2} := 0.084$ in^4 $\quad S_{x2} := 0.07$ in^3

$I_{y2} := 0.028$ in^4 $\quad S_{y2} := 0.106$ in^3

$P := Load$ $\quad P = 50$ lb

$M_2 := \frac{P \cdot (70.75)}{4}$ $\quad M_2 = 884$ in·lb

$f_{b2} := \frac{M_2}{S_{y2}}$ $\quad f_{b2} = 8343$ psi

Use Rails, As Shown 304A S.S. Minimum

Extruded Railing and Post

These calculations are based on emperical test data performed by Julius Blum & Co., Inc.

Post Analysis	SHT 3

Input Variables:

$F_H := 50$ $\frac{lb}{ft}$ Load Case 1 (Uniform Load)

$F_V := 0$ $\frac{lb}{ft}$ Optional vertical uniform load

$P := 200$ lb Load Case 2 (Point Load)

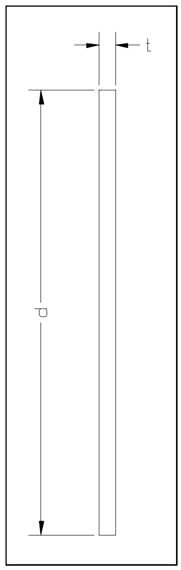
$L_{bp} := 13.5$ in Unbraced Length of Post

$h := 34.5$ in Railing Height

$L := 72$ in **POST SPACING (cl to cl)**

Number of Railing Spans:

- [x] 1 span
- [ ] 2 span
- [ ] 3 or more spans



Input d: 2.5 in.

Input t: 0.313 in.

Input L_b: 13.5 in.

===========================

$A=$ 0.7825 in^2

$I_x=$ 0.4076 in^4

$I_y=$ 0.0064 in^4

$S_x=$ 0.3260 in^3

$S_y=$ 0.0408 in^3

Post Section:

5/16 x 2 1/2

Post Temper:

- [x] S.S. 304A
- [ ] 6061-T6

- [ ] *4/3 increase allowed*
- [ ] Post Welded to Base Plate

All calculations below this line are automatic

Post Properties

Ixp=	0.408
Iyp=	0.0064
Sxp=	0.326
Syp=	0.041
Jp=	0.026
Ep=	10100000
dp=	2.5

$I_{xtotp} := I_{xp}$ $I_{xtotp} = 0.408$ in^4

$I_{ytotp} := I_{yp}$ $I_{ytotp} = 0.006$ in^4

Computational Factors

$K_1 := (8 \cdot q1) + (8 \cdot q2) + (9.5 \cdot q3)$ $K_1 = 8$

$K_2 := (4 \cdot q1) + (5 \cdot q2) + (5 \cdot q3)$ $K_2 = 4$

$K_3 := (48 \cdot q1) + (66 \cdot q2) + (87 \cdot q3)$ $K_3 = 48$

Post Analysis	SHT 3A

Post Analysis:

Case 1 - Uniform Load:

$\Delta_{xp1} := \dfrac{\left(\dfrac{F_H}{12}\right) \cdot L \cdot h^3}{3 \cdot E_p \cdot I_{xtotp}}$ $\Delta_{xp1} = 0.996$ in

$\Delta_{allp} := \dfrac{h}{12}$ $\Delta_{allp} = 2.88$ in Per ASTM E985

$M_{xp} := \left(\dfrac{F_H}{12} \cdot L \cdot h\right) + \left(\dfrac{F_V}{12} \cdot L\right) \cdot \Delta_{xp1}$ $M_{xpmax} := 0.5 \cdot M_{xp} \cdot q1 + M_{xp}q2 + M_{xp} \cdot q3$ $M_{xpmax} = 5175$ lb·in

$F_{bpx1} := 0.6 \cdot (35000)$ $F_{bpx1} = 21000$ psi

$f_{bpx1} := \dfrac{M_{xpmax} \cdot I_{xp}}{S_{xp} \cdot I_{xtotp}}$ $f_{bpx1} = 15874$ psi

Case 2 - Point Load:

$\Delta_{xp2} := \dfrac{P \cdot h^3}{3 \cdot E_p \cdot I_{xtotp}}$ $\Delta_{xp2} = 0.664$ in

$\Delta_{allp} := \dfrac{h}{12}$ $\Delta_{allp} = 2.88$ in Per ASTM E985

$M_{xpmax2} := P \cdot (h) \cdot (0.85)$ $M_{xpmax2} = 5865$ lb·in

$f_{bpx2} := \dfrac{M_{xpmax2} \cdot I_{xp}}{S_{xp} \cdot I_{xtotp}}$ $f_{bpx2} = 17991$ psi

$F_{bpx} := \begin{cases} (F_{bpx1} \cdot 1.34) & \text{if } IBC = 1 \\ F_{bpx1} & \text{otherwise} \end{cases}$

Calculation Results:

$Int_{p1} := \left(\dfrac{f_{bpx1}}{F_{bpx}}\right)$ $Int_{p1} = 0.76$

$Int_{p2} := \left(\dfrac{f_{bpx2}}{F_{bpx}}\right)$ $Int_{p2} = 0.86$

$Post := \begin{cases} \text{"POST OK"} & \text{if } \max(Int_{p1}, Int_{p2}) \le 1.0 \\ \text{"POST OVERSTRESSED"} & \text{otherwise} \end{cases}$ Post = "POST OK"

Anchor Bolts Live Loads	SHT 4

Calculations for Hilti Hit HY150

Assumptions:

Concrete:	f'c = 4,000 psi
Edge Distance:	2-1/2"
Embedment:	3-1/2"

From Sht A1, Maximum Anchor Allowables are:

$T_{all} := 1848$ lb (See Sht A1)

$V_{all} := 551$ lb (See Sht A1)

Inputs:

$L := 6.5$ in

$CF := 0.85$ (Compression Factor)

$h := 34.5$ in (Height of Rail)

Per Sheet 3A, Design Reactions per IBC 2006 are:

$M_1 := 5175 \cdot (2)$ $\quad M_1 = 10350$ in·lb

$V_1 := \frac{M_1}{h}$ $\quad V_1 = 300$ lb

$M_{tot} := 5175 \cdot (2) + V_1 \cdot (6.625)$ $\quad M_{tot} = 12338$ in·lb

Calculated Tension and Shear (per Anchor):

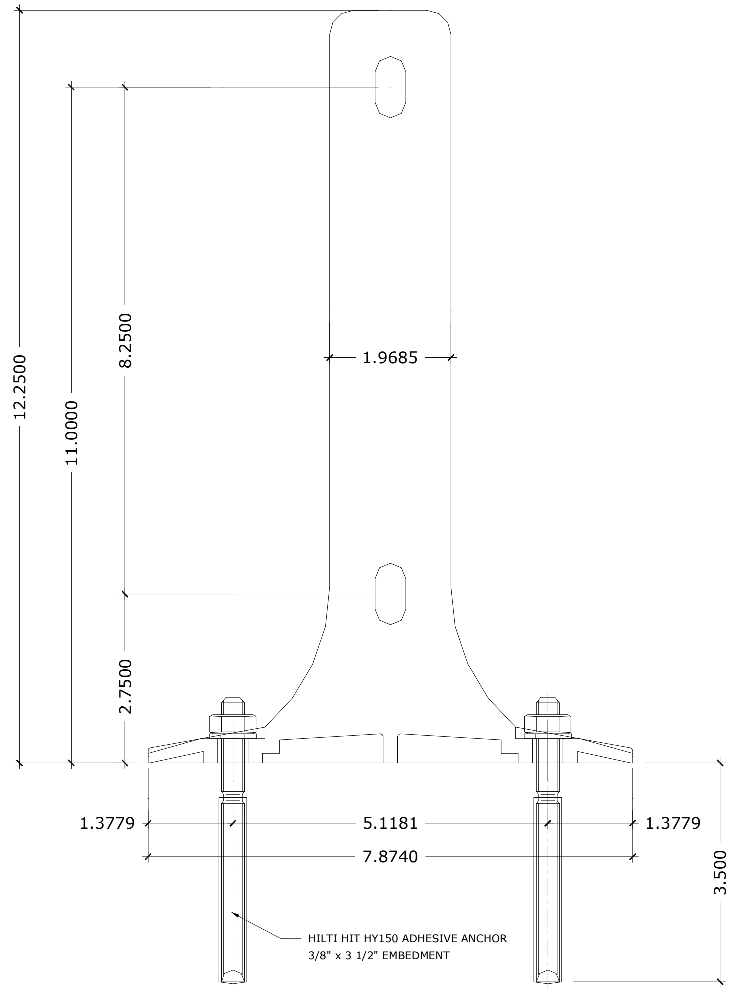
$T_{max} := \frac{M_{tot}}{L \cdot (CF)}$ $\quad T_{max} = 2233$ lb

$V_{max} := \frac{V_1}{2}$ $\quad V_{max} = 150$ lb

Interaction:

$$I := \left(\frac{T_{max}}{T_{all} \cdot 1.33}\right)^{\frac{5}{3}} + \left(\frac{V_{max}}{V_{all} \cdot 1.33}\right)^{\frac{5}{3}}$$

$I = 0.92$ < 1.0 "OK"



Use (2) - 3/8" Dia. S.S. HAS Rods
w/Hilti Hit HY150 As Shown
Emb.= 3-1/2" ED.= 2-1/2"

**** 4/3 Allowable Load Increase on Anchors Permitted per IBC2006***

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Steel Studio usa

Job No:	08-01-15C		
Engineer:	KEP	Sheet No:	4
Date:	1/24/08	Rev:	8/15/08
Chk By:	MPM	Date:	8/15/08

Post Embedment in Grout	SHT 4A

Chk conc. grout:

