Project Number: U2716-113-191

April 22, 2021

Sunmodo
14800 NE 65th Street
Vancouver, WA 98682

REFERENCE: Sunmodo Sunturf Ground Mount A4 (85x45)
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 2015 International Building Code. Vector Structural Engineering requires that we review each site specific install, and we are not liable for installs at site specific locations we have not reviewed. 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: 110 mph
- Wind exposure: B
- Ground snow load: 70 psf
- 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. A minimum of one ground screw or helical pier must be tested.

Load (ASD)	Value (lbs)	Factor of Safety	Test Value (lbs)
UPLIFT	1720	1.5	2580
LATERAL	1310	2	2620

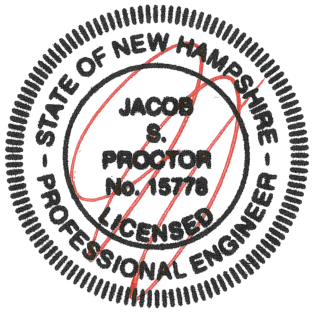
Foundation concrete shall have a minimum compressive strength of 2500 psi at 28 days. Cement for all concrete shall be Type I or II with a minimum of 6% entrained air with a water/cement ratio of 0.50. Maximum aggregate size shall be 3/4". No special inspection of concrete strength is required.

Footings are designed based on an allowable soil bearing pressure of 1500 psf an allowable skin friction of 250 psf, an allowable lateral bearing pressure of 150 pcf, and a coefficient of friction of 0.3. 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
Firm License: COA 01838



04/22/2021

Jacob Proctor, P.E.
License: 15778 - Expires: 09/30/2021
Project Engineer

Enclosures

JSP/stb

VECTOR ENGINEERS
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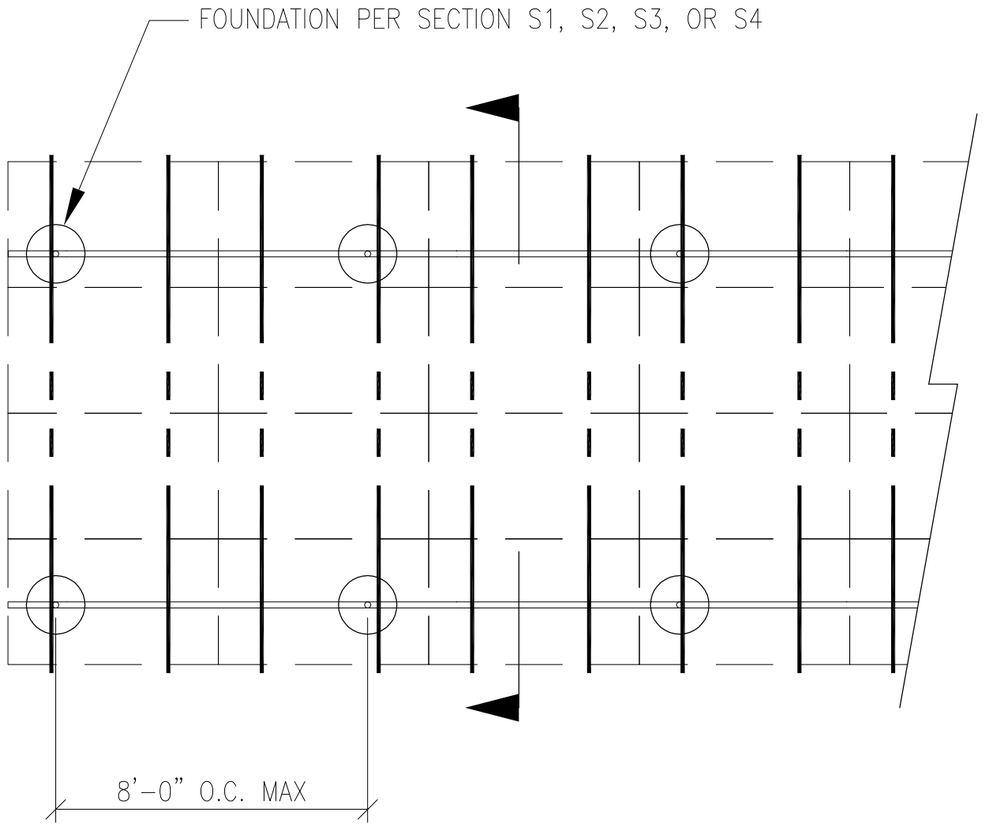
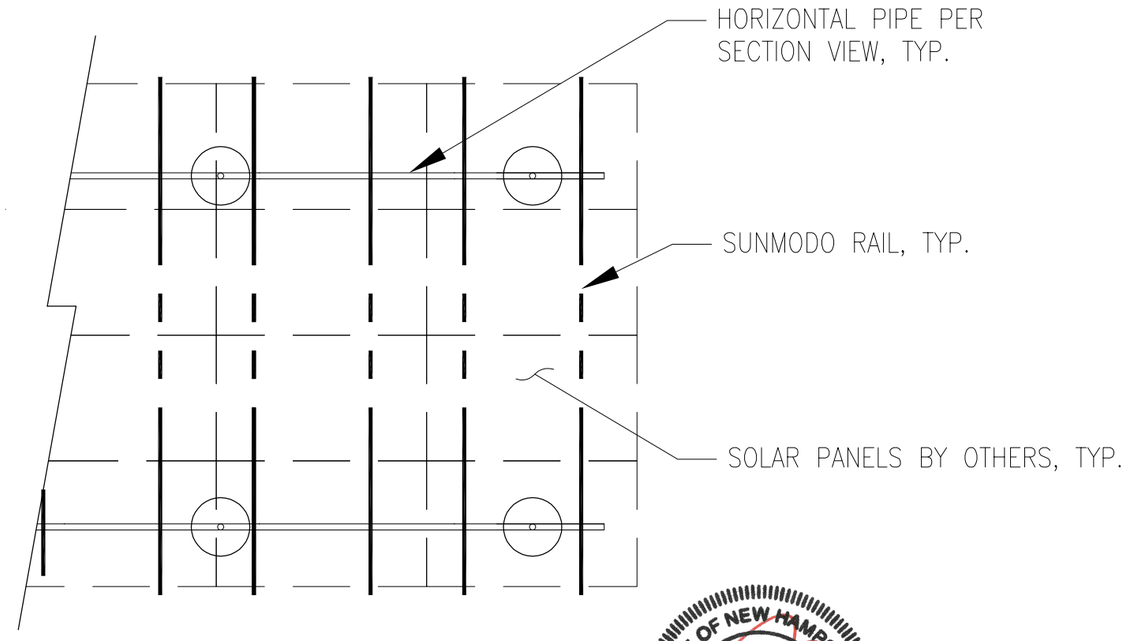
JOB NO. U2716-113-191
PROJECT SUNMODO SUNTURF GROUND MOUNTS A4
SUBJECT ALL OPTIONS





STATE OF NEW HAMPSHIRE - JACOB S. PROCTOR No. 15778 LICENSED PROFESSIONAL ENGINEER -

04/22/2021

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PV ARRAY PLAN

N.T.S.

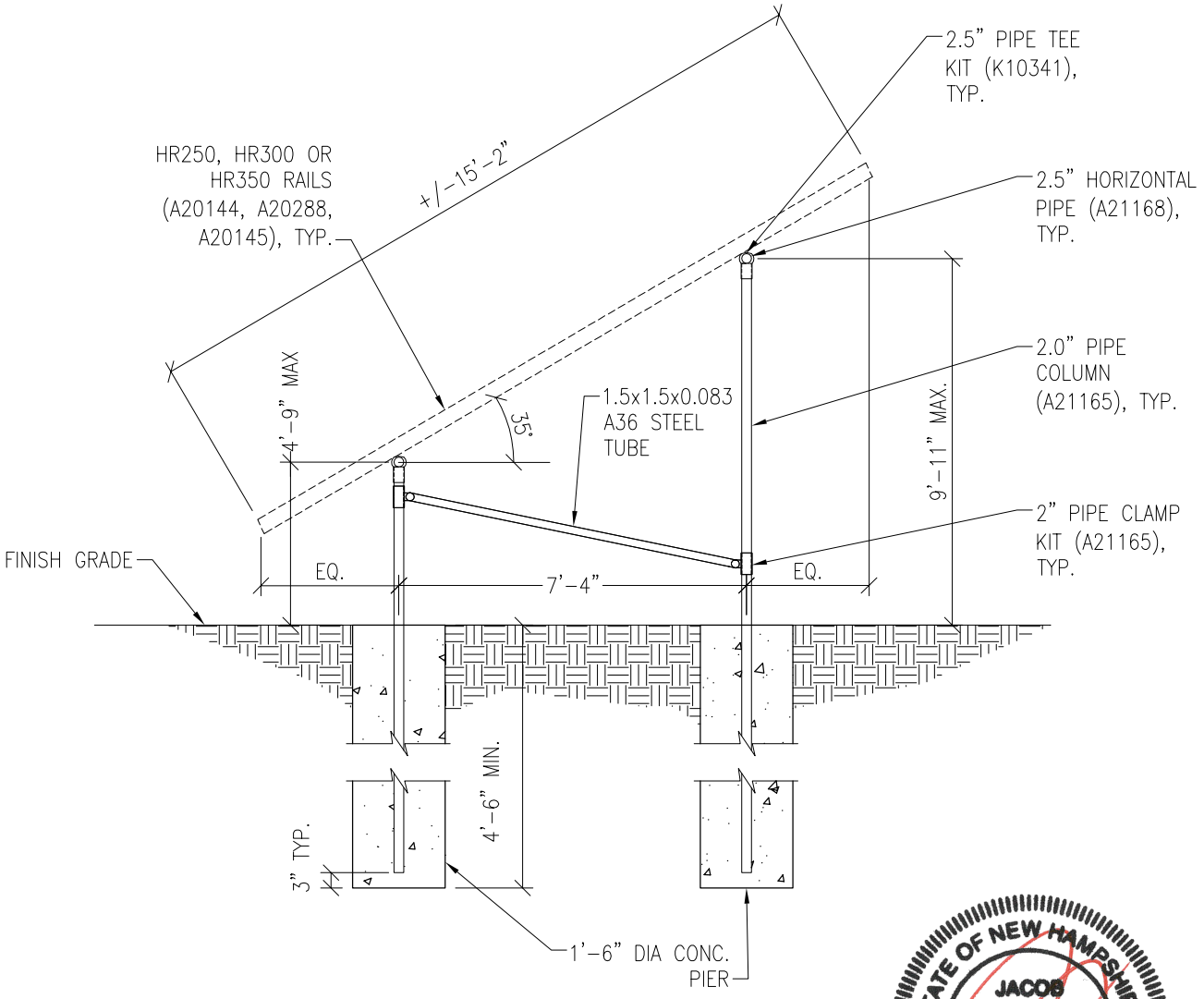
P1

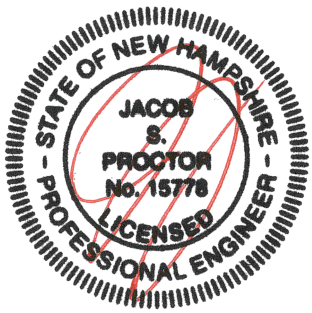
VECTOR ENGINEERS

JOB NO. U2716-113-191

PROJECT SUNMODO SUNTURF GROUND MOUNTS A4

SUBJECT DRILLED PIER OPTION





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PV ARRAY SECTION

N.T.S.

S1

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VECTOR ENGINEERS

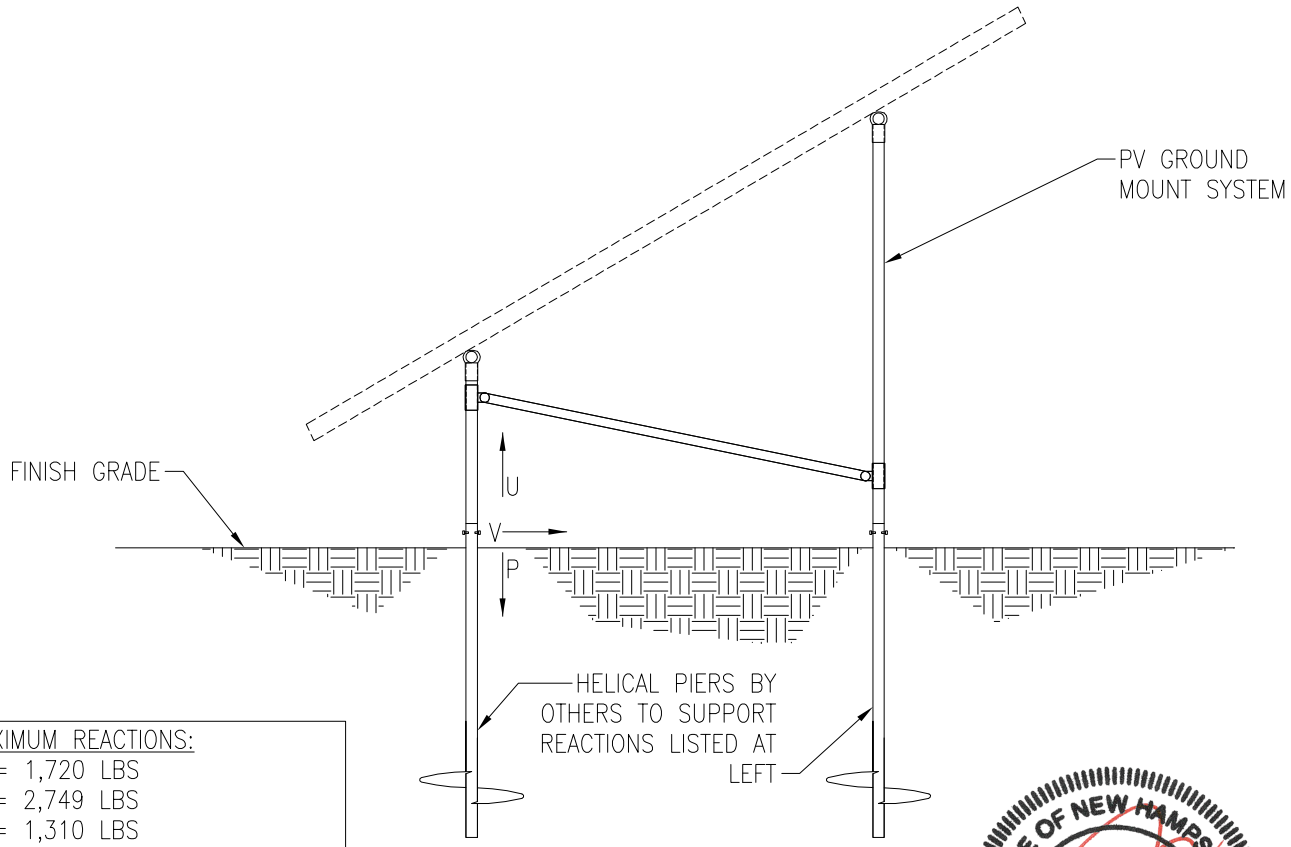
JOB NO. U2716-113-191

PROJECT SUNMODO SUNTURF GROUND MOUNTS A4

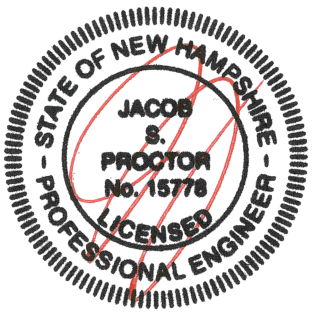
SUBJECT HELICAL PIER OPTION

NOTES:

1. For ground mount components see Section S1.
2. A minimum of (1) helical pier must be load-tested as follows:
   - 2.1. Safety factor for uplift = 1.5,
   - 2.2. Safety factor for lateral loads = 2.0
   - 2.3. Upward deflection limit = 1/2"
   - 2.4. Lateral deflection limit = 1"
   - 2.5. The load tests must be performed by an approved contractor.



MAXIMUM REACTIONS:
U = 1,720 LBS
P = 2,749 LBS
V = 1,310 LBS



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PV ARRAY SECTION

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S2

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VECTOR ENGINEERS

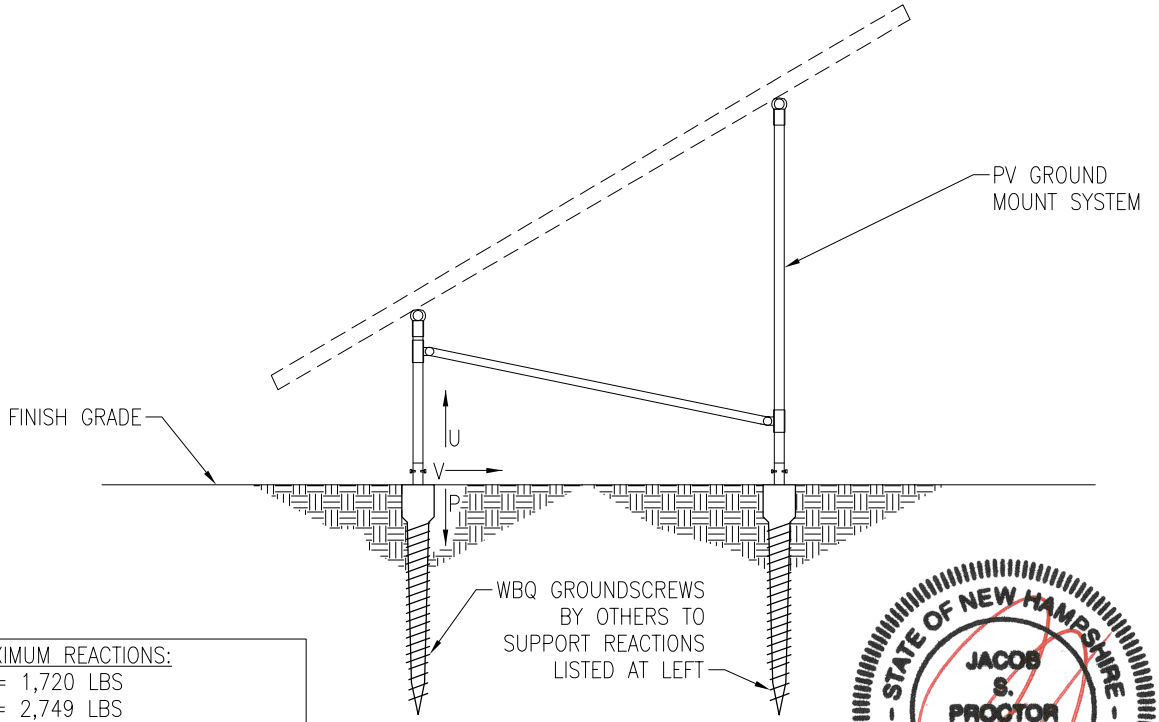
JOB NO. U2716-114-191

PROJECT SUNMODO SUNTURF GROUND MOUNTS A41

SUBJECT GROUND SCREW OPTION

NOTES:

1. For ground mount components see Section S1.
2. A minimum of (1) ground screw must be load-tested as follows:
   - 2.1. Safety factor for uplift = 1.5,
   - 2.2. Safety factor for lateral loads = 2.0
   - 2.3. Upward deflection limit = 1/2"
   - 2.4. Lateral deflection limit = 1"
   - 2.5. The load tests must be performed by an approved contractor.



MAXIMUM REACTIONS:
U = 1,720 LBS
P = 2,749 LBS
V = 1,310 LBS

STATE OF NEW HAMPSHIRE - JACOB S. PROCTOR No. 15778 LICENSED PROFESSIONAL ENGINEER -

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PV ARRAY SECTION

N.T.S.

