Project Details

Project Name: W-10317 45x75 - V1Jb

Location: Nevada City, CA 95959, USA

Unique ID: 1P-0-6TOP-SD-57-L-4Hx3W-J1DE

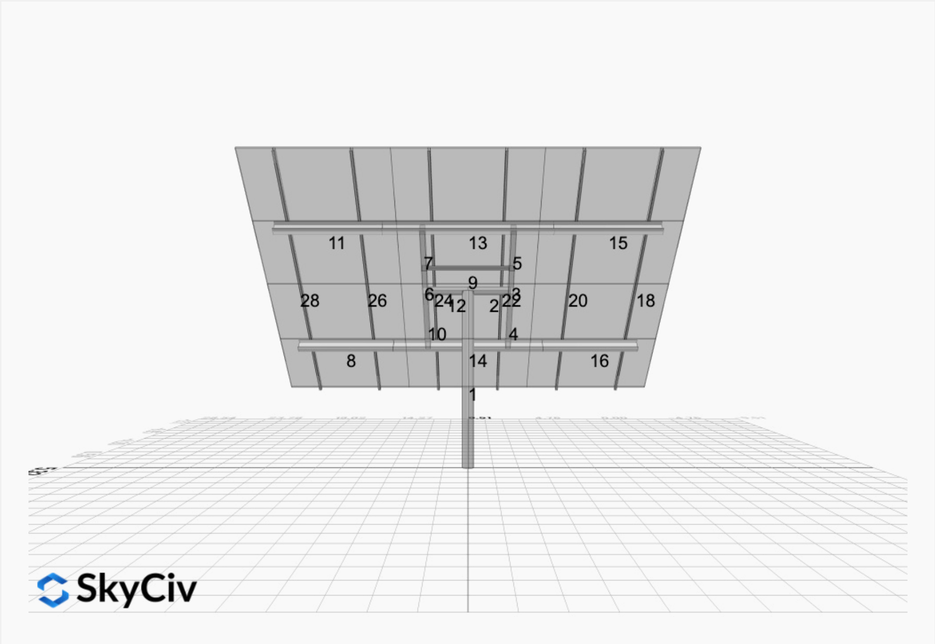
Dealer: ______________________________

Date: Mon Oct 06 2025

Number of Modules: 12

Number of Poles: 1

Date Sold: ______________________________



Array Dimensions N/S	15.03 ft
Array Dimensions E/W	19.02 ft
Winter Tilt Angle (Degrees)	45
Front Edge Clearance	3

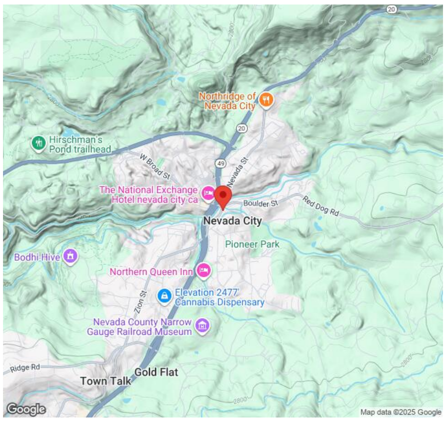
MT Solar Bill of Materials (1P-0-6TOP-SD-57-L-4Hx3W-J1DE)

Part	Short Description	BOM Qty
MTS-PC-6	6IN Pole Cap Assembly	1
MTS-HF-SD	H-Frame Assembly-SD	1
MTS-SD-Wing-57	57IN SD Wing	4
MTS-CLAMP-HOOK-4PK	Hook Clamp	3

Rail Bill of Materials

Part	Qty
Rails (180in Long)	6x
Rail Attachment	12x
Module Mid Clamp	18x
Module End Clamp	12x
Ground Lug	3x

Site Details:



Site Address: Nevada City, CA 95959, USA

Array Specification

Duty Classification:	SD
Module Width:	44.60 in
Module Length:	75.10 in
Number of Rows:	4
Number of Columns:	3
Total Number of Modules:	12
Winter Tilt Angle:	45
Front Edge Clearance:	3
Total Array Height at Tilt:	13.63 ft
Total Frame Length:	17.00 ft
Module Info/Notes:	Aptos 460W
Array Dimensions N/S:	15.03 ft
Array Dimensions E/W:	19.02 ft
Rail Length:	180.40 in
Rail Spacing:	3.17 ft

Support Specifications

Pole Size:	6in Pipe Sch 40
Pole Length above Grade:	8.32 ft
Number of Poles:	1
Pole Spacing:	0

Foundation Specifications

Foundation Type:	rectangular
Foundation Dimensions:	48x48 in
Foundation Depth (below grade):	7.3 ft
Foundation Volume:	116.00 ft^3

Site Info

Risk Category:	I
Exposure:	B
Soil Classification:	sand
Site Location:	Nevada City, CA 95959, USA
Wind Speed:	90 mph

Snow Load:	20 psf

Design Disclaimer

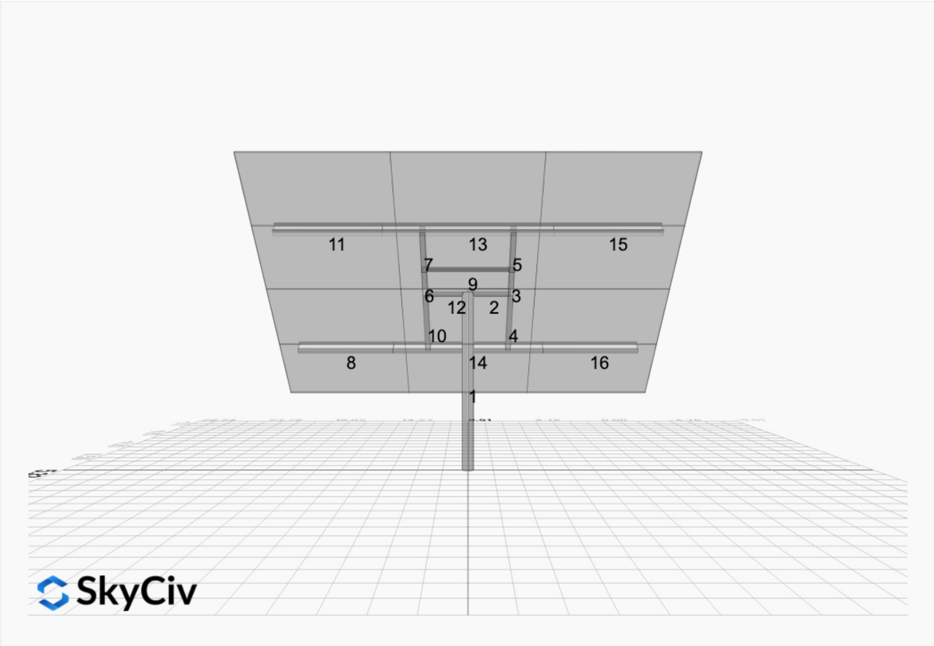
This software should be used for preliminary designs and should not be used as a final design unless reviewed, verified and designed by a qualified structural engineer.

