

Project Details



Project Name: MTSOLAR_2AKBDK072E6E4-Ileen-4x2-8ft

Location: Mt Pleasant, UT 84647, USA

Unique ID: 1P-0-6TOP-SD-24-L-4Hx2W-HG13

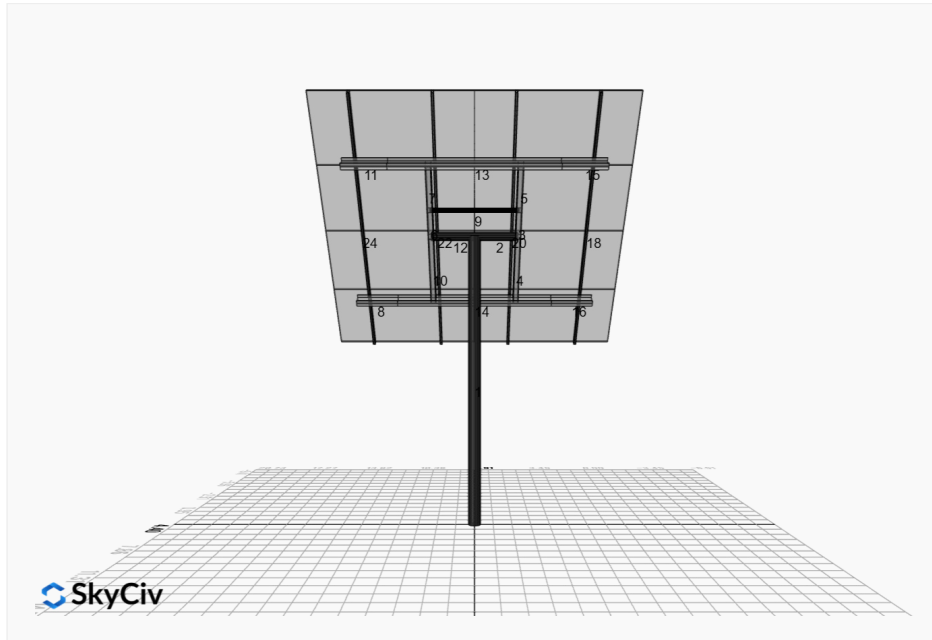
Dealer: _____

Date: Tue Oct 01 2024

Number of Modules: 8

Number of Poles: 1

Date Sold: _____



Array Dimensions N/S	13.70 ft
Array Dimensions E/W	13.82 ft
Winter Tilt Angle	50
Front Edge Clearance	8 ft

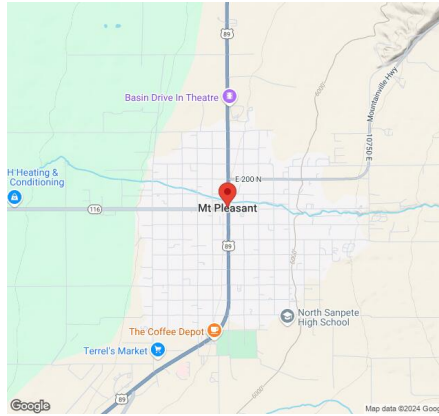
MT Solar Bill of Materials (1P-0-6TOP-SD-24-L-4Hx2W-HG13)

Part	Short Description	BOM Qty
MTS-PC-6	6IN Pole Cap Assembly	1
MTS-HF-SD	H-Frame Assembly-SD	1
MTS-SD-Wing-24	24IN SD Wing	4
MTS-CLAMP-HOOK-4PK	Hook Clamp	2

Rail Bill of Materials

Part	Qty
Rails (162in)	4
Rail Attachment	8
Module Mid Clamp	12
Module End Clamp	8
Ground Lug	2

Site Details:



Site Address: Mt Pleasant, UT 84647, USA

Array Specification

Duty Classification:	SD
Module Width:	40.60 in
Module Length:	81.90in
Number of Rows:	4
Number of Columns:	2
Total Number of Modules:	8
Winter Tilt Angle:	50
Front Edge Clearance:	8
Total Array Height at Tilt:	18.49 ft
Total Frame Length:	11.50 ft
Frame Weight:	764 lbs
Array Dimensions N/S:	13.70 ft
Array Dimensions E/W:	13.82 ft
Rail Length:	164.40 in
Rail Spacing:	3.45 ft

Support Specifications

Pole Size:	6in Pipe Sch 40
Pole Length above Grade:	13.25 ft
Number of Poles:	1
Pole Spacing:	0

Foundation Specifications

Foundation Type:	Square
Foundation Dimensions:	48 x 48 in
Foundation Depth (below grade):	Pile 1: 6.00 ft
Foundation Volume:	3.556 y ³

Site Info

Risk Category:	I
Exposure:	C
Soil Classification:	sand
Site Location:	Mt Pleasant, UT 84647, USA
Wind Speed:	97 mph
Snow Load:	210 psf

Design Disclaimer

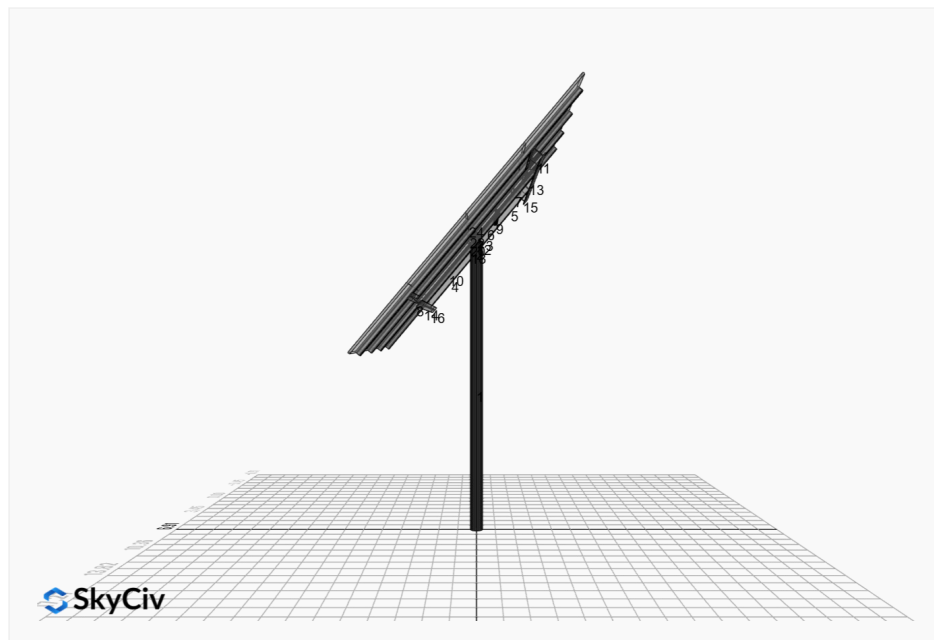
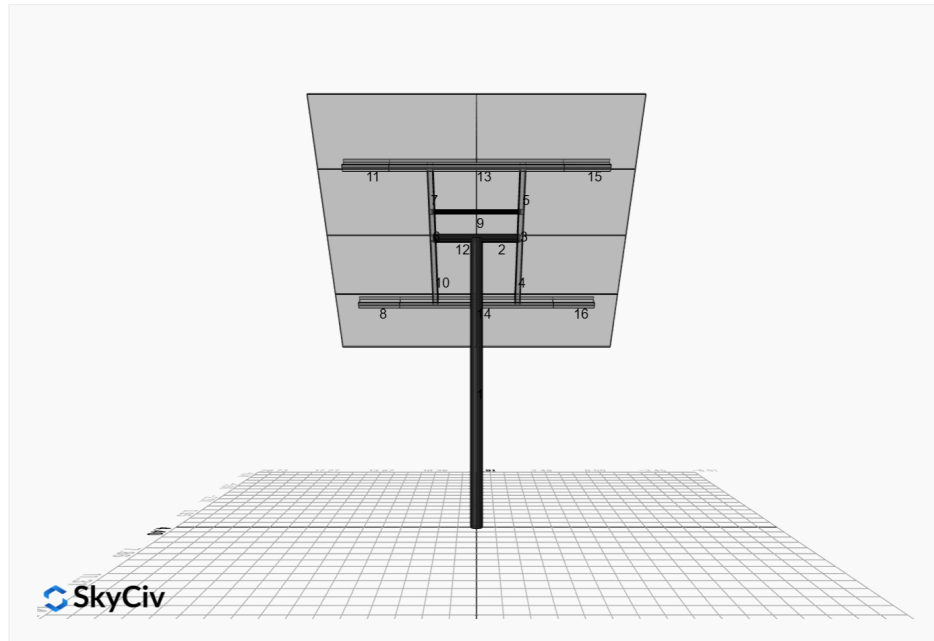
This software should be used for preliminary designs and should not be used as a final design unless reviewed, verified and designed by a qualified structural engineer.