$R_{max} := 300$ lb

$M := 12338$ lb·in

$L := 7$ in

$D_1 := 0.313$ in *(Post Width)*

$D_2 := 3$ in *(Grout Pocket Width)*

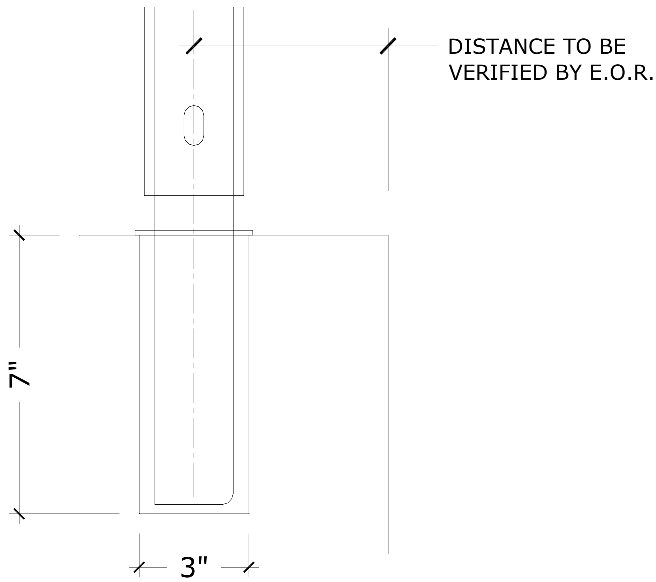
$f'_{c1} := 11250$ psi *Grout Strength*

$f'_{c2} := 4000$ psi *Conc. Strength*

$LF := 1.6$ *(Load Factor)*

$\phi := 0.65$

$c := \frac{L}{2}$



Assume Whitney stress block for bearing distribution:

$$\beta_1 := \max\left(\begin{pmatrix} 0.85 - .05 \cdot \frac{f'_{c1} - 4000}{1000} \\ 0.65 \end{pmatrix}\right) \qquad \beta_1 = 0.65 \qquad a_1 := \beta_1 \cdot c \qquad a_1 = 2.28$$

$A_1 := a_1 \cdot D_1$ $\quad A_1 = 0.71$ in *(Bearing Area)*

$E_1 := L - a_1$ $\quad E_1 = 4.72$ in *(Load Eccentricity)*

$P_1 := \frac{M}{E_1} + \frac{R_{max}}{2}$ $\quad P_1 = 2761$ lb *(Bearing Load)*

$\phi F_{p1} := \phi \cdot 0.85 \cdot A_1 \cdot f'_{c1}$ $\quad \phi F_{p1} = 4426$ lb *(Allowable Bearing Load)*

$I_1 := \frac{LF \cdot P_1}{\phi F_{p1}}$ $\quad \boxed{I_1 = 1}$

Chk concrete (for reference only):

$$\beta_2 := \max\left(\begin{pmatrix} 0.85 - .05 \cdot \frac{f'_{c2} - 4000}{1000} \\ 0.65 \end{pmatrix}\right) \qquad \beta_2 = 0.85 \qquad a_2 := \beta_2 \cdot c \qquad a_2 = 2.98$$

$A_2 := a_2 \cdot D_2$ $\quad A_2 = 8.93$ in *(Bearing Area)*

$E_2 := L - a_2$ $\quad E_2 = 4.03$ in *(Load Eccentricity)*

$P_2 := \frac{M}{E_2} + \frac{R_{max}}{2}$ $\quad P_2 = 3215$ lb *(Bearing Load)*

$\phi F_{p2} := \phi \cdot 0.85 \cdot A_2 \cdot f'_{c2}$ $\quad \phi F_{p2} = 19724$ lb *(Allowable Bearing Load)*

$I_2 := \frac{LF \cdot P_2}{\phi F_{p2}}$ $\quad \boxed{I_2 = 0.26}$

Use 11,250 psi, non-shrink Grout
-Design of Bearing on Concrete by others
-Design of Concrete Breakout and point loads
By others

Calculations for Hilti Hit HY150

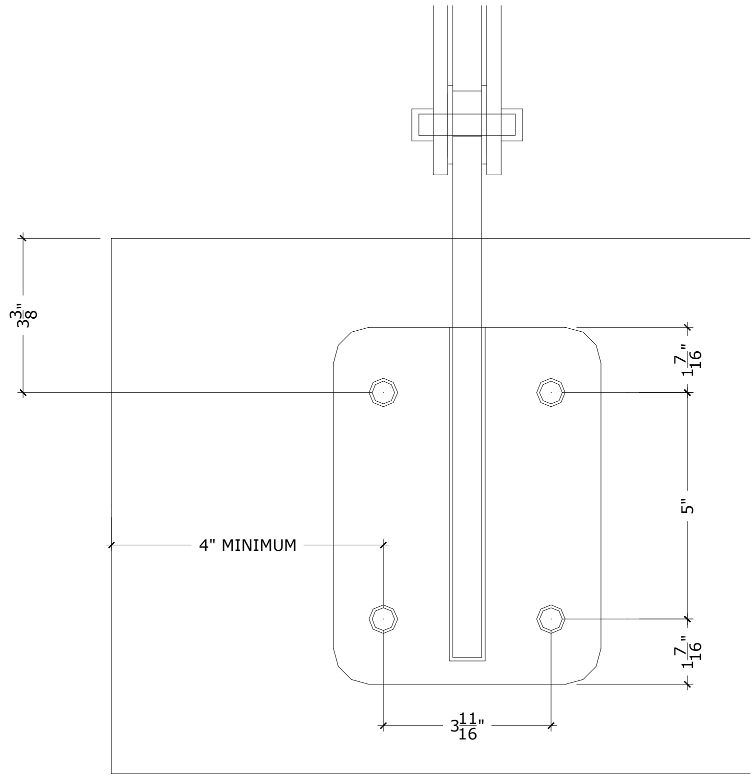
Side Mount Anchor Bolts Live Loads	SHT 4B

Assumptions:

Concrete: f'c = 4,000 psi

Edge Distance: 3-3/8"

Embedment: 3-1/2"



Hilti Hit HY150 Allowable Loads:

$V_{all} := 1875 \cdot 0.87 \cdot 1.0 \cdot 0.43 \cdot 0.73$ $\qquad V_{all} = 512$ lb

$T_{all} := 2705 \cdot 0.79 \cdot 0.87$ $\qquad T_{all} = 1859$ lb

Inputs:

$L := 6.438$ in

$CF := 0.85$ (Compression Factor)

$h := 72$ in (Length of Rail)

Per Sheet 3A, Design Reactions per IBC 2006 are:

$M_1 := 5175 \cdot (2)$ $\qquad M_1 = 10350$ in·lb

$V_1 := 4.17 \cdot h$ $\qquad V_1 = 300$ lb

$M_{tot} := 5175 \cdot (2) + V_1 \cdot (13)$ $\qquad M_{tot} = 14253$ in·lb

Calculated Tension and Shear (per Anchor):

$$T_{max} := \frac{M_{tot}}{2 \cdot L \cdot (CF)} + \frac{V_1}{4} \qquad T_{max} = 1377 \text{ lb}$$

$$V_{max} := \frac{V_1}{4} \qquad V_{max} = 75 \text{ lb}$$

Interaction:

$$I := \left(\frac{T_{max}}{T_{all}}\right)^{\frac{5}{3}} + \left(\frac{V_{max}}{V_{all}}\right)^{\frac{5}{3}}$$

$I = 0.65$ < 1.0 "OK"

Use (4) - 3/8" Dia. S.S. HAS Rods
w/Hilti Hit HY150 As Shown
Emb.= 3-1/2" ED.= 3-3/8"

Glass Infill Railings

48" Span Loads Based on Wind Pressures	SHT 5

Input Variables:

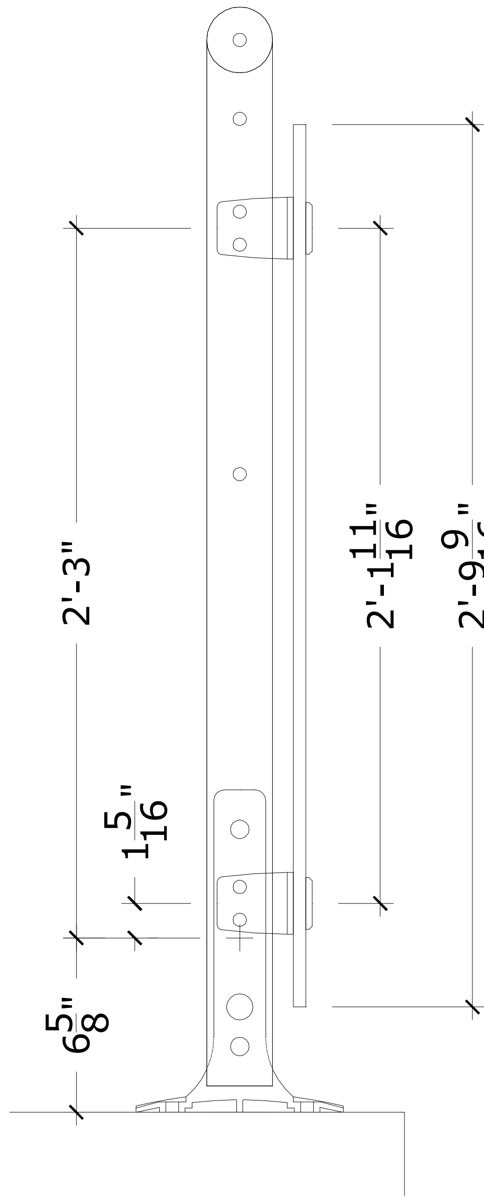
$H := 33.625$ in *(Glass height)*

$W := 45.25$ in *(Glass width)*

$t := 0.472$ in *(Glass thickness)*

$h_1 := 27$ in *(Post height - top bracket to CL Screws)*

$h_2 := 1.313$ in *(Post height - bottom bracket to CL Screws)*



Anchor Loads per 41 PSF:

$WL_1 := 41$ psf *(Wind Load)*

$R_{g1} := \frac{H \cdot WL_1 \cdot W}{2 \cdot 144}$ $R_{g1} = 217$ lb

$M_{p1} := (R_{g1} \cdot h_1) + (R_{g1} \cdot h_2)$ $M_{p1} = 6133$ in·lb

Check 12mm Glass:

$w := \frac{WL_1 \cdot H}{144}$ $w = 9.57$ pli

$M_g := \frac{w \cdot (48 - 4)^2}{8}$ $M_g = 2317$ in·lb

$S_{glass} := \frac{H \cdot t^2}{6}$ $S_{glass} = 1.25$ in^3

$f_{bglass} := \frac{M_g}{S_{glass}}$ $\boxed{f_{bglass} = 1856}$ psi < 6000 psi

$I_{glass} := \frac{H \cdot t^3}{12}$ $I_{glass} = 0.29$ in^4

$\Delta_g := \frac{5 \cdot w \cdot W^4}{384 \cdot 10400000 \cdot I_{glass}}$ $\Delta_g = 0.17$ in

$\Delta_{allg} := \frac{2W}{120}$ $\Delta_{allg} = 0.75$ in (3/4" Max)

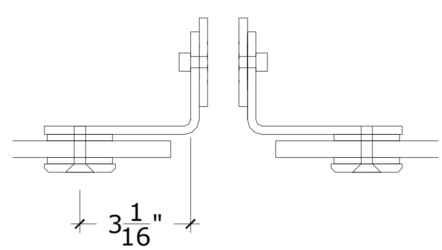
Use 12mm Fully Tempered Glass
as shown

Check 6mm Glass Bracket:

$t_2 := \frac{6}{25.4}$ $t_2 = 0.24$ in

$M_{pl} := 0.5 R_{g1} \cdot (3.0625)$ $M_{pl} = 332$ in·lb

$t_{req} := \sqrt{\frac{6 \cdot M_{pl}}{26250 \cdot (2.375)}}$ $t_{req} = 0.18$ in



Use 6mm SS Glass Bracket
as shown, 304A Minimum

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Steel Studio usa

Job No:	08-01-15C		
Engineer:	KEP	Sheet No:	5
Date:	1/24/08	Rev:	8/15/08
Chk By:	MPM	Date:	8/15/08

Glass Infill Railings

54" Span Loads Based on Wind Pressures	SHT 5A

Input Variables:

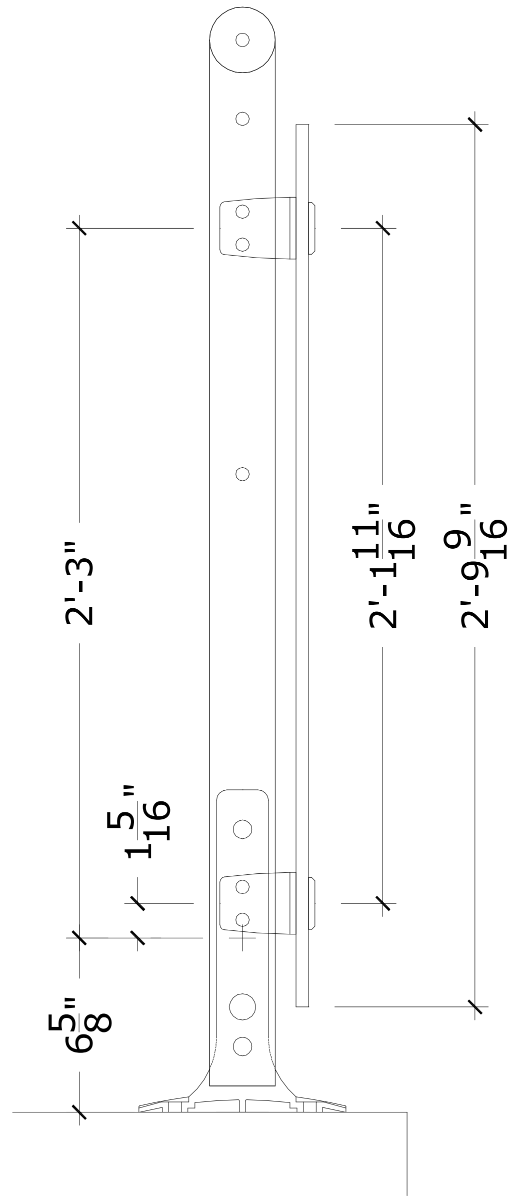
$H := 33.625$ in *(Glass height)*

$W := 51.25$ in *(Glass width)*

$t := 0.472$ in *(Glass thickness)*

$h_1 := 27$ in *(Post height - top bracket to CL Screws)*

$h_2 := 1.313$ in *(Post height - bottom bracket to CL Screws)*



Anchor Loads per 37 PSF:

$WL_1 := 37$ psf *(Wind Load)*

$R_{g1} := \dfrac{H \cdot WL_1 \cdot W}{2 \cdot 144}$ $R_{g1} = 221$ lb

$M_{p1} := (R_{g1} \cdot h_1) + (R_{g1} \cdot h_2)$ $M_{p1} = 6268$ in·lb

Check 12mm Glass:

$w := \dfrac{WL_1 \cdot H}{144}$ $w = 8.64$ pli

$M_g := \dfrac{w \cdot (54 - 4)^2}{8}$ $M_g = 2700$ in·lb

$S_{glass} := \dfrac{H \cdot t^2}{6}$ $S_{glass} = 1.25$ in^3

$f_{bglass} := \dfrac{M_g}{S_{glass}}$ $\boxed{f_{bglass} = 2163}$ psi < 6000 psi

$I_{glass} := \dfrac{H \cdot t^3}{12}$ $I_{glass} = 0.29$ in^4

$\Delta_g := \dfrac{5 \cdot w \cdot W^4}{384 \cdot 10400000 \cdot I_{glass}}$ $\Delta_g = 0.25$ in

$\Delta_{allg} := \dfrac{2W}{120}$ $\Delta_{allg} = 0.85$ in (3/4" Max)

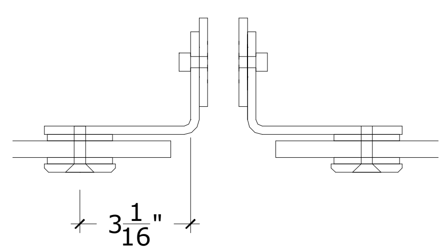
Use 12mm Fully Tempered Glass
as shown

Check 6mm Glass Bracket:

$t_2 := \dfrac{6}{25.4}$ $t_2 = 0.24$ in

$M_{pl} := 0.5 R_{g1} \cdot (3.0625)$ $M_{pl} = 339$ in·lb

$t_{req} := \sqrt{\dfrac{6 \cdot M_{pl}}{26250 \cdot (2.375)}}$ $t_{req} = 0.18$ in



Use 6mm SS Glass Bracket
as shown, 304A Minimum

Glass Infill Railings

60" Span Loads Based on Wind Pressures	SHT 5B

Input Variables:

$H := 33.625$ in *(Glass height)*

$W := 57.25$ in *(Glass width)*

$t := 0.472$ in *(Glass thickness)*

$h_1 := 27$ in *(Post height - top bracket to CL Screws)*

$h_2 := 1.313$ in *(Post height - bottom bracket to CL Screws)*

Anchor Loads per 33 PSF:

$WL_1 := 33$ psf *(Wind Load)*

$R_{g1} := \frac{H \cdot WL_1 \cdot W}{2 \cdot 144}$ $R_{g1} = 221$ lb

$M_{p1} := \left(R_{g1} \cdot h_1\right) + \left(R_{g1} \cdot h_2\right)$ $M_{p1} = 6245$ in·lb

Check 12mm Glass:

$w := \frac{WL_1 \cdot H}{144}$ $w = 7.71$ pli

$M_g := \frac{w \cdot (60 - 4)^2}{8}$ $M_g = 3021$ in·lb

$S_{glass} := \frac{H \cdot t^2}{6}$ $S_{glass} = 1.25$ in^3

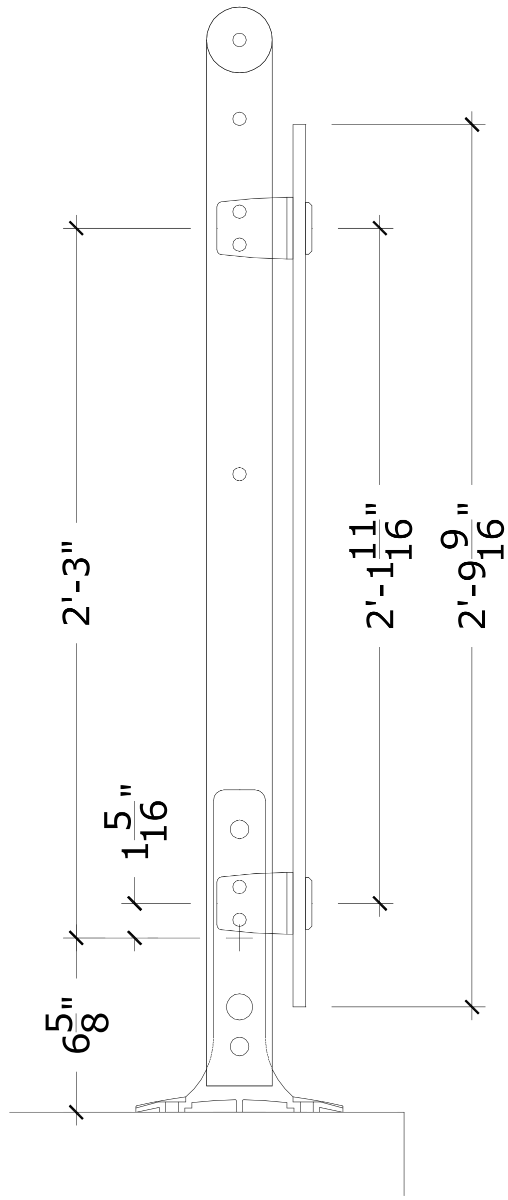
$f_{bglass} := \frac{M_g}{S_{glass}}$ $\boxed{f_{bglass} = 2419}$ psi < 6000 psi