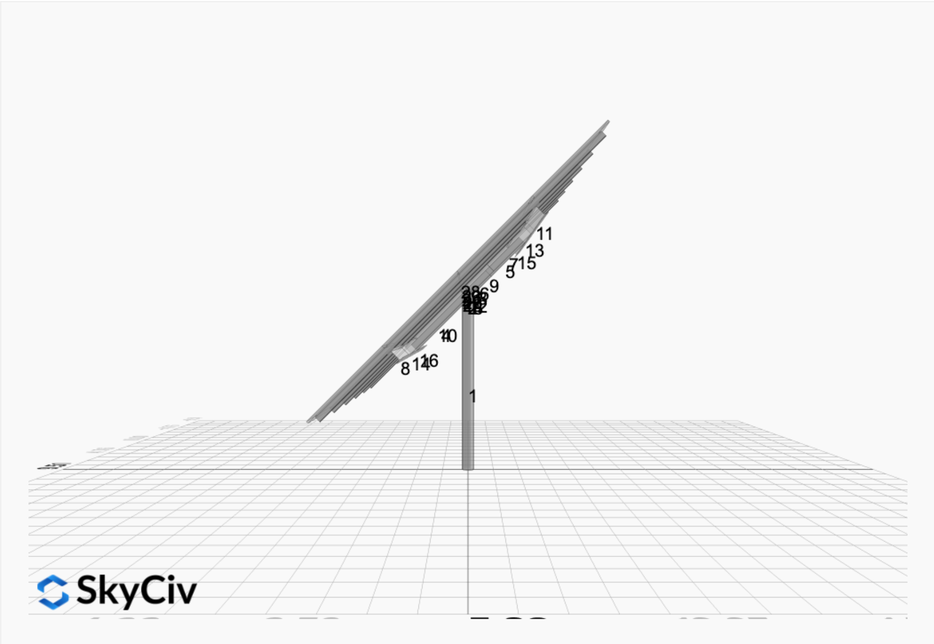
AutoDesigner Input

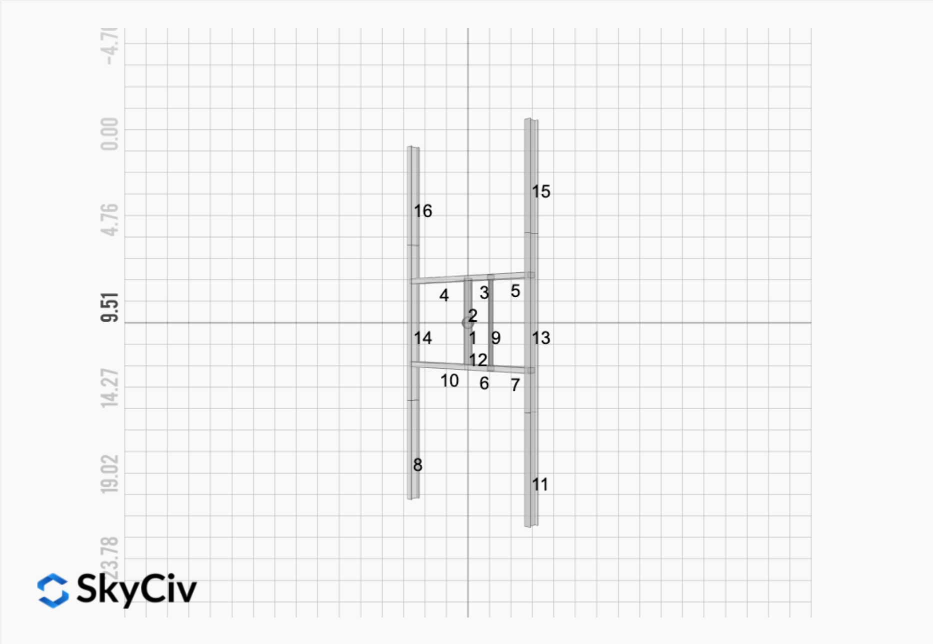
{"wind_speed_override":90,"snow_load_override":20,"direct_snow_load":false,"add_angle_brace":false,"product_type":"Beam","designer_name":"","designer_email":"","designer_phone":"","project_id":"W-10317 45x75 - V1Jb","site_address":"Nevada City, CA 95959, USA","module_info":"Aptos 460W","module_width":44.6,"module_length":75.1,"number_rows":"4","number_columns":3,"pole_mount_section":"4_40","core_pipe_width":65,"core_pipe_section":"2_40","adjuster_section":"2_40","core_beam_height":65,"core_beam_section":"HSS3x2x1/8","main_pipe_section":"2_12GA","pole_spacing":"15","tilt_angle":45,"ground_clearance":3,"risk_category":"I","exposure_category":"B","frame_duty_override":"auto","pole_override":"auto","soil_type":"sand","customer_foundation_override":"48_Square","foundation_type":"Square","foundation_size":48,"check_rails":false}

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.
- Foundation Design and Sizing is approximate only