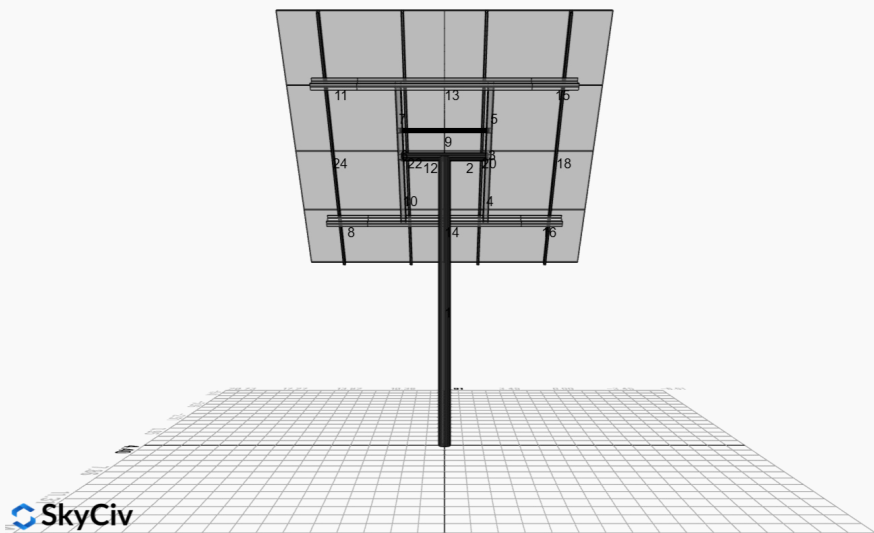
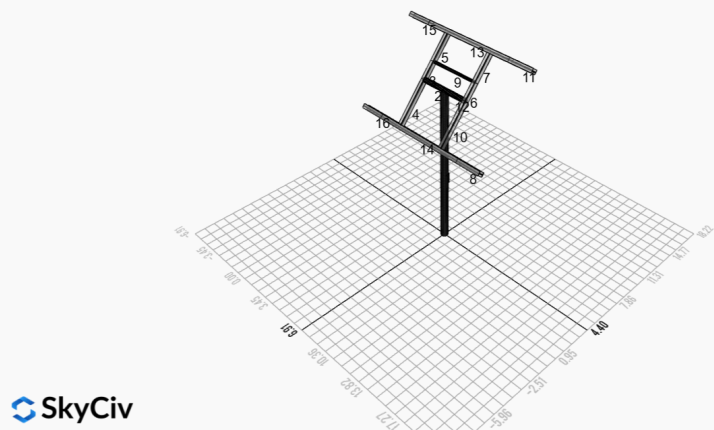
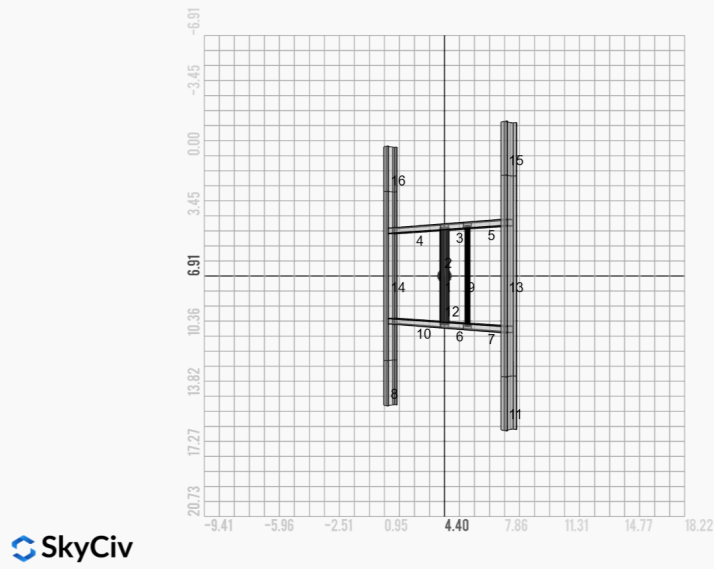
AutoDesigner Input

