Project Details

Project Name: MacDearmid 6x5

Location: 120 Sand Bar Rd, Rockwood, ME 04478, USA

Unique ID: 2P-17-8TOP-HD-57-L-5Hx6W-L05B

Dealer: ______________________________

Date: Wed Oct 15 2025

Number of Modules: 30

Number of Poles: 2

Date Sold:

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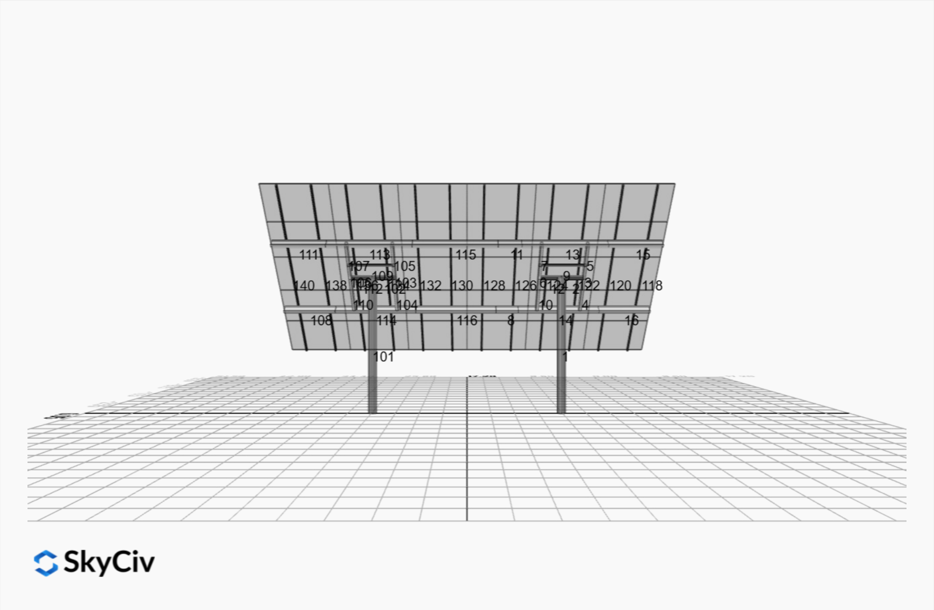


Array Dimensions N/S	18.81 ft
Array Dimensions E/W	34.40 ft
Winter Tilt Angle (Degrees)	50
Front Edge Clearance	5

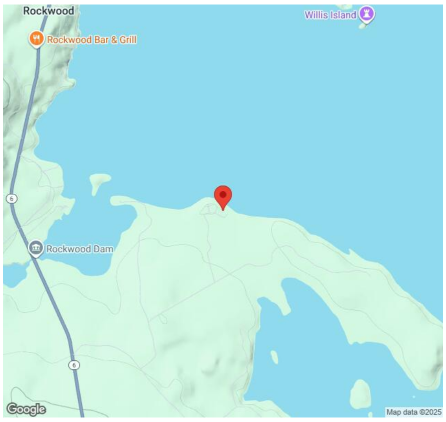
MT Solar Bill of Materials (2P-17-8TOP-HD-57-L-5Hx6W-L05B)

Part	Short Description	BOM Qty
MTS-PC-8	8IN Pole Cap Assembly	2
MTS-HF-HD	H-Frame Assembly-HD	2
MTS-HD-Wing-57	57IN HD Wing	4
MTS-HD-Splice-57	57IN HD Splice	4
MTS-CLAMP-ANGLE-4PK	Angle Clamp	6

Rail Bill of Materials

Part	Qty
Rails (226in Long)	12x
Rail Attachment	48x
Module Mid Clamp	48x
Module End Clamp	24x
Ground Lug	6x

Site Details:



Site Address: 120 Sand Bar Rd, Rockwood, ME 04478, USA

Array Specifications

Duty Classification:	HD
Module Width:	44.65 in
Module Length:	67.79 in
Number of Rows:	5
Number of Columns:	6
Total Number of Modules:	30
Winter Tilt Angle:	50
Front Edge Clearance:	5
Total Array Height at Tilt:	19.41 ft
Total Frame Length:	34.00 ft
Module Info/Notes:	
Array Dimensions N/S:	18.81 ft
Array Dimensions E/W:	34.40 ft
Rail Length:	225.75 in
Rail Spacing:	2.87 ft

Support Specifications

Pole Size:	8in Pipe Sch 80
Pole Length above Grade:	12.21 ft
Number of Poles:	2
Pole Spacing:	17 ft

Foundation Specifications

Foundation Type:	rectangular
Foundation Dimensions:	48x48 in
Foundation Depth (below grade):	8.0 ft
Foundation Volume:	128.00 ft^3

Site Info

Risk Category:	I
Exposure:	C
Soil Classification:	sand
Site Location:	120 Sand Bar Rd, Rockwood, ME 04478, USA
Wind Speed:	120 mph