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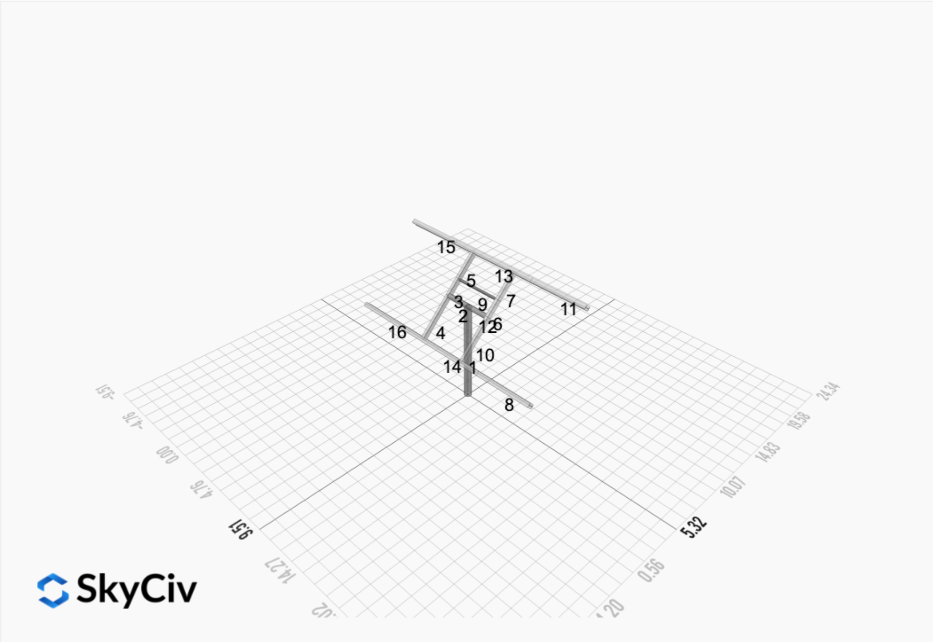
4.76
9.51
14.27
19.02
23.78
16
15
4
3
5
2
14
1
9
13
12
10
6
7
8
11
SkyCiv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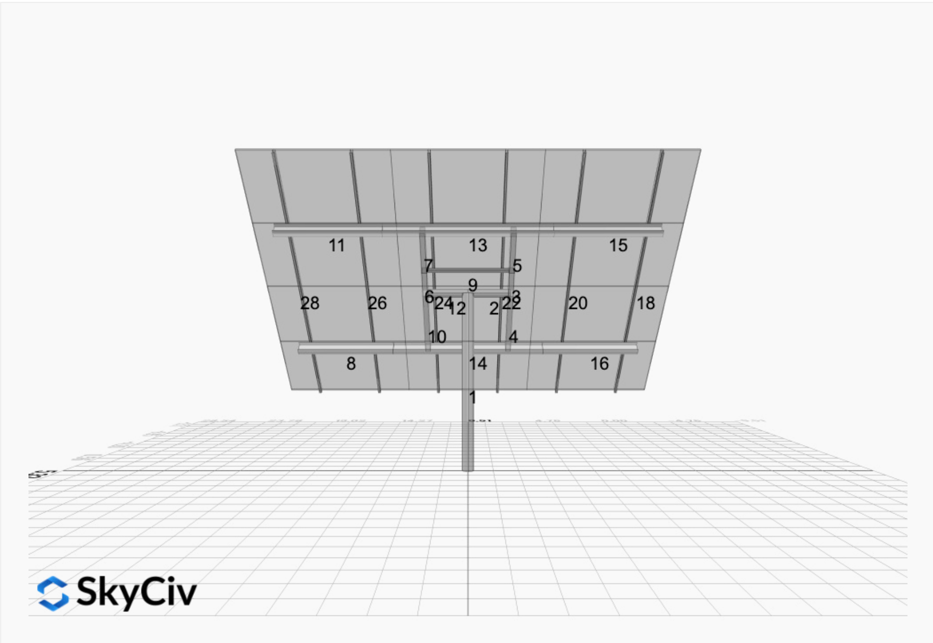
14.27
5.32
10.07
14.83
19.58
24.34
0.56
SkyCiv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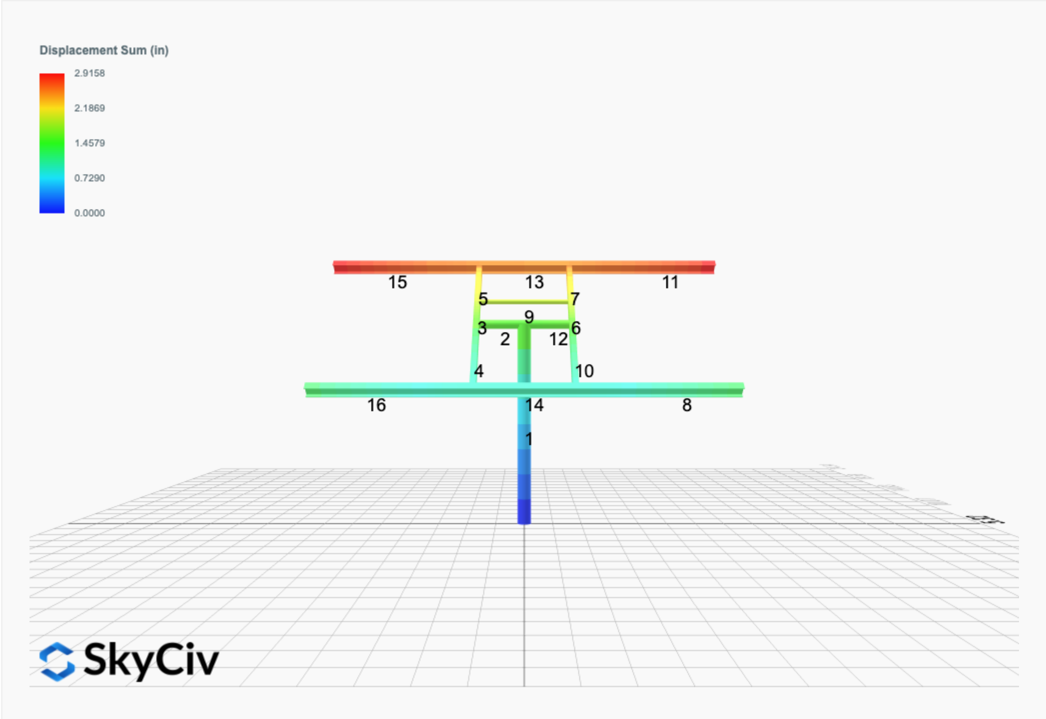
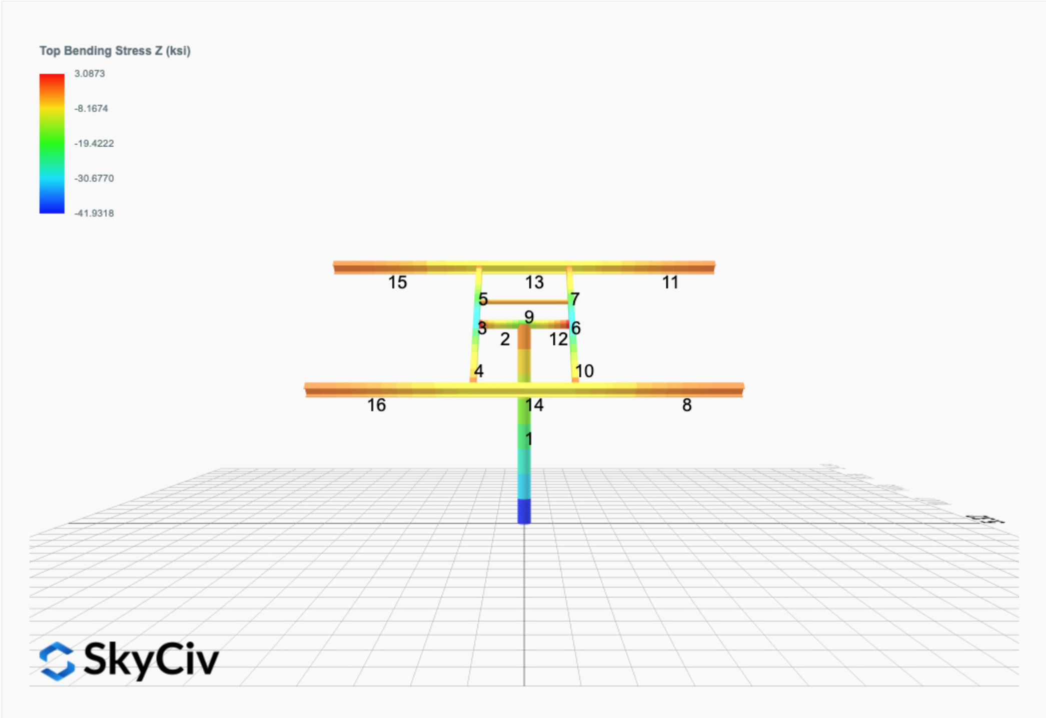
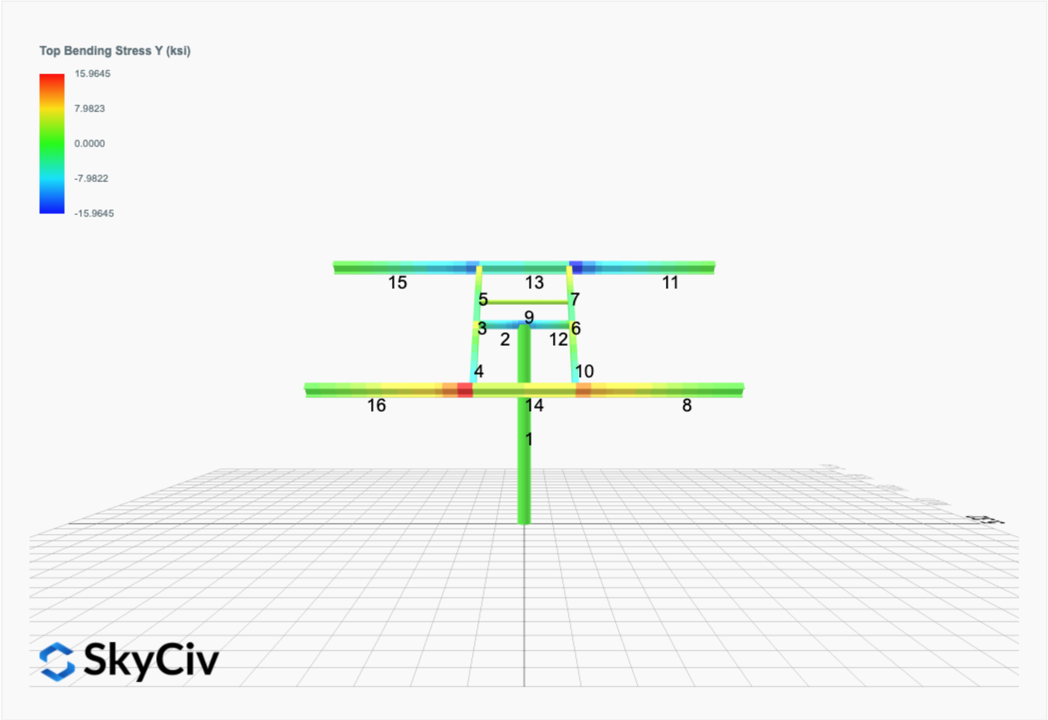
16
1
SkyCiv