S3

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VECTOR ENGINEERS

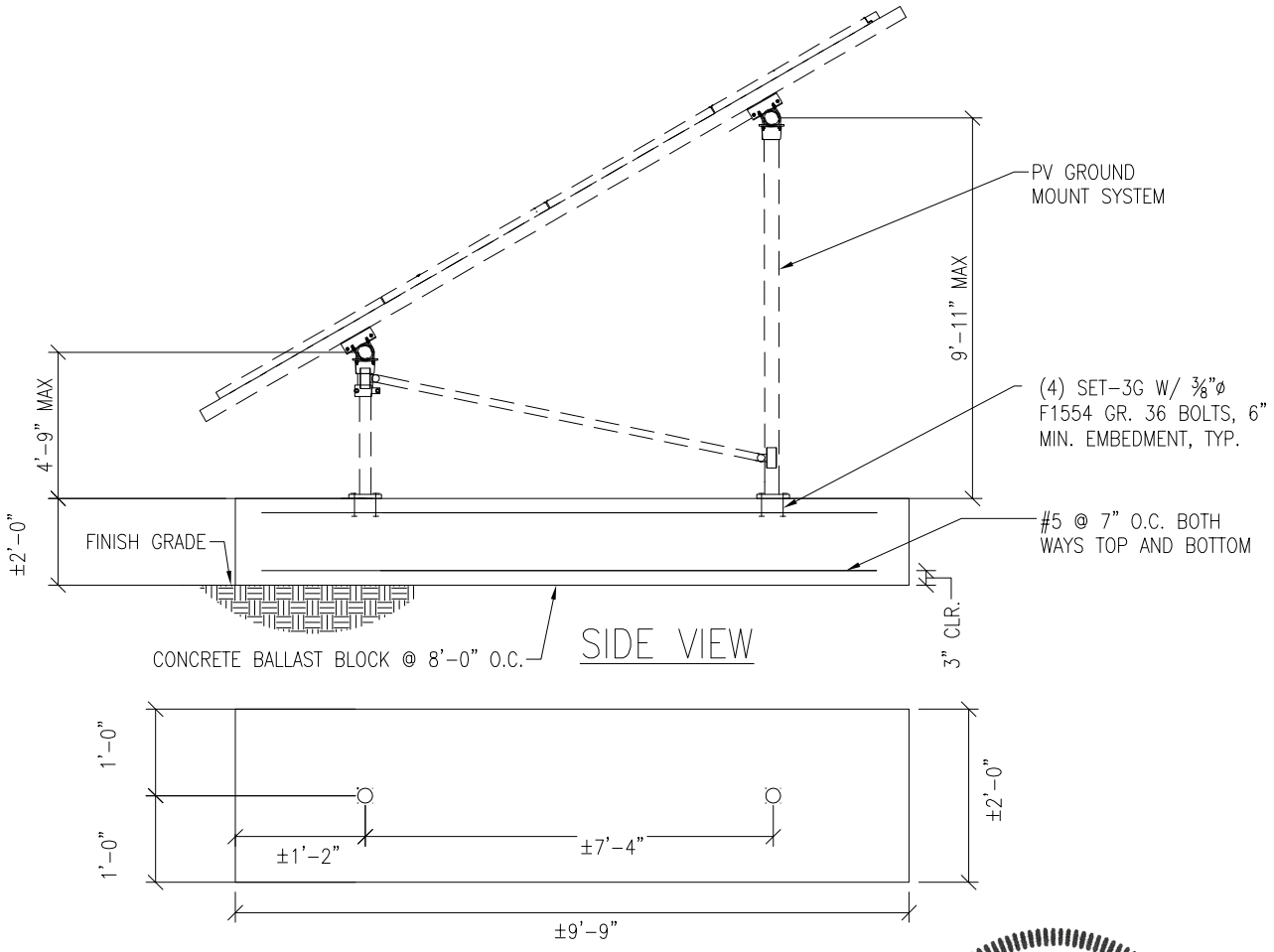
JOB NO. U2716-113-191

PROJECT SUNMODO SUNTURF GROUND MOUNTS A4

SUBJECT BALLASTED BLOCK OPTION

NOTES:

1. For ground mount components see Section S1.



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STATE OF NEW HAMPSHIRE - JACOB S. PROCTOR No. 15778 LICENSED PROFESSIONAL ENGINEER -

PV ARRAY SECTION

N.T.S.

S4

04/22/2021

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JOB NO.: U2716-113-191 **DESIGNED:** STB
DATE: 07/31/19

PROJECT: A4 – Sunmodo Sunturf GM **SUBJECT:** Snow Load

SNOW LOAD (S):

ASCE 7 Standard:	10	
Panel Slope from Horizontal [°]:	35.0	
Snow Ground Load, p_g [psf]:	70.0	(Section 7.2)
Terrain Category:	B	(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)
Minimum Roof Snow Load, p_m [psf]:	0	(Section 7.3.4)
Unobstructed Slippery Surface?	Yes	(Section 7.4)
Slope Factor Figure:	Figure 7-2c	(Section 7.4)
Roof Slope Factor, C_s:	0.636	(Figure 7-2)
Sloped Roof Snow Load, p_s [psf]:	27	(Equation 7.4-1)
Design Snow Load, S [psf]:	27	
Tributary Transverse Length [ft]:	5.6	
Tributary Longitudinal Length [ft]:	6	
Tributary Area per Column [ft^2]:	33.7	
Snow Load per Column (1.0 S) [lb]:	**909.2**	

JOB NO.: U2716-113-191 **DESIGNED:** STB
DATE: 07/31/19

PROJECT: A4 – Sunmodo Sunturf GM **SUBJECT:** Wind Pressure

Design Wind Load:

ASCE 7 Standard:	10	
Basic Wind Speed, V [mph]:	110	
Risk Category:	I	
Exposure Category	B	(Section 26.7.3)
Velocity Pressure Exposure Coefficient, K_h:	0.57	(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]:	15.0	(Equation 27.3-1)
Gust Effect Factor, G:	0.85	(Section 26.9.1)
Panel Slope [degrees]:	35.0	

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

Clear Wind Flow	C_{NW}	C_{NL}
Case 1 (γ = 0°, Load Case A)	-1.80	-1.80
Case 2 (γ = 0°, Load Case B)	-2.43	-0.57
Case 3 (γ = 180°, Load Case A)	2.10	2.17
Case 4 (γ = 180°, Load Case B)	2.67	1.07

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

Clear Wind Flow	q_hGC_{NW}	q_hGC_{NL}
Case 1 (γ = 0°, Load Case A)	-23.0	-23.0
Case 2 (γ = 0°, Load Case B)	-31.0	-7.2
Case 3 (γ = 180°, Load Case A)	26.8	27.6
Case 4 (γ = 180°, Load Case B)	34.0	13.6

Wind Pressure on Each Side of Panels [psf]

Clear Wind Flow	Short Col. Pressure	Long Col. Pressure
Case 1 (γ = 0°, Load Case A)	-23.0	-23.0
Case 2 (γ = 0°, Load Case B)	-7.2	-31.0
Case 3 (γ = 180°, Load Case A)	26.8	27.6
Case 4 (γ = 180°, Load Case B)	34.0	13.6

JOB NO.: U2716-113-191

PROJECT: A4 – Sunmodo Sunturf GM **SUBJECT:** Open Building Wind Loads

Design Wind Load Per ASCE 7-10

$p = q_h G C_n$

Velocity Pressure Exposure Coefficient, K_h:	0.57	(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)
Ultimate Wind Speed, V [mph]:	110	
Velocity Pressure, q_h [psf]:	15.0	(Equation 27.3-1)
Gust Effect Factor, G:	0.85	(Section 26.9.1)

γ= 90° or 270°

Force Coefficient, C_N:

Horizontal Distance from Winward Edge	Roof angle	Load Case	Obstructed Wind Flow CN
<= h	35	A	-0.8
		B	0.8
> h, <= 2h	35	A	-0.6
		B	0.5
> 2h	35	A	-0.3
		B	0.3

Design Wind Pressure, p [psf]:

	Roof angle	Load Case	Obstructed Wind Flow
<= h	35	A	-10.2
		B	10.2
> h, <= 2h	35	A	-7.7
		B	6.4
> 2h	35	A	-3.8
		B	3.8

JOB NO.: U2716-113-191 **DESIGNED:** STB

Foundation Option 1: Drilled Concrete Pier

JOB NO.: U2716-113-191
SUBJECT: CONC. PIER

PROJECT: A4 - Sunturf Ground Mount

DRILLED CONCRETE PIER DESIGN

Column Reactions:

Max. Shear, V [k]:	1.3	Max. Down, P_d [k]:	2.7
Max. Moment, M [k-ft]:	0.0	Max. Uplift, P_u [k]:	1.7

Pier Properties:

Pier Shape:	Round		
Pier Diameter, b [ft]:	1.5	Volume of Concrete [ft^3]:	8
Top of Pier Elevation [ft]:	0.00	Volume of Concrete [yd^3]:	0.3
Pier Depth, d [ft]:	4.5	Weight of Concrete [k]:	1.2

Soil Properties:

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

*per IBC Section 1810.3.3.1.4

Check Bearing:

Bearing Capacity [k]:	5.3	**Bearing capacity OK.**

Check Uplift:

Uplift Capacity [k]:	6.4	**Uplift capacity OK.**

Check Lateral Bearing:

Top of Pier Constrained?:	No	IBC Section1807.3.2.1
Applied Lateral Force, P [lb]:	1,310	
Point of Application, h [ft]:	0.0	
S_{max} [psf]:		
S [psf]:	450	
A = 2.34*P/(Sb):	4.54	
Required Pier Depth, d_{reqd} [ft]:	4.50	IBC Eq. 18-1

Result: **Lateral bearing capacity OK.**

JOB NO.: U2716-113-191 **DESIGNED:** STB

Foundation Option 2: Helical Pier

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)	Factor of Safety	Test Value (lbs)
UPLIFT	1560	1.5	2340
LATERAL	1130	2	2260

JOB NO.: U2716-113-191 **DESIGNED:** STB

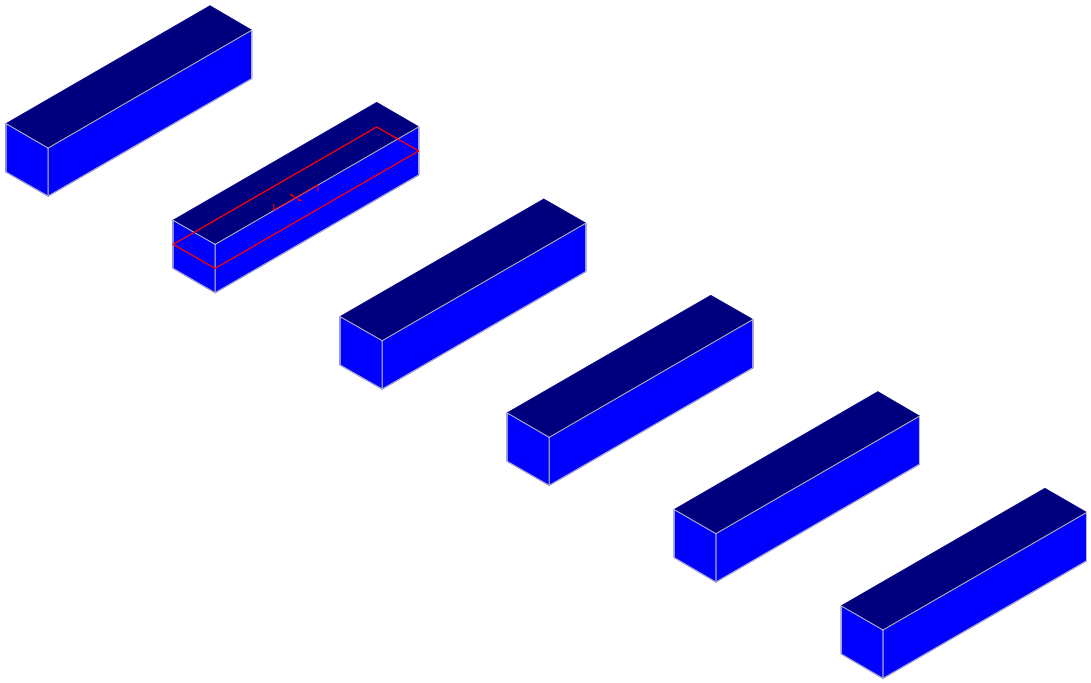
Foundation Option 3: Ground Screw

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.

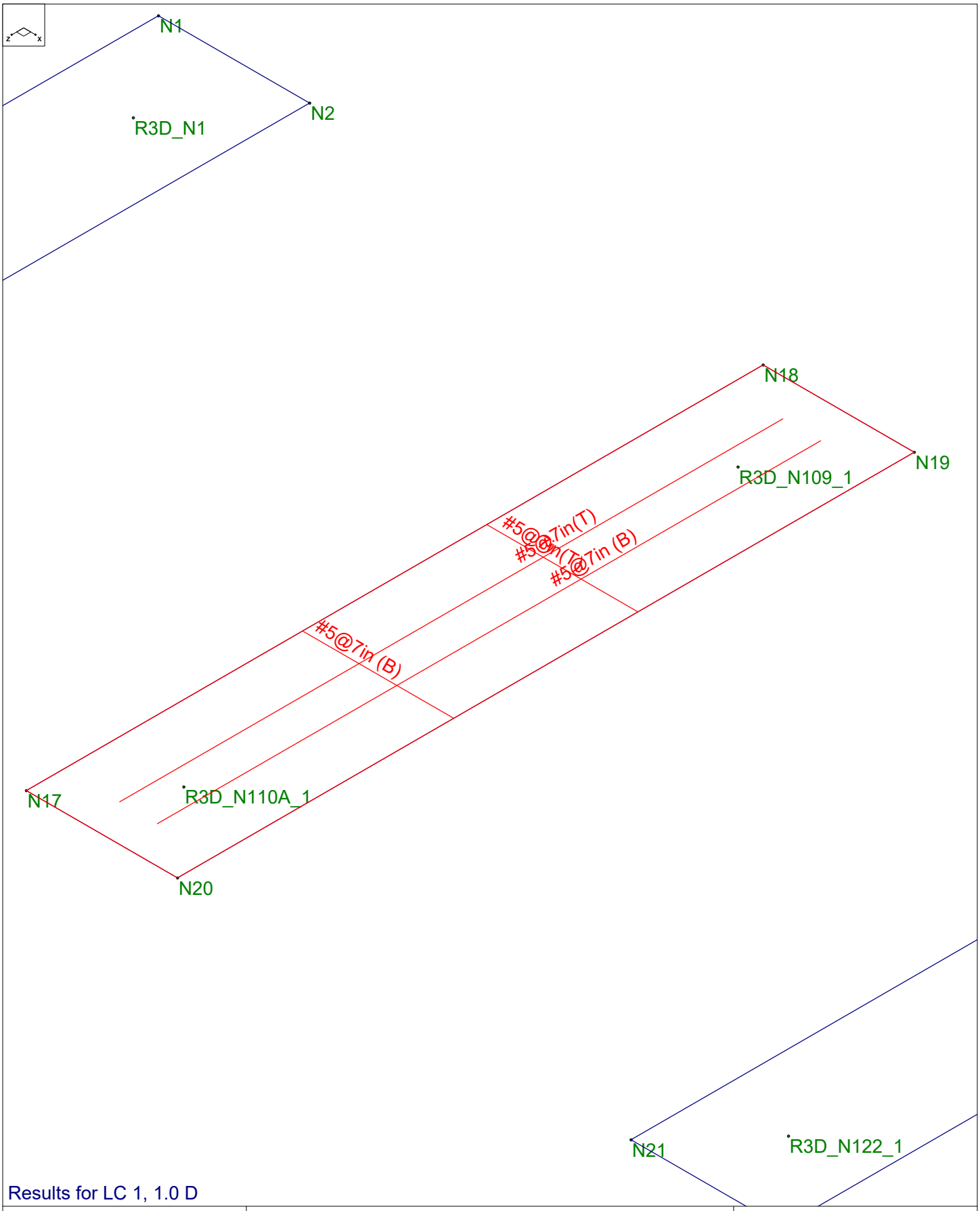
Load (ASD)	Value (lbs)	Factor of Safety	Test Value (lbs)
UPLIFT	1560	1.5	2340
LATERAL	1130	2	2260

JOB NO.: U2716-113-191 **DESIGNED:** STB

Foundation Option 4: Ballasted Block



Vector Structural Engineeri...		SK - 1
STB	Ground Mount	Apr 6, 2021 at 3:02 PM
U2716.113.191		Sunmodo Sunturf A4 v3 85x45.r3d



Results for LC 1, 1.0 D

Vector Structural Engineeri...	Ground Mount	SK - 1
STB		Apr 6, 2021 at 2:58 PM
U2716.113.191		Sunmodo Sunturf A4 v3 85x45.r3d

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	100
Mesh Size (in)	12
Max Iterations	10
Merge Tolerance (in)	.12
Solver	Sparse Accelerated
Coefficient of Friction	.3
No. of Shear Regions	4
Shear Region Spacing Increment (in)	4
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	0
Concrete Rebar Set	Rectangular
Concrete Code	ASTM A615
HR Steel Pile Code	ACI 318-14
Wood Pile Code	AISC 14th (360-10): ASD AWC NDS-15: ASD

Concrete Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (/...	Density[lb/ft^3]	f'c[psi]	Lambda	Flex Stee...	Shear St...
1	Conc3000NW	3156	1372	.15	.6	145	3000	1	60000	60000
2	Conc3500NW	3409	1482	.15	.6	145	3500	1	60000	60000
3	Conc4000NW	3644	1584	.15	.6	145	4000	1	60000	60000
4	Conc3000LW	2085	907	.15	.6	109.999	3000	.75	60000	60000
5	Conc3500LW	2252	979	.15	.6	109.999	3500	.75	60000	60000
6	Conc4000LW	2408	1047	.15	.6	109.999	4000	.75	60000	60000
7	Conc2500NW	3156	1372	.15	.6	145	2500	1	60000	60000

General Design Parameters

	Label	Max Bending Chk	Max Shear Chk	Top Cover[in]	Bottom Cover[in]
1	Typical	1	1	3	3

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	#5	#5	7	7	7	7	1	Optimize

Soil Definitions

	Label	Subgrade Modulus[lb/ft^3]	Allowable Bearing[psf]	Depth Properties	Default?
1	Default	1e+5	1500	None	Yes

Slabs

	Label	Thickness [in]	Material	Local Axis Angle ...	Analysis Offset [in]	Passive Pressur...	Soil Overburden [psf]
1	S1	24	Conc2500NW	0	0	0	0
2	S2	24	Conc2500NW	0	0	0	0
3	S3	24	Conc2500NW	0	0	0	0
4	S4	24	Conc2500NW	0	0	0	0
5	S5	24	Conc2500NW	0	0	0	0
6	S6	24	Conc2500NW	0	0	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...	F...	C...	F...
1	1.0 D	Yes	Yes		1.5	DL	1																		
2	1.0 D + 1....	Yes	Yes		1.5	DL	1	RLL	1																
3	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL		OL1	.6														
4	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL		OL2	.6														
5	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL		OL3	.6														
6	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL		OL4	.6														
7	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL		OL5	.6														
8	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL		OL6	.6														
9	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL	.75	OL1	.45														
10	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL	.75	OL2	.45														
11	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL	.75	OL3	.45														
12	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL	.75	OL4	.45														
13	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL	.75	OL5	.45														
14	1.0 D + 0....	Yes	Yes		1.5	DL	1	RLL	.75	OL6	.45														
15	0.9 D + 0....	Yes	Yes			DL	.9	RLL		OL1	.6														
16	0.6 D + 0....	Yes	Yes			DL	.9	RLL		OL2	.6														
17	0.9 D + 0....	Yes	Yes			DL	.9	RLL		OL3	.6														
18	0.9 D + 0....	Yes	Yes			DL	.9	RLL		OL4	.6														
19	0.9 D + 0....	Yes	Yes			DL	.9	RLL		OL5	.6														
20	0.9 D + 0....	Yes	Yes			DL	.9	RLL		OL6	.6														
21																									
22	1.4D	Yes				DL	1.4																		
23	1.2D+1.6SL	Yes				DL	1.2	RLL	1.6																
24	1.2D+1.6S...	Yes				DL	1.2	RLL	1.6	OL1	.5														
25	1.2D+1.6S...	Yes				DL	1.2	RLL	1.6	OL2	.5														
26	1.2D+1.6S...	Yes				DL	1.2	RLL	1.6	OL3	.5														
27	1.2D+1.6S...	Yes				DL	1.2	RLL	1.6	OL4	.5														
28	1.2D+1.6S...	Yes				DL	1.2	RLL	1.6	OL5	.5														
29	1.2D+1.6S...	Yes				DL	1.2	RLL	1.6	OL6	.5														
30	1.2D+1.0...	Yes				DL	1.2			OL1	1														
31	1.2D-1.0Wx	Yes				DL	1.2			OL2	1														
32	1.2D+1.0...	Yes				DL	1.2			OL3	1														
33	1.2D-1.0Wz	Yes				DL	1.2			OL4	1														
34	1.2D+1.0...	Yes				DL	1.2			OL5	1														
35	1.2D-1.0...	Yes				DL	1.2			OL6	1														
36	1.0D+1.0...	Yes				DL	1			OL1	1														
37	1.0D-1.0Wx	Yes				DL	1			OL2	1														
38	1.0D+1.0...	Yes				DL	1			OL3	1														
39	1.0D-1.0Wz	Yes				DL	1			OL4	1														
40	1.0D+1.0...	Yes				DL	1			OL5	1														
41	1.0D-1.0...	Yes				DL	1			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

