Project Details

Project Name: Mike Webb

Location: Bartlett, NH, USA

Unique ID: 2P-17-6TOP-SD-57-L-4Hx6W-K83J

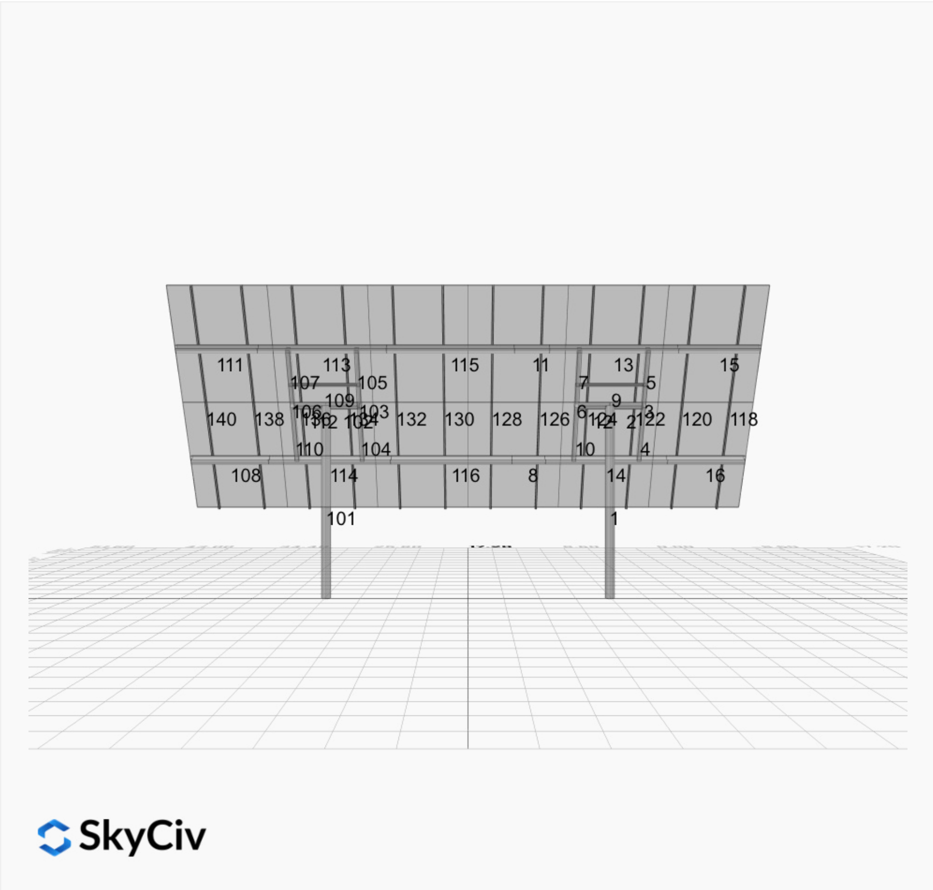
Dealer: ______________________________

Date: Mon Oct 06 2025

Number of Modules: 24

Number of Poles: 2

Date Sold: ______________________________



Array Dimensions N/S	15.05 ft
Array Dimensions E/W	34.40 ft
Winter Tilt Angle (Degrees)	60
Front Edge Clearance	5

MT Solar Bill of Materials (2P-17-6TOP-SD-57-L-4Hx6W-K83J)

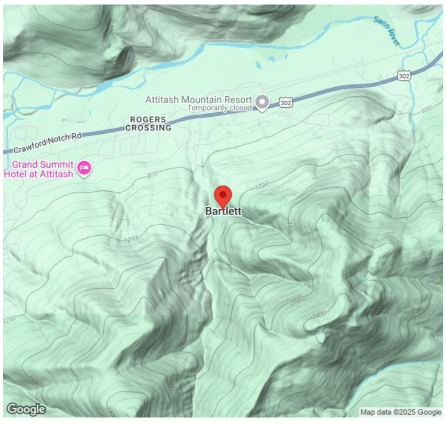
Part	Short Description	BOM Qty
MTS-PC-6	6IN Pole Cap Assembly	2
MTS-HF-SD	H-Frame Assembly-SD	2
MTS-SD-Wing-57	57IN SD Wing	4
MTS-SD-Splice-57	57IN SD Splice	4
MTS-CLAMP-HOOK-4PK	Hook Clamp	6

Rail Bill of Materials

Part	Qty
Rails (181in Long)	12x
Rail Attachment	24x
Module Mid Clamp	36x
Module End Clamp	24x

Part	Qty
Ground Lug	6x

Site Details:



Site Address: Bartlett, NH, USA

Array Specification

Duty Classification:	SD
Module Width:	44.65 in
Module Length:	67.80 in
Number of Rows:	4
Number of Columns:	6
Total Number of Modules:	24
Winter Tilt Angle:	60
Front Edge Clearance:	5
Total Array Height at Tilt:	18.03 ft
Total Frame Length:	34.00 ft
Module Info/Notes:	
Array Dimensions N/S:	15.05 ft
Array Dimensions E/W:	34.40 ft
Rail Length:	180.60 in
Rail Spacing:	2.87 ft

Support Specifications

Pole Size:	6in Pipe Sch 80
Pole Length above Grade:	11.52 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:	B
Soil Classification:	sand
Site Location:	Bartlett, NH, USA
Wind Speed:	100 mph

Snow Load:	90 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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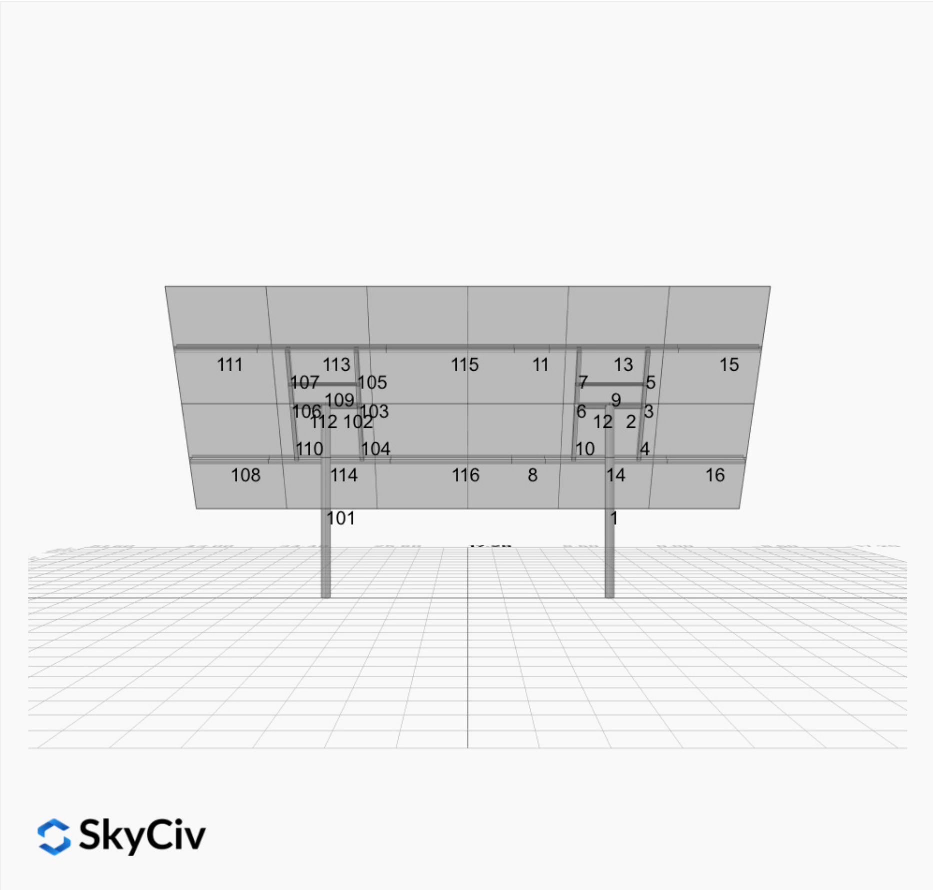
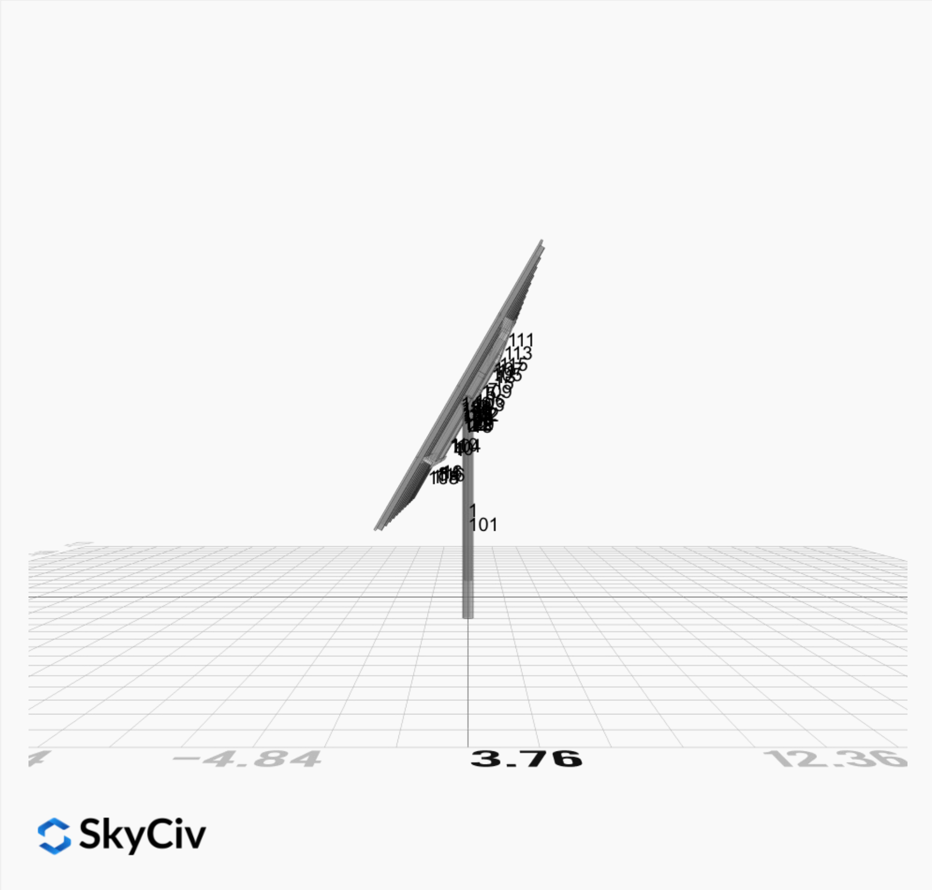
Design Notes:

- 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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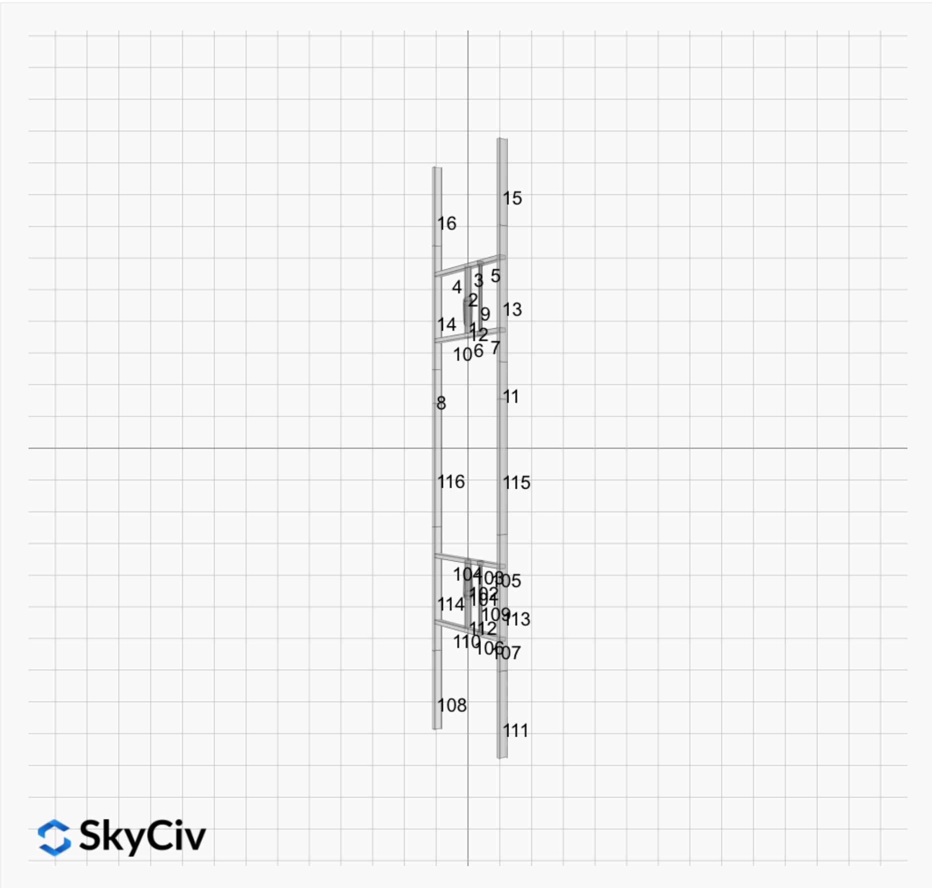
SkyCiv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