FEM Results (Envelope Worst Case)






Top Bending Stress Y (ksi)
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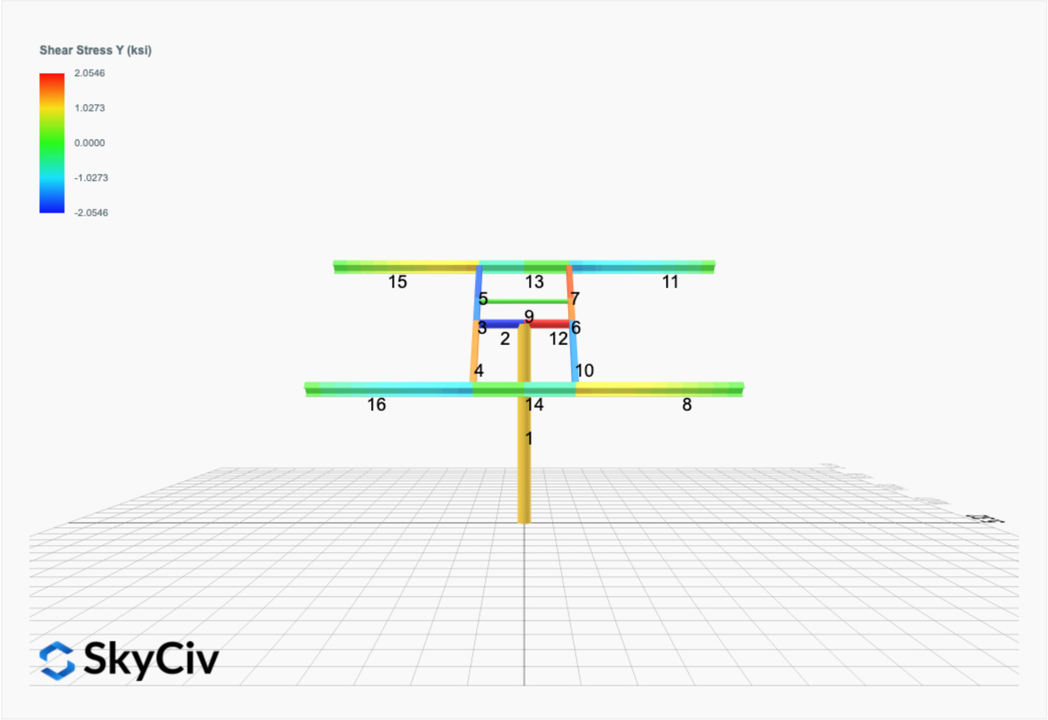
0.0000
-7.9822
-15.9645
15
13
11
5
7
9
3
6
2
12
4
10
16
14
8
1


