

STRUCTURAL CALCULATIONS

FOR

MERCER ISLAND RESIDENCE PV ARRAY SUB-
STRUCTURE
6838 96TH AVE SE
MERCER ISLAND, WA 98040

PREPARED BY
PCS STRUCTURAL SOLUTIONS



OCTOBER 6, 2023
21-201

SEISMIC

$R = 2, \Omega = 2$ [ASCE CHAP. 15, INV. PENDULUM]

$S_{D5} = 0.637$

MASON ROOF

$W = 895 \text{ ft}^2 (S_{psf}) = 4.475 \text{ k}$

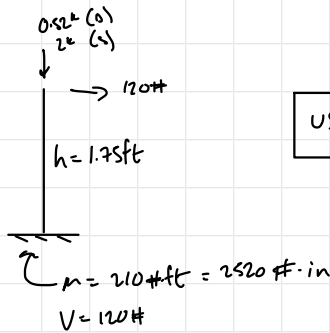
$C_s = 0.637 / (2/1) = 0.3185$

$V = 4.475 \text{ k} \times 0.3185 = 1.43 \text{ k}$

$V_{col} = 1.43 \text{ k} / 12 = 0.12 \text{ k} / \text{col}$

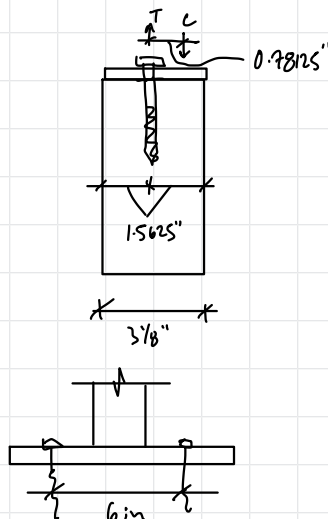
FRAMING +
RAILING + PV
ARRAY

CHECK POST:



USE 3" DIA. STD. PIPE

CHECK POST BASE ATTACHMENT:



$T_{APPLIED} = 2520 \text{ #} \cdot \text{in} (2) / 0.78125 \text{ in} = 6452 \text{ #}$

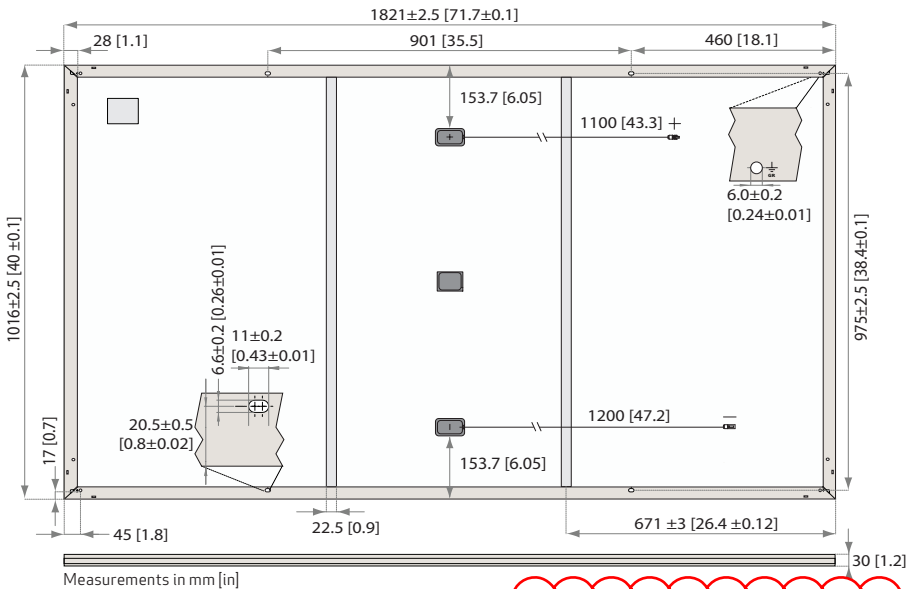
$T_{ALLOWABLE} = 1.6 (378 \text{ lb/in}) (2 \text{ SCREWS}) (6 \text{ in})$
 $= 7257 \text{ #} > 6452 \text{ #} \quad \checkmark$

USE 1/2" φ x 6" LAG SCREWS

$T_{APPLIED} = 2520 \text{ #} \cdot \text{in} (2) / 6 \text{ in} = 840 \text{ #}$

$T_{ALLOW} = 1.6 (378 \text{ #/in}) (6 \text{ in}) = 3628 \text{ #} > 840 \text{ #}$

$UPLIFT = [0.6 (395) - 0.6 (405)] (64 \text{ ft}^2) = -1.5 \text{ k} < 7257 \text{ #} \quad \checkmark$