Load Categories

	Category	Point Loads	Line Loads	Area Loads
1	DL	18		
2	RLL	24		
3	OL1	36		
4	OL2	36		
5	OL3	36		
6	OL4	36		
7	OL5	33		

Load Categories (Continued)

	Category	Point Loads	Line Loads	Area Loads
8	OL6	33		

Strip Reinforcing

	Label	UC Top	LC	Top Bars	Governing ...	UC Bot	LC	Bot B...	Gover...	UC Shear	LC	Governing De...
1	DS1	.027	26	#5@7in	DS1-X26	.024	37	#5@7in	DS1-...	.048	26	DS1-X15
2	DS2	0	36	#5@7in	DS2-X26	.003	26	#5@7in	DS2-...	.009	26	DS2-X25

Slab Overturning Safety Factors (By Combination)

	LC	Slab	Angle[deg]	Mo-xx[lb-ft]	Ms-xx[lb-ft]	Mo-zz[lb-ft]	Ms-zz[lb-ft]	Ms-xx/Mo-xx	Ms-zz/Mo-zz
1	1	S1	0	0	29151.432	0	6062.15	9.999+	9.999+
2	1	S2	0	0	30176.612	0	6158.804	9.999+	9.999+
3	1	S3	0	0	30023.866	0	6153.886	9.999+	9.999+
4	1	S4	0	0	30023.92	0	6153.867	9.999+	9.999+
5	1	S5	0	0	30176.602	0	6172.929	9.999+	9.999+
6	1	S6	0	0	29151.38	0	5940.789	9.999+	9.999+
7	2	S1	0	0	37172.367	0	8093.977	9.999+	9.999+
8	2	S2	0	0	44460.006	0	8829.816	9.999+	9.999+
9	2	S3	0	0	43369.231	0	8798.591	9.999+	9.999+
10	2	S4	0	0	43369.654	0	8807.972	9.999+	9.999+
11	2	S5	0	0	44459.737	0	8942.978	9.999+	9.999+
12	2	S6	0	0	37171.971	0	7270.575	9.999+	9.999+
13	3	S1	0	9244.504	29363.3	1044.123	6062.15	3.176	5.806
14	3	S2	0	16108.719	29940.355	1402.601	6172.86	1.859	4.401
15	3	S3	0	15090.668	29976.624	1355.246	6153.886	1.986	4.541
16	3	S4	0	15089.807	29976.389	1355.167	6153.867	1.987	4.541
17	3	S5	0	16110.39	29940.993	1402.804	6172.929	1.858	4.4
18	3	S6	0	9243.361	29363.017	1044.121	6062.143	3.177	5.806
19	4	S1	0	9874.744	29363.3	930.813	6062.15	2.974	6.513
20	4	S2	0	16764.61	29940.355	1129.415	6158.804	1.786	5.453
21	4	S3	0	15872.022	29976.624	1142.509	6153.886	1.889	5.386
22	4	S4	0	15871.005	29976.389	1142.389	6153.867	1.889	5.387
23	4	S5	0	16766.435	29940.993	1129.479	6158.864	1.786	5.453
24	4	S6	0	9873.592	29363.017	930.843	6062.143	2.974	6.513
25	5	S1	0	1017.233	29151.432	0	7299.081	9.999+	9.999+
26	5	S2	0	3198.363	30176.612	0	7776.385	9.435	9.999+
27	5	S3	0	2350.187	30023.866	0	7757.185	9.999+	9.999+
28	5	S4	0	2349.823	30023.92	0	7752.254	9.999+	9.999+
29	5	S5	0	3198.734	30176.602	0	7830.622	9.434	9.999+
30	5	S6	0	1016.884	29151.38	0	6752.73	9.999+	9.999+
31	6	S1	0	0	29862.874	0	7087.959	9.999+	9.999+
32	6	S2	0	0	30573.754	0	7580.052	9.999+	9.999+
33	6	S3	0	0	30787.579	0	7541.643	9.999+	9.999+
34	6	S4	0	0	30788.034	0	7538.656	9.999+	9.999+
35	6	S5	0	0	30573.657	0	7657.027	9.999+	9.999+
36	6	S6	0	0	29862.948	0	6636.606	9.999+	9.999+
37	7	S1	0	425.472	29151.432	0	6516.398	9.999+	9.999+
38	7	S2	0	1033.652	30176.612	0	6654.487	9.999+	9.999+
39	7	S3	0	396.671	30023.866	0	6455.319	9.999+	9.999+
40	7	S4	0	296.023	30023.92	0	6365.096	9.999+	9.999+
41	7	S5	0	446.78	30176.602	0	6393.534	9.999+	9.999+
42	7	S6	0	126.804	29151.38	0	6051.03	9.999+	9.999+
43	8	S1	0	4185.23	29363.3	456.668	6062.15	7.016	9.999+
44	8	S2	0	5362.354	29940.355	469.296	6172.86	5.583	9.999+
45	8	S3	0	3080.475	29976.624	290.431	6153.886	9.731	9.999+
46	8	S4	0	2404.336	29976.389	215.724	6153.867	9.999+	9.999+
47	8	S5	0	2606.358	29940.993	223.347	6158.864	9.999+	9.999+

Slab Overturning Safety Factors (By Combination) (Continued)

	LC	Slab	Angle[deg]	Mo-xx[lb-ft]	Ms-xx[lb-ft]	Mo-zz[lb-ft]	Ms-zz[lb-ft]	Ms-xx/Mo-xx	Ms-zz/Mo-zz
48	8	S6	0	1609.057	29363.017	194.031	6062.143	9.999+	9.999+
49	9	S1	0	6933.378	35639.866	783.092	7586.021	5.14	9.687
50	9	S2	0	12081.539	39120.192	1051.95	8250.083	3.238	7.843
51	9	S3	0	11318.001	39341.564	1016.434	8137.414	3.476	8.006
52	9	S4	0	11317.356	39340.378	1016.375	8137.29	3.476	8.006
53	9	S5	0	12082.792	39123.235	1052.103	8250.466	3.238	7.842
54	9	S6	0	6932.521	35638.342	783.091	7585.983	5.141	9.687
55	10	S1	0	7406.058	35639.866	698.11	7586.021	4.812	9.999+
56	10	S2	0	12573.457	39120.192	847.061	8162.063	3.111	9.636
57	10	S3	0	11904.016	39341.564	856.882	8137.414	3.305	9.497
58	10	S4	0	11903.254	39340.378	856.792	8137.29	3.305	9.497
59	10	S5	0	12574.826	39123.235	847.109	8162.263	3.111	9.635
60	10	S6	0	7405.194	35638.342	698.132	7585.983	4.813	9.999+
61	11	S1	0	762.925	35167.133	0	8513.719	9.999+	9.999+
62	11	S2	0	2398.773	40889.158	0	9375.248	9.999+	9.999+
63	11	S3	0	1762.64	40032.89	0	9339.889	9.999+	9.999+
64	11	S4	0	1762.367	40033.221	0	9343.236	9.999+	9.999+
65	11	S5	0	2399.05	40888.953	0	9493.736	9.999+	9.999+
66	11	S6	0	762.663	35166.823	0	7547.084	9.999+	9.999+
67	12	S1	0	0	35700.715	0	8355.377	9.999+	9.999+
68	12	S2	0	0	41187.014	0	9227.999	9.999+	9.999+
69	12	S3	0	0	40605.675	0	9178.232	9.999+	9.999+
70	12	S4	0	0	40606.306	0	9183.037	9.999+	9.999+
71	12	S5	0	0	41186.745	0	9363.539	9.999+	9.999+
72	12	S6	0	0	35700.5	0	7459.991	9.999+	9.999+
73	13	S1	0	319.104	35167.133	0	7926.707	9.999+	9.999+
74	13	S2	0	775.239	40889.158	0	8533.825	9.999+	9.999+
75	13	S3	0	297.503	40032.89	0	8363.49	9.999+	9.999+
76	13	S4	0	222.017	40033.221	0	8302.867	9.999+	9.999+
77	13	S5	0	335.085	40888.953	0	8415.919	9.999+	9.999+
78	13	S6	0	95.103	35166.823	0	7020.809	9.999+	9.999+
79	14	S1	0	3138.922	35639.866	342.501	7586.021	9.999+	9.999+
80	14	S2	0	4021.766	39120.192	351.972	8250.083	9.727	9.999+
81	14	S3	0	2310.357	39341.564	217.823	8144.497	9.999+	9.999+
82	14	S4	0	1803.252	39340.378	161.793	8137.29	9.999+	9.999+
83	14	S5	0	1954.769	39123.235	167.511	8162.263	9.999+	9.999+
84	14	S6	0	1206.793	35638.342	145.523	7585.983	9.999+	9.999+
85	15	S1	0	9244.504	26426.97	1044.123	5455.935	2.859	5.225
86	15	S2	0	16108.719	26946.32	1402.601	5555.574	1.673	3.961
87	15	S3	0	15090.668	26978.961	1355.246	5538.497	1.788	4.087
88	15	S4	0	15089.807	26978.75	1355.167	5538.481	1.788	4.087
89	15	S5	0	16110.39	26946.893	1402.804	5555.636	1.673	3.96
90	15	S6	0	9243.361	26426.715	1044.121	5455.929	2.859	5.225
91	16	S1	0	9874.744	26426.97	930.813	5455.935	2.676	5.861
92	16	S2	0	16764.61	26946.32	1129.415	5542.924	1.607	4.908
93	16	S3	0	15872.022	26978.961	1142.509	5538.497	1.7	4.848
94	16	S4	0	15871.005	26978.75	1142.389	5538.481	1.7	4.848
95	16	S5	0	16766.435	26946.893	1129.479	5542.978	1.607	4.908
96	16	S6	0	9873.592	26426.715	930.843	5455.929	2.677	5.861
97	17	S1	0	1017.233	26236.289	0	6692.866	9.999+	9.999+
98	17	S2	0	3198.363	27158.951	0	7160.504	8.492	9.999+
99	17	S3	0	2350.187	27021.479	0	7141.796	9.999+	9.999+
100	17	S4	0	2349.823	27021.528	0	7136.867	9.999+	9.999+
101	17	S5	0	3198.734	27158.942	0	7213.33	8.491	9.999+
102	17	S6	0	1016.884	26236.242	0	6158.651	9.999+	9.999+
103	18	S1	0	0	26947.731	0	6481.744	9.999+	9.999+
104	18	S2	0	0	27556.093	0	6964.171	9.999+	9.999+

Slab Overturning Safety Factors (By Combination) (Continued)

	LC	Slab	Angle[deg]	Mo-xx[lb-ft]	Ms-xx[lb-ft]	Mo-zz[lb-ft]	Ms-zz[lb-ft]	Ms-xx/Mo-xx	Ms-zz/Mo-zz
105	18	S3	0	0	27785.192	0	6926.254	9.999+	9.999+
106	18	S4	0	0	27785.642	0	6923.269	9.999+	9.999+
107	18	S5	0	0	27555.997	0	7039.734	9.999+	9.999+
108	18	S6	0	0	26947.81	0	6042.527	9.999+	9.999+
109	19	S1	0	425.472	26236.289	0	5910.183	9.999+	9.999+
110	19	S2	0	1033.652	27158.951	0	6038.607	9.999+	9.999+
111	19	S3	0	396.671	27021.479	0	5839.931	9.999+	9.999+
112	19	S4	0	296.023	27021.528	0	5749.71	9.999+	9.999+
113	19	S5	0	446.78	27158.942	0	5776.241	9.999+	9.999+
114	19	S6	0	126.804	26236.242	0	5456.951	9.999+	9.999+
115	20	S1	0	4185.23	26426.97	456.668	5455.935	6.314	9.999+
116	20	S2	0	5362.354	26946.32	469.296	5555.574	5.025	9.999+
117	20	S3	0	3080.475	26978.961	290.431	5538.497	8.758	9.999+
118	20	S4	0	2404.336	26978.75	215.724	5538.481	9.999+	9.999+
119	20	S5	0	2606.358	26946.893	223.347	5542.978	9.999+	9.999+
120	20	S6	0	1609.057	26426.715	194.031	5455.929	9.999+	9.999+

Slab Sliding Safety Factors (By Combination)

	LC	Slab	Angle[deg]	Va-xx[lb]	Vr-xx[lb]	Va-zz[lb]	Vr-zz[lb]	SR-xx	SR-zz
1	1	S1	0	30.325	1800.45	0	1800.45	9.999+	9.999+
2	1	S2	0	3.514	1849.75	0	1849.75	9.999+	9.999+
3	1	S3	0	0	1846.166	0	1846.166	9.999+	9.999+
4	1	S4	0	0	1846.16	0	1846.16	9.999+	9.999+
5	1	S5	0	3.516	1849.769	0	1849.769	9.999+	9.999+
6	1	S6	0	30.338	1800.44	0	1800.44	9.999+	9.999+
7	2	S1	0	205.743	2304.747	0	2304.747	9.999+	9.999+
8	2	S2	0	28.169	2665.846	0	2665.846	9.999+	9.999+
9	2	S3	0	2.361	2640.994	0	2640.994	9.999+	9.999+
10	2	S4	0	2.385	2640.96	0	2640.96	9.999+	9.999+
11	2	S5	0	28.229	2665.956	0	2665.956	9.999+	9.999+
12	2	S6	0	205.839	2304.676	0	2304.676	9.999+	9.999+
13	3	S1	0	59.138	1540.891	531.4	1540.891	9.999+	2.9
14	3	S2	0	5.137	1434.16	1062.671	1434.16	9.999+	1.35
15	3	S3	0	1.019	1440.204	929.167	1440.204	9.999+	1.55
16	3	S4	0	1.008	1440.215	929.132	1440.215	9.999+	1.55
17	3	S5	0	5.167	1434.138	1062.742	1434.138	9.999+	1.349
18	3	S6	0	59.167	1540.907	531.337	1540.907	9.999+	2.9
19	4	S1	0	55.768	1572.862	446.028	1572.862	9.999+	3.526
20	4	S2	0	4.164	1511.315	893.906	1511.315	9.999+	1.691
21	4	S3	0	1.215	1504.142	779.356	1504.142	9.999+	1.93
22	4	S4	0	1.199	1504.163	779.326	1504.163	9.999+	1.93
23	4	S5	0	4.131	1511.294	893.965	1511.294	9.999+	1.691
24	4	S6	0	55.806	1572.874	445.976	1572.874	9.999+	3.527
25	5	S1	0	136.521	2107.812	628.597	2107.812	9.999+	3.353
26	5	S2	0	13.482	2341.005	1257.108	2341.005	9.999+	1.862
27	5	S3	0	1.218	2326.425	1099.102	2326.425	9.999+	2.117
28	5	S4	0	1.204	2326.399	1099.059	2326.399	9.999+	2.117
29	5	S5	0	13.522	2341.074	1257.192	2341.074	9.999+	1.862
30	5	S6	0	136.586	2107.771	628.522	2107.771	9.999+	3.354
31	6	S1	0	112.785	2058.717	545.825	2058.717	9.999+	3.772
32	6	S2	0	19.182	2285.524	1089.838	2285.524	9.999+	2.097
33	6	S3	0	.739	2262.049	954.85	2262.049	9.999+	2.369
34	6	S4	0	.733	2262.037	954.812	2262.037	9.999+	2.369
35	6	S5	0	19.209	2285.583	1089.913	2285.583	9.999+	2.097
36	6	S6	0	112.829	2058.679	545.759	2058.679	9.999+	3.772
37	7	S1	0	65.442	1915.654	242.159	1915.654	9.999+	7.911

Slab Sliding Safety Factors (By Combination) (Continued)

	LC	Slab	Angle[deg]	Va-xx[lb]	Vr-xx[lb]	Va-zz[lb]	Vr-zz[lb]	SR-xx	SR-zz
38	7	S2	0	9.993	2002.342	392.016	2002.342	9.999+	5.108
39	7	S3	0	7.018	1940.806	212.933	1940.806	9.999+	9.115
40	7	S4	0	0	1909.529	144.086	1909.529	9.999+	9.999+
41	7	S5	0	2.534	1916.54	177.413	1916.54	9.999+	9.999+
42	7	S6	0	51.034	1845.929	87.202	1845.929	9.999+	9.999+
43	8	S1	0	5.217	1684.775	243.113	1684.775	9.999+	6.93
44	8	S2	0	4.653	1713.861	353.28	1713.861	9.999+	4.851
45	8	S3	0	4.961	1762.013	188.26	1762.013	9.999+	9.359
46	8	S4	0	0	1781.443	147.17	1781.443	9.999+	9.999+
47	8	S5	0	4.518	1783.366	177	1783.366	9.999+	9.999+
48	8	S6	0	9.383	1754.804	87.254	1754.804	9.999+	9.999+
49	9	S1	0	94.791	1984.004	398.55	1984.004	9.999+	4.978
50	9	S2	0	15.516	2150.13	797.003	2150.13	9.999+	2.698
51	9	S3	0	2.535	2137.815	696.876	2137.815	9.999+	3.068
52	9	S4	0	2.545	2137.801	696.849	2137.801	9.999+	3.068
53	9	S5	0	15.538	2150.186	797.057	2150.186	9.999+	2.698
54	9	S6	0	94.834	1983.967	398.502	1983.967	9.999+	4.979
55	10	S1	0	97.318	2007.982	334.521	2007.982	9.999+	6.003
56	10	S2	0	22.492	2207.996	670.43	2207.996	9.999+	3.293
57	10	S3	0	2.682	2185.769	584.517	2185.769	9.999+	3.739
58	10	S4	0	2.688	2185.762	584.495	2185.762	9.999+	3.74
59	10	S5	0	22.512	2208.053	670.474	2208.053	9.999+	3.293
60	10	S6	0	97.355	2007.942	334.482	2007.942	9.999+	6.003
61	11	S1	0	241.535	2409.194	471.448	2409.194	9.975	5.11
62	11	S2	0	29.481	2830.263	942.831	2830.263	9.999+	3.002
63	11	S3	0	.857	2802.481	824.326	2802.481	9.999+	3.4
64	11	S4	0	.886	2802.439	824.294	2802.439	9.999+	3.4
65	11	S5	0	29.555	2830.388	942.894	2830.388	9.999+	3.002
66	11	S6	0	241.649	2409.115	471.392	2409.115	9.969	5.111
67	12	S1	0	223.733	2372.373	409.369	2372.373	9.999+	5.795
68	12	S2	0	33.756	2788.653	817.378	2788.653	9.999+	3.412
69	12	S3	0	1.216	2754.199	716.137	2754.199	9.999+	3.846
70	12	S4	0	1.239	2754.168	716.109	2754.168	9.999+	3.846
71	12	S5	0	33.82	2788.77	817.434	2788.77	9.999+	3.412
72	12	S6	0	223.832	2372.296	409.319	2372.296	9.999+	5.796
73	13	S1	0	188.226	2265.076	181.62	2265.076	9.999+	9.999+
74	13	S2	0	26.864	2576.266	294.012	2576.266	9.999+	8.762
75	13	S3	0	7.034	2513.267	159.7	2513.267	9.999+	9.999+
76	13	S4	0	1.789	2489.787	108.065	2489.787	9.999+	9.999+
77	13	S5	0	21.314	2511.987	133.06	2511.987	9.999+	9.999+
78	13	S6	0	177.485	2212.734	65.401	2212.734	9.999+	9.999+
79	14	S1	0	135.232	2091.917	182.335	2091.917	9.999+	9.999+
80	14	S2	0	15.88	2359.905	264.96	2359.905	9.999+	8.907
81	14	S3	0	1.951	2379.172	141.195	2379.172	9.999+	9.999+
82	14	S4	0	1.789	2393.723	110.377	2393.723	9.999+	9.999+
83	14	S5	0	22.802	2412.107	132.75	2412.107	9.999+	9.999+
84	14	S6	0	146.247	2144.39	65.441	2144.39	9.999+	9.999+
85	15	S1	0	62.17	1360.846	531.4	1360.846	9.999+	2.561
86	15	S2	0	5.489	1249.185	1062.671	1249.185	9.999+	1.176
87	15	S3	0	1.019	1255.587	929.167	1255.587	9.999+	1.351
88	15	S4	0	1.008	1255.599	929.132	1255.599	9.999+	1.351
89	15	S5	0	5.518	1249.161	1062.742	1249.161	9.999+	1.175
90	15	S6	0	62.201	1360.863	531.337	1360.863	9.999+	2.561
91	16	S1	0	58.801	1392.817	446.028	1392.817	9.999+	3.123
92	16	S2	0	3.813	1326.34	893.906	1326.34	9.999+	1.484
93	16	S3	0	1.215	1319.525	779.356	1319.525	9.999+	1.693
94	16	S4	0	1.199	1319.547	779.326	1319.547	9.999+	1.693

