



Project Number: U2716-113-191

February 2, 2024

Sunmodo  
14800 NE 65<sup>th</sup> Street  
Vancouver, WA 98682

**REFERENCE: Sunmodo Sunturf Ground Mount A4  
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 Vermont Fire and Building Safety Code, 2015 Edition (2015 IBC). 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. This document does not address site-specific installations. 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	1560	1.5	2340
LATERAL	1130	2	2260

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

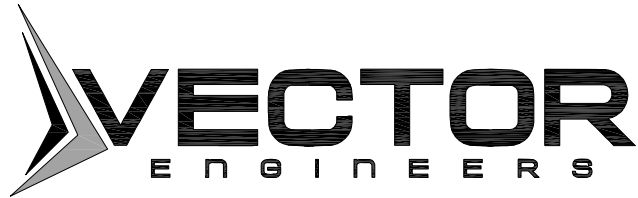
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Russell Emery, P.E.  
License: 018.0134496 - Expires: 7/31/2024  
Project Engineer

Enclosures

RNE/cjt

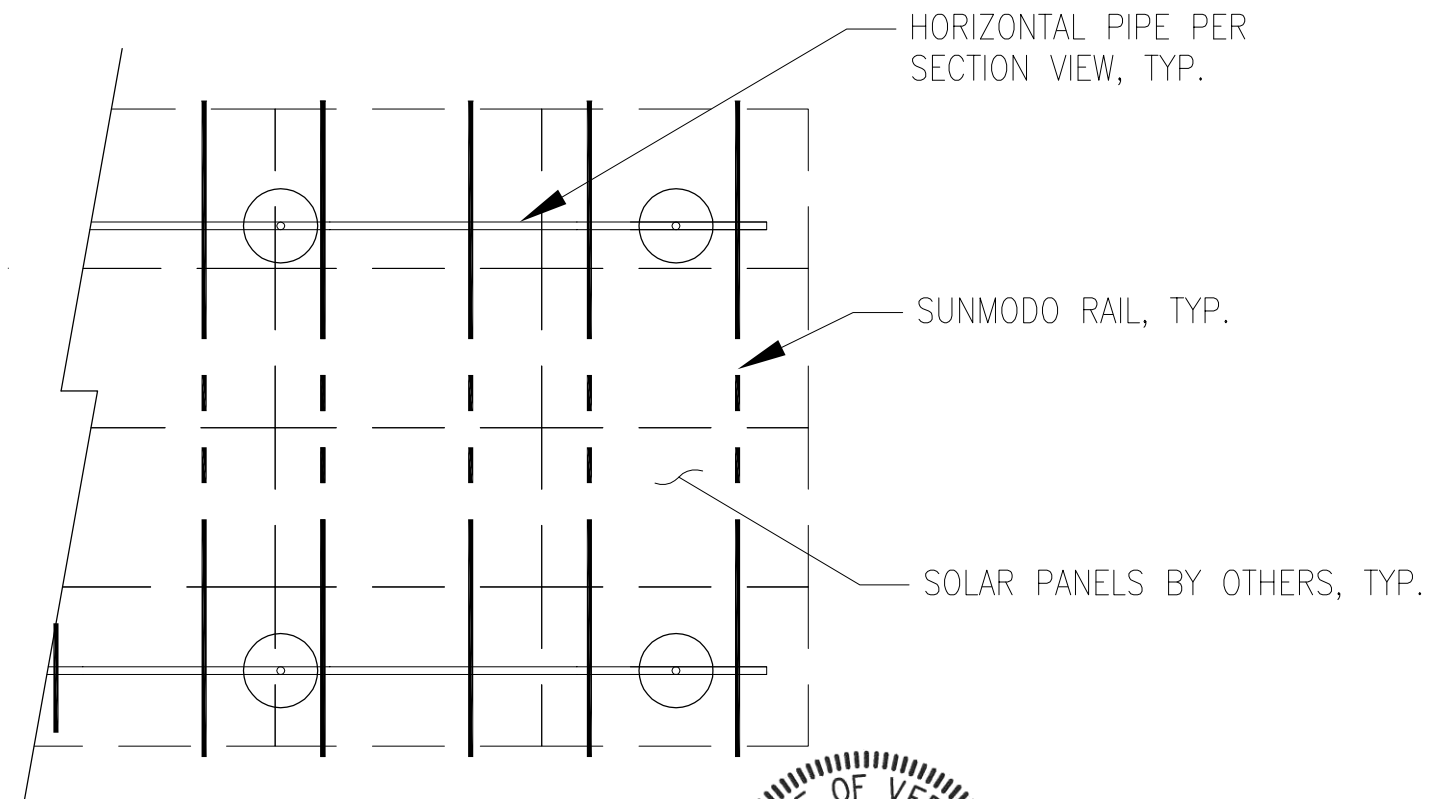
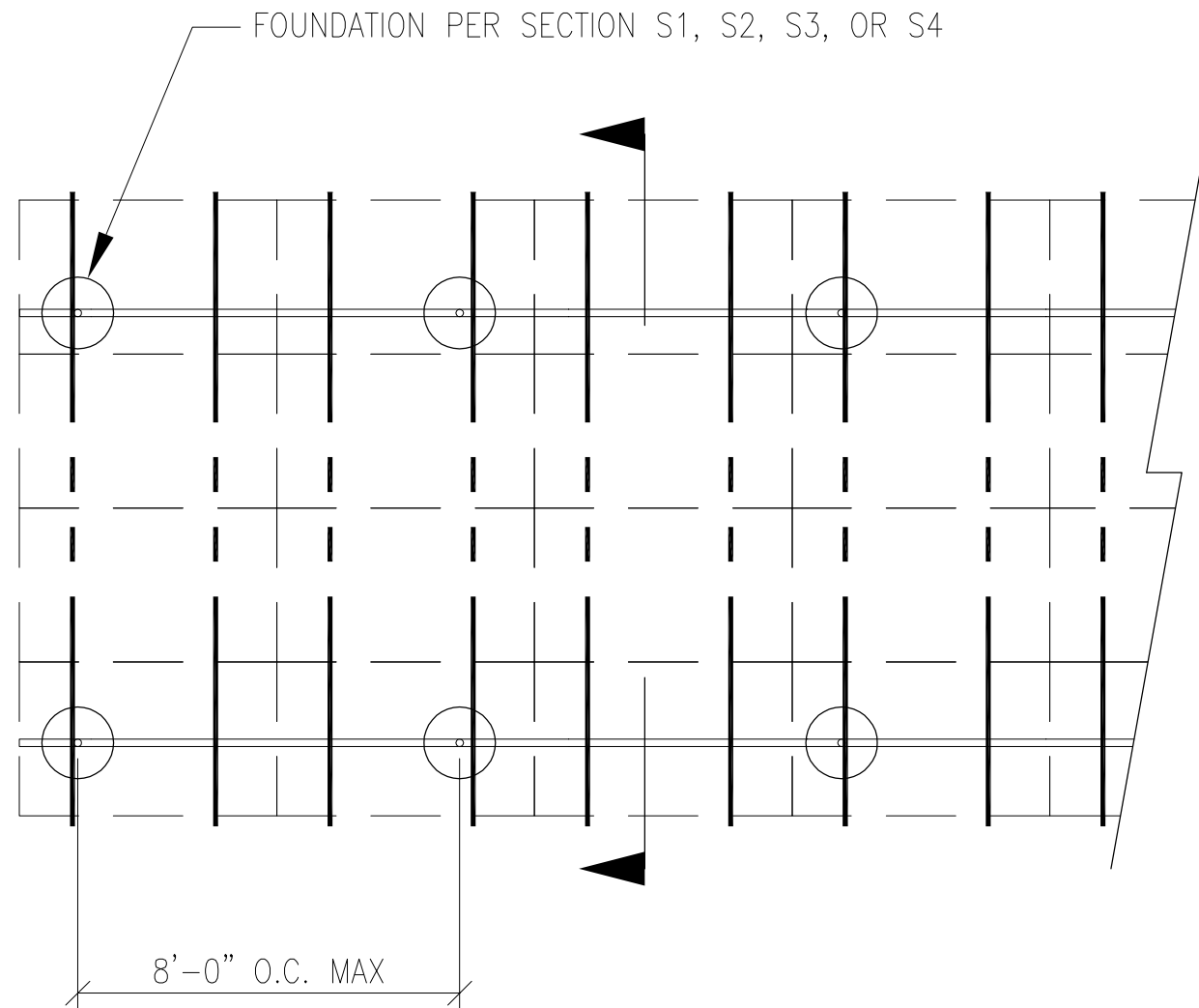


02/02/2024



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

651 W GALENA PARK BLVD. #101 (801) 990-1775  
 DRAPER, UTAH 84020 (801) 990-1776 FAX



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**PV ARRAY PLAN**

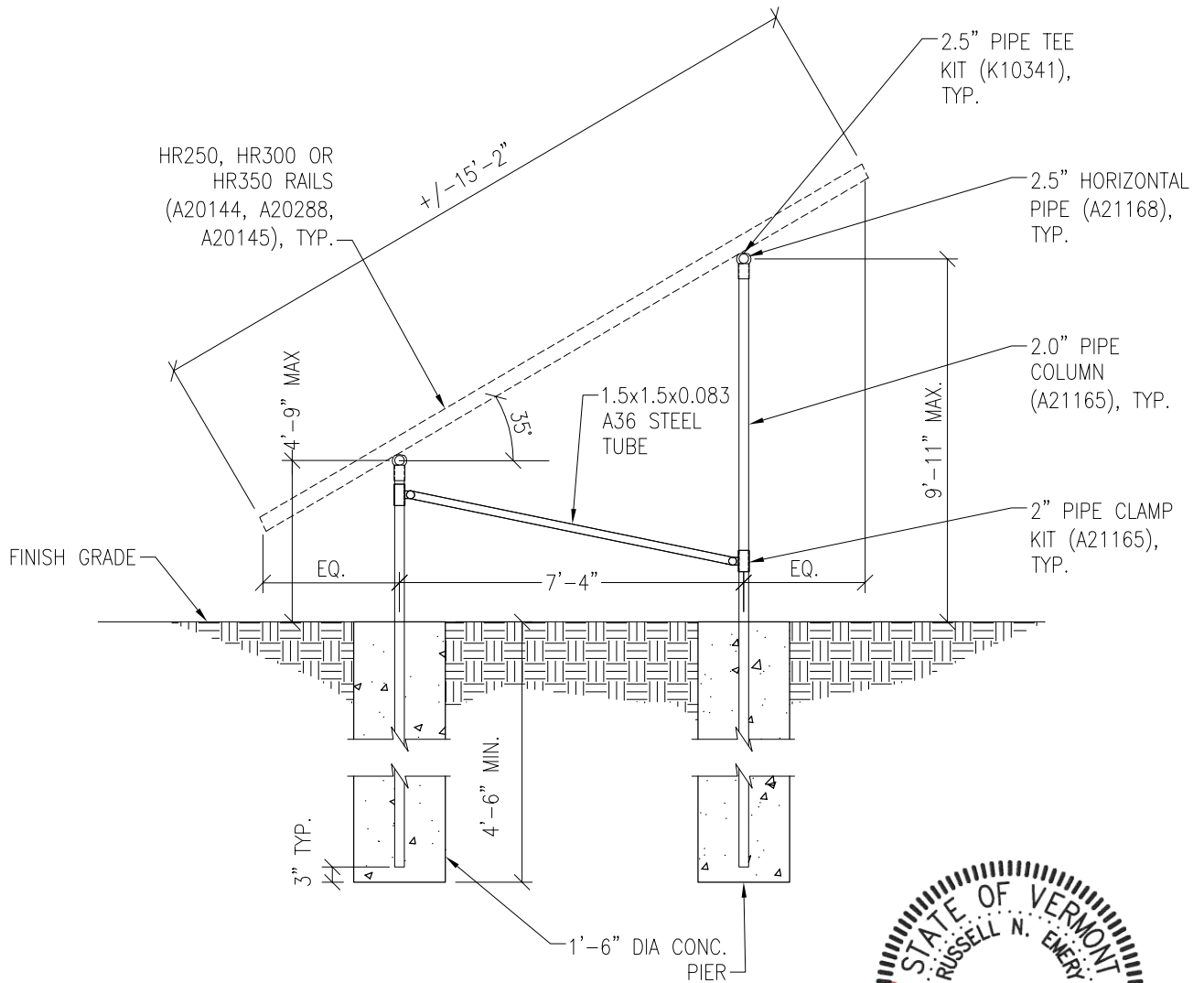
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N.T.S.

**P1**

PROJECT SUNMODO SUNTURF GROUND MOUNTS A4

SUBJECT DRILLED PIER OPTION



02/02/2024

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**PV ARRAY SECTION**

N.T.S.

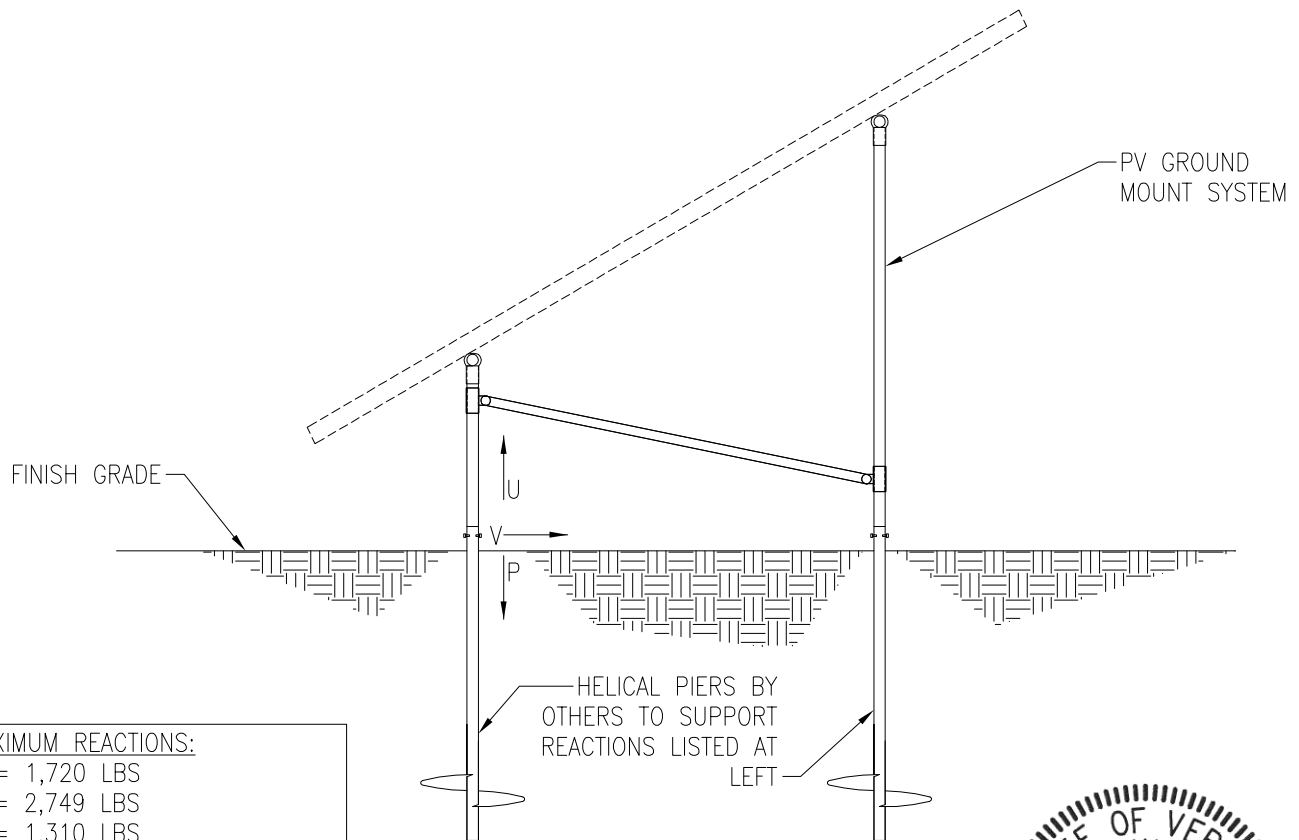
**S1**

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



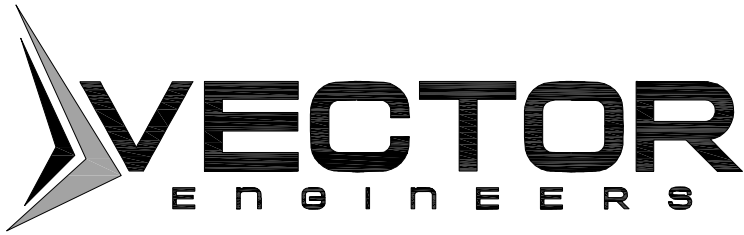
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**PV ARRAY SECTION**

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N.T.S.

