

Project Name: 12270-revised 5

Date: Wed Oct 08 2025

Location: 18955 Lake City Rd, Nevada City, CA 95959, **Number of Modules:** 15

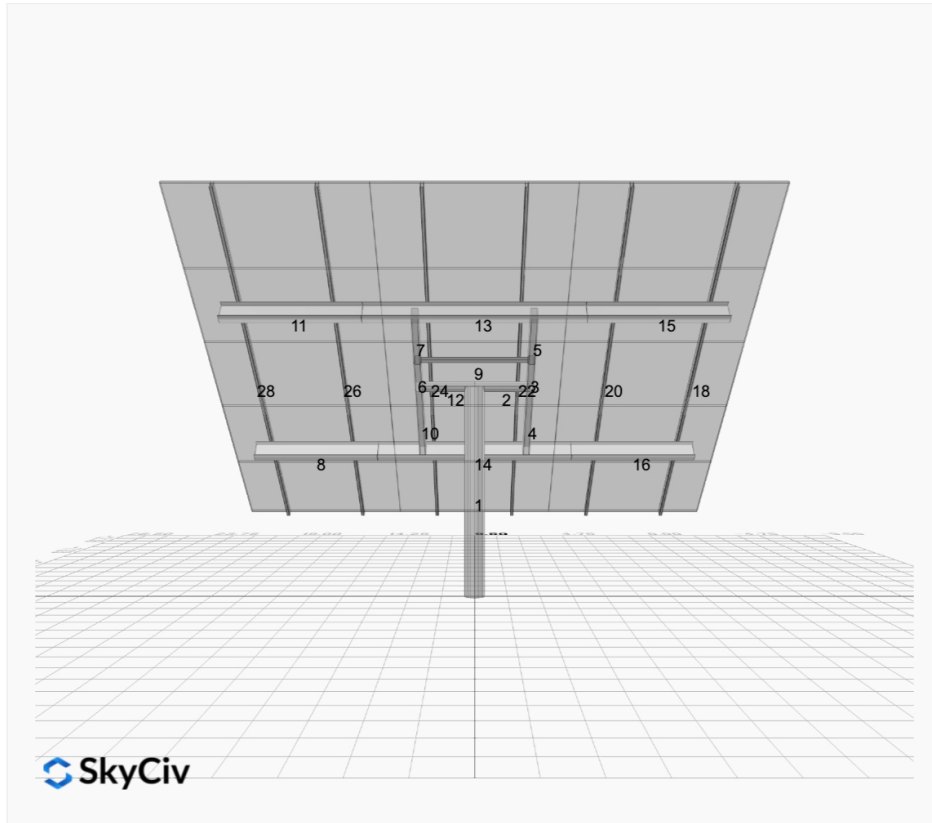
USA

Number of Poles: 1

Unique ID: 1P-0-8TOP-HD-57-L-5Hx3W-37IA

Date Sold:

Dealer: _____



Array Dimensions N/S	17.29 ft
Array Dimensions E/W	19.00 ft
Winter Tilt Angle (Degrees)	40
Front Edge Clearance	2

MT Solar Bill of Materials (1P-0-8TOP-HD-57-L-5Hx3W-37IA)

Part	Short Description	BOM Qty
MTS-PC-8	8IN Pole Cap Assembly	1
MTS-HF-HD	H-Frame Assembly-HD	1
MTS-HD-Wing-57	57IN HD Wing	4
MTS-CLAMP-ANGLE-4PK	Angle Clamp	3

Rail Bill of Materials

Part	Qty
Rails (208in Long)	6x
Rail Attachment	24x
Module Mid Clamp	24x
Module End Clamp	12x
Ground Lug	3x

Site Details:



Site Address: 18955 Lake City Rd, Nevada City, CA 95959, USA

Array Specification

Duty Classification:	HD
Module Width:	41.00 in
Module Length:	75.00 in
Number of Rows:	5
Number of Columns:	3
Total Number of Modules:	15
Winter Tilt Angle:	40
Front Edge Clearance:	2
Total Array Height at Tilt:	13.11 ft
Total Frame Length:	17.00 ft
Module Info/Notes:	
Array Dimensions N/S:	17.29 ft
Array Dimensions E/W:	19.00 ft
Rail Length:	207.50 in
Rail Spacing:	3.17 ft

Support Specifications

Pole Size:	8in Pipe Sch 40
Pole Length above Grade:	7.56 ft
Number of Poles:	1
Pole Spacing:	0

Foundation Specifications

Foundation Type:	rectangular
Foundation Dimensions:	60x60 in
Foundation Depth (below grade):	7.0 ft
Foundation Volume:	175.00 ft ³

Site Info

Risk Category:	I
Exposure:	B
Soil Classification:	sand
Site Location:	18955 Lake City Rd, Nevada City, CA 95959, USA
Wind Speed:	100 mph

Snow Load:

66 psf

Design Disclaimer

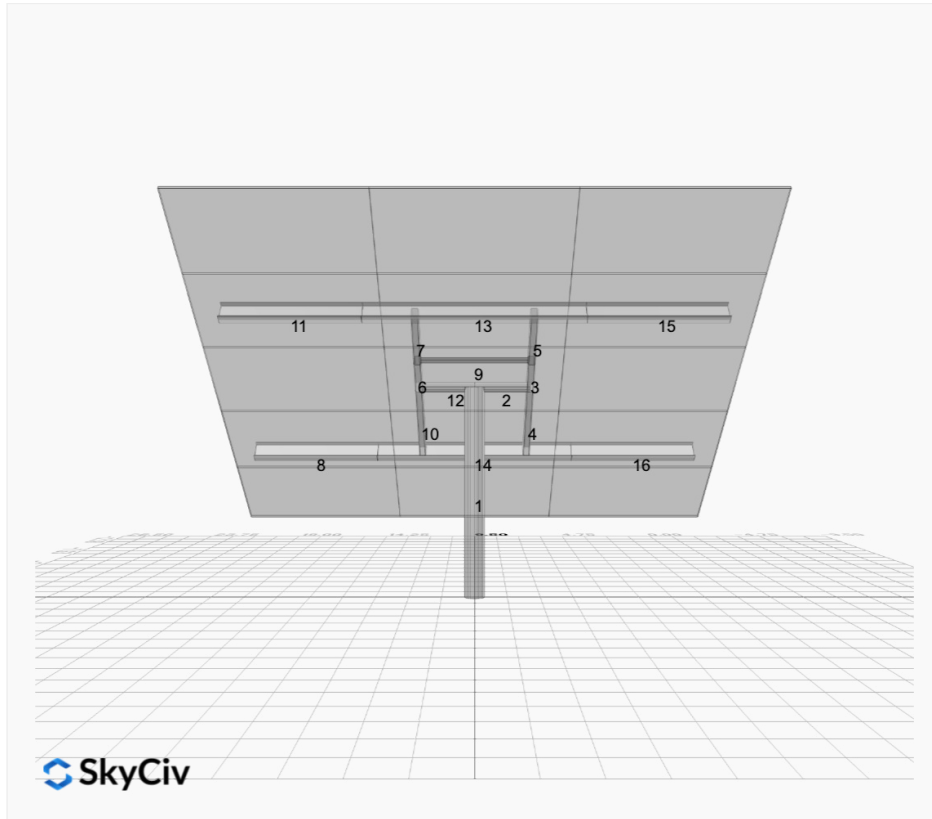
This software should be used for preliminary designs and should not be used as a final design unless reviewed, verified and designed by a qualified structural engineer.

