James A. Koppenhaver, P.E.
304 Logan Avenue
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Fence Calculations

For

Drawing 1056

Fabricators:

High Point JS Welding
Architectural Metal Fabricators, LLC
418 Route 206
Montague, New Jersey 07827
Tel: (973) 293-8330
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Drawing: 1056
Date: 11/13/2014

Drawings Reviewed:
SHT-1: Fence Calculation, Railing Layout Plan

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Fence Design Requirements

A minimum lateral wind load of 10 lb/sq.ft., applied to the net infill area of the fence, was used to determine superimposed forces on fence components and supports.

The SHT-1 Fence Calculations drawing shows proposed fence constructions of both steel and aluminum components. There is a plain configuration (Design #1) and an ornamental configuration (Design #2) shown for both the steel and aluminum options. Further, there are additional options indicated based on fence post spacings of 4', 5', 6', and 8'. Also, optional fence heights of 4', 5', and 6' are indicated.

The most critical option combinations of 8' span and 6' height were investigated for design. The net fence area subject to wind pressure was determined to be approximately 25 percent component area and 75 percent open area. Therefore, of the wind load of 10 psf, 2.5 psf acts on the fence and the rest passes through the fence.

Calculations follow for the steel and aluminum fence types including vertical infill components, top and bottom rails, posts, and optional base plates.

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Fence Calculations – SHT-1

Steel Design Fence Panel 6-feet high by 8-feet span

Post section properties:
S4x9.5 American Standard S-Shapes
S = 3.38 in^3, H = 72"
ASTM A36 Steel
Fb = 21.6 ksi, Fy = 36 ksi, E = 29,000 ksi

Rail section properties:
C2x1x0.125
S =0.062 in^3, L = 96"
ASTM A36 Steel
Fb = 21.6 ksi, Fy = 36 ksi, E = 29,000 ksi

Baluster section properties:
¾"Ø Solid Bar
S = 0.041 in^3, H = 63"
ASTM A36 Steel
Fb = 21.6 ksi, Fy = 36 ksi, E = 29,000 ksi

Baluster design:

Three members exist per 12-inch wide design section
Composite Section Modulus = 3 x 0.041 in^3 = 0.123 in^3

Bending moment, w = 2.5 plf

$M = w l^2 / 8$ = 2.5 plf x $5.25'^2$ / 12 = 8.61 lb-ft = 103 lb-in
Smin = M / Fb = 103 lb-in / 21,600 psi = 0.0048 in^3
S = 0.123 in^3 > Smin = 0.0048 in^3 OK

Rail design:

The top rail tributary load is slightly greater than the bottom rail.
(5.25' / 2) + (2" / 12") = 2.79 feet
Uniform load, w = 2.79' x 2.5 psf = 7 plf

Bending moment, w = 7 plf

$M = w l^2 / 8$ = 7 plf x $8'^2$ / 12 = 56 lb-ft = 672 lb-in
Smin = M / Fb = 672 lb-in / 21,600 psi = 0.0311 in^3
S = 0.062 in^3 > Smin = 0.0311 in^3 OK

Post design:

Each post has a tributary load area of 8' x 6' = 48 sq.ft.
As a uniform load along its' length, w = 8' x 2.5 psf = 20 plf

Bending moment, w = 20 plf

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$M = w l^2 / 2 = 20 plf \times 6'^2 / 2 = 360 lb\text{-}ft = 4{,}320 lb\text{-}in$
$Smin = M / Fb = 4{,}320 lb\text{-}in / 21{,}600 psi = 0.20 in^3$
$S = 3.38 in^3 > Smin = 0.20 in^3$ OK

Base Plate design:

Square, Stiffened / Unstiffened Base Plate, Any Rod Material - Rev. F /G

Assumptions: 1) Rod groups at corners. Total # rods divisible by 4. Maximum total # of rods = 48 (12 per Corner).
2) Rod Spacing = Straight Center-to-Center distance between any (2) adjacent rods (same corner)
3) Clear space between bottom of leveling nut and top of concrete **not** exceeding (1)*(Rod Diameter)

Site Data

BU#: *Steel Base Plate*
Site Name:
App #:

Anchor Rod Data		
Eta Factor, η	0.7	TIA G (Fig. 4-4)
Qty:	4	
Diam:	0.5	in
Rod Material:	Other	
Yield, Fy:	36	ksi
Strength, Fu:	58	ksi
Bolt Circle:	6	in

