VECTOR
ENGINEERS

Project Number: U2716-072-181

February 14, 2019

Sunmodo
14800 NE 65th Street
Vancouver, WA 98682

REFERENCE: British Columbia Ground Mount
Ground Mount PV Array Installation

To Whom It May Concern:

Per request of Sunmodo, we have been asked to prepare the structural design of a ground-mounted PV solar array system with several foundation options as shown in the attached calculations. The adopted building code in this jurisdiction is the British Columbia Building Code 2018. Vector Structural Engineering requires that we or another licensed engineer review each site specific install, and we are not liable for installs at site specific locations we have not reviewed. Because the British Columbia Building Code does not address the wind effects on open structures, the following design parameters are used in our analysis:

- Minimum Design Loads for Buildings and Other Structures (ASCE 7-10)
- Design wind speed for risk category I structures: 105 mph (46.9 m/s) (3-sec gust)
- Wind exposure: C
- Ground snow load: 68.9 psf (3.3 kPa)
- The ground screws and helical piers must be tested to 1.5 times uplift and 2.0 times lateral reactions found in the table below.

Load (ASD)	Value (lbs / kN)	Factor of Safety	Test Value (lbs / kN)
UPLIFT	2400 / 10.7	1.5	3600 / 16.0
LATERAL	1900 / 8.5	2	3800 / 16.9

Foundation concrete shall have a minimum compressive strength of 3000 psi (20.7 MPa) at 28 days. Cement for all concrete shall be Type I or II with a minimum of 6% entrained air with a water/cement ratio of 0.50. Maximum aggregate size shall be 3/4". Design is based on concrete strength of 2500 psi (17.2 MPa) thus no special inspection of concrete strength is required.

Footings are designed based on an allowable soil bearing pressure of 1500 psf (71.8 kPa) an allowable skin friction of 250 psf (12 kPa), an allowable lateral bearing pressure of 150 pcf (2403 kg/m^3), and a coefficient of friction of 0.25. Vector Structural Engineering strongly recommends independent soils testing be performed by a licensed geotechnical engineer to verify the assumed soil parameters.

All ground mounts are to be installed per manufacturer's recommendations. The use of solar panel support span tables provided by the manufacturer is allowed only where the site conditions and solar panel configuration match the description of the span tables. Electrical engineering is beyond our scope. All work performed must be in accordance with accepted industry-wide methods and applicable safety standards. Vector Structural Engineering assumes no responsibility for improper installation of the solar panels.

Very truly yours,

VECTOR STRUCTURAL ENGINEERING, LLC

02/15/2019

Russell Emery, P.E.
British Columbia License: 201804 - Expires: 12/31/2019
Project Engineer

RNE/stb

Enclosures

VECTOR ENGINEERS
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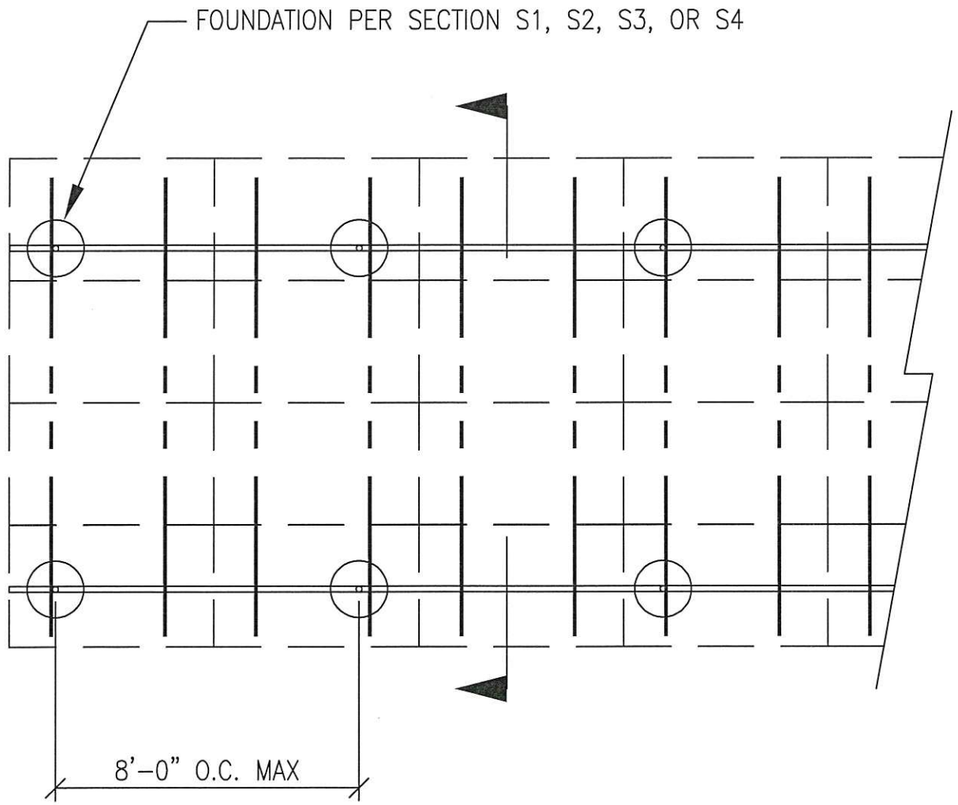
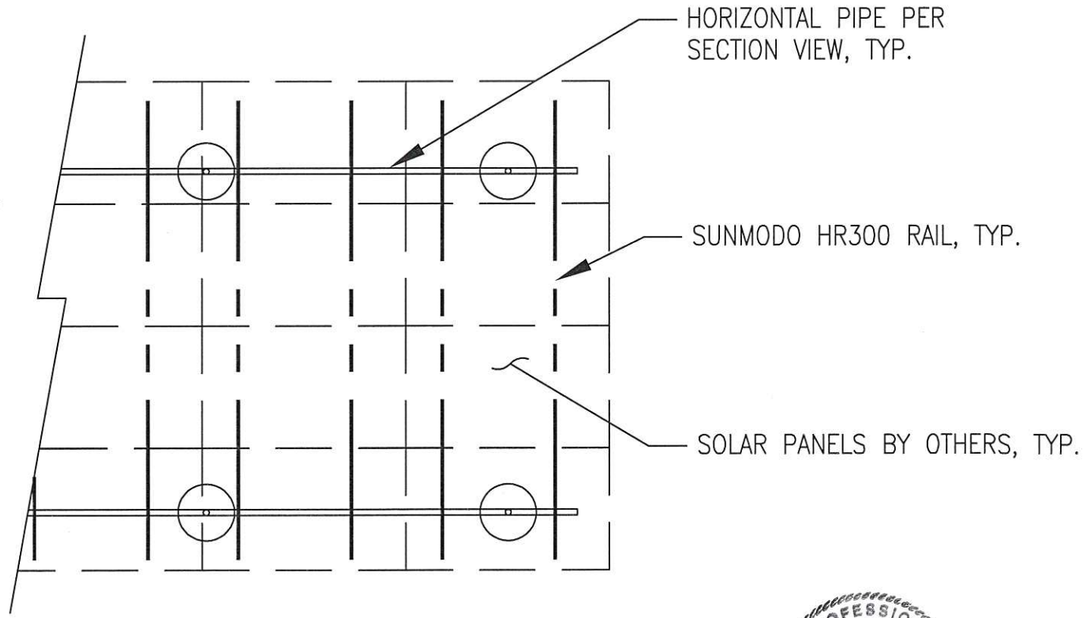
DRAPER, UTAH 84020 (801) 990-1776 FAX

JOB NO. U2716-072-181
PROJECT BRITISH COLUMBIA GROUND MOUNTS
SUBJECT ALL OPTIONS





PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
R. N. EMERY
201604

02/15/2019

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PV ARRAY PLAN

N.T.S.

P1

VECTOR ENGINEERS

JOB NO. U2716-072-181

DATE 12/20/2018

PROJECT BRITISH COLUMBIA GROUND MOUNTS

SUBJECT BALLASTED BLOCK OPTION DESIGNED STB CHECKED JSP

NOTES:

1. For list of racking components see Sunmodo drawings dated 02/14/2019

02/15/2019

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PV ARRAY SECTION S4

N.T.S.

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VECTOR ENGINEERS

JOB NO. U2716-072-181

DATE 12/20/2018

PROJECT BRITISH COLUMBIA GROUND MOUNTS

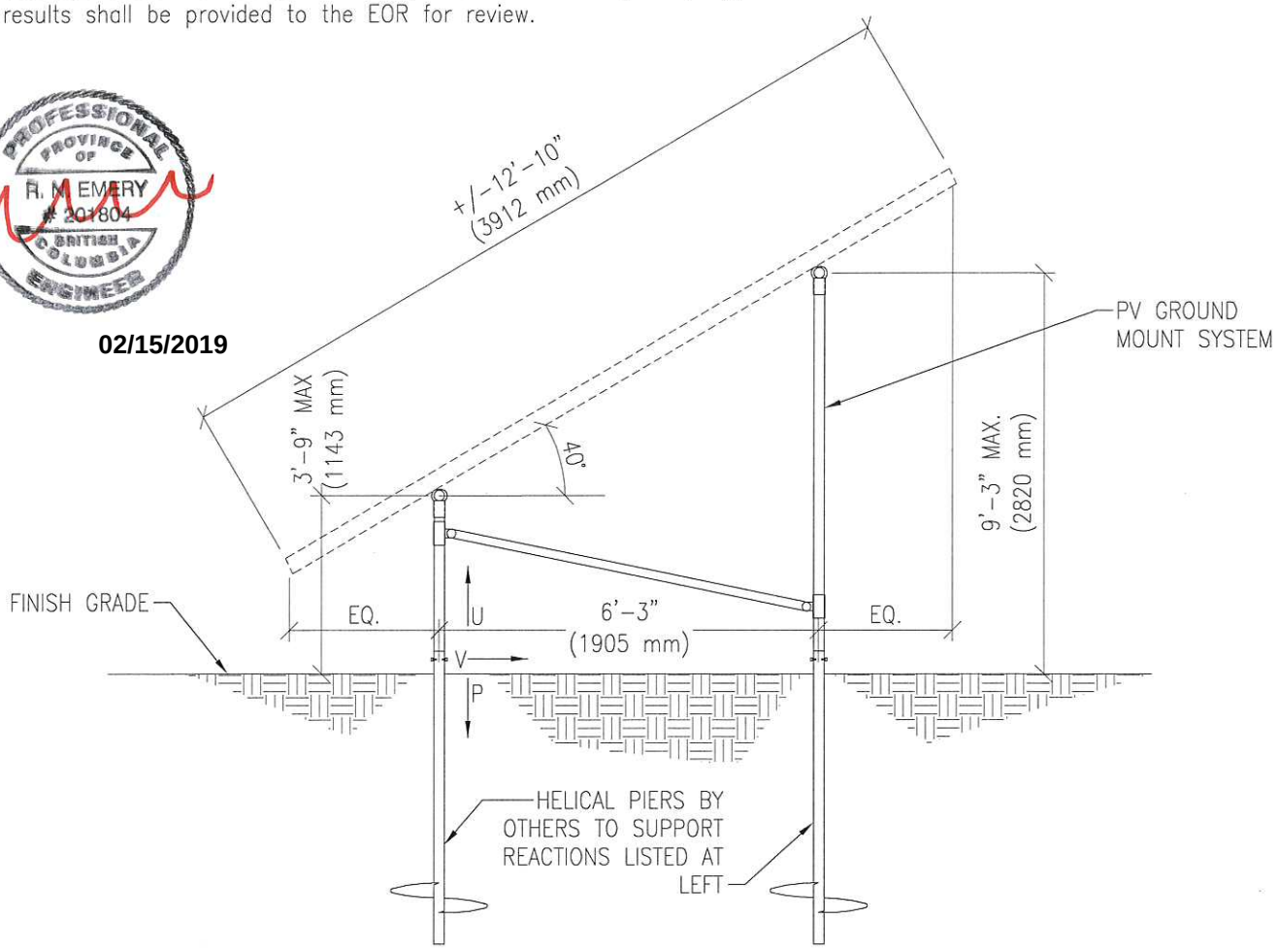
SUBJECT HELICAL PIER OPTION DESIGNED STB CHECKED JSP

NOTES:

1. For list of racking components see Sunmodo drawings dated 02/14/2019
2. Helical Piers shall be pull-tested per ASTM D3689
   - 2.1. Safety factor for uplift to be 1.5, S.F. for lateral loads to be 2.0
   - 2.2. Upward deflection limit = 1/2" (12.7 mm) Lateral deflection limit = 1" (25.4 mm)
   - 2.3. The load tests shall be performed by a certified testing company, and written results shall be provided to the EOR for review.

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA R. M. EMERY # 201804

02/15/2019



MAXIMUM REACTIONS:
U = 2,400 LBS (10.67 kN)
P = 2,900 LBS (12.90 kN)
V = 1,900 LBS (8.45 kN)

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PV ARRAY SECTION S2

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JOB NO. U2716-072-181

DATE 12/20/2018

PROJECT BRITISH COLUMBIA GROUND MOUNTS

SUBJECT GROUND SCREW OPTION DESIGNED STB CHECKED JSP

NOTES:

1. For list of racking components see Sunmodo drawings dated 02/14/2019
2. Ground screws shall be pull-tested per ASTM D3689
   - 2.1. Safety factor for uplift to be 1.5, S.F. for lateral loads to be 2.0
   - 2.2. Upward deflection limit = 1/2" (12.7 mm) Lateral deflection limit = 1" (25.4 mm)
   - 2.3. The load tests shall be performed by a certified testing company, and written results shall be provided to the EOR for review.

02/15/2019

MAXIMUM REACTIONS:
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P = 2,900 LBS (12.90 kN)
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PV ARRAY SECTION S3

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VECTOR ENGINEERS

JOB NO. U2716-072-181

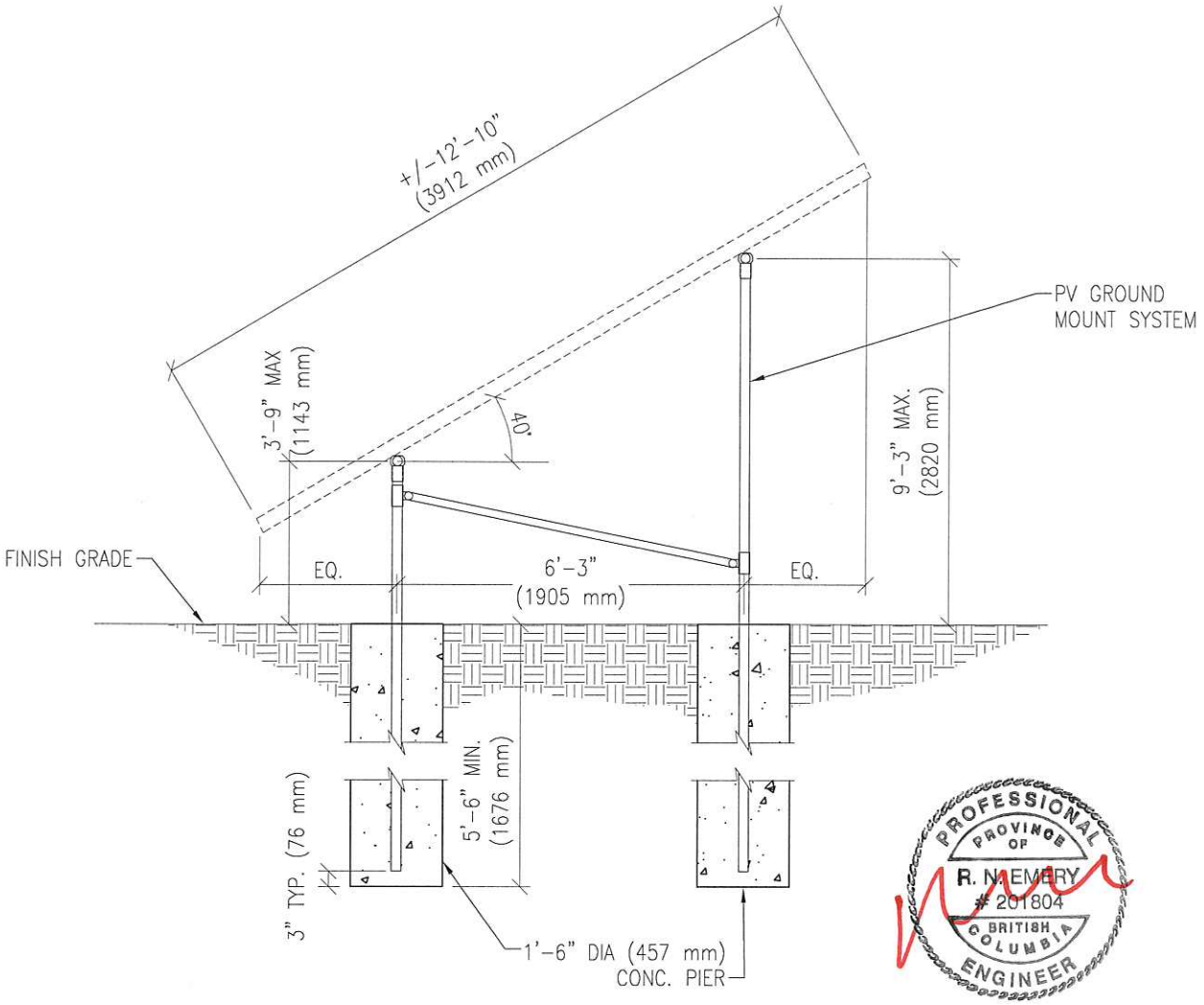
DATE 12/20/2018

PROJECT BRITISH COLUMBIA GROUND MOUNTS

SUBJECT DRILLED PIER OPTION DESIGNED STB CHECKED JSP

NOTES:

1. For list of racking components see Sunmodo drawings dated 02/14/2019



PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA R. N. EMERY # 201804

02/15/2019

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PV ARRAY SECTION S1

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JOB NO.: U2716-072-181 **DESIGNED:** STB
DATE: 02/14/19

PROJECT: Ground Mount Package for British Columbia **SUBJECT:** Dead Load

Design Weight:		Metric	Unit
Individual Panel Weight [lb]:	50.7	23	kg
Panel Transverse Length (T5) [in]:	77.0	1956	mm
Panel Transverse Length (T5) [ft]:	6.4	1956	mm
Panel Longitudinal Length (L2) [in]:	39.1	993	mm
Panel Longitudinal Length (L2) [ft]:	3.3	993	mm
Individual Panel Area [ft^2]:	20.9	1.94	m^2
Individual Panel Weight [psf]:	2.4	0.12	kPa
# of Panels in Transverse Direction:	2		
Approximate Transverse Length (T4) [ft]:	12.8	3.91	m
# of Panels in Longitudinal Direction:	14		
Approximate Longitudinal Length (L1) [ft]:	45.6	13.90	m
Transverse Column Spacing (T1) [ft]:	6.5	1981	mm
Longitudinal Column Spacing (L3) [ft]:	8.0	2438	mm
# of Columns in Longitudinal Direction:	6		
# of Columns in Transverse Direction:	2		
Total Number of Columns:	12		
Panel Slope from Horizontal (a) [°]:	40.0		
Short Column Height (H1) [ft]:	3.8	1143	mm
Approximate Tall Column Height (H2) [ft]:	9.2	2805	mm
Transverse Brace between Columns :	Yes		
Approximate Brace Length (B1) [ft]:	8.0	2438	mm
Weight of Columns [plf]:	3.7	1.66	kg/ft
Weight of Cross Pipe [plf]:	3.7	1.7	kg/ft
Weight of Brace [plf]:	3.7	2	kg/ft
Tributary Transverse Length per Column [ft]:	6.4	1956	mm
Tributary Longitudinal Length per Column [ft]:	8.0	2438	mm
Tributary Area per Column [ft^2]:	51.3	4.8	m^2
Rail Weight [plf]:	1.0	0.5	kg/ft
Transverse Rail Weight per Column [lb]:	38.5	17.5	kg
Longitudinal Rail Weight per Column [lb]:	29.2	13.3	kg
Tall Column Weight [lb]:	33.6	15.3	kg
Panel Weight per Column [lb]:	124.5	56.6	kg
Rail Weight per Column [lb]:	38.5	17.5	kg
Cross Pipe Weight per Column [lb]:	29.2	13.3	kg
Brace Weight per Column [lb]:	14.6	7	kg
Total Weight per Column (1.0 D) [lb]:	**240.4**		