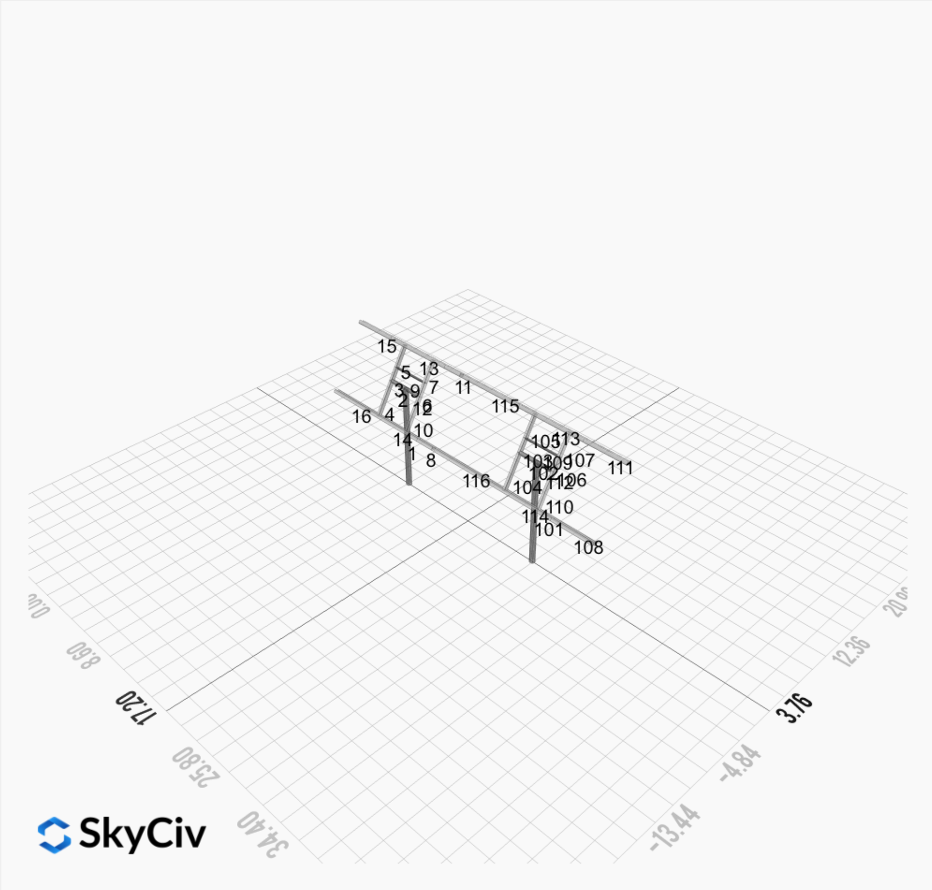
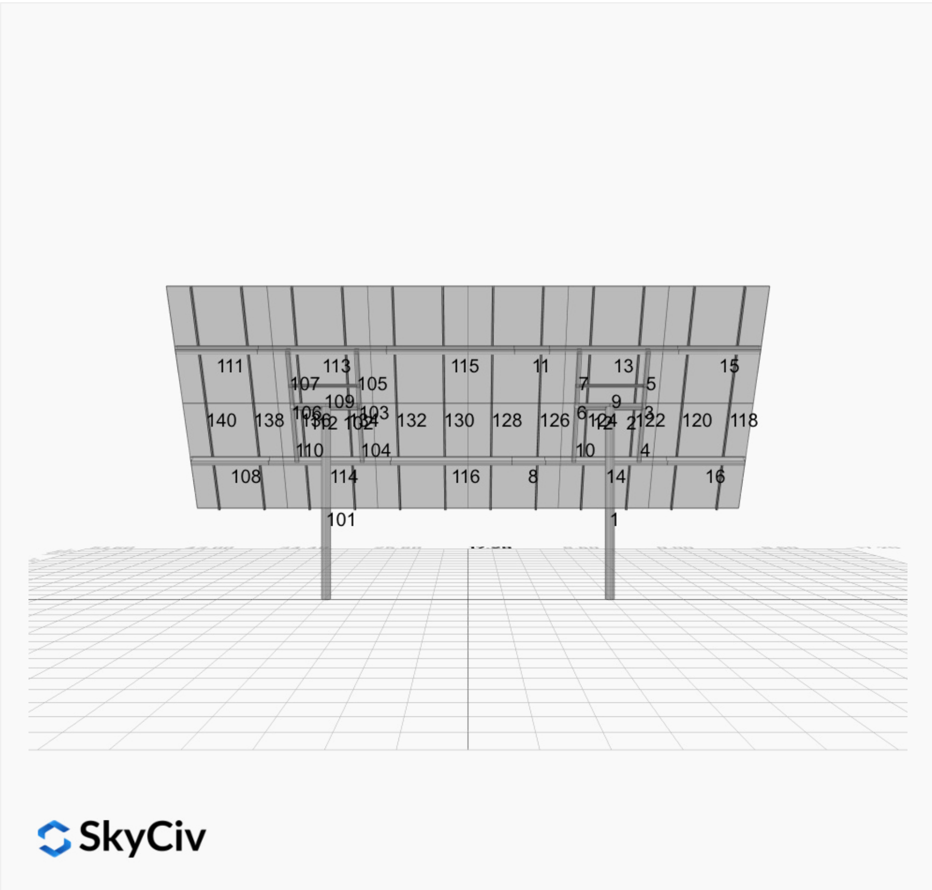
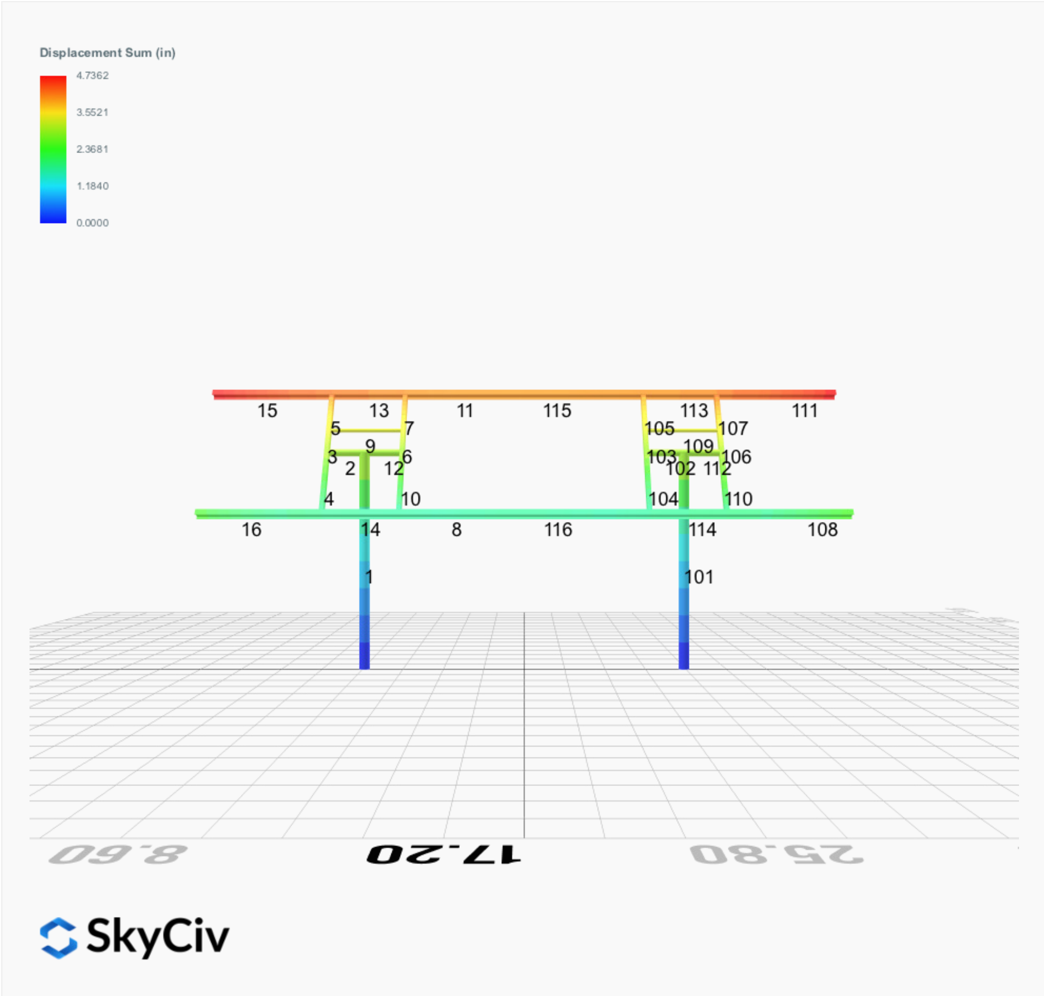
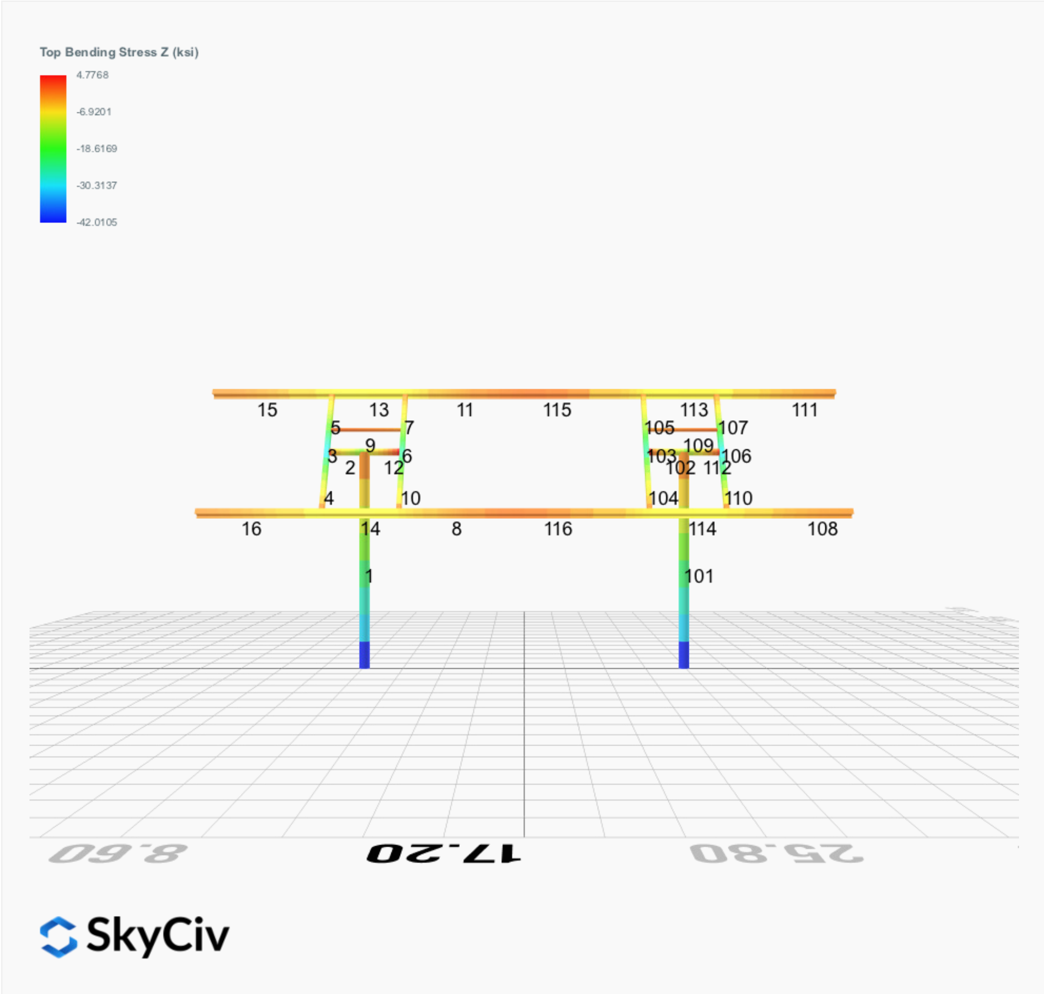
SkyCiv