Snow Load:	70 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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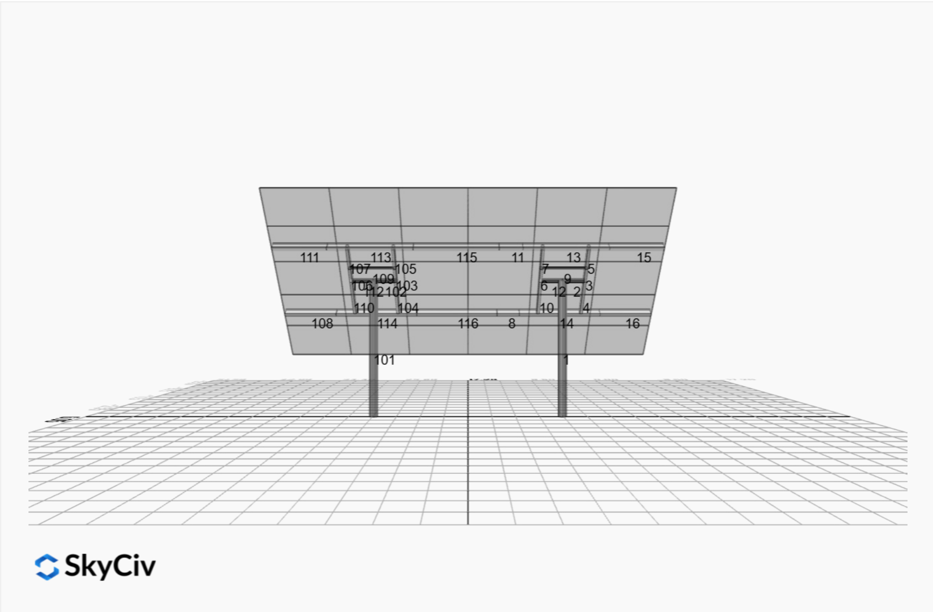
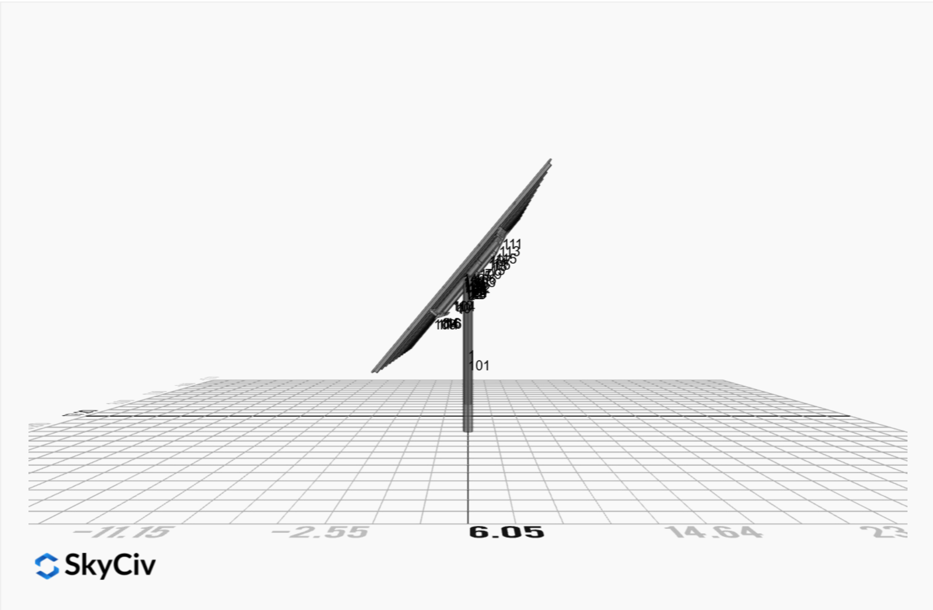
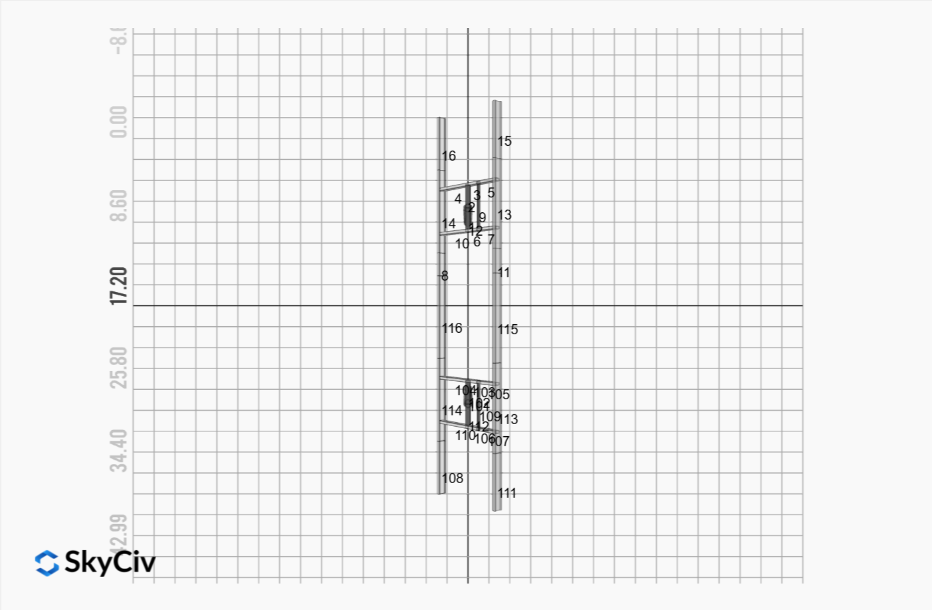
Design Notes:

- 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.
- Foundation Design and Sizing is approximate only