Slab Sliding Safety Factors (By Combination) (Continued)

	LC	Slab	Angle[deg]	Va-xx[lb]	Vr-xx[lb]	Va-zz[lb]	Vr-zz[lb]	SR-xx	SR-zz
95	16	S5	0	3.78	1326.317	893.965	1326.317	9.999+	1.484
96	16	S6	0	58.84	1392.83	445.976	1392.83	9.999+	3.123
97	17	S1	0	133.488	1927.767	628.597	1927.767	9.999+	3.067
98	17	S2	0	13.13	2156.03	1257.108	2156.03	9.999+	1.715
99	17	S3	0	1.218	2141.808	1099.102	2141.808	9.999+	1.949
100	17	S4	0	1.204	2141.783	1099.059	2141.783	9.999+	1.949
101	17	S5	0	13.17	2156.097	1257.192	2156.097	9.999+	1.715
102	17	S6	0	133.552	1927.727	628.522	1927.727	9.999+	3.067
103	18	S1	0	109.752	1878.672	545.825	1878.672	9.999+	3.442
104	18	S2	0	18.83	2100.549	1089.838	2100.549	9.999+	1.927
105	18	S3	0	.739	2077.433	954.85	2077.433	9.999+	2.176
106	18	S4	0	.733	2077.421	954.812	2077.421	9.999+	2.176
107	18	S5	0	18.857	2100.606	1089.913	2100.606	9.999+	1.927
108	18	S6	0	109.795	1878.635	545.759	1878.635	9.999+	3.442
109	19	S1	0	62.41	1735.609	242.159	1735.609	9.999+	7.167
110	19	S2	0	9.641	1817.367	392.016	1817.367	9.999+	4.636
111	19	S3	0	7.018	1756.19	212.933	1756.19	9.999+	8.248
112	19	S4	0	0	1724.913	144.086	1724.913	9.999+	9.999+
113	19	S5	0	2.183	1731.563	177.413	1731.563	9.999+	9.76
114	19	S6	0	48	1665.885	87.202	1665.885	9.999+	9.999+
115	20	S1	0	8.249	1504.73	243.113	1504.73	9.999+	6.189
116	20	S2	0	5.004	1528.886	353.28	1528.886	9.999+	4.328
117	20	S3	0	4.961	1577.397	188.26	1577.397	9.999+	8.379
118	20	S4	0	0	1596.827	147.17	1596.827	9.999+	9.999+
119	20	S5	0	4.166	1598.389	177	1598.389	9.999+	9.03
120	20	S6	0	6.35	1574.76	87.254	1574.76	9.999+	9.999+

Envelope Slab Soil Pressures

	Label	UC	LC	Soil Pressure[psf]	Allowable Bearing[psf]	Point
1	S1	.354	11	530.652	1500	N2
2	S2	.444	5	665.625	1500	N18
3	S3	.437	11	654.821	1500	N22
4	S4	.437	11	654.776	1500	N26
5	S5	.444	5	665.678	1500	N31
6	S6	.354	11	530.603	1500	N34

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 318-14
Units: Imperial units

Anchor Information:
Anchor type: Bonded anchor
Material: F1554 Grade 36
Diameter (inch): 0.375
Effective Embedment depth, h_{ef} (inch): 4.000
Code report: ICC-ES ESR-4057
Anchor category: -
Anchor ductility: Yes
h_{min} (inch): 5.25
c_{ac} (inch): 7.12
C_{min} (inch): 1.75
S_{min} (inch): 3.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 30.00
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: Periodic
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

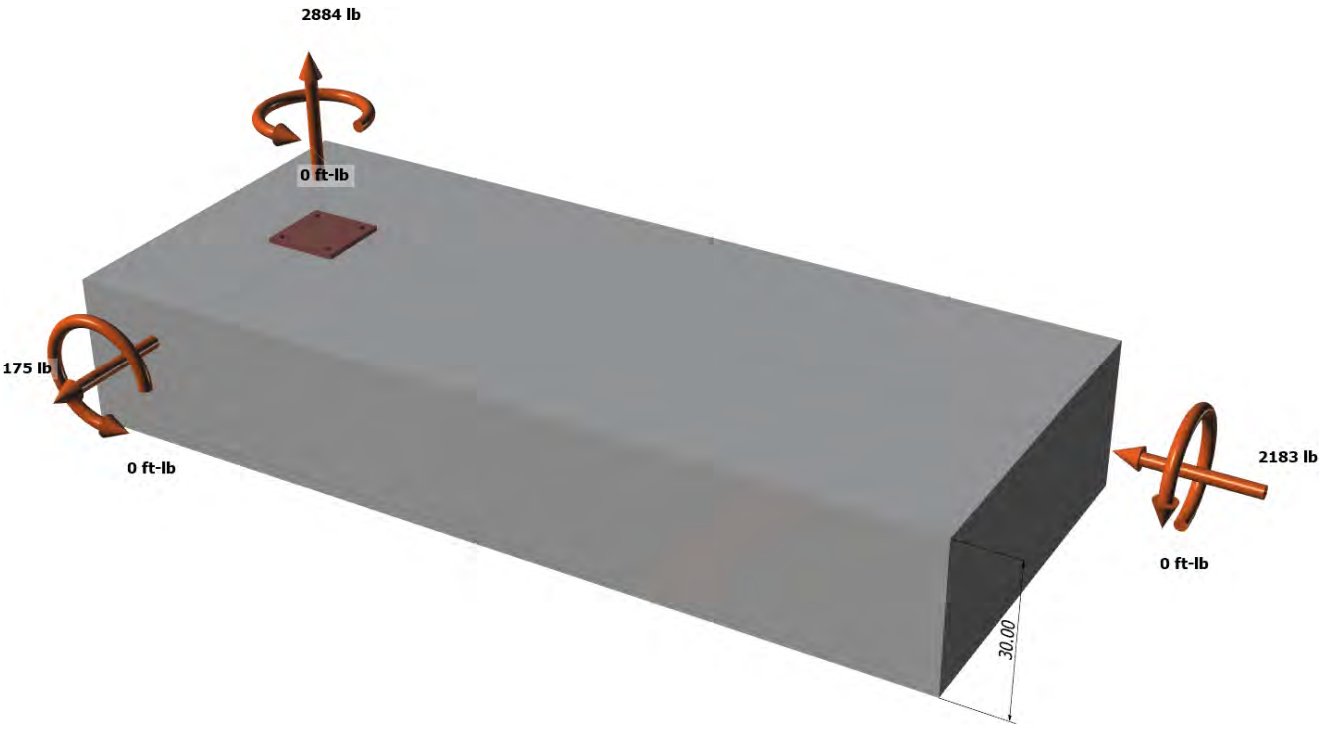
Recommended Anchor
Anchor Name: SET-3G - SET-3G w/ 3/8"Ø F1554 Gr. 36
Code Report: ICC-ES ESR-4057

Load and Geometry
Load factor source: ACI 318 Section 5.3
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]: 2884
V_{uax} [lb]: 175
V_{uay} [lb]: -2183
M_{ux} [ft-lb]: 0
M_{uy} [ft-lb]: 0
M_{uz} [ft-lb]: 0

<Figure 1>



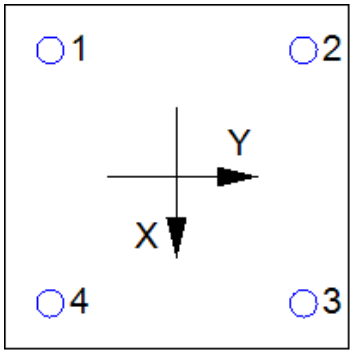
<Figure 2>

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	721.0	43.8	-545.8	547.5
2	721.0	43.8	-545.8	547.5
3	721.0	43.8	-545.8	547.5
4	721.0	43.8	-545.8	547.5
Sum	2884.0	175.0	-2183.0	2190.0

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 2884
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. 17.4.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
4525	0.75	3394

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.4.2)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ (Eq. 17.4.2.2a)

k_c	λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
17.0	1.00	2500	4.000	6800

$\phi N_{cbg} = \phi (A_{Nc} / A_{Nco}) \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ (Sec. 17.3.1 & Eq. 17.4.2.1b)

A_{Nc} (in²)	A_{Nco} (in²)	$c_{a,min}$ (in)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕN_{cbg} (lb)
240.25	144.00	7.25	1.000	1.000	1.00	1.000	6800	0.65	7374

6. Adhesive Strength of Anchor in Tension (Sec. 17.4.5)

$\tau_{k,cr} = \tau_{k,cr} f_{short\text{-}term} K_{sat} (f'_c / 2{,}500)^n$

$\tau_{k,cr}$ (psi)	$f_{short\text{-}term}$	K_{sat}	f'_c (psi)	n	$\tau_{k,cr}$ (psi)
1346	1.00	1.00	2500	0.24	1346

$N_{ba} = \lambda_a \tau_{cr} \pi d_a h_{ef}$ (Eq. 17.4.5.2)

λ_a	τ_{cr} (psi)	d_a (in)	h_{ef} (in)	N_{ba} (lb)
1.00	1346	0.38	4.000	6343

$\phi N_{ag} = \phi (A_{Na} / A_{Na0}) \Psi_{ec,Na} \Psi_{ed,Na} \Psi_{cp,Na} N_{ba}$ (Sec. 17.3.1 & Eq. 17.4.5.1b)

A_{Na} (in²)	A_{Na0} (in²)	c_{Na} (in)	$c_{a,min}$ (in)	$\Psi_{ec,Na}$	$\Psi_{ed,Na}$	$\Psi_{cp,Na}$	N_{ba}(lb)	ϕ	ϕN_{ag} (lb)
198.45	112.09	5.29	7.25	1.000	1.000	1.000	6343	0.55	6176

8. Steel Strength of Anchor in Shear (Sec. 17.5.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
2715	1.0	0.65	1765

9. Concrete Breakout Strength of Anchor in Shear (Sec. 17.5.2)

Shear perpendicular to edge in x-direction:

$V_{bx} = \min|7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda_a\sqrt{f'_c}c_{a1}^{1.5};\ 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}|$ (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

l_e (in)	d_a (in)	λ_a	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. 17.3.1 & Eq. 17.5.2.1b)

A_{Vc} (in²)	A_{Vco} (in²)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	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:

$V_{by} = \min|7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda_a\sqrt{f'_c}c_{a1}^{1.5};\ 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}|$ (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

l_e (in)	d_a (in)	λ_a	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. 17.3.1 & Eq. 17.5.2.1b)

A_{Vc} (in²)	A_{Vco} (in²)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	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:

$V_{by} = \min|7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda_a\sqrt{f'_c}c_{a1}^{1.5};\ 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}|$ (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

l_e (in)	d_a (in)	λ_a	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. 17.3.1, 17.5.2.1(c) & Eq. 17.5.2.1b)

A_{Vc} (in²)	A_{Vco} (in²)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	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:

$V_{bx} = \min|7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda_a\sqrt{f'_c}c_{a1}^{1.5};\ 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}|$ (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

l_e (in)	d_a (in)	λ_a	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. 17.3.1, 17.5.2.1(c) & Eq. 17.5.2.1b)

A_{Vc} (in²)	A_{Vco} (in²)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	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. 17.5.3)

$\phi V_{cpg} = \phi \min|k_{cp}N_{ag};\ k_{cp}N_{cbg}| = \phi \min|k_{cp}(A_{Na} / A_{Na0})\Psi_{ec,Na}\Psi_{ed,Na}\Psi_{cp,Na}N_{ba};\ k_{cp}(A_{Nc} / A_{Nco})\Psi_{ec,N}\Psi_{ed,N}\Psi_{c,N}\Psi_{cp,N}N_b|$ (Sec. 17.3.1 & Eq. 17.5.3.1b)

k_{cp}	A_{Na} (in²)	A_{Na0} (in²)	$\Psi_{ed,Na}$	$\Psi_{ec,Na}$	$\Psi_{cp,Na}$	N_{ba} (lb)	N_a (lb)
2.0	198.45	112.09	1.000	1.000	1.000	6343	11230

A_{Nc} (in²)	A_{Nco} (in²)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	N_{cb} (lb)	ϕ
240.25	144.00	1.000	1.000	1.000	1.000	6800	11345	0.70

ϕV_{cpg} (lb)
15722

11. Results

Interaction of Tensile and Shear Forces (Sec. R17.6)

Tension	Factored Load, N_{ua} (lb)	Design Strength, ϕN_n (lb)	Ratio	Status
Steel	721	3394	0.21	Pass
Concrete breakout	2884	7374	0.39	Pass
Adhesive	**2884**	**6176**	**0.47**	**Pass (Governs)**

Shear	Factored Load, V_{ua} (lb)	Design Strength, ϕV_n (lb)	Ratio	Status
Steel	548	1765	0.31	Pass
T Concrete breakout x+	175	7103	0.02	Pass
T Concrete breakout y-	2183	5313	0.41	Pass
|| Concrete breakout y-	88	9797	0.01	Pass
|| Concrete breakout x-	1092	12680	0.09	Pass
Concrete breakout, combined	**-**	**-**	**0.41**	**Pass (Governs)**
Pryout	2190	15722	0.14	Pass

Interaction check	$(N_{ua}/\phi N_{ua})^{5/3}$	$(V_{ua}/\phi V_{ua})^{5/3}$	Combined Ratio	Permissible	Status
Sec. R17.6	0.28	0.23	50.9%	1.0	Pass

SET-3G w/ 3/8"Ø F1554 Gr. 36 with hef = 4.000 inch meets the selected design criteria.

12. Warnings

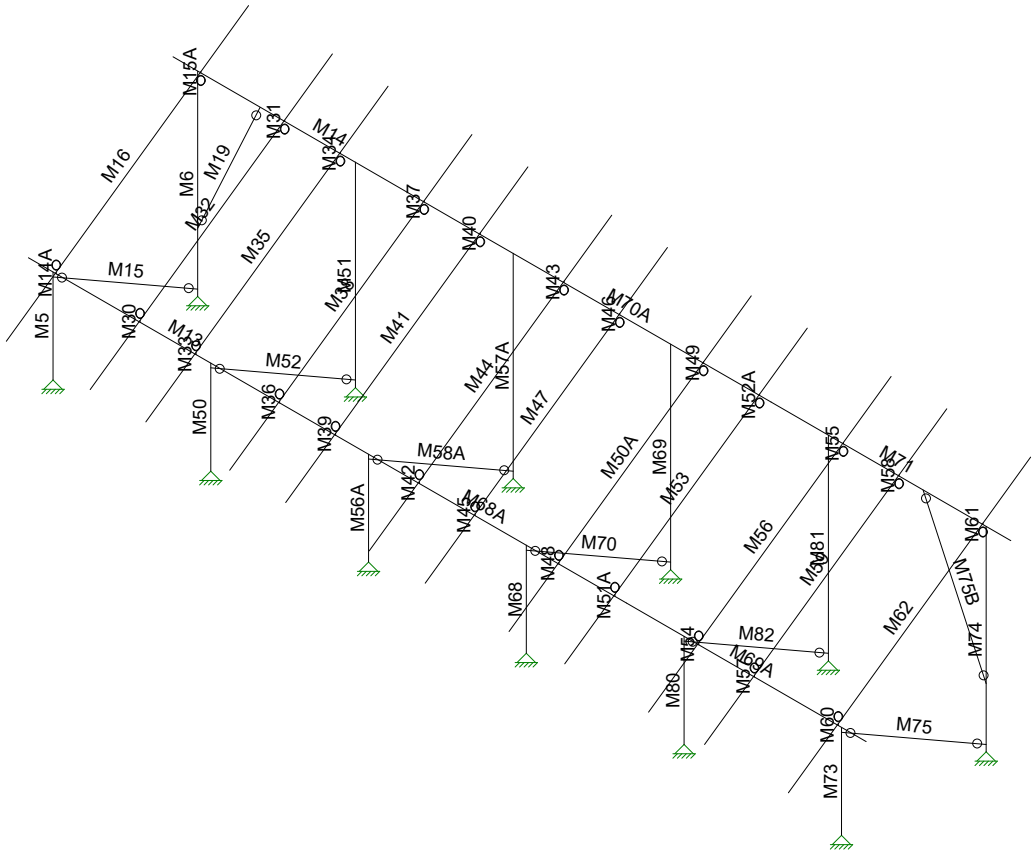
- Designer must exercise own judgement to determine if this design is suitable.