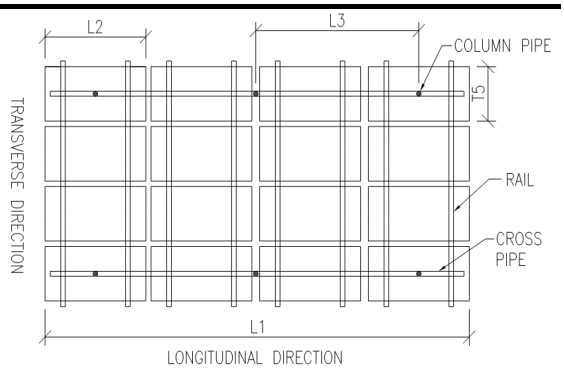
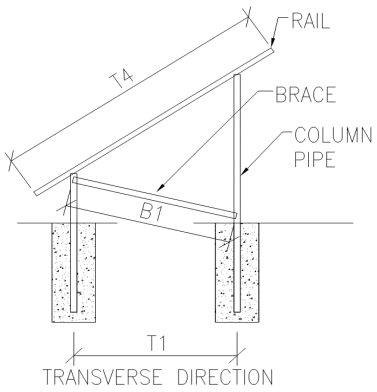


ILLUSTRATION ONLY



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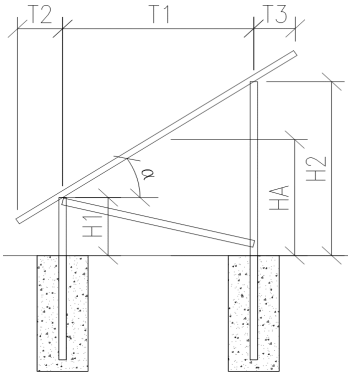


ILLUSTRATION ONLY

Assumptions:
- T2 = T3

JOB NO.: U2716-072-181 **DESIGNED:** STB
DATE: 02/14/19

PROJECT: Ground Mount Package for British Columbia **SUBJECT:** Snow Load

SNOW LOAD (S):			Metric	Unit
ASCE 7 Standard:	10	ASCE 7-10 Reference		
Panel Slope from Horizontal [°]:	40.0			
Snow Ground Load, p_g [psf]:	68.9	(Section 7.2)	3.3	kPa
Terrain Category:	C	(Table 7-2)		
Exposure of Roof:	Fully Exposed	(Table 7-2)		
Exposure Factor, C_e:	0.9	(Table 7-2)		
Thermal Factor, C_t:	1.2	(Table 7-3)		
Risk Category:	I	(Table 1.5-1)		
Importance Factor, I_S:	0.8	(Table 1.5-2)		
Flat Roof Snow Load, p_f [psf]:	42	(Equation 7.3-1)	2.0	kPa
Minimum Roof Snow Load, p_m [psf]:	0	(Section 7.3.4)	0	kPa
Unobstructed Slippery Surface?	Yes	(Section 7.4)		
Slope Factor Figure:	Figure 7-2c	(Section 7.4)		
Roof Slope Factor, C_s:	1.000	(Figure 7-2)		
Sloped Roof Snow Load, p_s [psf]:	42	(Equation 7.4-1)	2.0	kPa
Design Snow Load, S [psf]:	42		2.0	kPa
Tributary Transverse Length [ft]:	4.9		1498	mm
Tributary Longitudinal Length [ft]:	8		2438	mm
Tributary Area per Column [ft^2]:	39.3		3.7	m^2
Snow Load per Column (1.0 S) [lb]:	**1639.2**		7.29	kN

JOB NO.: U2716-072-181 **DESIGNED:** STB
DATE: 02/14/19

PROJECT: Ground Mount Package for British Columbia **SUBJECT:** Wind Pressure

Design Wind Load:

			Metric	Unit
ASCE 7 Standard:	10	ASCE 7-10 Reference		
Basic Wind Speed, V [mph]:	105		46.9392	m/s
Risk Category:	I			
Exposure Category	C	(Section 26.7.3)		
Velocity Pressure Exposure Coefficient, K_h:	0.85	(Table 27.3-1)		
Topographic Factor, K_{ht}:	1.0	(Section 26.8.2)		
Wind Directionality Factor, K_d:	0.85	(Table 26.6-1)		
Internal Pressure Coefficient, GC_{pi} :	0.00	(Table 26.11-1)		
Velocity Pressure, q_h [psf]:	20.4	(Equation 27.3-1)	0.98	kPa
Gust Effect Factor, G:	0.85	(Section 26.9.1)		
Panel Slope [degrees]:	40.0			

Net Pressure Coefficients (C_N) per: (Figure 27.4-4)

Clear Wind Flow	C_{NW}	C_{NL}
Case 1 (γ = 0°, Load Case A)	-1.73	-1.80
Case 2 (γ = 0°, Load Case B)	-2.37	-0.63
Case 3 (γ = 180°, Load Case A)	2.13	2.30
Case 4 (γ = 180°, Load Case B)	2.67	1.20

Design Wind Pressures (p) [psf] per: (Equation 27.4-3)

Clear Wind Flow	q_hGC_{NW}	q_hGC_{NL}	q_hGC_{NW}	q_hGC_{NL}	
Case 1 (γ = 0°, Load Case A)	-30.0	-31.2	-1.44	-1.49	kPa
Case 2 (γ = 0°, Load Case B)	-41.0	-11.0	-1.96	-0.53	kPa
Case 3 (γ = 180°, Load Case A)	37.0	39.9	1.77	1.91	kPa
Case 4 (γ = 180°, Load Case B)	46.2	20.8	2.21	1.00	kPa

Wind Pressure on Each Side of Panels [psf]

Clear Wind Flow	Short Col. Pressure	Long Col. Pressure	Short Col. Pressure	Long Col. Pressure	
Case 1 (γ = 0°, Load Case A)	-31.2	-30.0	-1.49	-1.44	kPa
Case 2 (γ = 0°, Load Case B)	-11.0	-41.0	-0.53	-1.96	kPa
Case 3 (γ = 180°, Load Case A)	37.0	39.9	1.77	1.91	kPa
Case 4 (γ = 180°, Load Case B)	46.2	20.8	2.21	1.00	kPa

JOB NO.: U2716-070-181 **DESIGNED:** STB

PROJECT: Ground Mount Package for Ontario Canada

Foundation Option 1: Drilled Concrete Pier

JOB NO.: U2716-072-181 **DESIGNED:** STB
DATE: 02/14/19

PROJECT: Ground Mount Package for British Columbia

Drilled Pier Design

Design Loads:

		Metric	Units			Metric	Units
Max. Shear, V [k]:	1.9	8.6	kN	Max. Down, P_d [k]:	3.9	17.3	kN
Max. Moment, M [k-ft]:	0.1	0.1	kN-m	Max. Uplift, P_u [k]:	2.5	11.1	kN

Pier Properties:

Pier Diameter, b [ft]:	1.5	457.2	mm	Volume of Concrete [ft^3]:	10	0.28	m^3
Min. Pier Diameter, b_{min} (opt'l) [ft]:				Volume of Concrete [yd^3]:	0.4	0.28	m^3
Top of Pier Elevation [ft]:	0.00	0	mm	Weight of Concrete [k]:	1.5	663	kg
Pier Depth, d [ft]:	5.5	1676.4	mm				
Min. Pier Depth, d_{min} (opt'l) [ft]:							
Max. Pier Depth, d_{max} (opt'l) [ft]:							

Soil Properties:

Allow. Bearing Pressure [psf]:	1,500	71.8	kPa	Optional Parameters for Uplift:			
1/3 increase for short term loads?	No						
				Skin Friction [psf]:	250	12.0	kPa
Lateral Bearing, S [pcf]:	150	23563	kN/m^3	Top Length to Ignore [ft]:	0.0	0	mm
Max. Lateral Bearing (opt'l) [psf]:				1/3 increase for short term loads?	No		
Top Depth to Ignore [ft]:	0.0						
1/3 increase for short term loads?	No			Combine w/ Bearing:	No		
1/2" deflection at t/o pier allowed:	Yes						

Check Bearing:

Bearing Capacity [k]:	6.5	28.8	kN	**Bearing capacity OK.**

Check Uplift:

Uplift Capacity [k]:	7.8	34.7	kN	**Uplift capacity OK.**

Check Lateral Bearing:

Applied Lateral Force, P [lb]:	1,930	8585	kN	
Point of Application, h [ft]:	0.1	16	mm	
S_{1_max} [psf]:			kPa	
S_1 [psf]:	550	26.3	kPa	
$A = 2.34*P/(S_1 b)$:	5.47			
Required Pier Depth, d_{reqd} [ft]:	5.5	1676	mm	**Lateral bearing capacity OK.**

JOB NO.: U2716-070-181 **DESIGNED:** STB

PROJECT: Ground Mount Package for Ontario Canada

Foundation Option 2: Helical Pier

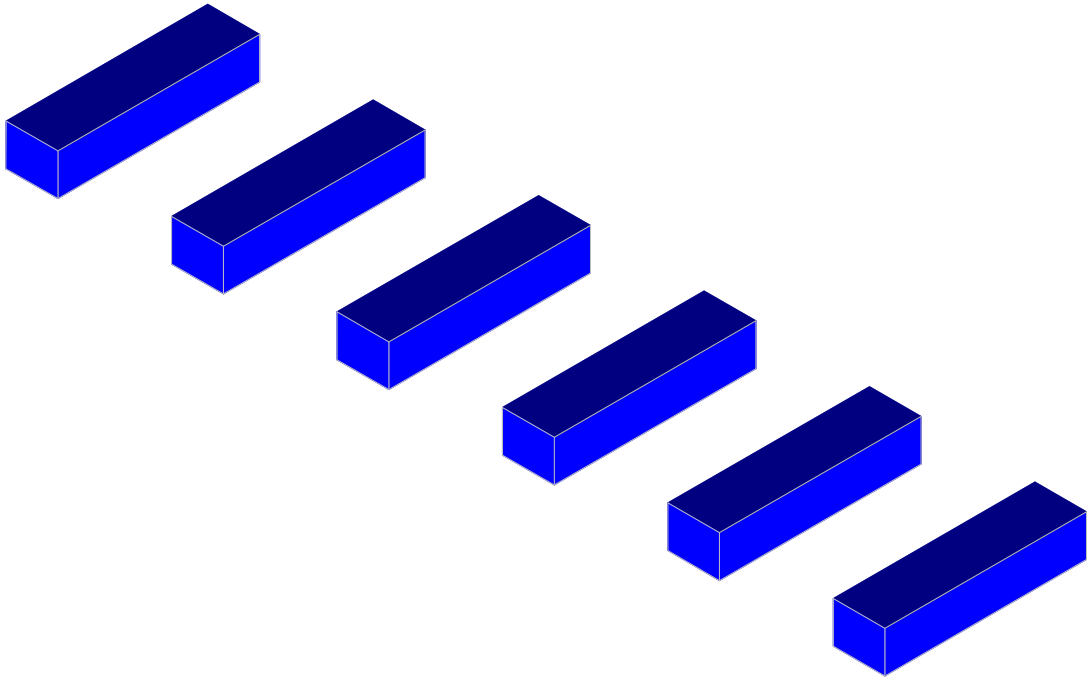
The helical piers must be tested to 1.5 times uplift and 2.0 times lateral reactions found in the table below.

Load (ASD)	Value (lbs / kN)	Factor of Safety	Test Value (lbs / kN)
UPLIFT	2400 / 10.7	1.5	3600 / 16.0
LATERAL	1900 / 8.5	2	3800 / 16.9

JOB NO.: U2716-070-181 **DESIGNED:** STB

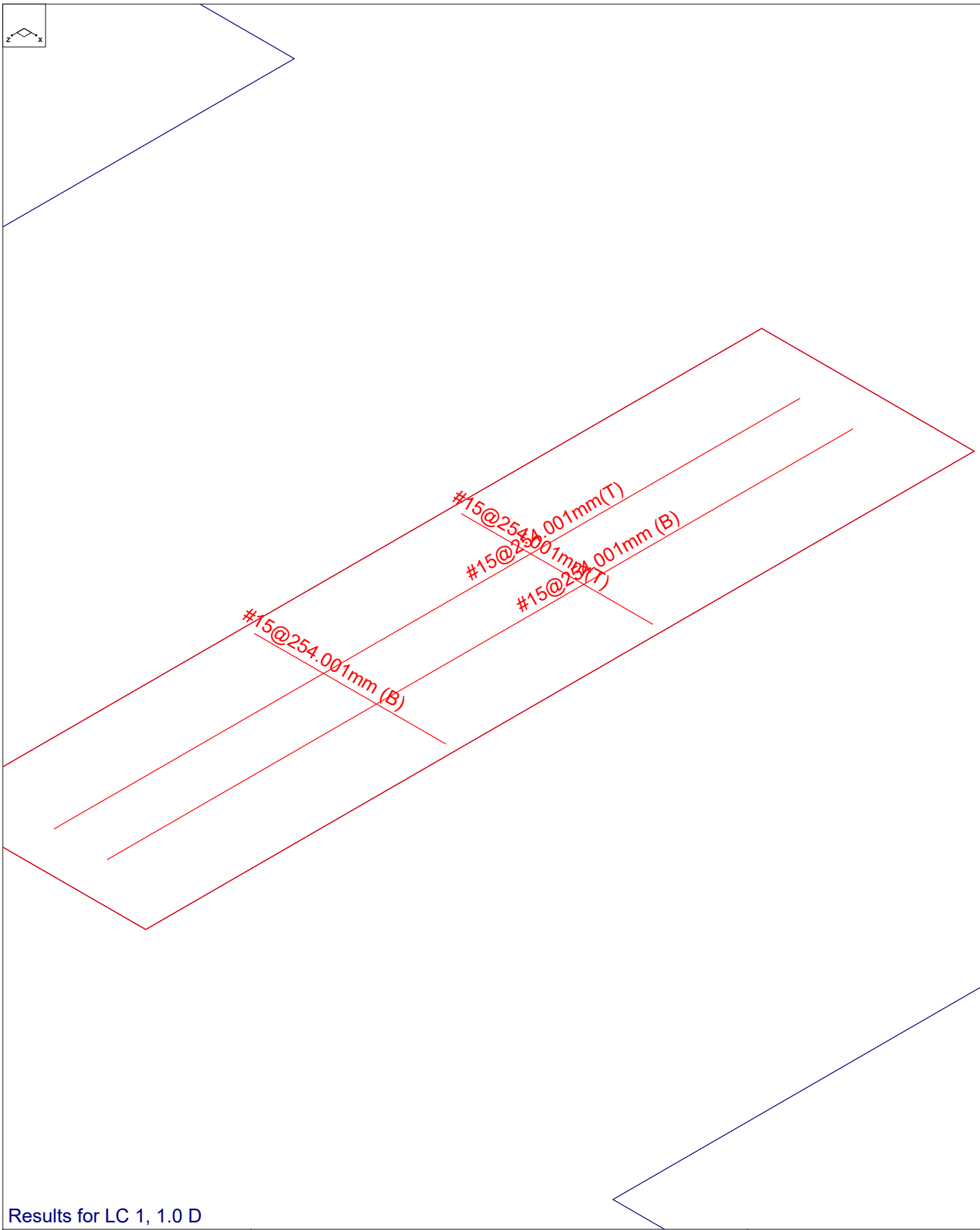
PROJECT: Ground Mount Package for Ontario Canada

Foundation Option 3: Ballasted Blocks



Results for LC 1, 1.0 D

Vector Structural Engineeri...	Ontario Ground Mount	SK - 19
STB		Feb 14, 2019 at 12:16 PM
U2716.070.181		BC GM 40 deg (2-12-19).r3d



Results for LC 1, 1.0 D

Vector Structural Engineeri...	Ontario Ground Mount	SK - 18
STB		Feb 14, 2019 at 12:15 PM
U2716.070.181		BC GM 40 deg (2-12-19).r3d

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	100
Mesh Size (mm)	304.801
Max Iterations	10
Merge Tolerance (mm)	3.048
Solver	Sparse Accelerated
Coefficient of Friction	.25
No. of Shear Regions	4
Shear Region Spacing Increment (mm)	101.6
Min 1 Bar Dia Spacing for Beams?	No
Optimize footings for OTM / Sliding?	Yes
Parme Beta Factor	.65
Pile Safety Factor	3
Concrete Stress Block	Rectangular
Concrete Rebar Set	CSA G30.18
Concrete Code	CSA A23.3-14
HR Steel Pile Code	CSA S16-14
Wood Pile Code	AWC NDS-15: ASD

Concrete Properties

	Label	E [MPa]	G [MPa]	Nu	Therm (\...	Density[mt/m^3]	f'c[kPa]	Lambda	Flex Stee..	Shear St...
1	Conc3000NW	21759.674	9459.529	.15	.6	2.323	20684.101	1	4.137e+5	4.137e+5
2	Conc3500NW	23504.034	10217.946	.15	.6	2.323	24131.451	1	4.137e+5	4.137e+5
3	Conc4000NW	25124.288	10921.205	.15	.6	2.323	27578.801	1	4.137e+5	4.137e+5
4	Conc3000LW	14375.45	6253.493	.15	.6	1.762	20684.101	.75	4.137e+5	4.137e+5
5	Conc3500LW	15526.865	6749.912	.15	.6	1.762	24131.451	.75	4.137e+5	4.137e+5
6	Conc4000LW	16602.438	7218.751	.15	.6	1.762	27578.801	.75	4.137e+5	4.137e+5

Slab Rebar Parameters

	Label	Top Bar	Bottom Bar	Max Top Bar Sp..	Min Top Bar Sp...	Max Bot Bar Sp...	Min Bot Bar Sp...	Spacing Incr..	Rebar Options
1	Typical	#15	#15	254.001	254.001	254.001	254.001	25.4	Optimize

Soil Definitions

	Label	Subgrade Modulus[mt/m^3]	Allowable Bearing[kPa]	Depth Properties	Default?
1	Default	1601.84	71.82	None	Yes

Slabs

	Label	Thickness [mm]	Material	Local Axis Angle [deg]	Analysis Offset [mm]
1	S1	609.601	Conc3000NW	0	0
2	S2	609.601	Conc3000NW	0	0
3	S3	609.601	Conc3000NW	0	0
4	S4	609.601	Conc3000NW	0	0
5	S5	609.601	Conc3000NW	0	0
6	S6	609.601	Conc3000NW	0	0

Load Combinations

	Label	Solve	Service	A...	SF	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	C...	Fa...	C...	Fa...
1	1.0 D	Yes	Yes		1.5	DL	1																		
2	1.0 D ...	Yes	Yes		1.5	DL	1	RLL	1																
3	1.0 D ...	Yes	Yes		1.5	DL	1	RLL		OL1	.6														
4	1.0 D ...	Yes	Yes		1.5	DL	1	RLL		OL2	.6														
5	1.0 D ...	Yes	Yes		1.5	DL	1	RLL		OL3	.6														

Load Combinations (Continued)

	Label	Solve	Service	A...	SF	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	Cat...	Fa...	C...	Fa...	C...	Fa...
6	1.0 D ...	Yes	Yes		1.5	DL	1	RLL		OL4	.6														
7	1.0 D ...	Yes	Yes		1.5	DL	1	RLL		OL5	.6														
8	1.0 D ...	Yes	Yes		1.5	DL	1	RLL		OL6	.6														
9	1.0 D ...	Yes	Yes		1.5	DL	1	RLL	.75	OL1	.45														
10	1.0 D ...	Yes	Yes		1.5	DL	1	RLL	.75	OL2	.45														
11	1.0 D ...	Yes	Yes		1.5	DL	1	RLL	.75	OL3	.45														
12	1.0 D ...	Yes	Yes		1.5	DL	1	RLL	.75	OL4	.45														
13	1.0 D ...	Yes	Yes		1.5	DL	1	RLL	.75	OL5	.45														
14	1.0 D ...	Yes	Yes		1.5	DL	1	RLL	.75	OL6	.45														
15	0.6 D ...	Yes	Yes		1.1	DL	.6	RLL		OL1	.6														
16	0.6 D ...	Yes	Yes		1.1	DL	.6	RLL		OL2	.6														
17	0.6 D ...	Yes	Yes		1.1	DL	.6	RLL		OL3	.6														
18	0.6 D ...	Yes	Yes		1.1	DL	.6	RLL		OL4	.6														
19	0.6 D ...	Yes	Yes		1.1	DL	.6	RLL		OL5	.6														
20	0.6 D ...	Yes	Yes		1.1	DL	.6	RLL		OL6	.6														
21																									
22	1.4D	Yes				DL	1.4																		
23	1.2D+...	Yes				DL	1.2	SL	1.6																
24	1.2D+...	Yes				DL	1.2	SL	1.6	OL1	.5														
25	1.2D+...	Yes				DL	1.2	SL	1.6	OL2	.5														
26	1.2D+...	Yes				DL	1.2	SL	1.6	OL3	.5														
27	1.2D+...	Yes				DL	1.2	SL	1.6	OL4	.5														
28	1.2D+...	Yes				DL	1.2	SL	1.6	OL5	.5														
29	1.2D+...	Yes				DL	1.2	SL	1.6	OL6	.5														
30	1.2D+...	Yes				DL	1.2			OL1	1														
31	1.2D-1...	Yes				DL	1.2			OL2	1														
32	1.2D+...	Yes				DL	1.2			OL3	1														
33	1.2D-1...	Yes				DL	1.2			OL4	1														
34	1.2D+...	Yes				DL	1.2			OL5	1														
35	1.2D-1...	Yes				DL	1.2			OL6	1														
36	.9D+1....	Yes				DL	.9			OL1	1														
37	.9D-1....	Yes				DL	.9			OL2	1														
38	.9D+1....	Yes				DL	.9			OL3	1														
39	.9D-1....	Yes				DL	.9			OL4	1														
40	.9D+1....	Yes				DL	.9			OL5	1														
41	.9D-1....	Yes				DL	.9			OL6	1														