Shear Stress Y (ksi)
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-2.0546
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11
5
7
9
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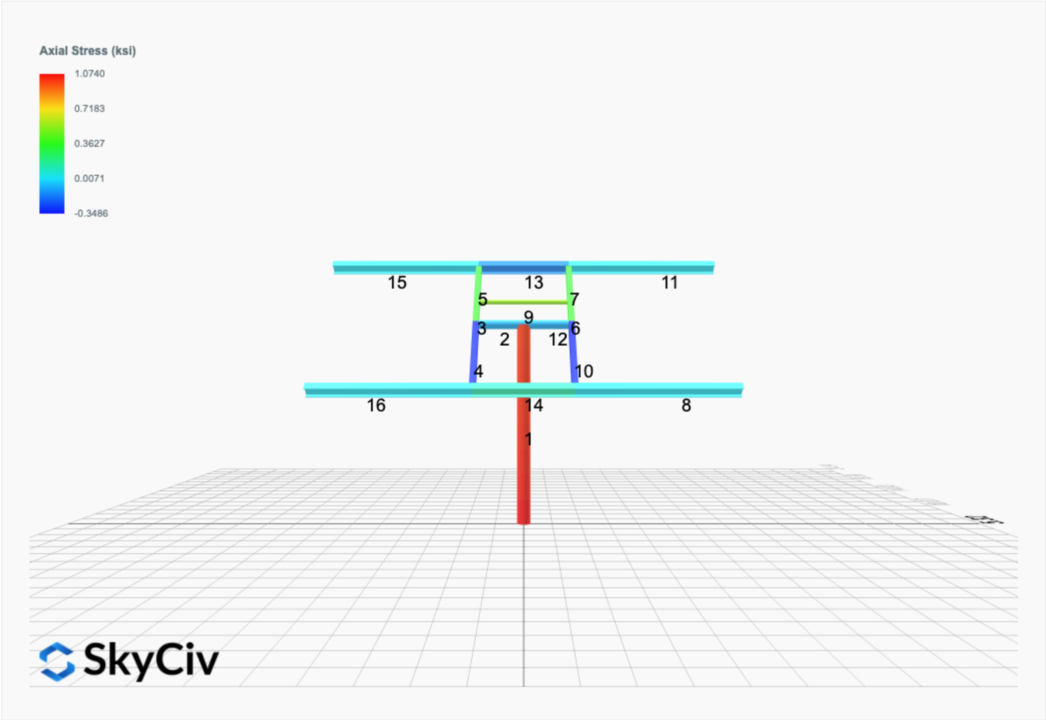
10
16
14
8
1


Axial Stress (ksi)
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0.0071
-0.3486
15
13
11
5
7
9
3
6
2
12
4
10
16
14
8
1
SkyCiv

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	2.5190	0.0000	0.0000	0.0000	0.0293
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	2.6559	0.0000	0.0000	0.0000	0.0279
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	2.1591	0.0000	0.0000	0.0000	0.0240
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0000	3.7489	0.0000	0.0000	0.0000	0.0398
ULS: 5. 1.2D + E + L + 0.2S	0.0000	2.3579	0.0000	0.0000	0.0000	0.0255
ULS: 7. 0.9D + 1.0E	0.0000	1.6193	0.0000	0.0000	0.0000	0.0168
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-3.3383	5.9942	0.0000	0.0000	0.0000	29.6869
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-3.3383	5.9942	0.0000	0.0000	0.0000	29.6869
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.4150	0.2410	0.0000	-0.0000	-0.0000	-19.3389
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	2.1308	0.5251	0.0000	-0.0000	-0.0000	-23.7950
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-3.3383	5.4974	0.0000	0.0000	0.0000	29.6135
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-3.3383	5.4974	0.0000	0.0000	0.0000	29.6135
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.4150	-0.2558	0.0000	-0.0000	-0.0000	-19.3000
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	2.1308	0.0283	0.0000	-0.0000	-0.0000	-23.7406
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.6692	5.4180	0.0000	0.0000	0.0000	14.8398
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-1.6692	5.4180	0.0000	0.0000	0.0000	14.8398
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.2075	2.5414	0.0000	-0.0000	-0.0000	-9.7387
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	1.0654	2.6835	0.0000	-0.0000	-0.0000	-11.9957
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.6692	3.8283	0.0000	0.0000	0.0000	14.7140
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-1.6692	3.8283	0.0000	0.0000	0.0000	14.7140
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.2075	0.9517	0.0000	-0.0000	-0.0000	-9.6848
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	1.0654	1.0937	0.0000	-0.0000	-0.0000	-11.9166
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-3.3383	4.9576	0.0000	0.0000	0.0000	29.5320
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-3.3383	4.9576	0.0000	0.0000	0.0000	29.5320
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	2.4150	-0.7956	0.0000	-0.0000	-0.0000	-19.2616
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	2.1308	-0.5115	0.0000	-0.0000	-0.0000	-23.6854

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0000	1.7993	0.0000	0.0000	0.0000	0.0191
ULS: 2. D + L	0.0000	1.7993	0.0000	0.0000	0.0000	0.0191
ULS: 3. D + (S or Lr or R)	0.0000	2.7929	0.0000	0.0000	0.0000	0.0267
ULS: 3. D + (S or Lr or R)	0.0000	1.7993	0.0000	0.0000	0.0000	0.0191
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	2.5445	0.0000	0.0000	0.0000	0.0244
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	1.7993	0.0000	0.0000	0.0000	0.0191
ULS: 5b. D + 0.7E	0.0000	1.7993	0.0000	0.0000	0.0000	0.0191
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0000	2.5445	0.0000	0.0000	0.0000	0.0244
ULS: 8. 0.6D + 0.7E	0.0000	1.0796	0.0000	0.0000	0.0000	0.0104
ULS: 5a. D + 0.6W_Wind downforce Case A only	-2.0030	3.8022	0.0000	0.0000	0.0000	17.6427
ULS: 5a. D + 0.6W_Wind downforce Case B only	-2.0030	3.8022	0.0000	0.0000	0.0000	17.6427
ULS: 5a. D + 0.6W_Wind uplift Case A only	1.4490	0.3503	0.0000	-0.0000	-0.0000	-11.6017
ULS: 5a. D + 0.6W_Wind uplift Case B only	1.2785	0.5208	0.0000	-0.0000	-0.0000	-14.2704
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.5022	4.0467	0.0000	0.0000	0.0000	13.2601
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-1.5022	4.0467	0.0000	0.0000	0.0000	13.2601
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.0867	1.4578	0.0000	-0.0000	-0.0000	-8.7330
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.9589	1.5856	0.0000	-0.0000	-0.0000	-10.7482

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	-1.5022	3.3015	0.0000	0.0000	0.0000	13.2088
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-1.5022	3.3015	0.0000	0.0000	0.0000	13.2088
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.0867	0.7126	0.0000	-0.0000	-0.0000	-8.7091
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.9589	0.8404	0.0000	-0.0000	-0.0000	-10.7138
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-2.0030	3.0825	0.0000	0.0000	0.0000	17.5756
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-2.0030	3.0825	0.0000	0.0000	0.0000	17.5756
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	1.4490	-0.3694	0.0000	-0.0000	-0.0000	-11.5738
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	1.2785	-0.1989	0.0000	-0.0000	-0.0000	-14.2290

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	5.9942
Shear X	3.3383
Shear Z	0.0000
Moment X	0.0000
Moment Y (Twist)	0.0000
Moment Z	29.6869