GENERAL DATA

Cell type:	132 half-cut REC heterojunction cells with lead-free, gapless technology 6 strings of 22 cells in series	<div style="border: 2px solid red; border-radius: 50%; padding: 10px; display: inline-block;"> $w = 45 \text{ psf} / ((71.7" \times 40") / 144) = 2.26 \text{ psf}$ </div>
Glass:	0.13 in (3.2 mm) solar glass with anti-reflection surface treatment	
Backsheet:	Highly resistant polymer (black)	
Frame:	Anodized aluminum (black)	
Junction box:	3-part, 3 bypass diodes, IP68 rated in accordance with IEC 62790	
Cable:	12AWG (4mm ²) PV wire, 43+47 in (1.1+1.2m) accordance with EN 50618	
Dimensions:	71.7 x 40 x 1.2 in (1821 x 1016 x 30 mm)	
Weight:	45 lbs (20.5 kg)	
Origin:	Made in Singapore	

ELECTRICAL DATA

Product Code*: RECxxxAA Pure

	385	390	395	400	405
Power Output - P _{MAX} (Wp)	385	390	395	400	405
Watt Class Sorting - (W)	0/+5	0/+5	0/+5	0/+5	0/+5
Nominal Power Voltage - V _{MPP} (V)	41.2	41.5	41.8	42.1	42.4
Nominal Power Current - I _{MPP} (A)	9.35	9.40	9.45	9.51	9.56
Open Circuit Voltage - V _{OC} (V)	48.5	48.6	48.7	48.8	48.9
Short Circuit Current - I _{SC} (A)	10.18	10.19	10.20	10.25	10.30
Power Density (W/sq ft)	19.3	19.6	19.8	20.1	20.3
Panel Efficiency (%)	20.8	21.1	21.3	21.6	21.9
Power Output - P _{MAX} (Wp)	293	297	301	305	309
Nominal Power Voltage - V _{MPP} (V)	38.8	39.1	39.4	39.7	40.0
Nominal Power Current - I _{MPP} (A)	7.55	7.59	7.63	7.68	7.72
Open Circuit Voltage - V _{OC} (V)	45.7	45.8	45.9	46.0	46.1
Short Circuit Current - I _{SC} (A)	8.16	8.20	8.24	8.28	8.32

Values at standard test conditions (STC: air mass AM1.5, irradiance 10.75 W/sq ft (1000 W/m²), temperature 77°F (25°C), based on a production spread with a tolerance of P_{MAX}, V_{OC} & I_{SC} ±3% within one watt class. Nominal module operating temperature (NMOT: air mass AM1.5, irradiance 800 W/m², temperature 68°F (20°C), windspeed 3.3 ft/s (1 m/s). *Where xxx indicates the nominal power class (P_{MAX}) at STC above.

CERTIFICATIONS

IEC 61215:2016, IEC 61730:2016, UL 61730	
IEC 62804	PID
IEC 61701	Salt Mist
IEC 62716	Ammonia Resistance
UL 61730	Fire Type Class 2
IEC 62782	Dynamic Mechanical Load
IEC 61215-2:2016	Hailstone (35mm)
IEC 62321	Lead-free acc. to RoHS EU 863/2015
ISO 14001:2004, ISO 9001:2015, OHSAS 18001:2007, IEC 62941	



WARRANTY

	Standard	REC ProTrust	
Installed by an REC Certified Solar Professional	No	Yes	Yes
System Size	All	≤25 kW	25-500 kW
Product Warranty (yrs)	20	25	25
Power Warranty (yrs)	25	25	25
Labor Warranty (yrs)	0	25	10
Power in Year 1	98%	98%	98%
Annual Degradation	0.25%	0.25%	0.25%
Power in Year 25	92%	92%	92%

See warranty documents for details. Conditions apply

MAXIMUM RATINGS

Operational temperature:	-40 ... +185°F (-40 ... +85°C)
Maximum system voltage:	1000 V
Maximum test load (front):	+7000 Pa (146 lbs/sq ft)*
Maximum test load (rear):	-4000 Pa (83.5 lbs/sq ft)*
Max series fuse rating:	25 A
Max reverse current:	25 A

*See installation manual for mounting instructions. Design load = Test load / 1.5 (safety factor)

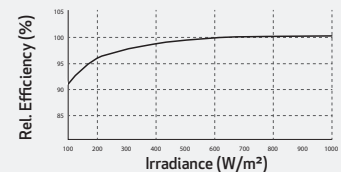
TEMPERATURE RATINGS*

Nominal Module Operating Temperature:	44°C (±2°C)
Temperature coefficient of P _{MAX} :	-0.26 %/°C
Temperature coefficient of V _{OC} :	-0.24 %/°C
Temperature coefficient of I _{SC} :	0.04 %/°C

*The temperature coefficients stated are linear values

LOW LIGHT BEHAVIOUR

Typical low irradiance performance of module at STC:



Founded in 1996, REC Group is an international pioneering solar energy company dedicated to empowering consumers with clean, affordable solar power. As Solar's Most Trusted, REC is committed to high quality, innovation, and a low carbon footprint in the solar materials and solar panels it manufactures. Headquartered in Norway with operational headquarters in Singapore, REC also has regional hubs in North America, Europe, and Asia-Pacific.