Design Strips

	Label	Rebar Angle from Pl...	No. of Design Cuts	Design Rule
1	DS1	0	50	Typical
2	DS2	90	50	Typical

Company:		Date:	5/14/2018
Engineer:		Page:	1/6
Project:			
Address:			
Phone:			
E-mail:			

1.Project information

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

Project description:
Location:
Fastening description:

2. Input Data & Anchor Parameters

General
Design method:ACI 318-05
Units: Imperial units

Anchor Information:
Anchor type: Bonded anchor
Material: F1554 Grade 36
Diameter (inch): 0.375
Effective Embedment depth, h_{ef} (inch): 3.000
Code report: ICC-ES ESR-2508
Anchor category: -
Anchor ductility: Yes
h_{min} (inch): 4.88
c_{ac} (inch): 3.62
C_{min} (inch): 1.75
S_{min} (inch): 3.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 34.00
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
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Hole condition: Dry concrete
Inspection: Continuous
Temperature range, Short/Long: 150/110°F
Ignore 6do requirement: Not applicable
Build-up grout pad: No

Base Plate
Length x Width x Thickness (inch): 4.75 x 4.75 x 0.31
Yield stress: 34084 psi

Profile type/size: Pipe1-1/2STD

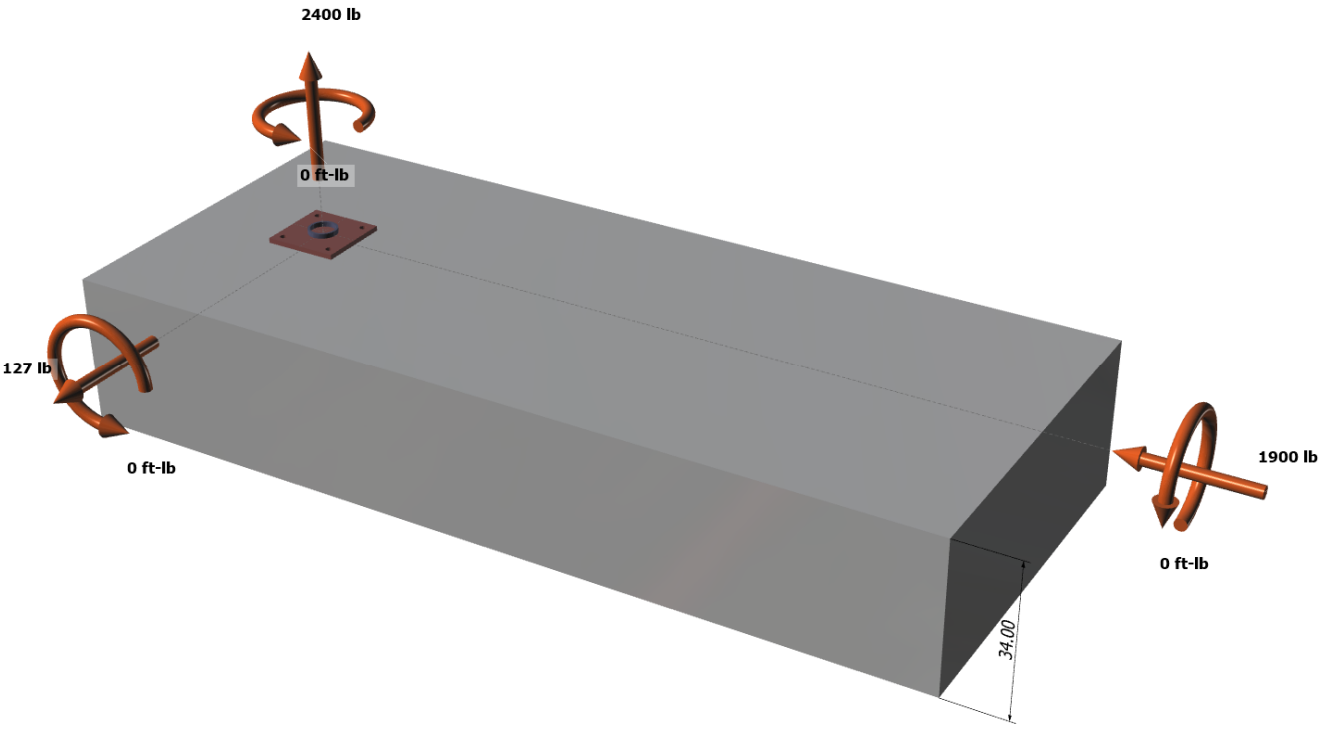
Recommended Anchor
Anchor Name: SET-XP® - SET-XP w/ 3/8"Ø F1554 Gr. 36
Code Report: ICC-ES ESR-2508

Load and Geometry
Load factor source: ACI 318 Section 9.2
Load combination: not set
Seismic design: No
Anchors subjected to sustained tension: No
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: No

Strength level loads:

N_{ua} [lb]: 2400
V_{uax} [lb]: 127
V_{uay} [lb]: -1900
M_{ux} [ft-lb]: 0
M_{uy} [ft-lb]: 0
M_{uz} [ft-lb]: 0

<Figure 1>



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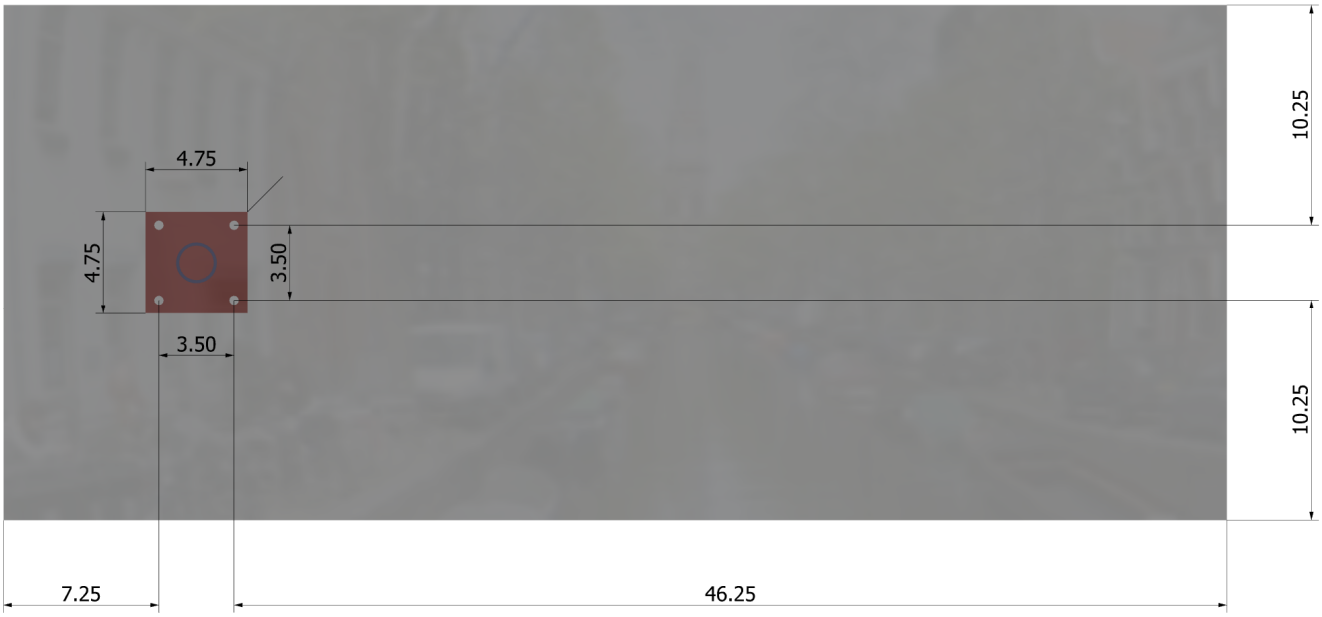
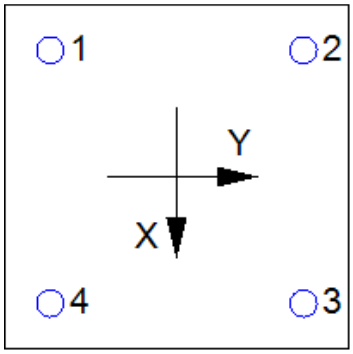


3. Resulting Anchor Forces

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	600.0	31.8	-475.0	476.1
2	600.0	31.8	-475.0	476.1
3	600.0	31.8	-475.0	476.1
4	600.0	31.8	-475.0	476.1
Sum	2400.0	127.0	-1900.0	1904.2

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 2400
Resultant compression force (lb): 0
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)
4525	0.75	3394

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

$N_b = k_c \lambda \sqrt{f'_c} h_{ef}^{1.5}$ (Eq. D-7)

k_c	λ	f'_c (psi)	h_{ef} (in)	N_b (lb)
17.0	1.00	2500	3.000	4417

$\phi N_{cbg} = \phi (A_{Nc} / A_{Nco}) \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ (Sec. D.4.1 & Eq. D-5)

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)
156.25	81.00	7.25	1.000	1.000	1.00	1.000	4417	0.65	5538

6. Adhesive Strength of Anchor in Tension (AC308 Sec. 3.3)

$\tau_{k,cr} = \tau_{k,cr} f_{short\text{-}term} K_{sat}$

$\tau_{k,cr}$ (psi)	$f_{short\text{-}term}$	K_{sat}	$\tau_{k,cr}$ (psi)
595	1.00	1.00	595

$N_{a0} = \tau_{k,cr} \pi d_a h_{ef}$ (Eq. D-16f)

$\tau_{k,cr}$ (psi)	d_a (in)	h_{ef} (in)	N_{a0} (lb)
595	0.38	3.000	2103

$\phi N_{ag} = \phi (A_{Na} / A_{Na0}) \Psi_{ed,Na} \Psi_{g,Na} \Psi_{ec,Na} \Psi_{p,Na} N_{a0}$ (Sec. D.4.1 & Eq. D-16b)

A_{Na} (in^2)	A_{Na0} (in^2)	$\Psi_{ed,Na}$	$\Psi_{g,Na}$	$\Psi_{ec,Na}$	$\Psi_{p,Na}$	N_{a0}(lb)	ϕ	ϕN_{ag} (lb)
80.38	29.87	1.000	1.134	1.000	1.000	2103	0.65	4171

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

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
2260	1.0	0.65	1469

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

Shear perpendicular to edge in x-direction:

$V_{bx} = 7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda\sqrt{f'_c}c_{a1}^{1.5}$ (Eq. D-24)

l_e (in)	d_a (in)	λ	f'_c (psi)	c_{a1} (in)	V_{bx} (lb)
3.00	0.375	1.00	2500	13.75	16564

$\phi V_{cbgx} = \phi\,(A_{Vc} / A_{Vco})\Psi_{ec,V}\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{bx}$ (Sec. D.4.1 & Eq. D-22)

A_{Vc} (in^2)	A_{Vco} (in^2)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V_{bx} (lb)	ϕ	ϕV_{cbgx} (lb)
647.11	850.78	1.000	0.805	1.000	1.000	16564	0.70	7103

Shear perpendicular to edge in y-direction:

$V_{by} = 7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda\sqrt{f'_c}c_{a1}^{1.5}$ (Eq. D-24)

l_e (in)	d_a (in)	λ	f'_c (psi)	c_{a1} (in)	V_{by} (lb)
3.00	0.375	1.00	2500	10.75	11450

$\phi V_{cbgy} = \phi\,(A_{Vc} / A_{Vco})\Psi_{ec,V}\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{by}$ (Sec. D.4.1 & Eq. D-22)

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)
387.00	520.03	1.000	0.891	1.000	1.000	11450	0.70	5313

Shear parallel to edge in x-direction:

$V_{by} = 7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda\sqrt{f'_c}c_{a1}^{1.5}$ (Eq. D-24)

l_e (in)	d_a (in)	λ	f'_c (psi)	c_{a1} (in)	V_{by} (lb)
3.00	0.375	1.00	2500	7.25	6342

$\phi V_{cbgx} = \phi\,(2)(A_{Vc} / A_{Vco})\Psi_{ec,V}\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{by}$ (Sec. D.4.1, D.6.2.1(c) & Eq. D-22)

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_{cbgx} (lb)
261.00	236.53	1.000	1.000	1.000	1.000	6342	0.70	9797

Shear parallel to edge in y-direction:

$V_{bx} = 7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda\sqrt{f'_c}c_{a1}^{1.5}$ (Eq. D-24)

l_e (in)	d_a (in)	λ	f'_c (psi)	c_{a1} (in)	V_{bx} (lb)
3.00	0.375	1.00	2500	10.25	10661

$\phi V_{cbgy} = \phi\,(2)(A_{Vc} / A_{Vco})\Psi_{ec,V}\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{bx}$ (Sec. D.4.1, D.6.2.1(c) & Eq. D-22)

A_{Vc} (in^2)	A_{Vco} (in^2)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V_{bx} (lb)	ϕ	ϕV_{cbgy} (lb)
401.67	472.78	1.000	1.000	1.000	1.000	10661	0.70	12680

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

$\phi V_{cpg} = \phi \min|k_{cp}N_{ag}\,;\, k_{cp}N_{cbg}| = \phi \min|k_{cp}(A_{Na} / A_{Na0})\Psi_{ed,Na}\Psi_{g,Na}\Psi_{ec,Na}\Psi_{p,Na}N_{a0}\,;\, k_{cp}(A_{Nc} / A_{Nco})\Psi_{ec,N}\Psi_{ed,N}\Psi_{c,N}\Psi_{cp,N}N_b|$ (Eq. D-30b)

k_{cp}	A_{Na} (in^2)	A_{Na0} (in^2)	$\Psi_{ed,Na}$	$\Psi_{g,Na}$	$\Psi_{ec,Na}$	$\Psi_{p,Na}$	N_{a0} (lb)	N_a (lb)
2.0	80.38	29.87	1.000	1.134	1.000	1.000	2103	6418

A_{Nc} (in^2)	A_{Nco} (in^2)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	N_{cb} (lb)	ϕ
156.25	81.00	1.000	1.000	1.000	1.000	4417	8520	0.70

ϕV_{cpg} (lb)
8985

11. Results

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

Tension	Factored Load, N_{ua} (lb)	Design Strength, ϕN_n (lb)	Ratio	Status
Steel	600	3394	0.18	Pass
Concrete breakout	2400	5538	0.43	Pass
Adhesive	**2400**	**4171**	**0.58**	**Pass (Governs)**

Shear	Factored Load, V_{ua} (lb)	Design Strength, ϕV_n (lb)	Ratio	Status
Steel	476	1469	0.32	Pass
T Concrete breakout x+	127	7103	0.02	Pass
T Concrete breakout y-	1900	5313	0.36	Pass
|| Concrete breakout y-	64	9797	0.01	Pass
|| Concrete breakout x-	950	12680	0.07	Pass
Concrete breakout, combined	**-**	**-**	**0.36**	**Pass (Governs)**
Pryout	1904	8985	0.21	Pass

Interaction check	$(N_{ua}/\phi N_{ua})^{5/3}$	$(V_{ua}/\phi V_{ua})^{5/3}$	Combined Ratio	Permissible	Status
Sec. RD.7	0.40	0.18	57.9%	1.0	Pass

SET-XP w/ 3/8"Ø F1554 Gr. 36 with hef = 3.000 inch meets the selected design criteria.

12. Warnings

- When cracked concrete is selected, concrete compressive strength used in concrete breakout strength in tension, adhesive strength in tension and concrete pryout strength in shear for SET-XP adhesive anchor is limited to 2,500 psi per ICC-ES ESR-2508 Section 5.3.

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

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

JOB NO.: U2716-070-181 **DESIGNED:** STB

PROJECT: Ground Mount Package for Ontario Canada

Foundation Option 4: Ground Screws

The helical piers must be tested to 1.5 times uplift and 2.0 times lateral reactions found in the table below.

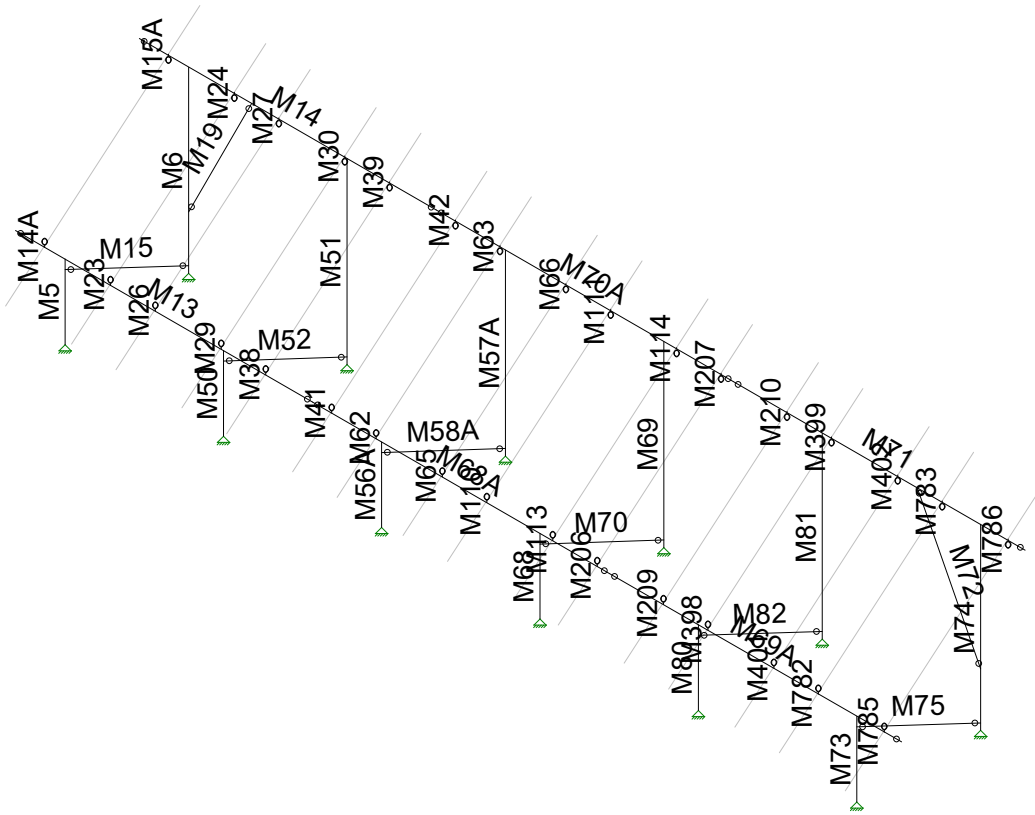
Capacity of ground screws is based of testing by BAYO.S in semi-solid clay. The ground screws must be tested to 1.5 times uplift and 2.0 times lateral reactions found in the table below.