**S2**



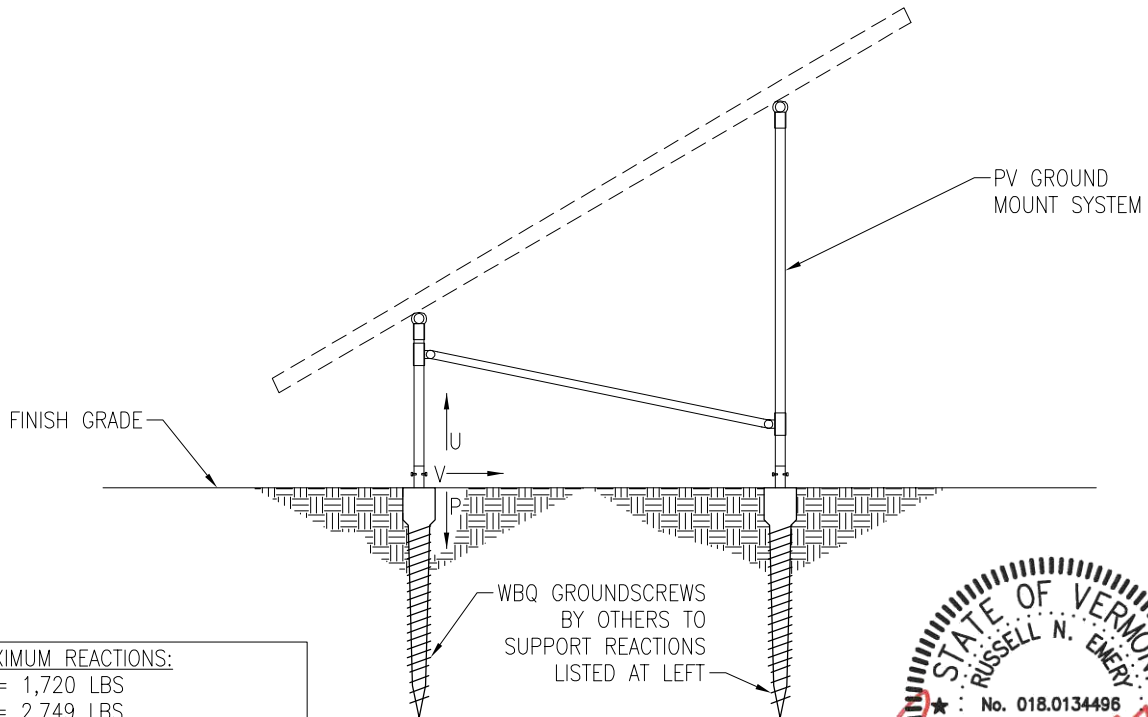
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PROJECT SUNMODO SUNTURF GROUND MOUNTS A41

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



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**PV ARRAY SECTION**

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**S3**

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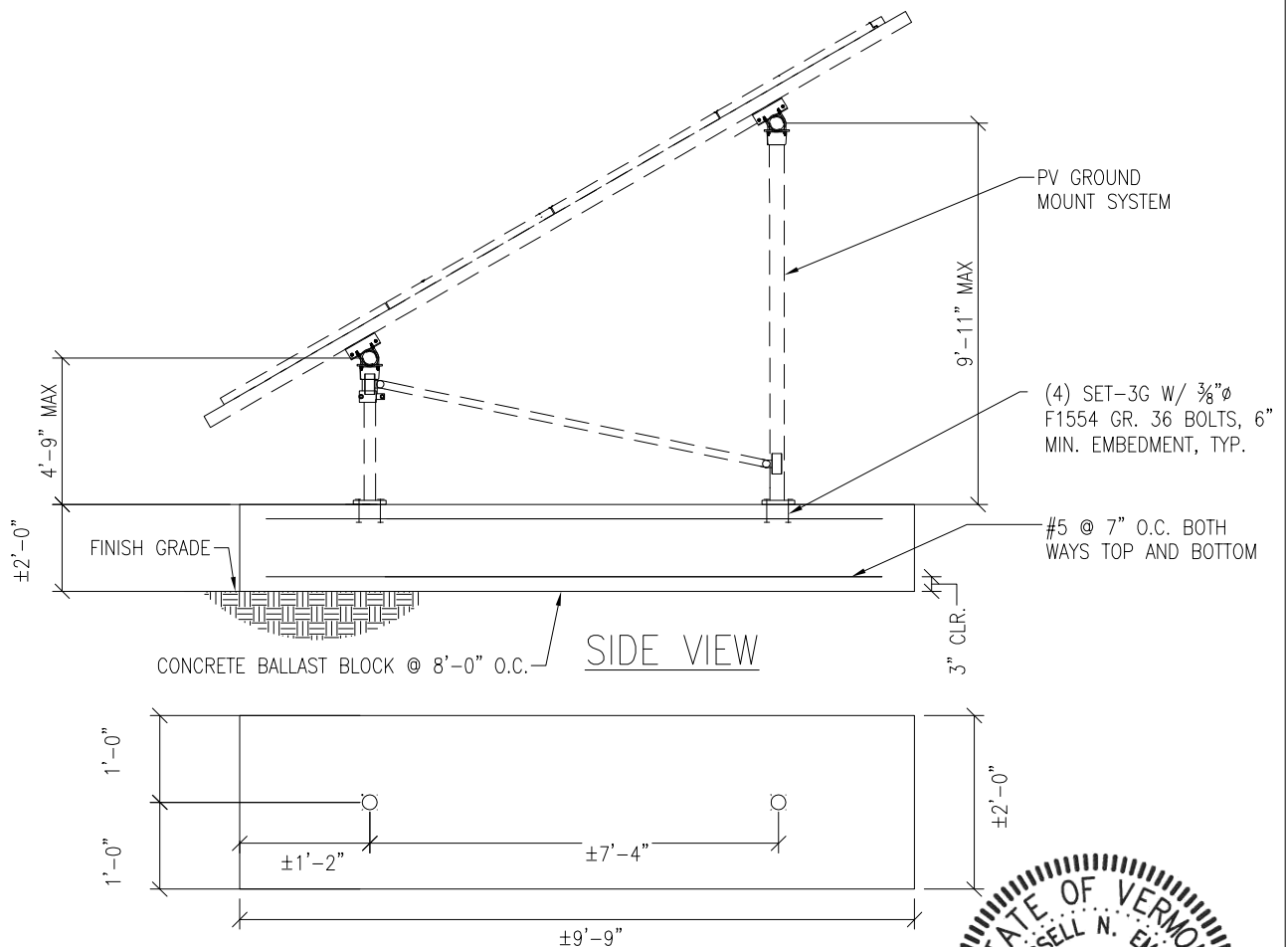
JOB NO. U2716-113-191

PROJECT SUNMODO SUNTURF GROUND MOUNTS A4

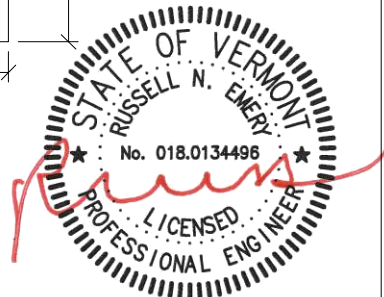
SUBJECT BALLASTED BLOCK OPTION

NOTES:

1. For ground mount components see Section S1.



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**PV ARRAY SECTION**

02/02/2024

**S4**

N.T.S.

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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 <sup>2</sup> ]:	33.7	
<b>Snow Load per Column (1.0 S) [lb]:</b>	<b>909.2</b>	



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 ( $\gamma = 0^\circ$ , Load Case A)	-1.80	-1.80
Case 2 ( $\gamma = 0^\circ$ , Load Case B)	-2.43	-0.57
Case 3 ( $\gamma = 180^\circ$ , Load Case A)	2.10	2.17
Case 4 ( $\gamma = 180^\circ$ , Load Case B)	2.67	1.07

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

Clear Wind Flow	$q_h GC_{NW}$	$q_h GC_{NL}$
Case 1 ( $\gamma = 0^\circ$ , Load Case A)	-23.0	-23.0
Case 2 ( $\gamma = 0^\circ$ , Load Case B)	-31.0	-7.2
Case 3 ( $\gamma = 180^\circ$ , Load Case A)	26.8	27.6
Case 4 ( $\gamma = 180^\circ$ , 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 ( $\gamma = 0^\circ$ , Load Case A)	-23.0	-23.0
Case 2 ( $\gamma = 0^\circ$ , Load Case B)	-7.2	-31.0
Case 3 ( $\gamma = 180^\circ$ , Load Case A)	26.8	27.6
Case 4 ( $\gamma = 180^\circ$ , 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, $K_{zt}$ :	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)

$\gamma = 90^\circ$  or  $270^\circ$

Force Coefficient,  $C_N$ :

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

Design Wind Pressure,  $p$  [psf]:

Horizontal Distance from Winward Edge	Roof angle		
	Load Case	Obstructed Wind Flow	
$\leq h$	35	A	-10.2
		B	10.2
$> h, \leq 2h$	35	A	-7.7
		B	6.4
$> 2h$	35	A	-3.8
		B	3.8



JOB NO.: U2716-113-191

DESIGNED: STB

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# Foundation Option 1: Drilled Concrete Pier



PROJECT: A4 - Sunturf Ground Mount

**DRILLED CONCRETE PIER DESIGN**

**Column Reactions:**

Max. Shear, V [k]:	1.3	Max. Down, P <sub>d</sub> [k]:	2.7
Max. Moment, M [k-ft]:	0.0	Max. Uplift, P <sub>u</sub> [k]:	1.7

**Pier Properties:**

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

**Soil Properties:**

Allow. Bearing Pressure [psf]:	1,500	<u>Optional Parameters for Uplift:</u>	
1/3 increase for short term loads?	No		
Lateral Bearing, S [pcf]:	150	Skin Friction* [psf]:	250
Max. Lateral Bearing (opt'l) [psf]:		Top Length to Ignore [ft]:	0
Top Depth to Ignore [ft]:	0	1/3 increase for short term loads?	No
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 Section 1807.3.2.1
Applied Lateral Force, P [lb]:	1,310	
Point of Application, h [ft]:	0.0	
S <sub>max</sub> [psf]:		
S [psf]:	450	
A = 2.34*P/(S <sub>b</sub> ):	4.54	
Required Pier Depth, d <sub>reqd</sub> [ft]:	4.50	IBC Eq. 18-1

Result: **Lateral bearing capacity OK.**

# 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

# 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

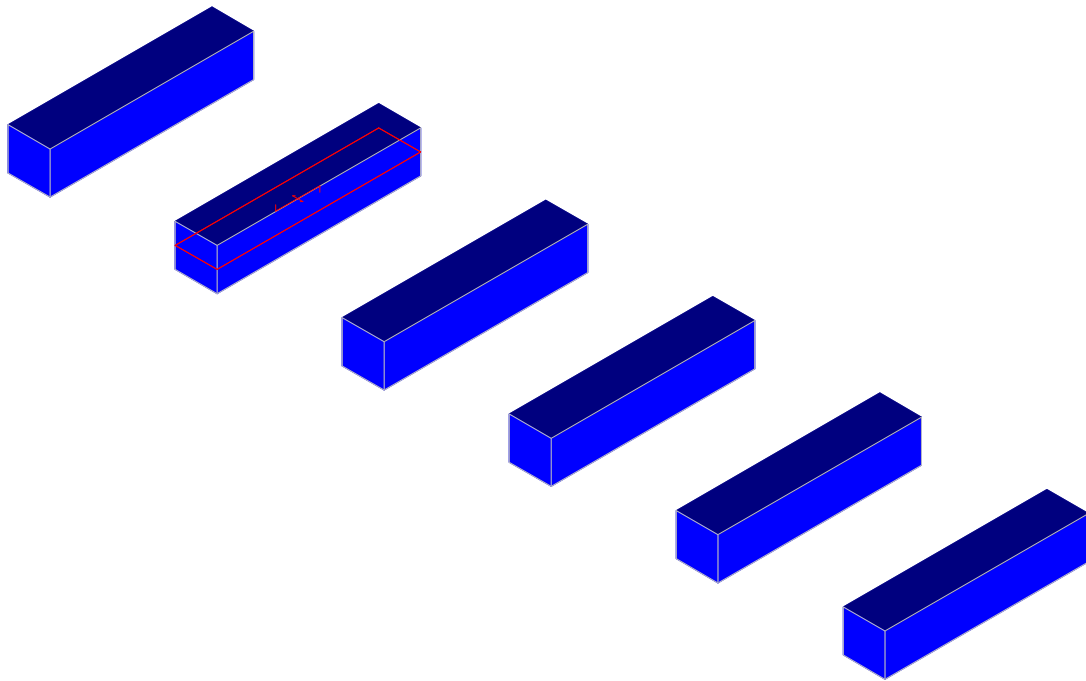


JOB NO.: U2716-113-191

DESIGNED: STB

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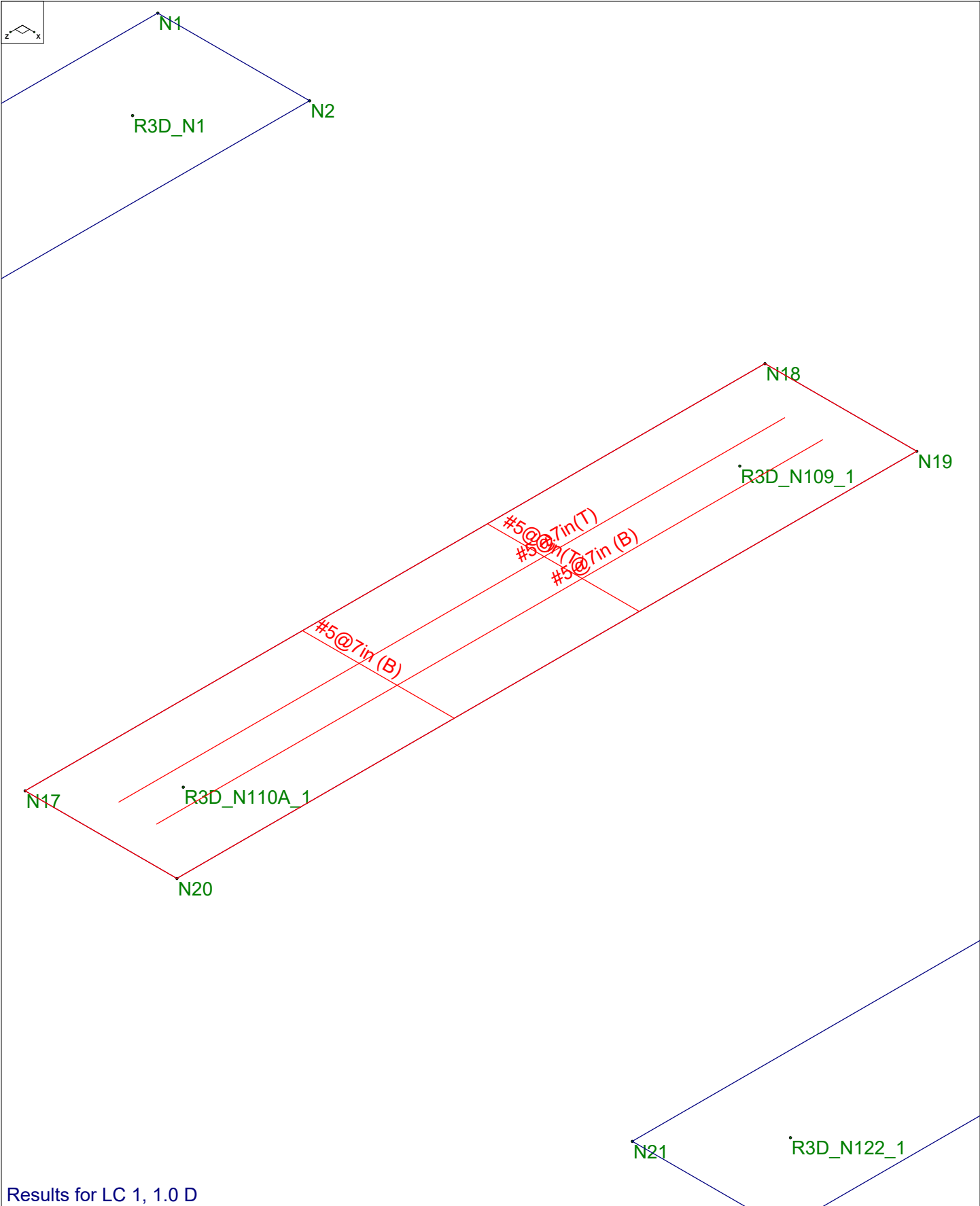
# Foundation Option 4: Ballasted Block