FEM Results (Envelope Worst Case)





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-18.6169
-30.3137
-42.0105
15
13
11
115
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111
5
7
105
107
9
109
3
2
12
6
103
102
112
106
4
10
104
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16
14
8
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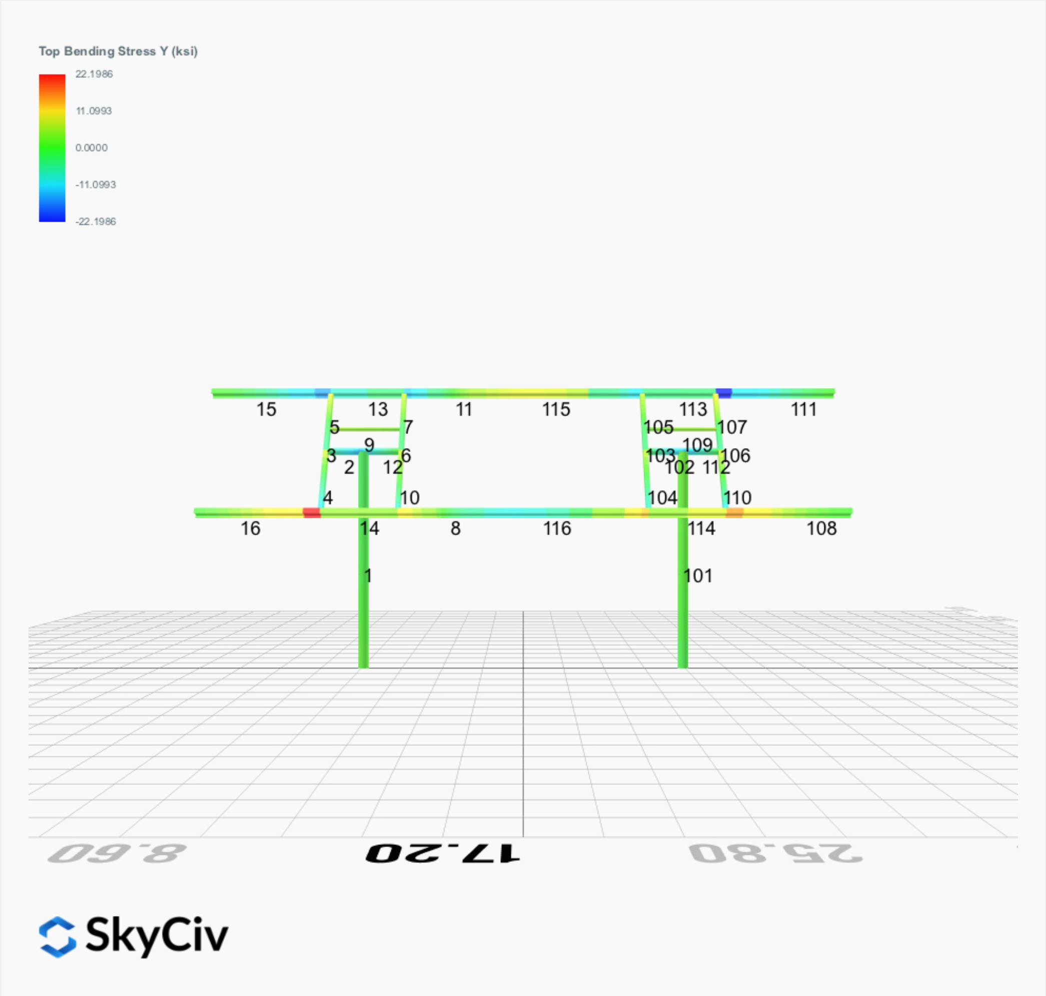
114
108
1
101
8.60
17.20
25.80
SkyCiv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-22.1986
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13
11
115
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111
5
7
105
107
9
109
3
2
12
6
103
102
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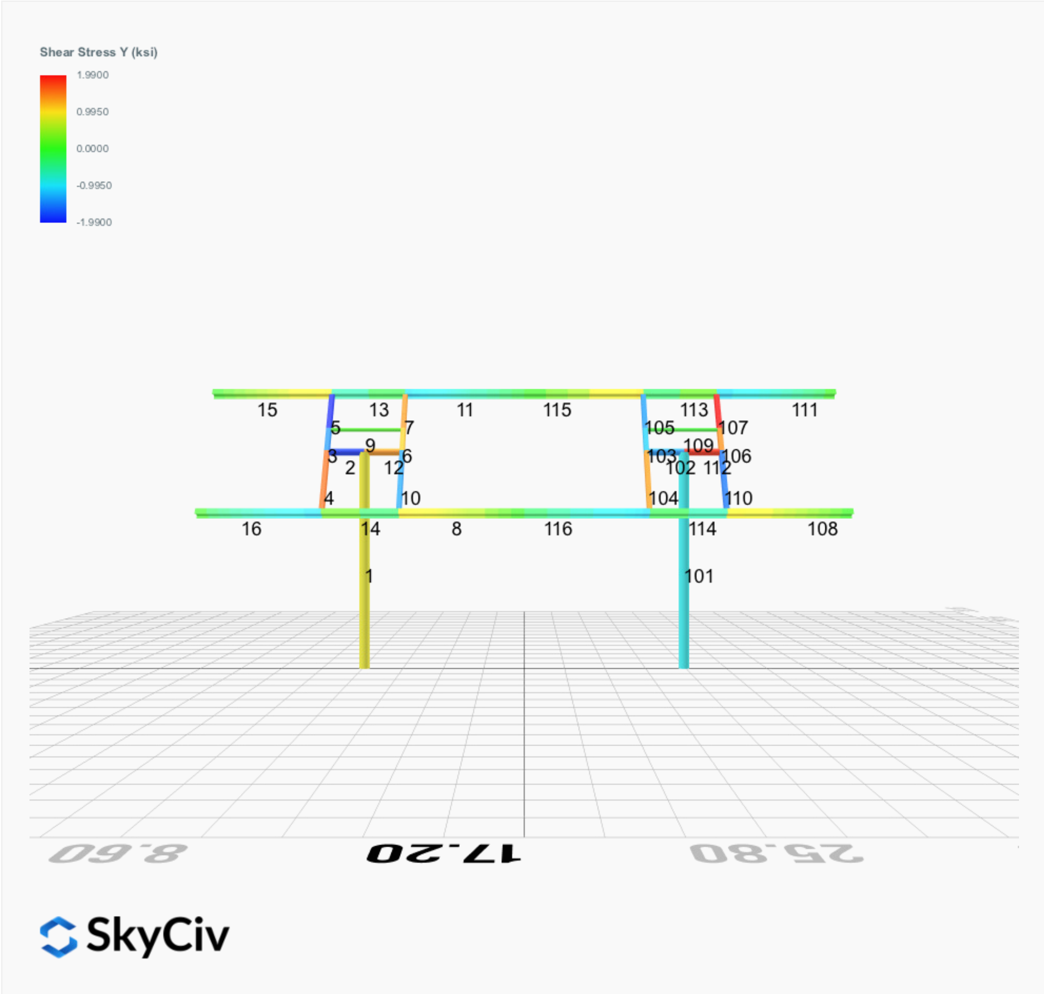
101
8.60
17.20
25.80
SkyCiv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-1.9900
15
13
11
115
113
111
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105
107
9
109
3
6
103
106
2
12
102
112
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101
8.60
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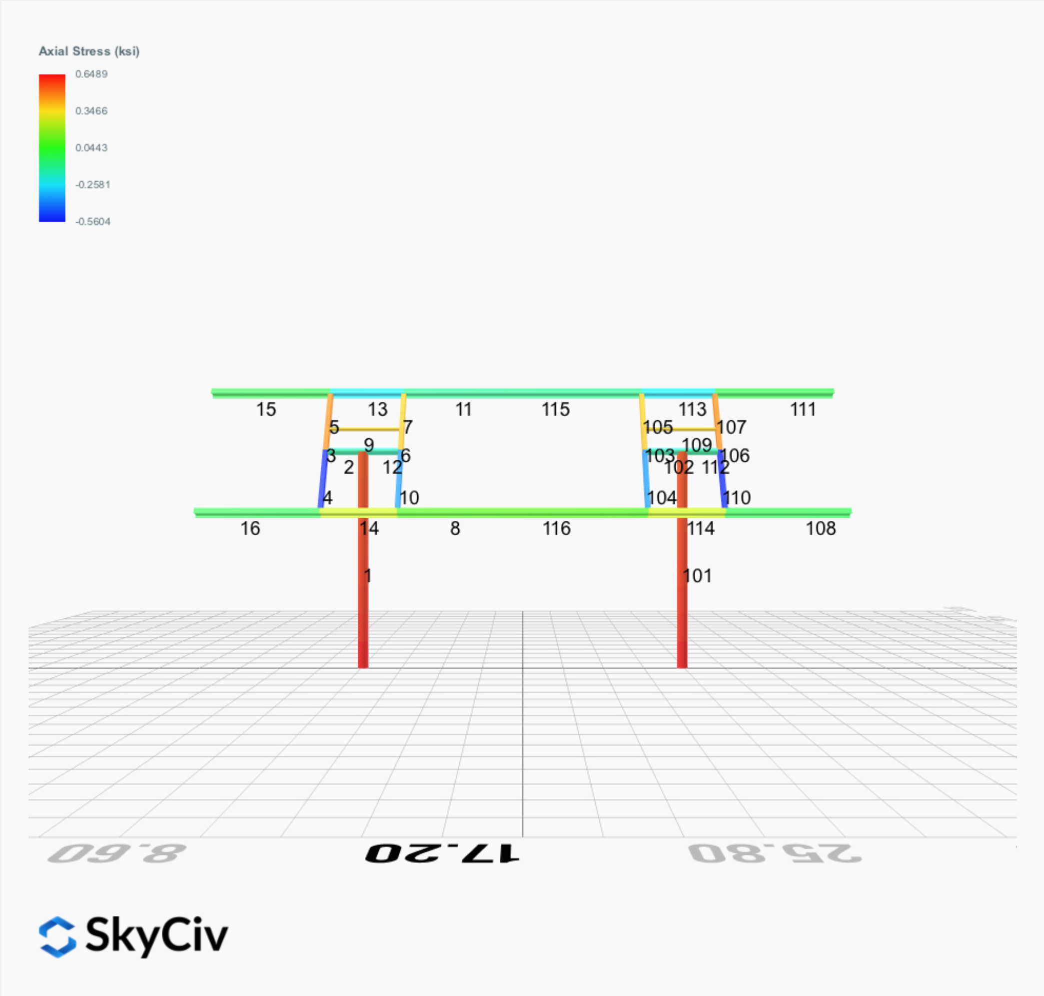
25.80
SkyCiv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0.3466
0.0443
-0.2581
-0.5604
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13
11
115
113
111
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105
107
9
109
3
2
12
6
103
102
112
106
4
10
104
110
16
14
8
116
114
108
1
101
8.60
17.20
25.80
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	2.7845	-0.0412	-0.1463	0.1379	0.0225
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0000	3.0197	-0.0477	-0.1691	0.1593	0.0229
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0000	2.3867	-0.0353	-0.1254	0.1182	0.0183
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	-0.0000	4.4124	-0.0748	-0.2657	0.2497	0.0379
ULS: 5. 1.2D + E + L + 0.2S	-0.0000	2.6399	-0.0403	-0.1429	0.1346	0.0200
ULS: 7. 0.9D + 1.0E	-0.0000	1.7900	-0.0265	-0.0940	0.0886	0.0126
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-3.6074	5.1024	-0.1613	-0.5607	0.8325	42.7929
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.0000	3.0197	-0.0477	-0.1691	0.1593	0.0229
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	3.6074	0.9370	0.0661	0.2219	-0.5155	-41.7690
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0000	3.0197	-0.0477	-0.1691	0.1593	0.0229
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-3.6074	4.4694	-0.1490	-0.5169	0.7919	42.6272
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.0000	2.3867	-0.0353	-0.1254	0.1182	0.0183
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	3.6074	0.3040	0.0785	0.2657	-0.5570	-41.6210
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0000	2.3867	-0.0353	-0.1254	0.1182	0.0183
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.8037	5.4537	-0.1316	-0.4614	0.5860	21.4754
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.0000	4.4124	-0.0748	-0.2657	0.2497	0.0379
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.8037	3.3710	-0.0180	-0.0701	-0.0870	-21.1505
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.0000	4.4124	-0.0748	-0.2657	0.2497	0.0379
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.8037	3.4281	-0.0922	-0.3211	0.4552	21.1991
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.0000	2.3867	-0.0353	-0.1254	0.1182	0.0183
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.8037	1.3454	0.0216	0.0702	-0.2193	-20.9200
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.0000	2.3867	-0.0353	-0.1254	0.1182	0.0183
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-3.6074	3.8727	-0.1402	-0.4855	0.7627	42.4727
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-0.0000	1.7900	-0.0265	-0.0940	0.0886	0.0126
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	3.6074	-0.2927	0.0873	0.2970	-0.5869	-41.4857
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	-0.0000	1.7900	-0.0265	-0.0940	0.0886	0.0126

