SIP ENGINEERING
CONSULTANTS, LLC
14845 SW MURRAY SCHOLLS DR
SUITE 110, PMB 306
BEAVERTON, OR 97007
503-554-4178
Mike@SIPconsultants.com

GLOBAL SOLARIUM
910 W. 11th ST. SUITE #A
VANCOUVER, WA 98660
OFF: (800) 810-7666
FAX: (360) 699-6476
E-MAIL: INFO@GLOBALSOLARIUMS.COM
WEB: WWW.GLOBALSOLARIUMS.COM

PRO-ALUMARAIL

100 SERIES
200 SERIES

w/ TOP-MOUNT POST-BASE IN
RESIDENTIAL APPLICATIONS
w/ 3 ft TALL RAIL POSTS

- [x] APPROVED
- [ ] APPROVED AS CORRECTED
- [ ] REVISE AND RESUBMIT
- [ ] FOR YOUR INFORMATION AND USE
- [ ] INCOMPLETE SUBMITTAL
- [ ] NOT APPROVED

Checking is only for conformance with the design concept of the Project and compliance with the information given in the Contract Documents. Contractor is responsible for dimensions to be confirmed and correlated at the job site; for information that pertains solely to the fabrication processes or to techniques of construction; and for coordination of the work of all trades.

STRUCTURAL DEPT., LLC
Date 10.29.21 By ZJB

CODE COMPLIANCE

2012 INTERNATIONAL RESIDENTIAL CODE
2014 OREGON RESIDENTIAL SPECIALTY CODE
2013 CALIFORNIA BUILDING CODE

STRUCTURAL CALCULATIONS*

FOR
GUARDRAIL, POST,
POST BASE & BASE ANCHORS

MICHAEL J. NELSON
STATE OF WASHINGTON
31656
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES 3/21/18

STRUCTURAL
REGISTERED PROFESSIONAL
ENGINEER
16,668
OREGON
JULY 20 1993
MIKE J. NELSON
EXPIRES 12/31/18

REGISTERED PROFESSIONAL ENGINEER
MIKE J. NELSON
C 62770
EXP. 6-30-18
CIVIL
STATE OF CALIFORNIA
EXPIRES 6/30/18

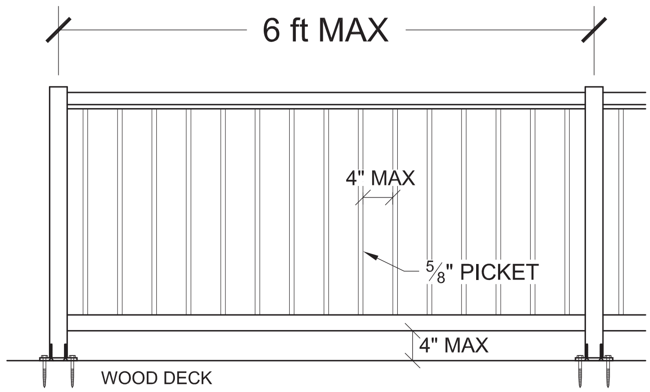
PROFESSIONAL ENGINEER
LICENSED
14980
STATE OF IDAHO
MIKE J. NELSON
EXPIRES 3/31/17

* *DESIGN OF (CONCRETE OR WOOD) DECK / STAIRS TO RESIST HORIZONTAL, VERTICAL, AND MOMENT FORCES AT THE BASE OF THE GUARDRAIL POSTS, INCLUDING DECKING, RIM JOIST, DECK JOISTS, AND ANY BLOCKING REQ'D FOR LAG SCREW ANCHORAGE, IS OUTSIDE THE SCOPE OF THIS ANALYSIS AND MUST BE EVALUATED ON A CASE-BY-CASE BASIS BY A QUALIFIED STRUCTURAL ENGINEER.*
FOR CONCRETE DECKS THE MINIMUM 28 DAY CONC.COMPRESSIVE STRENGTH, f'c = 2,500 psi

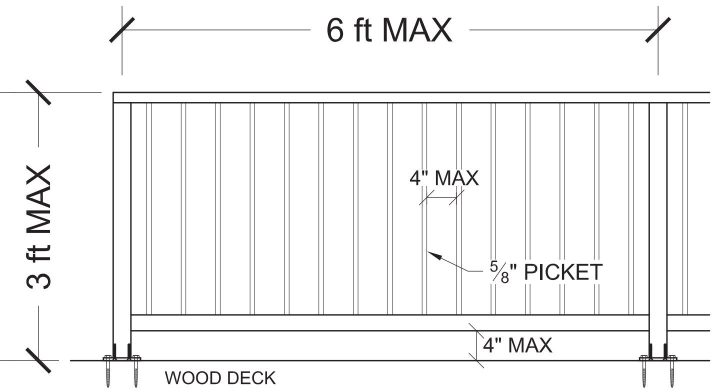
20-125328-DFS-01-RS

CONDITIONS OF USE:

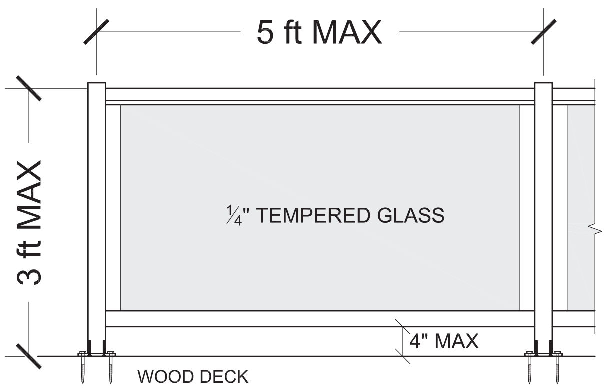
(SEE PAGE 5 & 6 FOR BASE PL ANCHOR REQ'TS)



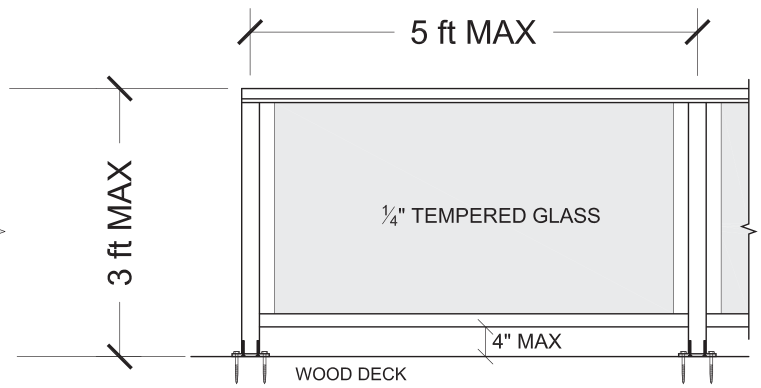
100 SERIES - PICKET INFILL



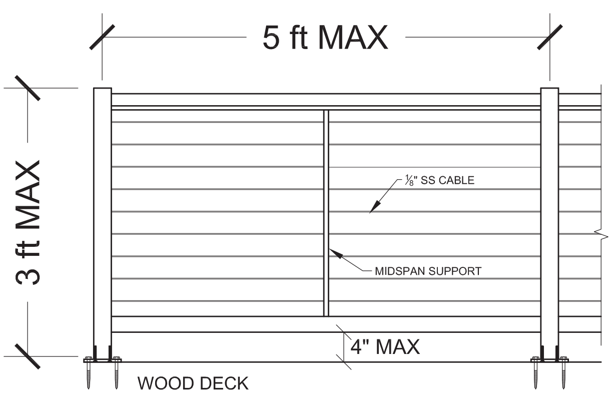
200 SERIES - PICKET INFILL



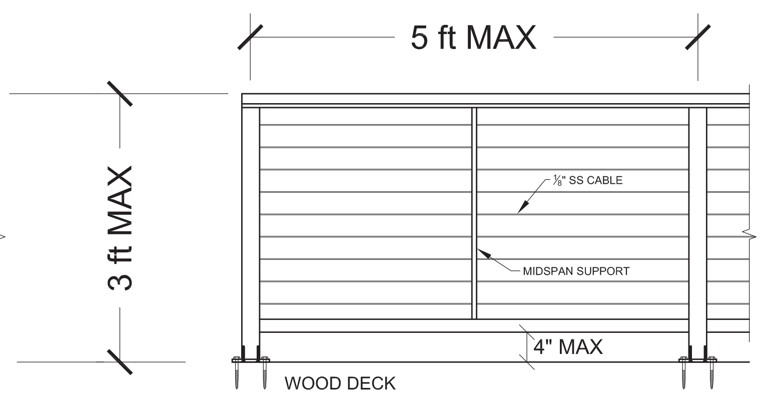
100 SERIES - GLASS INFILL



200 SERIES - GLASS INFILL



100 SERIES - CABLE INFILL



200 SERIES - CABLE INFILL

HANDRAIL - 100S / 200S

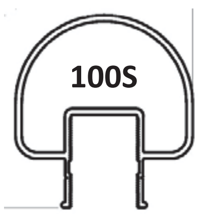
INCLUDES 200 lb HORIZ. PT LOAD AT MIDSPAN
& 412 lb COMPRESSION LOAD FROM CABLE TENSION

CLEAR SPAN = 5.83 ft
POST-TO-POST SPACING = 6 ft

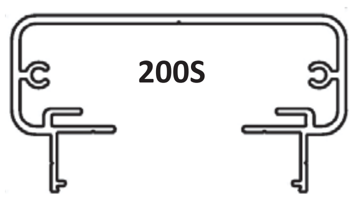
BENDING MOMENT = 292 lb-ft

COMPRESSION LOAD = 412 lb

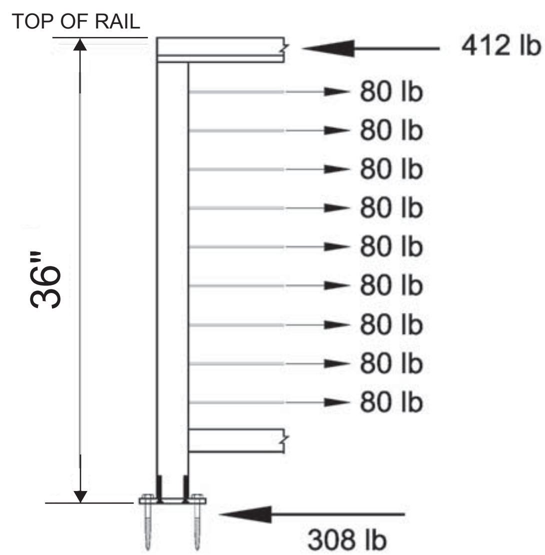
CALCS BASED ON THE HIGHEST STRESSED CONFIGURATION INVOLVING THE 100S HAND RAIL w/ CABLE INFILL, WHICH INCLUDES AXIAL COMPRESSION. THE 200S IS OK BY INSPECTION OF IT'S STRONGER SECTION PROPERTIES.