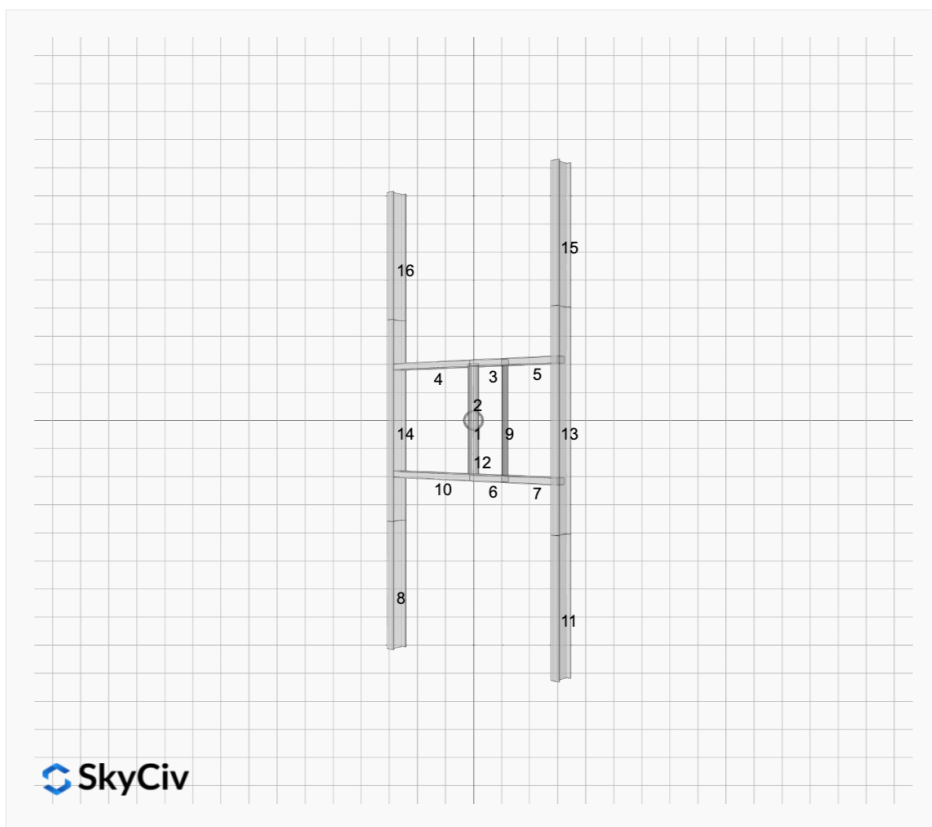
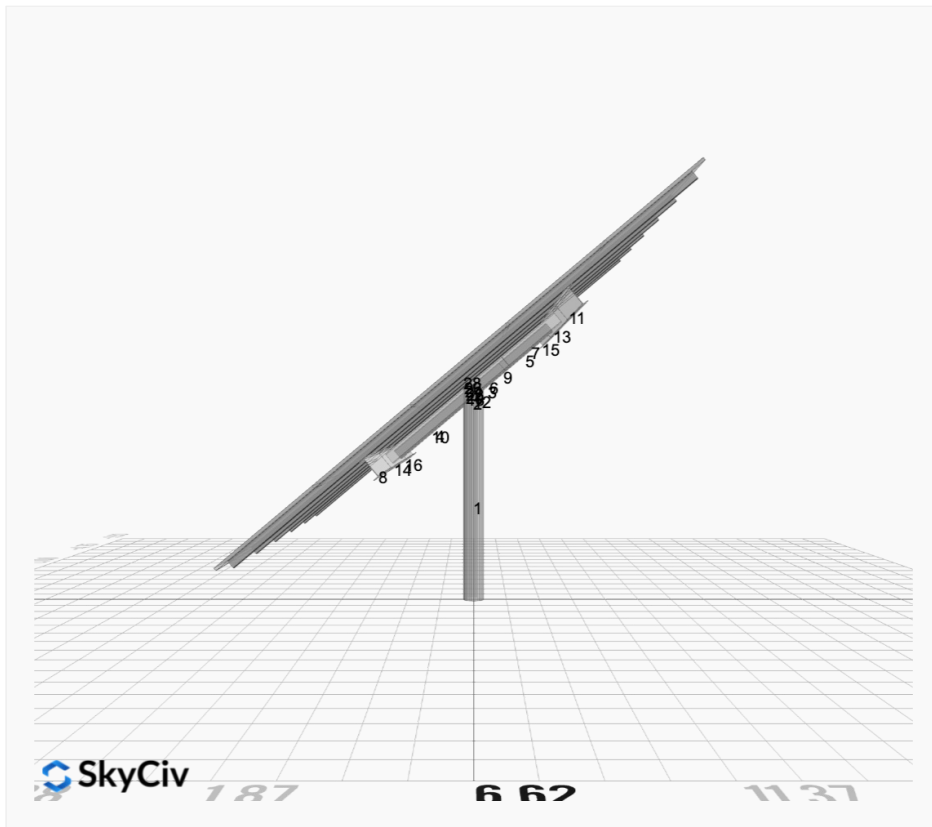
AutoDesigner Input