Plate Data		
W=Side:	6	in
Thick:	0.375	in
Grade:	36	ksi
Clip Distance:	0	in

Stiffener Data (Welding at both sides)		
Configuration:	Unstiffened	
Weld Type:		**
Groove Depth:		in **
Groove Angle:		degrees
Fillet H. Weld:		<-- Disregard
Fillet V. Weld:		in
Width:		in
Height:		in
Thick:		in
Notch:		in
Grade:		ksi
Weld str.:		ksi
Clear Space between Stiffeners at B.C.		in

Pole Data		
Diam:	4	in
Thick:	0.125	in
Grade:	36	ksi
# of Sides:	4	"0" IF Round

Base Reactions		
TIA Revision:	G	
Factored Moment, Mu:	0.36	ft-kips
Factored Axial, Pu:	0	kips
Factored Shear, Vu:	0.12	kips

Anchor Rod Results

TIA G --> Max Rod (Cu+ Vu/η):	0.8 Kips
Axial Design Strength, Φ*Fu*Anet:	6.6 Kips
Anchor Rod Stress Ratio:	11.6% **Pass**

Base Plate Results — Flexural Check

Base Plate Stress:	4.6 ksi
PL Design Bending Strength, Φ*Fy:	32.4 ksi
Base Plate Stress Ratio:	14.1% **Pass**

PL Ref. Data	
Yield Line (in):	4.47
Max PL Length:	4.49

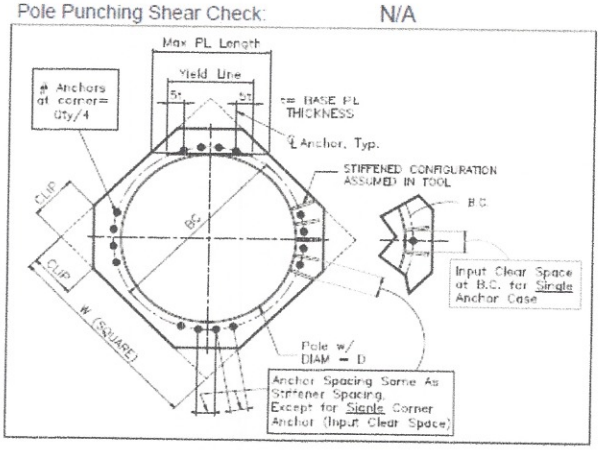
N/A - Unstiffened

Stiffener Results

Horizontal Weld :	N/A
Vertical Weld:	N/A
Plate Flex+Shear, fb/Fb+(fv/Fv)^2:	N/A
Plate Tension+Shear, ft/Ft+(fv/Fv)^2:	N/A
Plate Comp. (AISC Bracket):	N/A

Pole Results

Pole Punching Shear Check: N/A



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Aluminum Design Fence Panel 6-feet high by 8-feet span

Post section properties:
I4x2.31 Aluminum Association Standard I-Beams
S = 2.81 in^3, H = 72"
Aluminum Alloy 6061-T6
Fb = 27.6 ksi, Fy = 38 ksi, E = 10,100 ksi

Rail section properties:
CS2x0.577
S =0.288 in^3, L = 96"
Aluminum Alloy 6061-T6
Fb = 27.6 ksi, Fy = 38 ksi, E = 10,100 ksi

Baluster section properties:
¾"Ø Solid Bar
S = 0.041 in^3, H = 63"
Aluminum Alloy 6061-T6
Fb = 27.6 ksi, Fy = 38 ksi, E = 10,100 ksi

Baluster design:

Three members exist per 12-inch wide design section
Composite Section Modulus = 3 x 0.041 in^3 = 0.123 in^3

Bending moment, w = 2.5 plf

$M = w l^2 / 8$ = 2.5 plf x 5.25'^{2} / 12 = 8.61 lb-ft = 103 lb-in
Smin = M / Fb = 103 lb-in / 21,600 psi = 0.0048 in^3
S = 0.123 in^3 > Smin = 0.0048 in^3 OK

Rail design:

The top rail tributary load is slightly greater than the bottom rail.
(5.25' / 2) + (2" / 12") = 2.79 feet
Uniform load, w = 2.79' x 2.5 psf = 7 plf