Ftu	=	38	ksi
Fy	=	35	ksi
Sy	=	0.228	in^3
Ix	=	0.201	in^4
Iy	=	0.228	in^4
E	=	10,100	ksi
r_y	=	0.608	in
A	=	0.543	in^2



Ftu	=	38	ksi
Fy	=	35	ksi
Sy	=	0.824	in^3
Ix	=	0.249	in^4
Iy	=	1.442	in^4
E	=	10,100	ksi
r_y	=	0.545	in
A	=	0.839	in^2



HORIZ. LOAD CONTROLS FOR BENDING STRESS DUE TO ABSENCE OF LOAD SHARING w/ BOT. RAIL

Bending Stress, fb = 15.3 ksi < Fb = 19.50 ksi allowable **OK**

Axial Stress, fc = 0.8 ksi < Fc = 6.40 ksi allowable **OK**

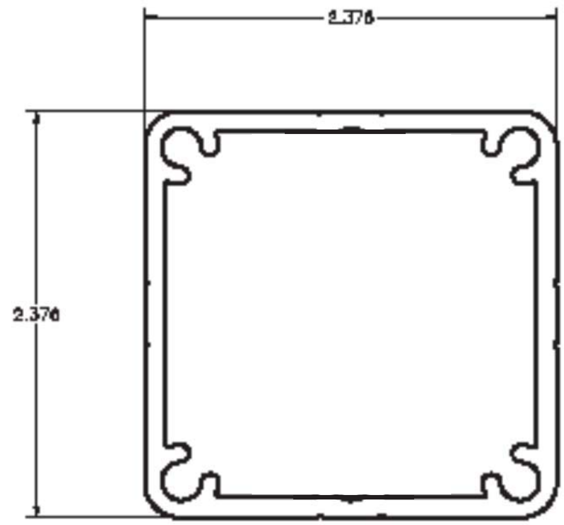
$$\frac{fb}{Fb} + \frac{fc}{Fc} = 0.79 + 0.12 = 0.91 < 1$$

OK

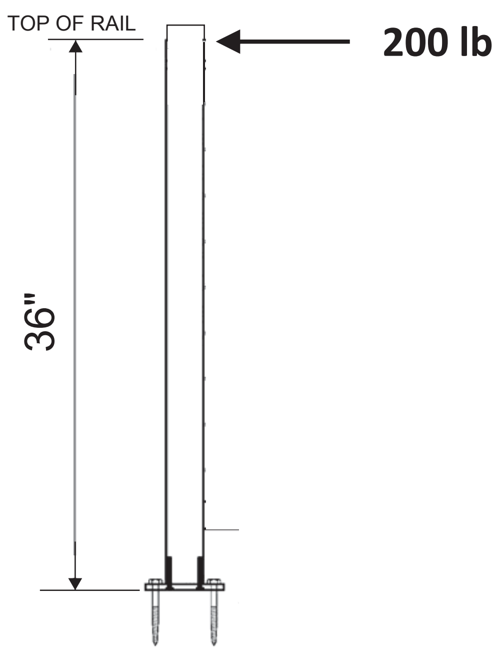
HAND RAIL POST - RESIDENTIAL (# 13503)

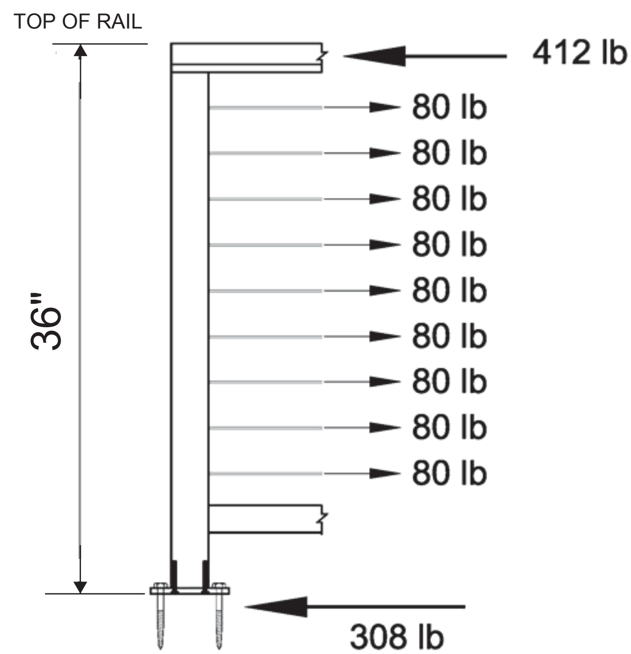
HEIGHT = 3.00 ft

PT LOAD AT TOP = 200 lb



Ftu	=	38	ksi
Fy	=	35	ksi
Sx	=	0.726	in^3
Sy	=	0.801	in^3
Ix	=	0.863	in^4
Iy	=	0.863	in^4
E	=	10,100	ksi