Vector Structural Engineeri...  
STB  
U2716.113.191

Ground Mount

SK - 1  
Apr 6, 2021 at 3:02 PM  
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
Parame 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]	fc[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











Company : Vector Structural Engineering  
 Designer : STB  
 Job Number : U2716.113.191  
 Model Name : Ground Mount

Apr 6, 2021  
 2:58 PM  
 Checked By: JSP

**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



Company : Vector Structural Engineering  
 Designer : STB  
 Job Number : U2716.113.191  
 Model Name : Ground Mount

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**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



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**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







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**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

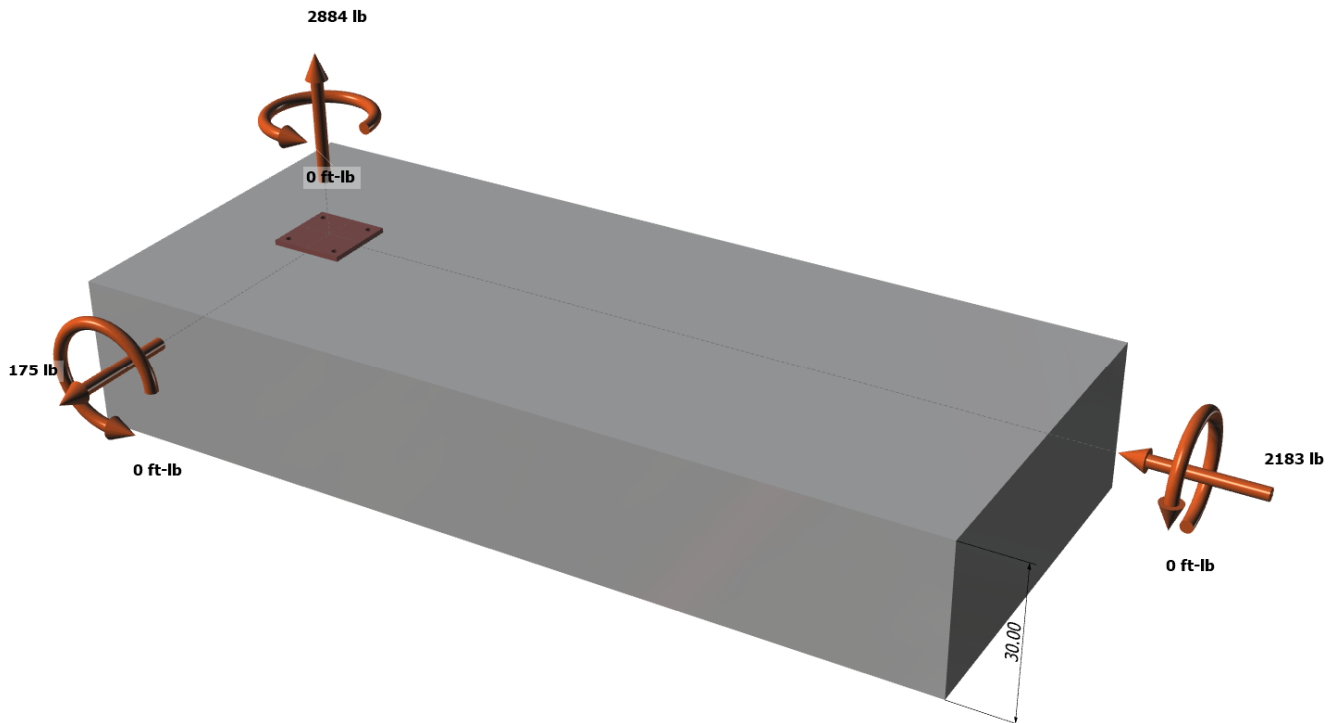
$V_{uay}$  [lb]: -2183

$M_{ux}$  [ft-lb]: 0

$M_{uy}$  [ft-lb]: 0

$M_{uz}$  [ft-lb]: 0

<Figure 1>





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<Figure 2>





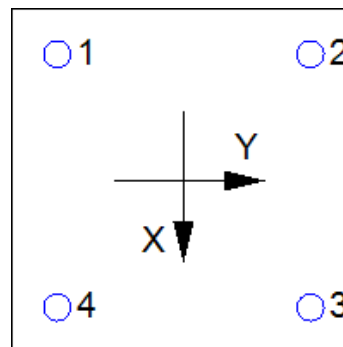
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### 3. Resulting Anchor Forces

Anchor	Tension load, N <sub>ua</sub> (lb)	Shear load x, V <sub>uax</sub> (lb)	Shear load y, V <sub>uay</sub> (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'<sub>Nx</sub> (inch): 0.00  
 Eccentricity of resultant tension forces in y-axis, e'<sub>Ny</sub> (inch): 0.00  
 Eccentricity of resultant shear forces in x-axis, e'<sub>Vx</sub> (inch): 0.00  
 Eccentricity of resultant shear forces in y-axis, e'<sub>Vy</sub> (inch): 0.00

<Figure 3>



### 4. Steel Strength of Anchor in Tension (Sec. 17.4.1)

N <sub>sa</sub> (lb)	φ	φN <sub>sa</sub> (lb)
4525	0.75	3394

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

$$N_b = K_c \lambda_a \sqrt{f_c} h_{ef}^{1.5} \text{ (Eq. 17.4.2.2a)}$$

K <sub>c</sub>	λ <sub>a</sub>	f <sub>c</sub> (psi)	h <sub>ef</sub> (in)	N <sub>b</sub> (lb)
17.0	1.00	2500	4.000	6800

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

A <sub>Nc</sub> (in <sup>2</sup> )	A <sub>Nco</sub> (in <sup>2</sup> )	C <sub>a,min</sub> (in)	Ψ <sub>ec,N</sub>	Ψ <sub>ed,N</sub>	Ψ <sub>c,N</sub>	Ψ <sub>cp,N</sub>	N <sub>b</sub> (lb)	φ	φN <sub>cbg</sub> (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)

$$\tau_{k,cr} = \tau_{k,cr,short-term} K_{sat} (f_c / 2,500)^n$$

τ <sub>k,cr</sub> (psi)	f <sub>short-term</sub>	K <sub>sat</sub>	f <sub>c</sub> (psi)	n	τ <sub>k,cr</sub> (psi)
1346	1.00	1.00	2500	0.24	1346

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

λ <sub>a</sub>	τ <sub>cr</sub> (psi)	d <sub>a</sub> (in)	h <sub>ef</sub> (in)	N <sub>ba</sub> (lb)
1.00	1346	0.38	4.000	6343

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

A <sub>Na</sub> (in <sup>2</sup> )	A <sub>Na0</sub> (in <sup>2</sup> )	C <sub>Na</sub> (in)	C <sub>a,min</sub> (in)	Ψ <sub>ec,Na</sub>	Ψ <sub>ed,Na</sub>	Ψ <sub>cp,Na</sub>	N <sub>ba</sub> (lb)	φ	φN <sub>ag</sub> (lb)
198.45	112.09	5.29	7.25	1.000	1.000	1.000	6343	0.55	6176



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

$V_{sa}$ (lb)	$\phi_{grout}$	$\phi$	$\phi_{grout}\phi V_{sa}$ (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)	$\lambda_a$	$f_c$ (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)

$A_{Vc}$ (in <sup>2</sup> )	$A_{Vco}$ (in <sup>2</sup> )	$\Psi_{ec,v}$	$\Psi_{ed,v}$	$\Psi_{c,v}$	$\Psi_{h,v}$	$V_{bx}$ (lb)	$\phi$	$\phi V_{cbgx}$ (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)	$\lambda_a$	$f_c$ (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)

$A_{Vc}$ (in <sup>2</sup> )	$A_{Vco}$ (in <sup>2</sup> )	$\Psi_{ec,v}$	$\Psi_{ed,v}$	$\Psi_{c,v}$	$\Psi_{h,v}$	$V_{by}$ (lb)	$\phi$	$\phi V_{cbgy}$ (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)	$\lambda_a$	$f_c$ (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)

$A_{Vc}$ (in <sup>2</sup> )	$A_{Vco}$ (in <sup>2</sup> )	$\Psi_{ec,v}$	$\Psi_{ed,v}$	$\Psi_{c,v}$	$\Psi_{h,v}$	$V_{by}$ (lb)	$\phi$	$\phi V_{cbgx}$ (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)	$\lambda_a$	$f_c$ (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)

$A_{Vc}$ (in <sup>2</sup> )	$A_{Vco}$ (in <sup>2</sup> )	$\Psi_{ec,v}$	$\Psi_{ed,v}$	$\Psi_{c,v}$	$\Psi_{h,v}$	$V_{bx}$ (lb)	$\phi$	$\phi V_{cbgy}$ (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)**

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

$k_{cp}$	$A_{Na}$ (in <sup>2</sup> )	$A_{Na0}$ (in <sup>2</sup> )	$\Psi_{ed,Na}$	$\Psi_{ec,Na}$	$\Psi_{cp,Na}$	$N_{ba}$ (lb)	$N_a$ (lb)
2.0	198.45	112.09	1.000	1.000	1.000	6343	11230

$A_{Nc}$ (in <sup>2</sup> )	$A_{Nco}$ (in <sup>2</sup> )	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	$N_b$ (lb)	$N_{cb}$ (lb)	$\phi$
240.25	144.00	1.000	1.000	1.000	1.000	6800	11345	0.70

Input data and results must be checked for agreement with the existing circumstances, the standards and guidelines must be checked for plausibility.



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$\phi V_{cpq}$  (lb)  
15722

## 11. Results

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

Tension	Factored Load, $N_{ua}$ (lb)	Design Strength, $\phi N_n$ (lb)	Ratio	Status	
Steel	721	3394	0.21	Pass	
Concrete breakout	2884	7374	0.39	Pass	
<b>Adhesive</b>	<b>2884</b>	<b>6176</b>	<b>0.47</b>	<b>Pass (Governs)</b>	
Shear	Factored Load, $V_{ua}$ (lb)	Design Strength, $\phi V_n$ (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	
<b>Concrete breakout, combined</b>	-	-	<b>0.41</b>	<b>Pass (Governs)</b>	
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.



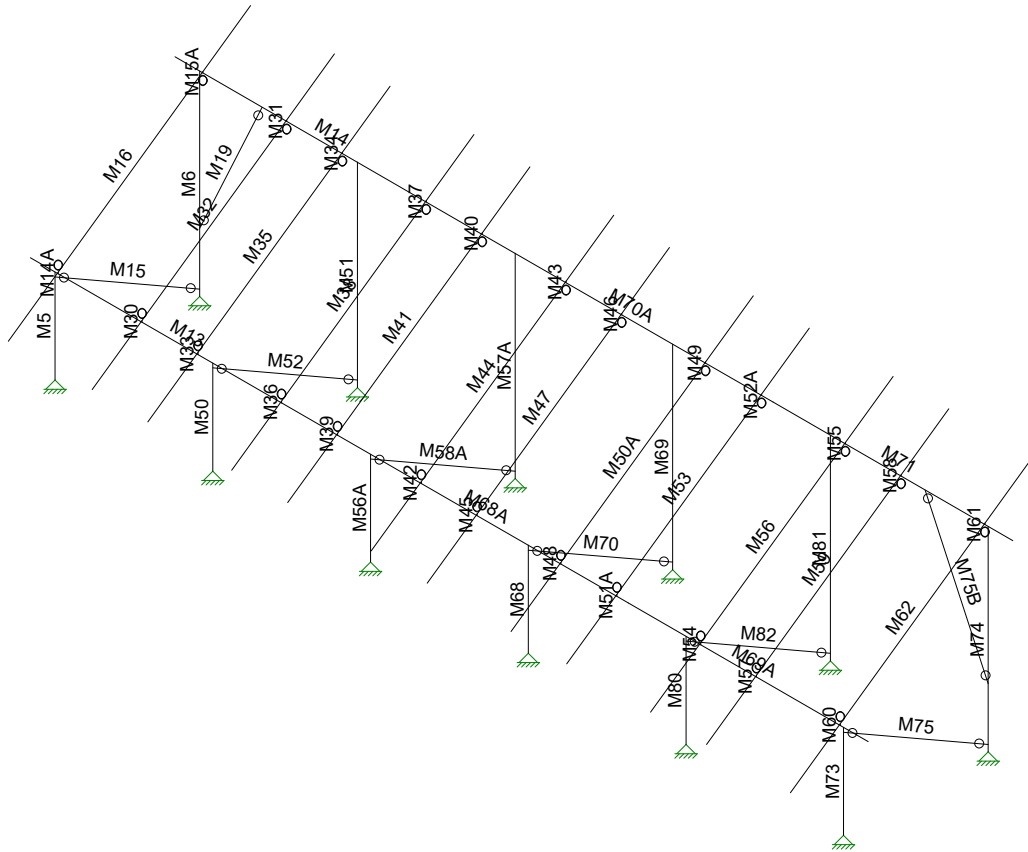
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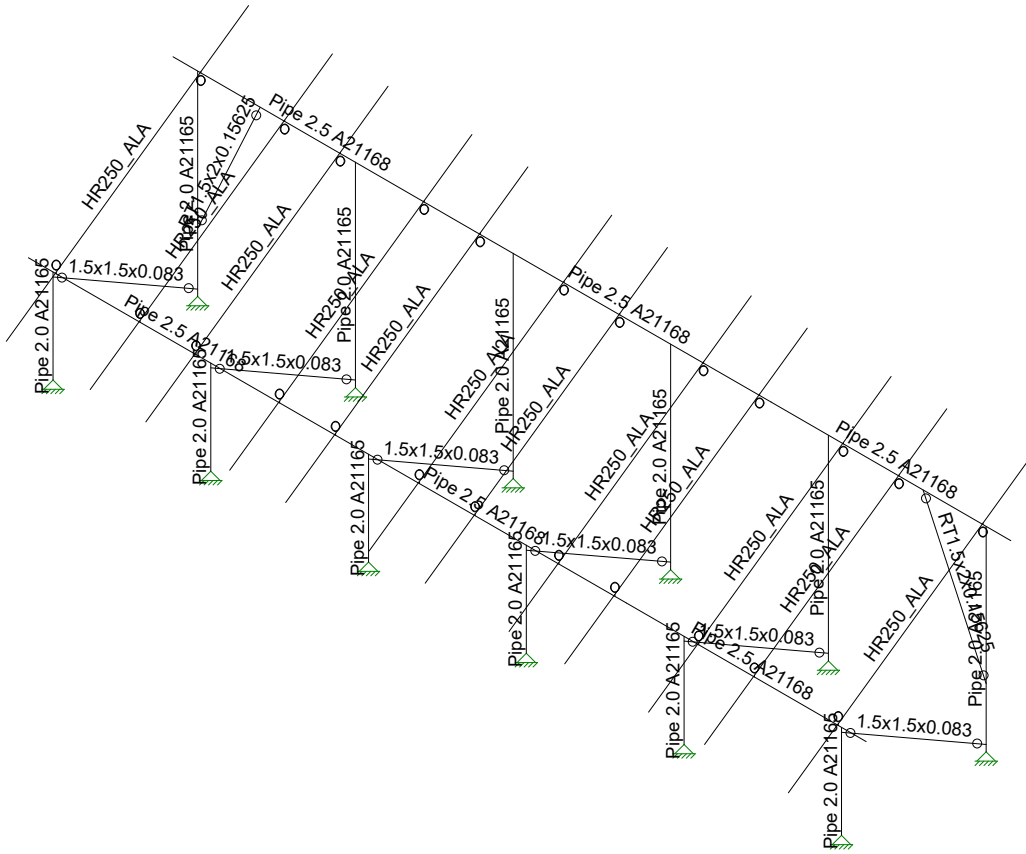
DESIGNED: STB