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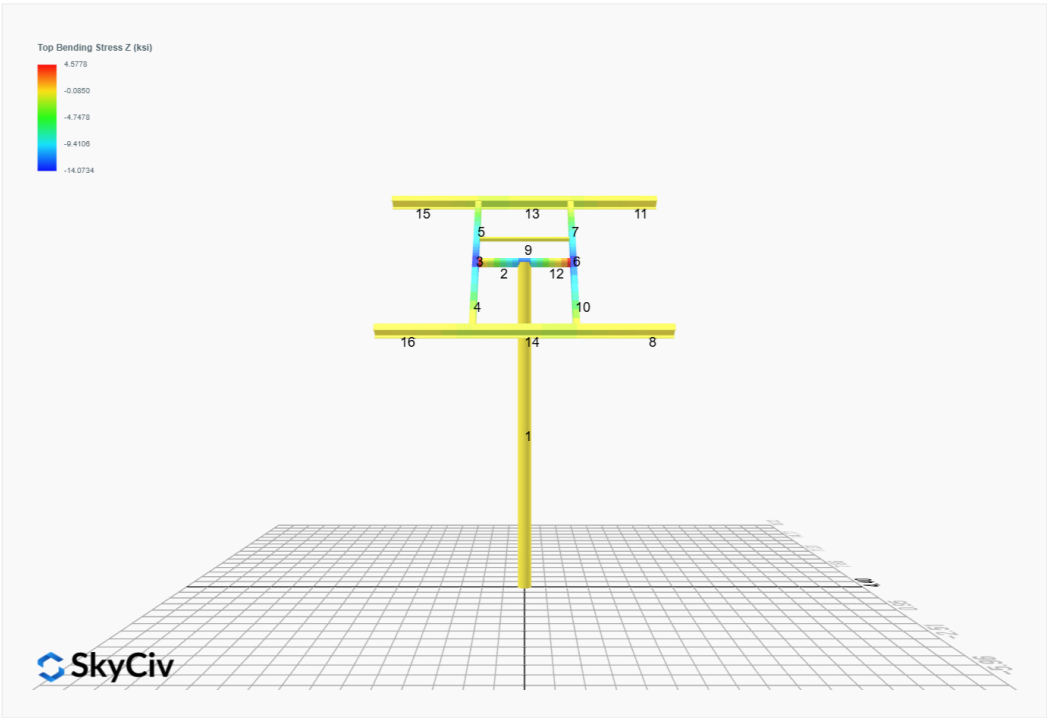
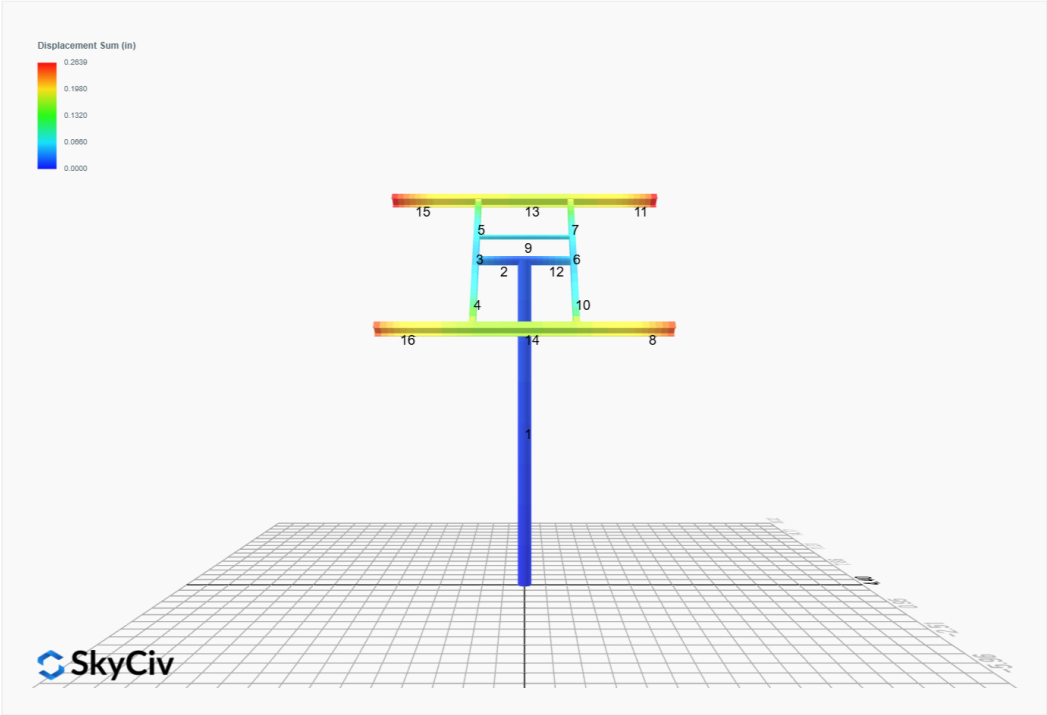
Design Notes:

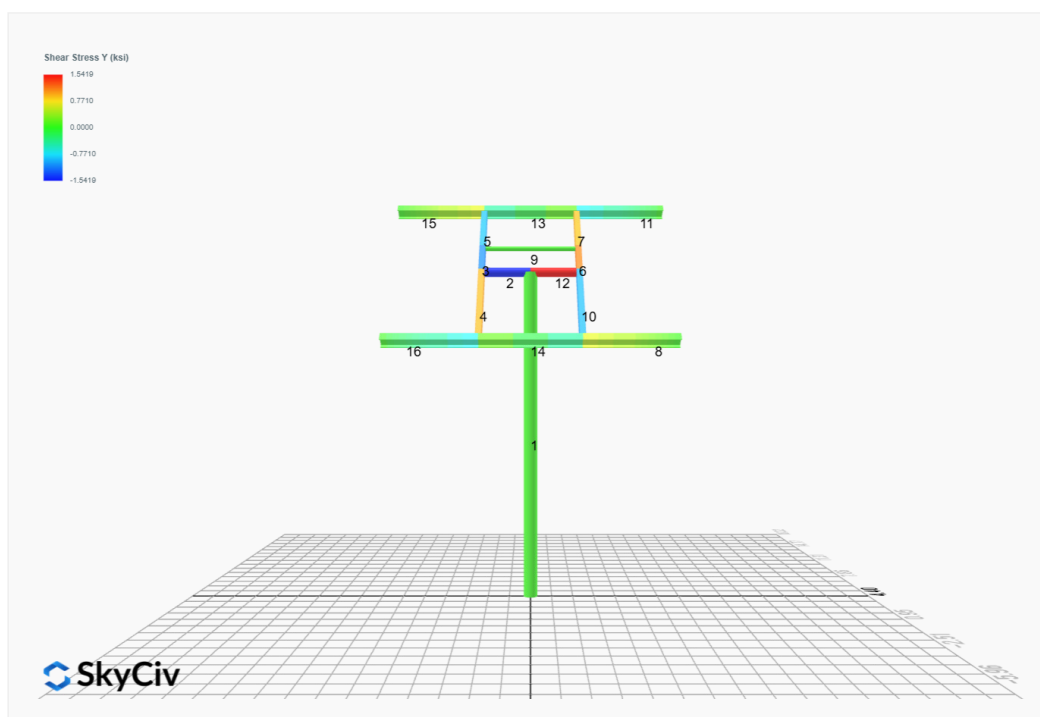
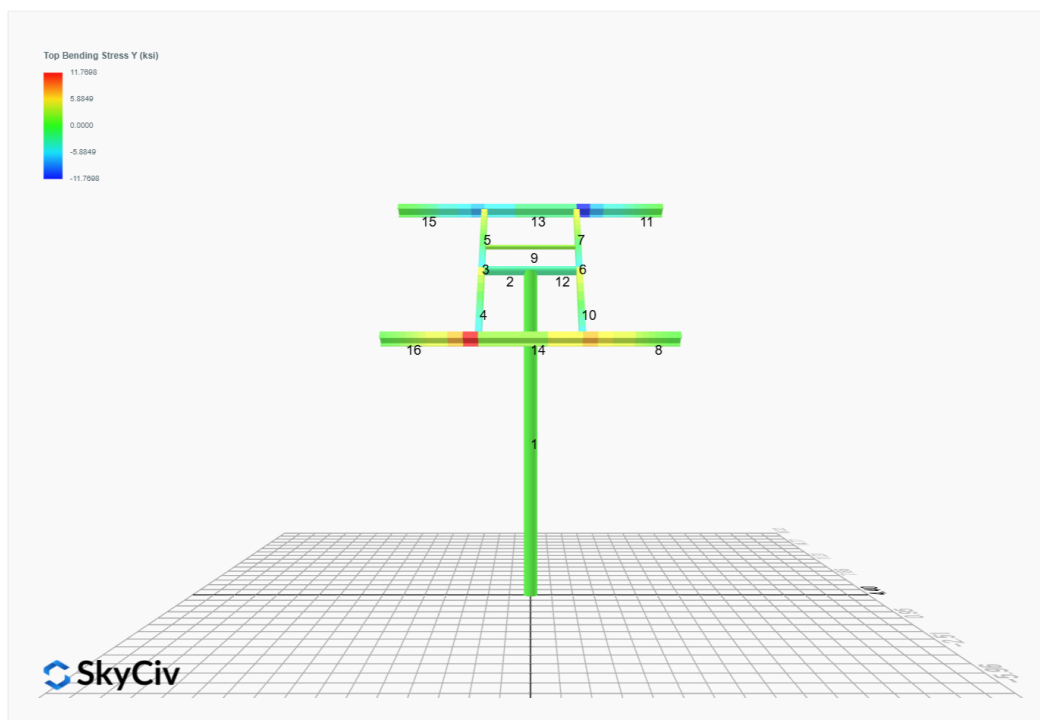
- AISC Deflection checks are set to L/1 due to structure design intent
- Foundation Soil Parameters used in this Autodesign are all estimates, proper geotechnical reports are required to confirm soil profiles
- Wind speeds, snow loads and other site specific results are based on ASCE 7 2016
- Steel frame design checks are based on AISC 360 2016 (LRFD)
- Foundation Design and Sizing is approximate only