TYP. LOADING - ALL INFILL OPTIONS

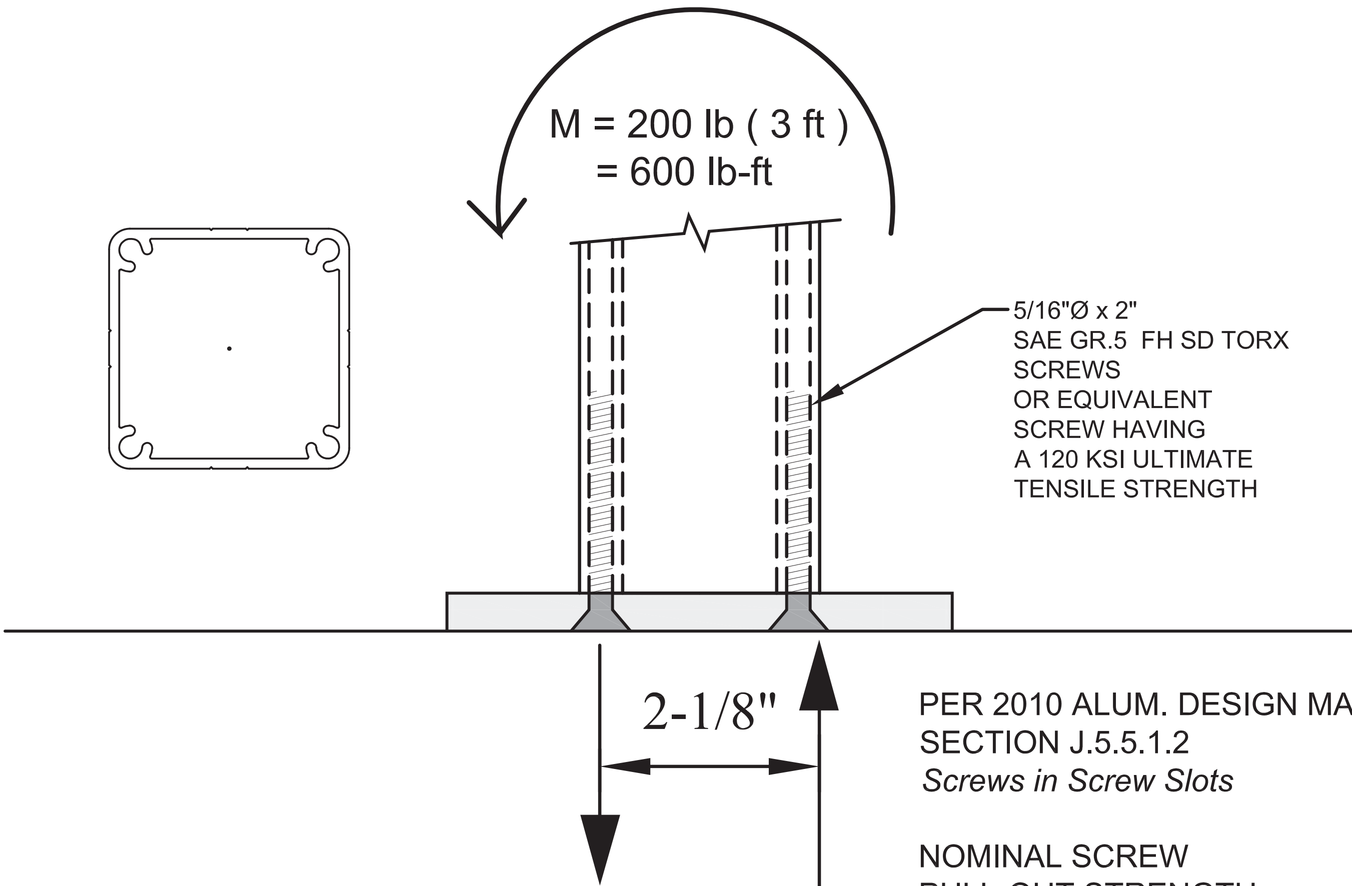
MOMENT = 600 lb-ft

CABLE INFILL LOADING

MOMENT = 340 lb-ft

Bending Moment	=	600	lb-ft	=	7,200	lb-in	
Bending Stress, fb	=	9.9	ksi	<	19.5 allowable	ksi	**OK**
Deflection	=	0.36	in.				