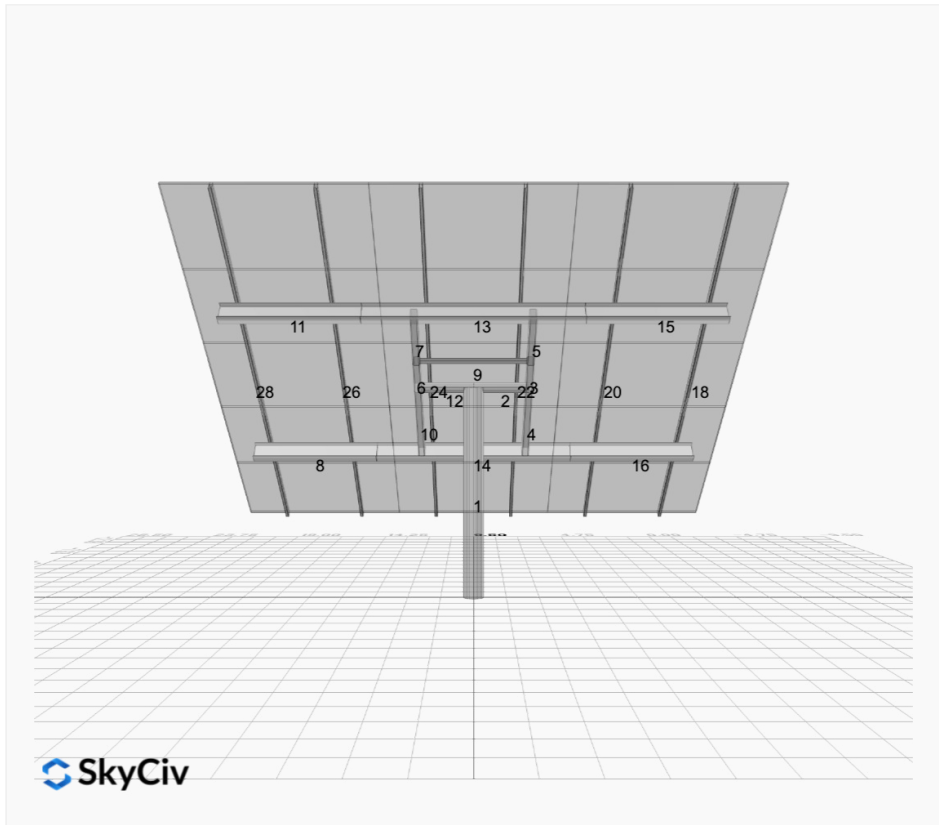
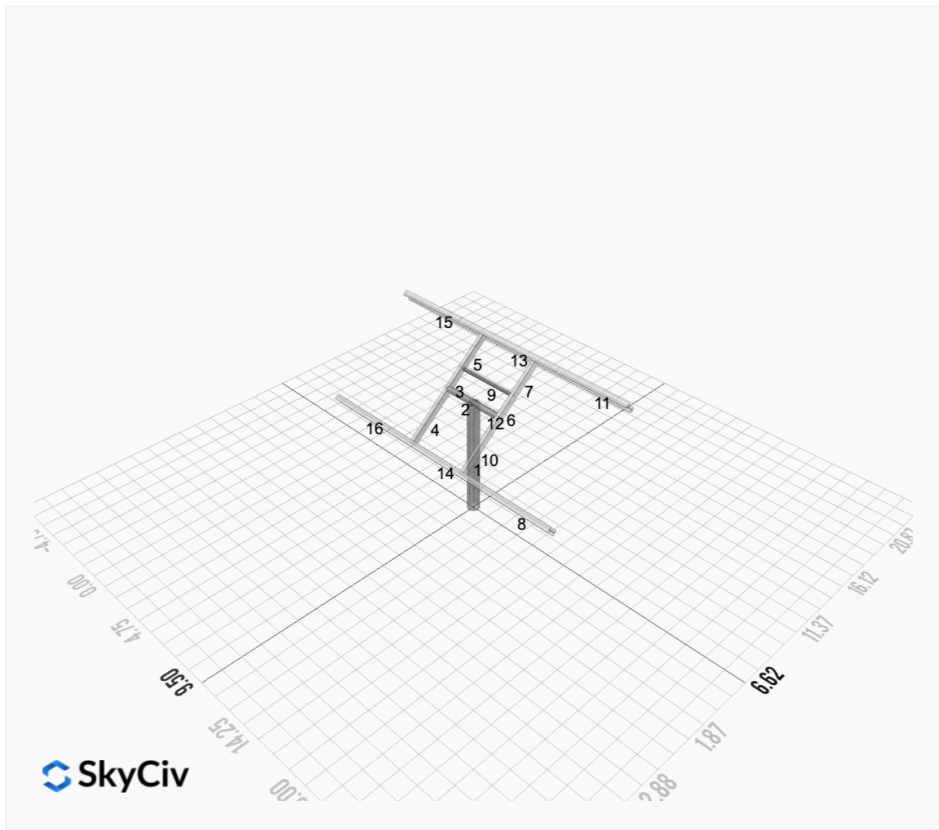
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Design Notes:

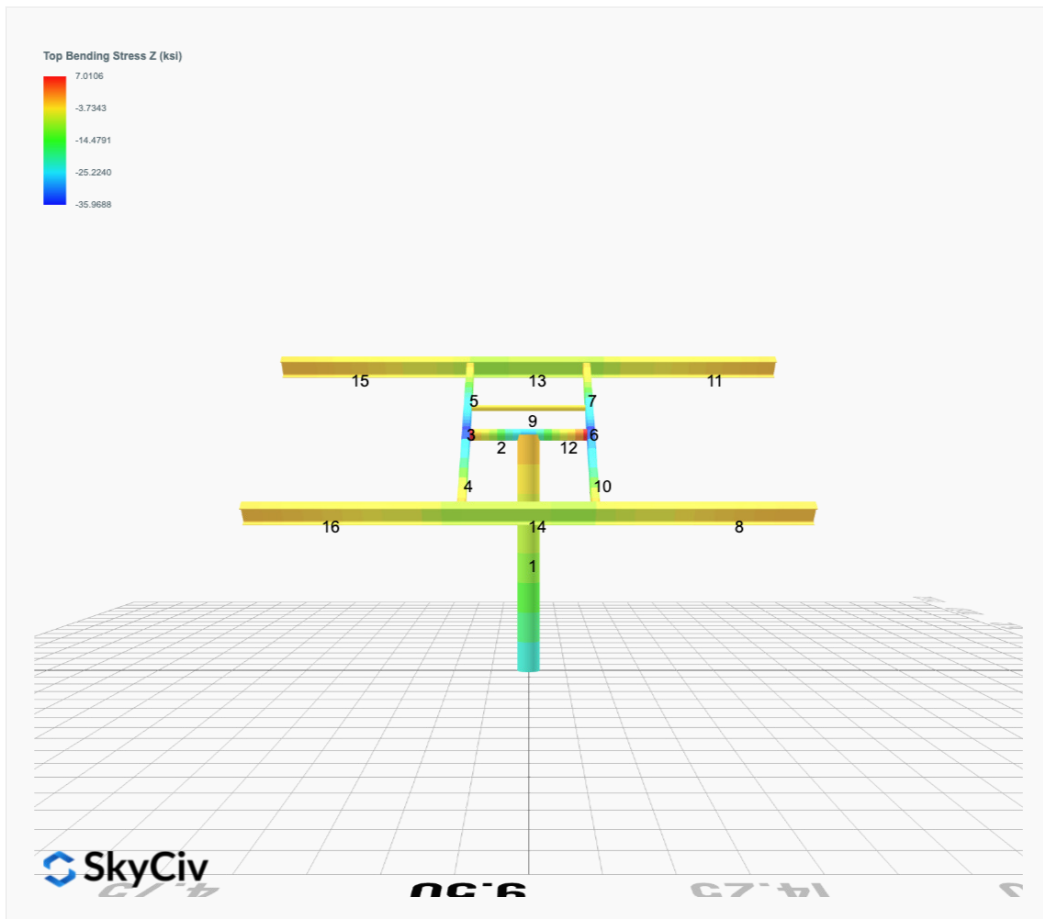
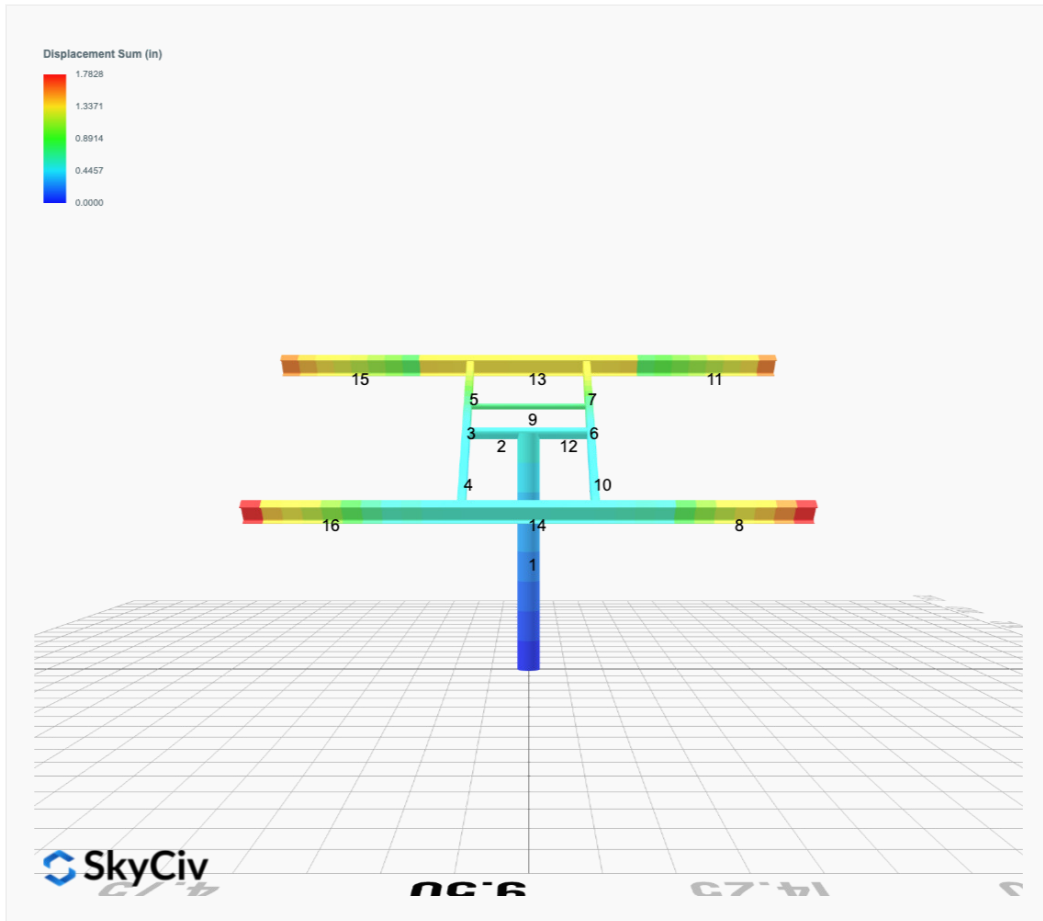
- Deflection checks are set to L/1 due to manufacturer structural design intent
- Foundation Soil Parameters used in this Autodesign are all estimates, proper geotechnical reports are required to confirm soil profiles
- Wind speeds, snow loads and other site specific results are based on ASCE 7-16
- Steel frame design checks are based on AISC 360-16 LRFD
- Design / analysis of fixings and connections are not carried out by this module.
- Impacts of eccentrically applied, partial or pattern loading are not considered by this module.

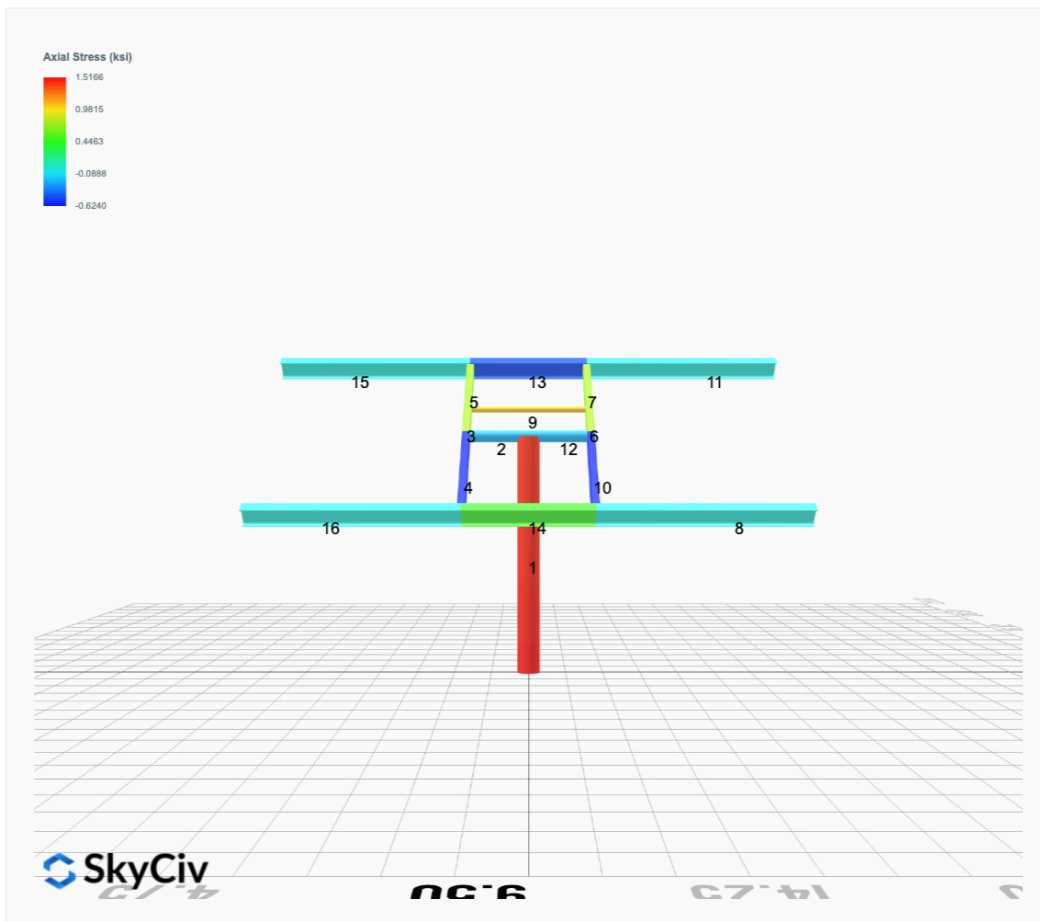






FEM Results (Envelope Worst Case)