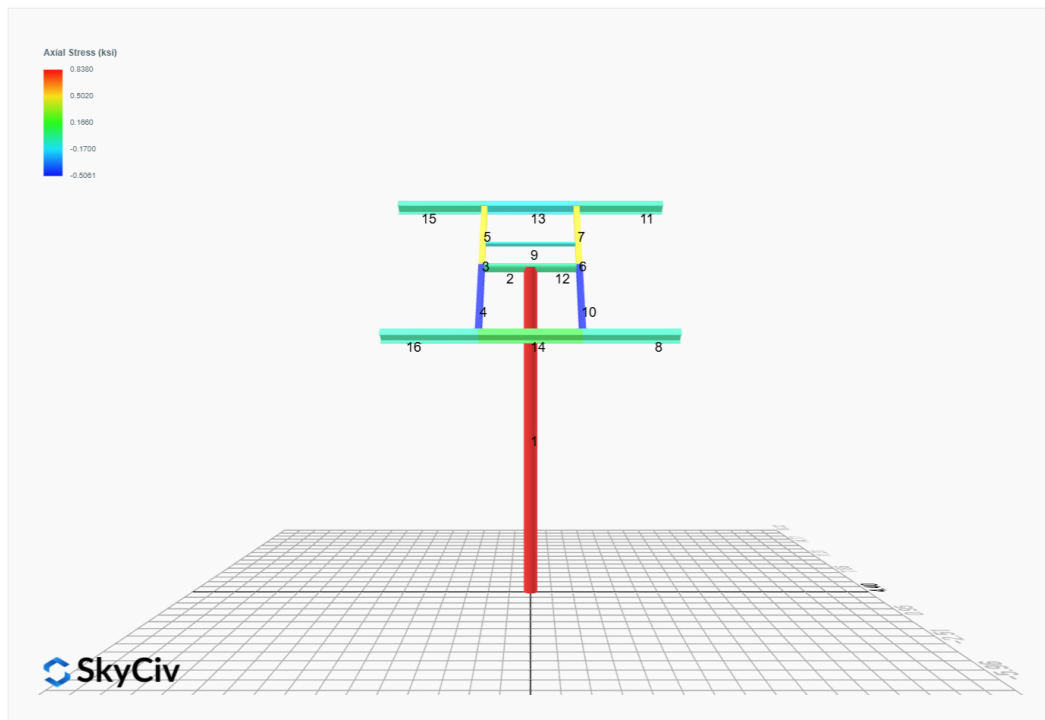




FEM Results (Envelope Worst Case for each member)







Reaction Forces for Foundation 1 (Node ID#1), (kip, kip-ft)

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0000	1.4867	0.0000	0.0000	-0.0000	0.0149
ULS: 2. D + L	0.0000	1.4867	0.0000	0.0000	-0.0000	0.0149
ULS: 3. D + (S or Lr or R)	0.0000	6.1639	0.0000	0.0000	-0.0000	0.0569
ULS: 3. D + (S or Lr or R)	0.0000	1.4867	0.0000	0.0000	-0.0000	0.0149
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	4.9946	0.0000	0.0000	-0.0000	0.0464
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	1.4867	0.0000	0.0000	-0.0000	0.0149
ULS: 5b. D + 0.7E	0.0000	1.4867	0.0000	0.0000	-0.0000	0.0149
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0000	4.9946	0.0000	0.0000	-0.0000	0.0464
ULS: 8. 0.6D + 0.7E	0.0000	0.8920	0.0000	0.0000	-0.0000	0.0090
ULS: 5a. D + 0.6W_Wind downforce Case A only	-1.4169	2.6756	0.0000	0.0000	-0.0000	19.1786
ULS: 5a. D + 0.6W_Wind downforce Case B only	0.0000	1.4867	0.0000	0.0000	-0.0000	0.0149
ULS: 5a. D + 0.6W_Wind uplift Case A only	1.4169	0.2978	0.0000	0.0000	-0.0000	-18.3805
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.0000	1.4867	0.0000	0.0000	-0.0000	0.0149
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.0627	5.8862	0.0000	0.0000	-0.0000	14.4192
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0000	4.9946	0.0000	0.0000	-0.0000	0.0464
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.0627	4.1029	0.0000	0.0000	-0.0000	-13.7501
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0000	4.9946	0.0000	0.0000	-0.0000	0.0464
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.0627	2.3784	0.0000	0.0000	-0.0000	14.3877
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0000	1.4867	0.0000	0.0000	-0.0000	0.0149
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.0627	0.5950	0.0000	0.0000	-0.0000	-13.7816
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0000	1.4867	0.0000	0.0000	-0.0000	0.0149
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-1.4169	2.0809	0.0000	0.0000	-0.0000	19.1726
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	0.0000	0.8920	0.0000	0.0000	-0.0000	0.0090
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	1.4169	-0.2969	0.0000	0.0000	-0.0000	-18.3864
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.0000	0.8920	0.0000	0.0000	-0.0000	0.0090

Worst Case Reactions LRFD

These calculations are taken directly from the FEA via SkyCiv and are used in the Concrete Checks of the Foundation Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	10.2583
Shear X	-2.3615
Shear Z	0.0000
Moment X	0.0000
Moment Y (Twist)	0.0000
Moment Z	33.4971

Worst Case Reactions ASD

These results are taken from the worst case values in the above table and are used in the Soil Checks in the Foundation Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	6.1639
Shear X	-1.4169
Shear Z	0.0000
Moment X	0.0000
Moment Y (Twist)	0.0000
Moment Z	19.1786

Project Details

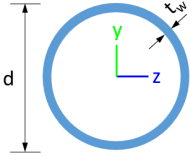
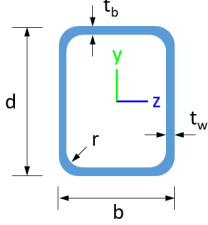
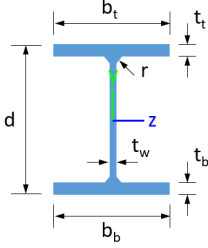
Design Code: AISC 360-16 LRFD
 Provision: LRFD
 Country: United States
 User Name: sales@mtsolar.us
 Unit System: imperial



Design Input Information

Design Factors			
Φ_t	Φ_c	Φ_b	Φ_v
0.9	0.9	0.9	0.9

Design Materials			
ID	E (ksi)	F_y (ksi)	F_u (ksi)
1	29000	50	65

Section Dimensions								
								
ID	Name	d (in)	t_w (in)					
1	2in Pipe Sch 40	2.38	0.15					
4	4in Pipe Sch 40	4.50	0.24					
7	6in Pipe Sch 40	6.63	0.28					
								
ID	Name	d (in)	b (in)	t_w (in)	t_b (in)	r (in)		
15	HSS5x3x1/8	5.00	3.00	0.12	0.12	0.12		
								
ID	Name	d (in)	t_w (in)	b_t (in)	b_b (in)	t_t (in)	t_b (in)	r (in)
18	W6x9	5.90	0.17	3.94	3.94	0.21	0.21	0.25