100 & 200 SERIES
POST-TO-BASE PL CONNECTION



$\dfrac{600(12''/\text{ft}) / 2.125''}{2 \text{ SCREWS}}$

= 1, 694 lb PER SCREW

PER 2010 ALUM. DESIGN MANUAL
SECTION J.5.5.1.2
Screws in Screw Slots

NOMINAL SCREW
PULL-OUT STRENGTH
= .29 D Le Ftu
= .29 (.3125") (1.625") (38,000 psi)
= 5,596 lbs

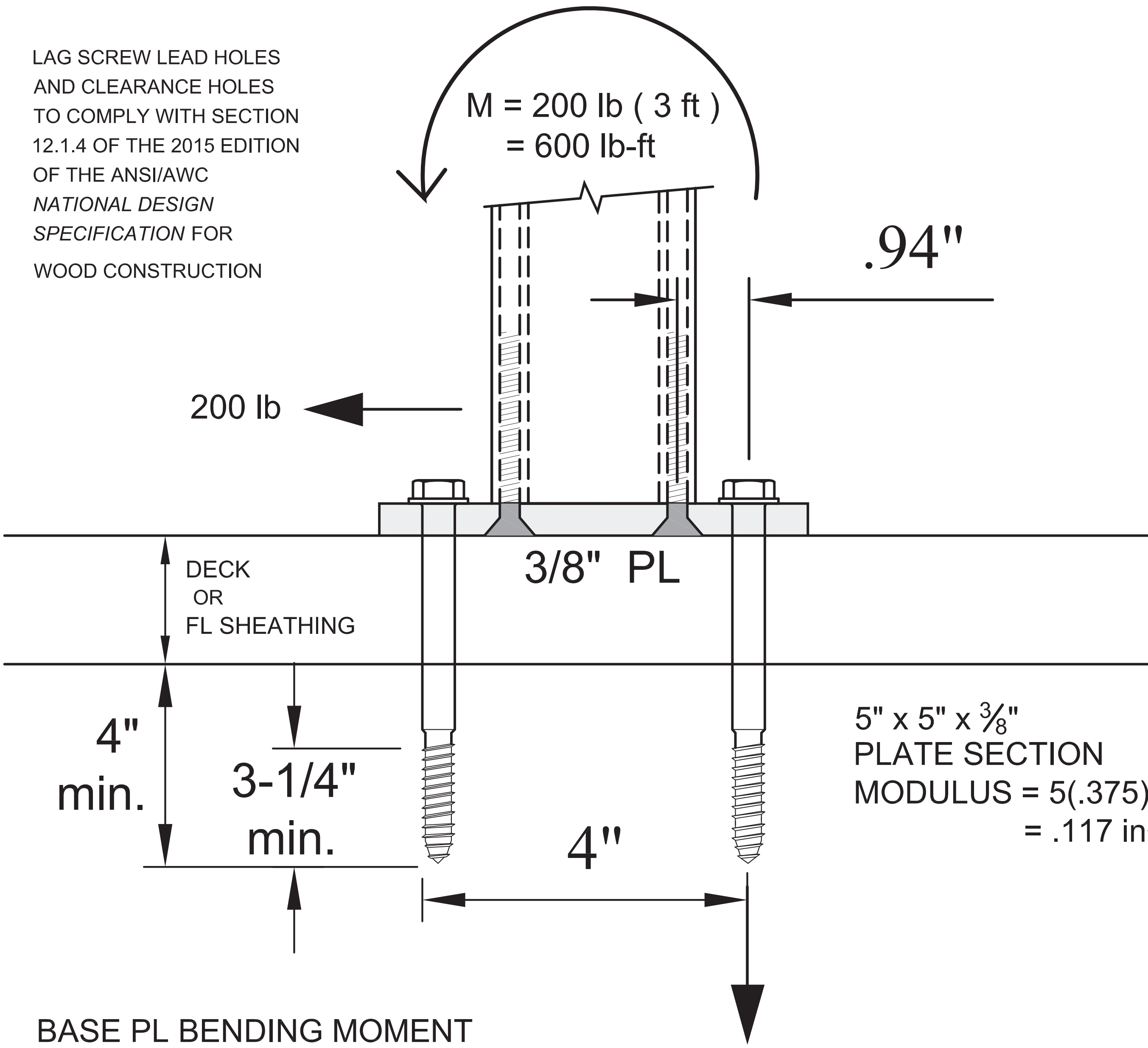
DESIGN STRENGH = 5,596 / 3
= 1,865 lb > 1,694 lb REQ'D - OK

ULTIMATE SCREW TENSILE CAP. = 6,440 lb

DESIGN CAP. = 6,440 / 3 = 2,147 lb > 1,694 lb REQ'D - OK

100 & 200 SERIES
POST BASE PL & ANCHORAGE TO WOOD DECK w/ 3/8" DIA. LAG SCREWS

LAG SCREW LEAD HOLES AND CLEARANCE HOLES TO COMPLY WITH SECTION 12.1.4 OF THE 2015 EDITION OF THE ANSI/AWC *NATIONAL DESIGN SPECIFICATION* FOR WOOD CONSTRUCTION