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

LRFD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. 1.4D	0.0000	2.9500	0.0000	0.0000	-0.0000	0.0382
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	4.9800	0.0000	0.0000	-0.0000	0.0526
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	2.5285	0.0000	0.0000	-0.0000	0.0318
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0000	10.3732	0.0000	0.0000	-0.0000	0.1535
ULS: 5. 1.2D + E + L + 0.2S	0.0000	3.5091	0.0000	0.0000	-0.0000	0.0383
ULS: 7. 0.9D + 1.0E	0.0000	1.8964	0.0000	0.0000	-0.0000	0.0228
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-3.9692	9.7103	0.0000	0.0000	0.0000	31.3702
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-3.9692	9.7103	0.0000	0.0000	0.0000	31.3702
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	3.1634	1.2100	0.0000	-0.0000	-0.0000	-23.5807
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	2.6859	1.7791	0.0000	-0.0000	-0.0000	-29.4105
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-3.9692	7.2588	0.0000	0.0000	0.0000	31.2208
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-3.9692	7.2588	0.0000	0.0000	0.0000	31.2208
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	3.1634	-1.2414	0.0000	-0.0000	-0.0000	-23.5065
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	2.6859	-0.6724	0.0000	-0.0000	-0.0000	-29.3054
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.9846	12.7383	0.0000	0.0000	-0.0000	15.9054
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-1.9846	12.7383	0.0000	0.0000	-0.0000	15.9054
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.5817	8.4882	0.0000	-0.0000	-0.0000	-11.7989
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	1.3429	8.7727	0.0000	-0.0000	-0.0000	-14.7553
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.9846	4.8937	0.0000	0.0000	0.0000	15.5770
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-1.9846	4.8937	0.0000	0.0000	0.0000	15.5770
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.5817	0.6436	0.0000	-0.0000	-0.0000	-11.7661
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	1.3429	0.9281	0.0000	-0.0000	-0.0000	-14.6722
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-3.9692	6.6267	0.0000	0.0000	0.0000	31.1798
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-3.9692	6.6267	0.0000	0.0000	0.0000	31.1798
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	3.1634	-1.8736	0.0000	-0.0000	-0.0000	-23.4920
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	2.6859	-1.3045	0.0000	-0.0000	-0.0000	-29.2828

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0000	2.1071	0.0000	0.0000	-0.0000	0.0257
ULS: 2. D + L	0.0000	2.1071	0.0000	0.0000	-0.0000	0.0257
ULS: 3. D + (S or Lr or R)	0.0000	7.0100	0.0000	0.0000	-0.0000	0.0784
ULS: 3. D + (S or Lr or R)	0.0000	2.1071	0.0000	0.0000	-0.0000	0.0257
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	5.7843	0.0000	0.0000	-0.0000	0.0594
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	2.1071	0.0000	0.0000	-0.0000	0.0257
ULS: 5b. D + 0.7E	0.0000	2.1071	0.0000	0.0000	-0.0000	0.0257
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0000	5.7843	0.0000	0.0000	-0.0000	0.0594
ULS: 8. 0.6D + 0.7E	0.0000	1.2643	0.0000	0.0000	-0.0000	0.0145
ULS: 5a. D + 0.6W_Wind downforce Case A only	-2.3815	4.9453	0.0000	0.0000	0.0000	18.6791
ULS: 5a. D + 0.6W_Wind downforce Case B only	-2.3815	4.9453	0.0000	0.0000	0.0000	18.6791
ULS: 5a. D + 0.6W_Wind uplift Case A only	1.8980	-0.1549	0.0000	-0.0000	-0.0000	-14.1154
ULS: 5a. D + 0.6W_Wind uplift Case B only	1.6115	0.1866	0.0000	-0.0000	-0.0000	-17.5978
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.7861	7.9129	0.0000	0.0000	-0.0000	14.1224
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-1.7861	7.9129	0.0000	0.0000	-0.0000	14.1224
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.4235	4.0878	0.0000	-0.0000	-0.0000	-10.6188
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	1.2087	4.3439	0.0000	-0.0000	-0.0000	-13.2533

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.7861	4.2357	0.0000	0.0000	-0.0000	14.0025
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-1.7861	4.2357	0.0000	0.0000	-0.0000	14.0025
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.4235	0.4106	0.0000	0.0000	-0.0000	-10.5879
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	1.2087	0.6667	0.0000	-0.0000	-0.0000	-13.2015
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-2.3815	4.1024	0.0000	0.0000	0.0000	18.6425
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-2.3815	4.1024	0.0000	0.0000	0.0000	18.6425
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	1.8980	-0.9977	0.0000	-0.0000	-0.0000	-14.1078
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	1.6115	-0.6563	0.0000	-0.0000	-0.0000	-17.5837

Worst Case Reactions (LRFD)

Note: Downforce / downwind wind load cases are assumed to govern.

Result	Value (kip, kip-ft)
Axial	12.7383
Shear X	3.9692
Shear Z	0.0000
Moment X	-0.0000
Moment Y (Twist)	0.0000
Moment Z	31.3702

Worst Case Reactions (ASD)

Note: Downforce / downwind wind load cases are assumed to govern.

Result	Value (kip, kip-ft)
Axial	7.9129
Shear X	2.3815
Shear Z	0.0000
Moment X	-0.0000
Moment Y (Twist)	0.0000
Moment Z	18.6791

Project Details

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

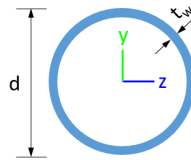


Design Input Information

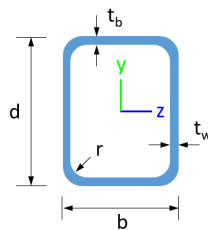
Design Factors			
Φ_t	Φ_c	Φ_b	Φ_v
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Design Materials			
ID	E (ksi)	F_y (ksi)	F_u (ksi)
1	29000	50	65

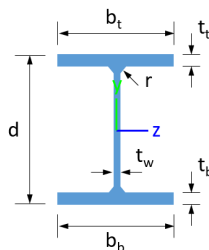
Section Dimensions



ID	Name	d (in)	t_w (in)				
2	2in Pipe Sch 80	2.38	0.22				
5	4in Pipe Sch 80	4.50	0.34				
9	8in Pipe Sch 40	8.63	0.32				



ID	Name	d (in)	b (in)	t_w (in)	t_b (in)	r (in)	
16	HSS5x3x3/16	5.00	3.00	0.17	0.17	0.17	



ID	Name	d (in)	t_w (in)	b_t (in)	b_b (in)	t_t (in)	t_b (in)	r (in)
19	W8x10	7.89	0.17	3.94	3.94	0.20	0.20	0.30