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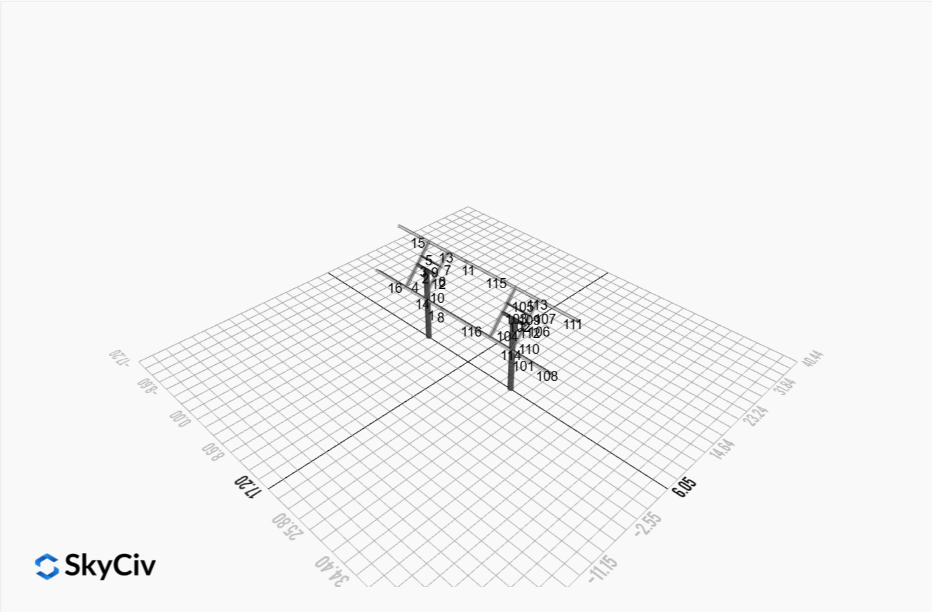
8.60
17.20
25.80
34.40
SkyCiv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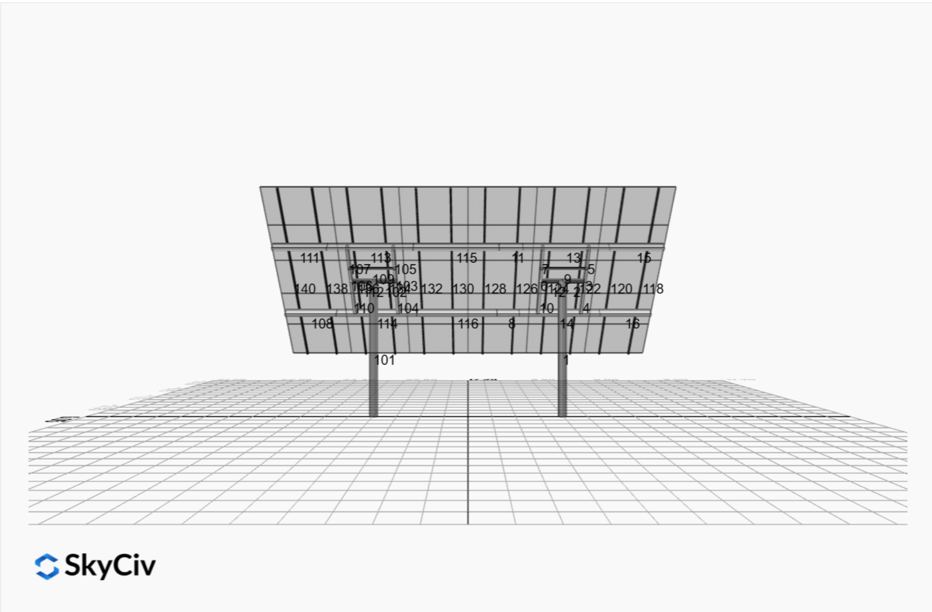
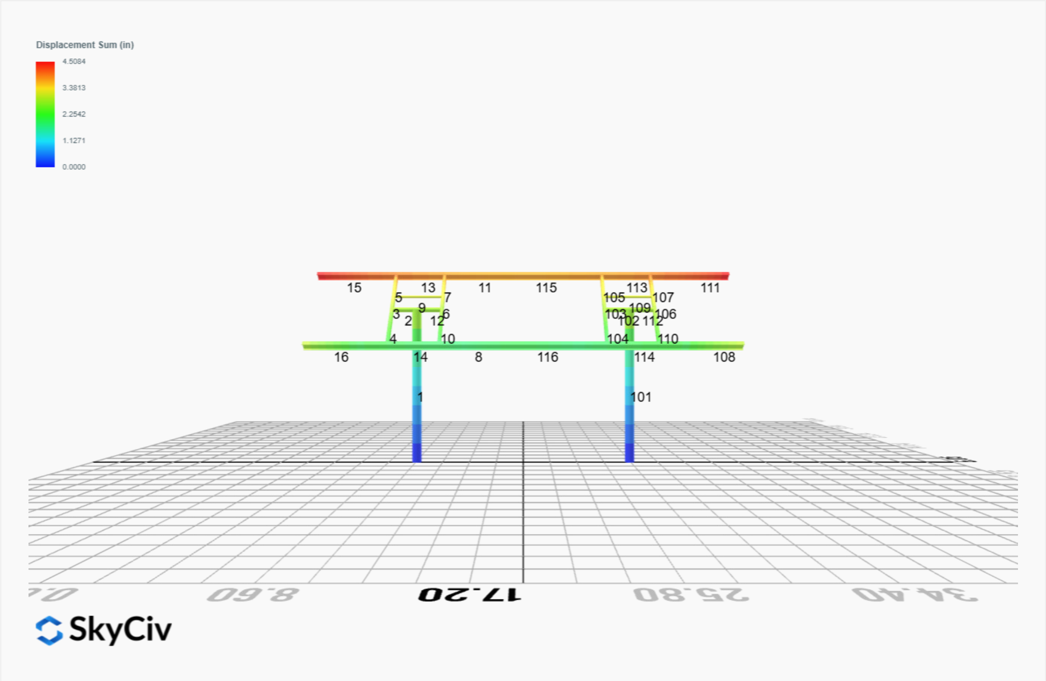
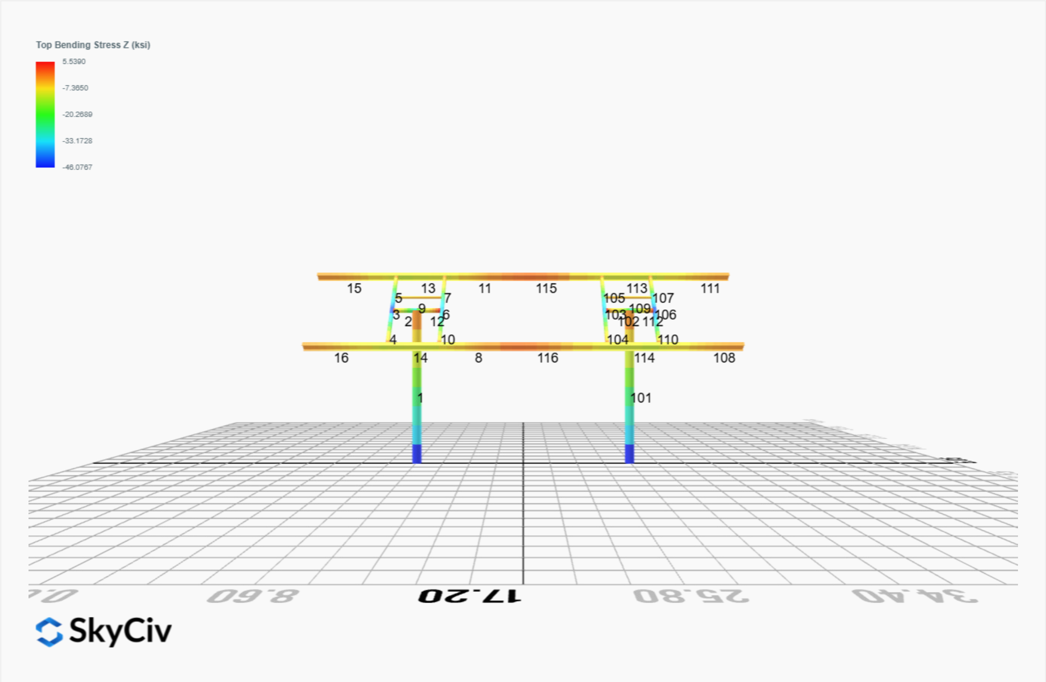
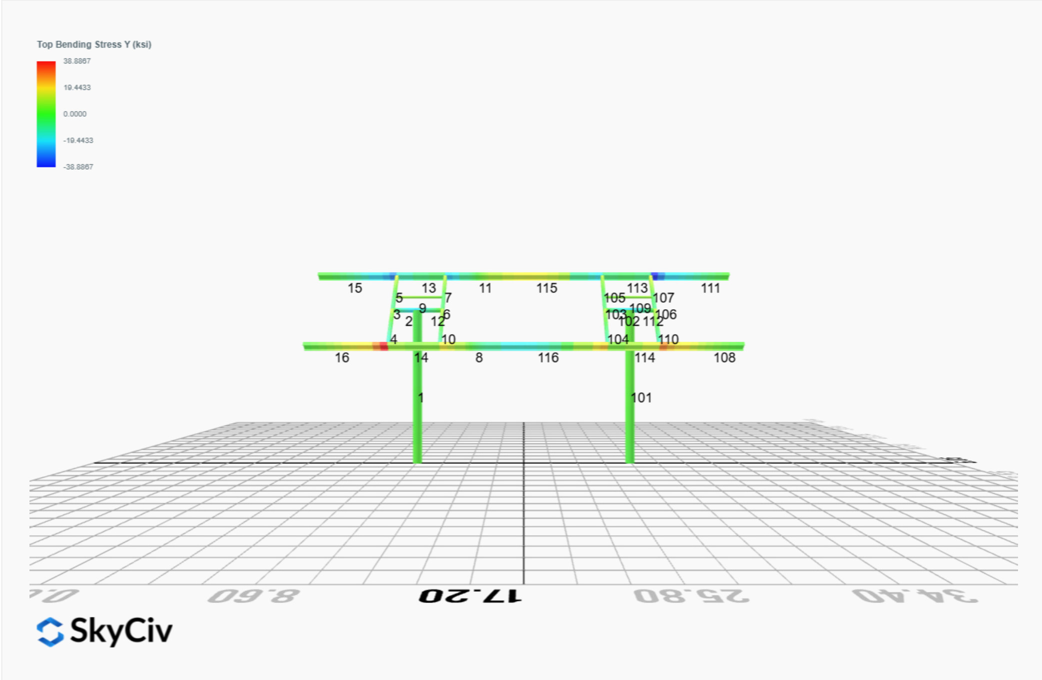
25.80
34.40
6.05
-2.55
-11.15
14.64
23.24
31.84
40.44
SkyCiv


SkyCiv

FEM Results (Envelope Worst Case)



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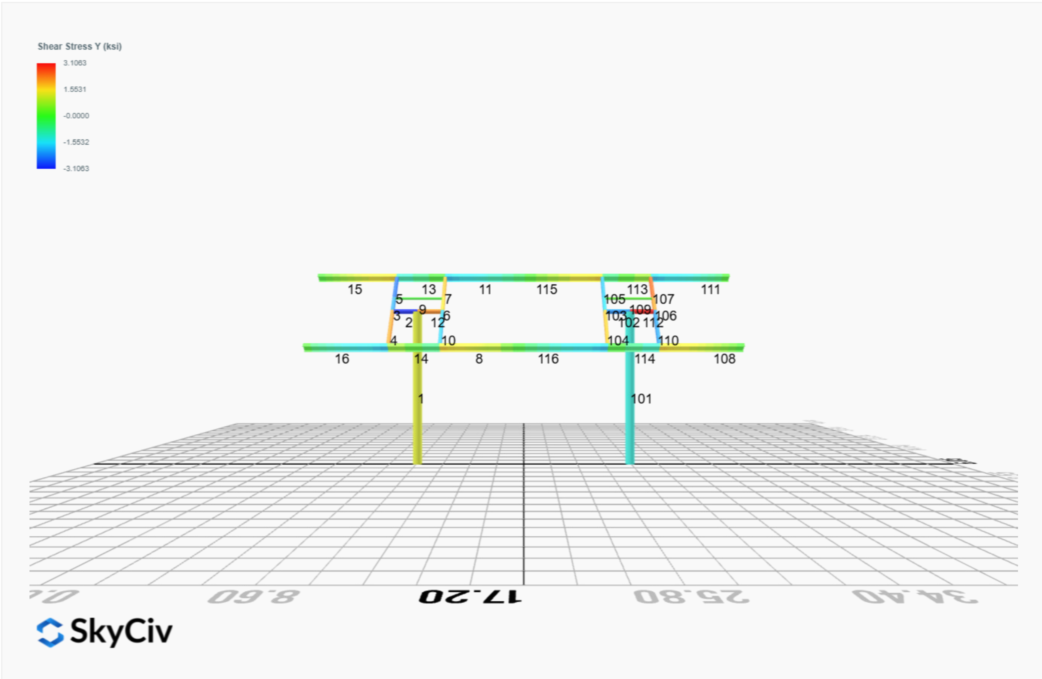
19.4433
0.0000
-19.4433
-38.8867
15
13
11
115
113
111
5
7
105
107
9
109
3
6
103
106
2
12
102
112
4
10
104
110
16
14
8
116
114
108
1
101
17.20
SkyCiv