$I_{glass} := \frac{H \cdot t^3}{12}$ $I_{glass} = 0.29$ in^4

$\Delta_g := \frac{5 \cdot w \cdot W^4}{384 \cdot 10400000 \cdot I_{glass}}$ $\Delta_g = 0.35$ in

$\Delta_{allg} := \frac{2W}{120}$ $\Delta_{allg} = 0.95$ in (3/4" Max)

Use 12mm Fully Tempered Glass
as shown

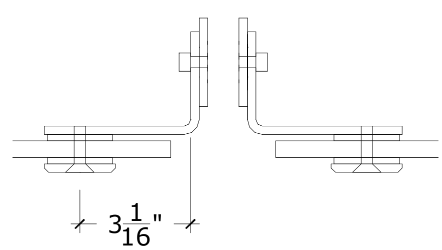


Check 6mm Glass Bracket:

$t_2 := \frac{6}{25.4}$ $t_2 = 0.24$ in

$M_{pl} := 0.5 R_{g1} \cdot (3.0625)$ $M_{pl} = 338$ in·lb

$t_{req} := \sqrt{\frac{6 \cdot M_{pl}}{26250 \cdot (2.375)}}$ $t_{req} = 0.18$ in



Use 6mm SS Glass Bracket
as shown, 304A Minimum

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Steel Studio USA

Job No:	08-01-15C		
Engineer:	KEP	Sheet No:	5B
Date:	1/24/08	Rev:	8/15/08
Chk By:	MPM	Date:	8/15/08

Glass Infill Railings

66" Span Loads Based on Wind Pressures	SHT 5C

Input Variables:

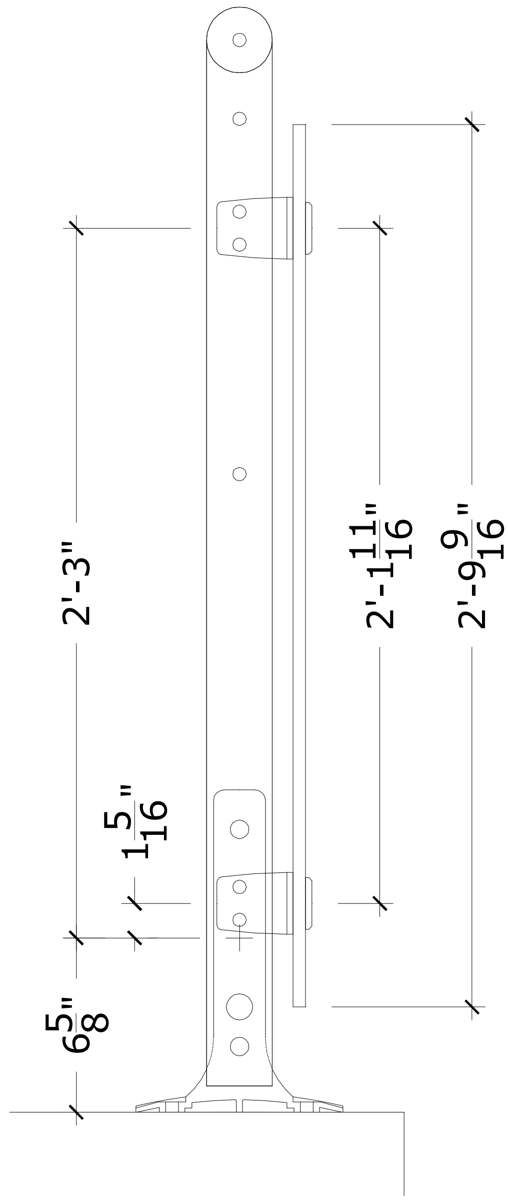
$H := 33.625$ in *(Glass height)*

$W := 63.25$ in *(Glass width)*

$t := 0.472$ in *(Glass thickness)*

$h_1 := 27$ in *(Post height - top bracket to CL Screws)*

$h_2 := 1.313$ in *(Post height - bottom bracket to CL Screws)*



Anchor Loads per 30 PSF:

$WL_1 := 30$ psf *(Wind Load)*

$R_{g1} := \frac{H \cdot WL_1 \cdot W}{2 \cdot 144}$ $\quad R_{g1} = 222$ lb

$M_{p1} := (R_{g1} \cdot h_1) + (R_{g1} \cdot h_2)$ $\quad M_{p1} = 6272$ in·lb

Check 12mm Glass:

$w := \frac{WL_1 \cdot H}{144}$ $\quad w = 7.01$ pli

$M_g := \frac{w \cdot (66 - 4)^2}{8}$ $\quad M_g = 3366$ in·lb

$S_{glass} := \frac{H \cdot t^2}{6}$ $\quad S_{glass} = 1.25$ in^3

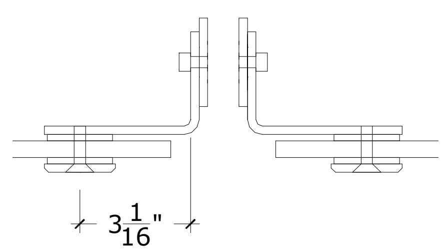
$f_{bglass} := \frac{M_g}{S_{glass}}$ $\quad \boxed{f_{bglass} = 2696}$ psi < 6000 psi

$I_{glass} := \frac{H \cdot t^3}{12}$ $\quad I_{glass} = 0.29$ in^4

$\Delta_g := \frac{5 \cdot w \cdot W^4}{384 \cdot 10400000 \cdot I_{glass}}$ $\quad \Delta_g = 0.48$ in

$\Delta_{allg} := \frac{2W}{120}$ $\quad \Delta_{allg} = 1.05$ in (3/4" Max)

Use 12mm Fully Tempered Glass
as shown



Check 6mm Glass Bracket:

$t_2 := \frac{6}{25.4}$ $\quad t_2 = 0.24$ in

$M_{pl} := 0.5 R_{g1} \cdot (3.0625)$ $\quad M_{pl} = 339$ in·lb

$t_{req} := \sqrt{\frac{6 \cdot M_{pl}}{26250 \cdot (2.375)}}$ $\quad t_{req} = 0.18$ in

Use 6mm SS Glass Bracket
as shown, 304A Minimum

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Steel Studio USA

Job No:	08-01-15C		
Engineer:	KEP	Sheet No:	5C
Date:	1/24/08	Rev:	8/15/08
Chk By:	MPM	Date:	8/15/08

Glass Infill Railings

72" Span Loads Based on Wind Pressures	SHT 5D

Input Variables:

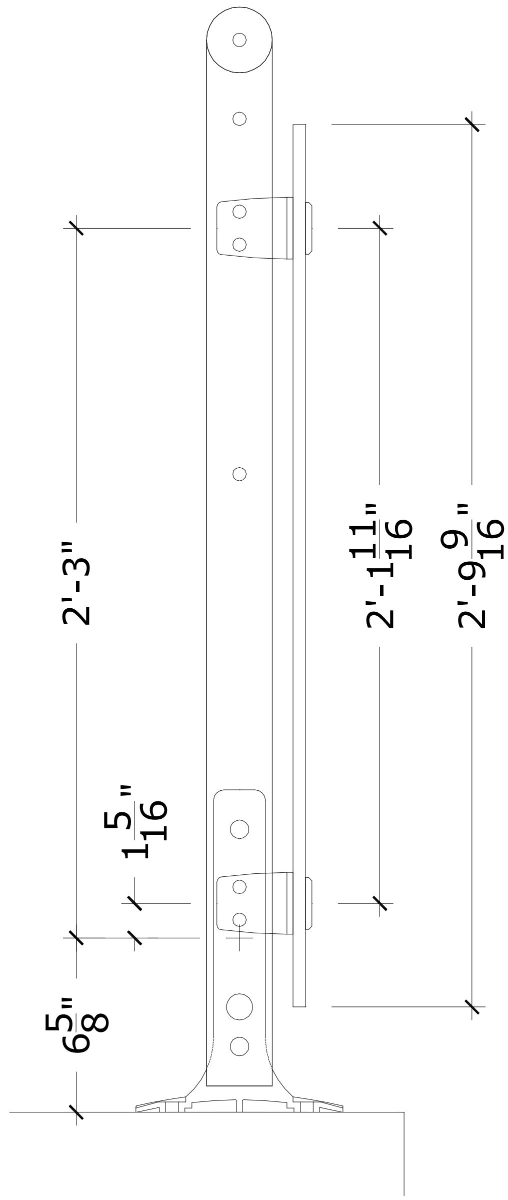
$H := 33.625$ in (Glass height)

$W := 69.25$ in (Glass width)

$t := 0.472$ in (Glass thickness)

$h_1 := 27$ in (Post height - top bracket to CL Screws)

$h_2 := 1.313$ in (Post height - bottom bracket to CL Screws)



Anchor Loads per 27 PSF:

$WL_1 := 27$ psf (Wind Load)