PROJECT: Ground Mount Package for Ontario Canada

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# Framing Analysis





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STB

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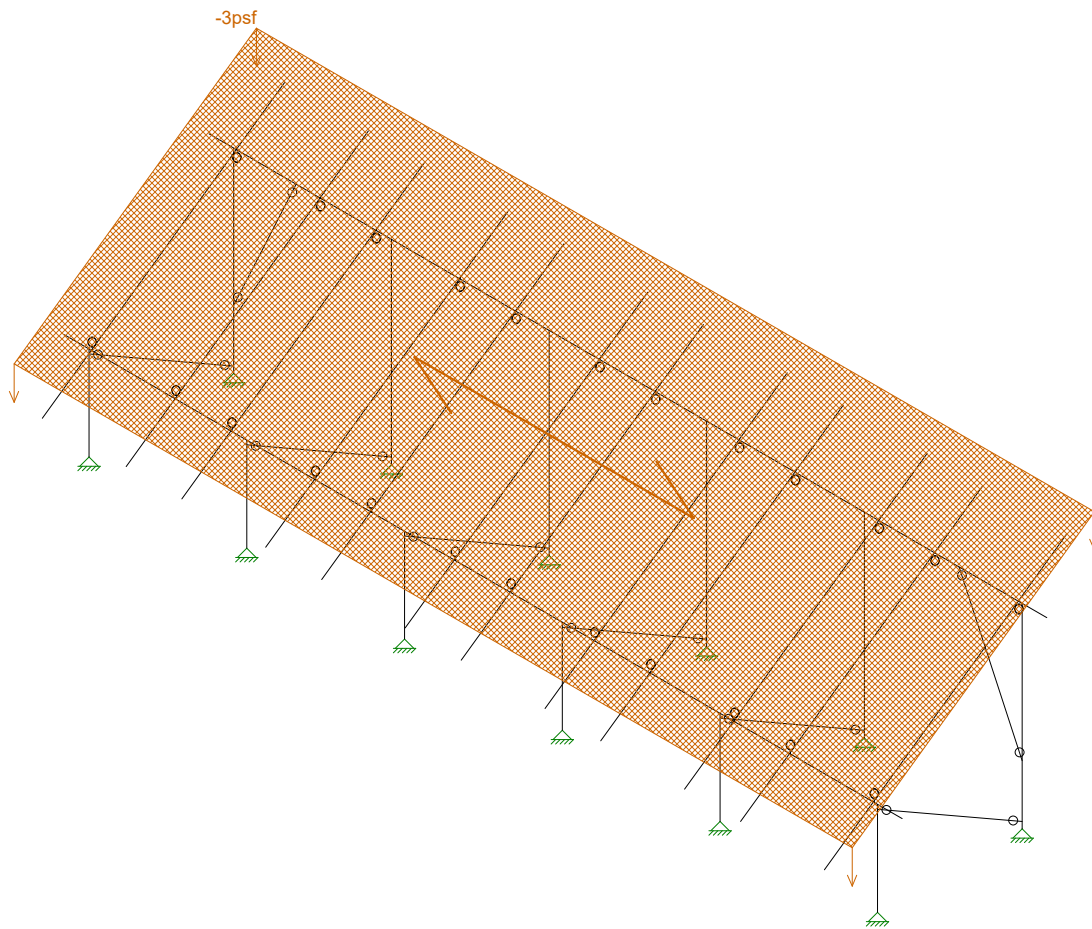
Ground Mount

SK - 6

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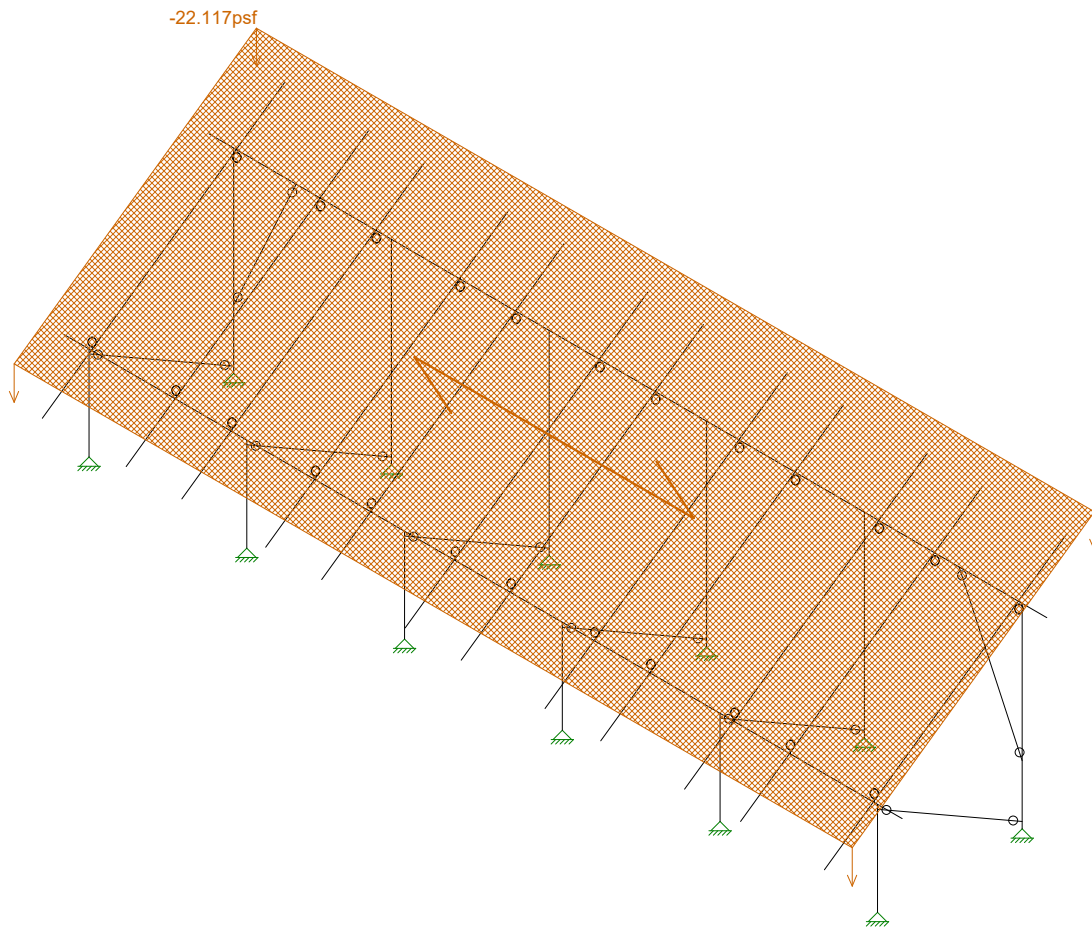
Sunmodo Sunturf A4 v3 85x45.r3d





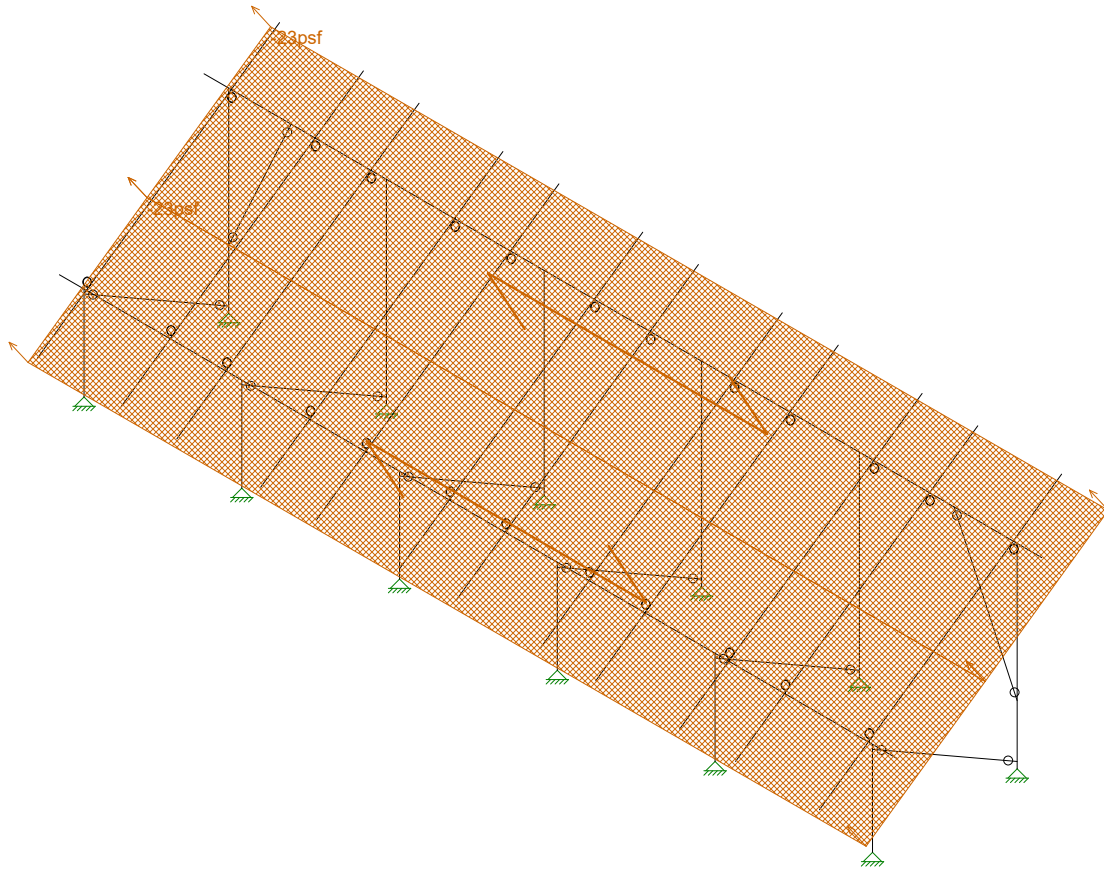
Loads: BLC 2, Solar Panel Weight

Vector Structural Engineeri...	Ground Mount	SK - 7
STB		Apr 6, 2021 at 2:47 PM
U2716.113.191		Sunmodo Sunturf A4 v3 85x45.r3d



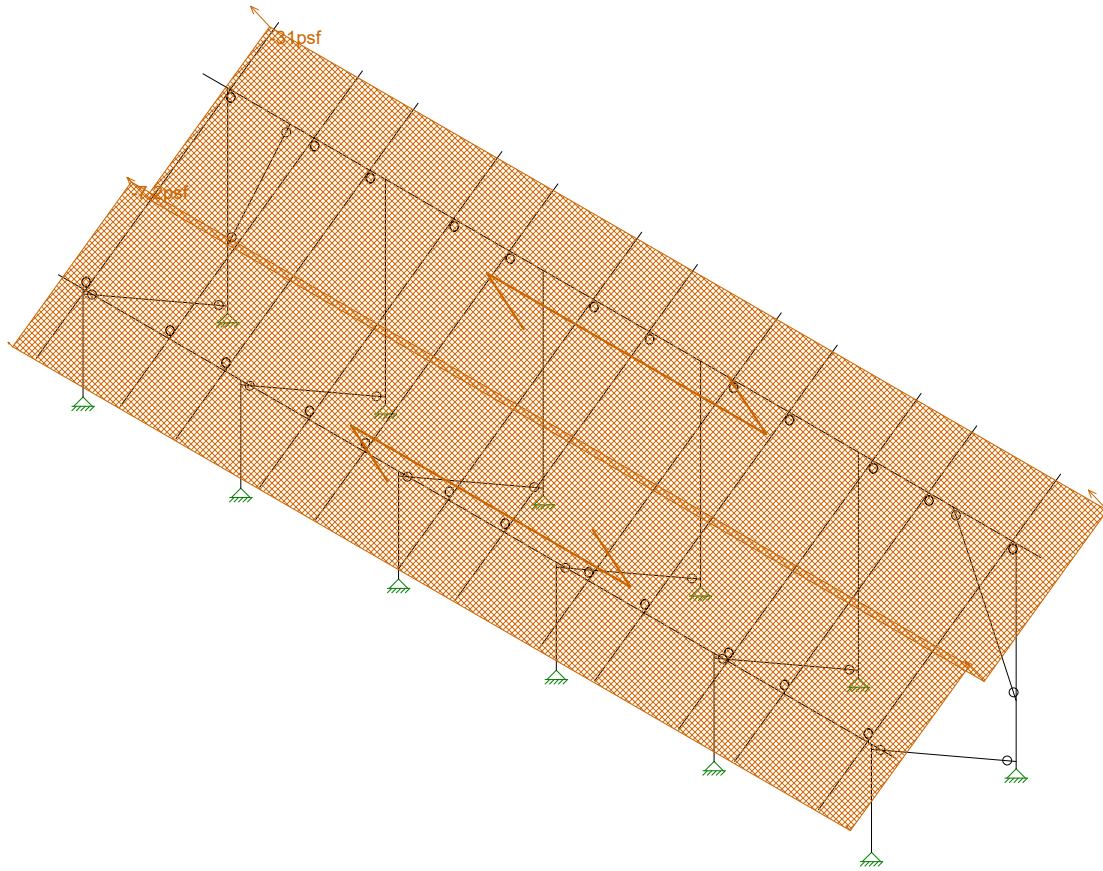
Loads: BLC 3, Roof Live/Snow

Vector Structural Engineeri...	Ground Mount	SK - 8
STB		Apr 6, 2021 at 2:48 PM
U2716.113.191		Sunmodo Sunturf A4 v3 85x45.r3d