XR Rail® Family

The XR Rail® Family offers the strength of a curved rail in three targeted sizes. Each size supports specific design loads, while minimizing material costs. Depending on your location, there is an XR Rail® to match.



XR10

XR10 is a sleek, low-profile mounting rail, designed for regions with light or no snow. It achieves spans up to 6 feet, while remaining light and economical.

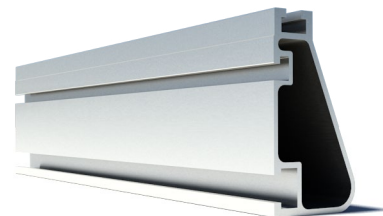
- 6' spanning capability
- Moderate load capability
- Clear & black anodized finish
- Internal splices available



XR100

XR100 is a residential and commercial mounting rail. It supports a range of wind and snow conditions, while also maximizing spans up to 10 feet.

- 10' spanning capability
- Heavy load capability
- Clear & black anodized finish
- Internal splices available



XR1000

XR1000 is a heavyweight among solar mounting rails. It's built to handle extreme climates and spans up to 12 feet for commercial applications.

- 12' spanning capability
- Extreme load capability
- Clear anodized finish
- Internal splices available

Rail Selection

The table below was prepared in compliance with applicable engineering codes and standards.* Values are based on the following criteria: ASCE 7-16, Gable Roof Flush Mount, Roof Zones 1 & 2e, Exposure B, Roof Slope of 8 to 20 degrees and Mean Building Height of 30 ft. Visit IronRidge.com for detailed certification letters.

Load		Rail Span					
Snow (PSF)	Wind (MPH)	4'	5' 4"	6'	8'	10'	12'
None	90	XR10		XR100		XR1000	
	120						
	140						
	160						
20	90	XR10		XR100		XR1000	
	120						
	140						
	160						
30	90	XR10		XR100		XR1000	
	160						
40	90	XR10		XR100		XR1000	
	160						
80	160	XR10		XR100		XR1000	
120	160	XR10		XR100		XR1000	

*Table is meant to be a simplified span chart for conveying general rail capabilities. Use approved certification letters for actual design guidance.

Steel Beam

Project File: 21-201 PV Sub-structure BRT.ec6

LIC#: KW-06014122, Build:20.23.08.01

PCS STRUCTURAL SOLUTIONS

(c) ENERCALC INC 1983-2023

DESCRIPTION: Main Roof Beams

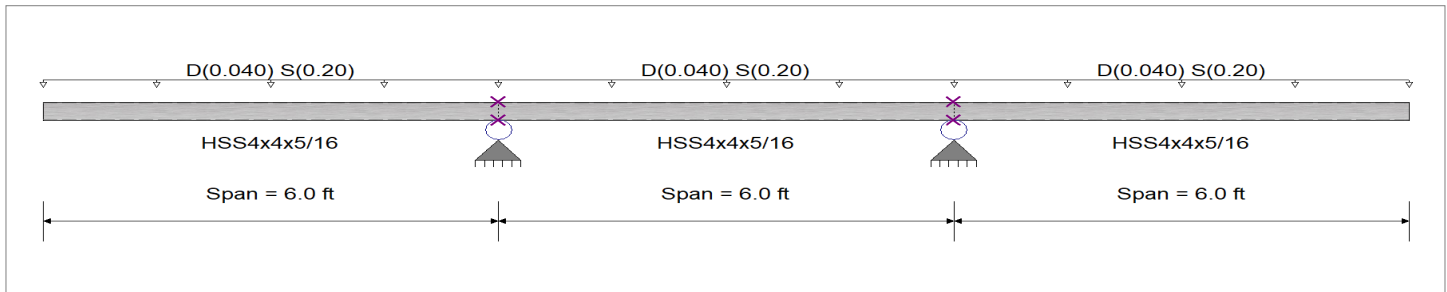
CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
 Load Combination Set : IBC 2018

Material Properties

Analysis Method Load Resistance Factor Design
 Beam Bracing : Completely Unbraced
 Bending Axis : Major Axis Bending