Load (ASD)	Value (lbs / kN)	Factor of Safety	Test Value (lbs / kN)
UPLIFT	2400 / 10.7	1.5	3600 / 16.0
LATERAL	1900 / 8.5	2	3800 / 16.9

JOB NO.: U2716-070-181 **DESIGNED:** STB

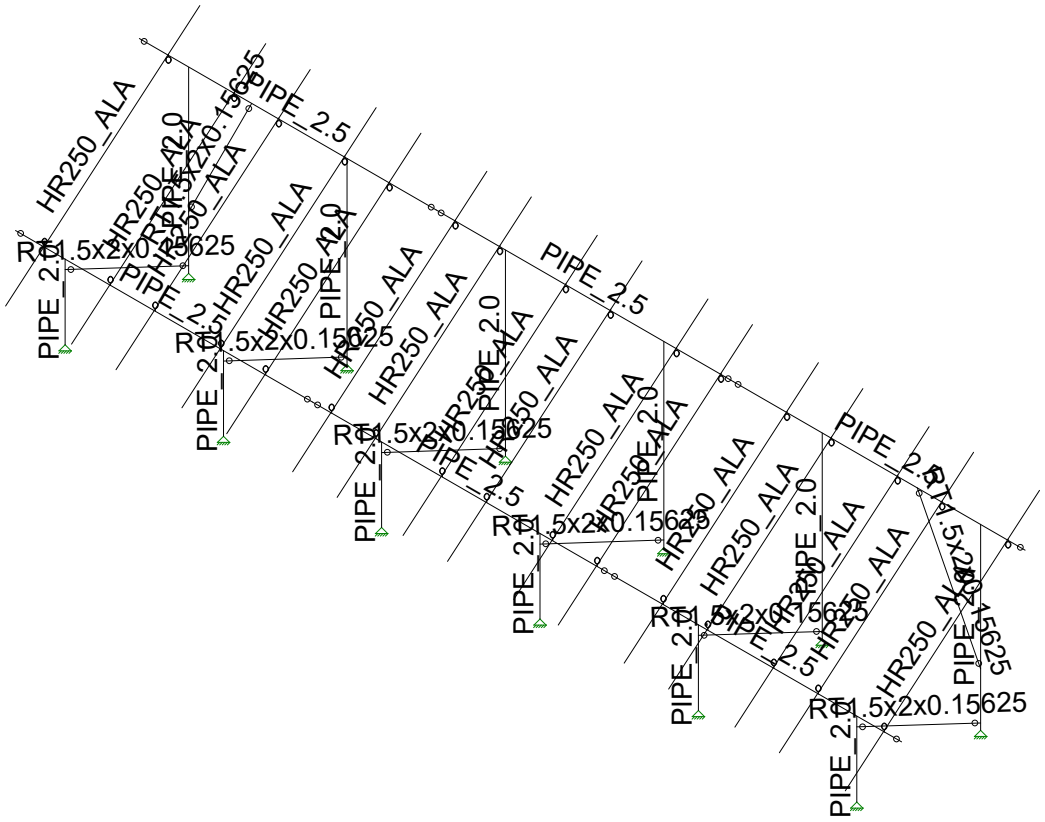
PROJECT: Ground Mount Package for Ontario Canada

Framing Analysis



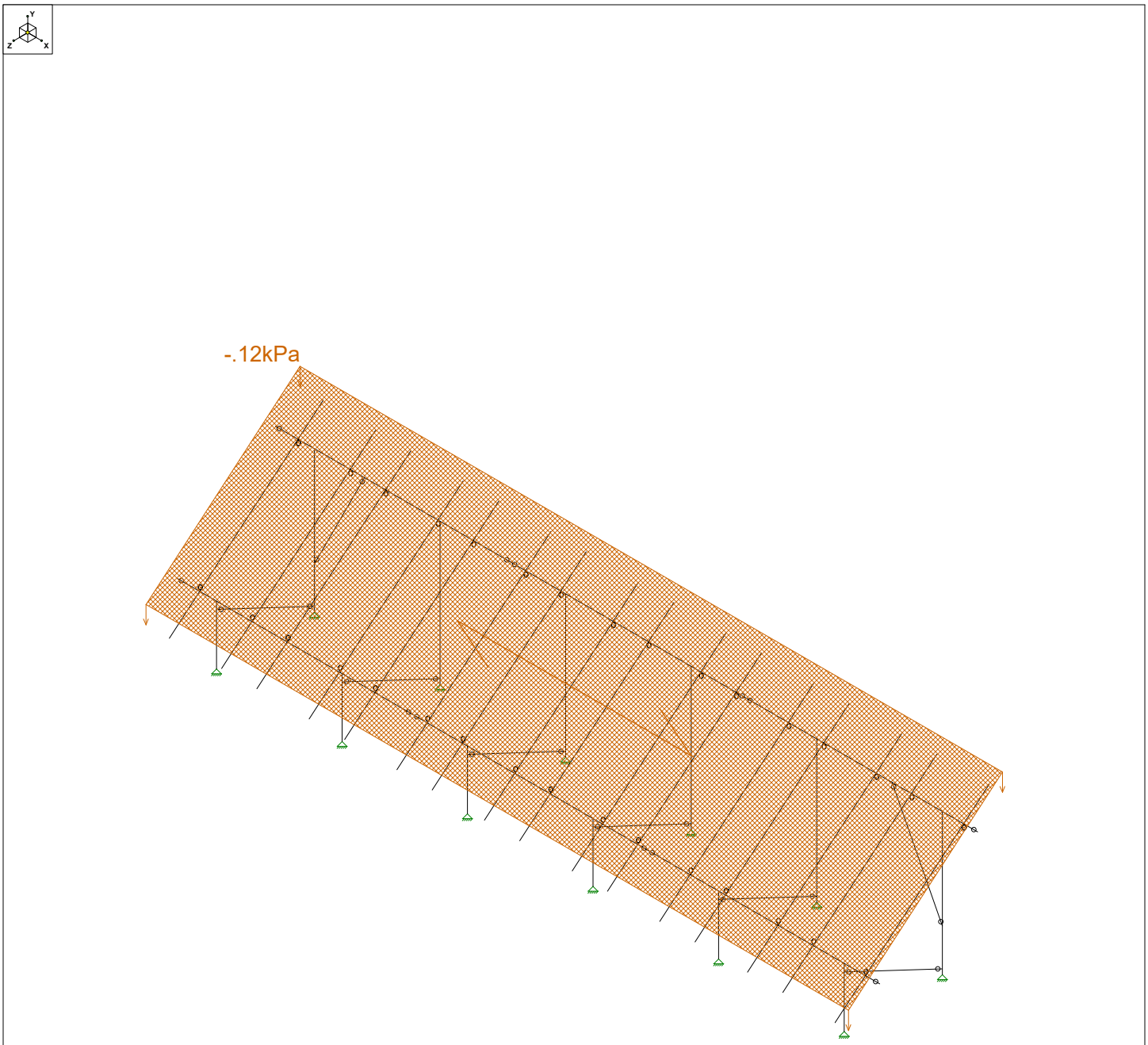
Envelope Only Solution

Vector Structural Engineeri...		SK - 6
STB	BC Ground Mount	Feb 14, 2019 at 12:11 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d



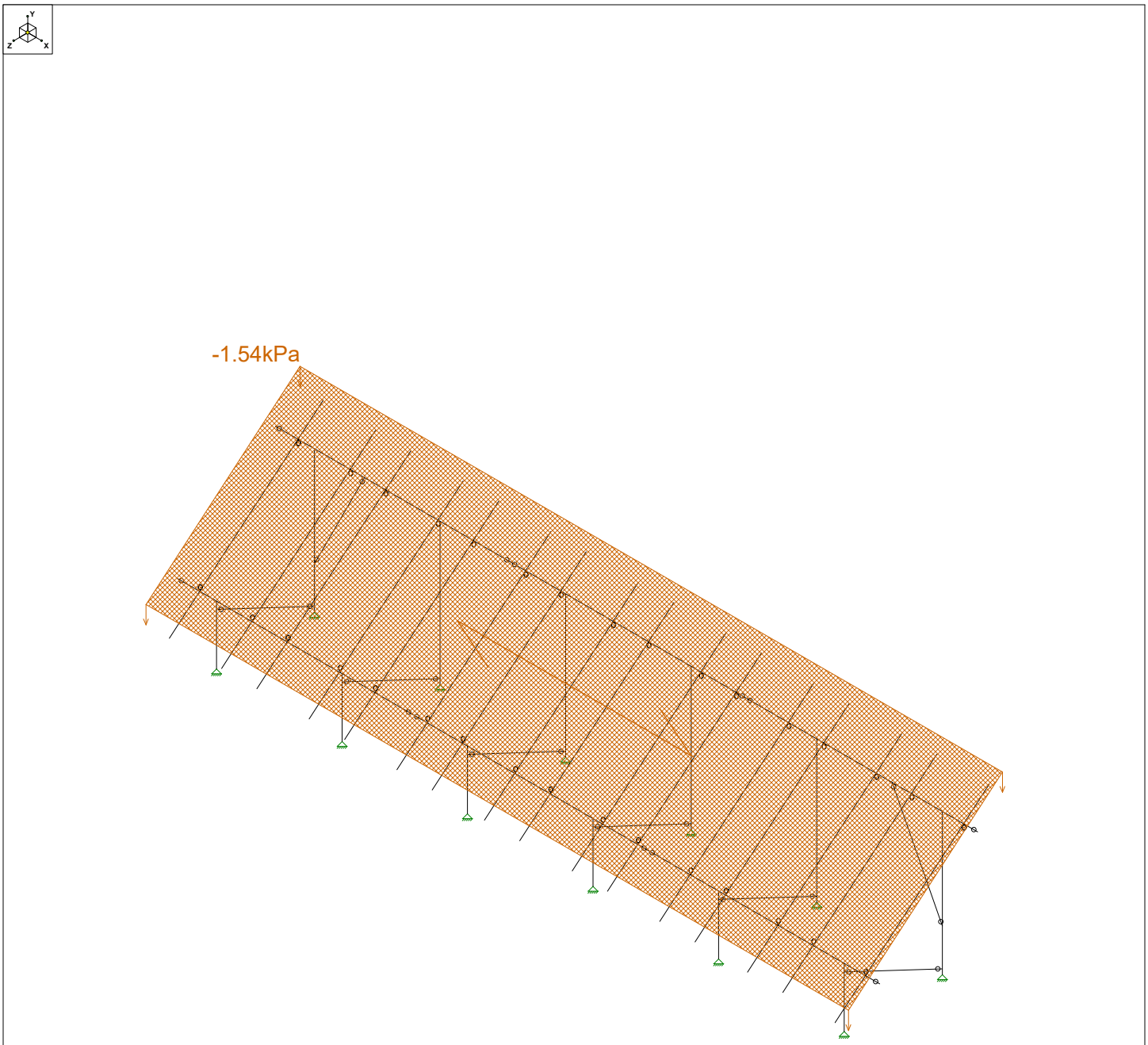
Envelope Only Solution

Vector Structural Engineeri...		SK - 7
STB	BC Ground Mount	Feb 14, 2019 at 12:11 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d



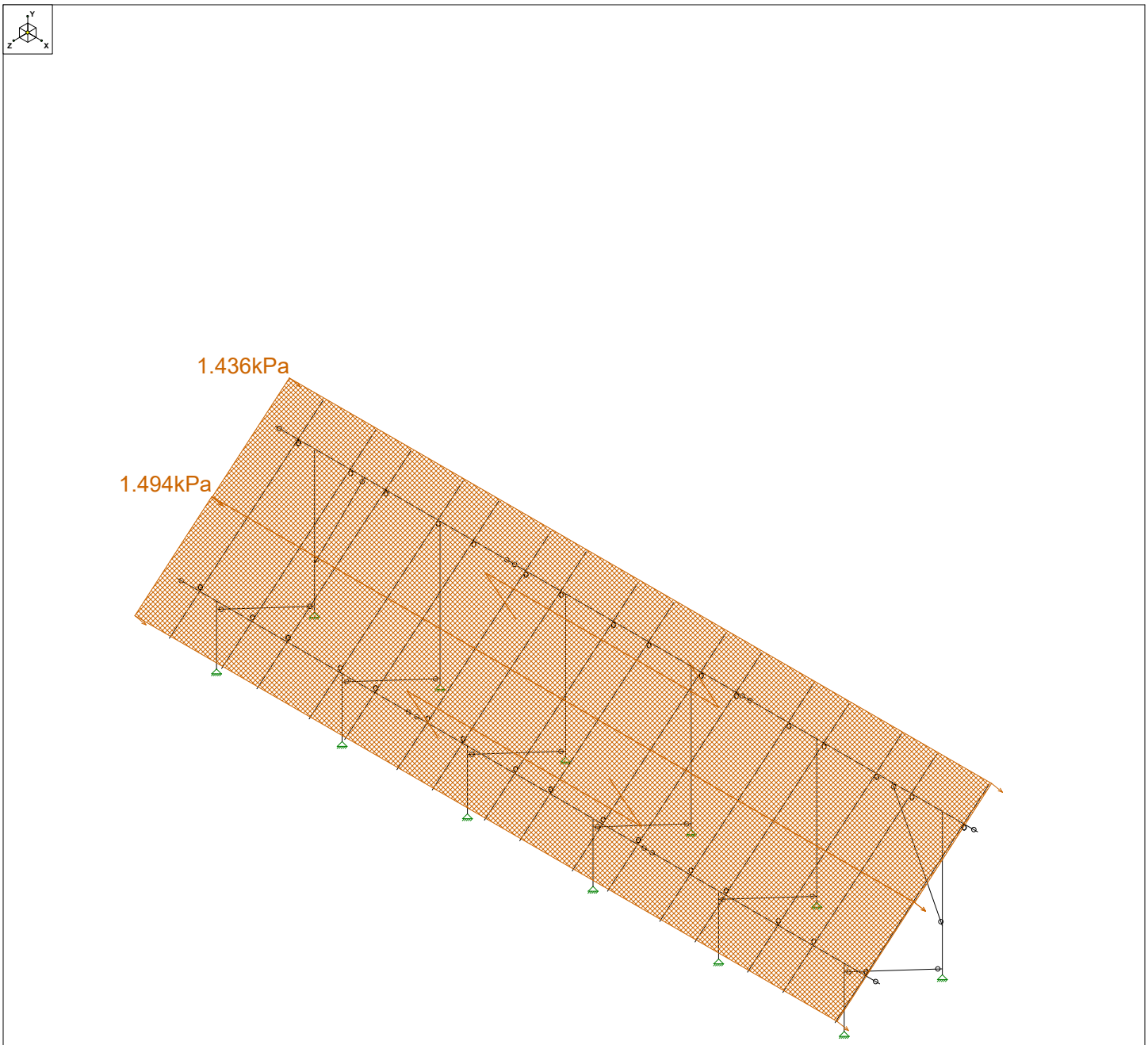
Loads: BLC 2, Solar Panel Weight
Envelope Only Solution

Vector Structural Engineeri...		SK - 8
STB	BC Ground Mount	Feb 14, 2019 at 12:11 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d



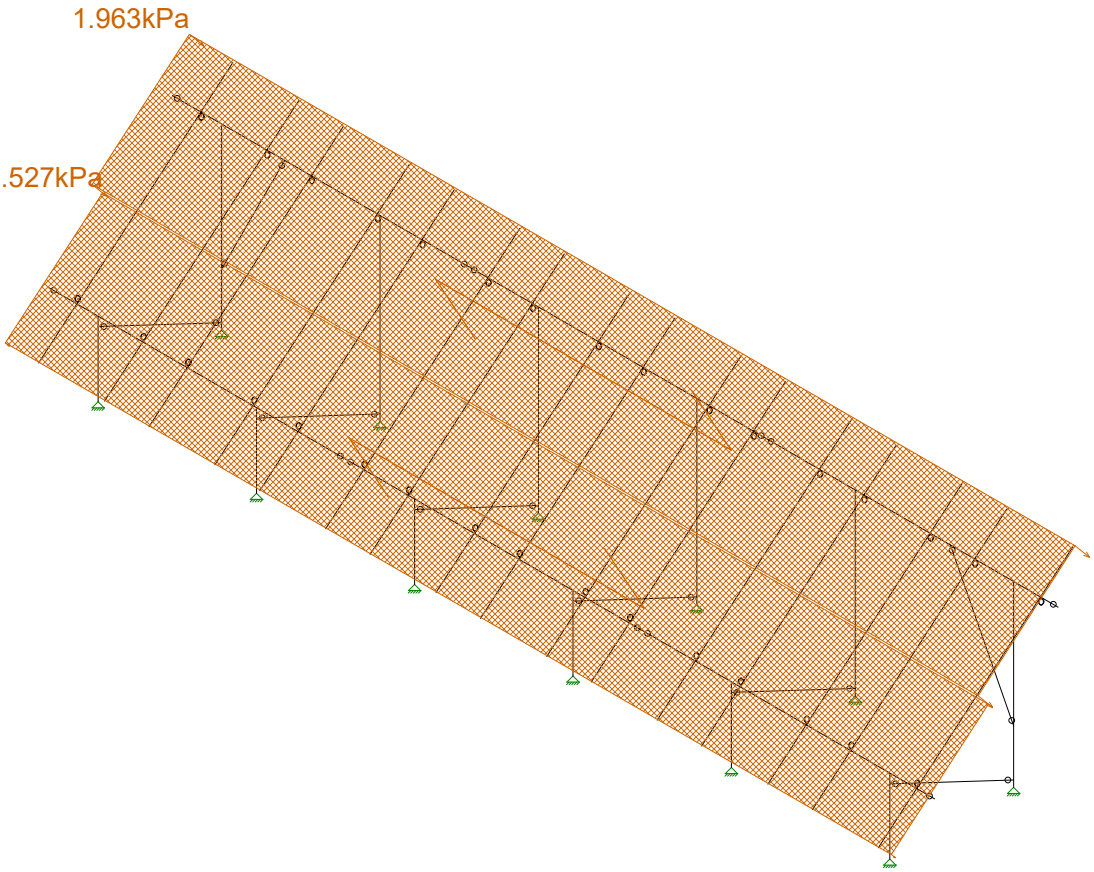
Loads: BLC 3, Roof Live/Snow
Envelope Only Solution

Vector Structural Engineeri...		SK - 9
STB	BC Ground Mount	Feb 14, 2019 at 12:11 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d



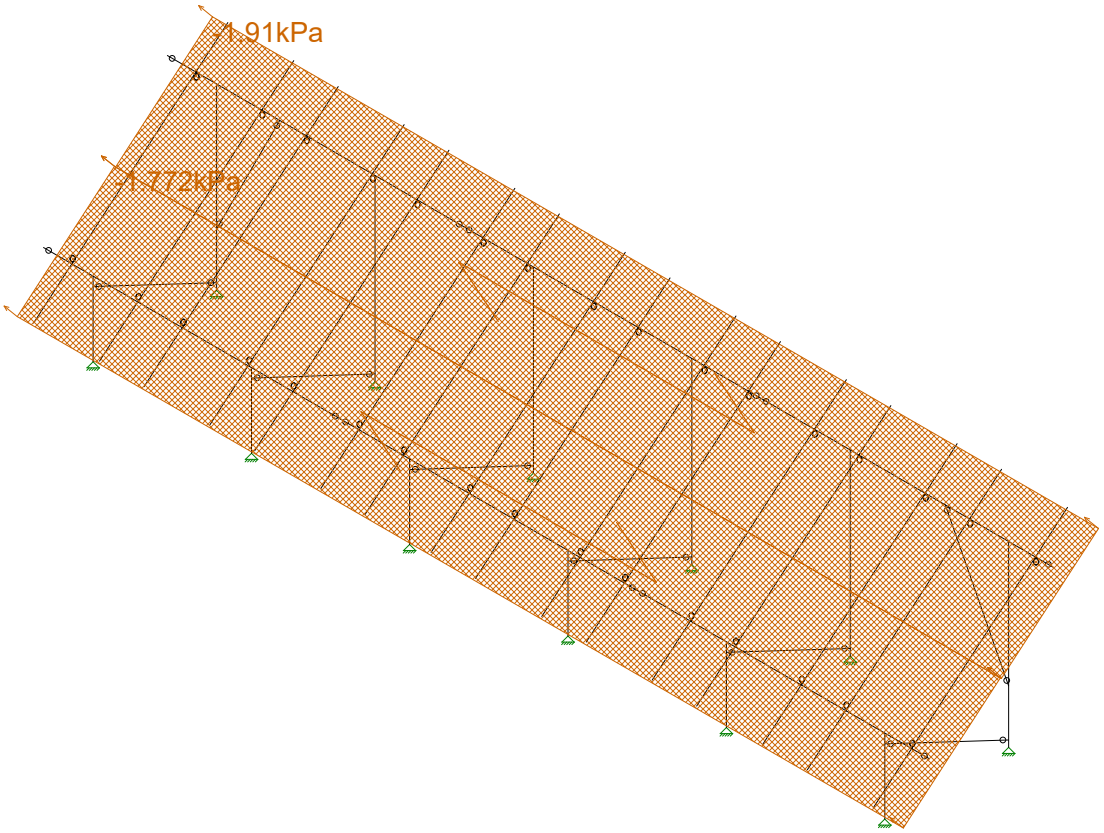
Loads: BLC 4, Wind A 0 deg
Envelope Only Solution