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

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

PROJECT: Ground Mount Package for Ontario Canada

Framing Analysis



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STB	Ground Mount	Apr 6, 2021 at 2:47 PM
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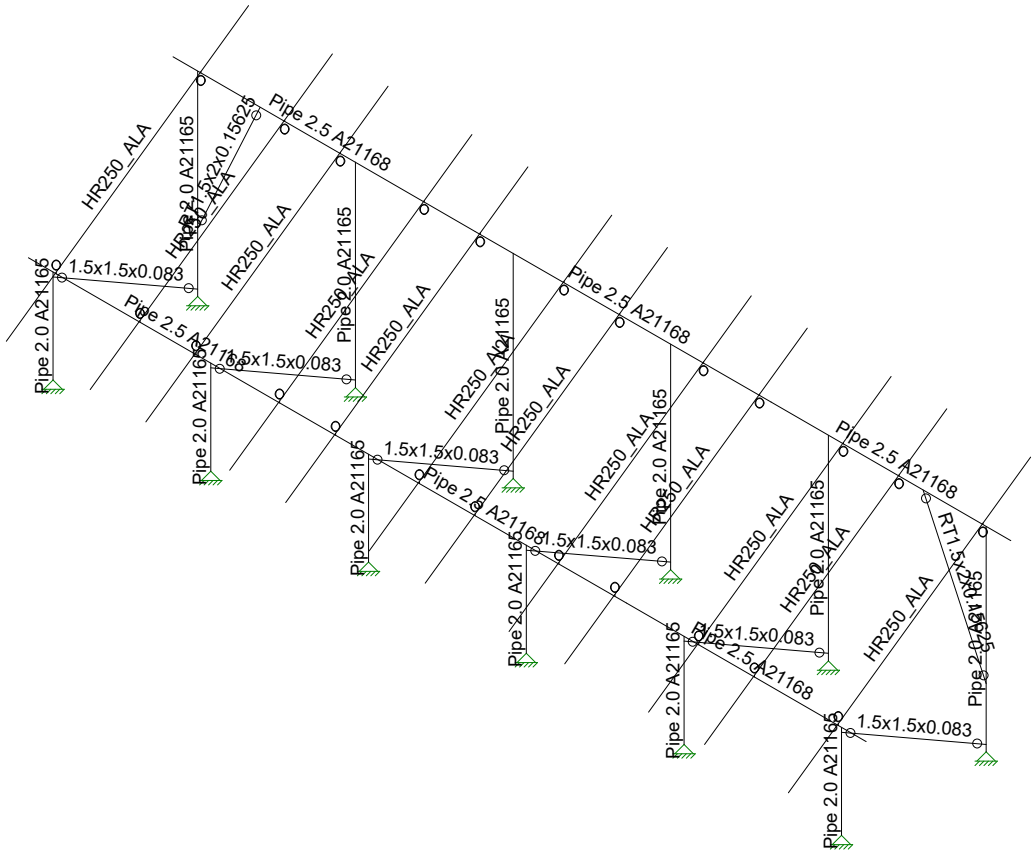

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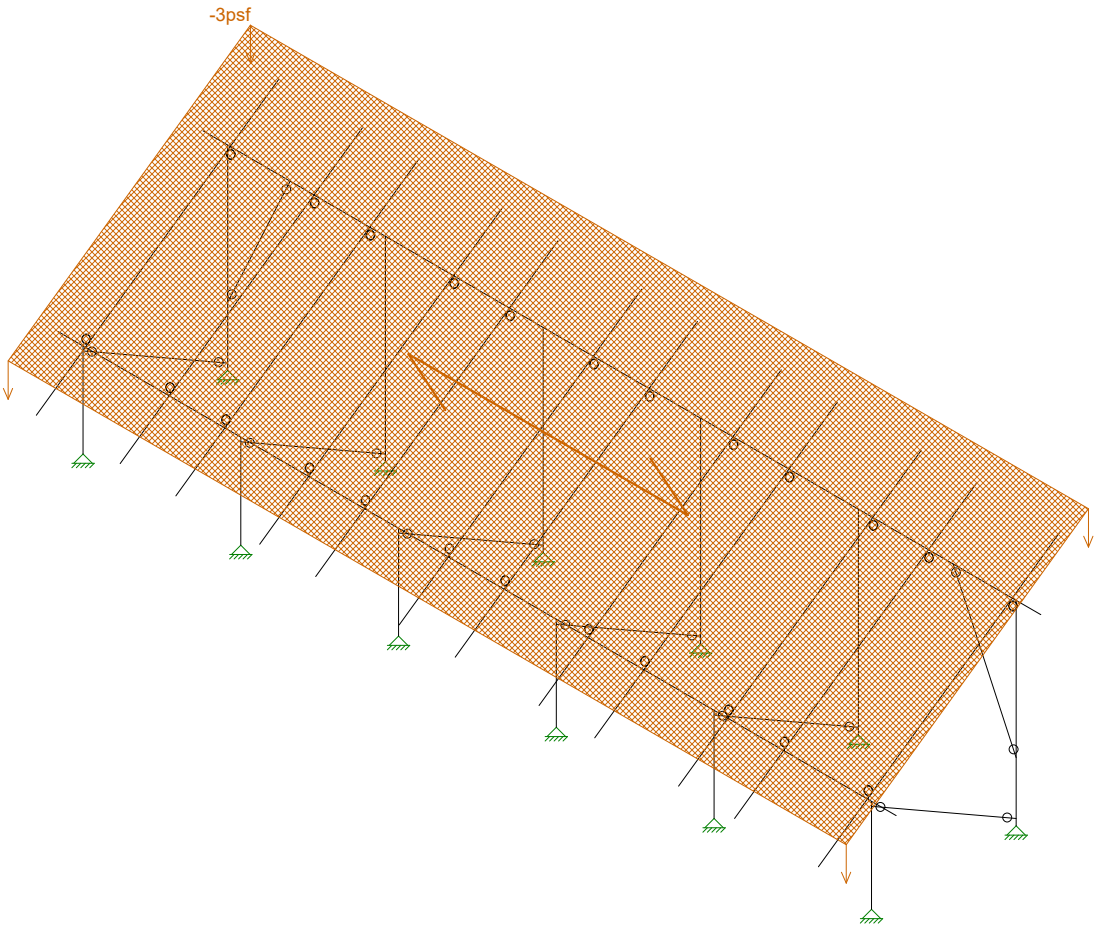

Loads: BLC 2, Solar Panel Weight

Vector Structural Engineeri...		SK - 7
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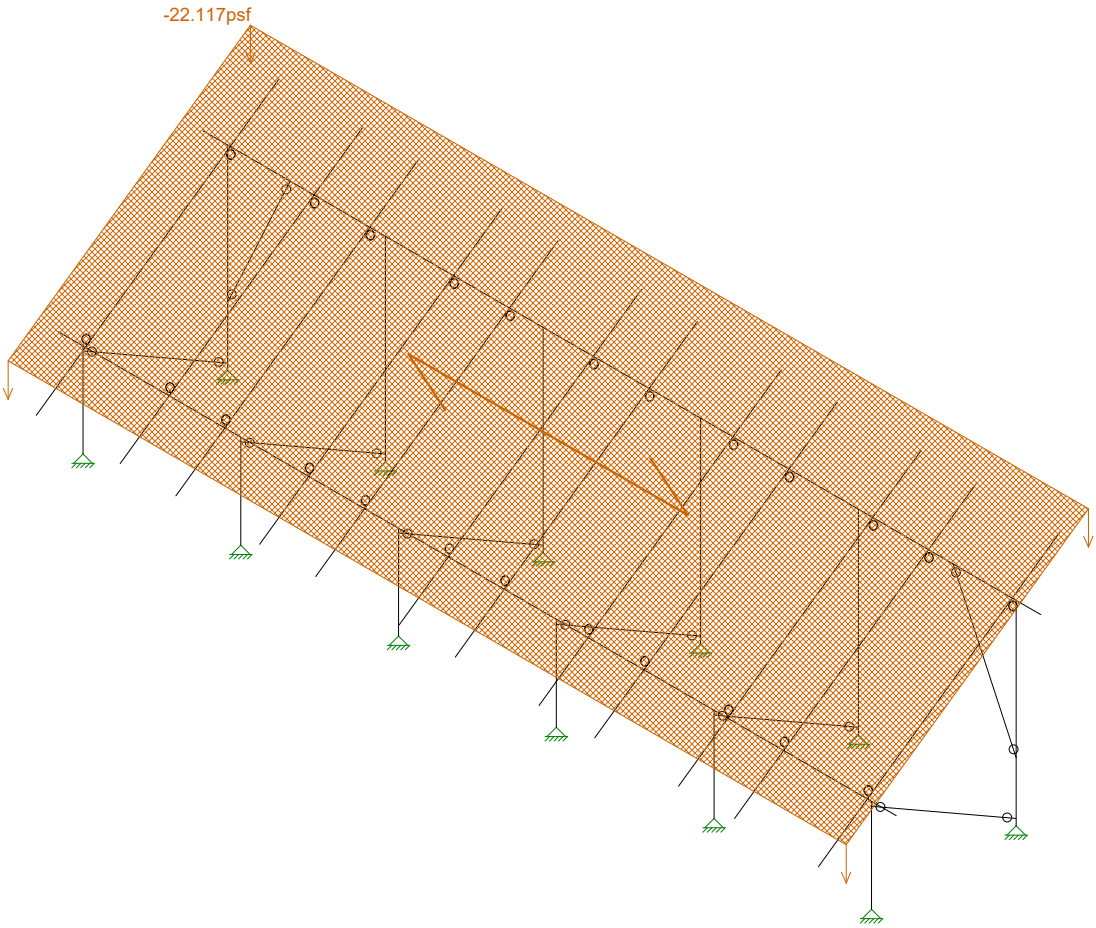

Loads: BLC 3, Roof Live/Snow

Vector Structural Engineeri...		SK - 8
STB	Ground Mount	Apr 6, 2021 at 2:48 PM
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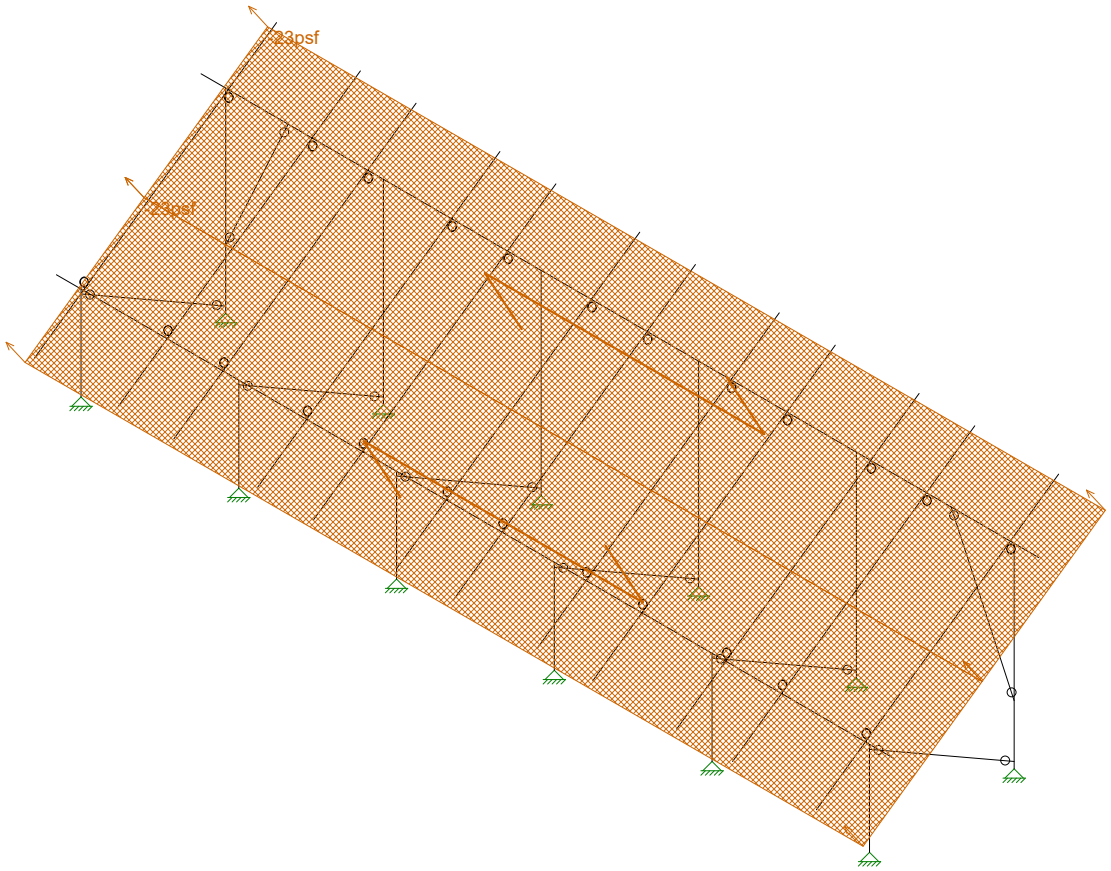
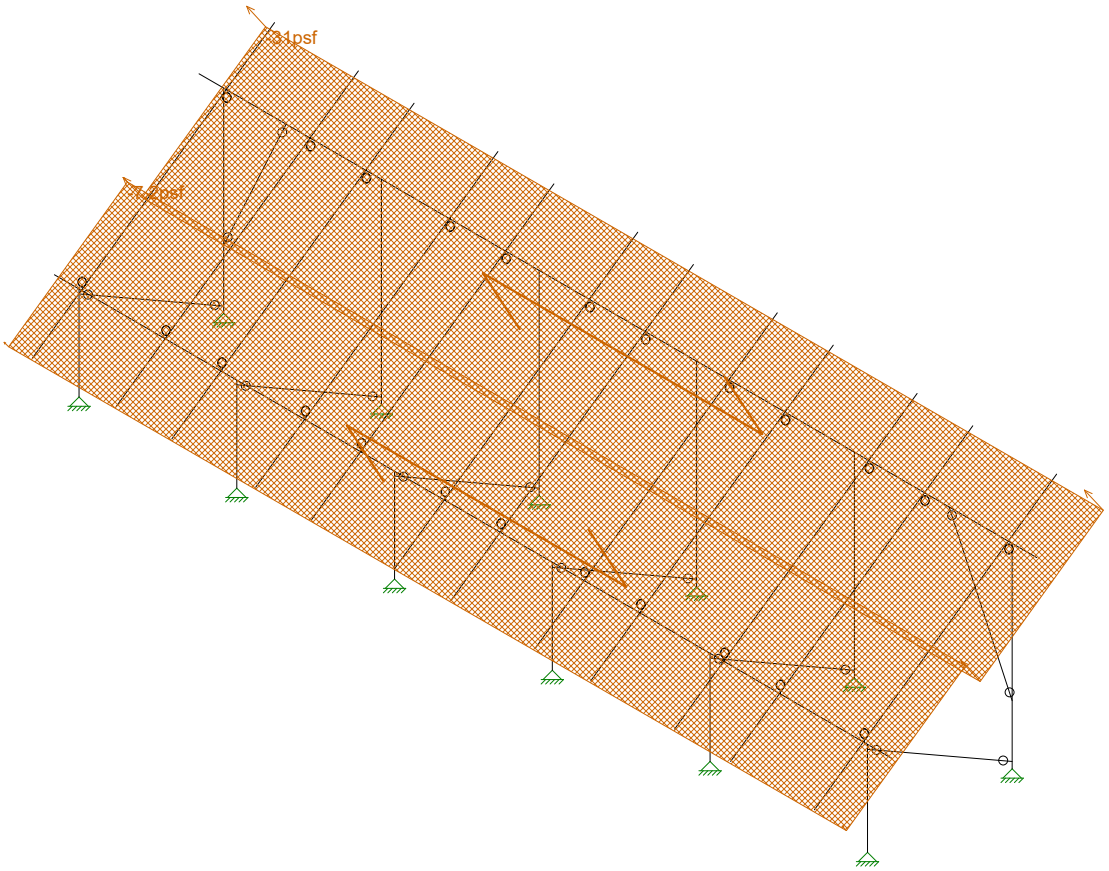


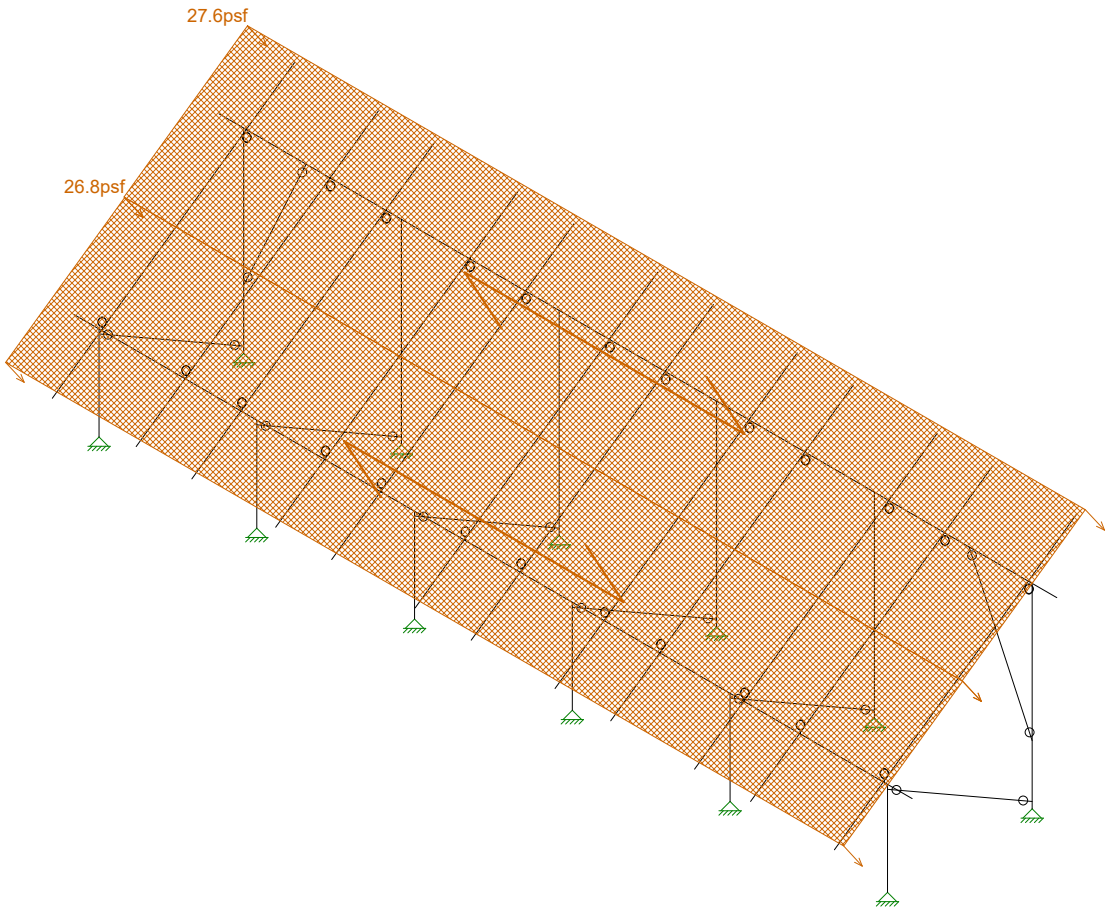
Loads: BLC 4, Wind A 0 deg

Vector Structural Engineeri...		SK - 9
STB	Ground Mount	Apr 6, 2021 at 2:48 PM
U2716.113.191		Sunmodo Sunturf A4 v3 85x45.r3d



Loads: BLC 5, Wind B 0 deg

Vector Structural Engineeri...		SK - 10
STB	Ground Mount	Apr 6, 2021 at 2:48 PM
U2716.113.191		Sunmodo Sunturf A4 v3 85x45.r3d



Loads: BLC 6, Wind A 180 deg

Vector Structural Engineeri...		SK - 11
STB	Ground Mount	Apr 6, 2021 at 2:48 PM
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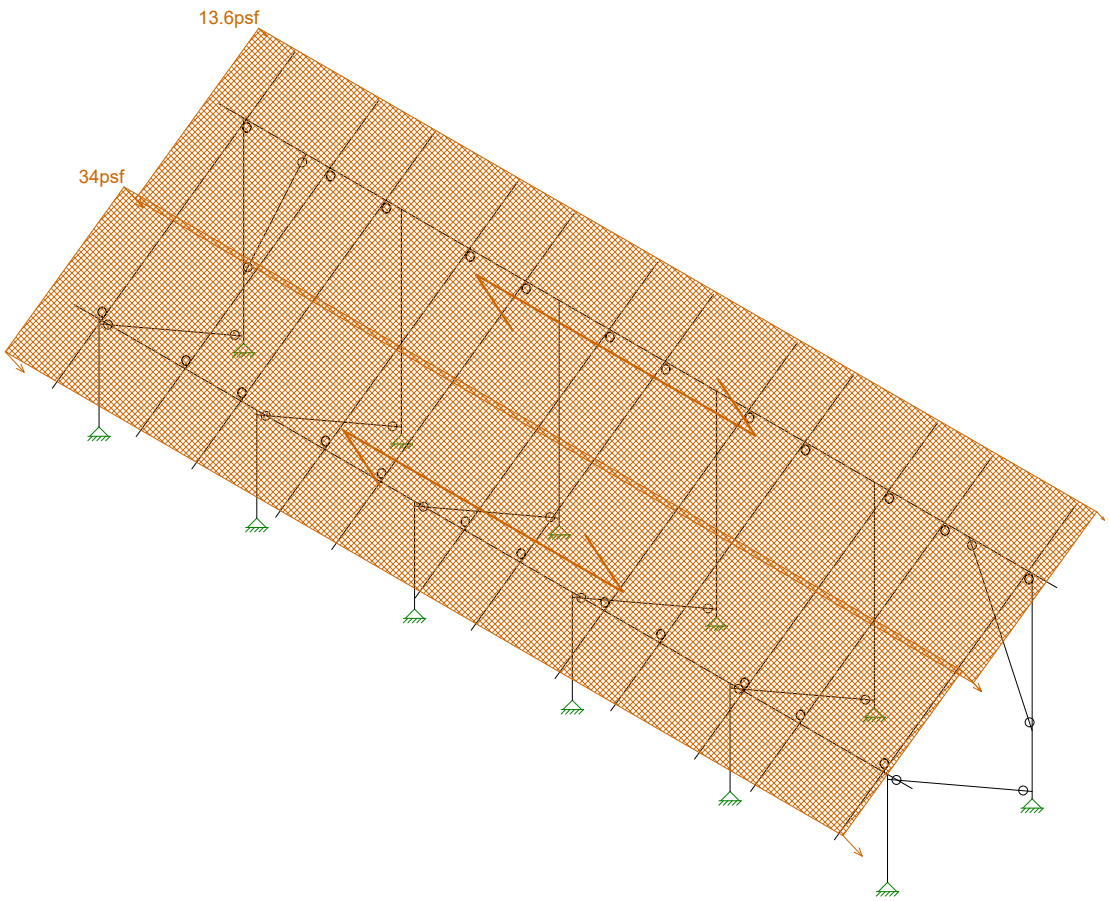