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0000	1.9889	-0.0294	-0.1044	0.0985	0.0145
ULS: 2. D + L	-0.0000	1.9889	-0.0294	-0.1044	0.0985	0.0145
ULS: 3. D + (S or Lr or R)	-0.0000	3.2550	-0.0541	-0.1920	0.1807	0.0237
ULS: 3. D + (S or Lr or R)	-0.0000	1.9889	-0.0294	-0.1044	0.0985	0.0145
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0000	2.9385	-0.0479	-0.1701	0.1601	0.0208
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0000	1.9889	-0.0294	-0.1044	0.0985	0.0145
ULS: 5b. D + 0.7E	-0.0000	1.9889	-0.0294	-0.1044	0.0985	0.0145
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0000	2.9385	-0.0479	-0.1701	0.1601	0.0208
ULS: 8. 0.6D + 0.7E	-0.0000	1.1934	-0.0177	-0.0626	0.0591	0.0077
ULS: 5a. D + 0.6W_Wind downforce Case A only	-2.1644	3.2386	-0.0977	-0.3393	0.5030	25.4019
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.0000	1.9889	-0.0294	-0.1044	0.0985	0.0145
ULS: 5a. D + 0.6W_Wind uplift Case A only	2.1644	0.7393	0.0388	0.1303	-0.3066	-25.0259
ULS: 5a. D + 0.6W_Wind uplift Case B only	-0.0000	1.9889	-0.0294	-0.1044	0.0985	0.0145
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.6233	3.8757	-0.0991	-0.3462	0.4633	19.1352
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0000	2.9385	-0.0479	-0.1701	0.1601	0.0208
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.6233	2.0013	0.0033	0.0060	-0.1433	-18.8957
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0000	2.9385	-0.0479	-0.1701	0.1601	0.0208

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	-1.6233	2.9261	-0.0806	-0.2806	0.4019	19.0220
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0000	1.9889	-0.0294	-0.1044	0.0985	0.0145
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.6233	1.0517	0.0218	0.0716	-0.2053	-18.7979
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0000	1.9889	-0.0294	-0.1044	0.0985	0.0145
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-2.1644	2.4430	-0.0859	-0.2974	0.4639	25.2782
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.0000	1.1934	-0.0177	-0.0626	0.0591	0.0077
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	2.1644	-0.0563	0.0506	0.1720	-0.3463	-24.9194
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	-0.0000	1.1934	-0.0177	-0.0626	0.0591	0.0077

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	5.4537
Shear X	3.6074
Shear Z	-0.1613
Moment X	-0.5607
Moment Y (Twist)	0.8325
Moment Z	42.7929

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	3.8757
Shear X	2.1644
Shear Z	-0.0991
Moment X	-0.3462
Moment Y (Twist)	0.5030
Moment Z	25.4019