Shear Stress Y (ksi)
3.1063
1.5531
-0.0000
-1.5532
-3.1063
15
13
11
115
113
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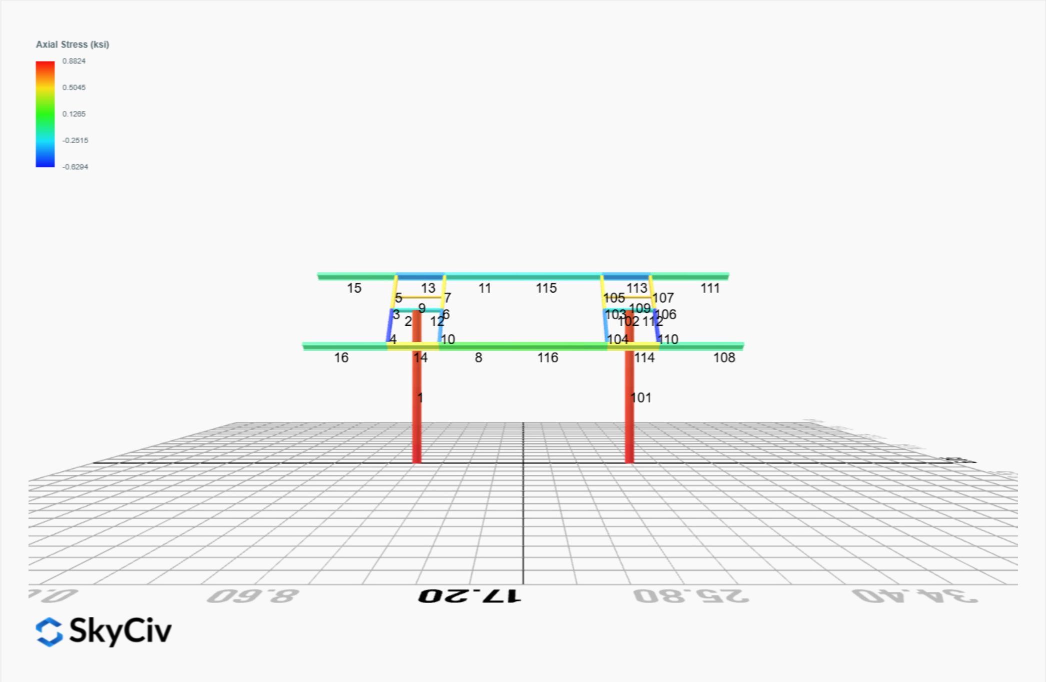
5
7
105
107
9
109
3
6
103
106
2
12
102
112
4
10
104
110
16
14
8
116
114
108
1
101
17.20
SkyCiv


Axial Stress (ksi)
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0.5045
0.1265
-0.2515
-0.6294
15
13
11
115
113
111
5
7
105
107
9
109
3
2
12
6
103
102
112
106
4
10
104
110
16
14
8
116
114
108
1
101
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	3.5581	-0.0488	-0.1695	0.1844	0.0346
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	4.6322	-0.0725	-0.2516	0.2733	0.0411
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	3.0498	-0.0418	-0.1453	0.1580	0.0286
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0000	8.1134	-0.1400	-0.4869	0.5268	0.0922
ULS: 5. 1.2D + E + L + 0.2S	0.0000	3.6827	-0.0541	-0.1878	0.2041	0.0328
ULS: 7. 0.9D + 1.0E	0.0000	2.2873	-0.0314	-0.1089	0.1185	0.0202
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-7.5045	10.9292	-0.3107	-1.0483	1.6538	94.1256
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0000	4.6322	-0.0725	-0.2516	0.2733	0.0411
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	7.5045	-1.6648	0.1651	0.5414	-1.1087	-91.2764
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0000	4.6322	-0.0725	-0.2516	0.2733	0.0411
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-7.5045	9.3468	-0.2800	-0.9417	1.5394	93.7221
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0000	3.0498	-0.0418	-0.1453	0.1580	0.0286
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	7.5045	-3.2472	0.1958	0.6475	-1.2247	-90.9240
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0000	3.0498	-0.0418	-0.1453	0.1580	0.0286
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.7522	11.2619	-0.2590	-0.8850	1.2162	47.2088
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0000	8.1134	-0.1400	-0.4869	0.5268	0.0922
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	3.7523	4.9649	-0.0211	-0.0897	-0.1631	-46.3182
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0000	8.1134	-0.1400	-0.4869	0.5268	0.0922
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.7522	6.1983	-0.1609	-0.5430	0.8489	46.5235
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0000	3.0498	-0.0418	-0.1453	0.1580	0.0286
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	3.7522	-0.0987	0.0770	0.2516	-0.5332	-45.7813
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0000	3.0498	-0.0418	-0.1453	0.1580	0.0286
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-7.5045	8.5843	-0.2696	-0.9052	1.5002	93.5307
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	0.0000	2.2873	-0.0314	-0.1089	0.1185	0.0202
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	7.5045	-4.0097	0.2062	0.6838	-1.2646	-90.7617
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	0.0000	2.2873	-0.0314	-0.1089	0.1185	0.0202

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0000	2.5415	-0.0349	-0.1210	0.1317	0.0229
ULS: 2. D + L	0.0000	2.5415	-0.0349	-0.1210	0.1317	0.0229
ULS: 3. D + (S or Lr or R)	0.0000	5.7062	-0.0961	-0.3340	0.3622	0.0514
ULS: 3. D + (S or Lr or R)	0.0000	2.5415	-0.0349	-0.1210	0.1317	0.0229
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	4.9151	-0.0808	-0.2806	0.3045	0.0418
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	2.5415	-0.0349	-0.1210	0.1317	0.0229
ULS: 5b. D + 0.7E	0.0000	2.5415	-0.0349	-0.1210	0.1317	0.0229
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0000	4.9151	-0.0808	-0.2806	0.3045	0.0418
ULS: 8. 0.6D + 0.7E	0.0000	1.5249	-0.0209	-0.0725	0.0790	0.0126
ULS: 5a. D + 0.6W_Wind downforce Case A only	-4.5027	6.3197	-0.1777	-0.5984	0.9608	55.8284
ULS: 5a. D + 0.6W_Wind downforce Case B only	0.0000	2.5415	-0.0349	-0.1210	0.1317	0.0229
ULS: 5a. D + 0.6W_Wind uplift Case A only	4.5027	-1.2367	0.1078	0.3551	-0.6979	-54.7990
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.0000	2.5415	-0.0349	-0.1210	0.1317	0.0229
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.3770	7.7487	-0.1879	-0.6387	0.9259	42.0607
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0000	4.9151	-0.0808	-0.2806	0.3045	0.0418
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.3770	2.0814	0.0262	0.0768	-0.3171	-41.4160
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0000	4.9151	-0.0808	-0.2806	0.3045	0.0418