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	4.0467
Shear X	2.0030
Shear Z	0.0000
Moment X	0.0000
Moment Y (Twist)	0.0000
Moment Z	17.6427

Project Details

Design Code: AISC 360-16 LRFD
Provision: LRFD
Country: United States

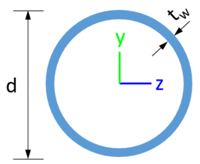
User Name: sales@mtsolar.us
Unit System: imperial

Design Input Information

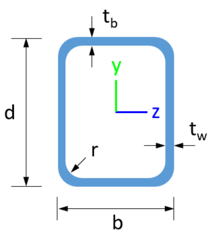
Design Factors			
Φ_t	Φ_c	Φ_b	Φ_v
0.9	0.9	0.9	0.9

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

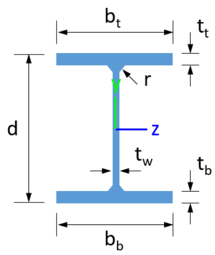
Section Dimensions



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	LST	LSC	LD
1	7	5.40	5.40	8.32	-	300	200	250
2	4	1.30	1.30	2.00	-	300	200	250
3	15	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.17,1.18,1.18,1.18,1.19,1.29,1.18,1.18,1.15,1.17,1.18,1.18,1.17,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.23,1.16,1.18,1.18,1.16,1.17,1.18,1.18,1.17,1.18	300	200	250
4	15	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.76,1.67,1.67,1.66,1.54,1.67,1.67,1.70,1.68,1.67,1.67,1.63,1.70,1.67,1.67,1.66,1.64,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.67,1.65,1.74,1.67,1.67,1.21,1.68,1.67,1.67,1.64,1.70,1.67,1.67,1.66,1.62	300	200	250
5	15	1.52	1.52	2.33	1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.68,1.84,1.67,1.67,1.63,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.66,1.67,1.67,1.73,1.65,1.67,1.67,1.64,1.66,1.67,1.67,1.66,1.66	300	200	250
6	15	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.17,1.18,1.18,1.18,1.19,1.29,1.18,1.18,1.15,1.17,1.18,1.18,1.17,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.23,1.16,1.18,1.18,1.16,1.17,1.18,1.18,1.17,1.18	300	200	250
7	15	1.52	1.52	2.33	1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.68,1.84,1.67,1.67,1.63,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.66,1.67,1.67,1.73,1.65,1.67,1.67,1.64,1.66,1.67,1.67,1.66,1.66	300	200	250
8	18	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
9	1	2.60	2.60	4.00	-	300	200	250
10	15	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.76,1.67,1.67,1.66,1.54,1.67,1.67,1.70,1.68,1.67,1.67,1.63,1.70,1.67,1.67,1.66,1.64,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.67,1.65,1.74,1.67,1.67,1.21,1.68,1.67,1.67,1.64,1.70,1.67,1.67,1.66,1.62	300	200	250
11	18	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.32,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
12	4	1.30	1.30	2.00	-	300	200	250
13	18	4.88	4.00	7.50	1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.06,1.03,1.03,1.03,1.05,1.03,1.03,1.03,1.02,1.03,1.03,1.03,1.08,1.03,1.03,1.03,1.05,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.06,1.03,1.03,1.04,1.16,1.03,1.03,1.03,1.08,1.03,1.03,1.03,1.05	300	200	250
14	18	4.88	4.00	7.50	1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,2.71,1.03,1.03,1.03,1.02,1.03,1.03,1.03,1.04,1.03,1.03,1.03,1.12,1.03,1.03,1.03,1.02,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.03,1.59,1.03,1.03,1.46,1.06,1.03,1.03,1.03,1.15,1.03,1.03,1.03,1.02	300	200	250
15	18	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.32,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
16	18	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250

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	236.30	42.30	42.30	75.35	75.35
2	142.83	141.72	16.17	16.17	42.85	42.85
3	79.65	74.89	10.99	6.26	29.14	16.61
4	79.65	72.84	10.99	6.26	29.14	16.61

5	79.65	74.30	10.99	6.26	29.14	16.61
6	79.65	74.89	10.99	6.26	29.14	16.61
7	79.65	74.30	10.99	6.26	29.14	16.61
8	120.60	34.69	23.36	6.45	30.09	45.74
9	48.35	43.11	2.85	2.85	14.51	14.51
10	79.65	72.84	10.99	6.26	29.14	16.61
11	120.60	34.69	23.36	6.45	30.09	45.74
12	142.83	141.72	16.17	16.17	42.85	42.85
13	120.60	84.02	17.91	6.45	30.09	45.74
14	120.60	84.02	17.89	6.45	30.09	45.74
15	120.60	34.69	23.36	6.45	30.09	45.74
16	120.60	34.69	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	0.025	0.702	0.000	0.044	0.000	0.715	#13	0.144	Not Required	Pass
2	0.003	0.306	0.215	0.068	0.039	0.522	#13	0.034	Not Required	Pass
3	0.008	0.575	0.051	0.058	0.003	0.614	#13	0.044	Not Required	Pass
4	0.008	0.521	0.166	0.052	0.027	0.597	#13	0.078	Not Required	Pass
5	0.008	0.357	0.174	0.057	0.035	0.388	#13	0.073	Not Required	Pass
6	0.008	0.575	0.051	0.058	0.003	0.614	#13	0.044	Not Required	Pass
7	0.008	0.357	0.174	0.057	0.035	0.388	#13	0.073	Not Required	Pass
8	0.000	0.086	0.123	0.028	0.007	0.188	#21	Not Required	Not Required	Pass
9	0.012	0.045	0.052	0.001	0.000	0.101	#13	0.198	Not Required	Pass
10	0.008	0.521	0.166	0.052	0.027	0.597	#13	0.078	Not Required	Pass
11	0.000	0.094	0.123	0.031	0.007	0.193	#21	Not Required	Not Required	Pass
12	0.003	0.306	0.215	0.068	0.039	0.522	#13	0.034	Not Required	Pass
13	0.005	0.232	0.230	0.042	0.010	0.398	#21	0.177	Not Required	Pass
14	0.005	0.217	0.230	0.038	0.010	0.388	#21	0.265	Not Required	Pass
15	0.000	0.094	0.123	0.031	0.007	0.193	#21	Not Required	Not Required	Pass
16	0.000	0.086	0.123	0.028	0.007	0.188	#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/comression)
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