Loads: BLC 7, Wind B 180 deg

Vector Structural Engineeri...		SK - 12
STB	Ground Mount	Apr 6, 2021 at 2:48 PM
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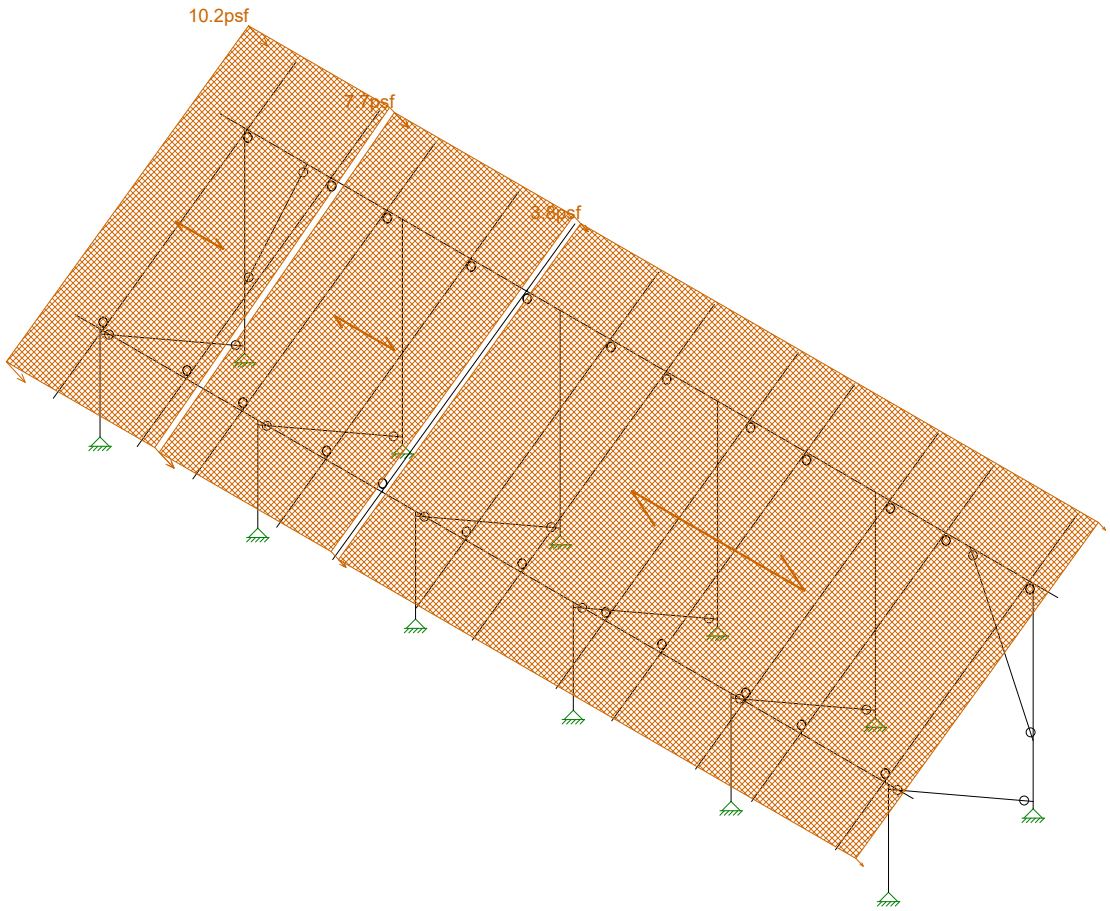
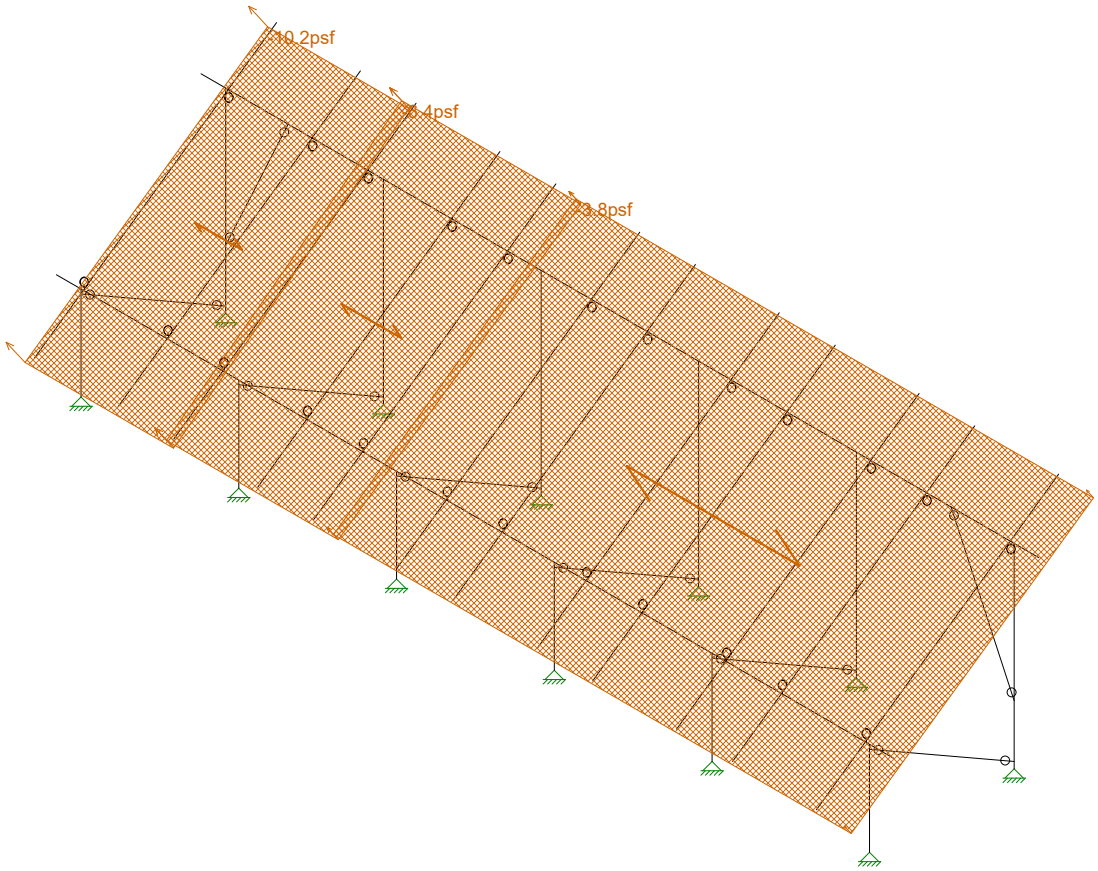


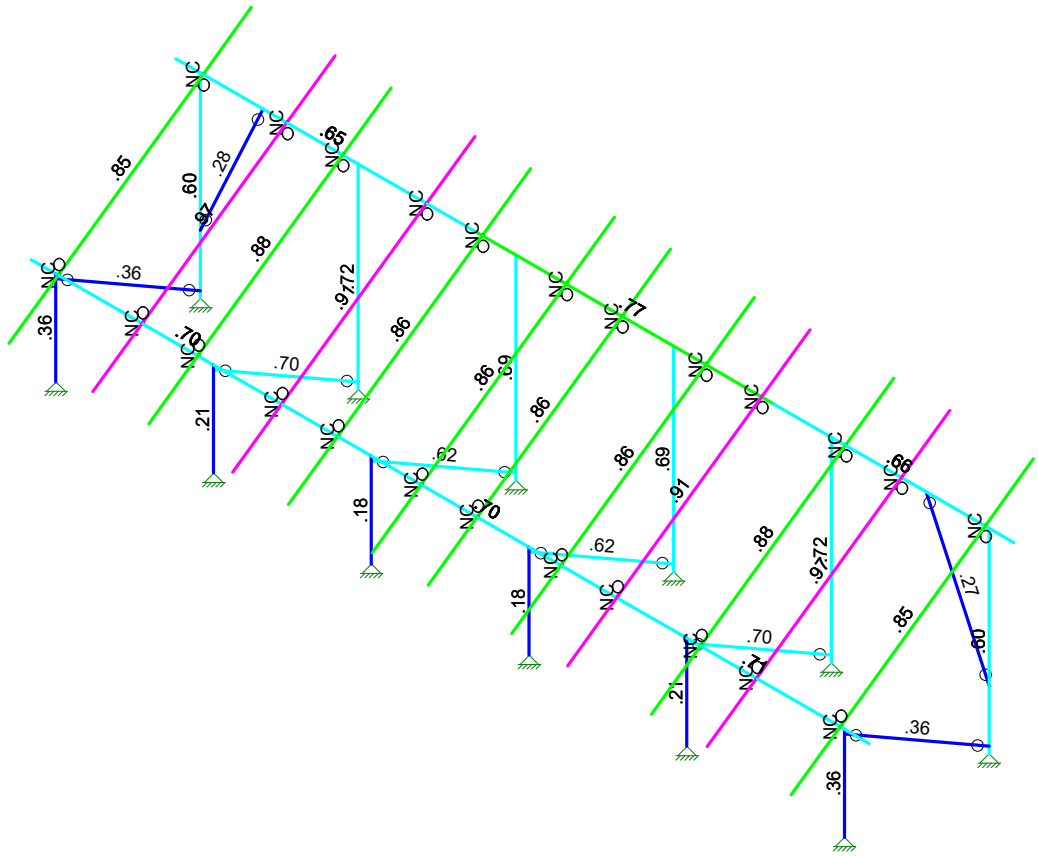
Loads: BLC 8, Wind A 90

Vector Structural Engineeri...		SK - 13
STB	Ground Mount	Apr 6, 2021 at 2:48 PM
U2716.113.191		Sunmodo Sunturf A4 v3 85x45.r3d



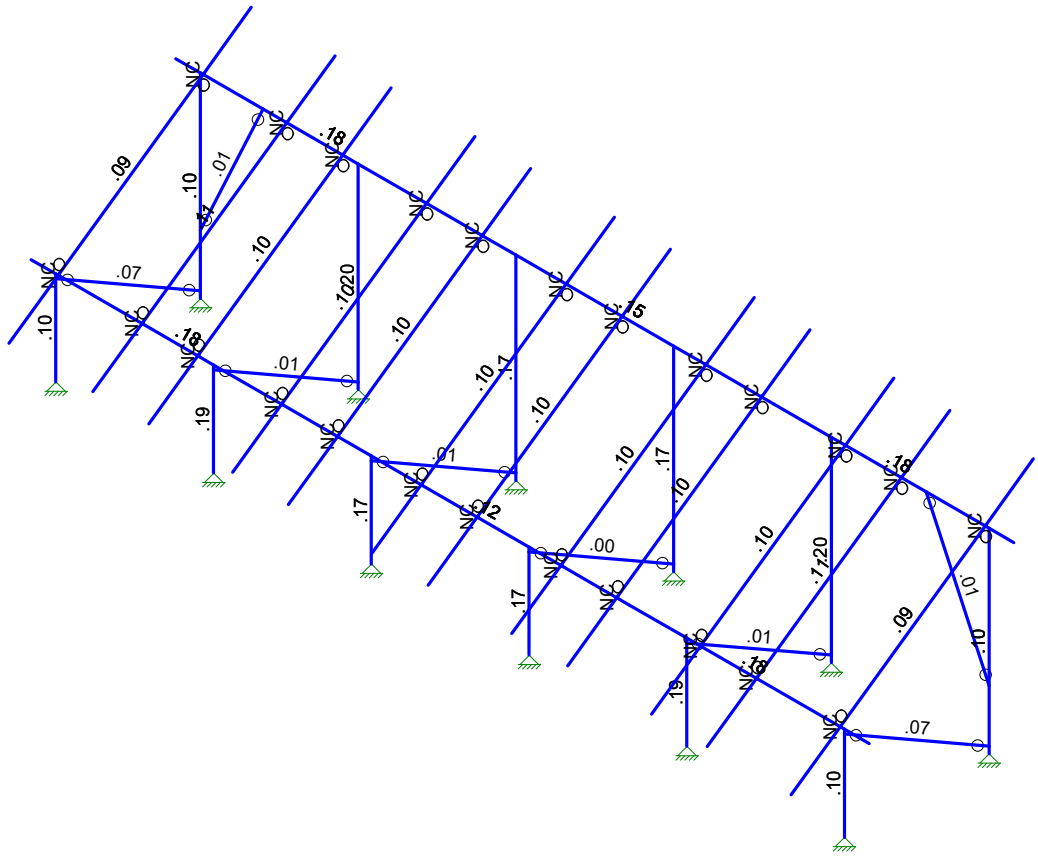
Loads: BLC 9, Wind B 90

Vector Structural Engineeri...		SK - 14
STB	Ground Mount	Apr 6, 2021 at 2:48 PM
U2716.113.191		Sunmodo Sunturf A4 v3 85x45.r3d



Member Code Checks Displayed (Enveloped)
Envelope Only Solution

Vector Structural Engineeri...		SK - 3
STB	Ground Mount	Apr 6, 2021 at 2:47 PM
U2716.113.191		Sunmodo Sunturf A4 v3 85x45.r3d



Member Shear Checks Displayed (Enveloped)
Envelope Only Solution

Vector Structural Engineeri...		SK - 4
STB	Ground Mount	Apr 6, 2021 at 2:47 PM
U2716.113.191		Sunmodo Sunturf A4 v3 85x45.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 (in^2)	144
Merge Tolerance (in)	.12
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 (in/sec^2)	386.4
Wall Mesh Size (in)	24
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
Stainless Steel Code	AISC 14th(360-10): ASD
Adjust Stiffness?	Yes(Iterative)

Number of Shear Regions	4
Region Spacing Increment (in)	4
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 (in)	15600
Add Base Weight?	Yes
Ct X	.02
Ct Z	.02
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 [ksi]	G [ksi]	Nu	Therm (/1E5 F)	Density[lb/ft^3]	Yield[psi]	Ry	Fu[psi]	Rt
1	A992	29000	11154	.3	.65	490	50000	1.1	65000	1.1
2	A36 Gr.36	29000	11154	.3	.65	490	36000	1.5	58000	1.2
3	A572 Gr.50	29000	11154	.3	.65	490	50000	1.1	65000	1.1
4	A500 Gr.B R...	29000	11154	.3	.65	527	42000	1.4	58000	1.3
5	A500 Gr.B Re...	29000	11154	.3	.65	527	46000	1.4	58000	1.3
6	A53 Gr.B	29000	11154	.3	.65	490	35000	1.6	60000	1.2
7	A1085	29000	11154	.3	.65	490	50000	1.4	65000	1.3

Aluminum Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (...	Density[...	Table B.4	kt	Ftu[psi]	Fty[psi]	Fcy[psi]	Fsu[psi]	Ct
1	3003-H14	10100	3787.5	.33	1.3	172.8	Table B.4-1	1	19000	16000	13000	12000	141
2	6061-T6	10100	3787.5	.33	1.3	172.8	Table B.4-2	1	38000	35000	35000	24000	141
3	6063-T5	10100	3787.5	.33	1.3	172.8	Table B.4-2	1	22000	16000	16000	13000	141
4	6063-T6	10100	3787.5	.33	1.3	172.8	Table B.4-2	1	30000	25000	25000	19000	141
5	5052-H34	10200	3787.5	.33	1.3	172.8	Table B.4-1	1	34000	26000	24000	20000	141
6	6061-T6 W	10100	3787.5	.33	1.3	172.8	Table B.4-1	1	24000	15000	15000	15000	141
7	6005-T5	10100	3787.5	.33	1.3	172.8	Table B.4-1	1	38000	35000	35000	24000	141

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design R...	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	Post	Pipe 2.0 A21165	Column	Pipe	A572 Gr.50	Typical	.776	.499	.499	.998
2	Cross Beam	Pipe 2.5 A21168	Beam	Wide Flange	A572 Gr.50	Typical	.947	.907	.907	1.814
3	Diagonal Brace	1.5x1.5x0.083	HBrace	SquareTube	A572 Gr.50	Typical	.47	.158	.158	.236

Aluminum Section Sets

	Label	Shape	Type	Design List	Material	Design R...	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	AL Posts	2.375ODX0.188	Column	Pipe	6005-T5	Typical	1.29	.778	.778	1.54
2	AL Brace	RT1.5x2x0.15625	VBrace	Rectangular Tubes	6005-T5	Typical	.996	.327	.524	.602
3	AL Rails	HR250 ALA	Beam	Rectangular Tubes	6005-T5	Typical	.723	.095	.486	.261
4	AL Cross Beam	Cross Rail	Beam	Rectangular Tubes	6005-T5	Typical	1.909	1.97	4.366	4.017

Member Area Loads (BLC 2 : Solar Panel Weight)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N199	N196	Y	A-B	-3

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

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N199	N196	PY	A-B	-27

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

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N201	N198	Perp	A-B	-23
2	N198	N201	N199	N196	Perp	A-B	-23

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

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N201	N198	Perp	A-B	-31
2	N198	N201	N199	N196	Perp	A-B	-7.2

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

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N201	N198	Perp	A-B	27.6
2	N198	N201	N199	N196	Perp	A-B	26.8

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

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N201	N198	Perp	A-B	13.6
2	N198	N201	N199	N196	Perp	A-B	34

Member Area Loads (BLC 8 : Wind A 90)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N203	N202	N196	Perp	A-B	10.2
2	N203	N209	N208	N202	Perp	A-B	7.7
3	N209	N200	N199	N208	Perp	A-B	3.8

Member Area Loads (BLC 9 : Wind B 90)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N203	N202	N196	Perp	A-B	-10.2
2	N203	N209	N208	N202	Perp	A-B	-6.4
3	N209	N200	N199	N208	Perp	A-B	-3.8

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						112		
13	BLC 5 Transient Area ...	None						112		
14	BLC 6 Transient Area ...	None						112		
15	BLC 7 Transient Area ...	None						112		
16	BLC 8 Transient Area ...	None						110		
17	BLC 9 Transient Area ...	None						110		

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...	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 [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-ft]	LC	MY [lb...	LC	MZ [lb-ft]	LC
1	N2	max	90.48	12	1011.025	10	32.655	3	0	20	0	20	0	20
2		min	-22.327	15	-65.087	17	-38.621	5	0	1	0	1	0	1
3	N1	max	147.776	11	1730.168	11	667.266	5	0	20	0	20	0	20
4		min	-69.965	16	-998.854	16	-564.0...	3	0	1	0	1	0	1
5	N132	max	4.512	11	2748.86	11	1310.4...	5	0	20	0	20	0	20
6		min	-2.223	16	-1720.148	16	-1108....	3	0	1	0	1	0	1
7	N133	max	31.558	12	1916.961	10	46.097	3	0	20	0	20	0	20
8		min	-4.596	15	-238.927	17	-53.291	5	0	1	0	1	0	1
9	N109	max	2.627	20	2748.161	11	1310.3...	5	0	20	0	20	0	20
10		min	-4.494	11	-1720.001	16	-1108....	3	0	1	0	1	0	1
11	N110A	max	4.59	15	1916.982	10	46.095	3	0	20	0	20	0	20
12		min	-31.528	12	-238.863	17	-53.29	5	0	1	0	1	0	1
13	N121	max	2.025	20	2675.396	11	1152.9...	5	0	20	0	20	0	20