Vector Structural Engineeri...		SK - 10
STB	BC Ground Mount	Feb 14, 2019 at 12:12 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d



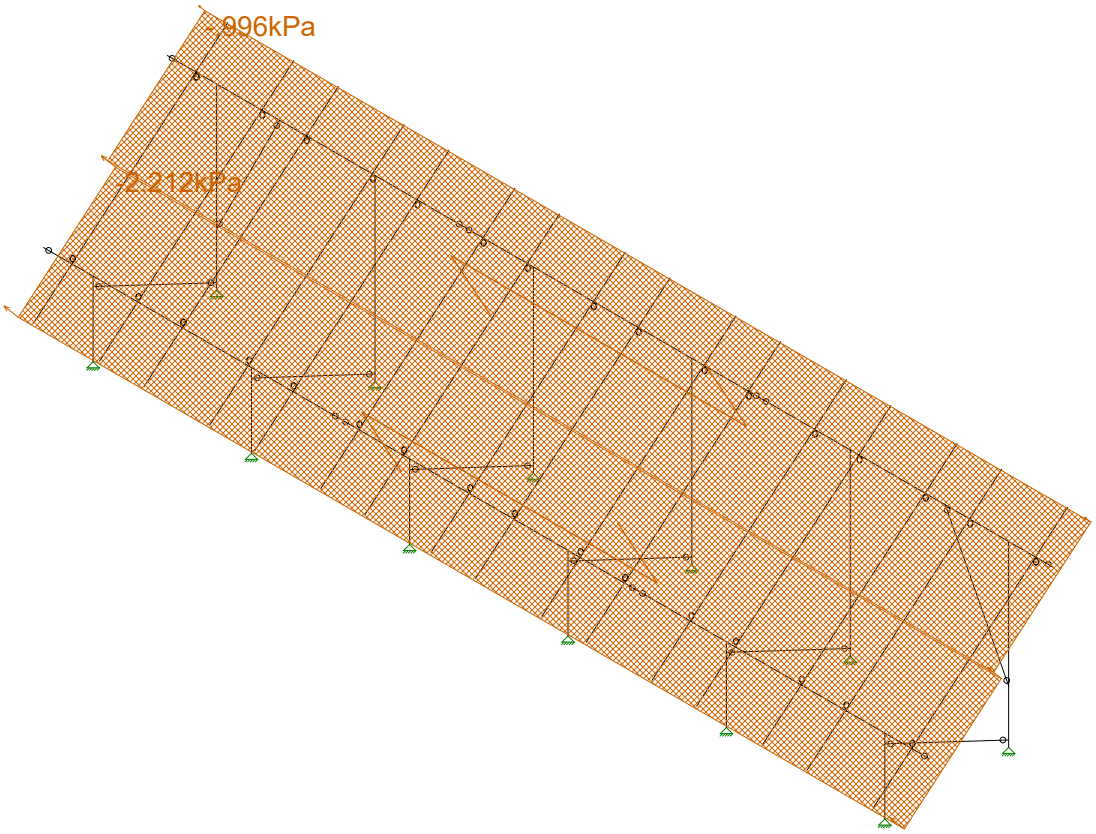
Loads: BLC 5, Wind B 0 deg
Envelope Only Solution

Vector Structural Engineeri...		SK - 11
STB	BC Ground Mount	Feb 14, 2019 at 12:12 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d



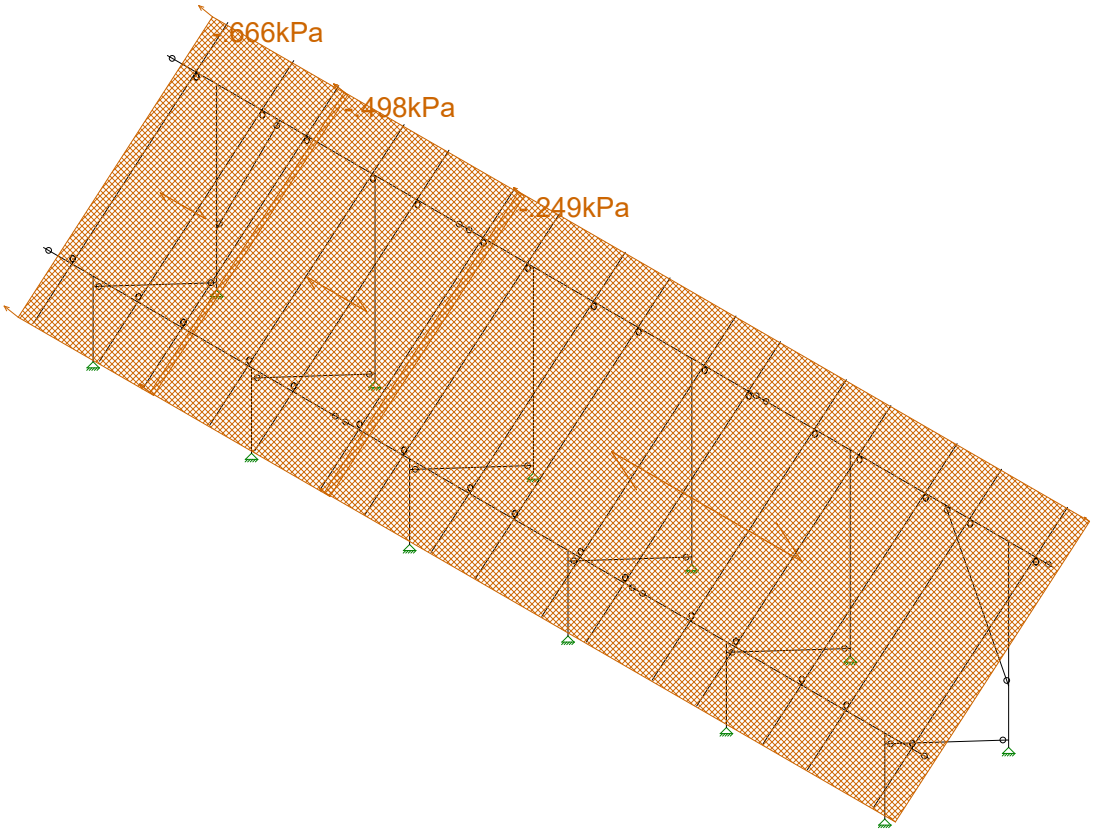
Loads: BLC 6, Wind A 180 deg
Envelope Only Solution

Vector Structural Engineeri...		SK - 13
STB	BC Ground Mount	Feb 14, 2019 at 12:12 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d



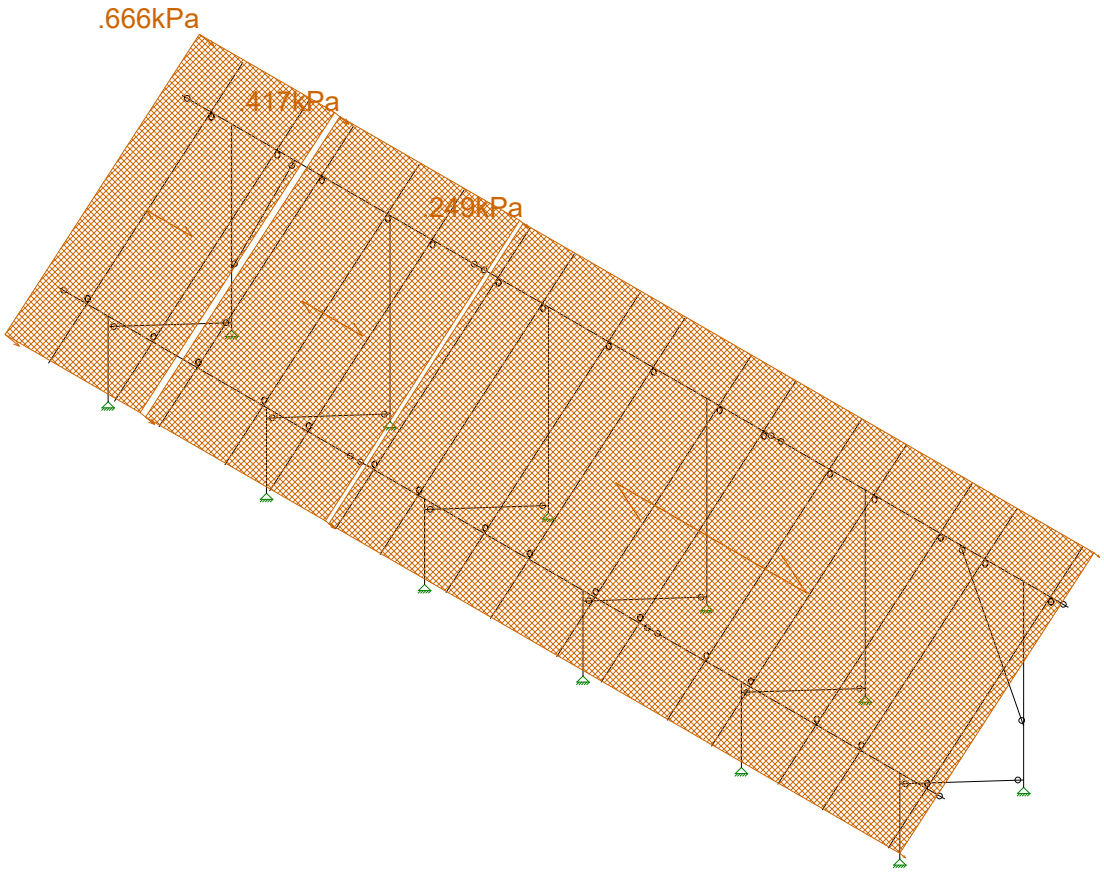
Loads: BLC 7, Wind B 180 deg
Envelope Only Solution

Vector Structural Engineeri...		SK - 15
STB	BC Ground Mount	Feb 14, 2019 at 12:12 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d



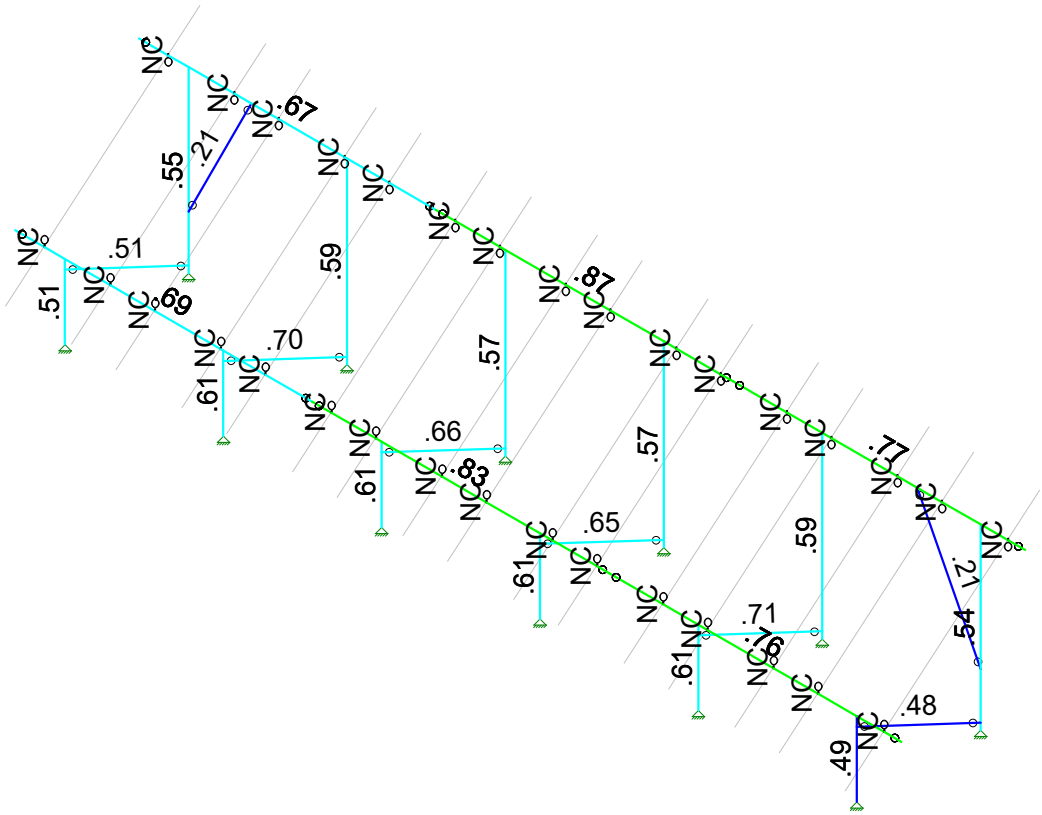
Loads: BLC 8, Wind A 90
Envelope Only Solution

Vector Structural Engineeri...		SK - 16
STB	BC Ground Mount	Feb 14, 2019 at 12:12 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d



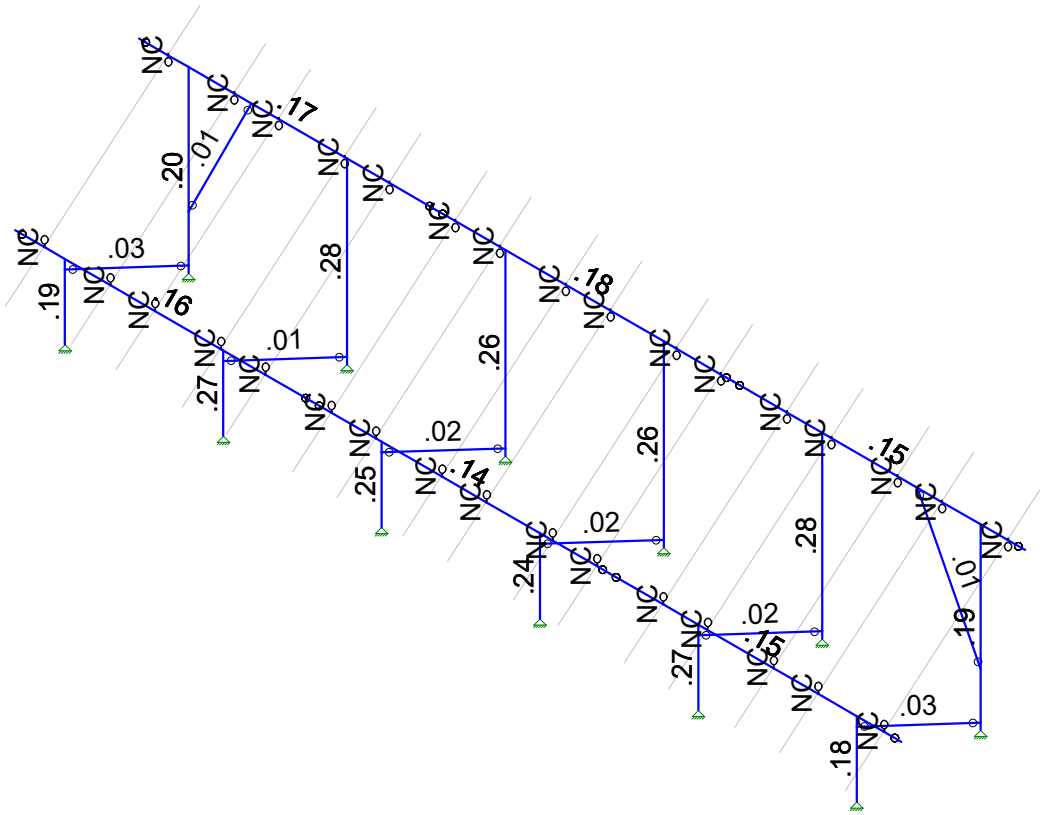
Loads: BLC 9, Wind B 90
Envelope Only Solution

Vector Structural Engineeri...		SK - 17
STB	BC Ground Mount	Feb 14, 2019 at 12:12 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d



Member Code Checks Displayed (Enveloped)
Envelope Only Solution

Vector Structural Engineeri...	BC Ground Mount	SK - 4
STB		Feb 14, 2019 at 12:10 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d



Member Shear Checks Displayed (Enveloped)
Envelope Only Solution

Vector Structural Engineeri...		SK - 5
STB	BC Ground Mount	Feb 14, 2019 at 12:10 PM
U2716.072.181		BC GM 40 deg (2-12-19).r3d

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Increase Nailing Capacity for Wind?	Yes
Include Warping?	Yes
Trans Load Btwn Intersecting Wood Wall?	Yes
Area Load Mesh (mm^2)	92903.412
Merge Tolerance (mm)	3.048
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automatically Iterate Stiffness for Walls?	Yes
Max Iterations for Wall Stiffness	3
Gravity Acceleration (mm/sec^2)	9814.58
Wall Mesh Size (mm)	609.601
Eigensolution Convergence Tol. (1.E-)	4
Vertical Axis	Y
Global Member Orientation Plane	XZ
Static Solver	Sparse Accelerated
Dynamic Solver	Accelerated Solver

Hot Rolled Steel Code	AISC 14th(360-10): ASD
Adjust Stiffness?	Yes(Iterative)
RISAConnection Code	AISC 14th(360-10): ASD
Cold Formed Steel Code	AISI S100-16: ASD
Wood Code	AWC NDS-15: ASD
Wood Temperature	< 100F
Concrete Code	ACI 318-14
Masonry Code	ACI 530-13: ASD
Aluminum Code	AA ADM1-15: ASD - Building
	AISC 14th(360-10): ASD

Number of Shear Regions	4
Region Spacing Increment (mm)	101.6
Biaxial Column Method	Exact Integration
Parme Beta Factor (PCA)	.65
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Use Cracked Sections Slab?	No
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR_SET_ASTMA615
Min % Steel for Column	1
Max % Steel for Column	8

(Global) Model Settings, Continued

Seismic Code	ASCE 7-10
Seismic Base Elevation (mm)	396240.792
Add Base Weight?	Yes
Ct X	.049
Ct Z	.049
T X (sec)	Not Entered
T Z (sec)	Not Entered
R X	3
R Z	3
Ct Exp. X	.75
Ct Exp. Z	.75
SD1	1
SDS	1
S1	1
TL (sec)	5
Risk Cat	I or II
Drift Cat	Other
Om Z	1
Om X	1
Cd Z	4
Cd X	4
Rho Z	1
Rho X	1

Hot Rolled Steel Properties

	Label	E [MPa]	G [MPa]	Nu	Therm (\1E5 F)	Density[mt/m^3]	Yield[kPa]	Ry	Fu[kPa]	Rt
1	A992	1.999e+5	76903....	.3	.65	7.849	3.447e+5	1.1	4.482e+5	1.1
2	A36 Gr.36	1.999e+5	76903....	.3	.65	7.849	2.482e+5	1.5	3.999e+5	1.2
3	A572 Gr.50	1.999e+5	76903....	.3	.65	7.849	3.447e+5	1.1	4.482e+5	1.1
4	A500 Gr.B R...	1.999e+5	76903....	.3	.65	8.442	2.896e+5	1.4	3.999e+5	1.3
5	A500 Gr.B Re...	1.999e+5	76903....	.3	.65	8.442	3.172e+5	1.4	3.999e+5	1.3
6	A53 Gr.B	1.999e+5	76903....	.3	.65	7.849	2.413e+5	1.6	4.137e+5	1.2
7	A1085	1.999e+5	76903....	.3	.65	7.849	3.447e+5	1.4	4.482e+5	1.3

Aluminum Properties

	Label	E [MPa]	G [MPa]	Nu	Therm (...	Density[...	Table B.4	kt	Ftu[kPa]	Fty[kPa]	Fcy[kPa]	Fsu[kPa]	Ct
1	3003-H14	69636.4...	26113.6...	.33	1.3	2.768	Table B.4-1	1	1.31e+5	1.103e+5	89631.1...	82736.4...	141
2	6061-T6	69636.4...	26113.6...	.33	1.3	2.768	Table B.4-2	1	2.62e+5	2.413e+5	2.413e+5	1.655e+5	141
3	6063-T5	69636.4...	26113.6...	.33	1.3	2.768	Table B.4-2	1	1.517e+5	1.103e+5	1.103e+5	89631.1...	141
4	6063-T6	69636.4...	26113.6...	.33	1.3	2.768	Table B.4-2	1	2.068e+5	1.724e+5	1.724e+5	1.31e+5	141
5	5052-H34	70325.9...	26113.6...	.33	1.3	2.768	Table B.4-1	1	2.344e+5	1.793e+5	1.655e+5	1.379e+5	141
6	6061-T6 W	69636.4...	26113.6...	.33	1.3	2.768	Table B.4-1	1	1.655e+5	1.034e+5	1.034e+5	1.034e+5	141
7	6005-T5	69636.4...	26113.6...	.33	1.3	2.768	Table B.4-1	1	2.62e+5	2.413e+5	2.413e+5	1.655e+5	141