Section Properties								
ID	Name	A (in ²)	J (in ⁴)	I_{yp} (in ⁴)	I_{zp} (in ⁴)	I_w (in ⁶)	S_{yp} (in ³)	S_{zp} (in ³)

1	2in Pipe Sch 40	1.07	1.33	0.67	0.67	0.00	0.76	0.76
4	4in Pipe Sch 40	3.17	14.47	7.23	7.23	0.00	4.31	4.31
7	6in Pipe Sch 40	5.58	56.28	28.14	28.14	0.00	11.28	11.28
15	HSS5x3x1/8	1.77	6.02	2.75	6.03	0.51	2.07	2.93
18	W6x9	2.68	0.04	2.20	16.40	17.70	1.72	6.23

Member Properties									
Member ID	Section ID	K _z L (ft)	K _y L (ft)	L _b (ft)	C _b	LS T	LS C	L D	
1	7	27.8 2	27.8 2	13.25	-	30 0	20 0	1	
2	4	1.30	1.30	2.0 0	-	30 0	20 0	1	
3	15	0.92	0.92	1.4 2	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.18,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.19	30 0	20 0	1	
4	15	2.44	2.44	3.7 5	1.69,1.67,1.69,1.67,1.68,1.69,1.67,1.67,1.67,1.65,1.67,1.67,1.69,1.66,1.69,1.67,1.67,1.67,1.67,1.67,1.69,1.64,1.69,1.67,1.69,1.66,1.69	30 0	20 0	1	
5	15	1.52	1.52	2.3 3	1.68,1.67,1.68,1.67,1.67,1.68,1.67,1.67,1.65,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.67,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68	30 0	20 0	1	
6	15	0.92	0.92	1.4 2	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.18,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.19	30 0	20 0	1	
7	15	1.52	1.52	2.3 3	1.68,1.67,1.68,1.67,1.67,1.68,1.67,1.67,1.65,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.67,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68	30 0	20 0	1	
8	18	4.20	4.20	2.0 0	2.33,2.33	30 0	20 0	1	
9	1	2.60	2.60	4.0 0	-	30 0	20 0	1	
10	15	2.44	2.44	3.7 5	1.69,1.67,1.69,1.67,1.68,1.69,1.67,1.67,1.65,1.67,1.67,1.69,1.66,1.69,1.67,1.67,1.67,1.67,1.67,1.69,1.64,1.69,1.67,1.69,1.66,1.69	30 0	20 0	1	
11	18	4.20	4.20	2.0 0	2.33,2.33	30 0	20 0	1	
12	4	1.30	1.30	2.0 0	-	30 0	20 0	1	
13	18	4.88	4.00	7.5 0	1.09,1.09	30 0	20 0	1	
14	18	4.88	4.00	7.5 0	1.09,1.09	30 0	20 0	1	
15	18	4.20	4.20	2.0 0	2.33,2.33	30 0	20 0	1	
16	18	4.20	4.20	2.0 0	2.33,2.33	30 0	20 0	1	

Member Design Capacity

Member ID	$\Phi_t P_n$ (kip)	$\Phi_c P_n$ (kip)	$\Phi_b M_{zn}$ (k-ft)	$\Phi_b M_{yn}$ (k-ft)	$\Phi_v V_{yn}$ (kip)	$\Phi_v V_{zn}$ (kip)
1	251.16	57.05	42.30	42.30	75.35	75.35
2	142.83	141.72	16.17	16.17	42.85	42.85
3	79.65	74.02	10.99	6.26	29.14	16.61
4	79.65	72.01	10.99	6.26	29.14	16.61
5	79.65	73.44	10.99	6.26	29.14	16.61
6	79.65	74.02	10.99	6.26	29.14	16.61
7	79.65	73.44	10.99	6.26	29.14	16.61
8	120.60	96.18	23.36	6.45	30.09	45.74
9	48.35	43.11	2.85	2.85	14.51	14.51
10	79.65	72.01	10.99	6.26	29.14	16.61
11	120.60	96.18	23.36	6.45	30.09	45.74
12	142.83	141.72	16.17	16.17	42.85	42.85
13	120.60	84.03	19.16	6.45	30.09	45.74
14	120.60	84.03	19.11	6.45	30.09	45.74

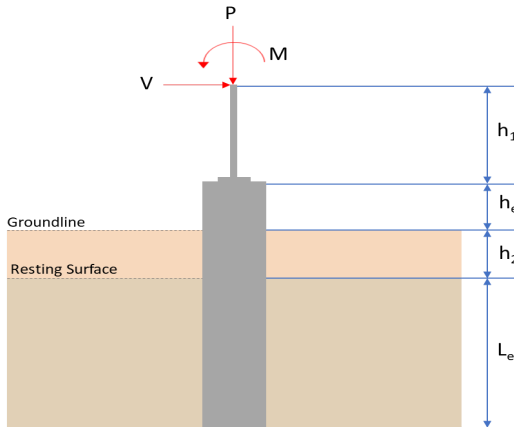
15	120.60	96.18	23.36	6.45	30.09	45.74
16	120.60	96.18	23.36	6.45	30.09	45.74

Design Ratio

Member ID	P	M _z	M _y	V _y	V _z	(P,M _z ,M _y)	Worst LC	KL/r	δ	Status
1	0.180	0.792	0.000	0.031	0.000	0.845	#13	0.743	Not Required	Pass
2	0.001	0.463	0.160	0.116	0.028	0.600	#21	0.052	Not Required	Pass
3	0.023	0.634	0.215	0.062	0.052	0.860	#21	0.044	Not Required	Pass
4	0.021	0.625	0.209	0.062	0.040	0.826	#21	0.078	Not Required	Pass
5	0.023	0.394	0.206	0.062	0.038	0.433	#21	0.073	Not Required	Pass
6	0.023	0.634	0.215	0.062	0.052	0.860	#21	0.044	Not Required	Pass
7	0.023	0.394	0.206	0.062	0.038	0.433	#21	0.073	Not Required	Pass
8	0.000	0.027	0.091	0.021	0.013	0.118	#21	Not Required	Not Required	Pass
9	0.005	0.029	0.057	0.001	0.000	0.088	#21	0.132	Not Required	Pass
10	0.021	0.625	0.209	0.062	0.040	0.826	#21	0.078	Not Required	Pass
11	0.000	0.027	0.091	0.021	0.013	0.118	#21	Not Required	Not Required	Pass
12	0.001	0.463	0.160	0.116	0.028	0.600	#21	0.052	Not Required	Pass
13	0.005	0.129	0.319	0.039	0.024	0.434	#21	0.177	Not Required	Pass
14	0.008	0.133	0.319	0.039	0.024	0.434	#21	0.177	Not Required	Pass
15	0.000	0.027	0.091	0.021	0.013	0.118	#21	Not Required	Not Required	Pass
16	0.000	0.027	0.091	0.021	0.013	0.118	#21	Not Required	Not Required	Pass

Definitions

Φ _t	Safety factor for tensile
Φ _c	Safety factor for compression
Φ _b	Safety factor for flexure
Φ _v	Safety factor for shear
E	Modulus of elasticity
F _y	Specified minimum yield stress
F _u	Specified minimum tensile strength
A	Cross-sectional area
J	Torsional constant
I _{yp}	Moment of inertia about the Y axes
I _{zp}	Moment of inertia about the Z axes
I _w	Warping constant
S _{yp}	Plastic section modulus about the Y axis
S _{zp}	Plastic section modulus about the Z axis
KL	Effective length
C _b	Buckling modification factor (from all load combinations)
L _b	Length between braced points
LST	Limited slenderness for tension
LSC	Limited slenderness for compression
LD	Limited deflection
P _n	Nominal axial strength (tension/compression)
M _n	Nominal flexural strength (about Z/Y axis)
V _n	Nominal shear strength (along Z/Y axis)
P	Design ratio in case of axial force
M _z	Design ratio in case of bending about Z axis
M _y	Design ratio in case of bending about Y axis
V _y	Design ratio in case of shear along Y axis
V _z	Design ratio in case of shear along Z axis
(P,M _z ,M _y)	Design ratio in case of axial force and bending action
KL/r	Design ratio in case of section slenderness
δ	Design ratio in case of member deflection
OK	Capacity is provided
NG	Capacity is not provided