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	-3.3770	5.3751	-0.1420	-0.4789	0.7536	41.7831
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0000	2.5415	-0.0349	-0.1210	0.1317	0.0229
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.3770	-0.2922	0.0721	0.2362	-0.4905	-41.1841
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0000	2.5415	-0.0349	-0.1210	0.1317	0.0229
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-4.5027	5.3031	-0.1638	-0.5499	0.9084	55.6743
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	0.0000	1.5249	-0.0209	-0.0725	0.0790	0.0126
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	4.5027	-2.2533	0.1217	0.4034	-0.7509	-54.6713
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.0000	1.5249	-0.0209	-0.0725	0.0790	0.0126

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	11.2619
Shear X	-7.5045
Shear Z	-0.3107
Moment X	-1.0483
Moment Y (Twist)	1.6538
Moment Z	94.1256

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	7.7487
Shear X	-4.5027
Shear Z	-0.1879
Moment X	-0.6387
Moment Y (Twist)	0.9608
Moment Z	55.8284

Reaction Forces for Foundation 2 (Node ID#101), (kip, kip-ft)

LRFD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. 1.4D	-0.0000	3.5581	0.0488	0.1696	-0.1843	0.0347
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0000	4.6322	0.0725	0.2517	-0.2732	0.0411
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0000	3.0498	0.0418	0.1453	-0.1580	0.0286
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	-0.0000	8.1134	0.1400	0.4871	-0.5267	0.0923
ULS: 5. 1.2D + E + L + 0.2S	-0.0000	3.6828	0.0541	0.1878	-0.2041	0.0328
ULS: 7. 0.9D + 1.0E	-0.0000	2.2873	0.0314	0.1089	-0.1185	0.0202
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-7.5045	10.9292	0.3107	1.0484	-1.6540	94.1267
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.0000	4.6322	0.0725	0.2517	-0.2732	0.0411
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	7.5045	-1.6648	-0.1651	-0.5413	1.1090	-91.2773
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0000	4.6322	0.0725	0.2517	-0.2732	0.0411
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-7.5045	9.3468	0.2800	0.9418	-1.5396	93.7232
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.0000	3.0498	0.0418	0.1453	-0.1580	0.0286
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	7.5045	-3.2472	-0.1958	-0.6475	1.2250	-90.9250
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0000	3.0498	0.0418	0.1453	-0.1580	0.0286
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.7522	11.2619	0.2590	0.8853	-1.2163	47.2094
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.0000	8.1134	0.1400	0.4871	-0.5267	0.0923
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	3.7522	4.9649	0.0211	0.0899	0.1633	-46.3186
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.0000	8.1134	0.1400	0.4871	-0.5267	0.0923
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.7522	6.1983	0.1609	0.5431	-0.8490	46.5241
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.0000	3.0498	0.0418	0.1453	-0.1580	0.0286
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	3.7522	-0.0987	-0.0770	-0.2516	0.5334	-45.7817
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.0000	3.0498	0.0418	0.1453	-0.1580	0.0286
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-7.5045	8.5844	0.2696	0.9053	-1.5004	93.5315
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-0.0000	2.2873	0.0314	0.1089	-0.1185	0.0202
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	7.5045	-4.0097	-0.2062	-0.6838	1.2648	-90.7624
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	-0.0000	2.2873	0.0314	0.1089	-0.1185	0.0202

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0000	2.5415	0.0349	0.1210	-0.1317	0.0229
ULS: 2. D + L	-0.0000	2.5415	0.0349	0.1210	-0.1317	0.0229
ULS: 3. D + (S or Lr or R)	-0.0000	5.7063	0.0961	0.3341	-0.3621	0.0514
ULS: 3. D + (S or Lr or R)	-0.0000	2.5415	0.0349	0.1210	-0.1317	0.0229
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0000	4.9151	0.0808	0.2807	-0.3045	0.0418
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0000	2.5415	0.0349	0.1210	-0.1317	0.0229
ULS: 5b. D + 0.7E	-0.0000	2.5415	0.0349	0.1210	-0.1317	0.0229
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0000	4.9151	0.0808	0.2807	-0.3045	0.0418
ULS: 8. 0.6D + 0.7E	-0.0000	1.5249	0.0209	0.0726	-0.0790	0.0126
ULS: 5a. D + 0.6W_Wind downforce Case A only	-4.5027	6.3197	0.1777	0.5984	-0.9609	55.8289
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.0000	2.5415	0.0349	0.1210	-0.1317	0.0229
ULS: 5a. D + 0.6W_Wind uplift Case A only	4.5027	-1.2367	-0.1078	-0.3550	0.6981	-54.7995
ULS: 5a. D + 0.6W_Wind uplift Case B only	-0.0000	2.5415	0.0349	0.1210	-0.1317	0.0229
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.3770	7.7487	0.1879	0.6388	-0.9259	42.0611
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0000	4.9151	0.0808	0.2807	-0.3045	0.0418
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.3770	2.0814	-0.0262	-0.0767	0.3172	-41.4163
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0000	4.9151	0.0808	0.2807	-0.3045	0.0418
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.3770	5.3751	0.1420	0.4790	-0.7537	41.7835
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0000	2.5415	0.0349	0.1210	-0.1317	0.0229
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.3770	-0.2922	-0.0721	-0.2361	0.4906	-41.1844
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0000	2.5415	0.0349	0.1210	-0.1317	0.0229
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-4.5027	5.3031	0.1638	0.5499	-0.9085	55.6746
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.0000	1.5249	0.0209	0.0726	-0.0790	0.0126
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	4.5027	-2.2533	-0.1217	-0.4034	0.7510	-54.6716
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	-0.0000	1.5249	0.0209	0.0726	-0.0790	0.0126

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	11.2619
Shear X	-7.5045
Shear Z	0.3107
Moment X	1.0484
Moment Y (Twist)	1.6540
Moment Z	94.1267

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	7.7487
Shear X	-4.5027
Shear Z	0.1879
Moment X	0.6388
Moment Y (Twist)	0.9609
Moment Z	55.8289

Project Details

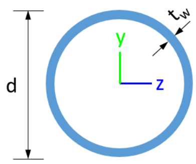
Design Code:	AISC 360-16 LRFD
Provision:	LRFD
Country:	United States
User Name:	sales@mtsolar.us
Unit System:	imperial

Design Input Information

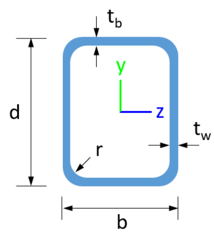
Design Factors			
Φ_t	Φ_c	Φ_b	Φ_v
0.9	0.9	0.9	0.9

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

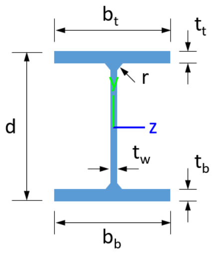
Section Dimensions



ID	Name	d (in)	t_w (in)					
2	2in Pipe Sch 80	2.38	0.22					
5	4in Pipe Sch 80	4.50	0.34					
10	8in Pipe Sch 80	8.63	0.50					



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)