Powered by SkyCiv

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	48 in
D	Section deph	48 in

Material Properties

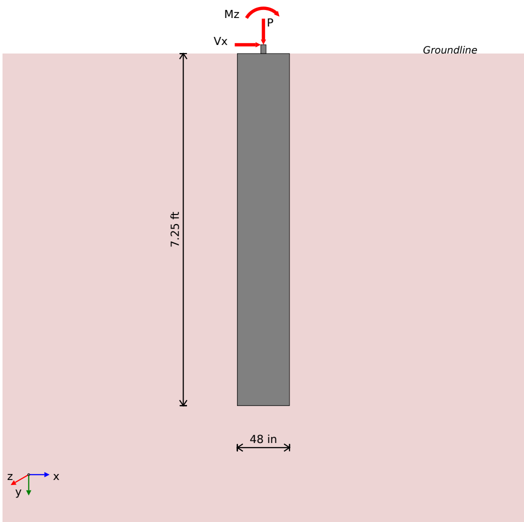
Input	Description	Value
f'_{ck}	Concrete compressive strength	2.5 ksi
f_{yk}	Yield strength of steel	60 ksi
d_b	Rebar diameter	#5 (0.625) in
cover	Concrete cover	3 in

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	4.047 kip	5.994 kip
Vx	2.003 kip	3.338 kip
Vz	0 kip	0 kip
Mx	0 kip-ft	0 kip-ft
Mz	17.64 kip-ft	29.69 kip-ft



REFERENCES | CALCULATIONS | RESULTS

Required depth to resist lateral loads (ASD)

Allowable lateral pressure $R =$ 150 psf/ft

Point of application of lateral load:

$$H = h_1 + h_2 + h_e = 0 + 0 + 0 = 0\ ft$$

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{1.57 \times D} = \frac{2.003}{1.57 \times 48} = 0.319\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{17.64 + (2.003 \times 0)}{1.57 \times 48} = 2.809\ \frac{kip - ft}{ft}$$

Required depth of embedment in earth:

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

Solving the cubic equation:

$$L_{e,x} = 7.12\ ft$$

Considering z-direction:

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

Minimum embedded depth

Depth of pile required

$$L_{e,req} = MAX[L_{e,x}, L_{e,z}] = MAX[7.12, 0] = 7.12\ ft$$

Actual embedded length

$$L_e = L - h_2 - h_e = 7.25 - 0 - 0 = 7.25\ ft$$

Utilisation

$$Ratio = \frac{L_{e,req}}{L_e} = \frac{7.12}{7.25} = 0.982$$

UTILITY: 0.98

REFERENCES	CALCULATIONS	RESULTS

End-bearing Capacity (ASD)

Allowable bearing pressure	$q_a =$	2000 psf
Unit weight of concrete	$w_c =$	0.15 kip/ft^3

Cross-sectional area:

$$A = b \times D = 48 \times 48 = 16\ ft^2$$

End-bearing pressure:

$$q = \frac{P}{A} = \frac{4.047}{16} = 252.9\ psf$$

Utilisation

$$Ratio = \frac{q}{q_a} = \frac{252.9}{2000} = 0.126$$

UTILITY: 0.13

Lateral Soil Pressure (ASD)

Allowable lateral pressure	$R =$	150 psf/ft

Length to least lateral dimension ratio:

$$\frac{L}{MIN[b, D]} = \frac{7.25}{MIN[4, 4]} = 1.813$$

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

Considering x-direction:

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 2.809 \times 7.25) + \left(3 \times 0.319 \times 7.25^2\right)}{(6 \times 2.809) + (4 \times 0.319 \times 7.25)} = 5.047\ ft$$

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

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

$$p = \frac{0.75 \times [(4 \times 2.809) + (3 \times 0.319 \times 7.25)]^2}{7.25^2 \times [(3 \times 2.809) + (2 \times 0.319 \times 7.25)]} = 0.361\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of a/2

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{5.047}{2} = 0.379\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{0.361}{0.379} = 0.954$$

UTILITY: 0.95

Earth pressure against the pile at distance L_e:

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times 2.809) + (0.319 \times 7.25)]}{7.25^2} = 0.905\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

$$p_s = R \times L_e = 0.15 \times 7.25 = 1.087\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{0.905}{1.087} = 0.832$$

UTILITY: 0.83

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

$$H_o = \frac{V_x}{1.57 \times D} = \frac{3.338}{1.57 \times 48} = 0.532\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{29.69 + (3.338 \times 0)}{1.57 \times 48} = 4.727\ \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 4.727 \times 7.25) + (3 \times 0.532 \times 7.25^2)}{(6 \times 4.727) + (4 \times 0.532 \times 7.25)} = 5.046\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{4.727}{0.532} = 8.893\ ft$$

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

$$V_{max,x} = (0.532 \times 48) \times [1 - [3 \times \left(\frac{4 \times 8.893}{7.25} + 3\right) \times \left(\frac{5.046}{7.25}\right)^2] + [4 \times \left(\frac{3 \times 8.893}{7.25} + 2\right) \times \left(\frac{5.046}{7.25}\right)^3]]$$

$$V_{max,x} = 6.018\ kip$$

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

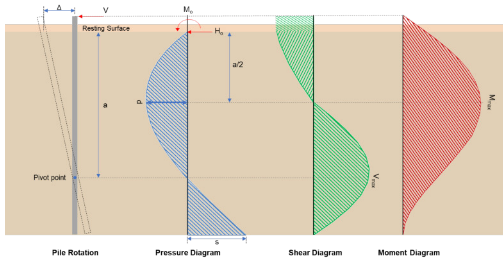
$$M_{max,x} = (H_o \times D \times L_e) \times [\left(\frac{E}{L_e} + \frac{a}{2 \times L_e}\right) - [\left(\frac{4 \times E}{L_e} + 3\right) \times \left(\frac{a}{2 \times L_e}\right)^3] + [\left(\frac{3 \times E}{L_e} + 2\right) \times \left(\frac{a}{2 \times L_e}\right)^4]]$$

$$M_{max,x} = (0.532 \times 48 \times 7.25) \times [\left(\frac{8.893}{7.25} + \frac{5.046}{2 \times 7.25}\right) - [\left(\frac{4 \times 8.893}{7.25} + 3\right) \times \left(\frac{5.046}{2 \times 7.25}\right)^3] + [\left(\frac{3 \times 8.893}{7.25} + 2\right) \times \left(\frac{5.046}{2 \times 7.25}\right)^4]]$$

$$M_{max,x} = 20.42\ kip - ft$$

Considering z-direction:

There are no loads applied in this direction.