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design R...	A [mm2]	Iyy [mm4]	Izz [mm4]	J [mm4]
1	Post	PIPE_2.0	Column	Pipe	A53 Gr.B	Typical	658.066	2.61e+5	2.61e+5	5.203e+5
2	Cross Beam	PIPE_2.5	Column	Pipe	A53 Gr.B	Typical	1038.712	6.035e+5	6.035e+5	1.203e+6

Aluminum Section Sets

	Label	Shape	Type	Design List	Material	Design R...	A [mm2]	Iyy [mm4]	Izz [mm4]	J [mm4]
1	AL Posts	2.375ODX0.188	Column	Pipe	6005-T5	Typical	832.26	3.238e+5	3.238e+5	6.41e+5
2	AL Brace	RT1.5x2x0.15625	VBrace	Rectangular Tubes	6005-T5	Typical	642.643	1.361e+5	2.183e+5	2.505e+5
3	AL Rails	HR250 ALA	Beam	Rectangular Tubes	6005-T5	Typical	466.453	39542.3...	2.023e+5	1.086e+5
4	AL Cross Beam	Cross Rail	Beam	Rectangular Tubes	6005-T5	Typical	1231.615	8.2e+5	1.817e+6	1.672e+6

Member Area Loads (BLC 2 : Solar Panel Weight)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[kPa]
1	N197	N200	N199	N196	Y	A-B	-.12

Member Area Loads (BLC 3 : Roof Live/Snow)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[kPa]
1	N197	N200	N199	N196	PY	A-B	-2.011

Member Area Loads (BLC 4 : Wind A 0 deg)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[kPa]
1	N197	N200	N201	N198	Perp	A-B	1.436
2	N198	N201	N199	N196	Perp	A-B	1.494

Member Area Loads (BLC 5 : Wind B 0 deg)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[kPa]
1	N197	N200	N201	N198	Perp	A-B	1.963
2	N198	N201	N199	N196	Perp	A-B	.527

Member Area Loads (BLC 6 : Wind A 180 deg)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[kPa]
1	N197	N200	N201	N198	Perp	A-B	-1.91
2	N198	N201	N199	N196	Perp	A-B	-1.772

Member Area Loads (BLC 7 : Wind B 180 deg)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[kPa]
1	N197	N200	N201	N198	Perp	A-B	-.996
2	N198	N201	N199	N196	Perp	A-B	-2.212

Member Area Loads (BLC 8 : Wind A 90)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[kPa]
1	N197	N203	N202	N196	Perp	A-B	-.666
2	N203	N209	N208	N202	Perp	A-B	-.498
3	N209	N200	N199	N208	Perp	A-B	-.249

Member Area Loads (BLC 9 : Wind B 90)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[kPa]
1	N197	N203	N202	N196	Perp	A-B	.666
2	N203	N209	N208	N202	Perp	A-B	.417
3	N209	N200	N199	N208	Perp	A-B	.249

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Joint	Point	Distributed	Area(M...	Surface...
1	Self Weight	DL		-1.05						
2	Solar Panel Weight	DL							1	

Basic Load Cases (Continued)

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Joint	Point	Distributed	Area(M...	Surface...
3	Roof Live/Snow	RLL							1	
4	Wind A 0 deg	OL1							2	
5	Wind B 0 deg	OL2							2	
6	Wind A 180 deg	OL3							2	
7	Wind B 180 deg	OL4							2	
8	Wind A 90	OL5							3	
9	Wind B 90	OL6							3	
10	BLC 2 Transient Area ...	None						36		
11	BLC 3 Transient Area ...	None						36		
12	BLC 4 Transient Area ...	None						128		
13	BLC 5 Transient Area ...	None						128		
14	BLC 6 Transient Area ...	None						128		
15	BLC 7 Transient Area ...	None						128		
16	BLC 8 Transient Area ...	None						106		
17	BLC 9 Transient Area ...	None						106		

Load Combinations

	Description	S...	PD...	SRSS	BLC	Fa...	BLC	Fa...	BLC	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...
1	1.0 D	Yes	Y		DL	1																		
2	1.0 D + 1.0 S	Yes	Y		DL	1	RLL	1																
3	1.0 D + 0.6 W1	Yes	Y		DL	1	RLL		OL1	.6														
4	1.0 D + 0.6 W2	Yes	Y		DL	1	RLL		OL2	.6														
5	1.0 D + 0.6 W3	Yes	Y		DL	1	RLL		OL3	.6														
6	1.0 D + 0.6 W4	Yes	Y		DL	1	RLL		OL4	.6														
7	1.0 D + 0.6 W5	Yes	Y		DL	1	RLL		OL5	.6														
8	1.0 D + 0.6 W6	Yes	Y		DL	1	RLL		OL6	.6														
9	1.0 D + 0.45 W1 + 0....	Yes	Y		DL	1	RLL	.75	OL1	.45														
10	1.0 D + 0.45 W2 + 0....	Yes	Y		DL	1	RLL	.75	OL2	.45														
11	1.0 D + 0.45 W3 + 0....	Yes	Y		DL	1	RLL	.75	OL3	.45														
12	1.0 D + 0.45 W4 + 0....	Yes	Y		DL	1	RLL	.75	OL4	.45														
13	1.0 D + 0.45 W5 + 0....	Yes	Y		DL	1	RLL	.75	OL5	.45														
14	1.0 D + 0.45 W6 + 0....	Yes	Y		DL	1	RLL	.75	OL6	.45														
15	0.6 D + 0.6 W1	Yes	Y		DL	.6	RLL		OL1	.6														
16	0.6 D + 0.6 W2	Yes	Y		DL	.6	RLL		OL2	.6														
17	0.6 D + 0.6 W3	Yes	Y		DL	.6	RLL		OL3	.6														
18	0.6 D + 0.6 W4	Yes	Y		DL	.6	RLL		OL4	.6														
19	0.6 D + 0.6 W5	Yes	Y		DL	.6	RLL		OL5	.6														
20	0.6 D + 0.6 W6	Yes	Y		DL	.6	RLL		OL6	.6														

Envelope Joint Reactions

	Joint		X [kN]	LC	Y [kN]	LC	Z [kN]	LC	MX [kN...	LC	MY [kN...	LC	MZ [kN-m]	LC
1	N2	max	.274	9	6.681	11	.829	5	0	1	0	1	0	1
2		min	-.164	18	-2.458	16	-.658	3	0	1	0	1	0	1
3	N1	max	.561	10	10.526	10	4.711	3	0	1	0	1	0	1
4		min	-.28	17	-7.928	17	-5.922	5	0	1	0	1	0	1
5	N132	max	.028	17	13.208	10	6.613	3	0	1	0	1	0	1
6		min	-.068	9	-10.558	17	-8.319	5	0	1	0	1	0	1
7	N133	max	.092	17	9.399	11	1	5	0	1	0	1	0	1
8		min	-.238	10	-3.557	16	-.79	3	0	1	0	1	0	1
9	N109	max	.062	10	13.246	10	6.55	3	0	1	0	1	0	1
10		min	-.029	17	-10.46	17	-8.237	5	0	1	0	1	0	1
11	N110A	max	.182	9	9.444	11	1.001	5	0	1	0	1	0	1
12		min	-.087	17	-3.506	16	-.791	3	0	1	0	1	0	1
13	N121	max	.051	17	13.1	10	6.12	3	0	1	0	1	0	1

Envelope Joint Reactions (Continued)

	Joint		X [kN]	LC	Y [kN]	LC	Z [kN]	LC	MX [kN...	LC	MY [kN...	LC	MZ [kN-m]	LC
14		min	-.111	10	-10.157	17	-7.697	5	0	1	0	1	0	1
15	N122	max	.158	17	8.837	11	.995	5	0	1	0	1	0	1
16		min	-.46	9	-3.212	16	-.788	3	0	1	0	1	0	1
17	N133B	max	.124	10	13.172	10	6.066	3	0	1	0	1	0	1
18		min	-.057	17	-10.097	17	-7.625	5	0	1	0	1	0	1
19	N134B	max	.484	9	8.892	2	.99	5	0	1	0	1	0	1
20		min	-.168	17	-3.091	16	-.785	3	0	1	0	1	0	1
21	N151	max	.287	17	10.074	10	4.481	3	0	1	0	1	0	1
22		min	-.561	10	-7.494	17	-5.631	5	0	1	0	1	0	1
23	N152	max	.178	18	6.457	11	.801	5	0	1	0	1	0	1
24		min	-.252	9	-2.259	16	-.637	3	0	1	0	1	0	1
25	Totals:	max	0	14	99.493	9	30.094	15						
26		min	0	19	-38.427	17	-37.814	5						

Envelope AISC 14th(360-10): ASD Steel Code Checks

	Member	Shape	Code Check	Loc[...	LC	Shear ...	Loc[...	Dir	LC	Pnc/om [...	Pnt/om [...	Mnyy/om...	Mnzz/om...	Cb	Eqn
1	M5	PIPE_2.0	.508	998....	5	.188	1010...		17	80.374	95.09	1.688	1.688	1....	H1-1b
2	M6	PIPE_2.0	.554	801....	10	.202	0		5	35.839	95.09	1.688	1.688	1....	H1-1a
3	M13	PIPE_2.5	.694	3238...	9	.165	3190...		11	77.354	150.094	3.244	3.244	2....	H1-1b
4	M14	PIPE_2.5	.673	3238...	10	.171	3190...		10	77.354	150.094	3.244	3.244	2....	H1-1b
5	M80	PIPE_2.0	.609	998....	5	.269	1010...		5	80.374	95.09	1.688	1.688	1....	H1-1b
6	M81	PIPE_2.0	.587	85.847	9	.281	0		5	35.839	95.09	1.688	1.688	1....	H1-1a
7	M50	PIPE_2.0	.609	998....	5	.265	1010...		5	80.374	95.09	1.688	1.688	1....	H1-1b
8	M51	PIPE_2.0	.586	85.847	9	.278	0		5	35.839	95.09	1.688	1.688	1....	H1-1a
9	M56A	PIPE_2.0	.609	998....	5	.246	1010...		5	80.374	95.09	1.688	1.688	1.7	H1-1b
10	M57A	PIPE_2.0	.566	85.847	9	.260	0		5	35.839	95.09	1.688	1.688	1....	H1-1a
11	M68	PIPE_2.0	.606	998....	5	.243	1010...		5	80.374	95.09	1.688	1.688	1....	H1-1b
12	M69	PIPE_2.0	.567	85.847	9	.257	0		5	35.839	95.09	1.688	1.688	1....	H1-1a
13	M68A	PIPE_2.5	.834	3524...	9	.138	1047...		11	77.354	150.094	3.244	3.244	1....	H1-1b
14	M69A	PIPE_2.5	.760	1358...	9	.151	1404...		11	77.354	150.094	3.244	3.244	2....	H1-1b
15	M70A	PIPE_2.5	.870	3524...	10	.181	1047...		10	77.354	150.094	3.244	3.244	1....	H1-1b
16	M71	PIPE_2.5	.771	1358...	10	.153	1404...		10	77.354	150.094	3.244	3.244	2....	H1-1b
17	M73	PIPE_2.0	.492	998....	5	.178	1010...		17	80.374	95.09	1.688	1.688	1....	H1-1b
18	M74	PIPE_2.0	.540	801....	10	.192	0		5	35.839	95.09	1.688	1.688	1....	H1-1a

Envelope AA ADM1-15: ASD - Building Aluminum Code Checks

	Member	Shape	Code C...	Loc[m...	LC	Shear ...	Loc[m...	Dir	LC	Pnc/O...	Pnt/Om...	Mny/O...	Mnz/O...	Vny/O...	Vnz/O...	Cb	Eqn
1	M15	RT1.5x2x...	.506	1097....	3	.032	0	z	10	10.862	86.344	1.045	1.257	27.09	18.245	1....	H.1-1
2	M19	RT1.5x2x...	.207	1326....	10	.011	0	z	3	10.352	86.344	1.045	1.257	27.09	18.245	1....	H.1-1
3	M82	RT1.5x2x...	.710	1097....	3	.016	0	z	10	10.862	86.344	1.045	1.257	27.09	18.245	1....	H.1-1
4	M52	RT1.5x2x...	.703	1097....	3	.012	0	z	10	10.862	86.344	1.045	1.257	27.09	18.245	1....	H.1-1
5	M58A	RT1.5x2x...	.656	1097....	3	.023	0	z	9	10.862	86.344	1.045	1.257	27.09	18.245	1....	H.1-1
6	M70	RT1.5x2x...	.651	1097....	3	.023	0	z	9	10.862	86.344	1.045	1.257	27.09	18.245	1....	H.1-1
7	M72	RT1.5x2x...	.209	1327....	10	.010	0	z	3	10.324	86.344	1.045	1.257	27.09	18.245	1....	H.1-1
8	M75	RT1.5x2x...	.481	1097....	3	.032	0	z	10	10.862	86.344	1.045	1.257	27.09	18.245	1....	H.1-1

JOB NO.: U2716-071-181 **DESIGNED:** STB

PROJECT: Ground Mount Package for Alberta Canada

HR250 Rail Analysis

Envelope Maximum Member Section Forces

	Member		Axial[...	Loc[...	LC	y Shear...	Loc[...	LC	z Shear...	Loc[...	LC	Torque[...	Loc[...	LC	y-y Mome...	Loc[...	LC	z-z Mome...	Loc[...	LC
1	M16	m...	2.648	813....	11	1.846	813....	9	0	0	9	.002	813....	3	.002	325...	17	.484	772....	9
2		min	-2.375	325...	10	-1.883	325...	10	0	329...	11	-.002	813....	17	-.001	325...	3	-.749	211...	10
3	M25	m...	2.089	813....	11	1.87	813....	9	0	0	2	.002	813....	2	0	325...	18	.527	207...	17
4		min	-1.964	325...	10	-1.96	325...	10	0	813....	2	-.001	813....	18	-.001	325...	2	-.766	215...	10
5	M28	m...	.773	813....	2	1.774	813....	9	0	813....	2	0	813....	18	0	325...	2	.481	207...	17
6		min	-1.464	325...	2	-1.795	325...	10	0	329...	2	0	813....	2	0	325...	18	-.741	207...	9
7	M31	m...	4.425	813....	5	1.76	813....	9	0	813....	2	0	813....	17	.001	325...	9	.523	203...	17
8		min	-4.227	325...	4	-1.814	325...	10	0	329...	2	-.001	813....	9	0	325...	17	-.762	211...	10
9	M40	m...	1.263	813....	11	1.774	813....	9	0	813....	10	0	813....	17	.002	325...	4	.486	207...	17
10		min	-1.296	325...	10	-1.797	325...	10	0	329...	10	-.002	813....	4	0	325...	17	-.741	211...	10
11	M43	m...	1.259	813....	10	1.777	813....	9	0	0	10	.002	813....	4	0	325...	17	.478	207...	17
12		min	-1.097	325...	2	-1.791	325...	10	0	813....	10	0	813....	17	-.002	325...	4	-.737	207...	9
13	M64	m...	4.458	813....	5	1.759	813....	9	0	0	10	.002	813....	10	0	325...	17	.524	203...	17
14		min	-4.465	325...	4	-1.816	325...	10	0	813....	10	0	813....	17	-.002	325...	10	-.764	211...	10
15	M67	m...	1.033	813....	11	1.774	813....	9	0	0	2	0	813....	11	0	325...	16	.484	207...	17
16		min	-1.224	325...	2	-1.796	325...	10	0	329...	10	0	813....	16	0	325...	11	-.741	207...	9
17	M112	m...	1.527	813....	11	1.771	813....	9	0	0	10	0	813....	16	0	325...	11	.49	207...	17
18		min	-1.602	325...	10	-1.799	325...	10	0	329...	2	0	813....	11	0	325...	16	-.744	211...	10
19	M115	m...	4.255	813....	5	1.76	813....	9	0	813....	10	.001	813....	17	.002	325...	10	.522	203...	17
20		min	-4.309	325...	4	-1.815	325...	10	0	329...	10	-.002	813....	4	-.001	325...	17	-.763	211...	10
21	M208	m...	1.54	813....	10	1.778	813....	9	0	813....	10	0	813....	17	.002	325...	4	.475	207...	17
22		min	-1.321	325...	11	-1.788	325...	10	0	329...	10	-.002	813....	4	0	325...	17	-.736	207...	9
23	M211	m...	1.887	813....	11	1.771	813....	9	0	0	10	.002	813....	4	0	325...	17	.493	207...	17
24		min	-1.828	325...	10	-1.8	325...	10	0	813....	10	0	813....	17	-.002	325...	4	-.746	211...	10
25	M400	m...	4.064	813....	11	1.761	813....	9	0	0	2	.001	813....	2	0	325...	18	.519	203...	17
26		min	-3.793	325...	4	-1.812	325...	10	0	813....	2	0	813....	18	-.001	325...	2	-.76	211...	10
27	M403	m...	.65	813....	2	1.774	813....	9	0	0	2	0	813....	2	0	325...	18	.479	207...	17
28		min	-1.588	325...	2	-1.795	325...	10	0	329...	14	0	813....	18	0	325...	2	-.741	207...	9
29	M784	m...	2.471	813....	11	1.851	813....	9	0	813....	2	.001	813....	18	.002	325...	2	.59	207...	17
30		min	-2.045	325...	10	-1.891	325...	10	0	329...	2	-.002	813....	2	-.001	325...	18	-.799	211...	10
31	M787	m...	2.094	813....	11	1.532	813....	9	0	0	11	.002	813....	17	.002	325...	3	.388	203...	17
32		min	-1.909	325...	10	-1.55	325...	10	0	329...	9	-.002	813....	3	-.002	325...	17	-.649	207...	9

Title: **HR 250**

Purpose: **Determine the flexural and shear capacity of the aluminum extrusion.**

References:

2015 Aluminum Design Manual

Assumptions & Limitations:

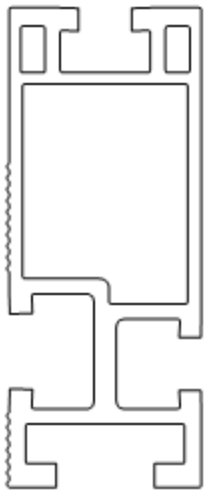
1. The shape is loaded in plane parallel to a principle axis that passes through the shear center, or the shape is restained against rotation about the longitudinal axis at load points and supports.
2. The aluminum is a wrought (not cast) product.
3. The beams ends are prevented from lateral deflection and axial rotation, but are free to rotate about the vertical axis.
4. The shape is not welded.
5. The shape has flat webs that are supported on both edges.