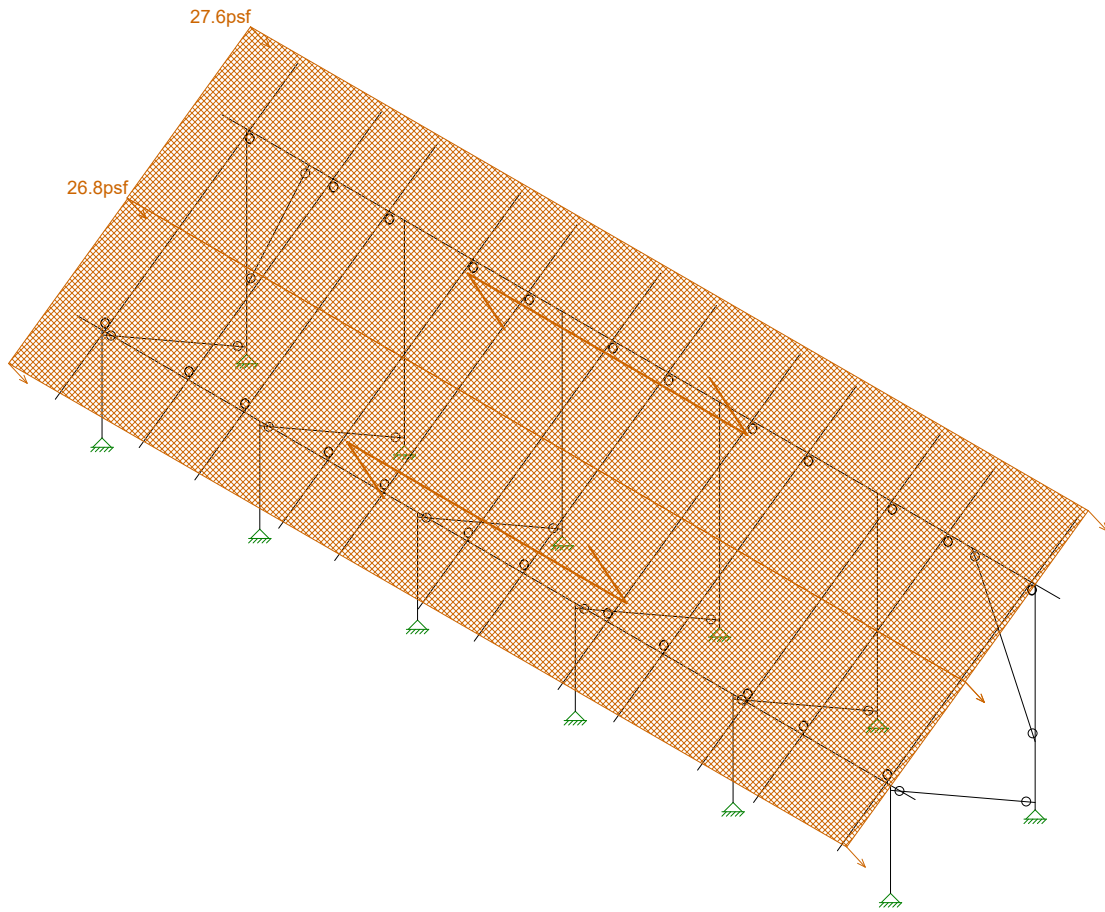
Loads: BLC 4, Wind A 0 deg

Vector Structural Engineeri..	Ground Mount	SK - 9
STB		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...	Ground Mount	SK - 10
STB		Apr 6, 2021 at 2:48 PM
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Loads: BLC 6, Wind A 180 deg

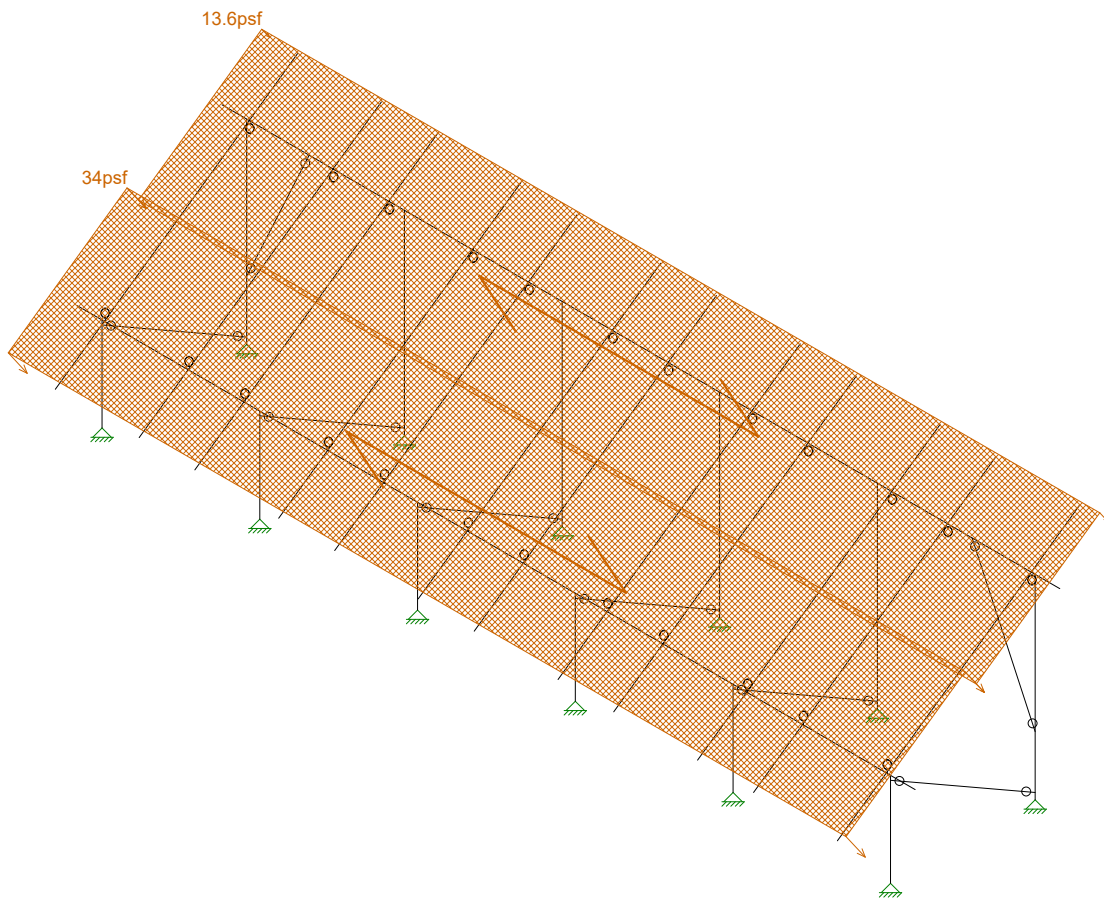
Vector Structural Engineeri...  
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Ground Mount

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Sunmodo Sunturf A4 v3 85x45.r3d



Loads: BLC 7, Wind B 180 deg

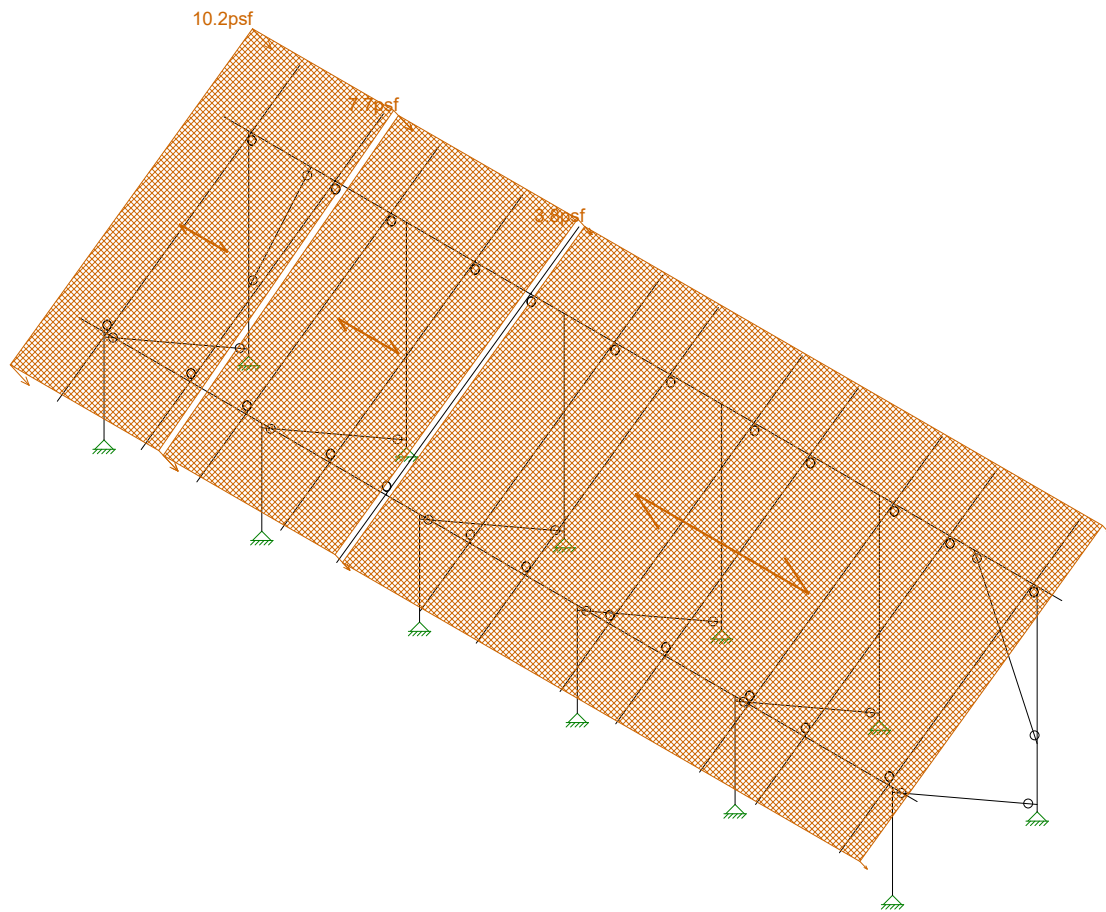
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STB  
U2716.113.191

Ground Mount

SK - 12

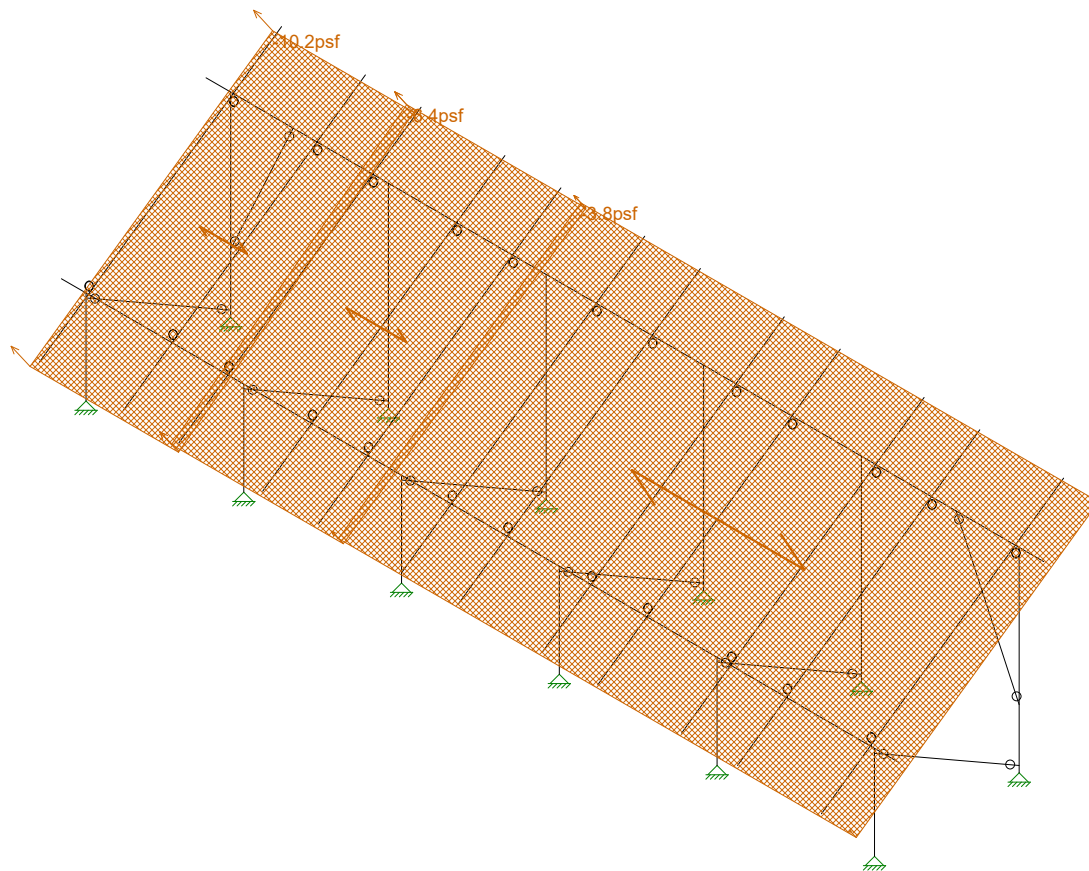
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Sunmodo Sunturf A4 v3 85x45.r3d



Loads: BLC 8, Wind A 90

Vector Structural Engineeri...	Ground Mount	SK - 13
STB		Apr 6, 2021 at 2:48 PM
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Loads: BLC 9, Wind B 90

Vector Structural Engineeri...

STB

U2716.113.191

Ground Mount

SK - 14

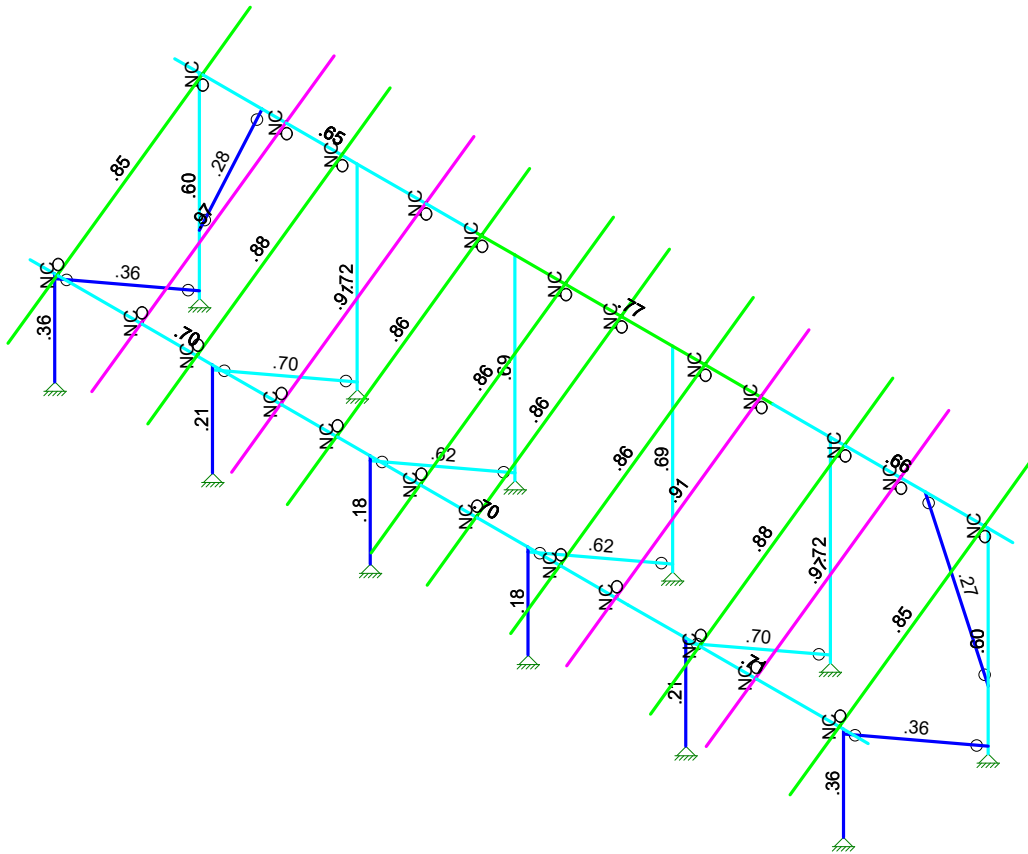
Apr 6, 2021 at 2:48 PM

Sunmodo Sunturf A4 v3 85x45.r3d





Code Check (Env)	
Black	No Calc
Red	> 1.0
Magenta	.90-1.0
Green	.75-.90
Cyan	.50-.75
Blue	0-.50



Member Code Checks Displayed (Enveloped)  
Envelope Only Solution

Vector Structural Engineeri...