Fy : Steel Yield : 50.0 ksi
 E: Modulus : 29,000.0 ksi



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loading

Load for Span Number 1

Uniform Load : D = 0.0050, S = 0.0250 ksf, Tributary Width = 8.0 ft

Load for Span Number 2

Uniform Load : D = 0.0050, S = 0.0250 ksf, Tributary Width = 8.0 ft

Load for Span Number 3

Uniform Load : D = 0.0050, S = 0.0250 ksf, Tributary Width = 8.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.331 : 1	Maximum Shear Stress Ratio =	0.047 : 1
Section used for this span	HSS4x4x5/16	Section used for this span	HSS4x4x5/16
Mu : Applied	6.944 k-ft	Vu : Applied	2.315 k
Mn * Phi : Allowable	20.963 k-ft	Vn * Phi : Allowable	49.138 k
Load Combination	+1.20D+0.50L+1.60S+1.60H	Load Combination	+1.20D+0.50L+1.60S+1.60H
Span # where maximum occurs	Span # 2	Location of maximum on span	6.000 ft
		Span # where maximum occurs	Span # 2
Maximum Deflection			
Max Downward Transient Deflection	0.564 in Ratio = 255 >=240.	Span: 3 : S Only	
Max Upward Transient Deflection	-0.085 in Ratio = 849 >=240.	Span: 3 : S Only	
Max Downward Total Deflection	0.719 in Ratio = 200 >=180.	Span: 3 : +D+S+H	
Max Upward Total Deflection	-0.108 in Ratio = 667 >=180.	Span: 3 : +D+S+H	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values					Summary of Shear Values				
			M	V	max Mu +	max Mu -	Mu Max	Mnx	Phi*Mnx	Cb	Rm	VuMax	Vnx	Phi*Vnx
+1.40D+1.60H														
Dsgn. L =	6.00 ft	1	0.066	0.009		-1.38	1.38	23.29	20.96	1.00	1.00	0.46	54.60	49.14
Dsgn. L =	6.00 ft	2	0.066	0.009	-0.00	-1.38	1.38	23.29	20.96	1.20	1.00	0.46	54.60	49.14
Dsgn. L =	6.00 ft	3	0.066	0.009		-1.38	1.38	23.29	20.96	1.00	1.00	0.46	54.60	49.14
+1.20D+0.50Lr+1.60L+1.60H														
Dsgn. L =	6.00 ft	1	0.056	0.008		-1.18	1.18	23.29	20.96	1.00	1.00	0.39	54.60	49.14
Dsgn. L =	6.00 ft	2	0.056	0.008	-0.00	-1.18	1.18	23.29	20.96	1.20	1.00	0.39	54.60	49.14
Dsgn. L =	6.00 ft	3	0.056	0.008		-1.18	1.18	23.29	20.96	1.00	1.00	0.39	54.60	49.14
+1.20D+1.60L+0.50S+1.60H														
Dsgn. L =	6.00 ft	1	0.142	0.020		-2.98	2.98	23.29	20.96	1.00	1.00	0.99	54.60	49.14
Dsgn. L =	6.00 ft	2	0.142	0.020	-0.00	-2.98	2.98	23.29	20.96	1.20	1.00	0.99	54.60	49.14
Dsgn. L =	6.00 ft	3	0.142	0.020		-2.98	2.98	23.29	20.96	1.00	1.00	0.99	54.60	49.14
+1.20D+1.60Lr+0.50L+1.60H														
Dsgn. L =	6.00 ft	1	0.056	0.008		-1.18	1.18	23.29	20.96	1.00	1.00	0.39	54.60	49.14