Minimum Reinforcement Check (LRFD)

Gross area of concrete:

$$A_g = b \times D = 48 \times 48 = 2304\,in^2$$

Main Reinforcement

22.4.2.2 Required reinforcement:

$$A_{st,req} = \frac{P - \left(0.85 \times f'_{ck} \times A_g\right)}{f_{yk} - \left(0.85 \times f'_{ck}\right)} = \frac{5.994 - (0.85 \times 2.5 \times 2304)}{60 - (0.85 \times 2.5)} = -84.49\,in^2$$

10.6.1.1 Maximum reinforcement:

$$A_{st,max} = 0.08 \times A_g = 0.08 \times 2304 = 184.3 in^2$$

7.6.1.1 Minimum reinforcement:

$$A_{st,min} = 0.0018 \times A_g = 0.0018 \times 2304 = 4.147 in^2$$

Governing minimum reinforcement area:

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

$$A_{min} = 4.147\,in^2$$

Minimum number of reinforcements:

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

$$n_{min} = \frac{A_{min}}{A_{bar}} = \frac{4.147}{0.307} = 14$$

25.2.3 Minimum spacing:

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

$$\text{Use: } n = 16\text{pcs at } 1.5 \text{ in minimum spacing}$$

Total reinforcement area:

$$A_{st} = 16 \times 0.307 = 4.909\,in^2$$

Shear Reinforcement

25.7.2.2 For main reinforcement $\leq$ 1.41 in: Use #3(0.375 in)

Maximum spacing of shear Reinforcements:

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

Detailing Summary	
Main reinforcement	#5 (0.625 in) - 16pcs 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:

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

$$\phi P_N = 0.65 \times 0.8 \times [(0.85 \times 2.5 \times [2304 - 4.909]) + (60 \times 4.909)] = 2694\,kip$$

Utilisation

$$Ratio = \frac{P}{\phi P_N} = \frac{5.994}{2694} = 0.002$$

UTILITY: 0.00

Shear Strength LRFD)

Effective shear width	$b_w =$	48 in
Effective shear depth	$d =$	44.31 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	$V_{max,x} =$	6.018 kip
Maximum shear in the z-direction	$V_{max,z} =$	0 kip

22.5.5.1.1 Max shear strength of concrete:

$$V_{c,max} = 5 \times \lambda \times \sqrt{f'_{ck}} \times b_w \times d = 5 \times 1 \times \sqrt{2.5} \times 48 \times 44.31 = 531.8\ kip$$

Table 22.5.5.1 Shear strength of concrete:

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

$$V_{c,a} = \left(2 \times 1 \times \sqrt{2.5} + MIN[\frac{5.994}{6 \times 2304}, (0.05 \times 2.5)]\right) \times (48 \times 44.31) = 213.6\ kip$$

Governing shear strength of concrete:

$$V_c = MIN[V_{c,max}, V_{c,a}] = MIN[531.8, 213.6] = 213.6\ kip$$

22.5.1.2 Shear strength of steel (a):

$$V_{s,a} = 8 \times \sqrt{f'_{ck}} \times b_w \times d = 8 \times \sqrt{2.5} \times 48 \times 44.31 = 850.8\ kip$$

22.5.8.5.3 Shear strength of steel (b):

$$V_{s,b} = \frac{A_v \times f_{yk} \times d}{s} = \frac{0.221 \times 60 \times 44.31}{10} = 58.73\ kip$$

Governing shear strength of steel:

$$V_s = MIN[V_{s,a}, V_{s,b}] = MIN[850.8, 58.73] = 58.73\ kip$$

22.5.1.1 Allowable shear strength:

$$\phi V_n = \phi \times (V_c + V_s) = 0.75 \times (213.6 + 58.73) = 204.3\ kip$$

$$V_{max} = MAX[6.018, 0] = 6.018\ kip$$

Utilisation

$$Ratio = \frac{V_{max}}{\phi V_n} = \frac{6.018}{204.3} = 0.029$$

UTILITY: 0.03

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	$\varepsilon_c =$	0.0030
Yield strain of steel f_y/E_s	$\varepsilon_y =$	0.0003
Section width	$b =$	48 in
Distance to the compression rebar	$d_s =$	3.688 in
Distance to the tension rebar	$d =$	44.31 in
Total bar area	$A_s =$	4.909 in^2
Maximum applied axial load	$P =$	5.994 kip
Maximum moment in the x-direction	$M_{max,x} =$	20.42 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:

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

$$\varepsilon_1 = (c - d_s) \times \frac{\varepsilon_c}{}$$

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

Tensile force due to bars in tension:

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

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

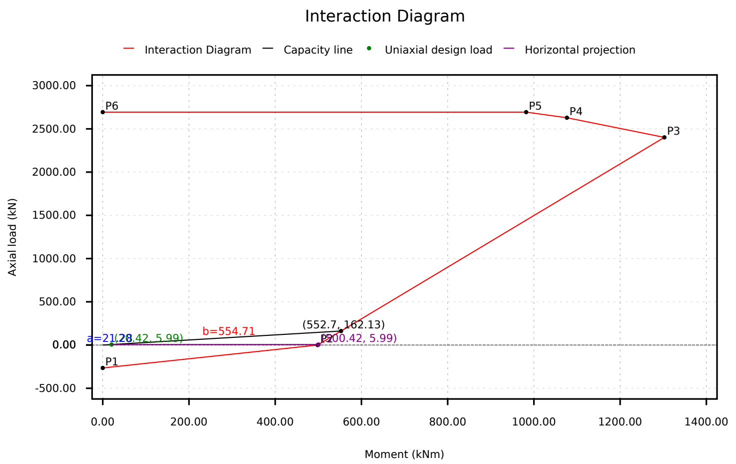
$$f_2 = E_s \times \varepsilon_2 \ (\varepsilon_2 < \varepsilon_{sy}),\ f_2 = \phi_s \times f_y \ (\varepsilon_2 \geq \varepsilon_{sy})$$

Interaction Diagram Summary

Point	Case	M_r	P_r
P1	Pure Tension	0	-265.1
P2	Pure Bending	498.4	0
P3	Balanced Failure	1303	2402
P4	Decompression	1077	2629
P5	Compression Limit	982	2694
P6	Pure Compression	0	2694

Uniaxial Bending Check

$$M_f = MAX[20.42, 0] = 20.42\ kip - ft$$



Segment	Signed Distance
P1 - P2	229.7
P2 - P3	455.2
P3 - P4	2599
P4 - P5	2760
P5 - P6	2688
Status	PASS: Point lies inside the curve

Utilisation

$$Ratio = \frac{a}{a+b} = \frac{21.28}{21.28 + 554.7} = 0.037$$

UTILITY: 0.04

REFERENCES	CALCULATIONS	RESULTS

Results Summary

Result Name	Results
PILE DETAILS	
Length of the pile	7.25 ft
Dimensions	48 x 48 in
Main bar reinforcement	#5-16pcs at 1.5 in min.
Shear reinforcement	#3 at 10 in max.
UTILISATIONS	
Required depth	0.98
End-bearing capacity	0.13
P_a	0.95
P_s	0.83
Axial compression strength	0.00
Shear strength	0.03
Uniaxial bending strength	0.04