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	2.7845	0.0412	0.1465	-0.1379	0.0224
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	3.0198	0.0477	0.1693	-0.1594	0.0228
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	2.3867	0.0353	0.1255	-0.1182	0.0182
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0000	4.4124	0.0748	0.2660	-0.2499	0.0376
ULS: 5. 1.2D + E + L + 0.2S	0.0000	2.6400	0.0403	0.1430	-0.1347	0.0199
ULS: 7. 0.9D + 1.0E	0.0000	1.7901	0.0265	0.0941	-0.0887	0.0126
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-3.6073	5.1024	0.1613	0.5606	-0.8331	42.7933
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0000	3.0198	0.0477	0.1693	-0.1594	0.0228
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	3.6073	0.9371	-0.0661	-0.2214	0.5158	-41.7697
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0000	3.0198	0.0477	0.1693	-0.1594	0.0228
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-3.6073	4.4694	0.1490	0.5167	-0.7924	42.6277
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0000	2.3867	0.0353	0.1255	-0.1182	0.0182
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	3.6073	0.3041	-0.0785	-0.2652	0.5574	-41.6217
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0000	2.3867	0.0353	0.1255	-0.1182	0.0182
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.8036	5.4538	0.1316	0.4616	-0.5864	21.4755
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0000	4.4124	0.0748	0.2660	-0.2499	0.0376
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.8037	3.3711	0.0180	0.0706	0.0871	-21.1510
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0000	4.4124	0.0748	0.2660	-0.2499	0.0376
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.8037	3.4281	0.0922	0.3211	-0.4555	21.1992
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0000	2.3867	0.0353	0.1255	-0.1182	0.0182
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.8037	1.3454	-0.0216	-0.0699	0.2194	-20.9204
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0000	2.3867	0.0353	0.1255	-0.1182	0.0182
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-3.6073	3.8727	0.1402	0.4853	-0.7631	42.4730
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	0.0000	1.7901	0.0265	0.0941	-0.0887	0.0126
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	3.6073	-0.2926	-0.0873	-0.2966	0.5872	-41.4862
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	0.0000	1.7901	0.0265	0.0941	-0.0887	0.0126

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0000	1.9889	0.0294	0.1046	-0.0985	0.0144
ULS: 2. D + L	0.0000	1.9889	0.0294	0.1046	-0.0985	0.0144
ULS: 3. D + (S or Lr or R)	0.0000	3.2550	0.0541	0.1922	-0.1808	0.0235
ULS: 3. D + (S or Lr or R)	0.0000	1.9889	0.0294	0.1046	-0.0985	0.0144
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	2.9385	0.0479	0.1703	-0.1602	0.0207
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	1.9889	0.0294	0.1046	-0.0985	0.0144
ULS: 5b. D + 0.7E	0.0000	1.9889	0.0294	0.1046	-0.0985	0.0144
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0000	2.9385	0.0479	0.1703	-0.1602	0.0207
ULS: 8. 0.6D + 0.7E	0.0000	1.1934	0.0177	0.0627	-0.0591	0.0076
ULS: 5a. D + 0.6W_Wind downforce Case A only	-2.1644	3.2385	0.0977	0.3392	-0.5033	25.4021
ULS: 5a. D + 0.6W_Wind downforce Case B only	0.0000	1.9889	0.0294	0.1046	-0.0985	0.0144
ULS: 5a. D + 0.6W_Wind uplift Case A only	2.1644	0.7394	-0.0388	-0.1299	0.3068	-25.0262
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.0000	1.9889	0.0294	0.1046	-0.0985	0.0144
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.6233	3.8757	0.0991	0.3463	-0.4636	19.1352
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0000	2.9385	0.0479	0.1703	-0.1602	0.0207
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.6233	2.0013	-0.0033	-0.0056	0.1434	-18.8960
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0000	2.9385	0.0479	0.1703	-0.1602	0.0207
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.6233	2.9261	0.0806	0.2805	-0.4022	19.0221
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0000	1.9889	0.0294	0.1046	-0.0985	0.0144
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.6233	1.0518	-0.0218	-0.0713	0.2054	-18.7982
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0000	1.9889	0.0294	0.1046	-0.0985	0.0144
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-2.1644	2.4430	0.0859	0.2973	-0.4641	25.2783
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	0.0000	1.1934	0.0177	0.0627	-0.0591	0.0076
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	2.1644	-0.0562	-0.0506	-0.1718	0.3464	-24.9196
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.0000	1.1934	0.0177	0.0627	-0.0591	0.0076

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	5.4538
Shear X	3.6073
Shear Z	0.1613
Moment X	0.5606
Moment Y (Twist)	0.8331
Moment Z	42.7933

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	3.8757
Shear X	2.1644
Shear Z	0.0991
Moment X	0.3463
Moment Y (Twist)	0.5033
Moment Z	25.4021

Project Details

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

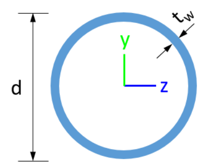
User Name: sales@mtsolar.us
Project Name: Mike Webb
Unit System: imperial

Design Input Information

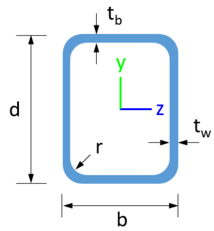
Design Factors			
Φ_t	Φ_c	Φ_b	Φ_v
0.9	0.9	0.9	0.9

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

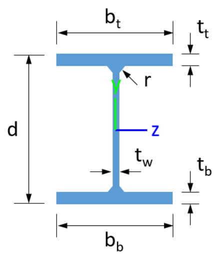
Section Dimensions



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					
8	6in Pipe Sch 80	6.63	0.43					



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
8	6in Pipe Sch 80	8.40	80.98	40.49	40.49	0.00	16.60	16.60
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_zL (ft)	K_yL (ft)	L_b (ft)	C_b	LST	LSC	LD
1	8	7.49	7.49	11.52	-	300	200	250
2	4	1.30	1.30	2.00	-	300	200	250
3	15	0.92	0.92	1.42	1.19,1.19,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.14,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19	300	200	250
4	15	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.60,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
5	15	1.52	1.52	2.33	1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.63,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.67,1.67	300	200	250
6	15	0.92	0.92	1.42	1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.14,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18	300	200	250
7	15	1.52	1.52	2.33	1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.62,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.65,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67	300	200	250
8	18	1.33	1.33	2.05	2.02,2.02,2.02,2.02,2.02,2.02,1.95,2.02,1.91,2.02,1.95,2.02,1.92,2.02,1.97,2.02,1.47,2.02,1.96,2.02,1.88,2.02,1.95,2.02,1.93,2.02,2.02,2.02,2.02,2.02,2.02,2.02,2.02,2.02,2.02,1.95,2.02,1.91,2.02,1.97,2.02,1.81,2.02,1.96,2.02,1.89,2.02,1.95,2.02,1.92,2.02	300	200	250
9	1	2.60	2.60	4.00	-	300	200	250
10	15	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.60,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
11	18	1.33	1.33	2.05	2.04,2.04,2.04,2.04,2.04,2.04,1.97,2.04,1.92,2.04,1.97,2.04,1.93,2.04,1.99,2.04,1.48,2.04,1.98,2.04,1.90,2.04,1.97,2.04,1.94,2.04,2.04,2.04,2.04,2.04,2.04,2.04,2.04,2.04,2.04,1.97,2.04,1.92,2.04,1.99,2.04,1.82,2.04,1.98,2.04,1.90,2.04,1.97,2.04,1.94,2.04	300	200	250
12	4	1.30	1.30	2.00	-	300	200	250
13	18	4.88	4.00	7.50	1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.05,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.09,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10	300	200	250
14	18	4.88	4.00	7.50	1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.04,1.10,1.10,1.10,1.09,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.09,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10	300	200	250
15	18	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	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
101	8	7.49	7.49	11.52	-	300	200	250
102	4	1.30	1.30	2.00	-	300	200	250
103	15	0.92	0.92	1.42	1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.14,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.17,1.18	300	200	250
104	15	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.60,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.65,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68	300	200	250