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Steel Beam

Project File: 21-201 PV Sub-structure BRT.ec6

LIC# : KW-06014122, Build:20.23.08.01

PCS STRUCTURAL SOLUTIONS

(c) ENERCALC INC 1983-2023

DESCRIPTION: Main Roof Beams

Maximum Forces & Stresses for Load Combinations

Load Combination	Max Stress Ratios		Summary of Moment Values							Summary of Shear Values				
	Segment Length	Span #	M	V	max Mu +	max Mu -	Mu Max	Mnx	Phi*Mnx	Cb	Rm	VuMax	Vnx	Phi*Vnx
Dsgn. L = 6.00 ft	2		0.056	0.008	-0.00	-1.18	1.18	23.29	20.96	1.20	1.00	0.39	54.60	49.14
Dsgn. L = 6.00 ft	3		0.056	0.008		-1.18	1.18	23.29	20.96	1.00	1.00	0.39	54.60	49.14
+1.20D+1.60Lr+0.50W+1.60H														
Dsgn. L = 6.00 ft	1		0.056	0.008		-1.18	1.18	23.29	20.96	1.00	1.00	0.39	54.60	49.14
Dsgn. L = 6.00 ft	2		0.056	0.008	-0.00	-1.18	1.18	23.29	20.96	1.20	1.00	0.39	54.60	49.14
Dsgn. L = 6.00 ft	3		0.056	0.008		-1.18	1.18	23.29	20.96	1.00	1.00	0.39	54.60	49.14
+1.20D+0.50L+1.60S+1.60H														
Dsgn. L = 6.00 ft	1		0.331	0.047		-6.94	6.94	23.29	20.96	1.00	1.00	2.31	54.60	49.14
Dsgn. L = 6.00 ft	2		0.331	0.047	-0.00	-6.94	6.94	23.29	20.96	1.20	1.00	2.31	54.60	49.14
Dsgn. L = 6.00 ft	3		0.331	0.047		-6.94	6.94	23.29	20.96	1.00	1.00	2.31	54.60	49.14
+1.20D+1.60S+0.50W+1.60H														
Dsgn. L = 6.00 ft	1		0.331	0.047		-6.94	6.94	23.29	20.96	1.00	1.00	2.31	54.60	49.14
Dsgn. L = 6.00 ft	2		0.331	0.047	-0.00	-6.94	6.94	23.29	20.96	1.20	1.00	2.31	54.60	49.14
Dsgn. L = 6.00 ft	3		0.331	0.047		-6.94	6.94	23.29	20.96	1.00	1.00	2.31	54.60	49.14
+1.20D+0.50Lr+0.50L+W+1.60H														
Dsgn. L = 6.00 ft	1		0.056	0.008		-1.18	1.18	23.29	20.96	1.00	1.00	0.39	54.60	49.14
Dsgn. L = 6.00 ft	2		0.056	0.008	-0.00	-1.18	1.18	23.29	20.96	1.20	1.00	0.39	54.60	49.14
Dsgn. L = 6.00 ft	3		0.056	0.008		-1.18	1.18	23.29	20.96	1.00	1.00	0.39	54.60	49.14
+1.20D+0.50L+0.50S+W+1.60H														
Dsgn. L = 6.00 ft	1		0.142	0.020		-2.98	2.98	23.29	20.96	1.00	1.00	0.99	54.60	49.14
Dsgn. L = 6.00 ft	2		0.142	0.020	-0.00	-2.98	2.98	23.29	20.96	1.20	1.00	0.99	54.60	49.14
Dsgn. L = 6.00 ft	3		0.142	0.020		-2.98	2.98	23.29	20.96	1.00	1.00	0.99	54.60	49.14
+1.20D+0.50L+0.70S+E+1.60H														
Dsgn. L = 6.00 ft	1		0.177	0.025		-3.70	3.70	23.29	20.96	1.00	1.00	1.23	54.60	49.14
Dsgn. L = 6.00 ft	2		0.177	0.025	-0.00	-3.70	3.70	23.29	20.96	1.20	1.00	1.23	54.60	49.14
Dsgn. L = 6.00 ft	3		0.177	0.025		-3.70	3.70	23.29	20.96	1.00	1.00	1.23	54.60	49.14
+0.90D+W+0.90H														
Dsgn. L = 6.00 ft	1		0.042	0.006		-0.89	0.89	23.29	20.96	1.00	1.00	0.30	54.60	49.14
Dsgn. L = 6.00 ft	2		0.042	0.006	-0.00	-0.89	0.89	23.29	20.96	1.20	1.00	0.30	54.60	49.14
Dsgn. L = 6.00 ft	3		0.042	0.006		-0.89	0.89	23.29	20.96	1.00	1.00	0.30	54.60	49.14
+0.90D+E+0.90H														
Dsgn. L = 6.00 ft	1		0.042	0.006		-0.89	0.89	23.29	20.96	1.00	1.00	0.30	54.60	49.14
Dsgn. L = 6.00 ft	2		0.042	0.006	-0.00	-0.89	0.89	23.29	20.96	1.20	1.00	0.30	54.60	49.14
Dsgn. L = 6.00 ft	3		0.042	0.006		-0.89	0.89	23.29	20.96	1.00	1.00	0.30	54.60	49.14

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	0.7189	0.000		0.0000	0.000
	2	0.0000	0.000	+D+S+H	-0.1080	3.000
+D+S+H	3	0.7165	6.000		0.0000	3.000

Vertical Reactions

Support notation : Far left is #'

Values in KIPS

Load Combination	Support 1	Support 2	Support 3	Support 4
Max Upward from all Load Conditions		2.293	2.293	
Max Upward from Load Combinations		2.293	2.293	
Max Upward from Load Cases		1.800	1.800	
+D+H		0.493	0.493	
+D+L+H		0.493	0.493	
+D+Lr+H		0.493	0.493	
+D+S+H		2.293	2.293	
+D+0.750Lr+0.750L+H		0.493	0.493	
+D+0.750L+0.750S+H		1.843	1.843	
+D+0.60W+H		0.493	0.493	
+D+0.70E+H		0.493	0.493	
+D+0.750Lr+0.750L+0.450W+H		0.493	0.493	
+D+0.750L+0.750S+0.450W+H		1.843	1.843	
+D+0.750L+0.750S+0.5250E+H		1.843	1.843	
+0.60D+0.60W+0.60H		0.296	0.296	
+0.60D+0.70E+0.60H		0.296	0.296	
D Only		0.493	0.493	
S Only		1.800	1.800	
H Only				