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)
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5	116.10	114.23	15.79	11.10	42.08	23.28
6	116.10	115.41	15.79	11.10	42.08	23.28
7	116.10	114.23	15.79	11.10	42.08	23.28
8	133.20	32.95	32.87	6.12	40.24	43.62
9	66.48	58.89	3.82	3.82	19.94	19.94
10	116.10	111.33	15.79	11.10	42.08	23.28
11	133.20	32.95	32.87	6.12	40.24	43.62
12	198.33	196.72	21.95	21.95	59.50	59.50
13	133.20	85.85	23.54	6.12	40.24	43.62
14	133.20	85.85	23.25	6.12	40.24	43.62
15	133.20	32.95	32.87	6.12	40.24	43.62
16	133.20	32.95	32.87	6.12	40.24	43.62

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	0.035	0.377	0.000	0.035	0.000	0.390	#13	0.100	Not Required	Pass
2	0.006	0.453	0.196	0.105	0.033	0.608	#21	0.035	Not Required	Pass
3	0.014	0.648	0.069	0.065	0.002	0.724	#21	0.045	Not Required	Pass
4	0.014	0.628	0.270	0.063	0.056	0.803	#21	0.080	Not Required	Pass
5	0.014	0.402	0.279	0.064	0.071	0.479	#21	0.074	Not Required	Pass
6	0.014	0.648	0.069	0.065	0.002	0.724	#21	0.045	Not Required	Pass
7	0.014	0.402	0.279	0.064	0.071	0.479	#21	0.074	Not Required	Pass
8	0.000	0.106	0.344	0.037	0.020	0.450	#21	Not Required	Not Required	Pass
9	0.028	0.048	0.061	0.001	0.000	0.121	#21	0.204	Not Required	Pass
10	0.014	0.628	0.270	0.063	0.056	0.803	#21	0.080	Not Required	Pass
11	0.000	0.109	0.344	0.037	0.020	0.452	#21	Not Required	Not Required	Pass
12	0.006	0.453	0.196	0.105	0.033	0.608	#21	0.035	Not Required	Pass
13	0.012	0.297	0.643	0.051	0.028	0.927	#21	0.190	Not Required	Pass
14	0.015	0.296	0.643	0.050	0.028	0.921	#21	0.190	Not Required	Pass
15	0.000	0.109	0.344	0.037	0.020	0.452	#21	Not Required	Not Required	Pass
16	0.000	0.106	0.344	0.037	0.020	0.450	#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

IBC 2018 Pile Design



Input	Description
Region	American Standard
Concrete design code	American Concrete Institute (ACI 318:2019)

Cross-section

Input	Description	Value
Shape	Cross-sectional shape	Square
b	Section width	60 in
D	Section depth	60 in

Material Properties

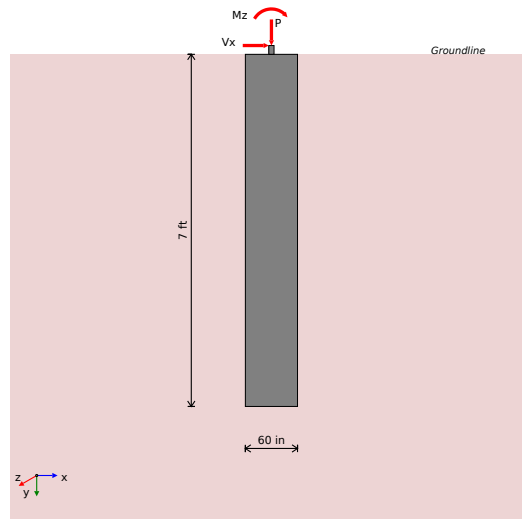
Input	Description	Value
f'_{ck}	Concrete compressive strength	2.5 ksi
f_{yk}	Yield strength of steel	60 ksi
d_b	Rebar diameter	#5 (0.625) in
cover	Concrete cover	3 in

Soil Parameters (IBC 1806)

Input	Description	Value
Soil type	Sand, silty sand, clayey sand, silty gravel & clayey gravel	
q_a	Allowable bearing pressure	2000 psf
R	Allowable lateral pressure	150 psf/ft

Loading

Load	ASD	LRFD
P	7.913 kip	12.74 kip
V _x	2.381 kip	3.969 kip
V _z	0 kip	0 kip
M _x	0 kip-ft	0 kip-ft
M _z	18.68 kip-ft	31.37 kip-ft



Required depth to resist lateral loads (ASD)

Allowable lateral pressure

$$R = 150 \text{ psf/ft}$$

Point of application of lateral load:

$$H = h_1 + h_2 + h_e = 0 + 0 + 0 = 0 \text{ ft}$$

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{1.57 \times D} = \frac{2.381}{1.57 \times 60} = 0.303 \frac{\text{kip}}{\text{ft}}$$

Moment per section length

$$M_o = \frac{M_x + (V_x \times H)}{1.57 \times D} = \frac{18.68 + (2.381 \times 0)}{1.57 \times 60} = 2.379 \frac{\text{kip-ft}}{\text{ft}}$$

Required depth of embedment in earth:

$$L_e^3 - \left(9 \times \frac{H_o \times L_x}{R}\right) - \left(12 \times \frac{M_o}{R}\right) = 0$$

Solving the cubic equation:

$$L_{e,z} = 6.798 \text{ ft}$$

Considering z-direction:

Since there are no loads applied in this direction, the required effective length: $L_{e,z} = 0 \text{ ft}$.

Minimum embedded depth

Depth of pile required

$$L_{e,req} = \text{MAX}[L_{e,x}, L_{e,z}] = \text{MAX}[6.798, 0] = 6.798 \text{ ft}$$

Actual embedded length

$$L_e = L - h_2 - h_e = 7 - 0 - 0 = 7 \text{ ft}$$

Utilisation

$$\text{Ratio} = \frac{L_{e,req}}{L_e} = \frac{6.798}{7} = 0.971$$

UTILITY: 0.97

REFERENCES

CALCULATIONS

RESULTS

End-bearing Capacity (ASD)

Allowable bearing pressure
Unit weight of concrete

$q_a = 2000 \text{ psf}$
 $w_c = 0.15 \text{ kip/ft}^3$

Cross-sectional area:

$$A = b \times D = 60 \times 60 = 25 \text{ ft}^2$$

End-bearing pressure:

$$q = \frac{P}{A} = \frac{7.913}{25} = 316.5 \text{ psf}$$

Utilisation

$$\text{Ratio} = \frac{q}{q_a} = \frac{316.5}{2000} = 0.158$$

UTILITY: 0.16

Lateral Soil Pressure (ASD)

Allowable lateral pressure

$R = 150 \text{ psf/ft}$

Length to least lateral dimension ratio:

$$\frac{L}{\text{MIN}[b, D]} = \frac{7}{\text{MIN}[5, 5]} = 1.4$$

L/D ratio ≤ 10 . This pile is classified as a short pile.