REFERENCES	CALCULATIONS	RESULTS																											
	<div>SkyCiv Foundation Design</div> <div>Pile Foundation</div> <div>Design Information :</div> <div>Design code : IBC 2021 (International Building Code)</div> <div>Unit System : Imperial</div>																												
	<div>Pile Input</div> <div></div> <div>Geometry</div> <div>Pile shape: rectangular</div> <div>b = 48 in - Pile width</div> <div>D = 48 in - Pile depth</div> <div>L = 6 ft - Total pile length</div> <div>h1 = 0 ft - Lateral load height from the top of the pile,</div> <div>h2 = 0 ft - Depth to resisting surface</div> <div>he = 0 ft - Length of pile above the ground</div> <div>Tabulation of Soil Parameters</div> <table><tr><th>Layer</th><th>Label</th><th>Allowable Bearing Pressure (qa) (psf)</th><th>Allowable Lateral Pressure (R) (psf/ft)</th></tr><tr><td>1</td><td>Sand, silty sand, clayey sand, silty gravel & clayey gravel</td><td>2000.000</td><td>150.000</td></tr></table> <div>Tabulation of Loads</div> <table><tr><th>Load Component</th><th>ASD</th><th>LRFD</th></tr><tr><td>P (kip)</td><td>6.164</td><td>10.258</td></tr><tr><td>Vx (kip)</td><td>-1.417</td><td>-2.361</td></tr><tr><td>Vz (kip)</td><td>0.000</td><td>0.000</td></tr><tr><td>Mx (kipft)</td><td>0.000</td><td>0.000</td></tr><tr><td>Mz (kipft)</td><td>19.179</td><td>33.497</td></tr></table> <div>Material Properties</div> <div>f'ck = 2.5 ksi - Concrete strength,</div>	Layer	Label	Allowable Bearing Pressure (qa) (psf)	Allowable Lateral Pressure (R) (psf/ft)	1	Sand, silty sand, clayey sand, silty gravel & clayey gravel	2000.000	150.000	Load Component	ASD	LRFD	P (kip)	6.164	10.258	Vx (kip)	-1.417	-2.361	Vz (kip)	0.000	0.000	Mx (kipft)	0.000	0.000	Mz (kipft)	19.179	33.497	<div>Required depth to resist lateral loads (ASD)</div> <div>H - Point of application of the lateral load</div> <div>H = h1 + h2 + he</div> <div>H = (0 ft) + (0 ft) + (0 ft)</div> <div>H = 0 ft</div> <div>Considering x-direction:</div> <div>Ho - Lateral force per length of pile,</div> <div>Ho = Vx / 1.57 D</div> <div>Ho = (-1.417 kip) / 1.57 x (48 in)</div> <div>Ho = -0.22564 kip/ft</div>	
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	<p>M_o - Moment per length of pile,</p> $M_o = \frac{M_z + (V_x H)}{1.57 D}$ $M_o = \frac{(19.179 \text{ kipft}) + ((-1.417 \text{ kip}) \times (0 \text{ ft}))}{1.57 \times (48 \text{ in})}$ $M_o = 3.054 \text{ kipft/ft}$ <p>Required depth of embedment in earth:</p> $L_x^3 - \left(14.14 \times \frac{H_o \times L_x}{R} \right) - \left(18.85 \times \frac{M_o}{R} \right) = 0$ <p>Solving the cubic equation: $L_{e,x} = 5.5332 \text{ ft}$ - Required depth in x-direction,</p> <p>Considering z-direction: $L_{e,z} = 0 \text{ ft}$ - Required depth in z-direction,</p> <p>Minimum embedded depth required: $L_{e,req}$ - Depth of pile required,</p> $L_{e,req} = MAX[L_{e,x}, L_{e,z}]$ $L_{e,req} = MAX[(5.5332 \text{ ft}), (0 \text{ ft})]$ $L_{e,req} = 5.533 \text{ ft}$ <p>L_e - Actual embedded length of pile,</p> $L_e = L - h_e - h_2$ $L_e = (6 \text{ ft}) - (0 \text{ ft}) - (0 \text{ ft})$ $L_e = 6 \text{ ft}$ <p>Ratio - Embedded depth</p> $Ratio = \frac{L_{e,req}}{L_e}$ $Ratio = \frac{(5.533 \text{ ft})}{(6 \text{ ft})}$ $Ratio = 0.92217$	<p>Status: PASS Ratio: 0.920</p>
	<p>End-bearing Capacity (ASD) A - Pile cross-section area</p> $A = b D$ $A = (48 \text{ in}) \times (48 \text{ in})$ $A = 16 \text{ ft}^2$ <p>q - End-bearing pressure</p> $q = \frac{P_v}{A}$ $q = \frac{(6.164 \text{ kip})}{(16 \text{ ft}^2)}$ $q = 0.38525 \text{ kip/ft}^2$ <p>Check bearing capacity ratio: Ratio - Capacity</p> $Ratio = \frac{q}{q_a}$ $Ratio = \frac{(0.38525 \text{ kip/ft}^2)}{(2000 \text{ psf})}$ $Ratio = 0.19262$	<p>Status: PASS Ratio: 0.190</p>
Czerniak	<p>Lateral Soil Pressure (ASD): L/D - Length to least lateral dimension ratio,</p>	

$$L/D = \frac{L}{D}$$

$$L/D = \frac{(6 \text{ ft})}{(48 \text{ in})}$$

$$L/D = 1.5$$

Since $L/D \leq 10$,

Pile is short.

Considering x-direction:

$H_o = -0.22564 \text{ kip/ft}$ - Lateral force per length of pile,

$M_o = 3.054 \text{ kipft/ft}$ - Overturning moment per length of pile,

a - Distance from resting surface to pivot point,

$$a = \frac{(4 M_o L_e) + (3 H_o L_e^2)}{(6 M_o) + (4 H_o L_e)}$$

$$a = \frac{(4 \times (3.054 \text{ kipft/ft}) \times (6 \text{ ft})) + (3 \times (-0.22564 \text{ kip/ft}) \times (6 \text{ ft})^2)}{(6 \times (3.054 \text{ kipft/ft})) + (4 \times (-0.22564 \text{ kip/ft}) \times (6 \text{ ft}))}$$

$$a = 4.1141 \text{ ft}$$

p - Earth pressure against the pile at distance $a/2$ from resting surface,

$$p = \frac{0.75 [(4 M_o) + (3 H_o L_e)]^2}{L_e^2 [(3 M_o) + (2 H_o L_e)]}$$

$$p = \frac{0.75 \times [(4 \times (3.054 \text{ kipft/ft})) + (3 \times (-0.22564 \text{ kip/ft}) \times (6 \text{ ft}))]^2}{(6 \text{ ft})^2 \times [(3 \times (3.054 \text{ kipft/ft})) + (2 \times (-0.22564 \text{ kip/ft}) \times (6 \text{ ft}))]}$$