Steel Beam

Project File: 21-201 PV Sub-structure BRT.ec6

LIC# : KW-06014122, Build:20.23.08.01

PCS STRUCTURAL SOLUTIONS

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DESCRIPTION: 3rd floor Main Roof Beams

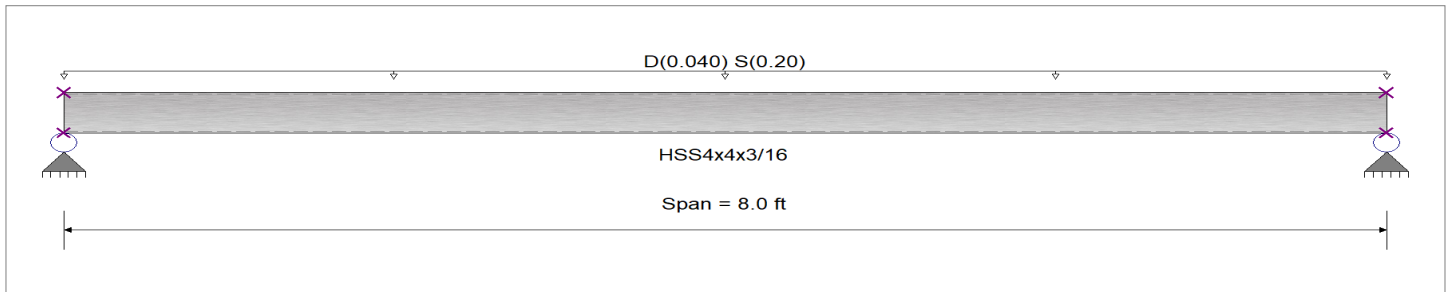
CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
 Load Combination Set : IBC 2018

Material Properties

Analysis Method Load Resistance Factor Design
 Beam Bracing : Completely Unbraced
 Bending Axis : Major Axis Bending

Fy : Steel Yield : 50.0 ksi
 E: Modulus : 29,000.0 ksi



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loading
 Uniform Load : D = 0.0050, S = 0.0250 ksf, Tributary Width = 8.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.220 : 1	Maximum Shear Stress Ratio =	0.046 : 1
Section used for this span	HSS4x4x3/16	Section used for this span	HSS4x4x3/16
Mu : Applied	3.034 k-ft	Vu : Applied	1.517 k
Mn * Phi : Allowable	13.763 k-ft	Vn * Phi : Allowable	32.679 k
Load Combination	+1.20D+0.50L+1.60S+1.60H	Load Combination	+1.20D+0.50L+1.60S+1.60H
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
		Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.103 in Ratio =	933	>=240. Span: 1 : S Only
Max Upward Transient Deflection	0 in Ratio =	0	<240.0 n/a
Max Downward Total Deflection	0.128 in Ratio =	749	>=180. Span: 1 : +D+S+H
Max Upward Total Deflection	0 in Ratio =	0	<180.0 n/a

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios			Summary of Moment Values					Summary of Shear Values		
			M	V	max Mu +	max Mu -	Mu Max	Mnx	Phi*Mnx	Cb	Rm	VuMax	Vnx
+1.40D+1.60H	Dsgn. L = 8.00 ft	1	0.040	0.008	0.55	0.55	15.29	13.76	1.14	1.00	0.28	36.31	32.68
+1.20D+0.50Lr+1.60L+1.60H	Dsgn. L = 8.00 ft	1	0.034	0.007	0.47	0.47	15.29	13.76	1.14	1.00	0.24	36.31	32.68
+1.20D+1.60L+0.50S+1.60H	Dsgn. L = 8.00 ft	1	0.093	0.019	1.27	1.27	15.29	13.76	1.14	1.00	0.64	36.31	32.68
+1.20D+1.60Lr+0.50L+1.60H	Dsgn. L = 8.00 ft	1	0.034	0.007	0.47	0.47	15.29	13.76	1.14	1.00	0.24	36.31	32.68
+1.20D+1.60Lr+0.50W+1.60H	Dsgn. L = 8.00 ft	1	0.034	0.007	0.47	0.47	15.29	13.76	1.14	1.00	0.24	36.31	32.68
+1.20D+0.50L+1.60S+1.60H	Dsgn. L = 8.00 ft	1	0.220	0.046	3.03	3.03	15.29	13.76	1.14	1.00	1.52	36.31	32.68
+1.20D+1.60S+0.50W+1.60H	Dsgn. L = 8.00 ft	1	0.220	0.046	3.03	3.03	15.29	13.76	1.14	1.00	1.52	36.31	32.68
+1.20D+0.50Lr+0.50L+W+1.60H	Dsgn. L = 8.00 ft	1	0.034	0.007	0.47	0.47	15.29	13.76	1.14	1.00	0.24	36.31	32.68
+1.20D+0.50L+0.50S+W+1.60H	Dsgn. L = 8.00 ft	1	0.093	0.019	1.27	1.27	15.29	13.76	1.14	1.00	0.64	36.31	32.68
+1.20D+0.50L+0.70S+E+1.60H	Dsgn. L = 8.00 ft	1	0.116	0.024	1.59	1.59	15.29	13.76	1.14	1.00	0.80	36.31	32.68
+0.90D+W+0.90H	Dsgn. L = 8.00 ft	1	0.026	0.005	0.36	0.36	15.29	13.76	1.14	1.00	0.18	36.31	32.68