Bending moment, w = 7 plf

$M = w l^2 / 8$ = 7 plf x 8'^{2} / 12 = 56 lb-ft = 672 lb-in
Smin = M / Fb = 672 lb-in / 21,600 psi = 0.0311 in^3
S = 0.288 in^3 > Smin = 0.0311 in^3 OK

Post design:

Each post has a tributary load area of 8' x 6' = 48 sq.ft.
As a uniform load along its' length, w = 8' x 2.5 psf = 20 plf

Bending moment, w = 20 plf

$M = w l^2 / 2$ = 20 plf x 6'^{2} / 2 = 360 lb-ft = 4,320 lb-in
Smin = M / Fb = 4,320 lb-in / 21,600 psi = 0.20 in^3

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$S = 2.81\ in^3 > Smin = 0.20\ in^3$ OK

Base Plate design:

Square, Stiffened / Unstiffened Base Plate, Any Rod Material - Rev. F /G

Assumptions: 1) Rod groups at corners. Total # rods divisible by 4. Maximum total # of rods = 48 (12 per Corner).
2) Rod Spacing = Straight Center-to-Center distance between any (2) adjacent rods (same corner)
3) Clear space between bottom of leveling nut and top of concrete **not** exceeding (1)*(Rod Diameter)

Site Data

BU#: *Aluminum Base Plate*
Site Name:
App #:

Anchor Rod Data		
Eta Factor, η	0.7	TIA G (Fig. 4-4)
Qty:	4	
Diam:	0.5	in
Rod Material:	Other	
Yield, Fy:	36	ksi
Strength, Fu:	58	ksi
Bolt Circle:	6	in

Plate Data		
W=Side:	6	in
Thick:	0.375	in
Grade:	38	ksi
Clip Distance:	0	in

Stiffener Data (Welding at both sides)		
Configuration:	Unstiffened	
Weld Type:		**
Groove Depth:		in **
Groove Angle:		degrees
Fillet H. Weld:		<-- Disregard
Fillet V. Weld:		in
Width:		in
Height:		in
Thick:		in
Notch:		in
Grade:		ksi
Weld str.:		ksi
Clear Space between Stiffeners at B.C.		in

Pole Data		
Diam:	4	in
Thick:	0.125	in
Grade:	38	ksi
# of Sides:	4	"0" IF Round

Base Reactions		
TIA Revision:	G	
Factored Moment, Mu:	0.36	ft-kips
Factored Axial, Pu:	0	kips
Factored Shear, Vu:	0.12	kips

Anchor Rod Results

TIA G --> Max Rod (Cu+ Vu/η):	0.8 Kips
Axial Design Strength, Φ*Fu*Anet:	6.6 Kips
Anchor Rod Stress Ratio:	11.6% **Pass**

Base Plate Results

	Flexural Check
Base Plate Stress:	4.6 ksi
PL Design Bending Strength, Φ*Fy:	34.2 ksi
Base Plate Stress Ratio:	13.4% **Pass**

PL Ref. Data	
Yield Line (in):	4.47
Max PL Length:	4.49

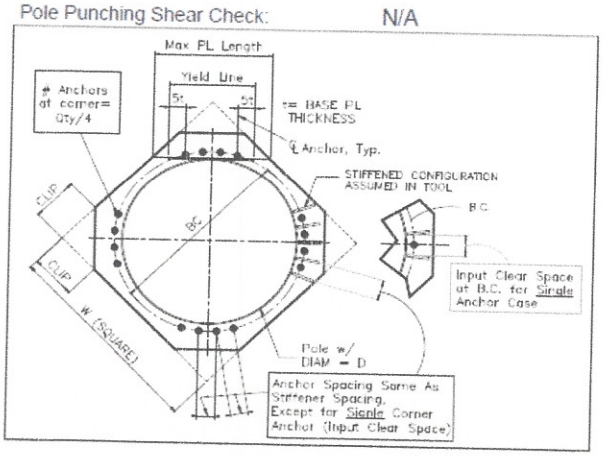
N/A - Unstiffened

Stiffener Results

Horizontal Weld :	N/A
Vertical Weld:	N/A
Plate Flex+Shear, fb/Fb+(fv/Fv)^2:	N/A
Plate Tension+Shear, ft/Ft+(fv/Fv)^2:	N/A
Plate Comp. (AISC Bracket):	N/A

Pole Results

Pole Punching Shear Check: N/A



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