$$p = 0.21463 \text{ kip/ft}^2$$

s - Earth pressure against the pile at distance L_e ,

$$s = \frac{6 [(2 M_o) + (H_o L_e)]}{L_e^2}$$

$$s = \frac{6 \times [(2 \times (3.054 \text{ kipft/ft})) + ((-0.22564 \text{ kip/ft}) \times (6 \text{ ft}))]}{(6 \text{ ft})^2}$$

$$s = 0.79236 \text{ kip/ft}^2$$

Check lateral soil pressure capacity:

p_a - Allowable lateral soil pressure at depth $a/2$,

$$p_a = R \frac{a}{2}$$

$$p_a = (150 \text{ psf/ft}) \times \frac{(4.1141 \text{ ft})}{2}$$

$$p_a = 0.30855 \text{ kip/ft}^2$$

Ratio - Lateral soil capacity

$$\text{Ratio} = \frac{p}{p_a}$$

$$\text{Ratio} = \frac{(0.21463 \text{ kip/ft}^2)}{(0.30855 \text{ kip/ft}^2)}$$

$$\text{Ratio} = 0.69561$$

p_s - Allowable lateral soil pressure at depth L_e ,

$$p_s = R L_e$$

$$p_s = (150 \text{ psf/ft}) \times (6 \text{ ft})$$

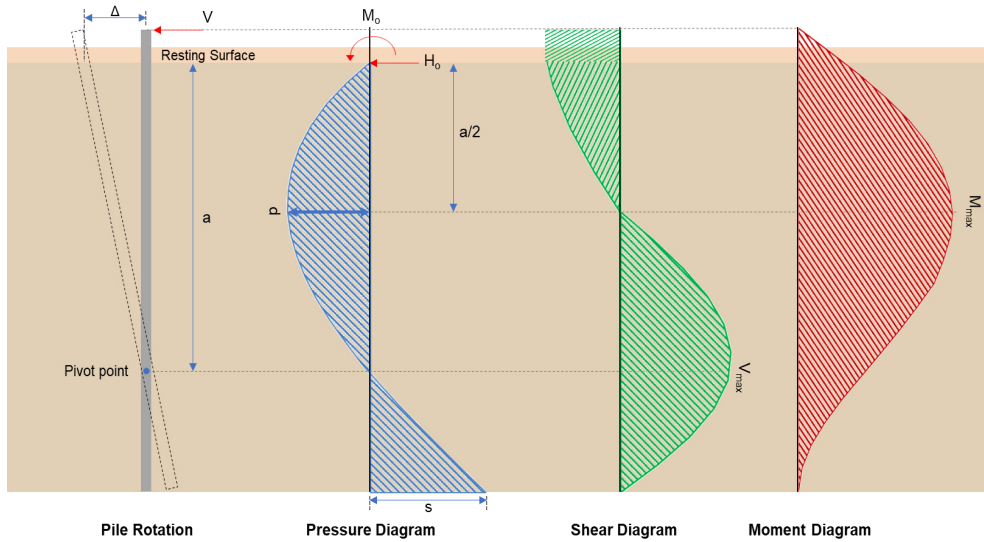
$$p_s = 0.9 \text{ kip/ft}^2$$

Ratio - Lateral soil capacity

$$\text{Ratio} = \frac{s}{p_s}$$

$$\text{Ratio} = \frac{(0.79236 \text{ kip/ft}^2)}{(0.9 \text{ kip/ft}^2)}$$

Status: **PASS**
Ratio: **0.700**

**Shear force and Bending moment (x-direction, LRFD)** H_o - Lateral force per length of pile,

$$H_o = \frac{V_x}{1.57 D}$$

$$H_o = \frac{(-2.361 \text{ kip})}{1.57 \times (48 \text{ in})}$$

$$H_o = -0.37596 \text{ kip/ft}$$

 M_o - Moment per length of pile,

$$M_o = \frac{M_z + (V_x H)}{1.57 D}$$

$$M_o = \frac{(33.497 \text{ kipft}) + ((-2.361 \text{ kip}) \times (0 \text{ ft}))}{1.57 \times (48 \text{ in})}$$

$$M_o = 5.3339 \text{ kipft/ft}$$

 E - Distance from lateral load to resisting surface,

$$E = \frac{M_o}{H_o}$$

$$E = \frac{(5.3339 \text{ kipft/ft})}{(-0.37596 \text{ kip/ft})}$$

$$E = 14.188 \text{ ft}$$

 a - Distance from resting surface to pivot point,

$$a = \frac{(4 M_o L_e) + (3 H_o L_e^2)}{(6 M_o) + (4 H_o L_e)}$$

$$a = \frac{(4 \times (5.3339 \text{ kipft/ft}) \times (6 \text{ ft})) + (3 \times (-0.37596 \text{ kip/ft}) \times (6 \text{ ft})^2)}{(6 \times (5.3339 \text{ kipft/ft})) + (4 \times (-0.37596 \text{ kip/ft}) \times (6 \text{ ft}))}$$

$$a = 4.11 \text{ ft}$$

 V_{max} - Max shear force located at depth a ,

$$V_{max} = (H_o D) \left[1 - \left[3 \left(\frac{4 E}{L_e} + 3 \right) \left(\frac{a}{L_e} \right)^2 \right] + \left[4 \left(\frac{3 E}{L_e} + 2 \right) \left(\frac{a}{L_e} \right)^3 \right] \right]$$

$$V_{max} = ((-0.37596 \text{ kip/ft}) \times (48 \text{ in})) \times \left[1 - \left[3 \times \left(\frac{4 \times (14.188 \text{ ft})}{(6 \text{ ft})} + 3 \right) \times \left(\frac{(4.11 \text{ ft})}{(6 \text{ ft})} \right)^2 \right] + \left[4 \times \left(\frac{3 \times (14.188 \text{ ft})}{(6 \text{ ft})} + 2 \right) \times \left(\frac{(4.11 \text{ ft})}{(6 \text{ ft})} \right)^3 \right] \right]$$