$R_{g1} := \frac{H \cdot WL_1 \cdot W}{2 \cdot 144}$ $\qquad R_{g1} = 218$ lb

$M_{p1} := (R_{g1} \cdot h_1) + (R_{g1} \cdot h_2)$ $\qquad M_{p1} = 6181$ in·lb

Check 12mm Glass:

$w := \frac{WL_1 \cdot H}{144}$ $\qquad w = 6.3$ pli

$M_g := \frac{w \cdot (66 - 4)^2}{8}$ $\qquad M_g = 3029$ in·lb

$S_{glass} := \frac{H \cdot t^2}{6}$ $\qquad S_{glass} = 1.25$ in^3

$f_{bglass} := \frac{M_g}{S_{glass}}$ $\qquad \boxed{f_{bglass} = 2426}$ psi < 6000 psi

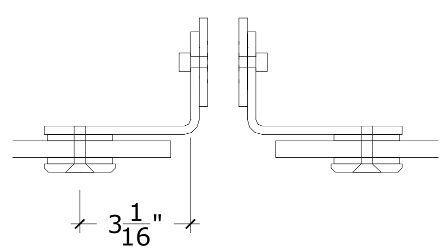
$I_{glass} := \frac{H \cdot t^3}{12}$ $\qquad I_{glass} = 0.29$ in^4

$\Delta_g := \frac{5 \cdot w \cdot W^4}{384 \cdot 10400000 \cdot I_{glass}}$ $\qquad \Delta_g = 0.62$ in

$\Delta_{allg} := \frac{2W}{120}$ $\qquad \Delta_{allg} = 1.15$ in (3/4" Max)

Use 12mm Fully Tempered Glass *as shown*

Check 6mm Glass Bracket:



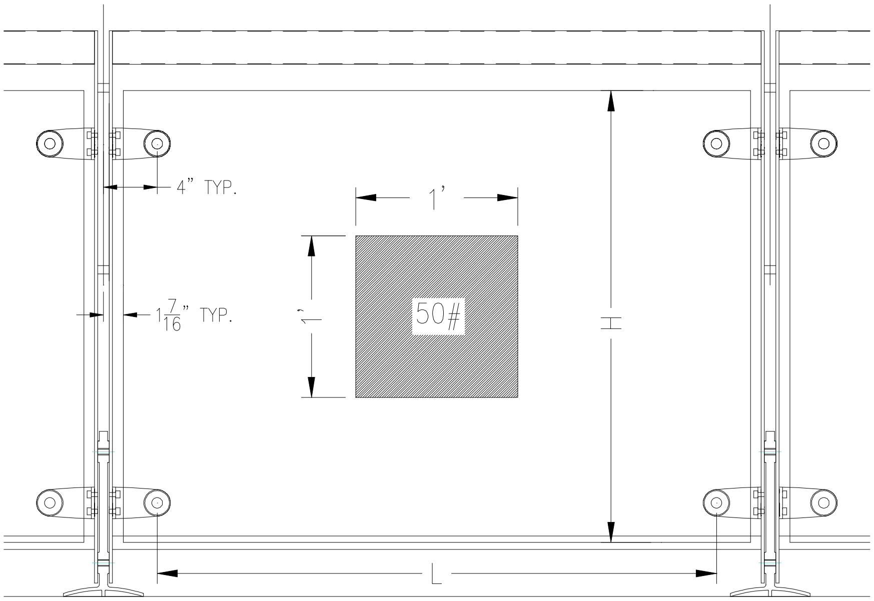
$t_2 := \frac{6}{25.4}$ $\qquad t_2 = 0.24$ in

$M_{pl} := 0.5R_{g1} \cdot (3.0625)$ $\qquad M_{pl} = 334$ in·lb

$t_{req} := \sqrt{\frac{6 \cdot M_{pl}}{26250 \cdot (2.375)}}$ $\qquad t_{req} = 0.18$ in

Use 6mm SS Glass Bracket *as shown, 304A Minimum*

Glass Infill Check per IBC 2006	SHT 5E



Glass Analysis:

Case 1 - Live Load:

$H := 33.625$ in

$L := 69.25$ in

$t := 0.472$ in

$I_y := \frac{L \cdot t^3}{12}$ $I_y = 0.607$ in^4

$S_y := \frac{L \cdot t^2}{6}$ $S_y = 2.57$ in^3

$E := 10100000$

$Load := 50$ psf

$M := \frac{Load \cdot L}{4}$ $M = 865.63$ lb·in

$f_b := \frac{M}{S_y}$ $f_b = 337$ psi

$F_b := 6000$ psi

$\Delta := \frac{Load \cdot L^3}{48E \cdot I_y}$ $\Delta = 0.0564$ in

$\Delta_{all} := \frac{2H}{175}$ $\Delta_{all} = 0.38$ in

Use 12mm thick fully tempered glass w/ polished edges, as shown

Calculations for Hilti Hit HY150

Worse Case Anchor Bolts per Wind Loads	SHT 6

Assumptions:

Concrete: f'c = 4,000 psi

Edge Distance: 2-1/2"

Embedment: 3-1/2"

From Sht A1, Maximum Anchor Allowables are:

$T_{all} := 1848$ lb (See Sht A1)

$V_{all} := 551$ lb (See Sht A1)

Inputs:

$L := 6.5$ in

$CF := 0.85$ (Compression Factor)

$h := 27$ in (Height of Rail)

Per Sheet 5C, Design Reactions are:

$M_1 := 6272$ in·lb

$V_1 := 221 \cdot (2)$ $V_1 = 442$ lb

$M_{tot} := M_1 + V_1 \cdot (6.625)$ $M_{tot} = 9200$ in·lb

Calculated Tension and Shear (per Anchor):

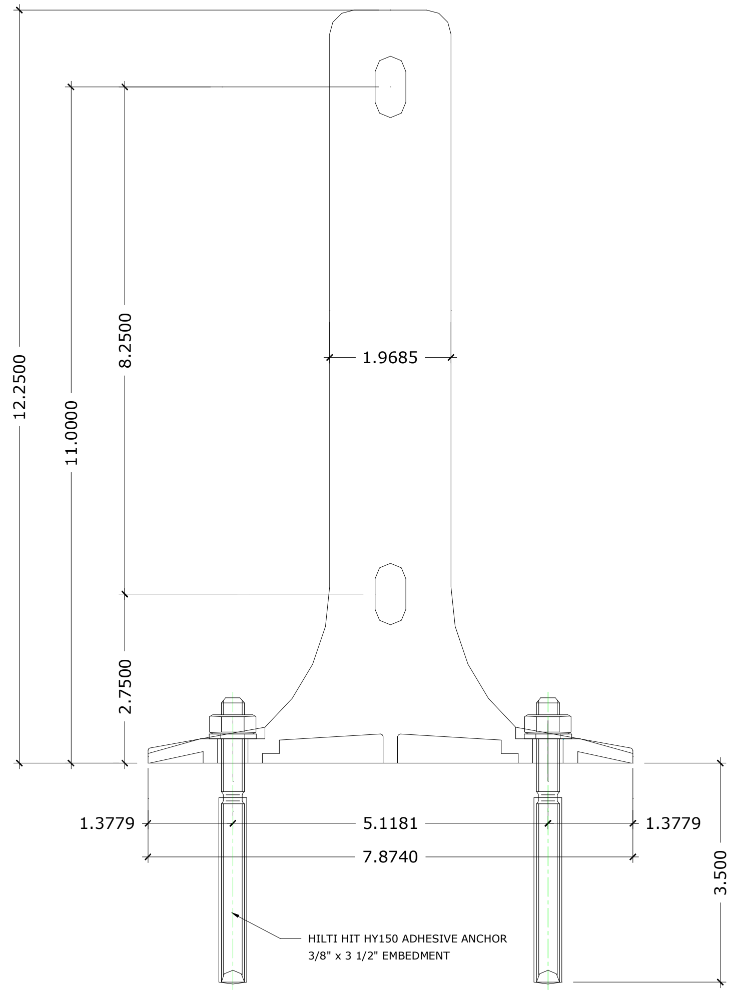
$T_{max} := \frac{M_{tot}}{L \cdot (CF)}$ $T_{max} = 1665$ lb

$V_{max} := \frac{V_1}{2}$ $V_{max} = 221$ lb

Interaction:

$$I := \left(\frac{T_{max}}{T_{all}}\right)^{\frac{5}{3}} + \left(\frac{V_{max}}{V_{all}}\right)^{\frac{5}{3}}$$

$I = 1.06$ 7% over "OK"



Use (2) - 3/8" Dia. or M10 S.S. HAS Rods
w/Hilti Hit HY150 As Shown
Emb.= 3-1/2" ED.= 2-1/2"

Post Embedment in Grout per Wind Loads	SHT 6A

Chk conc. grout:

$R_{max} := 442$ lb

$M := 9200$ lb·in

$L := 7$ in

$D_1 := 0.313$ in *(Post Width)*

$D_2 := 3$ in *(Grout Pocket Width)*

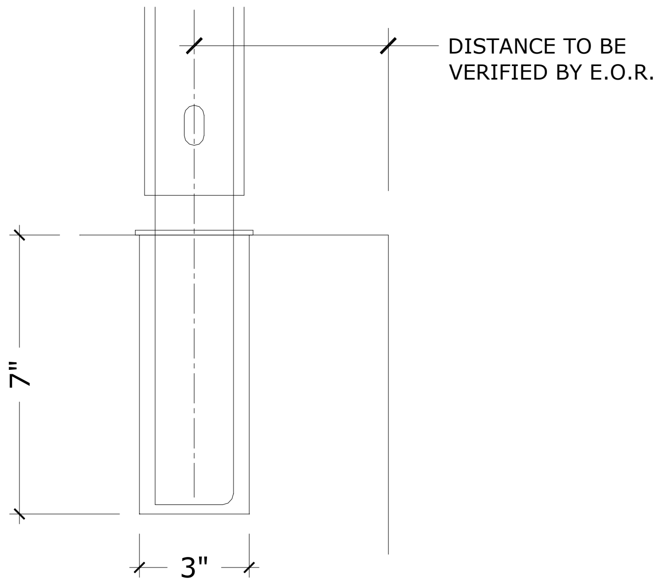
$f'_{c1} := 11250$ psi *Grout Strength*

$f'_{c2} := 4000$ psi *Conc. Strength*

$LF := 1.6$ *(Load Factor)*

$c := \frac{L}{2}$

$\phi := 0.65$



Assume Whitney stress block for bearing distribution:

$\beta_1 := \max\left(\begin{pmatrix} 0.85 - .05 \cdot \frac{f'_{c1} - 4000}{1000} \\ 0.65 \end{pmatrix}\right)$ $\beta_1 = 0.65$ $a_1 := \beta_1 \cdot c$ $a_1 = 2.28$

$A_1 := a_1 \cdot D_1$ $A_1 = 0.71$ in *(Bearing Area)*

$E_1 := L - a_1$ $E_1 = 4.72$ in *(Load Eccentricity)*

$P_1 := \frac{M}{E_1} + \frac{R_{max}}{2}$ $P_1 = 2168$ lb *(Bearing Load)*

$\phi F_{p1} := \phi \cdot 0.85 \cdot A_1 \cdot f'_{c1}$ $\phi F_{p1} = 4426$ lb *(Allowable Bearing Load)*

$I_1 := \frac{LF \cdot P_1}{\phi F_{p1}}$ $\boxed{I_1 = 0.78}$

Chk concrete (for reference only):

$\beta_2 := \max\left(\begin{pmatrix} 0.85 - .05 \cdot \frac{f'_{c2} - 4000}{1000} \\ 0.65 \end{pmatrix}\right)$ $\beta_2 = 0.85$ $a_2 := \beta_2 \cdot c$ $a_2 = 2.98$

$A_2 := a_2 \cdot D_2$ $A_2 = 8.93$ in *(Bearing Area)*

$E_2 := L - a_2$ $E_2 = 4.03$ in *(Load Eccentricity)*

$P_2 := \frac{M}{E_2} + \frac{R_{max}}{2}$ $P_2 = 2507$ lb *(Bearing Load)*

$\phi F_{p2} := \phi \cdot 0.85 \cdot A_2 \cdot f'_{c2}$ $\phi F_{p2} = 19724$ lb *(Allowable Bearing Load)*

$I_2 := \frac{LF \cdot P_2}{\phi F_{p2}}$ $\boxed{I_2 = 0.2}$

Use 11,250 psi, non-shrink Grout
-Design of Bearing on Concrete by others
-Design of Concrete Breakout and point loads By others

Side Mount Anchor Bolts Wind Loads	SHT 6B

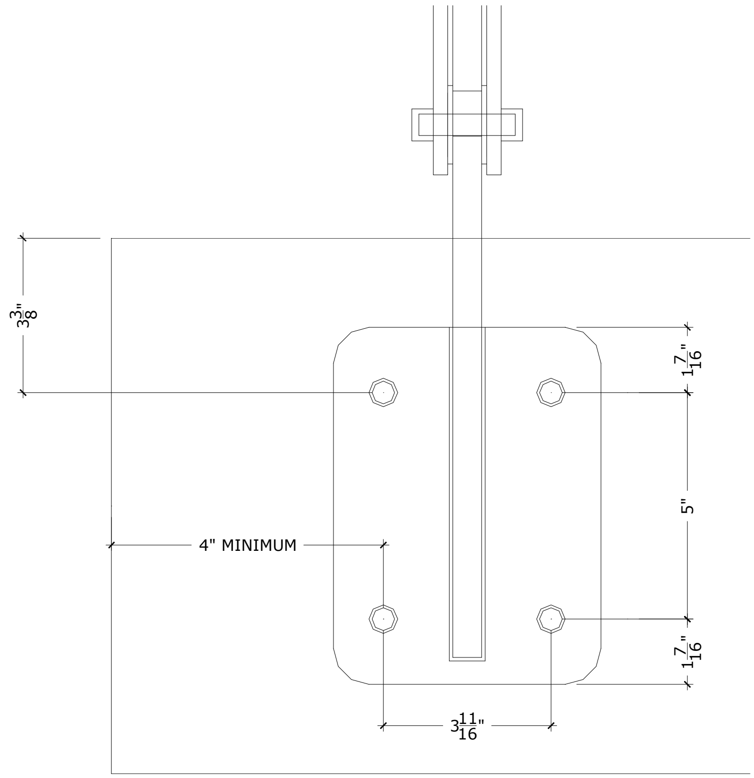
Calculations for Hilti Hit HY150

Assumptions:

Concrete: f'c = 4,000 psi

Edge Distance: 3-3/8"

Embedment: 3-1/2"



Hilti Hit HY150 Allowable Loads:

$V_{all} := 1875 \cdot 0.87 \cdot 1.0 \cdot 0.43 \cdot 0.73$ $\quad V_{all} = 512$ lb

$T_{all} := 2705 \cdot 0.79 \cdot 0.87$ $\quad T_{all} = 1859$ lb

Inputs:

$L := 6.438$ in

$CF := 0.85$ (Compression Factor)

$h := 72$ in (Length of Rail)

Per Sheet 3A, Design Reactions per IBC 2006 are:

$M_1 := 6272$ in·lb

$V_1 := 222 \cdot (2)$ $\quad V_1 = 444$ lb

$M_{tot} := M_1 + V_1 \cdot (13)$ $\quad M_{tot} = 12044$ in·lb

Calculated Tension and Shear (per Anchor):

$$T_{max} := \frac{M_{tot}}{2 \cdot L \cdot (CF)} + \frac{V_1}{4} \qquad T_{max} = 1211 \text{ lb}$$

$$V_{max} := \frac{V_1}{4} \qquad V_{max} = 111 \text{ lb}$$

Interaction:

$$I := \left(\frac{T_{max}}{T_{all}}\right)^{\frac{5}{3}} + \left(\frac{V_{max}}{V_{all}}\right)^{\frac{5}{3}}$$

$I = 0.57$ < 1.0 "OK"

Use (4) - 3/8" Dia. S.S. HAS Rods
w/Hilti Hit HY150 As Shown
Emb.= 3-1/2" ED.= 3-3/8"

Calculations for Cast Post Stem and Base

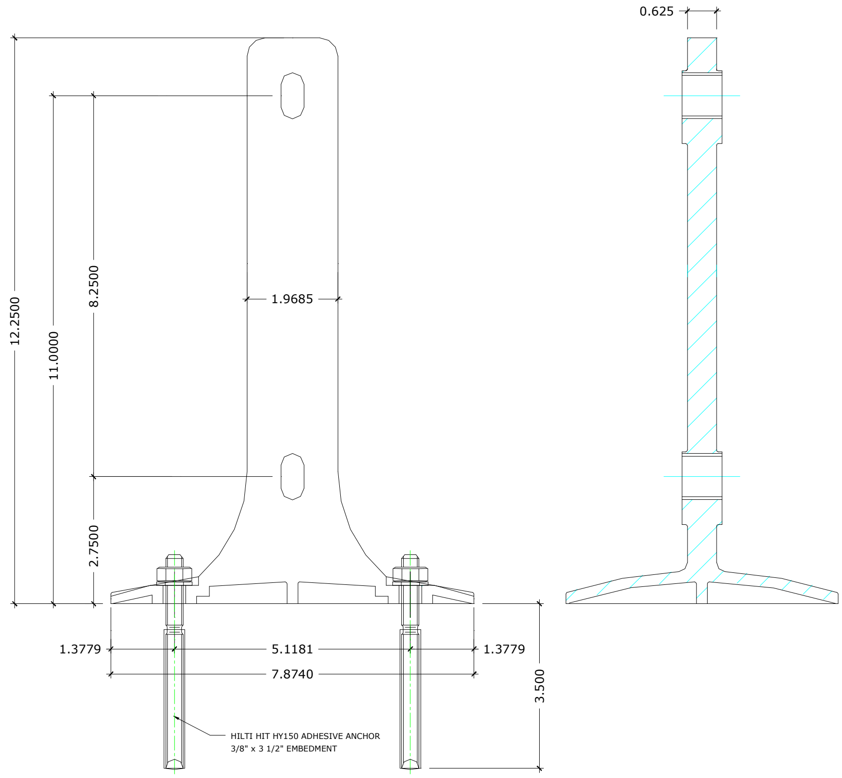
Cast Post Stem and Base Plate	SHT 7

Assumptions:

S.S. Yield Strength: Fy= 45,000 psi

S.S. Strong Axis: Fbx= 29,700 psi

S.S. Weak Axis: Fby= 33,750 psi



Per Sheet 4, Design Reactions are:

$M_{max} := 12338$ in·lb

$T := 2233$ lb

Inputs:

$S_x := \frac{0.625 \cdot 1.9685^2}{6}$ $S_x = 0.4$ in^3

$S_1 := 0.0974$ in^3 (at 1/2")

$S_2 := 0.162$ in^3 (at 1")

$S_3 := 0.638$ in^3 (at 1-1/2")

Cast Post Stem Analysis:

$f_b := \frac{M_{max}}{S_x}$ $f_b = 30566$ psi

$M_{wk1} := T \cdot (0.5)$ $M_{wk1} = 1117$ in·lb

$M_{wk2} := T \cdot (1)$ $M_{wk2} = 2233$ in·lb

$M_{wk3} := T \cdot (1.5)$ $M_{wk3} = 3350$ in·lb

$f_{bwk1} := \frac{M_{wk1}}{S_1}$ $f_{bwk1} = 11463$ psi

$f_{bwk2} := \frac{M_{wk2}}{S_2}$ $f_{bwk2} = 13784$ psi

$f_{bwk3} := \frac{M_{wk3}}{S_3}$ $f_{bwk3} = 5250$ psi

Interactions:

$I := \frac{f_b}{29700}$ $I = 1.03$ < 7% over "OK"

Use S.S. Post Stem and Base, as shown
304A or 316A S.S., Fy=45 ksi

Calculations for Post Stem

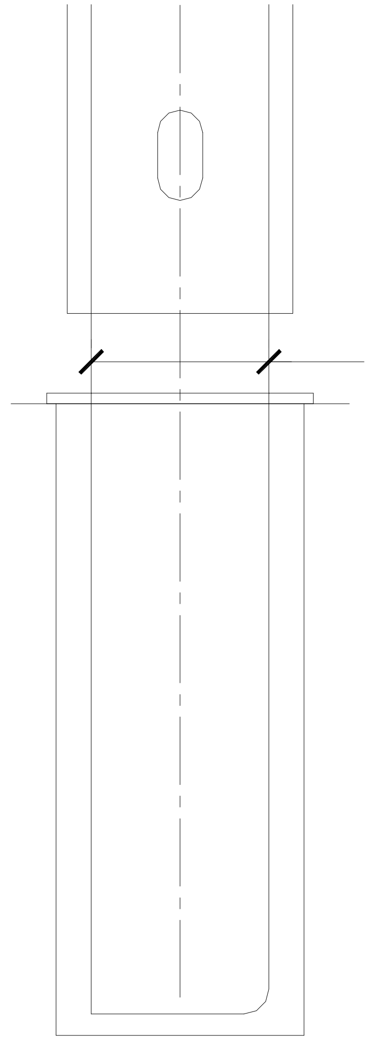
Post Stem	SHT 7A

Assumptions:

S.S. Yield Strength: Fy= 45,000 psi

S.S. Strong Axis: Fbx= 29,700 psi

S.S. Weak Axis: Fby= 33,750 psi



Per Sheet 4, Design Reactions are:

$M_{max} := 12338 \quad in \cdot lb$

Inputs:

$S_x := \frac{0.625 \cdot 1.9685^2}{6} \qquad S_x = 0.4 \quad in^3$

Cast Post Stem Analysis:

$f_b := \frac{M_{max}}{S_x} \qquad f_b = 30566 \quad psi$

Interactions:

$I := \frac{f_b}{29700} \qquad I = 1.03$ 3% Over "OK"

Use S.S. Post Stem, as shown
304A or 316A S.S., Fy=45 ksi

Calculations for Post Stem

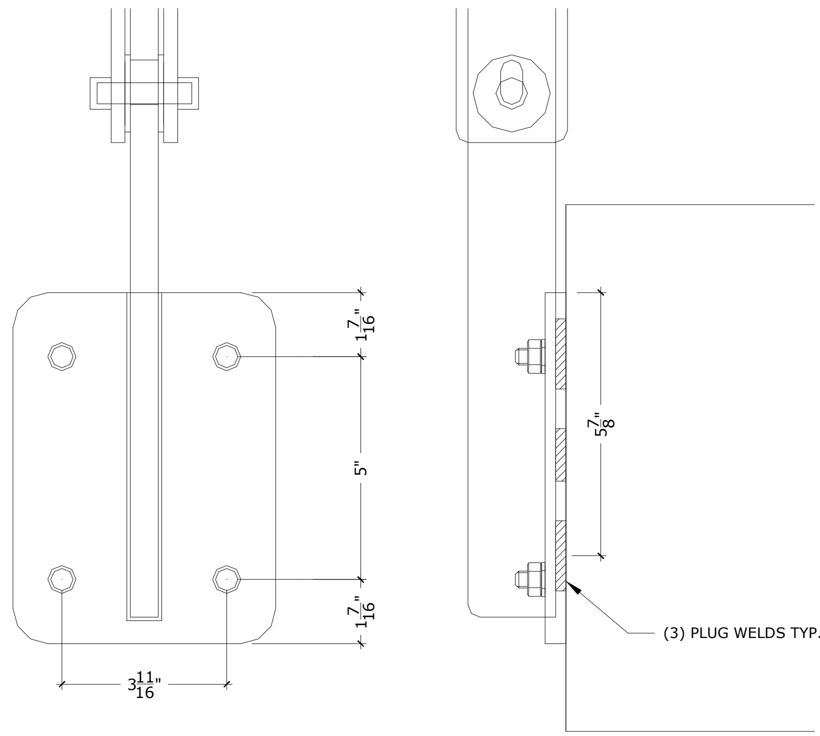
Post Stem & Side Plate	SHT 7B

Assumptions:

S.S. Yield Strength: Fy= 45,000 psi

S.S. Strong Axis: Fbx= 29,700 psi

S.S. Weak Axis: Fby= 33,750 psi



Per Sheet 4B, Design Reactions are:

$V_{max} := 300$ lb

$M_{max} := 10350 + V_{max} \cdot 13$ $M_{max} = 14250$ in·lb

Cast Post Stem Analysis:

$S_x := \frac{0.625 \cdot 1.9685^2}{6}$ $S_x = 0.4$ in^3

$f_b := \frac{M_{max}}{S_x}$ $f_b = 35303$ psi

Interactions:

$I := \frac{f_b}{29700 \cdot (1.33)}$ $I = 0.89$ < 1.0 "OK"

Use S.S. Post Stem, As Shown
304A or 316A S.S., Fy=45 ksi

Side Plate Analysis:

$P := \frac{M_{max}}{5.875} + V_{max}$ $P = 2726$ lb

$M_{pl} := \frac{P \cdot 3.6875}{4}$ $M_{pl} = 2513$ in·lb

$t_{req} := \sqrt{\frac{2236 \cdot 6}{26250 \cdot 0.85 \cdot 7.875}}$ $t_{req} = 0.28$ in < 1/2" OK

Use 8" x 6" x 1/2" Thick S.S. Side Plate
304A or 316A S.S., Fy=35 ksi

Weld Analysis:

$A_w := 0.625$ in^2

$f_w := \frac{P}{A_w}$ $f_w = 4361$ psi

$F_w := 70000 \cdot 0.3$ $F_w = 21000$ psi

Use Plug Welds As Shown
E316L-XX filler, 70 ksi (tensile strength)

**** 4/3 Allowable Load Increase on Anchors Permitted per IBC2006***

Attached are page(s) from the 2006 Hilti North American Product Technical Guide. For complete details on this product, including data development, product specifications, general suitability, installation, corrosion, and spacing & edge distance guidelines, please refer to the Technical Guide, or contact Hilti.

Max Loads For Hilti Hit HY 150	SHT A1

4.2.5 HIT-ICE/HIT HY 150 Adhesive Anchor

HIT-ICE/HY 150 Allowable and Ultimate Bond/Concrete Capacity for HAS Rods in Normal-Weight Concrete[1,2,3]

Anchor Diameter in (mm)	Embedment Depth in (mm)	HIT-ICE/HIT HY 150 Allowable Bond/Concrete Capacity				HIT-ICE/HIT HY 150 Ultimate Bond/Concrete Capacity			
		Tensile		Shear		Tensile		Shear	
		f'_c = 2000 psi (13.8 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 2000 psi (13.8 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 2000 psi (13.8 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 2000 psi (13.8 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)
3/8 (9.5)	1-3/4 (44)	720 (3.2)	1265 (5.6)	1395 (6.2)	1970 (8.8)	2710 (12.1)	4750 (21.1)	4175 (18.6)	5900 (26.2)
	3-1/2 (89)	1895 (8.4)	2705 (12.0)	3335 (14.8)	4715 (21.0)	7120 (31.7)	10160 (45.2)	10000 (44.5)	14140 (62.9)
	5-1/4 (133)	2635 (11.7)	2800 (12.5)	6120 (27.2)	8655 (38.5)	9880 (44.0)	10510 (46.8)	18360 (81.7)	25960 (115.5)
1/2 (12.7)	2-1/8 (54)	1220 (5.4)	1575 (7.0)	1980 (8.8)	2800 (12.5)	4580 (20.4)	5910 (26.3)	5940 (26.4)	8400 (37.4)
	4-1/4 (108)	2725 (12.1)	3935 (17.5)	5150 (22.9)	7280 (32.4)	10220 (44.5)	14760 (65.7)	15440 (68.7)	21840 (97.1)
	6-3/8 (162)	4300 (19.1)	5295 (23.6)	9455 (42.1)	13375 (59.5)	16140 (71.8)	19860 (88.3)	28360 (126.2)	40120 (178.5)

Note: Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing Tension/Shear

$s_{min} = 0.5\, h_{ef}$, $s_{cr} = 1.5\, h_{ef}$

$f_A = 0.3(s/h_{ef}) + 0.55$

for $s_{cr} > s > s_{min}$

Edge Distance Tension

$c_{min} = 0.5\, h_{ef}$, $c_{cr} = 1.5\, h_{ef}$

$f_{RN} = 0.4(c/h_{ef}) + 0.40$

for $c_{cr} > c > c_{min}$

Edge Distance Shear (⊥ toward edge)

$c_{min} = 0.5\, h_{ef}$, $c_{cr} = 2.0\, h_{ef}$

$f_{RV1} = 0.54(c/h_{ef}) - 0.09$

for $c_{cr} > c > c_{min}$

Edge Distance Shear (ll to or away from edge)