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Steel Beam

Project File: 21-201 PV Sub-structure BRT.ec6

LIC# : KW-06014122, Build:20.23.08.01

PCS STRUCTURAL SOLUTIONS

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DESCRIPTION: 3rd floor Main Roof Beams

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values					
			M	V	max Mu +	max Mu -	Mu Max	Mnx	Phi*Mnx	Cb	Rm	VuMax	Vnx	Phi*Vnx		
+0.90D+E+0.90H																
Dsgn. L =	8.00 ft	1	0.026	0.005	0.36		0.36	15.29	13.76	1.14	1.00	0.18	36.31	32.68		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	0.1282	4.023		0.0000	0.000

Vertical Reactions

Load Combination	Support notation : Far left is #'		Values in KIPS	
	Support 1	Support 2		
Max Upward from all Load Conditions	0.998	0.998		
Max Upward from Load Combinations	0.998	0.998		
Max Upward from Load Cases	0.800	0.800		
+D+H	0.198	0.198		
+D+L+H	0.198	0.198		
+D+Lr+H	0.198	0.198		
+D+S+H	0.998	0.998		
+D+0.750Lr+0.750L+H	0.198	0.198		
+D+0.750L+0.750S+H	0.798	0.798		
+D+0.60W+H	0.198	0.198		
+D+0.70E+H	0.198	0.198		
+D+0.750Lr+0.750L+0.450W+H	0.198	0.198		
+D+0.750L+0.750S+0.450W+H	0.798	0.798		
+D+0.750L+0.750S+0.5250E+H	0.798	0.798		
+0.60D+0.60W+0.60H	0.119	0.119		
+0.60D+0.70E+0.60H	0.119	0.119		
D Only	0.198	0.198		
S Only	0.800	0.800		
H Only				

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Steel Column

Project File: 21-201 PV Sub-structure BRT.ec6

LIC# : KW-06014122, Build:20.23.08.01

PCS STRUCTURAL SOLUTIONS

(c) ENERCALC INC 1983-2023

DESCRIPTION: Cantilevered Post

Code References

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
 Load Combinations Used : IBC 2018

General Information

Steel Section Name :	Pipe3STD	Overall Column Height	1.750 ft
Analysis Method :	Load Resistance Factor	Top & Bottom Fixity	Top & Bottom Pinned
Steel Stress Grade		Brace condition :	
Fy : Steel Yield	35.0 ksi	Unbraced Length for buckling ABOUT X-X Axis =	1.750 ft, K = 2.1
E : Elastic Bending Modulus	29,000.0 ksi	Unbraced Length for buckling ABOUT Y-Y Axis =	1.750 ft, K = 2.1

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 13.265 lbs * Dead Load Factor

AXIAL LOADS . . .

Axial Load at 1.750 ft, D = 0.520, S = 2.0 k

BENDING LOADS . . .

Lat. Point Load at 1.750 ft creating Mx-x, E = 0.120 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.06332** : 1
 Load Combination +1.20D+1.60S
 Location of max.above base 0.0 ft
 At maximum location values are . . .

Pu	3.840 k
0.9 * Pn	60.648 k
Mu-x	0.0 k-ft
0.9 * Mn-x :	5.749 k-ft
Mu-y	0.0 k-ft
0.9 * Mn-y :	5.749 k-ft

Maximum Load Reactions . .

Top along X-X	0.0 k
Bottom along X-X	0.0 k
Top along Y-Y	0.120 k
Bottom along Y-Y	0.0 k

Maximum Load Deflections . . .

Along Y-Y	0.0 in at	0.0ft	above base
for load combination :			
Along X-X	0.0 in at	0.0ft	above base
for load combination :			

PASS Maximum Shear Stress Ratio = **0.007361** : 1
 Load Combination +1.20D+0.70S+E
 Location of max.above base 1.750 ft
 At maximum location values are . . .