		$V_{max} = 1.2011 \text{ kip}$	
		<p>M_{max} - Max bending moment located at depth a/2,</p> $M_{max} = (H_o D L_e) \left[\left(\frac{E}{L_e} + \frac{a}{2 L_e} \right) - \left[\left(\frac{4 E}{L_e} + 3 \right) \left(\frac{a}{2 L_e} \right)^3 + \left[\left(\frac{3 E}{L_e} + 2 \right) \left(\frac{a}{2 L_e} \right)^4 \right] \right] \right]$ $M_{max} = ((-0.37596 \text{ kip/ft}) \times (48 \text{ in}) \times (6 \text{ ft})) \times \left[\left(\frac{(14.188 \text{ ft})}{(6 \text{ ft})} + \frac{(4.11 \text{ ft})}{2 \times (6 \text{ ft})} \right) - \left[\left(\frac{4 \times (14.188 \text{ ft})}{(6 \text{ ft})} + 3 \right) \times \left(\frac{(4.11 \text{ ft})}{2 \times (6 \text{ ft})} \right)^3 + \left[\left(\frac{3 \times (14.188 \text{ ft})}{(6 \text{ ft})} + 2 \right) \times \left(\frac{(4.11 \text{ ft})}{2 \times (6 \text{ ft})} \right)^4 \right] \right] \right]$ $M_{max} = 21.039 \text{ kipft}$	
		<p>Minimum Reinforcement Check (LRFD)</p> <p>Parameters:</p> <p>$f'_{ck} = 2.5 \text{ ksi}$ - Concrete strength, $f_{yk} = 60 \text{ ksi}$ - Longitudinal reinforcement strength, $\phi = 0.65$ - Reduction factor for axial strength, $\alpha = 0.8$ - Alpha factor for axial strength, $A_g = 2304 \text{ in}^2$ - Gross area of concrete,</p> <p>Longitudinal reinforcement:</p> <p>Required reinforcement due to axial load, $A_{st,required}$</p> $A_{st,required} = \text{Min} \left[\frac{\frac{P}{\phi \alpha} - (0.85 f'_{ck} A_g)}{f_{yk} - (0.85 f'_{ck})}, (0.08 A_g) \right]$ $A_{st,required} = \text{Min} \left[\frac{\left(\frac{(10.258 \text{ kip})}{(0.65) \times (0.8)} - (0.85 \times (2.5 \text{ ksi}) \times (2304 \text{ in}^2)) \right)}{(60 \text{ ksi}) - (0.85 \times (2.5 \text{ ksi}))}, (0.08 \times (2304 \text{ in}^2)) \right]$ $A_{st,required} = -84.255 \text{ in}^2$ <p>A_{min} - Governing minimum reinforcement area,</p> $A_{min} = \text{Max} [A_{st,required}, (0.0018 A_g)]$ $A_{min} = \text{Max} [(-84.255 \text{ in}^2), (0.0018 \times (2304 \text{ in}^2))]$ $A_{min} = 4.1472 \text{ in}^2$ <p>n_{rebar} - Required number of reinforcement,</p> $n_{rebar} = \frac{A_{min}}{A_{rebar}}$ $n_{rebar} = \frac{(4.1472 \text{ in}^2)}{(0.3068 \text{ in}^2)}$ $n_{rebar} = 14$ <p>A_{st} - Actual total reinforcement area,</p> $A_{st} = n_{rebar} \frac{\pi d_{bar}^2}{4}$ $A_{st} = (14) \times \frac{\pi \times (0.625 \text{ in})^2}{4}$ $A_{st} = 4.2951 \text{ in}^2$ <p>Ratio - Capacity</p> $\text{Ratio} = \frac{A_{min}}{A_{st}}$ $\text{Ratio} = \frac{(4.1472 \text{ in}^2)}{(4.2951 \text{ in}^2)}$ $\text{Ratio} = 0.96556$	
		<p>s_{rebar} - Minimum spacing of reinforcement,</p> $s_{rebar} = \text{Max} [1.5, (1.5 d_{bar})]$	
			<p>Status: PASS Ratio: 0.970</p>

$$V_{c,a} = \left[2 \times (0.64282) \times \sqrt{(2500 \text{ psi})} + \frac{(10258 \text{ lbf})}{6 \times (2304 \text{ in}^2)} \right] \times (48 \text{ in}) \times (38.4 \text{ in})$$

$$V_{c,a} = 119.85 \text{ kip}$$

22.5.5.1.2 The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$,
 $V_{c,b}$ - Shear strength of concrete (b)

$$V_{c,b} = \left[2 \lambda_s \sqrt{f'_{ck}} + (0.05 f'_{ck}) \right] b_w d$$

$$V_{c,b} = \left[2 \times (0.64282) \times \sqrt{(2500 \text{ psi})} + (0.05 \times (2500 \text{ psi})) \right] \times (48 \text{ in}) \times (38.4 \text{ in})$$

$$V_{c,b} = 348.89 \text{ kip}$$

V_c - Governing shear strength of concrete

$$V_c = \text{Min}[V_{c,max}, V_{c,a}, V_{c,b}]$$

$$V_c = \text{Min}[(296.21 \text{ kip}), (119.85 \text{ kip}), (348.89 \text{ kip})]$$

$$V_c = 119.85 \text{ kip}$$

22.5.1.2 The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$,
 $V_{s,a}$ - Shear strength of steel (a)

$$V_{s,a} = 8 \sqrt{f'_{ck}} b_w d$$

$$V_{s,a} = 8 \times \sqrt{(2500 \text{ psi})} \times (48 \text{ in}) \times (38.4 \text{ in})$$

$$V_{s,a} = 737.28 \text{ kip}$$

A_v - Ties rebar area,

$$A_v = \frac{\pi d_{ties}^2}{4}$$

$$A_v = \frac{\pi \times (0.375 \text{ in})^2}{4}$$

$$A_v = 0.11045 \text{ in}^2$$

22.5.8.5.3 $V_{s,b}$ - Shear strength of steel (b)

$$V_{s,b} = \frac{2 A_v f_{ywk} d}{s_{ties}}$$

$$V_{s,b} = \frac{2 \times (0.11045 \text{ in}^2) \times (60 \text{ ksi}) \times (38.4 \text{ in})}{(10 \text{ in})}$$

$$V_{s,b} = 50.894 \text{ kip}$$

V_s - Governing shear strength of steel

$$V_s = \text{MIN}[V_{s,a}, V_{s,b}]$$

$$V_s = \text{MIN}[(737.28 \text{ kip}), (50.894 \text{ kip})]$$

$$V_s = 50.894 \text{ kip}$$

22.5.1.1 ϕV_n - Allowable shear strength

$$\phi V_n = \phi (V_c + V_s)$$

$$\phi V_n = (0.65) \times ((119.85 \text{ kip}) + (50.894 \text{ kip}))$$

$$\phi V_n = 110.99 \text{ kip}$$

Considering x-direction:

$V_{max} = 7.2871 \text{ kip}$ - Maximum shear force in the x-direction,

$Ratio$ - Capacity

$$Ratio = \frac{V_{max}}{\phi V_n}$$

$$Ratio = \frac{(7.2871 \text{ kip})}{(110.99 \text{ kip})}$$

$$Ratio = 0.065658$$

Status: **PASS**
Ratio: **0.070**

Flexural Strength (ACI 318-19, LRFD)

S_m - Section modulus

$$S_m = \frac{b D^2}{6}$$

$$S_m = \frac{(48 \text{ in}) \times (48 \text{ in})^2}{6}$$

$$S_m = 18432 \text{ in}^3$$

$\lambda = 1$ - Concrete modification factor (Normal concrete),

Allowable flexural strength:

M_n shall be the lesser of:

$\phi M_{n,1}$

$$\phi M_{n,1} = \phi \times 5 \times \lambda \times \sqrt{f'_c} \times S_m$$

$$\phi M_{n,1} = 0.65 \times 5 \times 1 \times \sqrt{2.5 \text{ ksi}} \times 18432.001 \text{ in}^3$$

$$\phi M_{n,1} = 249.600 \text{ kipft}$$

14.5.2.1b

$\phi M_{n,2}$

$$\phi M_{n,2} = \phi \times 0.85 \times f'_c \times S_m$$

$$\phi M_{n,2} = (0.65) \times 0.85 \times (2.5 \text{ ksi}) \times (18432 \text{ in}^3)$$

$$\phi M_{n,2} = 2121.6 \text{ kipft}$$

Therefore,

ϕM_n - Allowable flexural strength,

$$\phi M_n = \text{MIN}[\phi M_{n,1}, \phi M_{n,2}]$$

$$\phi M_n = \text{MIN}[(249.6 \text{ kipft}), (2121.6 \text{ kipft})]$$

$$\phi M_n = 249.6 \text{ kipft}$$

Considering x-direction:

$M_{max} = 21.039 \text{ kipft}$ - Maximum moment in the x-direction,

Ratio - Capacity

$$\text{Ratio} = \frac{M_{max}}{\phi M_n}$$

$$\text{Ratio} = \frac{(21.039 \text{ kipft})}{(249.6 \text{ kipft})}$$

$$\text{Ratio} = 0.08429$$

Status: **PASS**
Ratio: **0.080**