Considering x-direction:

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 2.379 \times 7) + (3 \times 0.303 \times 7^2)}{(6 \times 2.379) + (4 \times 0.303 \times 7)} = 4.884 \text{ ft}$$

Earth pressure against the pile at a distance a/2 from the resting surface:

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

$$p = \frac{0.75 \times [(4 \times 2.379) + (3 \times 0.303 \times 7)]^2}{7^2 \times [(3 \times 2.379) + (2 \times 0.303 \times 7)]} = 0.339 \frac{\text{kip}}{\text{ft}^2}$$

Allowable lateral soil pressure at a depth of $a/2$:

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{4.884}{2} = 0.366 \frac{\text{kip}}{\text{ft}^2}$$

Utilisation - pressure at a depth of $a/2$

$$\text{Ratio} = \frac{p}{p_a} = \frac{0.339}{0.366} = 0.926$$

UTILITY: 0.93

Earth pressure against the pile at distance L_e :

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times 2.379) + (0.303 \times 7)]}{7^2} = 0.843 \frac{\text{kip}}{\text{ft}^2}$$

Allowable lateral soil pressure at a depth of L_e :

$$p_s = R \times L_e = 0.15 \times 7 = 1.05 \frac{\text{kip}}{\text{ft}^2}$$

Utilisation - pressure at a depth of L_e

$$\text{Ratio} = \frac{s}{p_s} = \frac{0.843}{1.05} = 0.803$$

UTILITY: 0.80

Considering z-direction:

Since no loads are applied in this direction, lateral soil pressure check is not required.

REFERENCES

CALCULATIONS

RESULTS

Shear force and bending moment (LRFD)

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{1.57 \times D} = \frac{3.969}{1.57 \times 60} = 0.506 \frac{\text{kip}}{\text{ft}}$$

Moment per section length

$$M_o = \frac{M_x + (V_x \times H)}{1.57 \times D} = \frac{31.37 + (3.969 \times 0)}{1.57 \times 60} = 3.996 \frac{\text{kip-ft}}{\text{ft}}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 3.996 \times 7) + (3 \times 0.506 \times 7^2)}{(6 \times 3.996) + (4 \times 0.506 \times 7)} = 4.883 \text{ ft}$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{3.996}{0.506} = 7.903 \text{ ft}$$

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

$$V_{max,x} = (0.506 \times 60) \times \left[1 - \left[3 \times \left(\frac{4 \times 7.903}{7} + 3 \right) \times \left(\frac{4.883}{7} \right)^2 + \left[4 \times \left(\frac{3 \times 7.903}{7} + 2 \right) \times \left(\frac{4.883}{7} \right)^3 \right] \right] \right]$$

$$V_{max,x} = 6.719 \text{ kip}$$

Max bending moment located at a depth of $a/2$:

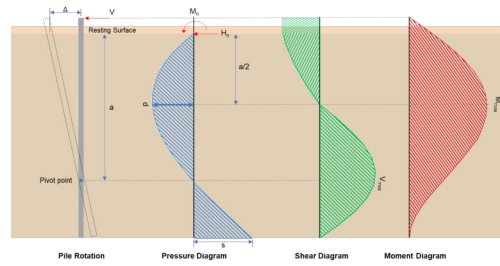
$$M_{max,x} = (H_o \times D \times L_e) \times \left[\left(\frac{E}{L_e} + \frac{a}{2 \times L_e} \right) - \left[\left(\frac{4 \times E}{L_e} + 3 \right) \times \left(\frac{a}{2 \times L_e} \right)^3 + \left[\left(\frac{3 \times E}{L_e} + 2 \right) \times \left(\frac{a}{2 \times L_e} \right)^4 \right]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

$$M_{max,x} = (0.506 \times 60 \times 7) \times \left[\left(\frac{7.903}{7} + \frac{4.883}{2 \times 7} \right) - \left[\left(\frac{4 \times 7.903}{7} + 3 \right) \times \left(\frac{4.883}{2 \times 7} \right)^3 + \left[\left(\frac{3 \times 7.903}{7} + 2 \right) \times \left(\frac{4.883}{2 \times 7} \right)^4 \right] \right] \right]$$

$$M_{max,x} = 21.92 \text{ kip-ft}$$

Considering z-direction:

There are no loads applied in this direction.



Minimum Reinforcement Check (LRFD)

Gross area of concrete:

$$A_g = b \times D = 60 \times 60 = 3600 \text{ in}^2$$

Main Reinforcement

22.4.2.2 Required reinforcement:

$$A_{st,req} = \frac{P - (0.85 \times f'_{ck} \times A_g)}{f_{yk} - (0.85 \times f'_{ck})} = \frac{12.74 - (0.85 \times 2.5 \times 3600)}{60 - (0.85 \times 2.5)} = -132 \text{ in}^2$$

10.6.1.1 Maximum reinforcement:

$$A_{st,max} = 0.08 \times A_g = 0.08 \times 3600 = 288 \text{ in}^2$$

7.6.1.1 Minimum reinforcement:

$$A_{st,min} = 0.0018 \times A_g = 0.0018 \times 3600 = 6.48 \text{ in}^2$$

Governing minimum reinforcement area:

$$(0.0018 \times A_g) \leq A_{st,req} \leq (0.08 \times A_g)$$

$$A_{min} = 6.48 \text{ in}^2$$

Minimum number of reinforcements:

$$A_{bar} = 0.307 \text{ in}^2$$

$$n_{min} = \frac{A_{min}}{A_{bar}} = \frac{6.48}{0.307} = 22$$

25.2.3 Minimum spacing:

$$s_{rebar} = \text{MAX}[1.5, 1.5 \times d_b] = \text{MAX}[1.5, (1.5 \times 0.625)] = 1.5 \text{ in}$$

Use: $n = 24$ pcs at 1.5 in minimum spacing

Total reinforcement area:

$$A_{st} = 24 \times 0.307 = 7.363 \text{ in}^2$$

Shear Reinforcement

25.7.2.2 For main reinforcement ≤ 1.41 in: Use #3(0.375 in)

Maximum spacing of shear Reinforcements:

$$s = \text{MIN}[16 \times d_b, 48 \times d_{b,trans}, \text{MIN}(b, D)] = \text{MIN}[(16 \times 0.625), (48 \times 0.375), \text{MIN}(60, 60)] = 10 \text{ in}$$

Detailing Summary

Main reinforcement	#5 (0.625 in) - 24 pcs at 1.5 in min. spacing
Shear reinforcement	#3 (0.375 in) at 10 in max. spacing

Axial Compression Strength (LRFD)

22.4.2.2 Allowable axial compressive strength:

$$\phi P_N = \phi \times 0.8 \times [(0.85 \times f'_{ck} \times [A_g - A_{st}]) + (f_{yk} \times A_{st})]$$

$$\phi P_N = 0.65 \times 0.8 \times [(0.85 \times 2.5 \times [3600 - 7.363]) + (60 \times 7.363)] = 4200 \text{ kip}$$

Utilisation

$$Ratio = \frac{P}{\phi P_N} = \frac{12.74}{4200} = 0.003$$

UTILITY: 0.00

Shear Strength LRFD)