105	15	1.52	1.52	2.33	1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.62,1.67,1.67,1.67,1.66,1.67,1.66,1.67,1.66,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.65,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67	300	200	250
106	15	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	15	1.52	1.52	2.33	1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.63,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.67,1.67	300	200	250
108	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	300	200	250
109	1	2.60	2.60	4.00	-	300	200	250
110	15	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.60,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
111	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	300	200	250
112	4	1.30	1.30	2.00	-	300	200	250
113	18	4.88	4.00	7.50	1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.05,1.10,1.10,1.10,1.09,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.09,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10	300	200	250
114	18	4.88	4.00	7.50	1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.05,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.09,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10	300	200	250
115	18	7.45	7.45	7.45	1.82,1.82,1.82,1.82,1.82,1.82,1.96,1.82,2.03,1.82,1.96,1.82,2.01,1.82,1.91,1.82,3.38,1.82,1.94,1.82,2.07,1.82,1.97,1.82,2.01,1.82,1.82,1.82,1.82,1.82,1.82,1.82,1.82,1.82,1.82,1.96,1.82,2.03,1.82,1.93,1.82,2.19,1.82,1.95,1.82,2.05,1.82,1.97,1.82,2.01,1.82	300	200	250
116	18	4.84	4.84	7.45	1.85,1.86,1.85,1.86,1.86,1.85,1.99,1.86,2.05,1.86,1.99,1.85,2.03,1.85,1.96,1.86,3.44,1.86,1.97,1.85,2.08,1.85,1.99,1.85,2.02,1.85,1.85,1.85,1.86,1.85,1.86,1.85,1.85,1.86,1.85,1.98,1.85,2.05,1.85,1.97,1.86,2.21,1.86,1.98,1.85,2.07,1.85,1.99,1.85,2.02,1.85	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	378.22	334.62	62.23	62.23	113.47	113.47
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	115.40	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	115.40	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	18.49	6.45	30.09	45.74
14	120.60	84.02	18.35	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
101	378.22	334.62	62.23	62.23	113.47	113.47
102	142.83	141.72	16.17	16.17	42.85	42.85
103	79.65	74.89	10.99	6.26	29.14	16.61
104	79.65	72.84	10.99	6.26	29.14	16.61
105	79.65	74.30	10.99	6.26	29.14	16.61
106	79.65	74.89	10.99	6.26	29.14	16.61

107	79.65	74.30	10.99	6.26	29.14	16.61
108	120.60	34.69	23.36	6.45	30.09	45.74
109	48.35	43.11	2.85	2.85	14.51	14.51
110	79.65	72.84	10.99	6.26	29.14	16.61
111	120.60	34.69	23.36	6.45	30.09	45.74
112	142.83	141.72	16.17	16.17	42.85	42.85
113	120.60	84.02	18.46	6.45	30.09	45.74
114	120.60	84.02	18.40	6.45	30.09	45.74
115	120.60	59.18	23.36	6.45	30.09	45.74
116	120.60	84.26	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	0.016	0.688	0.021	0.032	0.001	0.704	#13	0.205	Not Required	Pass
2	0.002	0.269	0.252	0.066	0.046	0.522	#13	0.034	Not Required	Pass
3	0.013	0.512	0.104	0.052	0.018	0.586	#13	0.044	Not Required	Pass
4	0.012	0.510	0.221	0.051	0.037	0.584	#13	0.078	Not Required	Pass
5	0.013	0.317	0.228	0.051	0.044	0.350	#13	0.073	Not Required	Pass
6	0.011	0.427	0.067	0.042	0.006	0.471	#13	0.044	Not Required	Pass
7	0.010	0.266	0.160	0.042	0.032	0.293	#13	0.073	Not Required	Pass
8	0.002	0.048	0.066	0.025	0.010	0.085	#21	0.088	Not Required	Pass
9	0.010	0.032	0.067	0.002	0.002	0.098	#13	0.198	Not Required	Pass
10	0.010	0.424	0.168	0.042	0.030	0.524	#13	0.078	Not Required	Pass
11	0.002	0.047	0.065	0.025	0.010	0.086	#21	0.059	Not Required	Pass
12	0.003	0.197	0.200	0.052	0.039	0.391	#13	0.034	Not Required	Pass
13	0.006	0.174	0.320	0.034	0.014	0.449	#21	0.177	Not Required	Pass
14	0.007	0.177	0.320	0.034	0.014	0.449	#21	0.177	Not Required	Pass
15	0.000	0.077	0.171	0.025	0.010	0.228	#21	Not Required	Not Required	Pass
16	0.000	0.077	0.171	0.025	0.010	0.228	#21	Not Required	Not Required	Pass
101	0.016	0.688	0.021	0.032	0.001	0.704	#13	0.205	Not Required	Pass
102	0.003	0.197	0.200	0.052	0.039	0.391	#13	0.034	Not Required	Pass
103	0.011	0.427	0.067	0.042	0.006	0.472	#13	0.044	Not Required	Pass
104	0.010	0.424	0.168	0.042	0.030	0.524	#13	0.078	Not Required	Pass
105	0.010	0.266	0.160	0.042	0.032	0.294	#13	0.073	Not Required	Pass
106	0.013	0.512	0.104	0.052	0.018	0.586	#13	0.044	Not Required	Pass
107	0.013	0.317	0.228	0.051	0.044	0.350	#13	0.073	Not Required	Pass
108	0.000	0.077	0.171	0.025	0.010	0.228	#21	Not Required	Not Required	Pass
109	0.010	0.032	0.067	0.002	0.002	0.098	#13	0.198	Not Required	Pass
110	0.012	0.510	0.221	0.051	0.037	0.584	#13	0.078	Not Required	Pass
111	0.000	0.077	0.171	0.025	0.010	0.228	#21	Not Required	Not Required	Pass
112	0.002	0.269	0.252	0.066	0.046	0.522	#13	0.034	Not Required	Pass
113	0.006	0.174	0.320	0.034	0.014	0.449	#21	0.177	Not Required	Pass
114	0.007	0.177	0.320	0.034	0.014	0.449	#21	0.265	Not Required	Pass
115	0.002	0.047	0.121	0.025	0.010	0.144	#21	0.329	Not Required	Pass
116	0.002	0.047	0.122	0.025	0.010	0.144	#21	0.321	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

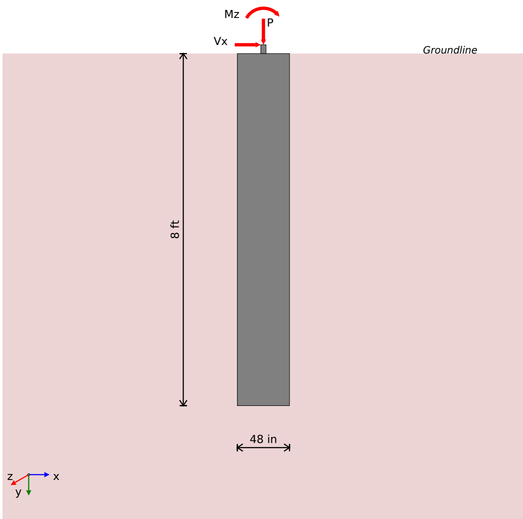
Input	Description	Value
f'_{ck}	Concrete compressive strength	2.5 ksi
f_{yk}	Yield strength of steel	60 ksi
d_b	Rebar diameter	#5 (0.625) in
cover	Concrete cover	3 in

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	3.876 kip	5.454 kip
Vx	2.164 kip	3.607 kip
Vz	0.099 kip	0.161 kip
Mx	0.346 kip-ft	0.561 kip-ft
Mz	25.4 kip-ft	42.79 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

$$H_o = \frac{V_x}{1.57 \times D} = \frac{2.164}{1.57 \times 48} = 0.345\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{25.4 + (2.164 \times 0)}{1.57 \times 48} = 4.045\ \frac{kip-ft}{ft}$$

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:

$$L_{e,x} = 7.863\ ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{0.099}{1.57 \times 48} = 0.016\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{1.57 \times b} = \frac{0.346 + (0.099 \times 0)}{1.57 \times 48} = 0.055\ \frac{kip-ft}{ft}$$

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:

$$L_{e,z} = 1.832\ ft$$

Minimum embedded depth

Depth of pile required

$$L_{e,req} = MAX[L_{e,x}, L_{e,z}] = MAX[7.863, 1.832] = 7.863\ ft$$

Actual embedded length

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

Utilisation

$$Ratio = \frac{L_{e,req}}{L_e} = \frac{7.863}{8} = 0.983$$

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:

$$q = \frac{P}{A} = \frac{3.876}{16} = 242.2\ psf$$

Utilisation

$$Ratio = \frac{q}{q_a} = \frac{242.2}{2000} = 0.121$$

UTILITY: 0.12

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:

$$(4 \times M_o \times L_e) + (3 \times H_o \times L_e^2)$$

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

$$a = \frac{(4 \times 4.045 \times 8) + \left(3 \times 0.345 \times 8^2\right)}{(6 \times 4.045) + (4 \times 0.345 \times 8)} = 5.542\ ft$$

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

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

$$p = \frac{0.75 \times [(4 \times 4.045) + (3 \times 0.345 \times 8)]^2}{8^2 \times [(3 \times 4.045) + (2 \times 0.345 \times 8)]} = 0.397\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{5.542}{2} = 0.416\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{0.397}{0.416} = 0.955$$