5" x 5" x ⅜"
PLATE SECTION
MODULUS = 5(.375)(.375)/6
= .117 in^3

BASE PL BENDING MOMENT
= 1.8 (.94) = 1.69 k-in

BENDING STRESS =1.69 / .117
= 14.5 ksi < .75(35) = 26.25 ksi
OK

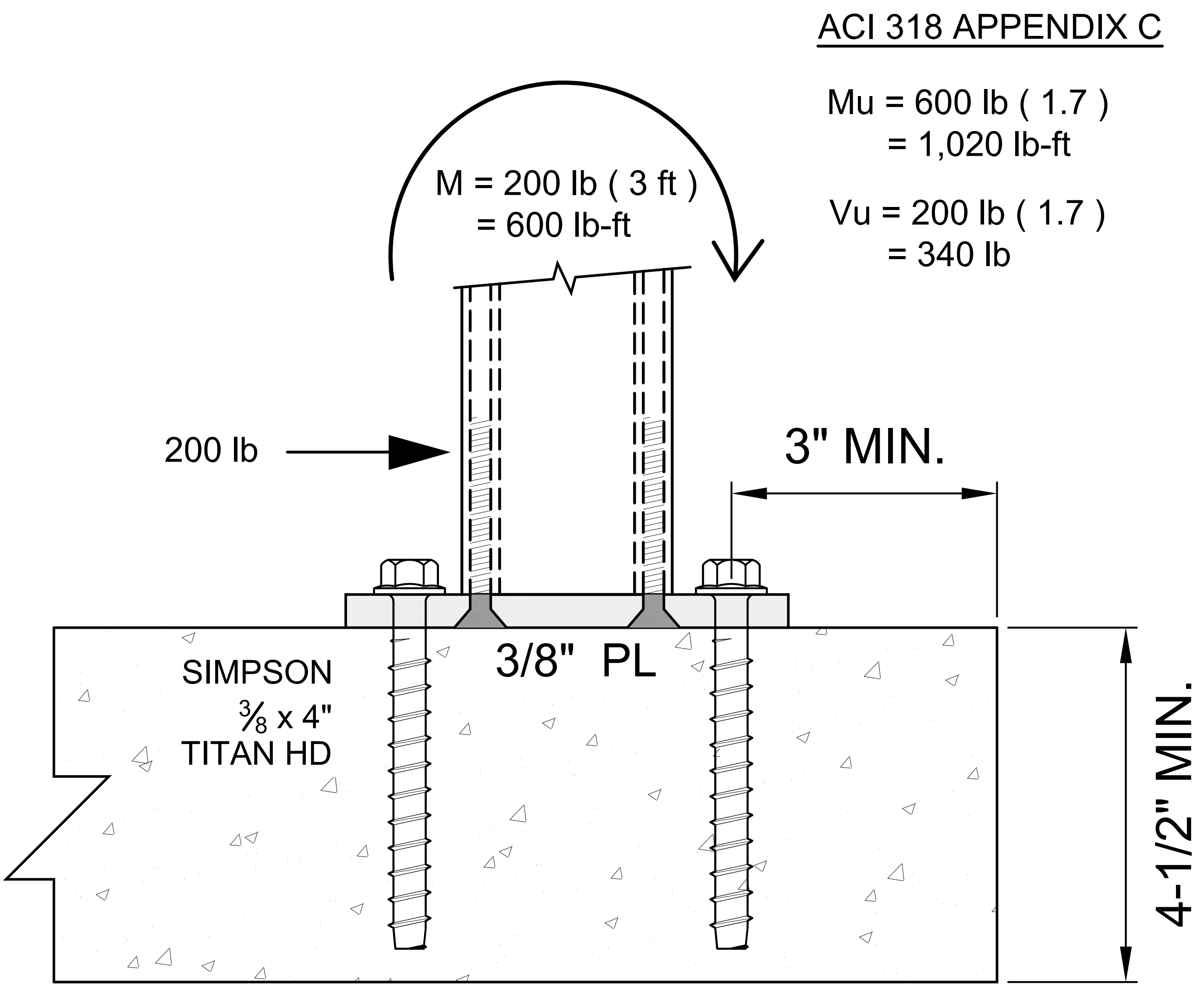
600(12) / 4 = 1,800 lb
OR
900 LB PER ANCHOR

FOR HEM FIR & Cd = 1.33

MIN. REQ'D ⅜" DIA. LAG SCREW THREAD

$$\text{LENGTH} = \frac{900}{243(1.33)} + .5 = 3.25\text{"}$$

100 & 200 SERIES
POST BASE PL & ANCHORAGE TO CONCRETE DECK



SEE PAGE 6 FOR BASE PL BENDING ANALYSIS THAT ALSO APPLIES TO THIS CONDITION.

SEE NEXT 8 PAGES FOR ANCHOR CALCULATIONS.