2	2in Pipe Sch 80	1.48	1.74	0.87	0.87	0.00	1.02	1.02
5	4in Pipe Sch 80	4.41	19.22	9.61	9.61	0.00	5.85	5.85
10	8in Pipe Sch 80	12.76	211.43	105.72	105.72	0.00	33.05	33.05
16	HSS5x3x3/16	2.58	8.64	3.85	8.53	0.73	2.96	4.21
19	W8x10	2.96	0.04	2.09	30.80	30.90	1.66	8.87

Member Properties								
Member ID	Section ID	K_z L (ft)	K_y L (ft)	L_b (ft)	C_b	LST	LSC	LD
1	10	7.93	7.93	12.21	-	300	200	250
2	5	1.30	1.30	2.00	-	300	200	250
3	16	0.92	0.92	1.42	1.19,1.19,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.14,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19	300	200	250
4	16	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.59,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.67,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
5	16	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.67,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.67,1.68,1.67,1.67,1.62,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.67,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.67,1.68	300	200	250
6	16	0.92	0.92	1.42	1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.13,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18	300	200	250
7	16	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.62,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
8	19	1.33	1.33	2.05	1.96,1.96,1.96,1.96,1.96,1.96,1.92,1.96,1.91,1.96,1.92,1.96,1.91,1.96,1.93,1.96,1.50,1.96,1.93,1.96,1.90,1.96,1.92,1.96,1.92,1.96,1.96,1.96,1.96,1.96,1.96,1.96,1.96,1.96,1.96,1.92,1.96,1.91,1.96,1.93,1.96,1.86,1.96,1.93,1.96,1.90,1.96,1.92,1.96,1.91,1.96	300	200	250
9	2	2.60	2.60	4.00	-	300	200	250
10	16	2.44	2.44	3.75	1.69,1.68,1.69,1.67,1.68,1.69,1.67,1.68,1.66,1.68,1.67,1.69,1.66,1.69,1.67,1.67,1.58,1.67,1.67,1.69,1.66,1.69,1.67,1.69,1.66,1.69,1.69,1.69,1.67,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.69,1.66,1.69,1.67,1.68,1.65,1.68,1.67,1.69,1.66,1.69,1.67,1.69,1.66,1.69	300	200	250
11	19	1.33	1.33	2.05	1.98,1.98,1.98,1.98,1.98,1.98,1.94,1.98,1.92,1.98,1.94,1.98,1.93,1.98,1.96,1.98,1.51,1.98,1.95,1.98,1.92,1.98,1.94,1.98,1.93,1.98,1.98,1.98,1.98,1.98,1.98,1.98,1.98,1.98,1.98,1.94,1.98,1.92,1.98,1.95,1.98,1.87,1.98,1.94,1.98,1.92,1.98,1.94,1.98,1.93,1.98	300	200	250
12	5	1.30	1.30	2.00	-	300	200	250
13	19	4.88	4.00	7.50	1.09,1.10,1.09,1.10,1.10,1.09,1.09,1.10,1.09,1.10,1.09,1.09,1.09,1.09,1.09,1.10,1.04,1.10,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.10,1.09,1.10,1.09,1.09,1.10,1.09,1.09,1.09,1.09,1.09,1.09,1.10,1.09,1.10,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09	300	200	250
14	19	4.88	4.00	7.50	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.04,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09	300	200	250
15	19	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
16	19	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
101	10	7.93	7.93	12.21	-	300	200	250
102	5	1.30	1.30	2.00	-	300	200	250
103	16	0.92	0.92	1.42	1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.13,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18	300	200	250
104	16	2.44	2.44	3.75	1.69,1.68,1.69,1.67,1.68,1.69,1.67,1.68,1.66,1.68,1.67,1.69,1.66,1.69,1.67,1.67,1.58,1.67,1.67,1.69,1.66,1.69,1.67,1.69,1.66,1.69,1.69,1.69,1.67,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.69,1.66,1.69,1.67,1.68,1.65,1.68,1.67,1.69,1.66,1.69,1.67,1.69,1.66,1.69	300	200	250
105	16	1.	1.	2.	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.62,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.	3	2	2

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106	16	0.92	0.92	1.42	1.19,1.19,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.14,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19	300	200	250
107	16	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.67,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.67,1.68,1.67,1.67,1.62,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.67,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.67,1.68	300	200	250
108	19	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
109	2	2.60	2.60	4.00	-	300	200	250
110	16	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.59,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.67,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
111	19	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
112	5	1.30	1.30	2.00	-	300	200	250
113	19	4.88	4.00	7.50	1.09,1.10,1.09,1.10,1.10,1.09,1.09,1.10,1.09,1.10,1.09,1.09,1.09,1.09,1.09,1.10,1.04,1.10,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.10,1.09,1.10,1.09,1.09,1.10,1.09,1.09,1.09,1.09,1.09,1.09,1.10,1.09,1.10,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09	300	200	250
114	19	4.88	4.00	7.50	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.04,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09	300	200	250
115	19	4.84	4.84	7.45	1.89,1.90,1.89,1.90,1.90,1.90,1.98,1.90,2.03,1.90,1.98,1.89,2.02,1.89,1.95,1.90,3.20,1.90,1.97,1.89,2.03,1.89,1.99,1.90,2.01,1.90,1.90,1.90,1.90,1.90,1.90,1.90,1.90,1.90,1.90,1.98,1.90,2.02,1.90,1.96,1.90,2.10,1.90,1.97,1.90,2.03,1.90,1.98,1.90,2.01,1.90	300	200	250
116	19	4.84	4.84	7.45	1.93,1.94,1.93,1.94,1.94,1.93,2.03,1.94,2.05,1.94,2.03,1.93,2.04,1.93,2.00,1.94,3.26,1.94,2.02,1.93,2.06,1.93,2.03,1.93,2.04,1.93,1.93,1.93,1.94,1.93,1.94,1.93,1.93,1.94,1.93,2.02,1.93,2.05,1.93,2.01,1.94,2.13,1.94,2.02,1.93,2.05,1.93,2.03,1.93,2.04,1.93	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	574.32	530.16	123.94	123.94	172.30	172.30
2	198.33	196.72	21.95	21.95	59.50	59.50
3	116.10	115.41	15.79	11.10	42.08	23.28
4	116.10	111.33	15.79	11.10	42.08	23.28
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	123.95	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	123.95	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	23.95	6.12	40.24	43.62
14	133.20	85.85	23.84	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
101	574.32	530.16	123.94	123.94	172.30	172.30
102	198.33	196.72	21.95	21.95	59.50	59.50
103	116.10	115.41	15.79	11.10	42.08	23.28
104	116.10	111.33	15.79	11.10	42.08	23.28
105	116.10	114.23	15.79	11.10	42.08	23.28
106	116.10	115.41	15.79	11.10	42.08	23.28
107	116.10	114.23	15.79	11.10	42.08	23.28