STB

U2716.113.191

Ground Mount

SK - 3

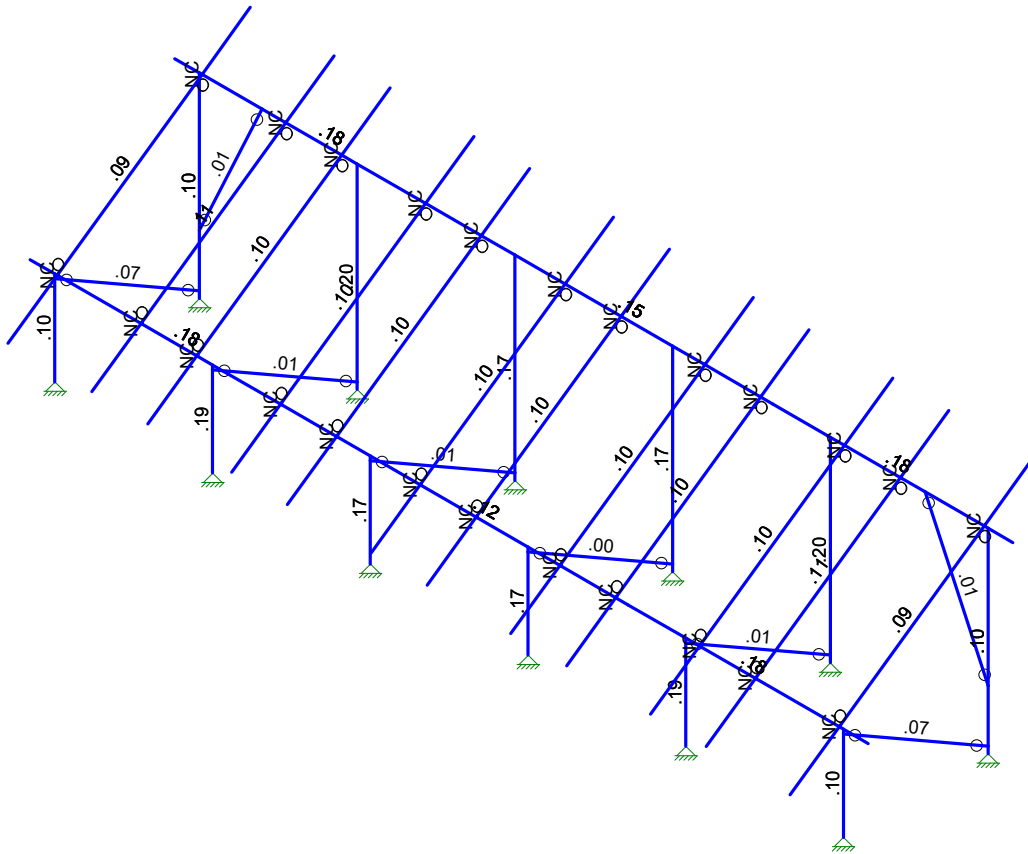
Apr 6, 2021 at 2:47 PM

Sunmodo Sunturf A4 v3 85x45.r3d



Shear Check  
( Env )

- No Calc
- > 1.0
- .90-1.0
- .75-.90
- .50-.75
- 0-.50



Member Shear Checks Displayed (Enveloped)  
Envelope Only Solution

Vector Structural Engineeri...

STB

U2716.113.191

Ground Mount

SK - 4

Apr 6, 2021 at 2:47 PM

Sunmodo Sunturf A4 v3 85x45.r3d





### 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...	
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





Company : Vector Structural Engineering  
 Designer : STB  
 Job Number : U2716.113.191  
 Model Name : Ground Mount

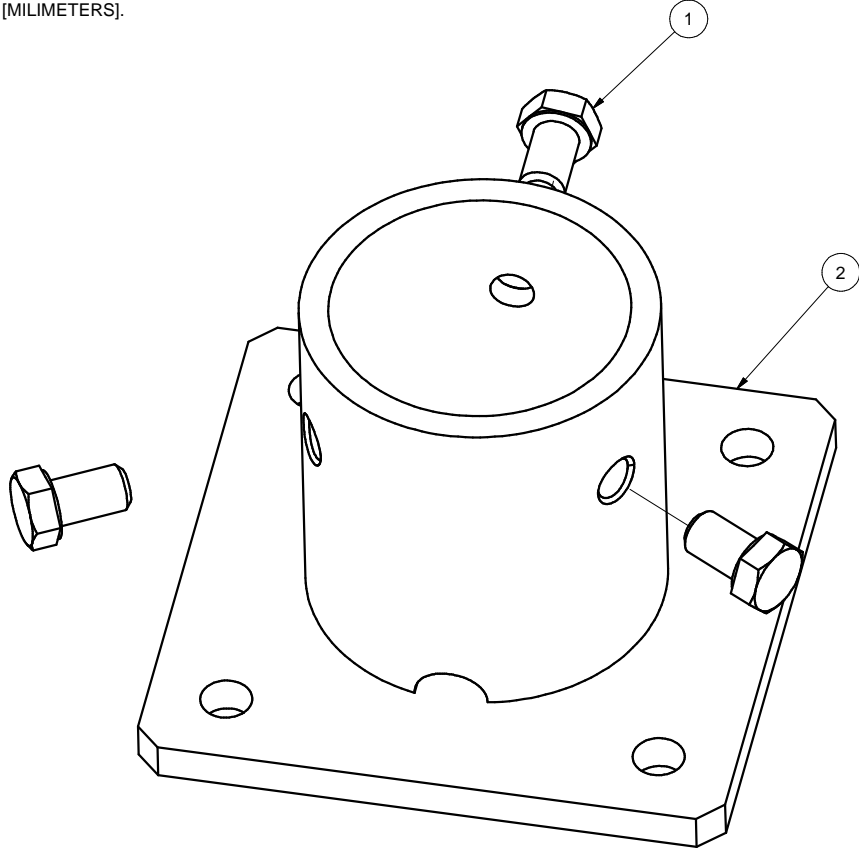
Apr 6, 2021  
 2:48 PM  
 Checked By: \_\_\_\_\_

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

Member	Shape	Code C...	Loc[fin]	LC Shear ...	Loc[fin]	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



NOTES: UNLESS OTHERWISE SPECIFIED  
 1. DIMENSIONS SHOWN ARE INCHES [MILLIMETERS].



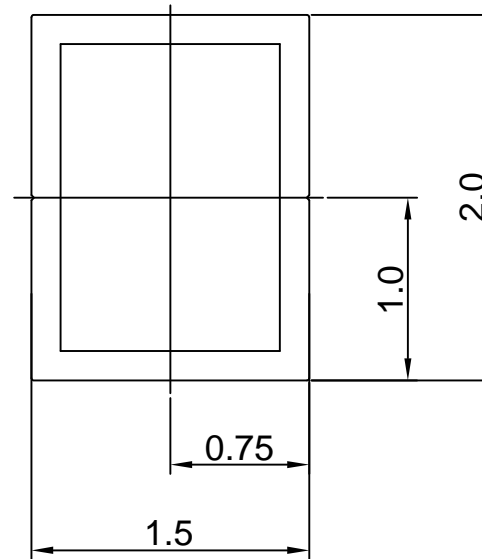
REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	10/20/2016

2	A21120-001	2" PIPE BASE	1
1	B15018-011	HEX CAP SCREW 3/8-16 X 5/8	3
ITEM	PART NUMBER	DESCRIPTION	QTY
MATERIAL		SEE NOTES	
Third Angle Projection:			
GENERAL SPECIFICATIONS		<b>Sunmodo Corp.</b> 1905 E 5TH STREET, STE A, VANCOUVER, WA 98661	
Tolerances		TITLE	
X.XXX ±0.01 [0.25mm]		2" PIPE BASE KIT	
X.XX ±0.02 [0.50mm]		DRAWING NUMBER	
X.X ±0.039 [1.0mm]		B K10268-001	
Unless otherwise spec'd		SCALE: NONE	
DRAWN BY		DATE	
LWF		10/20/2016	
CHECKED BY		APPROVALS	
		SHEET 1 of 1	

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NOTES: UNLESS OTHERWISE SPECIFIED

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



## Section properties:

Weight: 1.156 lbs/ft

Area: 0.992 in<sup>2</sup>

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<sup>4</sup>): I<sub>x</sub>=0.506,I<sub>y</sub>=0.322

Section modulus in bending(in<sup>3</sup>): W<sub>x</sub>=0.675,W<sub>y</sub>=0.322

Radii of Gyration: X: 0.714, Y: 0.570

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

**Sunmodo Corp.**

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

TITLE  
1.5X2 AL TUBE BRACE EXTRUSION

DRAWING NUMBER  
A20164

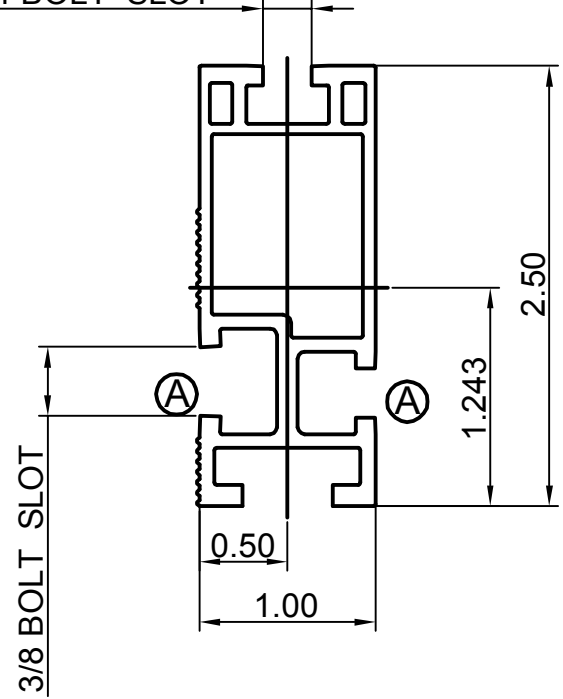
SCALE: NONE SHEET 1 of 1

REVISIONS			
REV	DESCRIPTION	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  $\mu$ m THICK.
3. THE UNSPECIFIED DIMENSIONS ARE SPECIFIED BY 2D CAD FILE.

2X 1/4 BOLT SLOT



### Section properties:

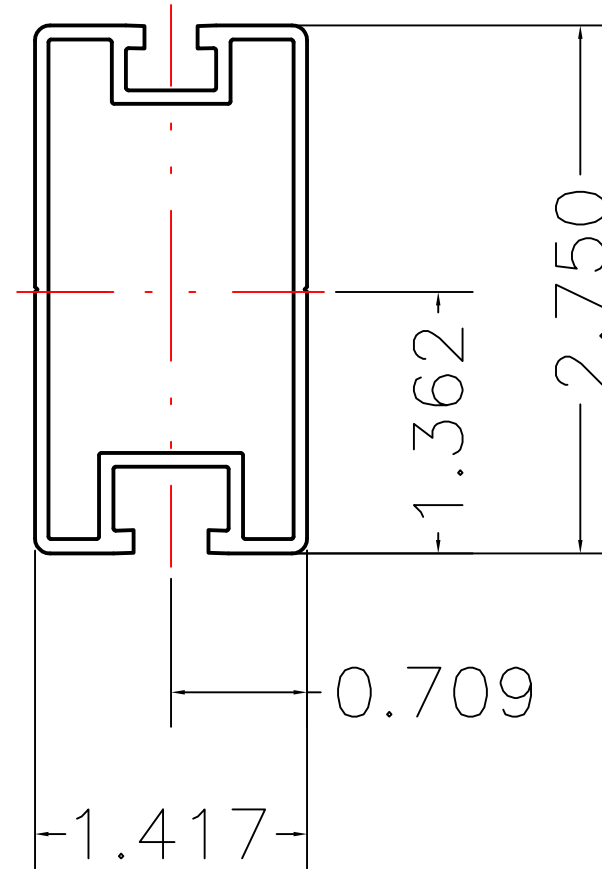
Weight: 0.850 lbs/ft  
 Area: 0.723 in<sup>2</sup>  
 Perimeter: 17.325 in  
 Bounding Box: X: -0.500,0.500  
 Y: -1.243,1.257

Centroid:(0.000,0.000)  
 Moments of Incertia(in<sup>4</sup>): Ix=0.486,Iy=0.095  
 Section modulus in bending(in<sup>3</sup>): Wx=0.387,Wy=0.190  
 Radii of Gyration: X: 0.820, Y: 0.363

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

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<sup>2</sup>  
 Perimeter: 19.824 in  
 Bounding Box: X: -0.709,0.709  
                   Y: -1.362,1.388  
 Centroid:(0.000,0.000)  
 Moments of Inertia(in<sup>4</sup>): I<sub>x</sub>=0.727,I<sub>y</sub>=0.214  
 Section modulus in bending(in<sup>3</sup>): W<sub>x</sub>=0.524,W<sub>y</sub>=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]	Break all sharp edges .010-.020 unless otherwise specified.
X.XX ±0.02 [0.50mm]	
X.X ±0.039 [1.0mm]	
Unless otherwise spec'd	
DRAWN BY KYY	DATE 01/18/2018
CHECKED BY	
APPROVALS	

<b>SunModo Corp.</b>	
14800 NE 65TH STREET, VANCOUVER WA 98682	
TITLE RAIL, HR300 (SUNRAY), EXTRUSION	
B	DRAWING NUMBER A20288
SCALE: NONE	SHEET 1 of 1

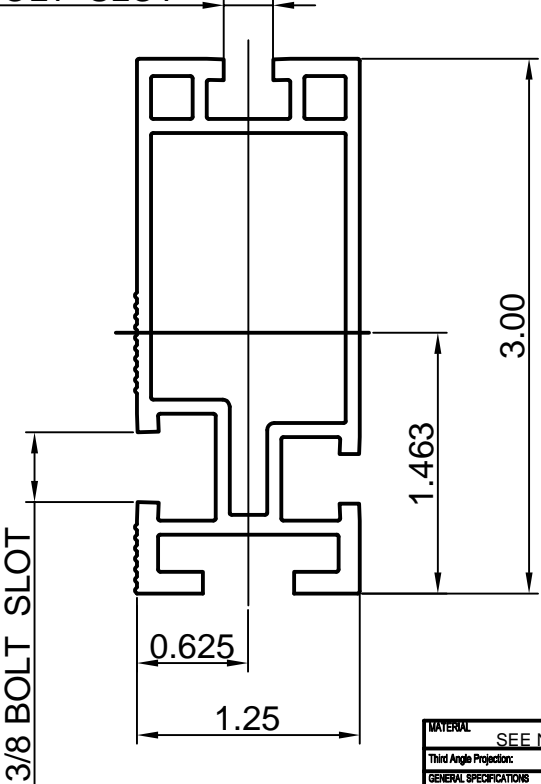
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REV	DESCRIPTON	BY	DATE
A	0.44 WAS 0.41, 0.44 WAS 0.33	LWF	11/30/2015