SIMPSON Strong-Tie®

Anchor Designer™
Software
Version 2.5.6163.6

Company:		Date:	6/14/2015
Engineer:		Page:	1/4
Project:			
Address:			
Phone:			
E-mail:			

1.Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment:

Project description: POST ANCHORAGE
Location:
Fastening description:

2. Input Data & Anchor Parameters

General
Design method:ACI 318-11
Units: Imperial units

Anchor Information:
Anchor type: Concrete screw
Material: Carbon Steel
Diameter (inch): 0.375
Nominal Embedment depth (inch): 3.250
Effective Embedment depth, h_{ef} (inch): 2.400
Code report: ICC-ES ESR-2713
Anchor category: 1
Anchor ductility: No
h_{min} (inch): 5.00
c_{ac} (inch): 3.63
C_{min} (inch): 1.75
S_{min} (inch): 3.00

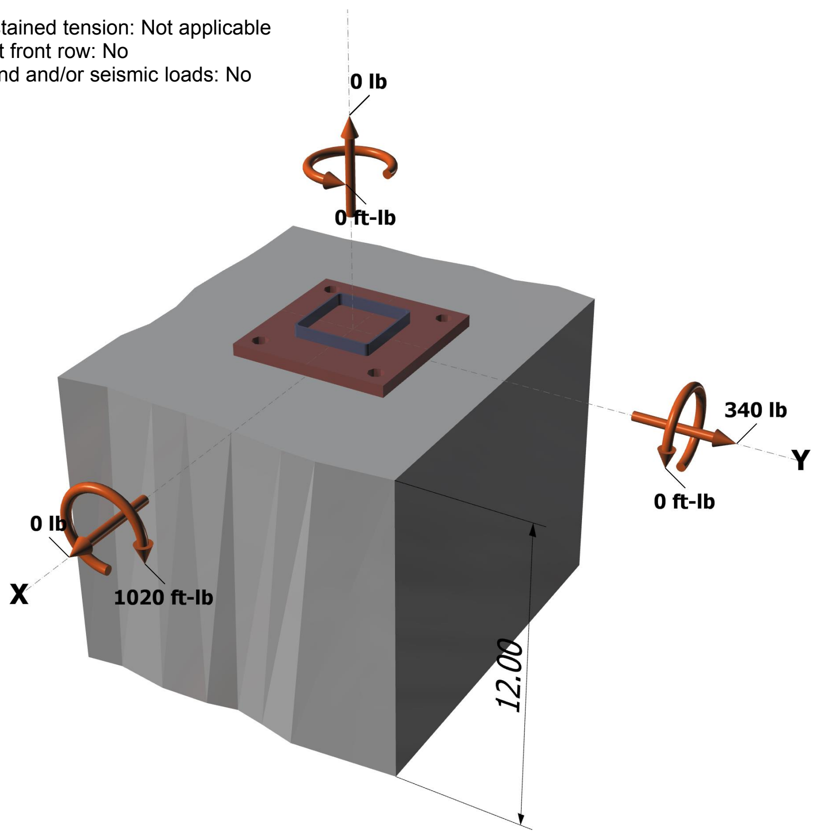
Load and Geometry
Load factor source: ACI 318 Appendix C
Load combination: not set
Seismic design: No
Anchors subjected to sustained tension: Not applicable
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: No

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 12.00
State: Cracked
Compressive strength, f'c (psi): 2500
$\Psi_{c,V}$: 1.0
Reinforcement condition: B tension, B shear
Supplemental reinforcement: Not applicable
Reinforcement provided at corners: No
Do not evaluate concrete breakout in tension: No
Do not evaluate concrete breakout in shear: No
Ignore 6do requirement: Not applicable
Build-up grout pad: No

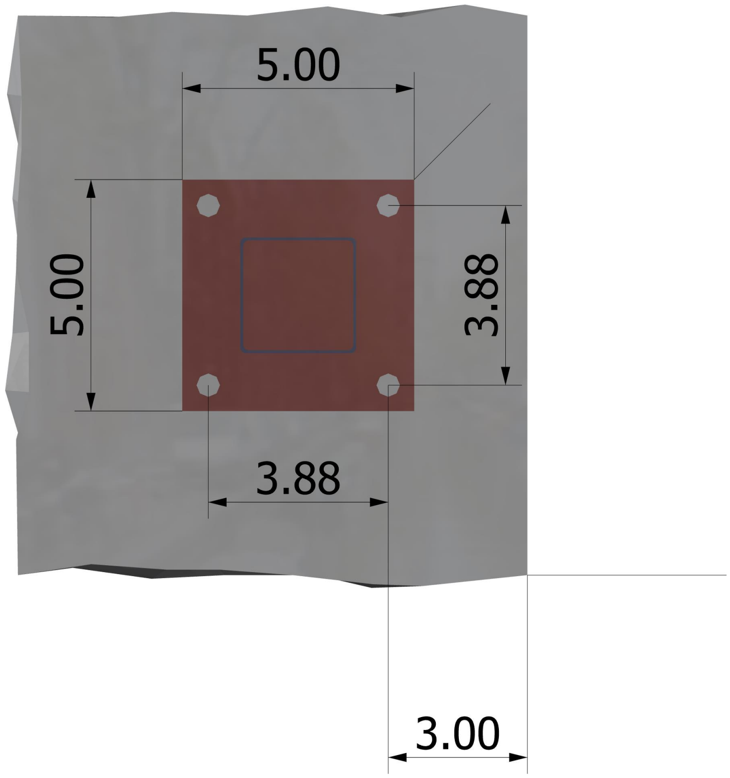
Base Plate
Length x Width x Thickness (inch): 5.00 x 5.00 x 0.38
Yield stress: 35000 psi

Profile type/size: HSS2-1/2X2-1/2X1/8

<Figure 1>



<Figure 2>



Recommended Anchor
Anchor Name: Titen HD® - 3/8"Ø Titen HD, hnom:3.25" (83mm)
Code Report: ICC-ES ESR-2713