108	133.20	32.95	32.87	6.12	40.24	43.62
109	66.48	58.89	3.82	3.82	19.94	19.94
110	116.10	111.33	15.79	11.10	42.08	23.28
111	133.20	32.95	32.87	6.12	40.24	43.62
112	198.33	196.72	21.95	21.95	59.50	59.50
113	133.20	85.85	23.90	6.12	40.24	43.62
114	133.20	85.85	23.91	6.12	40.24	43.62
115	133.20	86.20	32.87	6.12	40.24	43.62
116	133.20	86.20	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	0.021	0.759	0.022	0.044	0.002	0.778	#13	0.165	Not Required	Pass
2	0.003	0.451	0.371	0.098	0.068	0.823	#13	0.035	Not Required	Pass
3	0.013	0.800	0.094	0.081	0.019	0.858	#13	0.045	Not Required	Pass
4	0.014	0.797	0.225	0.080	0.047	0.850	#13	0.080	Not Required	Pass
5	0.013	0.496	0.230	0.079	0.056	0.524	#13	0.074	Not Required	Pass
6	0.011	0.669	0.060	0.066	0.005	0.699	#13	0.045	Not Required	Pass
7	0.011	0.416	0.163	0.067	0.043	0.440	#13	0.074	Not Required	Pass
8	0.003	0.078	0.110	0.042	0.018	0.155	#21	0.095	Not Required	Pass
9	0.015	0.064	0.089	0.002	0.002	0.157	#13	0.204	Not Required	Pass
10	0.011	0.665	0.172	0.067	0.039	0.753	#13	0.080	Not Required	Pass
11	0.003	0.077	0.108	0.042	0.018	0.155	#21	0.063	Not Required	Pass
12	0.004	0.327	0.296	0.080	0.058	0.623	#13	0.035	Not Required	Pass
13	0.010	0.310	0.562	0.058	0.024	0.798	#21	0.190	Not Required	Pass
14	0.013	0.316	0.562	0.058	0.024	0.798	#21	0.190	Not Required	Pass
15	0.000	0.123	0.300	0.042	0.018	0.396	#21	Not Required	Not Required	Pass
16	0.000	0.123	0.300	0.042	0.018	0.396	#21	Not Required	Not Required	Pass
101	0.021	0.759	0.022	0.044	0.002	0.778	#13	0.165	Not Required	Pass
102	0.004	0.327	0.296	0.080	0.058	0.623	#13	0.035	Not Required	Pass
103	0.011	0.669	0.060	0.066	0.005	0.699	#13	0.045	Not Required	Pass
104	0.011	0.665	0.172	0.067	0.039	0.753	#13	0.080	Not Required	Pass
105	0.011	0.416	0.163	0.067	0.043	0.440	#13	0.074	Not Required	Pass
106	0.013	0.800	0.094	0.081	0.019	0.858	#13	0.045	Not Required	Pass
107	0.013	0.496	0.230	0.079	0.056	0.524	#13	0.074	Not Required	Pass
108	0.000	0.123	0.300	0.042	0.018	0.396	#21	Not Required	Not Required	Pass
109	0.015	0.064	0.089	0.002	0.002	0.157	#13	0.204	Not Required	Pass
110	0.014	0.797	0.225	0.080	0.047	0.850	#13	0.080	Not Required	Pass
111	0.000	0.123	0.300	0.042	0.018	0.396	#21	Not Required	Not Required	Pass
112	0.003	0.451	0.371	0.098	0.068	0.823	#13	0.035	Not Required	Pass
113	0.010	0.310	0.562	0.058	0.024	0.798	#21	0.190	Not Required	Pass
114	0.013	0.316	0.562	0.058	0.024	0.798	#21	0.286	Not Required	Pass
115	0.003	0.077	0.204	0.042	0.018	0.242	#21	0.231	Not Required	Pass
116	0.004	0.078	0.207	0.042	0.018	0.242	#21	0.346	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

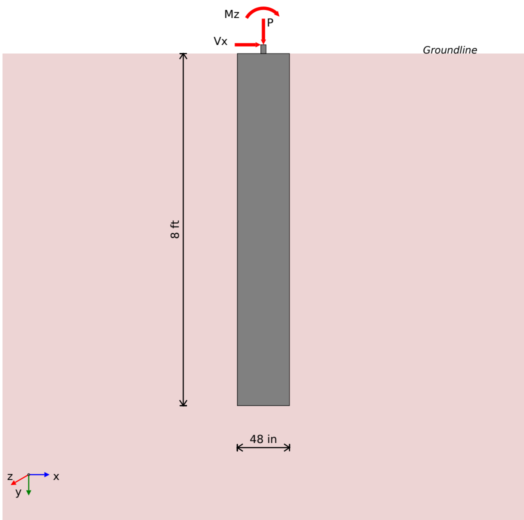
Input	Description	Value
f'_{ck}	Concrete compressive strength	2.5 ksi
f_{yk}	Yield strength of steel	60 ksi
d_b	Rebar diameter	#5 (0.625) in
cover	Concrete cover	3 in

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	7.749 kip	11.26 kip
Vx	-4.503 kip	-7.504 kip
Vz	0.188 kip	0.311 kip
Mx	0.639 kip-ft	1.048 kip-ft
Mz	55.83 kip-ft	94.13 kip-ft



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

$$H_o = \frac{V_x}{1.57 \times D} = \frac{-4.503}{1.57 \times 48} = -0.717\,\frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{55.83 + (-4.503 \times 0)}{1.57 \times 48} = 8.89\ \frac{kip-ft}{ft}$$

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:

$$L_{e,x} = 7.34\ ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{0.188}{1.57 \times 48} = 0.03\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{1.57 \times b} = \frac{0.639 + (0.188 \times 0)}{1.57 \times 48} = 0.102\ \frac{kip-ft}{ft}$$

Required depth of embedment in earth:

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

Solving the cubic equation:

$$L_{e,z} = 2.307\ ft$$

Minimum embedded depth

Depth of pile required

$$L_{e,req} = MAX[L_{e,x}, L_{e,z}] = MAX[7.34, 2.307] = 7.34\ ft$$

Actual embedded length

$$L_e = L - h_2 - h_e = 8 - 0 - 0 = 8\ ft$$

Utilisation

$$Ratio = \frac{L_{e,req}}{L_e} = \frac{7.34}{8} = 0.917$$

UTILITY: 0.92

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:

$$q = \frac{P}{A} = \frac{7.749}{16} = 484.3\ psf$$

Utilisation

$$Ratio = \frac{q}{q_a} = \frac{484.3}{2000} = 0.242$$

UTILITY: 0.24

Lateral Soil Pressure (ASD)

Allowable lateral pressure	$R =$	150 psf/ft

Length to least lateral dimension ratio:

$$\frac{L}{MIN[b, D]} = \frac{8}{MIN[4, 4]} = 2$$

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

Considering x-direction:

Distance from resting surface to pivot point:

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

$$(6 \times M_o) + (4 \times H_o \times L_e)$$

$$a = \frac{(4 \times 8.89 \times 8) + \left(3 \times 0.717 \times 8^2\right)}{(6 \times 8.89) + (4 \times 0.717 \times 8)} = 5.534\ ft$$

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

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

$$p = \frac{0.75 \times [(4 \times 8.89) + (3 \times -0.717 \times 8)]^2}{8^2 \times [(3 \times 8.89) + (2 \times -0.717 \times 8)]} = 0.26\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{5.534}{2} = 0.415\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{0.26}{0.415} = 0.626$$

UTILITY: 0.63

Earth pressure against the pile at distance L_e:

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times 8.89) + (-0.717 \times 8)]}{8^2} = 1.129\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

$$p_s = R \times L_e = 0.15 \times 8 = 1.2\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{1.129}{1.2} = 0.941$$

UTILITY: 0.94

Considering z-direction:

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.102 \times 8) + \left(3 \times 0.03 \times 8^2\right)}{(6 \times 0.102) + (4 \times 0.03 \times 8)} = 5.74\ ft$$

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

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

$$p = \frac{0.75 \times [(4 \times 0.102) + (3 \times 0.03 \times 8)]^2}{8^2 \times [(3 \times 0.102) + (2 \times 0.03 \times 8)]} = 0.019\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{5.74}{2} = 0.431\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{0.019}{0.431} = 0.044$$

UTILITY: 0.04

Earth pressure against the pile at distance L_e:

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times 0.102) + (0.03 \times 8)]}{8^2} = 0.042\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

$$p_s = R \times L_e = 0.15 \times 8 = 1.2\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{0.042}{1.2} = 0.035$$