Input:

Shape Name = HR 250

Material = 6005-T5

$L_b := 8.083\ ft$ (beam unbraced length, rupture controls up to an unbraced length of 4.75 ft, then lateral-torsional buckling will control)



Material Properties: (highlighted items change based on the temper)

$E := 10100\ ksi$ (modulus of elasticity, Table A.3.1)

$F_{ty} := 35\ ksi$ (tensile yield strength, Table A.3.3)

$F_{tu} := 38\ ksi$ (tensile ultimate strength, Table A.3.3)

$k_t := 1.25$ (tension coefficient, Table A.3.3)

$F_{cy} := F_{ty} = 35\ ksi$ (compressive yield strength, Table A.3.1; not always = Fty)

$F_{sy} := 0.6 \cdot F_{ty} = 21\ ksi$ (shear yield strength, Table A.3.1)

$F_{su} := 0.6 \cdot F_{tu} = 22.8\ ksi$ (shear ultimate strength, Table A.3.1)

Section Properties: (highlighted items changed based on the shape)

$Z := 0.521\ in^3$ (plastic section modulus about strong axis; per RISASection)

$I_x := 0.487\ in^4$ (moment of inertia about strong axis per RISASection)

$I_y := 0.095\ in^4$ (moment of inertia about weak axis per RISASection)

$S_t := 0.387\ in^3$ (section modulus on the tension side of the neutral axis per RISASection)

$S_c := 0.387\ in^3$ (section modulus on the compression side of the neutral axis per RISASection)

$S_{xc} := S_c = 0.387\ in^3$ (section modulus on the compression side of the x-axis)

$b := 1.1224\ in$ (clear height of the web)

$t := 0.07\ in$ (web thickness)

$n_w := 2$ (# of webs)

$d := 2.5\ in$ (full depth of section per RISASection)

$J_c := 0.091\ in^4$ (torsion constant per RISASection)

Constants:

$\kappa := 1.0\ ksi$ (metric converstion factor, Tables B.4.1 & B.4.2)

F.2 Yielding & Rupture:

Yielding:

$M_{np} := min\left(Z \cdot F_{cy}, 1.5 \cdot S_t \cdot F_{ty}, 1.5 \cdot S_c \cdot F_{cy}\right)$ (nominal flexural strength)

$M_{np} = 1.52\ kip \cdot ft$

Rupture:

$M_{nu} := \frac{Z \cdot F_{tu}}{k_t}$ (nominal flexural strength, Equation F.2-1)

$M_{nu} = 1.32\ kip \cdot ft$

F.3 Local Buckling:

$F_b := 35\ ksi$ (see attached spreadsheet)

$M_{nlb} := F_b \cdot S_{xc} = 1.129\ kip \cdot ft$ (nominal flexural strength)

F.4 Lateral-Torsional Buckling: (highlighted equations change based on the temper)

$B_c := F_{cy} \cdot \left(1 + \left(\frac{F_{cy}}{2250 \cdot \kappa}\right)^{\frac{1}{2}}\right) = 39.365\ ksi$ (buckling constant intercept for member buckling, Table B.4.2)

$D_c := \frac{B_c}{10} \cdot \left(\frac{B_c}{E}\right)^{\frac{1}{2}} = 0.246\ ksi$ (buckling constant slope for member buckling, Table B.4.2)

$C_c := 0.41 \cdot \frac{B_c}{D_c} = 65.673$ (buckling constant intersection for member buckling, Table B.4.2)

$C_b := 1.0$ (coefficient that accounts for the moment gradient along a beam's length, Section F.4.1; conservatively assume Cb = 1.0)

$\lambda := 2.3 \cdot \sqrt{\frac{L_b \cdot S_{xc}}{C_b \cdot \sqrt{I_y \cdot J_c}}} = 46.214$ (slenderness, Equation F.4-6)

$M_{nmbo} := M_{np} \cdot \left(1 - \frac{\lambda}{C_c}\right) + \frac{\pi^2 \cdot E \cdot \lambda \cdot S_{xc}}{{C_c}^3} = 0.975\ kip \cdot ft$ (nominal flexural strength if no part of the cross section is weld-affected)

$M_{nmb} := M_{nmbo} = 0.975\ kip \cdot ft$ (nominal flexural strength for the limit state of lateral-torsional buckling)

Available Flexural Strength:

$\phi_{bnp} := 0.90$ $\phi_{bnu} := 0.75$ $\phi_{bnlb} := 0.90$ $\phi_{bnmb} := 0.90$ (resistance factors, Section F.1)

$\Omega_{np} := 1.65$ $\Omega_{bnu} := 1.95$ $\Omega_{bnlb} := 1.65$ $\Omega_{bnmb} := 1.65$ (safety factors, Section F.1)

LRFD Capacity:

$$M_u := min\left(\phi_{bnp} \cdot M_{np}, \phi_{bnu} \cdot M_{nu}, \phi_{bnlb} \cdot M_{nlb}, \phi_{bnmb} \cdot M_{nmb}\right) = 1.189 \ \boldsymbol{kN \cdot m}$$

ASD Capacity:

$$M_a := min\left(\frac{M_{np}}{\Omega_{np}}, \frac{M_{nu}}{\Omega_{bnu}}, \frac{M_{nlb}}{\Omega_{bnlb}}, \frac{M_{nmb}}{\Omega_{bnmb}}\right) = 0.801 \ \boldsymbol{kN \cdot m}$$

G.1 General Provisions:

Yielding & Shear Buckling: (highlighted equations change based on the temper)

$$B_s := F_{sy} \cdot \left(1 + \left(\frac{F_{sy}}{800 \cdot \kappa}\right)^{\frac{1}{3}}\right) = 27.241 \ ksi$$ (buckling constant intercept for shear in flat elements, Table B.4.2)

$$D_s := \frac{B_s}{10} \cdot \left(\frac{B_s}{E}\right)^{\frac{1}{2}} = 0.141 \ ksi$$ (buckling constant slope for shear in flat elements, Table B.4.2)

$$C_s := 0.41 \ \frac{B_s}{D_s} = 78.946$$ (buckling constant intersection for shear in flat elements, Table B.4.2)

$$\lambda_1 := \frac{B_s - F_{sy}}{1.25 \cdot D_s} = 35.292$$ (slenderness at the intersection of the equations for yielding and inelastic buckling, Section G.2)

$$\lambda_2 := \frac{C_s}{1.25} = 63.157$$ (slenderness at the intersection of the equations for inelastic buckling and elastic buckling, Section G.2)

$$\frac{b}{t} = 16.034$$

Since b/t <= lamda_1:

$$F_s := F_{sy} = 21 \ ksi$$ (shear stress corresponding to the shear strength, Section G.2; equation changes based on b/t)

$$F_{so} := F_s = 21 \ ksi$$ (shear stress corresponding to the unwelded shear strength)

$$A_v := d \cdot t \cdot n_w = 0.35 \ in^2$$ (web area, Equation G.2-3)

$$V_{n1} := F_{so} \cdot A_v = 7.35 \ kip$$ (nominal shear strength, Equation G.1-1)

G.2 Members with Flat Webs Supported on Both Edges:

Rupture:

$$A_n := A_v = 0.35 \ in^2$$ (net area of the web)

$$V_{n2} := \frac{F_{su} \cdot A_n}{k_t} = 6.384 \ kip$$ (nominal shear strength, Equation G.2-1)

Available Shear Strength:

$\phi_{v1} := 0.90$ $\phi_{v2} := 0.75$ $\Omega_{v1} := 1.65$ $\Omega_{v2} := 1.95$ (resistance & safety factors, Section G.1)

LRFD Capacity:

$$V_u := min\left(\phi_{v1} \cdot V_{n1}, \phi_{v2} \cdot V_{n2}\right) = 21.298 \ kN$$

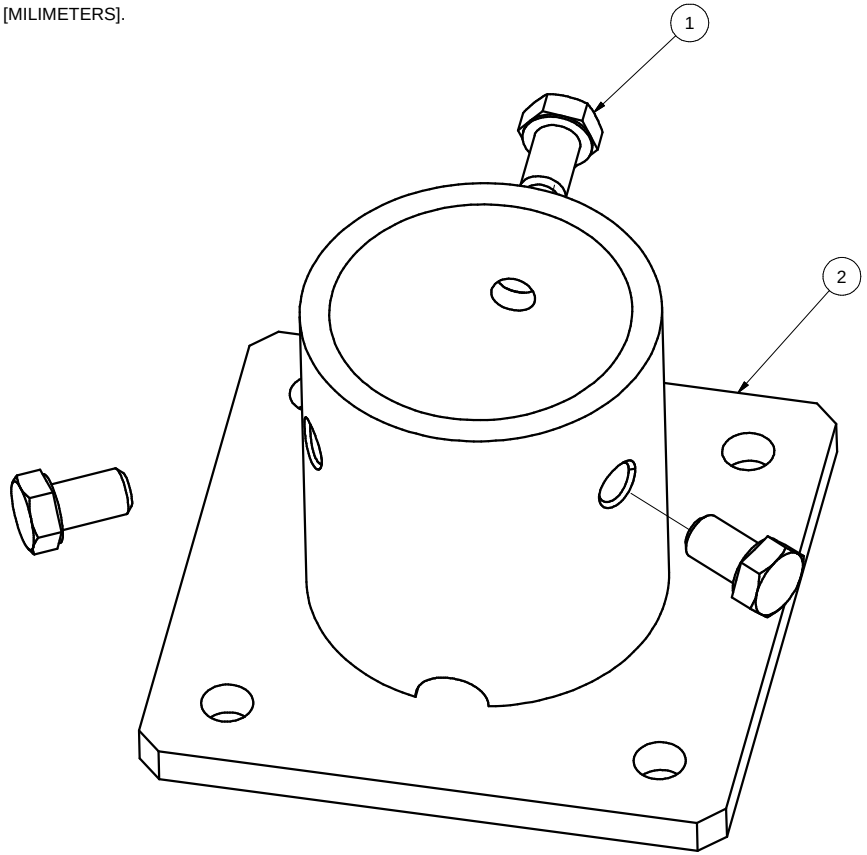
ASD Capacity:

$$V_a := min\left(\frac{V_{n1}}{\Omega_{v1}}, \frac{V_{n2}}{\Omega_{v2}}\right) = 14.563 \ kN$$

REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	10/20/2016

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].



ITEM	PART NUMBER	DESCRIPTION	QTY
2	A21120-001	2" PIPE BASE	1
1	B15018-011	HEX CAP SCREW 3/8-16 X 5/8	3

MATERIAL: SEE NOTES

Third Angle Projection:

GENERAL SPECIFICATIONS
All Dimensions in inches [millimeters]
Tolerances
X.XXX ±0.01 [0.25mm]
X.XX ±0.02 [0.50mm]
X.X ±0.039 [1.0mm]
Unless otherwise spec'd
Break all sharp edges .010-.020 unless otherwise specified.

DRAWN BY: LWF
DATE: 10/20/2016
CHECKED BY:
APPROVALS:

Sunmodo Corp.

1905 E 5TH STREET, STE A, VANCOUVER, WA 98661

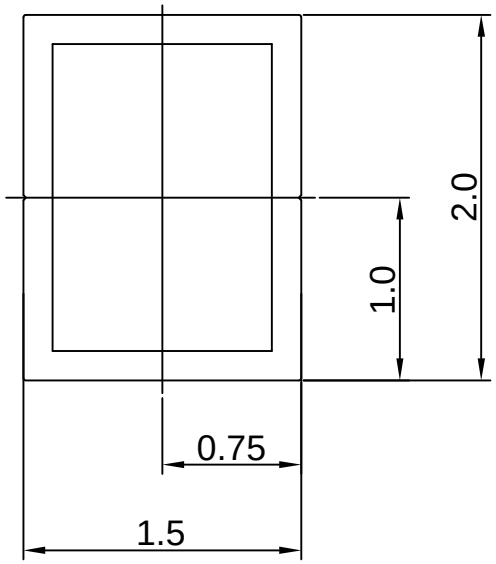
TITLE: 2" PIPE BASE KIT

B
DRAWING NUMBER: K10268-001

SCALE: NONE
SHEET 1 of 1

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].
2. MATERAIL: ALUMINUM 6005-T5.
   FINISH: CLEAR ANODIZED 10 ųm THICK.
3. THE UNSPECIFIED DIMENSIONS ARE SPECIFIED BY 2D CAD FILE.



Section properties:

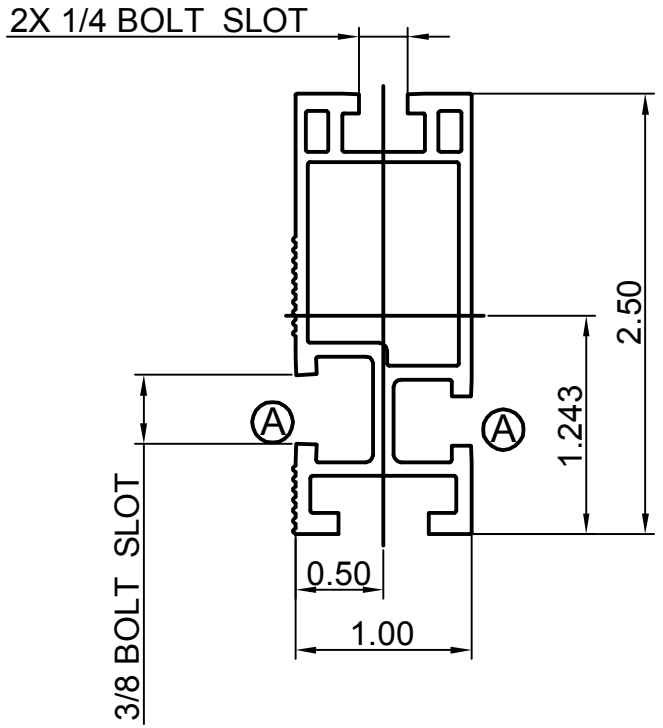
Weight: 1.156 lbs/ft
Area: 0.992 in^2
Perimeter: 12.601 in
Bounding Box: X: -1.000,1.000
Y: -0.750, 0.750
Centroid:(0.000,0.000)
Moments of Inertia(in^4): Ix=0.506,Iy=0.322
Section modulus in bending(in^3): Wx=0.675,Wy=0.322
Radii of Gyration: X: 0.714, Y: 0.570

MATERIAL: SEE NOTES		**Sunmodo Corp.**
Third Angle Projection:		1905 E 5TH STREET, SUITE A, VANCOUVER, WA 98661
GENERAL SPECIFICATIONS: All Dimensions in inches [millimeters]. Tolerances: X.XXX ± 0.01 [0.25mm]; X.XX ± 0.02 [0.50mm]; X.X ± 0.039 [1.0mm]; Unless otherwise spec'd. Break all sharp edges .010-.020 unless otherwise specified.		TITLE: 1.5X2 AL TUBE BRACE EXTRUSION
DRAWN BY: zcg	DATE: 03/12/2014	B — DRAWING NUMBER: A20164
CHECKED BY		
APPROVALS		SCALE: NONE — SHEET 1 of 1

REVISIONS			
REV	DESCRIPTON	BY	DATE
A	ADDED BOTTOM CHANNEL & CHANGED ONE 3/8 CHANNEL TO 1/4	zcg	02/21/2013

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].
2. MATERAIL: ALUMINUM 6005-T5.
   FINISH: CLEAR ANODIZED 15 µm THICK.
3. THE UNSPECIFIED DIMENSIONS ARE SPECIFIED BY 2D CAD FILE.



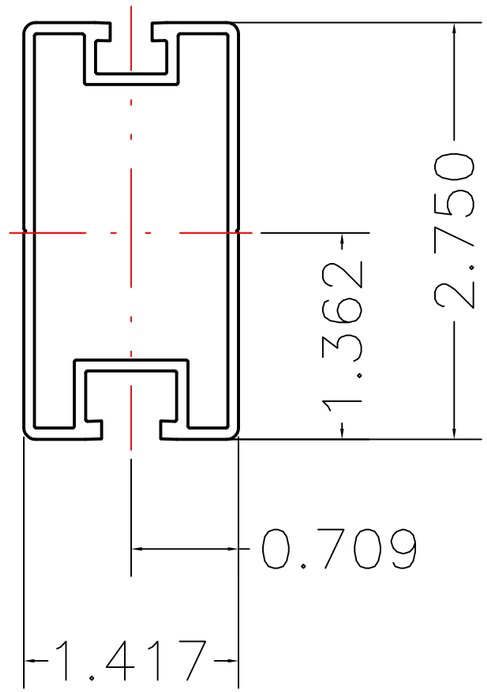
Section properties:

Weight: 0.850 lbs/ft
Area: 0.723 in^2
Perimeter: 17.325 in
Bounding Box: X: -0.500,0.500
Y: -1.243,1.257
Centroid:(0.000,0.000)
Moments of Incertia(in^4): Ix=0.486,Iy=0.095
Section modulus in bending(in^3): Wx=0.387,Wy=0.190
Radii of Gyration: X: 0.820, Y: 0.363

MATERIAL: SEE NOTES		**Sunmodo Corp.**	
Third Angle Projection:		1905 E 5TH STREET, SUITE A, VANCOUVER, WA 98661	
GENERAL SPECIFICATIONS All Dimensions in inches [millimeters] Tolerances X.XXX ± 0.01 [0.25mm] X.XX ± 0.02 [0.50mm] X.X ± 0.039 [1.0mm] Unless otherwise spec'd Break all sharp edges .010-.020 unless otherwise specified.		TITLE: HELIO STANDARD RAIL	
DRAWN BY: zcg	DATE: 02/21/2013	B	DRAWING NUMBER: A20144
CHECKED BY			
APPROVALS		SCALE: NONE	SHEET 1 of 1

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].
2. MATERIAL: 6005-T5.
   FINISH: CLEAR ANODIZED 10um THICK.
3. THE UNSPECIFIED RADII ARE .02" MAX.
4. THE UNSPECIFIED DIMENSIONS ARE SPECIFIED BY 2D CAD FILE.



Section properties:

Weight: 0.862 lbs/ft
Area: 0.736 in^2
Perimeter: 19.824 in
Bounding Box: X: -0.709,0.709
Y: -1.362,1.388
Centroid:(0.000,0.000)
Moments of Incertia(in^4): Ix=0.727,Iy=0.214
Section modulus in bending(in^3): Wx=0.524,Wy=0.302
Radii of Gyration: X: 994, Y: 0.539

MATERIAL	SEE NOTES
Third Angle Projection:	
GENERAL SPECIFICATIONS	All Dimensions in Inches [millimeters]
Tolerances	X.XXX ±0.01 [0.25mm] X.XX ±0.02 [0.50mm] X.X ±0.039 [1.0mm] Unless otherwise spec'd
	Break all sharp edges .010-.020 unless otherwise specified.
DRAWN BY	KYY
DATE	01/18/2018
CHECKED BY	
APPROVALS	

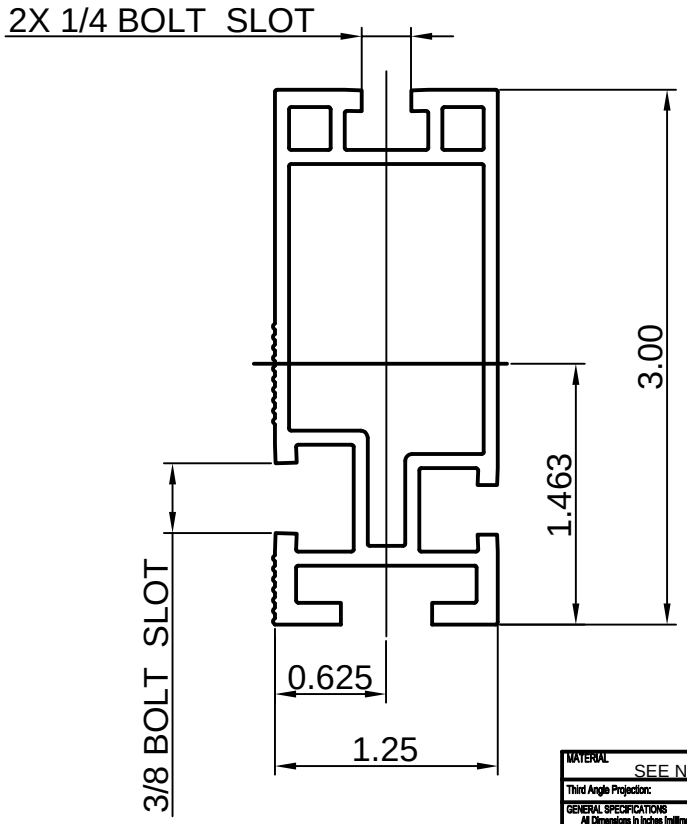
SunModo Corp.
14800 NE 65TH STREET, VANCOUVER WA 98682

TITLE	RAIL, HR300 (SUNRAY), EXTRUSION
B	DRAWING NUMBER A20288
SCALE:	NONE
SHEET	1 of 1

REV	DESCRIPTON	BY	DATE
A	0.44 WAS 0.41, 0.44 WAS 0.33	LWF	11/30/2015

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].
2. MATERAIL: ALUMINUM 6005-T5.
   FINISH: CLEAR ANODIZED 15 ųm THICK.
3. THE UNSPECIFIED DIMENSIONS ARE SPECIFIED BY 2D CAD FILE.