$c_{min} = 0.5\, h_{ef}$, $c_{cr} = 2.0\, h_{ef}$

$f_{RV2} = 0.36(c/h_{ef}) + 0.28$

for $c_{cr} > c > c_{min}$

Load Adjustment Factors for 3/8" Diameter Anchor

Anchor Diameter	3/8" diameter											
Adjustment Factor	Spacing Tension/Shear, f_A			Edge Distance Tension, f_{RN}			Edge Distance Shear (⊥ toward edge), f_{RV1}			Edge Distance Shear (ll to or away from edge), f_{RV2}		
Embedment Depth, in.	1-3/4	3-1/2	5-1/4	1-3/4	3-1/2	5-1/4	1-3/4	3-1/2	5-1/4	1-3/4	3-1/2	5-1/4
Spacing (s)/Edge Distance (c), in. 7/8	0.70			0.60			0.18			0.46		
1-1/4	0.76			0.69			0.30			0.54		
1-3/4	0.85	0.70		0.80	0.60		0.45	0.18		0.64	0.46	
2	0.89	0.72		0.86	0.63		0.53	0.22		0.69	0.49	
2-5/8	1.00	0.78	0.70	1.00	0.70	0.60	0.72	0.32	0.18	0.82	0.55	0.46
3		0.81	0.72		0.74	0.63	0.84	0.37	0.22	0.90	0.59	0.49
3-1/2		0.85	0.75		0.80	0.67	1.00	0.45	0.27	1.00	0.64	0.52
4		0.89	0.78		0.86	0.70		0.53	0.32		0.69	0.55
4-1/2		0.94	0.81		0.91	0.74		0.60	0.37		0.74	0.59
5-1/4		1.00	0.85		1.00	0.80		0.72	0.45		0.82	0.64

Hilti Hit HY150 Allowable Loads:

$V_{all} := 1875 \cdot 0.99 \cdot 0.99 \cdot 0.3$ $\quad V_{all} = 551$ lb

$T_{all} := 2705 \cdot 0.99 \cdot 0.69$ $\quad T_{all} = 1848$ lb

Fasteners	SHT A2

Calculations for Connection Fasteners:

Assumptions:

All SS Fasteners to be Minimum Grade A2-70:

$F_u := 700$ MPa

$F_{u2} := \frac{700000000}{6895}$ $F_{u2} = 101523$ psi

$F_t := 0.4 \cdot F_{u2}$ $F_t = 40609$ psi

$F_v := \frac{0.4 \cdot F_{u2}}{\sqrt{3}}$ $F_v = 23446$ psi

Check M12 Post Stem Screws:

$M_1 := 10350$ in·lb

$V_1 := 300$ lb

$V_2 := \frac{M_1}{8.25}$ $V_2 = 1255$ lb

$V_{tot} := \sqrt{V_1{}^2 + V_2{}^2}$ $V_{tot} = 1290$ lb

$f_v := \frac{V_{tot}}{2 \cdot (0.151)}$ $f_v = 4271$ psi

$f_p := \frac{V_{tot}}{2 \cdot (0.313)(0.472)}$ $f_p = 4366$ psi

Use M12 SS Cap Screws As Shown
A2-70 SS Minimum, Fu = 101 ksi

Check M8 SS Screws:

$V_{max} := 200$ lb (Worse Case)

$f_{v2} := \frac{V_{max}}{0.077}$ $f_{v2} = 2597$ psi

$f_{p2} := \frac{V_{max}}{0.315 \cdot (0.197)}$ $f_{p2} = 3223$ psi

Use M8 SS Cap Screws All Locations Shown
A2-70 SS Minimum, Fu = 101 ksi

Input d: 2.5 in.

Input t: 0.313 in.

Input L_b: 13.5 in.

================================

$A=$ 0.7825 in^2

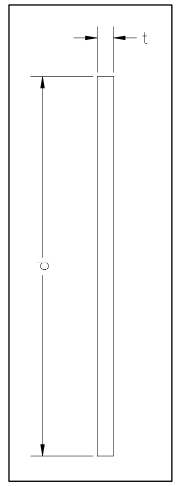
$I_x=$ 0.4076 in^4

$I_y=$ 0.0064 in^4

$S_x=$ 0.3260 in^3

$S_y=$ 0.0408 in^3

$S_r=$ 18.5606



Input D: 2.5 in.

Input t: 0.059 in.

================================

$A_m=$ 4.793576 in^2

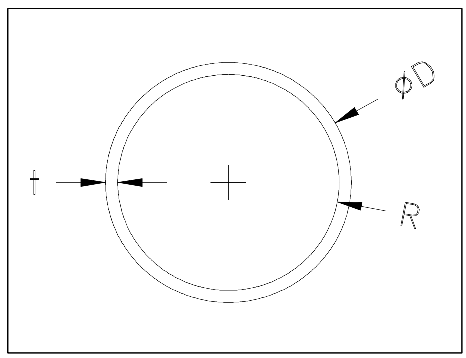
$P_m=$ 7.761305 in.

$J=$ 0.699 in^4

$I=$ 0.337183 in^4

$S=$ 0.269749 in^3

$S_r=$ 20.68644



Input D: 1 in.

Input t: 0.059 in.

================================

$A_m=$ 0.739743 in^2

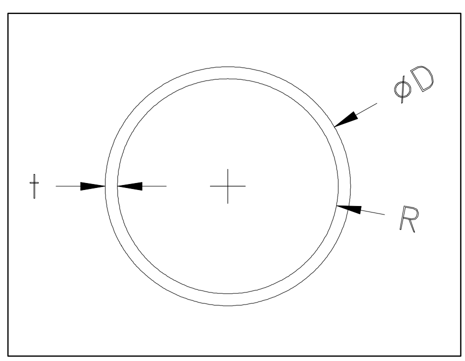
$P_m=$ 3.048916 in.

$J=$ 0.042 in^4

$I=$ 0.019381 in^4

$S=$ 0.038763 in^3

$S_r=$ 7.974576



Input B: 0.787 in.
Input D: 1.574 in.
Input t: 0.059 in.
Input L_b: 4.5 in.
================================

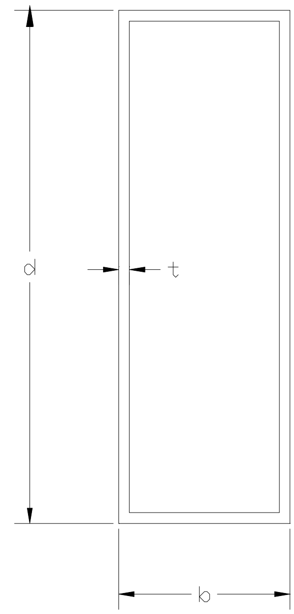
A_m= 1.10292 in^2

A= 0.264674 in^2

P_m= 4.486 in.

J= 0.064 in^4

I_x= 0.083666 in^4
I_y= 0.027607 in^4
S_x= 0.10631 in^3
S_y= 0.070157 in^3



Input D: 0.75 in.

Input t: 0.059 in.
================================

A_m= 0.407716 in^2

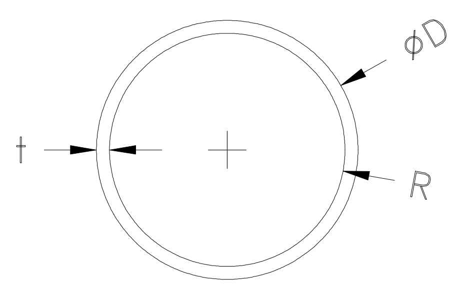
P_m= 2.263518 in.

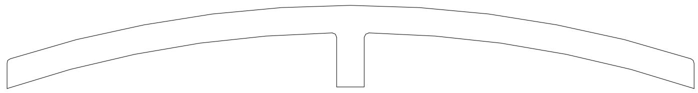
J= 0.017 in^4

I= 0.0077 in^4

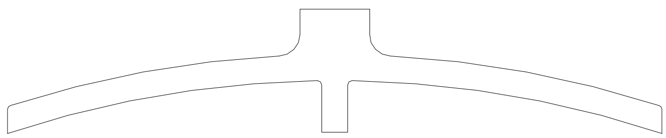
S= 0.020534 in^3

S_r= 5.855932

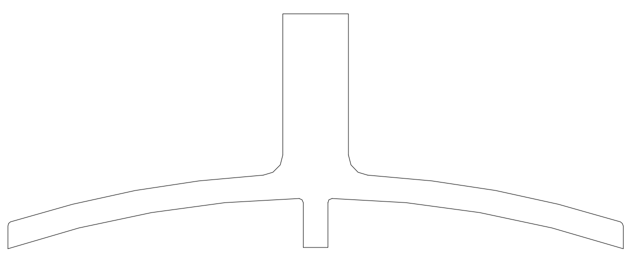




Area:	1.5312 sq in
Perimeter:	13.4079 in
Bounding box:	X: -2.9527 -- 2.9528 in
	Y: -0.4291 -- 0.2924 in
Centroid:	X: 0.0000 in
	Y: 0.0000 in
Moments of inertia:	X: 0.0418 in4
	Y: 4.1805 in4
Section Modulii:	X: 0.0974 in3
	Y: 1.417 in3



Area:	1.8095 sq in
Perimeter:	14.0983 in
Bounding box:	X: -2.9527 -- 2.9528 in
	Y: -0.5045 -- 0.6333 in
Centroid:	X: 0.0000 in
	Y: 0.0000 in
Moments of inertia:	X: 0.1027 in4
	Y: 4.1911 in4
Section Modulii:	X: 0.162 in3
	Y: 1.420 in3



Area:	2.5182 sq in
Perimeter:	16.3483 in
Bounding box:	X: -2.9528 -- 2.9528 in
	Y: -0.8410 -- 1.4218 in
Centroid:	X: 0.0000 in
	Y: 0.0000 in
Moments of inertia:	X: 0.9056 in4
	Y: 4.2146 in4
Section Modulii:	X: 0.638 in3
	Y: 1.428 in3