SIMPSON Strong-Tie®

Anchor Designer™ Software
Version 2.5.6163.6

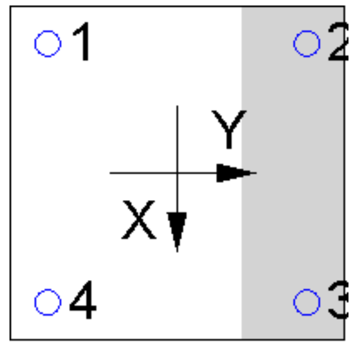
Company:		Date:	6/14/2015
Engineer:		Page:	3/4
Project:			
Address:			
Phone:			
E-mail:			

3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	1556.9	0.0	85.0	85.0
2	0.0	0.0	85.0	85.0
3	0.0	0.0	85.0	85.0
4	1556.9	0.0	85.0	85.0
Sum	3113.8	0.0	340.0	340.0

Maximum concrete compression strain (‰): 0.19
Maximum concrete compression stress (psi): 814
Resultant tension force (lb): 3114
Resultant compression force (lb): 3114
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

<Figure 3>



4. Steel Strength of Anchor in Tension (Sec. D.5.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
10890	0.70	7623

5. Concrete Breakout Strength of Anchor in Tension (Sec. D.5.2)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ (Eq. D-6)

k_c	λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
17.0	1.00	2500	2.400	3160

$\phi N_{cbg} = \phi\,(A_{Nc} / A_{Nco})\,\Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ (Sec. D.4.1 & Eq. D-4)

A_{Nc} (in^2)	A_{Nco} (in^2)	$c_{a,min}$ (in)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕN_{cbg} (lb)
79.78	51.84	6.88	1.000	1.000	1.00	1.000	3160	0.75	3648

6. Pullout Strength of Anchor in Tension (Sec. D.5.3)

$\phi N_{pn} = \phi \Psi_{c,P} \lambda_a N_p (f'_c / 2{,}500)^n$ (Sec. D.4.1, Eq. D-13 & Code Report)

$\Psi_{c,P}$	λ_a	N_p (lb)	f'_c (psi)	n	ϕ	ϕN_{pn} (lb)
1.0	1.00	2700	2500	0.50	0.75	2025

SIMPSON Strong-Tie®
Anchor Designer™ Software
Version 2.5.6163.6

Company:		Date:	6/14/2015
Engineer:		Page:	4/4
Project:			
Address:			
Phone:			
E-mail:			

8. Steel Strength of Anchor in Shear (Sec. D.6.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
4460	1.0	0.65	2899

9. Concrete Breakout Strength of Anchor in Shear (Sec. D.6.2)

Shear perpendicular to edge in y-direction:

$V_{by} = \min|7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda_a\sqrt{f'_c}c_{a1}^{1.5};\ 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}|$ (Eq. D-33 & Eq. D-34)

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{by} (lb)
2.40	0.375	1.00	2500	3.00	1614

$\phi V_{cbgy} = \phi\ (A_{Vc} / A_{Vco})\Psi_{ec,V}\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{by}$ (Sec. D.4.1 & Eq. D-31)

A_{Vc} (in^2)	A_{Vco} (in^2)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V_{by} (lb)	ϕ	ϕV_{cbgy} (lb)
57.96	40.50	1.000	1.000	1.000	1.000	1614	0.75	1733

10. Concrete Pryout Strength of Anchor in Shear (Sec. D.6.3)

$\phi V_{cpg} = \phi k_{cp}N_{cbg} = \phi k_{cp}(A_{Nc} / A_{Nco})\Psi_{ec,N}\Psi_{ed,N}\Psi_{c,N}\Psi_{cp,N}N_b$ (Sec. D.4.1 & Eq. D-41)

k_{cp}	A_{Nc} (in^2)	A_{Nco} (in^2)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cpg} (lb)
1.0	116.12	51.84	1.000	0.950	1.000	1.000	3160	0.75	5044

11. Results

Interaction of Tensile and Shear Forces (Sec. D.7)

Tension	Factored Load, N_{ua} (lb)	Design Strength, $øN_n$ (lb)	Ratio	Status
Steel	1557	7623	0.20	Pass
Concrete breakout	**3114**	**3648**	**0.85**	**Pass (Governs)**
Pullout	1557	2025	0.77	Pass

Shear	Factored Load, V_{ua} (lb)	Design Strength, $øV_n$ (lb)	Ratio	Status
Steel	85	2899	0.03	Pass
T Concrete breakout y+	**170**	**1733**	**0.10**	**Pass (Governs)**
Pryout	340	5044	0.07	Pass

Interaction check	$N_{ua}/\phi N_n$	$V_{ua}/\phi V_n$	Combined Ratio	Permissible	Status
Sec. D.7.1	0.85	0.00	85.4 %	1.0	Pass

3/8"Ø Titen HD, hnom:3.25" (83mm) meets the selected design criteria.

12. Warnings

- Designer must exercise own judgement to determine if this design is suitable.

- Refer to manufacturer's product literature for hole cleaning and installation instructions.