Envelope Joint Reactions (Continued)

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-ft]	LC	MY [lb...	LC	MZ [lb-ft]	LC
14		min	-2.436	7	-1628.625	16	-975.3...	3	0	1	0	1	0	1
15	N122	max	2.734	20	1733.446	10	46.107	3	0	20	0	20	0	20
16		min	-4.679	7	-171.711	17	-53.895	5	0	1	0	1	0	1
17	N133B	max	1.981	11	2675.109	11	1152.9...	5	0	20	0	20	0	20
18		min	-1.437	16	-1628.533	16	-975.2...	3	0	1	0	1	0	1
19	N134B	max	2.934	10	1733.482	10	46.107	3	0	20	0	20	0	20
20		min	-2.724	17	-171.655	17	-53.895	5	0	1	0	1	0	1
21	N151	max	70.003	16	1729.744	11	667.19	5	0	20	0	20	0	20
22		min	-147.8...	11	-998.757	16	-564.0...	3	0	1	0	1	0	1
23	N152	max	22.34	15	1010.974	10	32.653	3	0	20	0	20	0	20
24		min	-90.498	12	-65.044	17	-38.619	5	0	1	0	1	0	1
25	Totals:	max	.019	7	19682.87	11	5969.5...	17						
26		min	-.018	8	-5579.966	15	-5046....	3						

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

	Member	Shape	Code Check	Loc[in]	LC	Shear ...	Loc[in]	Dir	LC	Pnc/om [...	Pnt/om [lb]	Mnyy/om...	Mnzz/om...	Cb	Eqn
1	M5	Pipe 2.0 A2...	.359	56.934	12	.102	54.562		5	16072.847	23232.186	1397.505	1397.505	1....	H1-1b
2	M6	Pipe 2.0 A2...	.601	35.904	11	.101	0		5	5311.62	23232.186	1397.505	1397.505	1....	H1-1a
3	M13	Pipe 2.5 A2...	.704	111....	12	.179	109.25		12	11641.036	28358.413	2081.747	2081.747	3....	H1-1b
4	M14	Pipe 2.5 A2...	.654	111....	11	.180	109.25		11	11641.036	28358.413	2081.747	2081.747	3....	H1-1b
5	M15	1.5x1.5x0.083	.363	52.814	5	.075	101....	y	11	2309.21	14085.15	624.421	624.421	1....	H1-1a
6	M80	Pipe 2.0 A2...	.208	54.562	12	.189	54.562		5	16072.847	23232.186	1397.505	1397.505	1....	H1-1b
7	M81	Pipe 2.0 A2...	.725	3.714	11	.199	0		5	5311.62	23232.186	1397.505	1397.505	1....	H1-1a
8	M82	1.5x1.5x0.083	.699	52.814	5	.010	101....	y	10	2309.21	14085.15	624.421	624.421	1....	H1-1a
9	M50	Pipe 2.0 A2...	.208	54.562	12	.189	54.562		5	16072.847	23232.186	1397.505	1397.505	1....	H1-1b
10	M51	Pipe 2.0 A2...	.725	3.714	11	.199	0		5	5311.62	23232.186	1397.505	1397.505	1....	H1-1a
11	M52	1.5x1.5x0.083	.699	52.814	5	.010	0	y	10	2309.21	14085.15	624.421	624.421	1....	H1-1a
12	M56A	Pipe 2.0 A2...	.182	54.562	5	.166	54.562		5	16072.847	23232.186	1397.505	1397.505	1....	H1-1b
13	M57A	Pipe 2.0 A2...	.686	3.714	11	.175	0		5	5311.62	23232.186	1397.505	1397.505	1....	H1-1a
14	M58A	1.5x1.5x0.083	.617	52.814	5	.006	0	y	13	2309.21	14085.15	624.421	624.421	1....	H1-1a
15	M68	Pipe 2.0 A2...	.182	54.562	5	.166	54.562		5	16072.847	23232.186	1397.505	1397.505	1....	H1-1b
16	M69	Pipe 2.0 A2...	.686	3.714	11	.175	0		5	5311.62	23232.186	1397.505	1397.505	1....	H1-1a
17	M70	1.5x1.5x0.083	.617	52.814	5	.005	0	y	10	2309.21	14085.15	624.421	624.421	1....	H1-1a
18	M68A	Pipe 2.5 A2...	.701	22.5	12	.123	22.5		12	11641.036	28358.413	2081.747	2081.747	2....	H1-1b
19	M69A	Pipe 2.5 A2...	.708	34.979	12	.179	36.5		12	11641.036	28358.413	2081.747	2081.747	1....	H1-1b
20	M70A	Pipe 2.5 A2...	.774	22.5	11	.146	22.5		11	11641.036	28358.413	2081.747	2081.747	3....	H1-1b
21	M71	Pipe 2.5 A2...	.658	34.979	11	.180	36.5		11	11641.036	28358.413	2081.747	2081.747	1....	H1-1b
22	M73	Pipe 2.0 A2...	.359	56.934	12	.102	54.562		5	16072.847	23232.186	1397.505	1397.505	1....	H1-1b
23	M74	Pipe 2.0 A2...	.601	35.904	11	.101	0		5	5311.62	23232.186	1397.505	1397.505	1....	H1-1a
24	M75	1.5x1.5x0.083	.363	52.814	5	.075	0	y	11	2309.21	14085.15	624.421	624.421	1....	H1-1a

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

	Member	Shape	Code C...	Loc[in]	LC	Shear ...	Loc[in]	Dir	LC	Pnc/O...	Pnt/Om...	Mny/O...	Mnz/O...	Vny/O...	Vnz/O...	Cb	Eqn
1	M19	RT1.5x2x...	.275	57.986	11	.012	0	z	11	2016.504	19411....	770.742	927.083	5889.423	3966.346	1....	H.1-1
2	M16	HR250_A...	.852	90.015	11	.095	37.506	y	12	2162.5	14089....	309.506	687.273	4940.308	1617.231	1....	H.1-1
3	M75B	RT1.5x2x...	.274	58.052	11	.012	0	z	12	2011.884	19411....	770.742	927.083	5889.423	3966.346	1....	H.1-1
4	M32	HR250_A...	.965	37.506	12	.106	37.506	y	12	2162.5	14089....	309.506	597.691	4940.308	1617.231	1....	H.1-1
5	M35	HR250_A...	.882	91.89	11	.102	37.506	y	12	2162.5	14089....	309.506	687.273	4940.308	1617.231	1....	H.1-1
6	M38	HR250_A...	.913	37.506	12	.097	37.506	y	12	2162.5	14089....	309.506	599.616	4940.308	1617.231	1....	H.1-1
7	M41	HR250_A...	.865	91.89	11	.096	37.506	y	12	2162.5	14089....	309.506	687.273	4940.308	1617.231	1....	H.1-1
8	M44	HR250_A...	.862	37.506	12	.098	37.506	y	12	2162.5	14089....	309.506	599.462	4940.308	1617.231	1....	H.1-1
9	M47	HR250_A...	.862	37.506	12	.098	37.506	y	12	2162.5	14089....	309.506	599.462	4940.308	1617.231	1....	H.1-1
10	M50A	HR250_A...	.865	91.89	11	.096	37.506	y	12	2162.5	14089....	309.506	687.273	4940.308	1617.231	1....	H.1-1
11	M53	HR250_A...	.913	37.506	12	.097	37.506	y	12	2162.5	14089....	309.506	599.616	4940.308	1617.231	1....	H.1-1

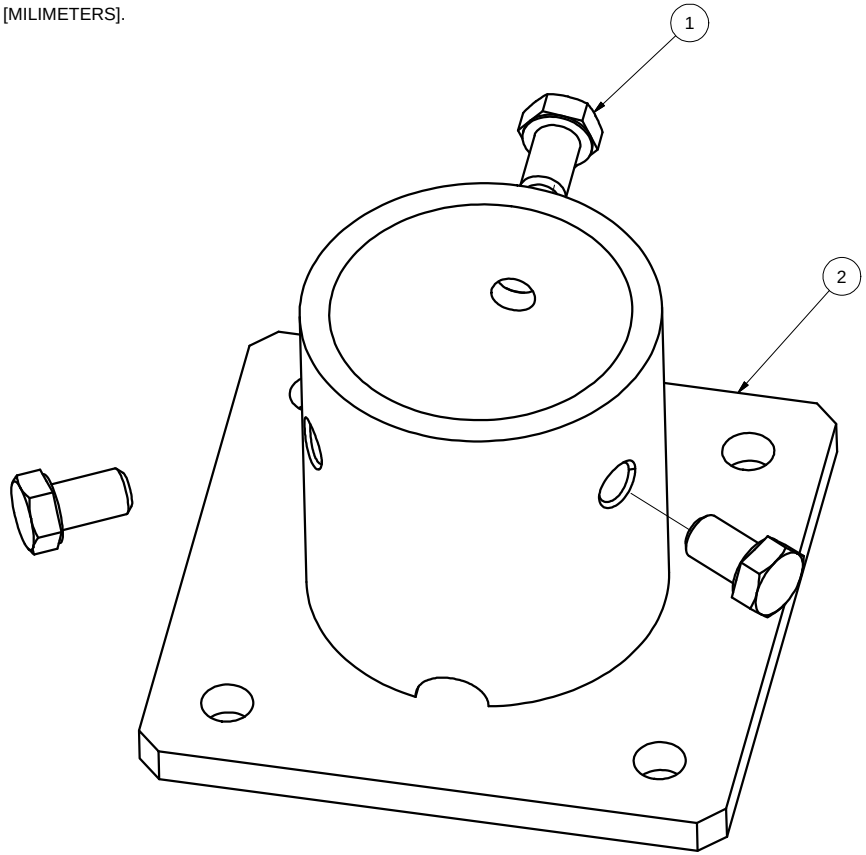
Envelope AA ADM1-15: ASD - Building Aluminum Code Checks (Continued)

	Member	Shape	Code C...	Loc[in]	LC	Shear ...	Loc[in]	Dir	LC	Pnc/O...	Pnt/Om...	Mny/O...	Mnz/O...	Vny/O...	Vnz/O...	Cb	Eqn
12	M56	HR250_A...	.882	91.89	11	.102	37.506	y	12	2162.5	14089....	309.506	687.273	4940.308	1617.231	1....	H.1-1
13	M59	HR250_A...	.965	37.506	12	.106	37.506	y	12	2162.5	14089....	309.506	597.684	4940.308	1617.231	1....	H.1-1
14	M62	HR250_A...	.852	90.015	11	.095	37.506	y	12	2162.5	14089....	309.506	687.273	4940.308	1617.231	1....	H.1-1

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

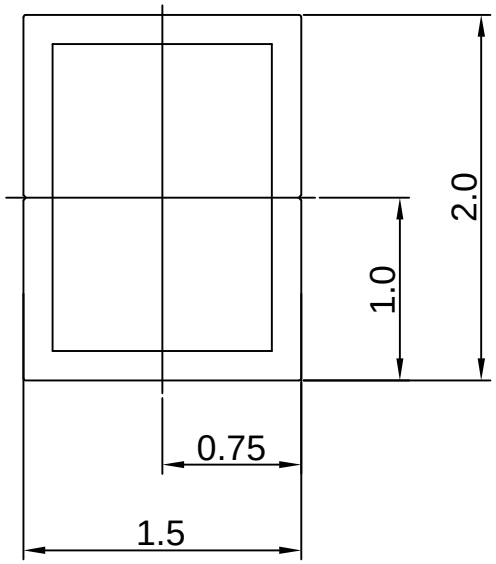
B
DRAWING NUMBER: K10268-001

SCALE: NONE
SHEET 1 of 1

THIS DRAWING IS CONFIDENTIAL PROPERTY OF SUNMODO AND ITS CONTENTS MAY NOT BE DISCLOSED WITHOUT THE PRIOR WRITTEN CONSENT OF SUNMODO CORP.

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:

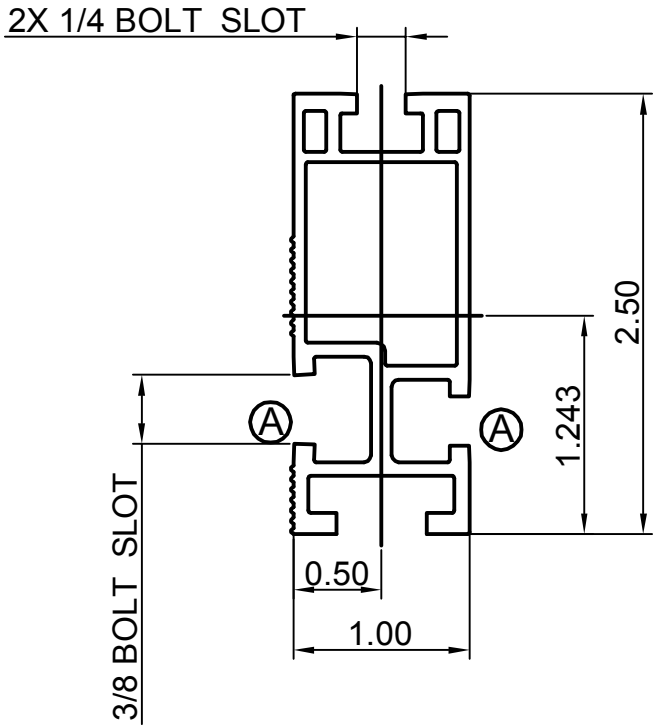
Weight: 1.156 lbs/ft
Area: 0.992 in^2
Perimeter: 12.601 in
Bounding Box: X: -1.000,1.000
Y: -0.750, 0.750
Centroid:(0.000,0.000)
Moments of Inertia(in^4): Ix=0.506,Iy=0.322
Section modulus in bending(in^3): Wx=0.675,Wy=0.322
Radii of Gyration: X: 0.714, Y: 0.570

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.



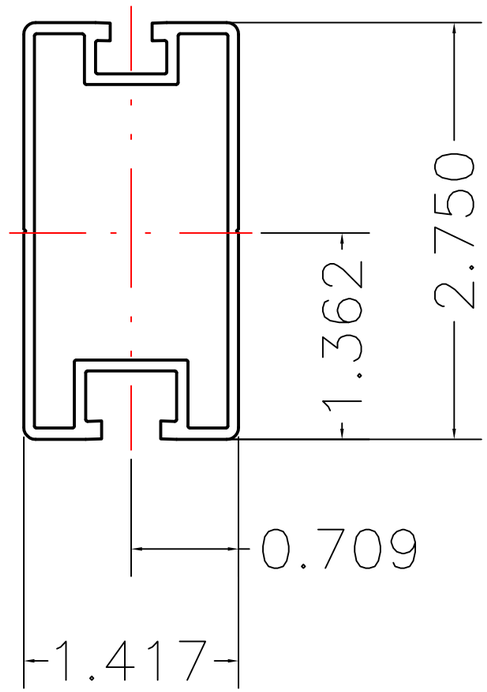
Section properties:

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

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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	

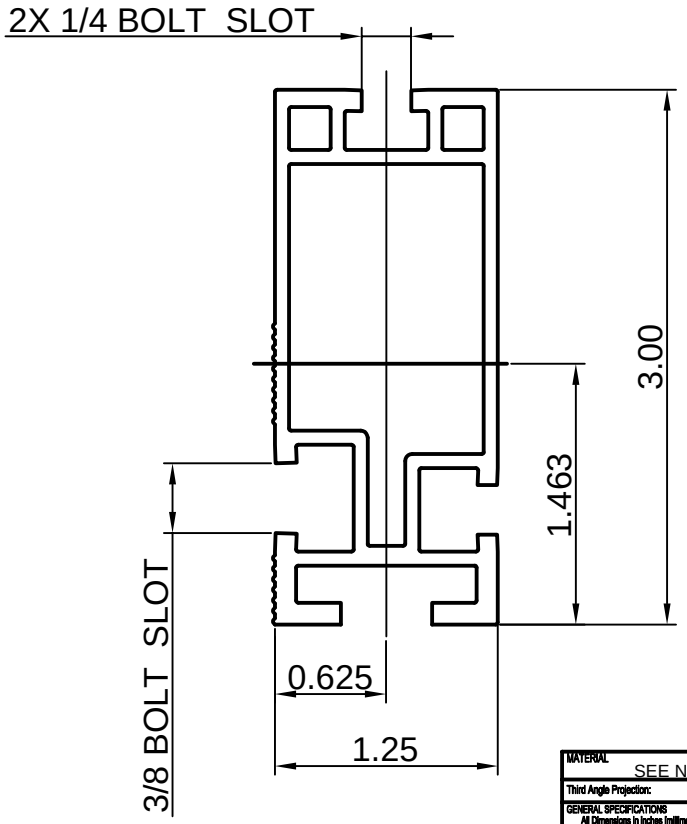
SunModo Corp.
14800 NE 65TH STREET, VANCOUVER WA 98682

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:

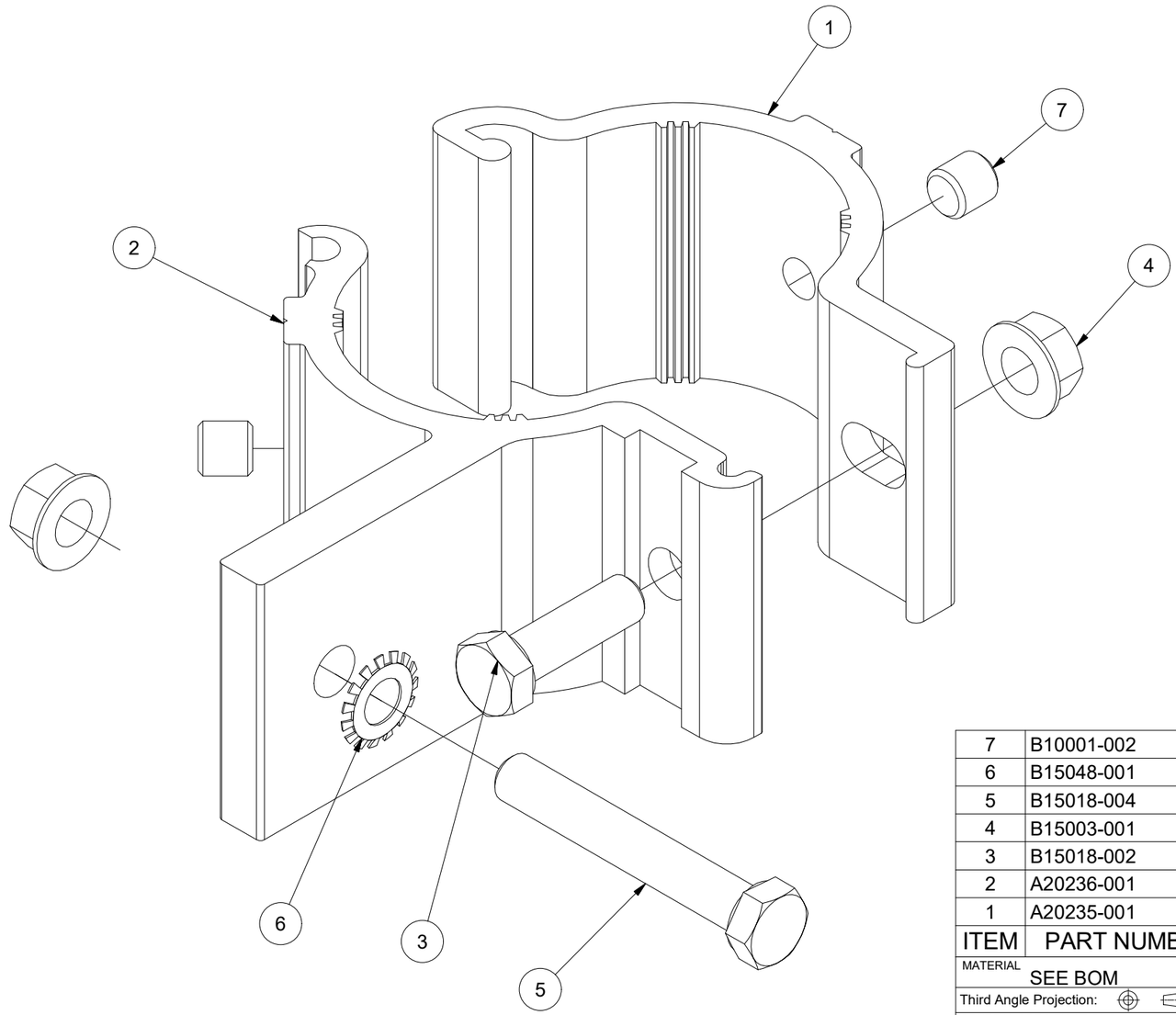
Weight: 1.151 lbs/ft
Area: 0.980 in^2
Perimeter: 22.104 in
Bounding Box: X: -0.625,0.625
Y: -1.463,1.537
Centroid:(0.000,0.000)
Moments of Inertia(in^4): Ix=1.047,Iy=0.207
Section modulus in bending(in^3): Wx=0.681,Wy=0.331
Radii of Gyration: X: 1.034, Y: 0.460