Effective shear width	$b_w = 60$ in
Effective shear depth	$d = 56.31$ in
Shear reinforcement area	$A_v = 0.221$ in ²
Shear reinforcement spacing	$s = 10$ in
Concrete type factor (Normal concrete)	$\lambda = 1$
Strength reduction factor for shear	$\phi = 0.75$
Maximum shear in the x-direction	$V_{max,x} = 6.719$ kip
Maximum shear in the z-direction	$V_{max,z} = 0$ kip

22.5.5.1.1 Max shear strength of concrete:

$$V_{c,max} = 5 \times \lambda \times \sqrt{f'_{ck}} \times b_w \times d = 5 \times 1 \times \sqrt{2.5} \times 60 \times 56.31 = 844.7 \text{ kip}$$

Table 22.5.5.1 Shear strength of concrete:

$$V_{c,a} = \left(2 \times \lambda \times \sqrt{f'_{ck}} + \text{MIN} \left[\frac{P}{6 \times A_g}, (0.05 \times f'_{ck}) \right] \right) \times (b_w \times d)$$

$$V_{c,a} = \left(2 \times 1 \times \sqrt{2.5} + \text{MIN} \left[\frac{12.74}{6 \times 3600}, (0.05 \times 2.5) \right] \right) \times (60 \times 56.31) = 339.9 \text{ kip}$$

Governing shear strength of concrete:

$$V_c = \text{MIN}[V_{c,max}, V_{c,a}] = \text{MIN}[844.7, 339.9] = 339.9 \text{ kip}$$

22.5.1.2 Shear strength of steel (a):

$$V_{s,a} = 8 \times \sqrt{f'_{ck}} \times b_w \times d = 8 \times \sqrt{2.5} \times 60 \times 56.31 = 1352 \text{ kip}$$

22.5.8.5.3 Shear strength of steel (b):

$$V_{s,b} = \frac{A_v \times f_{yk} \times d}{s} = \frac{0.221 \times 60 \times 56.31}{10} = 74.63 \text{ kip}$$

Governing shear strength of steel:

$$V_s = \text{MIN}[V_{s,a}, V_{s,b}] = \text{MIN}[1352, 74.63] = 74.63 \text{ kip}$$

22.5.1.1 Allowable shear strength:

$$\phi V_n = \phi \times (V_c + V_s) = 0.75 \times (339.9 + 74.63) = 310.9 \text{ kip}$$

$$V_{max} = \text{MAX}[6.719, 0] = 6.719 \text{ kip}$$

Utilisation

$$Ratio = \frac{V_{max}}{\phi V_n} = \frac{6.719}{310.9} = 0.022$$

UTILITY: 0.02

Flexural Strength (LRFD)

Concrete type factor (Normal concrete)	$\lambda = 1$
Strength reduction factor for flexure	$\phi = 0.65$
Modulus of steel reinforcement	$E_s = 200e3$ ksi
Maximum concrete strain	$\epsilon_c = 0.0030$
Yield strain of steel f_y/E_s	$\epsilon_y = 0.0003$
Section width	$b = 60$ in
Distance to the compression rebar	$d_c = 3.688$ in
Distance to the tension rebar	$d = 56.31$ in
Total bar area	$A_s = 7.363$ in ²
Maximum applied axial load	$P = 12.74$ kip
Maximum moment in the x-direction	$M_{max,x} = 21.92$ kip-ft
Maximum moment in the z-direction	$M_{max,z} = 0$ kip-ft

Compressive force due to concrete:

$$\beta_1 = 0.85$$

$$C_{rc} = 0.85 \times \beta_1 \times f'_c \times b \times c$$

Compressive force due to bars in compression:

$$C_{rs} = f_1 \times A_{sc}$$

$$\epsilon_1 = (c - d_s) \times \frac{\epsilon_c}{c}$$

$$f_1 = E_s \times \varepsilon_1 \quad (\varepsilon_1 < \varepsilon_{sy}), f_1 = f_y \quad (\varepsilon_1 \geq \varepsilon_{sy})$$

Tensile force due to bars in tension:

$$T_{rs} = f_2 \times A_{st}$$

$$\varepsilon_2 = (d - c) \times \frac{\varepsilon_{cu}}{c}$$

$$f_2 = E_s \times \varepsilon_2 \quad (\varepsilon_2 < \varepsilon_{sy}), f_2 = \phi_s \times f_y \quad (\varepsilon_2 \geq \varepsilon_{sy})$$

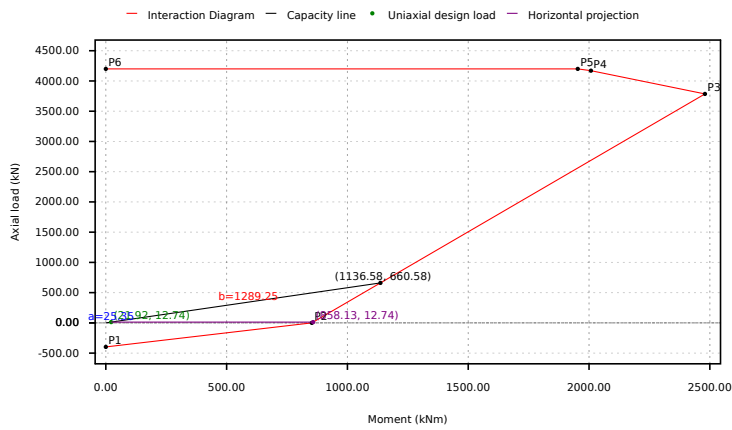
Interaction Diagram Summary

Point	Case	M _r	P _r
P1	Pure Tension	0	-397.6
P2	Pure Bending	852.7	0
P3	Balanced Failure	2480	3786
P4	Decompression	2008	4170
P5	Compression Limit	1953	4200
P6	Pure Compression	0	4200

Uniaxial Bending Check

$$M_f = \text{MAX}[21.92, 0] = 21.92 \text{ kip-ft}$$

Interaction Diagram



Segment	Signed Distance
P1 - P2	362.6
P2 - P3	768.2
P3 - P4	4477
P4 - P5	4602
P5 - P6	4187
Status	PASS: Point lies inside the curve

Utilisation

$$\text{Ratio} = \frac{a}{a+b} = \frac{25.35}{25.35 + 1289} = 0.019$$

UTILITY: 0.02

REFERENCES

CALCULATIONS

RESULTS

Results Summary

Result Name	Results
PILE DETAILS	
Length of the pile	7.00 ft
Dimensions	60 x 60 in
Main bar reinforcement	#5-24pcs at 1.5 in min.
Shear reinforcement	#3 at 10 in max.
UTILISATIONS	
Required depth	0.97
End-bearing capacity	0.16
P _a	0.93
P _s	0.80
Axial compression strength	0.00
Shear strength	0.02
Uniaxial bending strength	0.02