Section properties:

Weight: 1.151 lbs/ft
Area: 0.980 in^2
Perimeter: 22.104 in
Bounding Box: X: -0.625,0.625
Y: -1.463,1.537
Centroid:(0.000,0.000)
Moments of Inertia(in^4): Ix=1.047,Iy=0.207
Section modulus in bending(in^3): Wx=0.681,Wy=0.331
Radii of Gyration: X: 1.034, Y: 0.460

MATERIAL	SEE NOTES
Third Angle Projection:	
GENERAL SPECIFICATIONS All Dimensions in Inches [millimeters] Tolerances X.XXX ±0.01 [0.25mm] X.XX ±0.02 [0.50mm] X.X ±0.039 [1.0mm] Unless otherwise specfd	Break all sharp edges .010-.020 unless otherwise specified.
DRAWN BY: zcg	DATE: 02/21/2013
CHECKED BY	
APPROVALS	

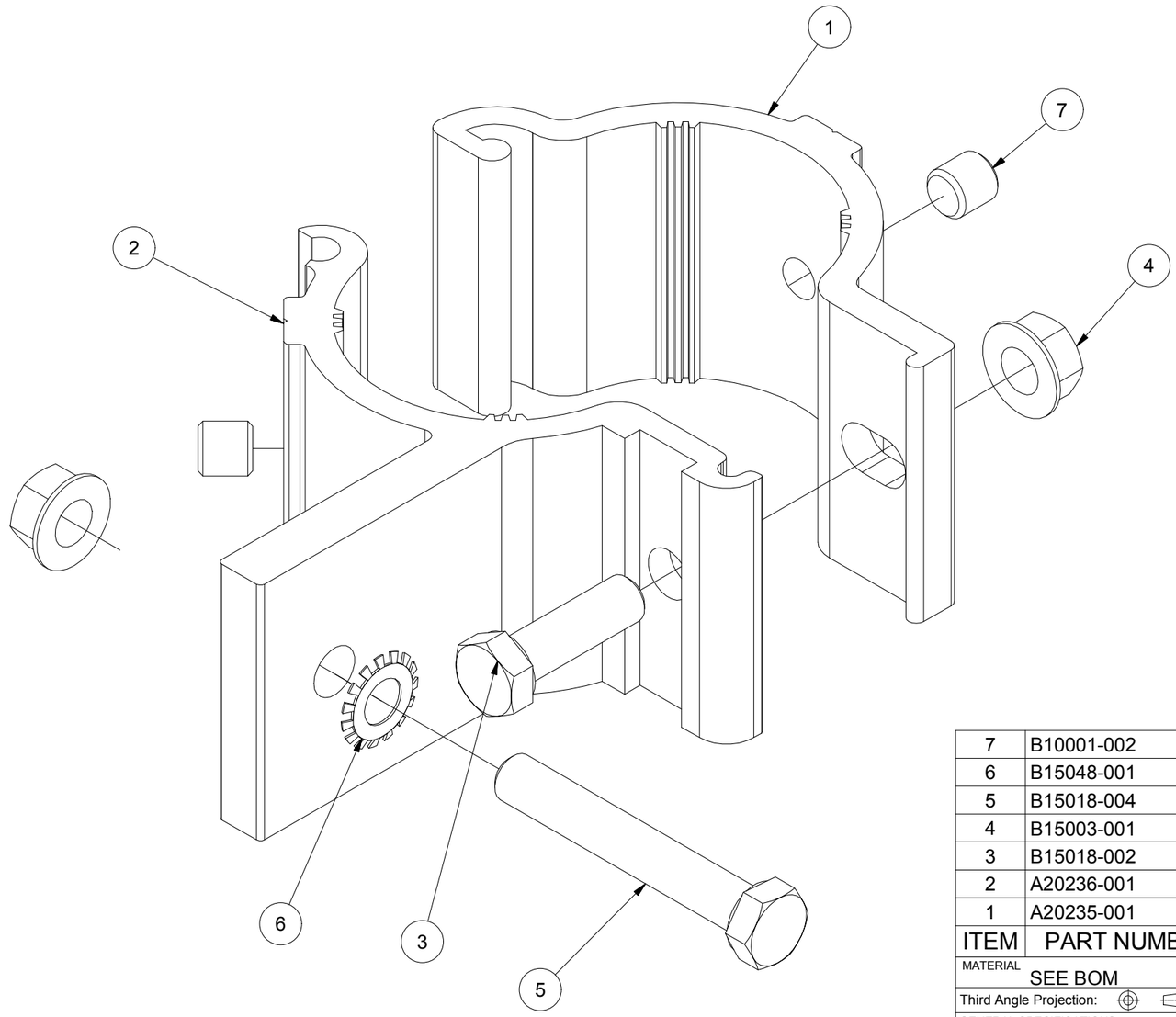
Sunmodo Corp.

1905 E 5TH STREET, SUITE A, VANCOUVER, WA 98661

TITLE: HELIO HEAVY RAIL

B | DRAWING NUMBER: A20145

SCALE: NONE | SHEET 1 of 1



ITEM	PART NUMBER	DESCRIPTION	QTY
7	B10001-002	SET SCREW M10X10	2
6	B15048-001	STAR WASHER FOR 3/8 BOLT	1
5	B15018-004	HEX CAP SCREW 3/8-16 X2.5	1
4	B15003-001	FLANGE NUT 3/8-16	2
3	B15018-002	HEX CAP SCREW 3/8-16 X 1.25	1
2	A20236-001	2 AL PIPE CLAMP, FEMALE	1
1	A20235-001	2 AL PIPE CLAMP, MALE	1

MATERIAL: SEE BOM

Third Angle Projection:

GENERAL SPECIFICATIONS
All Dimensions in inches [millimeters]
Tolerances
X.XXX ±0.01 [0.25mm]
X.XX ±0.02 [0.50mm]
X.X ±0.039 [1.0mm]
Unless otherwise spec'd

Break all sharp edges .010-.020 unless otherwise specified.

DRAWN BY: zcg
DATE: 08/12/2015
CHECKED BY:
APPROVALS:

Sunmodo Corp.

1905 E 5TH STREET, STE A, VANCOUVER, WA 98661

TITLE: 2 AL PIPE CLAMP KIT

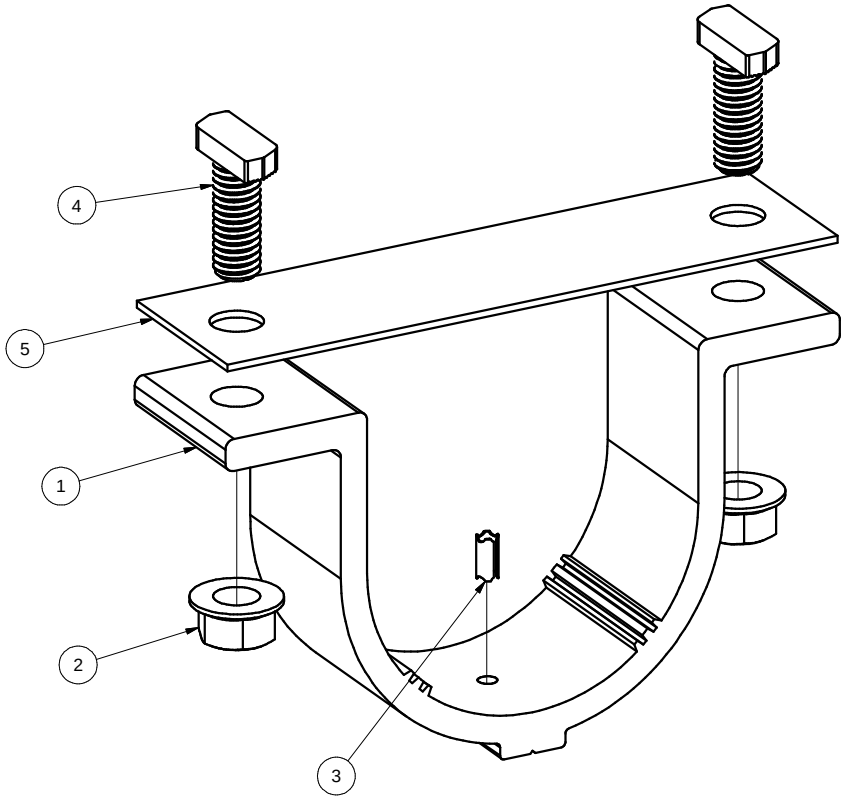
B

DRAWING NUMBER: K10219-001

SCALE: NONE

SHEET 1 of 1

REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018
B	ADD C10005-006	LWF	06/27/2018



ITEM	PART NUMBER	DESCRIPTION	QTY
5	C10005-006	PVC GASKTE T=1.5mm	1
4	B50033-001	T-BOLT, RAIL BOTTOM SLOT, 3/8-16 X 1"	2
3	B20018-002	GROUNDING PIN	1
2	B15003-001	FLANGE NUT 3/8-16	2
1	A20329-001	2.5" AL PIPE U-BOLT	1

MATERIAL: SEE NOTES

Third Angle Projection:

GENERAL SPECIFICATIONS
All Dimensions in inches [millimeters]
Tolerances
X.XXX ±0.01 [0.25mm]
X.XX ±0.02 [0.50mm]
X.X ±0.039 [1.0mm]
Unless otherwise spec'd
Break all sharp edges .010-.020 unless otherwise specified.

DRAWN BY: KYY
DATE: 06/12/2018
CHECKED BY:
APPROVALS:

SunModo Corp.

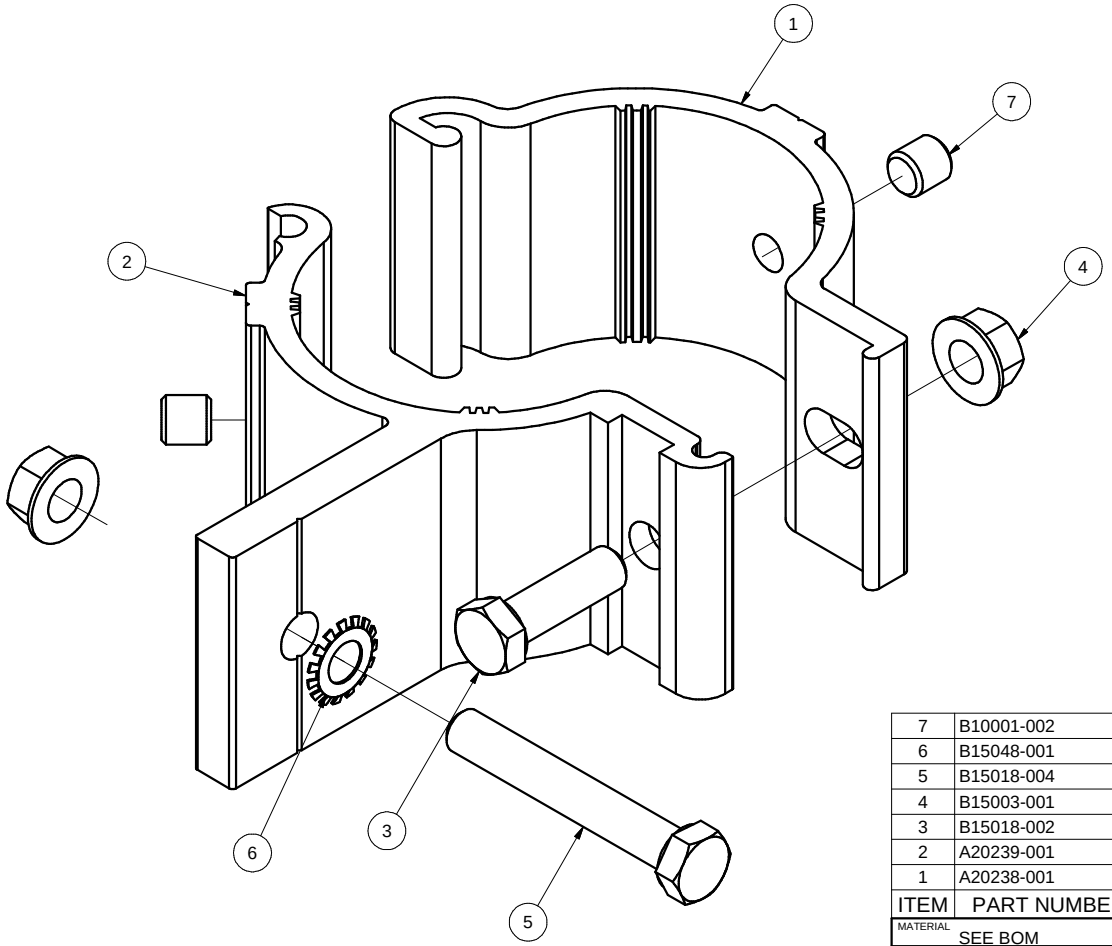
14800 NE 65TH STREET, VANCOUVER WA 98682

TITLE: 2.5" AL PIPE U-CLAMP KIT

B | DRAWING NUMBER: K10343-001

SCALE: NONE | SHEET 1 of 1

REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	zcg	09/25/2015



ITEM	PART NUMBER	DESCRIPTION	QTY
7	B10001-002	SET SCREW M10X10	2
6	B15048-001	STAR WASHER FOR 3/8 BOLT	1
5	B15018-004	HEX CAP SCREW 3/8-16 X2.5	1
4	B15003-001	FLANGE NUT 3/8-16	2
3	B15018-002	HEX CAP SCREW 3/8-16 X 1.25	1
2	A20239-001	2.5 AL PIPE CLAMP, FEMALE	1
1	A20238-001	2.5 AL PIPE CLAMP, MALE	1

MATERIAL: SEE BOM

Third Angle Projection:

GENERAL SPECIFICATIONS
All Dimensions in inches [millimeters]
Tolerances
X.XXX ±0.01 [0.25mm]
X.XX ±0.02 [0.50mm]
X.X ±0.039 [1.0mm]
Unless otherwise spec'd
Break all sharp edges .010-.020 unless otherwise specified.

DRAWN BY: LWF
DATE: 08/21/2015
CHECKED BY:
APPROVALS:

Sunmodo Corp.

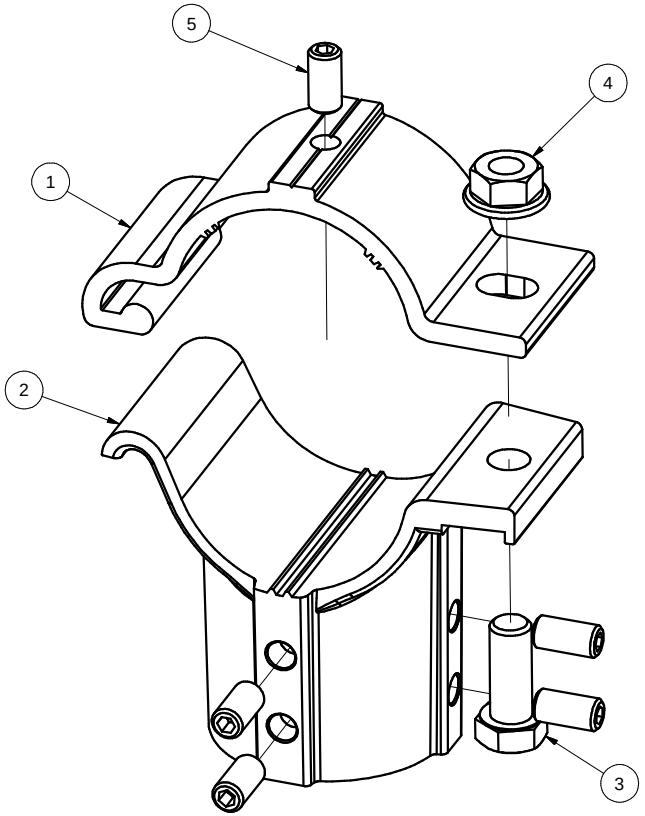
1905 E 5TH STREET, STE A, VANCOUVER, WA 98661

TITLE: 2.5 AL PIPE CLAMP KIT

B | DRAWING NUMBER: K10222-001

SCALE: NONE | SHEET 1 of 1

REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018



ITEM	PART NUMBER	DESCRIPTION	QTY
5	B10001-001	SET SCREW M10X20	5
4	B15020-001	FLANGE NUT 1/2-13	1
3	B15014-005	HEX CAP SCREW 1/2-13 X 1.25", 304 SS	1
2	A20327-001	2.5" AL PIPE TEE, FEMALE	1
1	A20326-001	2.5" AL PIPE TEE, MALE	1

MATERIAL: SEE NOTES

Third Angle Projection:

GENERAL SPECIFICATIONS
All Dimensions in inches [millimeters]
Tolerances
X.XXX ±0.01 [0.25mm]
X.XX ±0.02 [0.50mm]
X.X ±0.039 [1.0mm]
Unless otherwise spec'd
Break all sharp edges .010-.020 unless otherwise specified.

DRAWN BY: LWF
DATE: 06/12/2018
CHECKED BY:
APPROVALS:

SunModo Corp.

14800 NE 65TH STREET, VANCOUVER WA 98682

TITLE: 2.5" PIPE TEE KIT

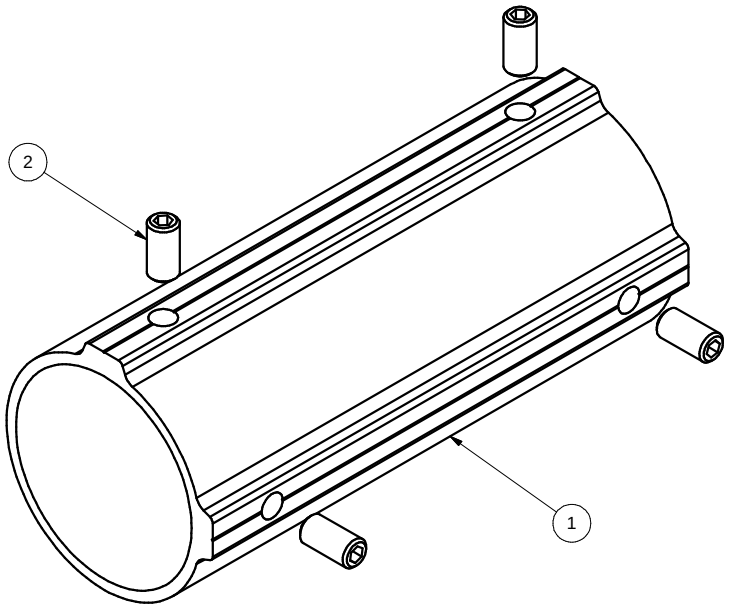
B

DRAWING NUMBER: K10341-001

SCALE: NONE

SHEET 1 of 1

REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018



ITEM	PART NUMBER	DESCRIPTION	QTY
2	B10001-001	SET SCREW M10X20	4
1	A20328-001	2.5" PIPE SPLICE	1

MATERIAL: SEE NOTES

Third Angle Projection:

GENERAL SPECIFICATIONS
All Dimensions in inches [millimeters]
Tolerances
X.XXX ±0.01 [0.25mm]
X.XX ±0.02 [0.50mm]
X.X ±0.039 [1.0mm]
Unless otherwise spec'd
Break all sharp edges .010-.020 unless otherwise specified.

DRAWN BY: LWF
DATE: 06/12/2018
CHECKED BY:
APPROVALS:

SunModo Corp.

14800 NE 65TH STREET, VANCOUVER WA 98682

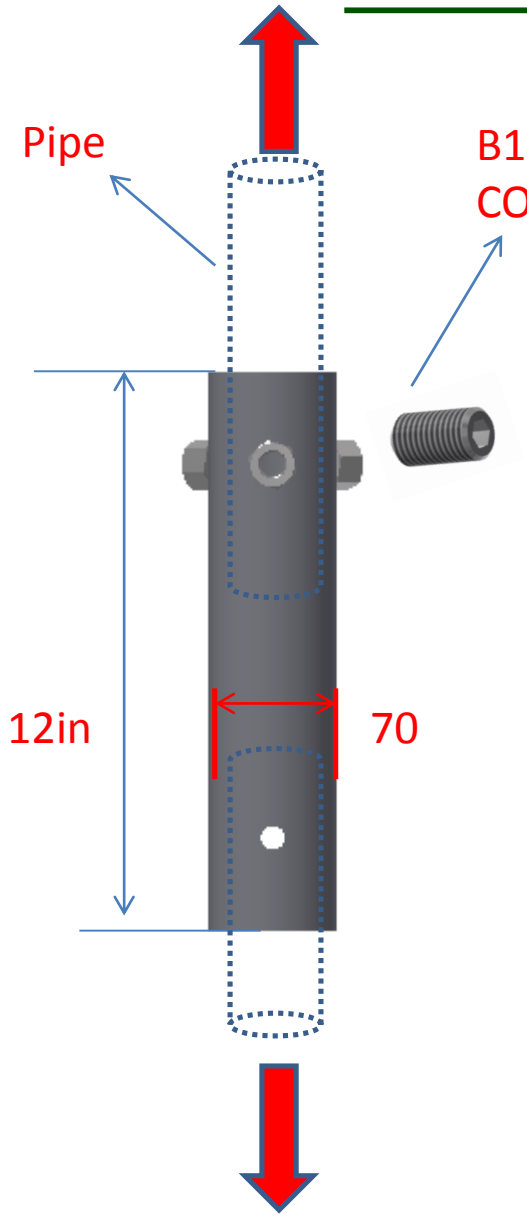
TITLE: 2.5" PIPE SPLICE KIT

B

DRAWING NUMBER: K10342-001

SCALE: NONE

SHEET 1 of 1



B10051-002, SET SCREW M16X30
CONE TIPPED SET SCRE M16X30

Conditions for load test：

1. The helical auger and ground screw use the same top section, so only one was used for testing
2. A 12 inch section from the top of the auger/ground screw was used
3. Three tests on each pipe type was used
4. The auger/screw material supplied by the auger/screw supplier.