Vu : Applied	0.120 k
Vn * Phi : Allowable	16.301 k

Load Combination Results

Load Combination	Maximum Axial + Bending Stress Ratios				Cb _x	Cb _y	K _x L _x /R _y	K _y L _y /R _x	Maximum Shear Ratios		
	Stress Ratio	Status	Location	Stress Ratio					Status	Location	
+1.40D	0.012	PASS	0.00 ft	1.00	1.00	37.69	0.00	0.000	PASS	0.00 ft	
+1.20D	0.011	PASS	0.00 ft	1.00	1.00	37.69	0.00	0.000	PASS	0.00 ft	
+1.20D+0.50S	0.027	PASS	0.00 ft	1.00	1.00	37.69	0.00	0.000	PASS	0.00 ft	
+1.20D+1.60S	0.063	PASS	0.00 ft	1.00	1.00	37.69	0.00	0.000	PASS	0.00 ft	
+1.20D+0.70S+E	0.034	PASS	0.00 ft	1.00	1.00	37.69	0.00	0.007	PASS	1.75 ft	
+0.90D	0.008	PASS	0.00 ft	1.00	1.00	37.69	0.00	0.000	PASS	1.75 ft	
+0.90D+E	0.008	PASS	0.00 ft	1.00	1.00	37.69	0.00	0.007	PASS	1.75 ft	

Maximum Reactions

Note: Only non-zero reactions are listed.

Load Combination	Axial Reaction	X-X Axis Reaction		k	Y-Y Axis Reaction		Mx - End Moments		My - End Moments	
	@ Base	@ Base	@ Top		@ Base	@ Top	@ Base	@ Top	@ Base	@ Top
D Only	0.533									
+D+S	2.533									
+D+0.750S	2.033									
+D+0.70E	0.533					0.084				
+D+0.750S+0.5250E	2.033					0.063				
+0.60D	0.320									
+0.60D+0.70E	0.320					0.084				

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Steel Column

Project File: 21-201 PV Sub-structure BRT.ec6

LIC# : KW-06014122, Build:20.23.08.01

PCS STRUCTURAL SOLUTIONS

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DESCRIPTION: Cantilevered Post

Maximum Reactions

Note: Only non-zero reactions are listed.

Load Combination	Axial Reaction	X-X Axis Reaction		k	Y-Y Axis Reaction		Mx - End Moments		k-ft	My - End Moments	
	@ Base	@ Base	@ Top		@ Base	@ Top	@ Base	@ Top		@ Base	@ Top
S Only	2.000										
E Only					0.120						

Extreme Reactions

Item	Extreme Value	Axial Reaction	X-X Axis Reaction		k	Y-Y Axis Reaction		Mx - End Moments		k-ft	My - End Moments	
		@ Base	@ Base	@ Top		@ Base	@ Top	@ Base	@ Top		@ Base	@ Top
Axial @ Base	Maximum	2.533										
"	Minimum					0.120						
Reaction, X-X Axis Base	Maximum	0.533										
"	Minimum	0.533										
Reaction, Y-Y Axis Base	Maximum	0.533										
"	Minimum	0.533										
Reaction, X-X Axis Top	Maximum	0.533										
"	Minimum	0.533										
Reaction, Y-Y Axis Top	Maximum	0.533										
"	Minimum	0.533										
Moment, X-X Axis Base	Maximum	0.533										
"	Minimum	0.533										
Moment, Y-Y Axis Base	Maximum	0.533										
"	Minimum	0.533										
Moment, X-X Axis Top	Maximum	0.533										
"	Minimum	0.533										
Moment, Y-Y Axis Top	Maximum	0.533										
"	Minimum	0.533										

Maximum Deflections for Load Combinations

Load Combination	Max. Deflection in X dir	Distance	Max. Deflection in Y dir	Distance
D Only	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+S	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+0.750S	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+0.70E	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+0.750S+0.5250E	0.0000 in	0.000 ft	0.000 in	0.000 ft
+0.60D	0.0000 in	0.000 ft	0.000 in	0.000 ft
+0.60D+0.70E	0.0000 in	0.000 ft	0.000 in	0.000 ft
S Only	0.0000 in	0.000 ft	0.000 in	0.000 ft
E Only	0.0000 in	0.000 ft	0.000 in	0.000 ft

Steel Section Properties : Pipe3STD

Depth	=	3.500 in	I xx	=	2.85 in^4	J	=	5.690 in^4
			S xx	=	1.63 in^3			
Diameter	=	3.500 in	R xx	=	1.170 in			
Wall Thick	=	0.216 in	Zx	=	2.190 in^3			
Area	=	2.070 in^2	I yy	=	2.850 in^4			
Weight	=	7.580 plf	S yy	=	1.630 in^3			
			R yy	=	1.170 in			
Ycg	=	0.000 in						

Project Title:
Engineer:
Project ID:
Project Descr:

Steel Column

Project File: 21-201 PV Sub-structure BRT.ec6

LIC# : KW-06014122, Build:20.23.08.01

PCS STRUCTURAL SOLUTIONS

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DESCRIPTION: Cantilevered Post

Sketches