NOTES: UNLESS OTHERWISE SPECIFIED

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

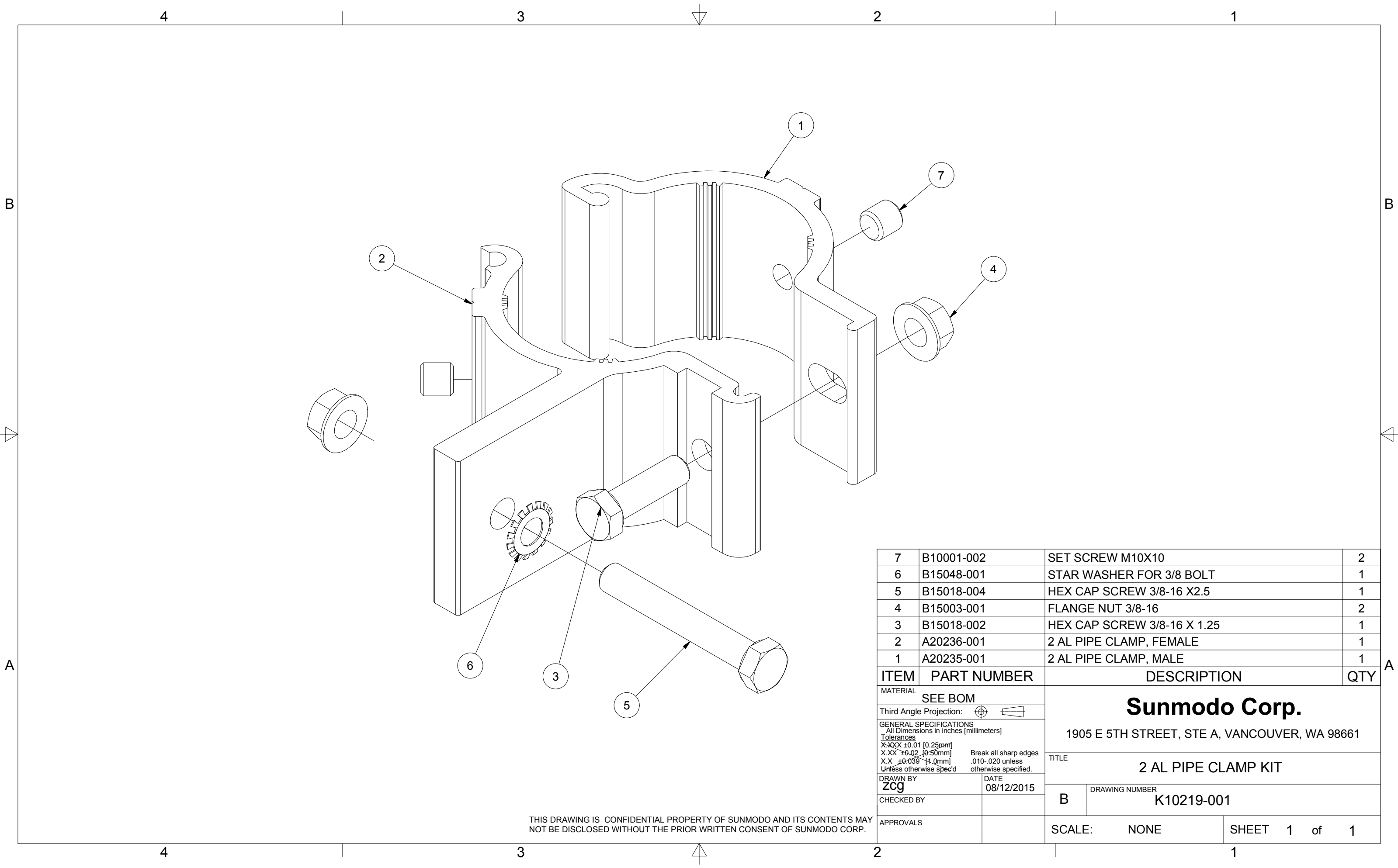
2X 1/4 BOLT SLOT



**Section properties:**

Weight: 1.151 lbs/ft  
 Area: 0.980 in<sup>2</sup>  
 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<sup>4</sup>): Ix=1.047,Iy=0.207  
 Section modulus in bending(in<sup>3</sup>): Wx=0.681,Wy=0.331  
 Radii of Gyration: X: 1.034, Y: 0.460

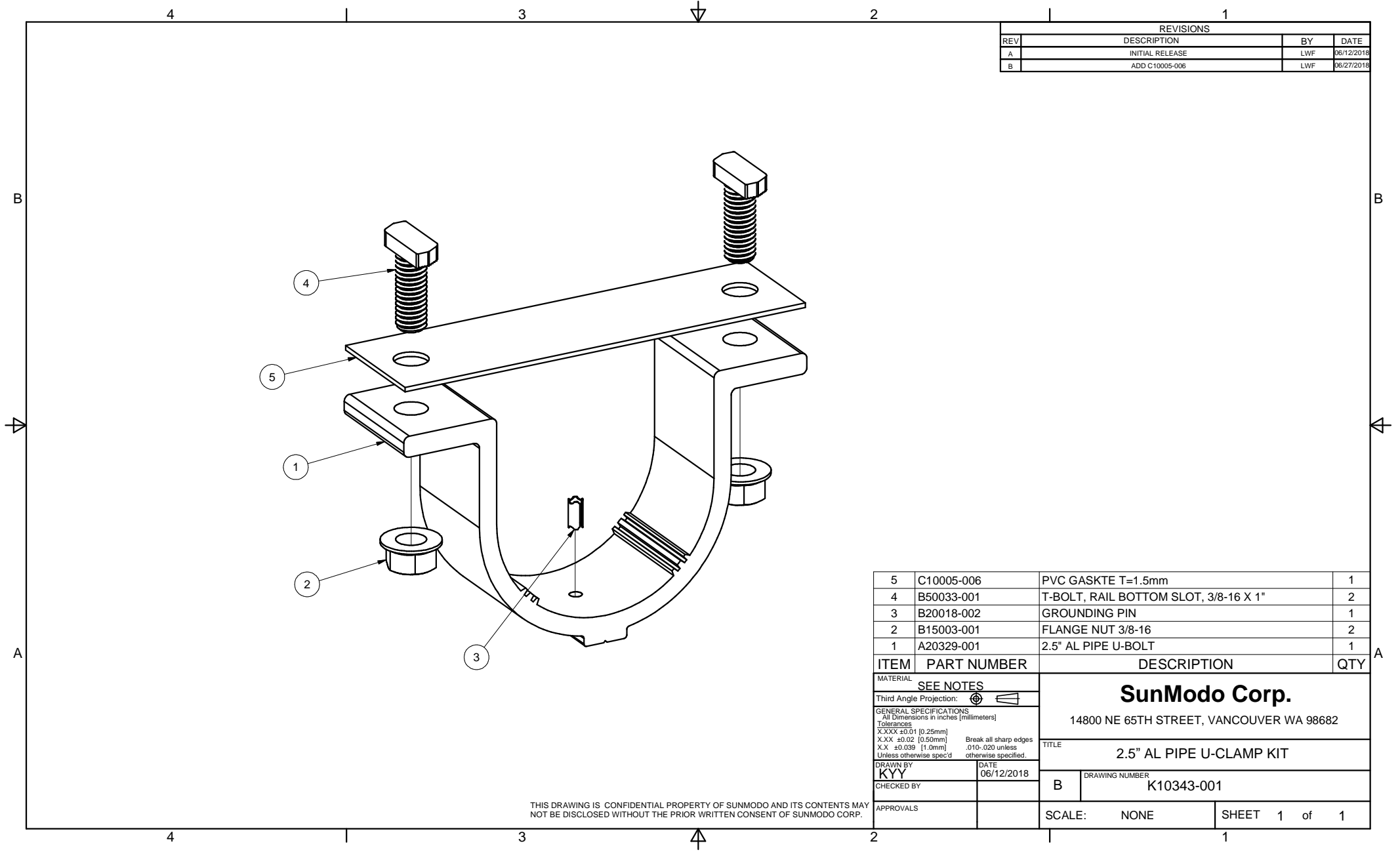
MATERIAL		SEE NOTES	
Third Angle Projection			
GENERAL SPECIFICATIONS			
All Dimensions in Inches (millimeters)			
Tolerances			
XXX ±0.01 (0.25mm)			
XX ±0.02 (0.50mm)			
X ±0.03 (1.0mm)			
Unless otherwise specified.			
DRAWN BY		DATE	
ZCJ		02/1/2013	
CHECKED BY		DATE	
APPROVALS		DATE	
Sunmodo Corp.		1905 E 5TH STREET, SUITE A, VANCOUVER, WA 98661	
		TITLE	
HELIO HEAVY RAIL		DRAWING NUMBER	
		A20145	
SCALE: NONE		SHEET 1 of 1	



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

ITEM	PART NUMBER	DESCRIPTION	QTY
MATERIAL		SEE BOM	
Third Angle Projection:			
GENERAL SPECIFICATIONS All Dimensions in inches (millimeters)			
Tolerances			
X.XXX ±0.01 [0.25mm]		Break all sharp edges	
X.XX ±0.02 [0.50mm]		.010-.020 unless	
X.X ±0.039 [1.0mm]		otherwise specified.	
DRAWN BY		DATE	
zcg		08/12/2015	
CHECKED BY		TITLE	
		2 AL PIPE CLAMP KIT	
APPROVALS		DRAWING NUMBER	
		B K10219-001	
SCALE:		NONE	SHEET 1 of 1

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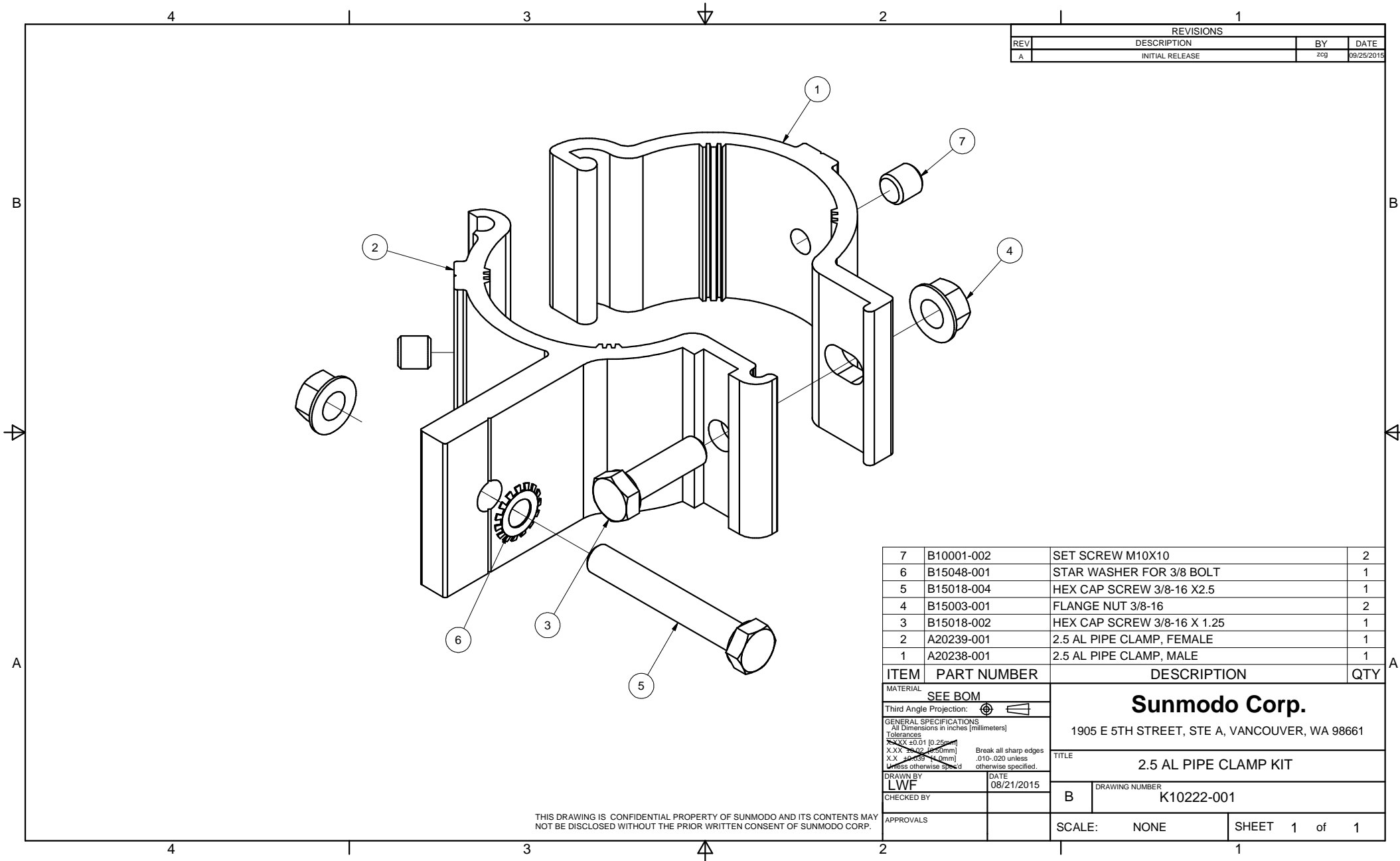


REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018
B	ADD C10005-006	LWF	06/27/2018

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		<b>SEE NOTES</b>	
Third Angle Projection:			
GENERAL SPECIFICATIONS		<b>SunModo Corp.</b> 14800 NE 65TH STREET, VANCOUVER WA 98682	
Tolerances		TITLE	
X.XXX ±0.01 [0.25mm] X.XX ±0.02 [0.50mm] X.X ±0.039 [1.0mm] Unless otherwise spec'd		2.5" AL PIPE U-CLAMP KIT	
DRAWN BY	DATE	DRAWING NUMBER	
KYY	06/12/2018	B K10343-001	
CHECKED BY		SCALE: NONE SHEET 1 of 1	
APPROVALS			