UTILITY: 0.96

Earth pressure against the pile at distance L_e:

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times 4.045) + (0.345 \times 8)]}{8^2} = 1.017\ \frac{kip}{ft^2}$$

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

$$Ratio = \frac{s}{p_s} = \frac{1.017}{1.2} = 0.847$$

UTILITY: 0.85

Considering z-direction:

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.055 \times 8) + \left(3 \times 0.016 \times 8^2\right)}{(6 \times 0.055) + (4 \times 0.016 \times 8)} = 5.736\ ft$$

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

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

$$p = \frac{0.75 \times [(4 \times 0.055) + (3 \times 0.016 \times 8)]^2}{8^2 \times [(3 \times 0.055) + (2 \times 0.016 \times 8)]} = 0.01\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{5.736}{2} = 0.43\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{0.01}{0.43} = 0.023$$

UTILITY: 0.02

Earth pressure against the pile at distance L_e:

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times 0.055) + (0.016 \times 8)]}{8^2} = 0.022\ \frac{kip}{ft^2}$$

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

$$Ratio = \frac{s}{p_s} = \frac{0.022}{1.2} = 0.018$$

UTILITY: 0.02

REFERENCES	CALCULATIONS	RESULTS

Shear force and bending moment (LRFD)

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{1.57 \times D} = \frac{3.607}{1.57 \times 48} = 0.574\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{42.79 + (3.607 \times 0)}{1.57 \times 48} = 6.814\ \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 6.814 \times 8) + \left(3 \times 0.574 \times 8^2\right)}{(6 \times 6.814) + (4 \times 0.574 \times 8)} = 5.54\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{6.814}{0.574} = 11.86\ ft$$

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

$$V_{max,x} = (0.574 \times 48) \times [1 - [3 \times \left(\frac{4 \times 11.86}{8} + 3\right) \times \left(\frac{5.54}{8}\right)^2] + [4 \times \left(\frac{3 \times 11.86}{8} + 2\right) \times \left(\frac{5.54}{8}\right)^3]]$$

$$V_{max,x} = 7.544\ kip$$

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

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

$$M_{max,x} = (0.574 \times 48 \times 8) \times [\left(\frac{11.86}{8} + \frac{5.54}{2 \times 8}\right) - [\left(\frac{4 \times 11.86}{8} + 3\right) \times \left(\frac{5.54}{2 \times 8}\right)^3] + [\left(\frac{3 \times 11.86}{8} + 2\right) \times \left(\frac{5.54}{2 \times 8}\right)^4]]$$

$$M_{max,x} = 28.51\ kip - ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{0.161}{1.57 \times 48} = 0.026\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{1.57 \times b} = \frac{0.561 + (0.161 \times 0)}{1.57 \times 48} = 0.089\ \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.089 \times 8) + \left(3 \times 0.026 \times 8^2\right)}{(6 \times 0.089) + (4 \times 0.026 \times 8)} = 5.737\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{0.089}{0.026} = 3.475\ ft$$

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

$$V_{max,z} = (0.026 \times 48) \times [1 - [3 \times \left(\frac{4 \times 3.475}{8} + 3\right) \times \left(\frac{5.737}{8}\right)^2] + [4 \times \left(\frac{3 \times 3.475}{8} + 2\right) \times \left(\frac{5.737}{8}\right)^3]]$$

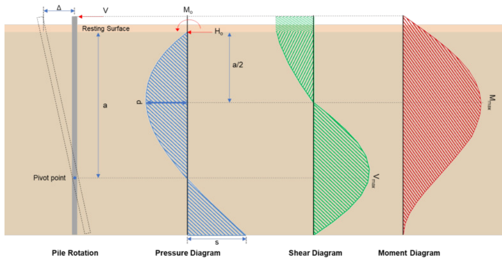
$$V_{max,z} = 0.148\, kip$$

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

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

$$M_{max,z} = (0.026 \times 48 \times 8) \times [\left(\frac{3.475}{8} + \frac{5.737}{2 \times 8}\right) - [\left(\frac{4 \times 3.475}{8} + 3\right) \times \left(\frac{5.737}{2 \times 8}\right)^3] + [\left(\frac{3 \times 3.475}{8} + 2\right) \times \left(\frac{5.737}{2 \times 8}\right)^4]]$$

$$M_{max,z} = 0.517\, kip - ft$$



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:

$$A_{st,req} = \frac{P - (0.85 \times f'_{ck} \times A_g)}{f_{yk} - (0.85 \times f'_{ck})} = \frac{5.454 - (0.85 \times 2.5 \times 2304)}{60 - (0.85 \times 2.5)} = -84.5\, in^2$$

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

SkyCiv

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

$$Ratio = \frac{P}{\phi P_N} = \frac{5.454}{2694} = 0.002$$

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	$V_{max,x} =$	7.544 kip
Maximum shear in the z-direction	$V_{max,z} =$	0.148 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:

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

$$V_{c,a} = \left(2 \times 1 \times \sqrt{2.5} + MIN[\frac{5.454}{6 \times 2304}, (0.05 \times 2.5)]\right) \times (48 \times 44.31) = 213.5\ kip$$

Governing shear strength of concrete:

$$V_c = MIN[V_{c,max}, V_{c,a}] = MIN[531.8, 213.5] = 213.5\ kip$$

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:

$$\phi V_n = \phi \times (V_c + V_s) = 0.75 \times (213.5 + 58.73) = 204.2\ kip$$

$$V_{max} = MAX[7.544, 0.148] = 7.544\ kip$$

Utilisation

$$Ratio = \frac{V_{max}}{\phi V_n} = \frac{7.544}{204.2} = 0.037$$

UTILITY: 0.04

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	$P =$	5.454 kip
Maximum moment in the x-direction	$M_{max,x} =$	28.51 kip-ft

Maximum moment in the z-direction	$M_{max,z} =$ 0.517 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:

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

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

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

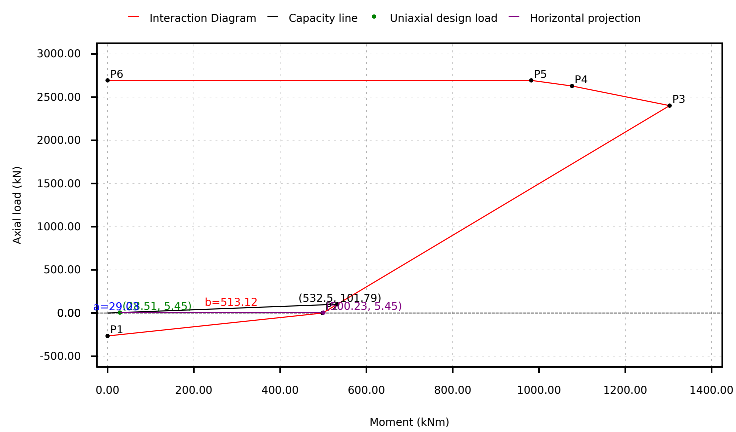
Interaction Diagram Summary

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

$$M_f = MAX[28.51, 0.517] = 28.51\ kip - ft$$

Interaction Diagram



Segment	Signed Distance
P1 - P2	225.5
P2 - P3	447.3
P3 - P4	2594
P4 - P5	2756
P5 - P6	2688
Status	PASS: Point lies inside the curve

Utilisation

$$Ratio = \frac{a}{a+b} = \frac{29.03}{29.03 + 513.1} = 0.054$$

UTILITY: 0.05

Biaxial Bending Check

Maximum moment in the x-direction	$M_{max,x} =$ 28.51 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$ 0.517 kip-ft
Nominal uniaxial moment strength about the x-axis	$M_{nox} =$ 500.2 kip-ft
Nominal uniaxial moment strength about the z-axis	$M_{noz} =$ 500.2 kip-ft
Interaction exponent	$\alpha =$ 1

Bresler (1960)	According to Bresler (method B): $$\left(\frac{M_{max,x}}{M_{nox}}\right)^{\alpha}+\left(\frac{M_{max,z}}{M_{noz}}\right)^{\alpha}=1.0$$ $$\left(\frac{28.51}{500.2}\right)^{1}+\left(\frac{0.517}{500.2}\right)^{1}=0.058$$	**UTILITY: 0.06**

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	0.98
End-bearing capacity	0.12
p_a	0.96
p_s	0.85
Axial compression strength	0.00
Shear strength	0.04
Uniaxial bending strength	0.05
Biaxial bending strength	0.06