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

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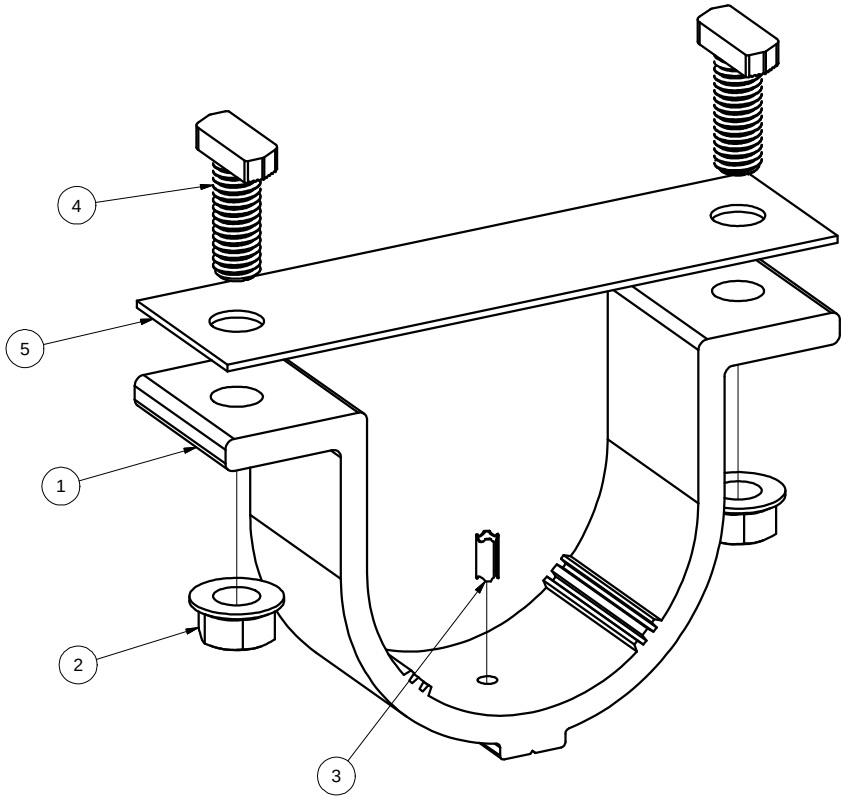
REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018
B	ADD C10005-006	LWF	06/27/2018



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

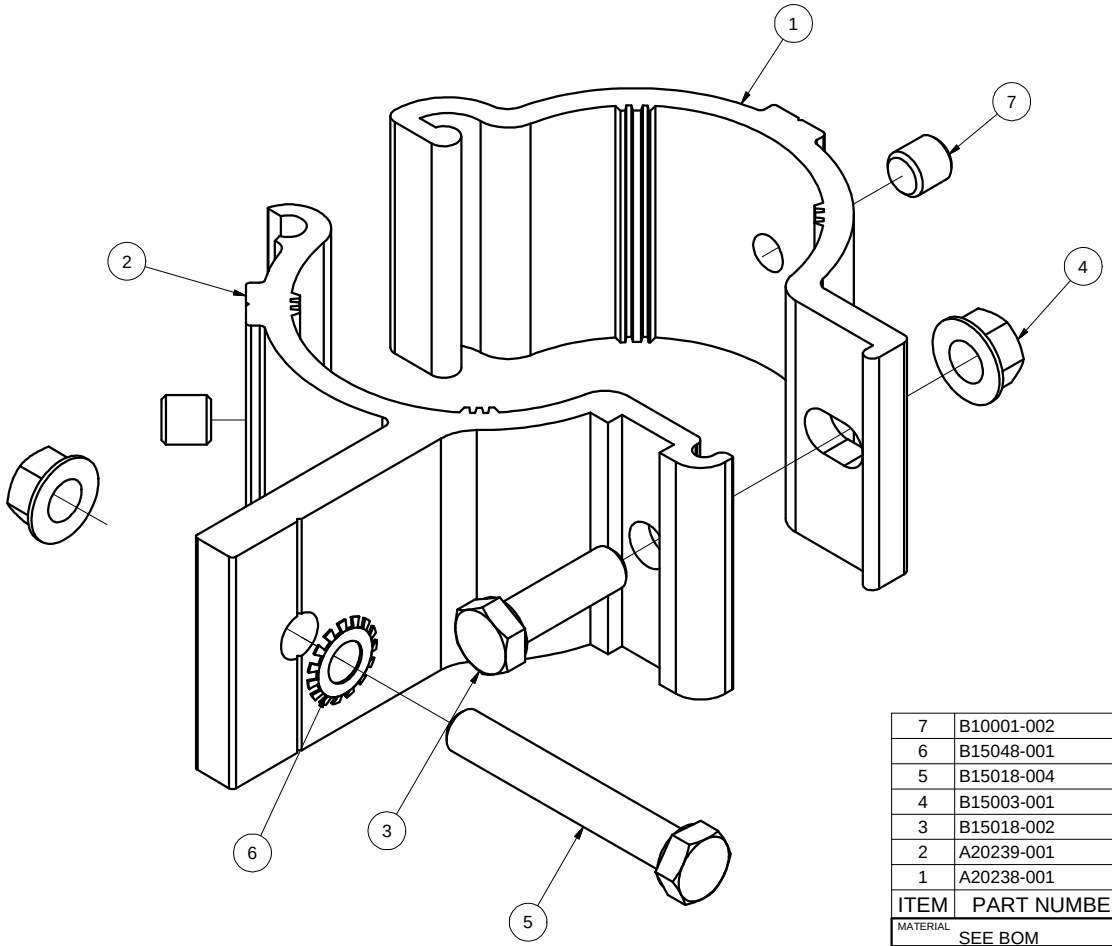
TITLE: 2.5" AL PIPE U-CLAMP KIT

B | DRAWING NUMBER: K10343-001

SCALE: NONE | SHEET 1 of 1

THIS DRAWING IS CONFIDENTIAL PROPERTY OF SUNMODO AND ITS CONTENTS MAY NOT BE DISCLOSED WITHOUT THE PRIOR WRITTEN CONSENT OF SUNMODO CORP.

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

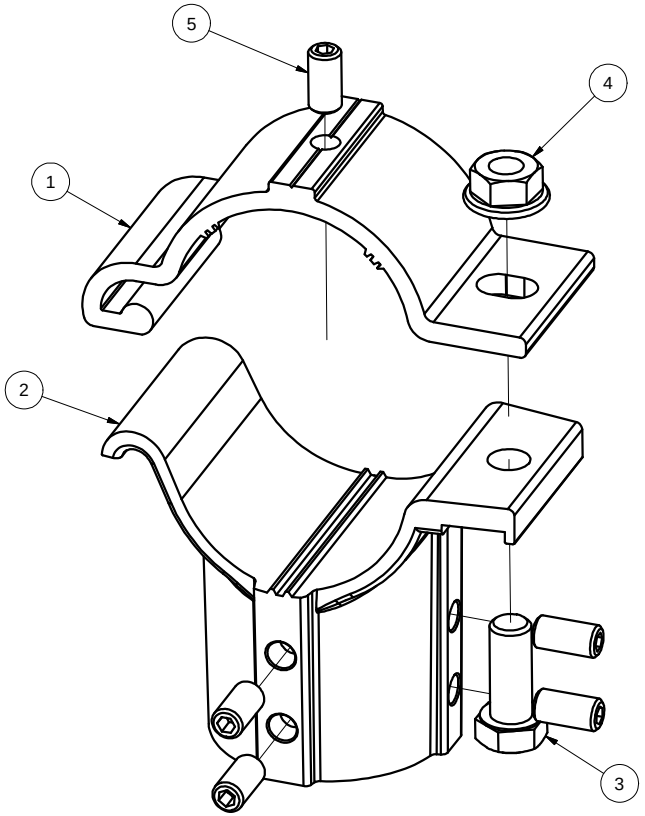
DRAWING NUMBER: K10222-001

SCALE: NONE

SHEET 1 of 1

THIS DRAWING IS CONFIDENTIAL PROPERTY OF SUNMODO AND ITS CONTENTS MAY NOT BE DISCLOSED WITHOUT THE PRIOR WRITTEN CONSENT OF SUNMODO CORP.

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

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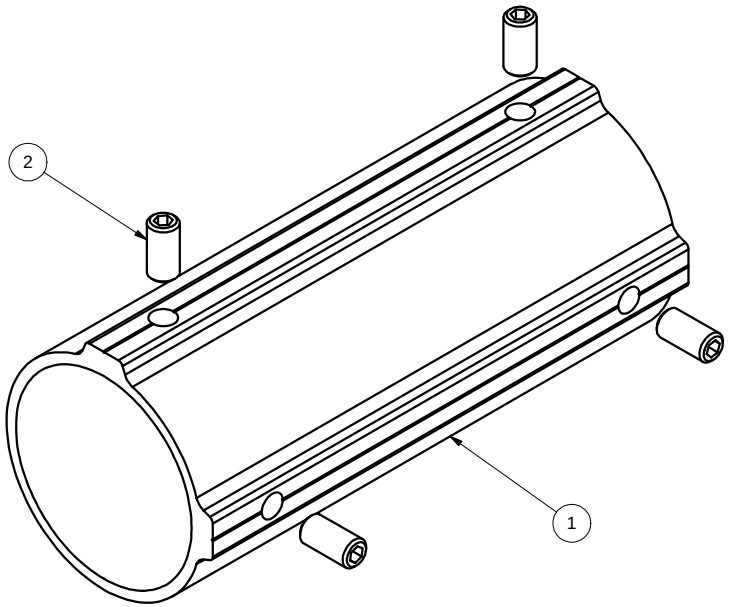
REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018



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

THIS DRAWING IS CONFIDENTIAL PROPERTY OF SUNMODO AND ITS CONTENTS MAY NOT BE DISCLOSED WITHOUT THE PRIOR WRITTEN CONSENT OF SUNMODO CORP.

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].

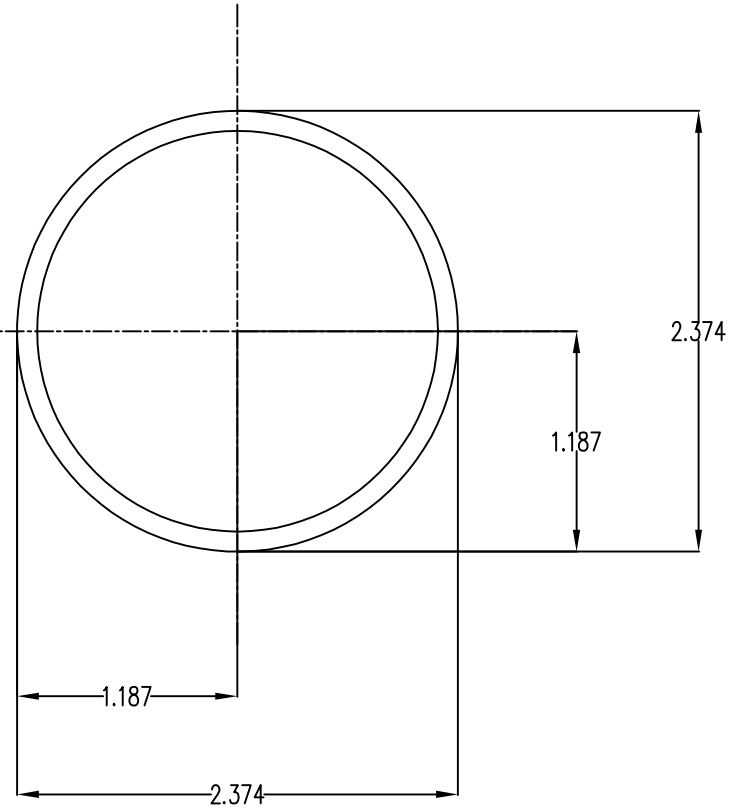
2. MATERAIL:HIGH STRENGTH STEEL PIPE OR TUBE.

3. FINISH: HOT DIP GALVANIZE PER ASTM A123 / A123M - 02.

   MINIMUM 50 KSI YIELD STRESS.

4. BREAK ALL BURRS AND SHARP EDGES.

5. ALL WELDING MUST BE IN COMPLIANCE WITH AWS CODE D1;1.



Section properties:

Weight: 2.641 lbs/ft
Area: 0.776 in^2
Perimeter: 14.238 in
Bounding Box: X: -1.187,1.187
Y: -1.187,1.187
Centroid:(0.000,0.000)
Moments of Inertia(in^4): Ix=0.499,Iy=0.499
Section modulus in bending(in^3): Wx=0.420,Wy=0.420
Radii of Gyration: X: 0.802, Y: 0.802

MATERIAL: SEE NOTES		**Sunmodo Corp.**	
Third Angle Projection:		14800 NE 65TH STREET, VANCOUVER WA 98682	
GENERAL SPECIFICATIONS All Dimensions in Inches [millimeters] Tolerances XXXX ±0.01 [0.25mm] XXX ±0.02 [0.50mm] XX ±0.039 [1.0mm] Unless otherwise spec'd	Break all sharp edges .010-.020 unless otherwise specified.	TITLE: PIPE, HSS, 2.375" OD X 12 GAUGE,L=XXX	
DRAWN BY: LWF	DATE: 04/03/2019	B	DRAWING NUMBER: A21165
CHECKED BY			
APPROVALS		SCALE: NONE	SHEET 1 of 1

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].

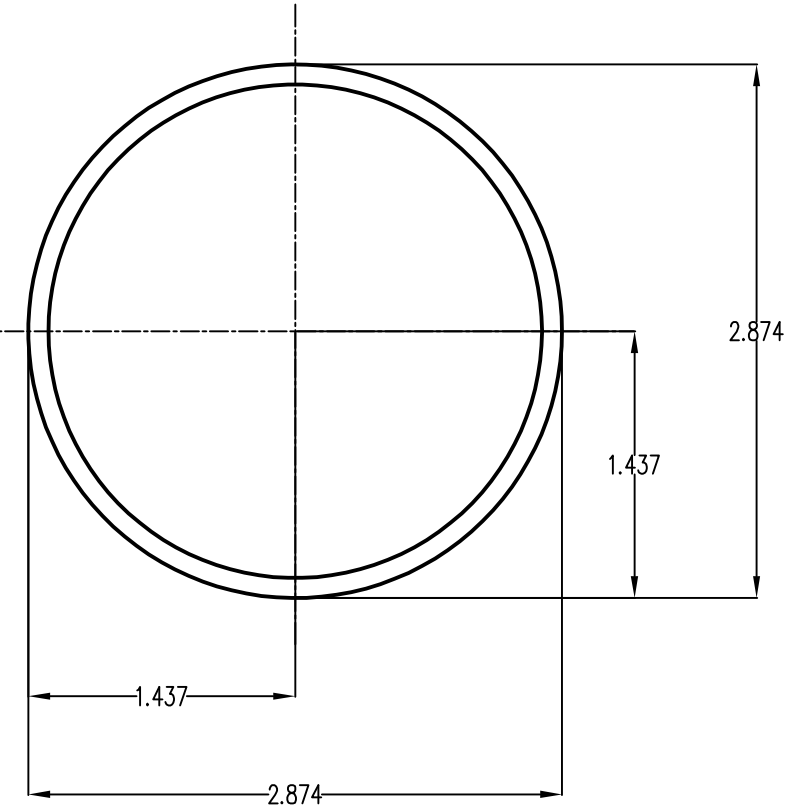
2. MATERAIL:HIGH STRENGTH STEEL PIPE OR TUBE.

3. FINISH: HOT DIP GALVANIZE PER ASTM A123 / A123M - 02.

   MINIMUM 50 KSI YIELD STRESS.

4. BREAK ALL BURRS AND SHARP EDGES.

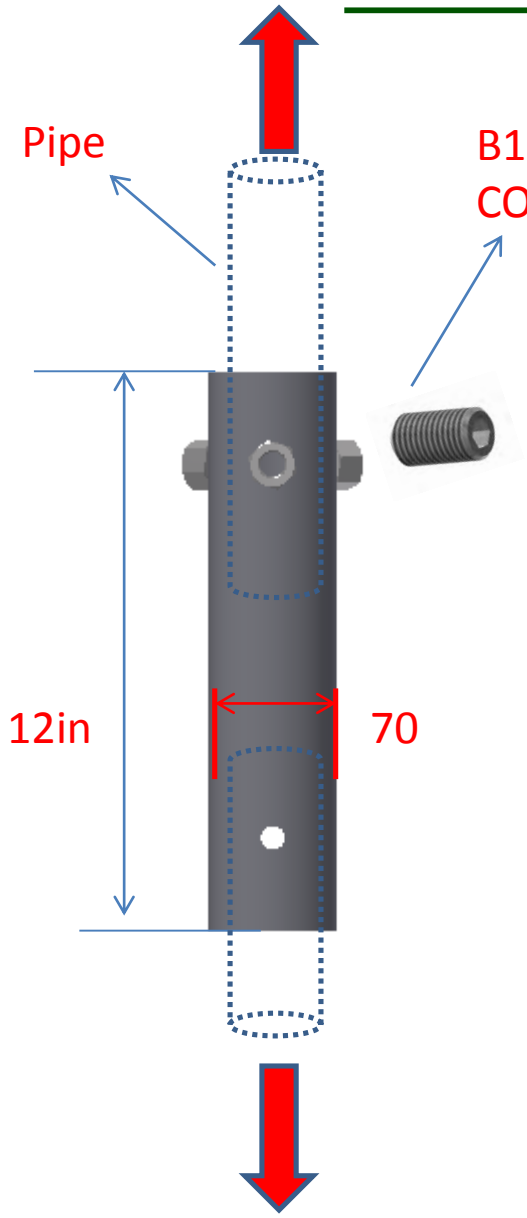
5. ALL WELDING MUST BE IN COMPLIANCE WITH AWS CODE D1;1.



Section properties:

Weight: 3.201 lbs/ft
Area: 0.941 in^2
Perimeter: 17.378 in
Bounding Box: X: -1.437,1.437
Y: -1.437,1.437
Centroid:(0.000,0.000)
Moments of Inertia(in^4): Ix=0.901,Iy=0.901
Section modulus in bending(in^3): Wx=0.627,Wy=0.627
Radii of Gyration: X: 0.979, Y: 0.979

MATERIAL: SEE NOTES		**Sunmodo Corp.**	
Third Angle Projection:		14800 NE 65TH STREET, VANCOUVER WA 98682	
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: PIPE, HSS, 2.875" OD X 12 GAUGE,L=XXX	
DRAWN BY: LWF	DATE: 04/03/2019	B	DRAWING NUMBER: A21168
CHECKED BY			
APPROVALS		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.