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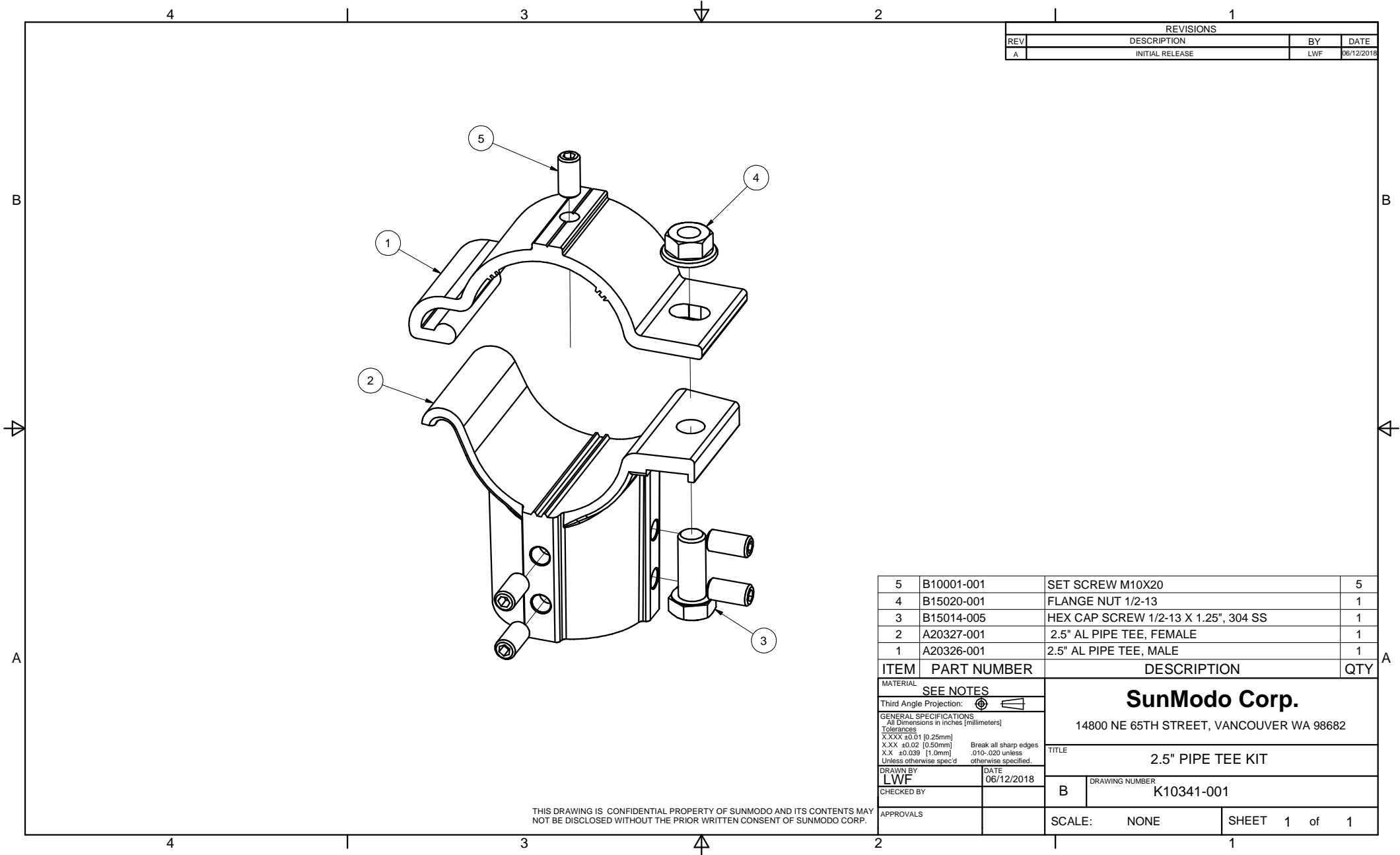
REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	zcg	09/25/2015

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		<b>SEE BOM</b>	
Third Angle Projection:			
<b>GENERAL SPECIFICATIONS</b> All Dimensions in inches [millimeters] <b>Tolerances</b> X.XX ±0.01 (0.25mm) X.X ±0.02 (0.5mm) X.X ±0.03 (0.75mm) Unless otherwise specified, Break all sharp edges .010-.020 unless otherwise specified.			
DRAWN BY	DATE	<b>Sunmodo Corp.</b> 1905 E 5TH STREET, STE A, VANCOUVER, WA 98661 <b>TITLE</b> 2.5 AL PIPE CLAMP KIT	
LWF	08/21/2015		
CHECKED BY		B	DRAWING NUMBER K10222-001
APPROVALS		SCALE: NONE	SHEET 1 of 1

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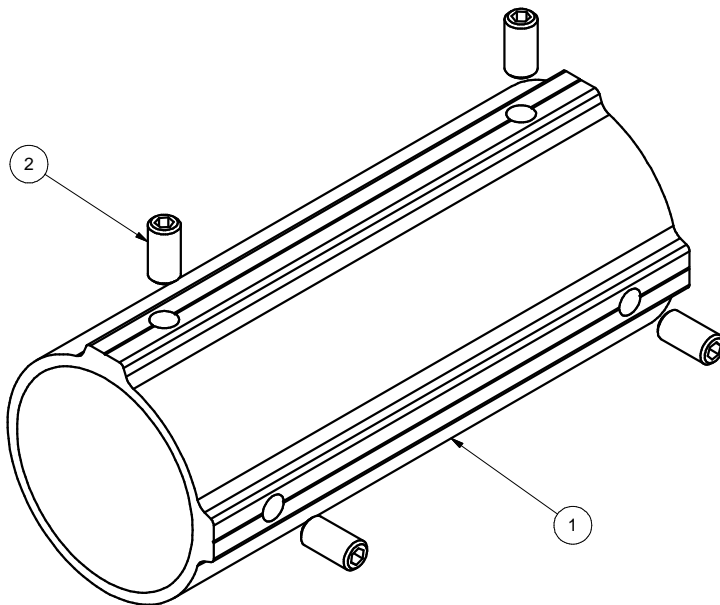
REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018

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
ITEM	PART NUMBER	DESCRIPTION	QTY

MATERIAL		<b>SEE NOTES</b>	
Third Angle Projection:			
GENERAL SPECIFICATIONS		<b>SunModo Corp.</b> 14800 NE 65TH STREET, VANCOUVER WA 98682	
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			
TITLE		2.5" PIPE TEE KIT	
DRAWN BY	DATE	DRAWING NUMBER	
LWF	06/12/2018	B K10341-001	
CHECKED BY			
APPROVALS		SCALE: NONE	SHEET 1 of 1

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



2	B10001-001	SET SCREW M10X20	4
1	A20328-001	2.5" PIPE SPLICE	1
ITEM	PART NUMBER	DESCRIPTION	QTY
MATERIAL		SEE NOTES	
Third Angle Projection:			
GENERAL SPECIFICATIONS		<b>SunModo Corp.</b> 14800 NE 65TH STREET, VANCOUVER WA 98682	
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		TITLE	
LWF		2.5" PIPE SPLICE KIT	
DATE		DRAWING NUMBER	
06/12/2018		B K10342-001	
CHECKED BY		SCALE: NONE	
APPROVALS		SHEET 1 of 1	

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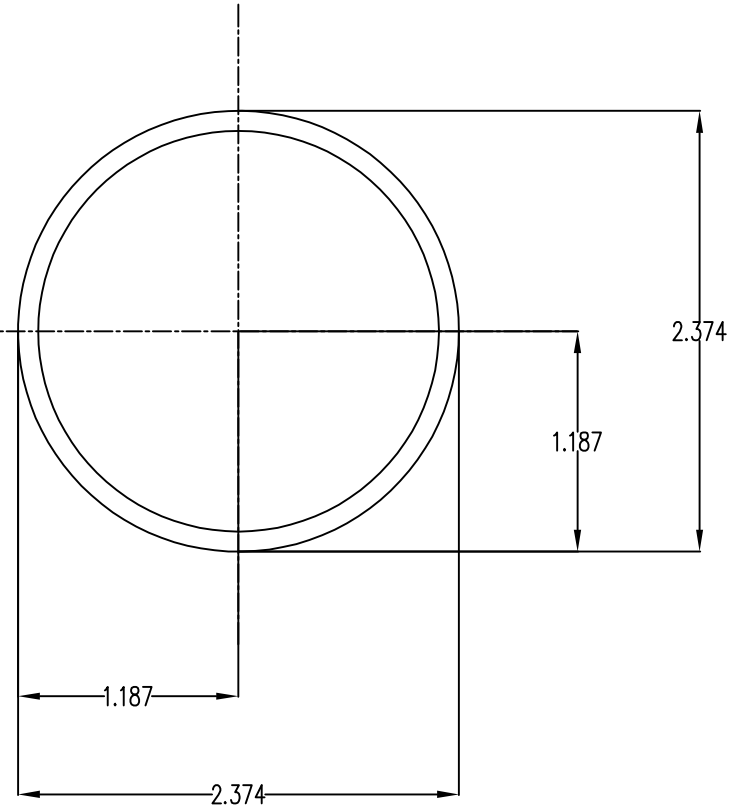
NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].
2. MATERIAL: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<sup>2</sup>

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<sup>4</sup>): Ix=0.499,Iy=0.499

Section modulus in bending(in<sup>3</sup>): Wx=0.420,Wy=0.420

Radii of Gyration: X: 0.802, Y: 0.802

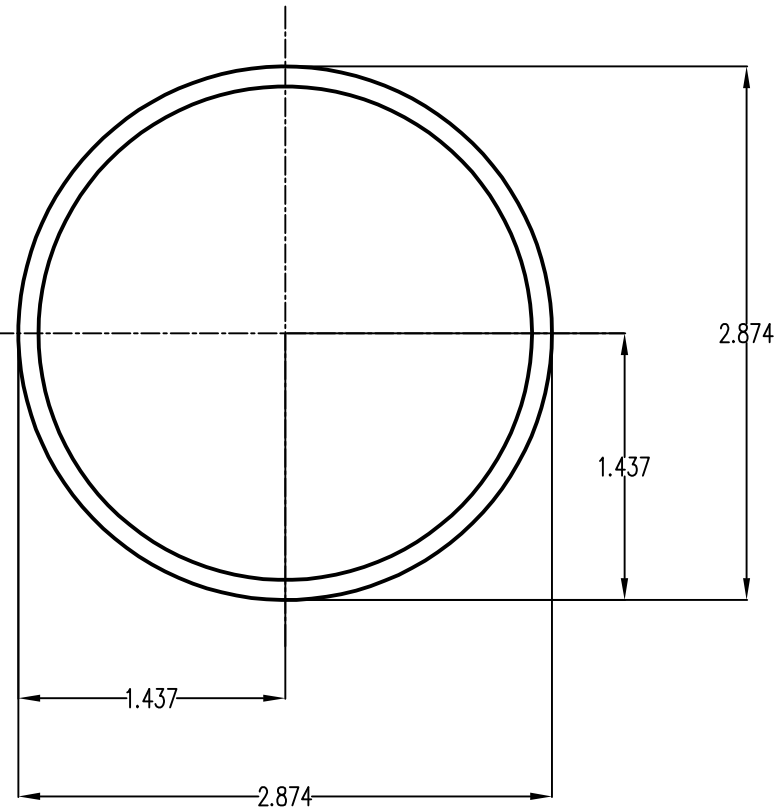
MATERIAL		SEE NOTES		<b>Sunmodo Corp.</b> 14800 NE 85TH STREET, VANCOUVER WA 98682	
Third Angle Projection:					
GENERAL SPECIFICATIONS				TITLE	
All Dimensions in Inches (millimeters)				PIPE, HSS, 2.375" OD X 12 GAUGE,L=XXX	
Tolerances				Break all sharp edges .010-.020 unless otherwise specified.	
XXX ±0.01 (0.25mm)					
XX ±0.02 (0.50mm)					
X ±0.050 (1.27mm)					
Unless otherwise specified					
DRAWN BY	DATE	B		DRAWING NUMBER	
LWF	04/03/2019			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<sup>2</sup>

Perimeter: 17.378 in

Bounding Box: X: -1.437,1.437

Y: -1.437,1.437

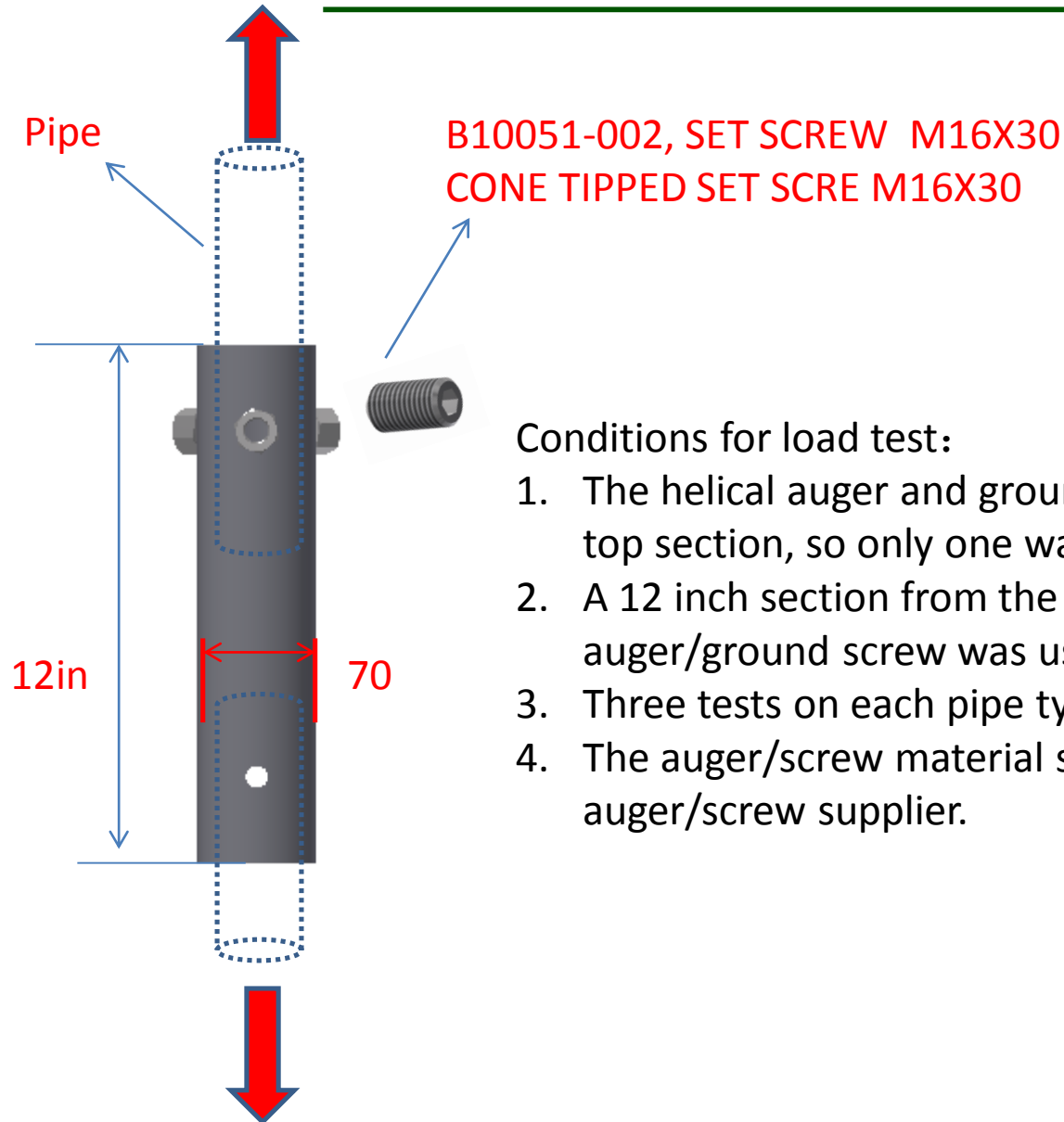
Centroid:(0.000,0.000)

Moments of Inertia(in<sup>4</sup>): Ix=0.901,Iy=0.901

Section modulus in bending(in<sup>3</sup>): Wx=0.627,Wy=0.627

Radii of Gyration: X: 0.979, Y: 0.979

MATERIAL		SEE NOTES		<b>Sunmodo Corp.</b> 14800 NE 85TH STREET, VANCOUVER WA 98682	
Third Angle Projection:					
GENERAL SPECIFICATIONS All Dimensions in Inches (millimeters)				TITLE	
Tolerances XXX ±0.01 (0.25mm) XX ±0.02 (0.50mm) X ±0.030 (1.0mm) Unless otherwise specified				PIPE, HSS, 2.875" OD X 12 GAUGE,L=XXX	
DRAWN BY LWF		DATE 04/03/2019		DRAWING NUMBER A21168	
CHECKED BY				B	
APPROVALS				SCALE: NONE SHEET 1 of 1	



### 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.