UTILITY: 0.03

REFERENCES	CALCULATIONS	RESULTS

Shear force and bending moment (LRFD)

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{1.57 \times D} = \frac{-7.504}{1.57 \times 48} = -1.195\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{94.13 + (-7.504 \times 0)}{1.57 \times 48} = 14.99\ \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 14.99 \times 8) + \left(3 \times 1.195 \times 8^2\right)}{(6 \times 14.99) + (4 \times 1.195 \times 8)} = 5.532\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{14.99}{-1.195} = 12.54\ ft$$

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

$$V_{max,x} = (-1.195 \times 48) \times [1 - [3 \times \left(\frac{4 \times 12.54}{8} + 3\right) \times \left(\frac{5.532}{8}\right)^2] + [4 \times \left(\frac{3 \times 12.54}{8} + 2\right) \times \left(\frac{5.532}{8}\right)^3]]$$

$$V_{max,x} = 16.41\ kip$$

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

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

$$M_{max,x} = (-1.195 \times 48 \times 8) \times [\left(\frac{12.54}{8} + \frac{5.532}{2 \times 8}\right) - [\left(\frac{4 \times 12.54}{8} + 3\right) \times \left(\frac{5.532}{2 \times 8}\right)^3] + [\left(\frac{3 \times 12.54}{8} + 2\right) \times \left(\frac{5.532}{2 \times 8}\right)^4]]$$

$$M_{max,x} = 62.18\ kip - ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{0.311}{1.57 \times 48} = 0.049\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{1.57 \times b} = \frac{1.048 + (0.311 \times 0)}{1.57 \times 48} = 0.167\ \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.167 \times 8) + \left(3 \times 0.049 \times 8^2\right)}{(6 \times 0.167) + (4 \times 0.049 \times 8)} = 5.742\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{0.167}{0.049} = 3.375\ ft$$

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

$$V_{max,z} = (0.049 \times 48) \times [1 - [3 \times \left(\frac{4 \times 3.375}{8} + 3\right) \times \left(\frac{5.742}{8}\right)] + [4 \times \left(\frac{3 \times 3.375}{8} + 2\right) \times \left(\frac{5.742}{8}\right)]]$$

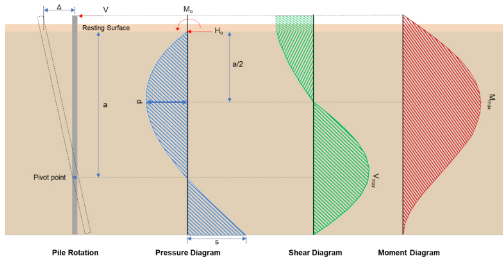
$$V_{max,z} = 0.28\ kip$$

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

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

$$M_{max,z} = (0.049 \times 48 \times 8) \times [\left(\frac{3.375}{8} + \frac{5.742}{2 \times 8}\right) - [\left(\frac{4 \times 3.375}{8} + 3\right) \times \left(\frac{5.742}{2 \times 8}\right)^3] + [\left(\frac{3 \times 3.375}{8} + 2\right) \times \left(\frac{5.742}{2 \times 8}\right)^4]]$$

$$M_{max,z} = 0.979\ kip - ft$$



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:

$$A_{st,req} = \frac{P - (0.85 \times f'_{ck} \times A_g)}{f_{yk} - (0.85 \times f'_{ck})} = \frac{11.26 - (0.85 \times 2.5 \times 2304)}{60 - (0.85 \times 2.5)} = -84.4\ in^2$$

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:

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

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

Utilisation

$$Ratio = \frac{P}{\phi P_N} = \frac{11.26}{2694} = 0.004$$

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	$V_{max,x} =$	16.41 kip
Maximum shear in the z-direction	$V_{max,z} =$	0.28 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:

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

$$V_{c,a} = \left(2 \times 1 \times \sqrt{2.5} + MIN[\frac{11.26}{6 \times 2304}, (0.05 \times 2.5)]\right) \times (48 \times 44.31) = 214.4\ kip$$

Governing shear strength of concrete:

$$V_c = MIN[V_{c,max}, V_{c,a}] = MIN[531.8, 214.4] = 214.4\ kip$$

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:

$$\phi V_n = \phi \times (V_c + V_s) = 0.75 \times (214.4 + 58.73) = 204.9\ kip$$

$$V_{max} = MAX[16.41, 0.28] = 16.41\ kip$$

Utilisation

$$Ratio = \frac{V_{max}}{\phi V_n} = \frac{16.41}{204.9} = 0.08$$

UTILITY: 0.08

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	$P =$	11.26 kip
Maximum moment in the x-direction	$M_{max,x} =$	62.18 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$	0.979 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:

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

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

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

Tensile force due to bars in tension:

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

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

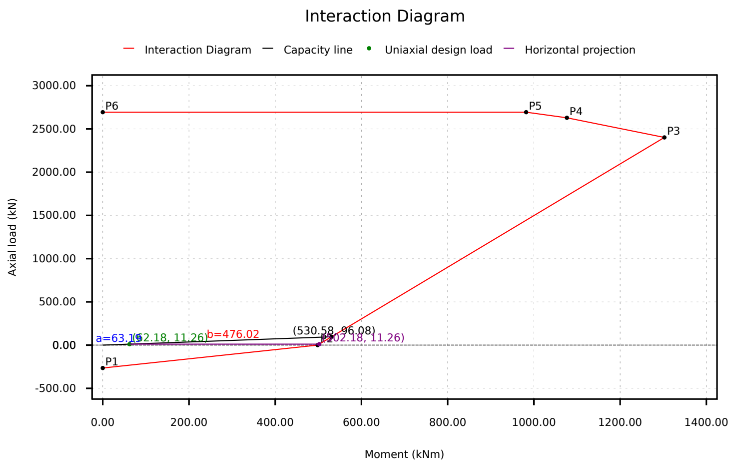
$$f_2 = E_s \times \varepsilon_2 \ (\varepsilon_2 < \varepsilon_{sy}), \ f_2 = \phi_s \times f_y \ (\varepsilon_2 \geq \varepsilon_{sy})$$

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

$$M_f = MAX[62.18, 0.979] = 62.18 \ kip - ft$$



Segment	Signed Distance
P1 - P2	214.8
P2 - P3	417.2
P3 - P4	2566
P4 - P5	2732
P5 - P6	2682
Status	PASS: Point lies inside the curve

Utilisation

$$Ratio = \frac{a}{a+b} = \frac{63.19}{63.19 + 476} = 0.117$$

UTILITY: 0.12

Biaxial Bending Check

Maximum moment in the x-direction	$M_{max,x} =$	62.18 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$	0.979 kip-ft
Nominal uniaxial moment strength about the x-axis	$M_{nox} =$	502.2 kip-ft
Nominal uniaxial moment strength about the z-axis	$M_{noz} =$	502.2 kip-ft
Interaction exponent	$\alpha =$	1

Bresler (1960)	According to Bresler (method B): $$\left(\frac{M_{max,x}}{M_{nox}}\right)^{\alpha}+\left(\frac{M_{max,z}}{M_{noz}}\right)^{\alpha}=1.0$$ $$\left(\frac{62.18}{502.2}\right)^{1}+\left(\frac{0.979}{502.2}\right)^{1}=0.126$$	**UTILITY: 0.13**

REFERENCES	CALCULATIONS	RESULTS

Results Summary

Result Name	Results
PILE DETAILS	
Length of the pile	8.00 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	0.92
End-bearing capacity	0.24
p_a	0.63
p_s	0.94
Axial compression strength	0.00
Shear strength	0.08
Uniaxial bending strength	0.12
Biaxial bending strength	0.13