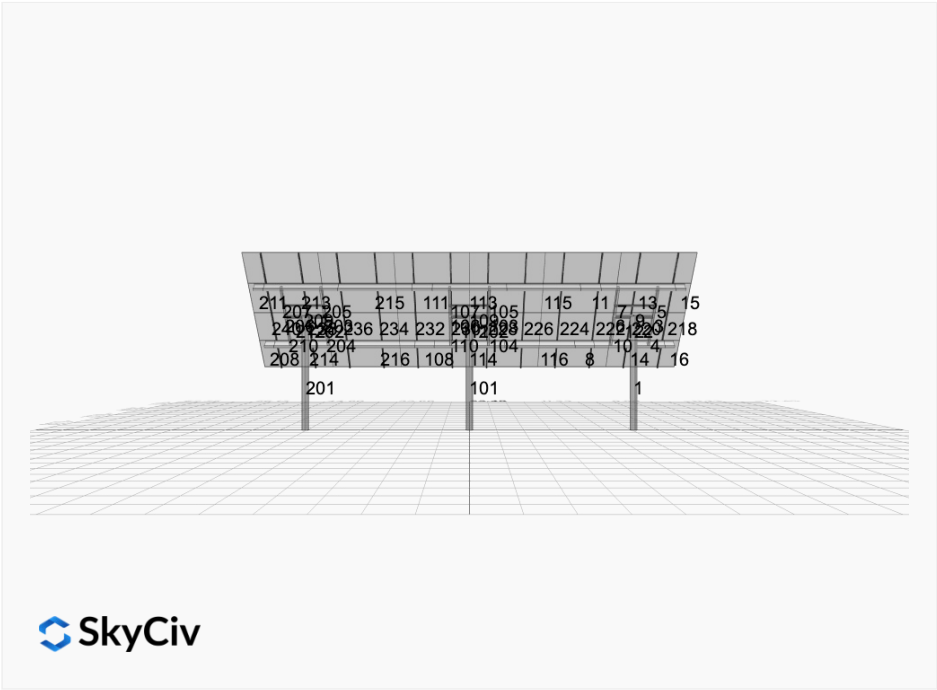
Project Details

Project Name: Cardamone-Sammon-V2 **Date:** Thu Nov 13 2025

Location: 3330 Fountain St, Clinton, NY 13323, USA **Number of Modules:** 24

Unique ID: 3P-17-8TOP-XD-12-L-4Hx6W-DKC0 **Number of Poles:** 3

Dealer: _____ **Date Sold:** _____



Array Dimensions N/S	15.03 ft
Array Dimensions E/W	44.90 ft
Winter Tilt Angle (Degrees)	50
Front Edge Clearance	6

MT Solar Bill of Materials (3P-17-8TOP-XD-12-L-4Hx6W-DKC0)

Part	Short Description	BOM Qty
MTS-PC-8	8IN Pole Cap Assembly	3
MTS-HF-XD	H-Frame Assembly-XD	3
MTS-XD-Wing-12	12IN XD Wing	4
MTS-XD-Splice-57	57IN XD Splice	8
MTS-CLAMP-HOOK-4PK	Hook Clamp	6

Rail Bill of Materials

Part	Qty
Rails (180in Long)	12x
Rail Attachment	24x
Module Mid Clamp	36x
Module End Clamp	24x
Ground Lug	6x

Site Details:

Site Address: 3330 Fountain St, Clinton, NY 13323, USA

Array Specifications

Duty Classification:	XD
Module Width:	44.60 in
Module Length:	88.80 in
Number of Rows:	4
Number of Columns:	6
Total Number of Modules:	24
Winter Tilt Angle:	50
Front Edge Clearance:	6
Total Array Height at Tilt:	17.52 ft
Total Frame Length:	43.50 ft
Module Info/Notes:	Longi Hi-Mo 5
Array Dimensions N/S:	15.03 ft
Array Dimensions E/W:	44.90 ft
Rail Length:	180.40 in
Rail Spacing:	3.74 ft

Support Specifications

Pole Size:	8in Pipe Sch 40
Pole Length above Grade:	11.76 ft
Number of Poles:	3
Pole Spacing:	17 ft

Foundation Specifications

Foundation Type:	rectangular
Foundation Dimensions:	48x48 in
Foundation Depth (below grade):	5.5 ft
Foundation Volume:	88.00 ft^3

Site Info

Risk Category:	I
Exposure:	C
Soil Classification:	sand
Site Location:	3330 Fountain St, Clinton, NY 13323, USA
Wind Speed:	80 mph

Snow Load:	60 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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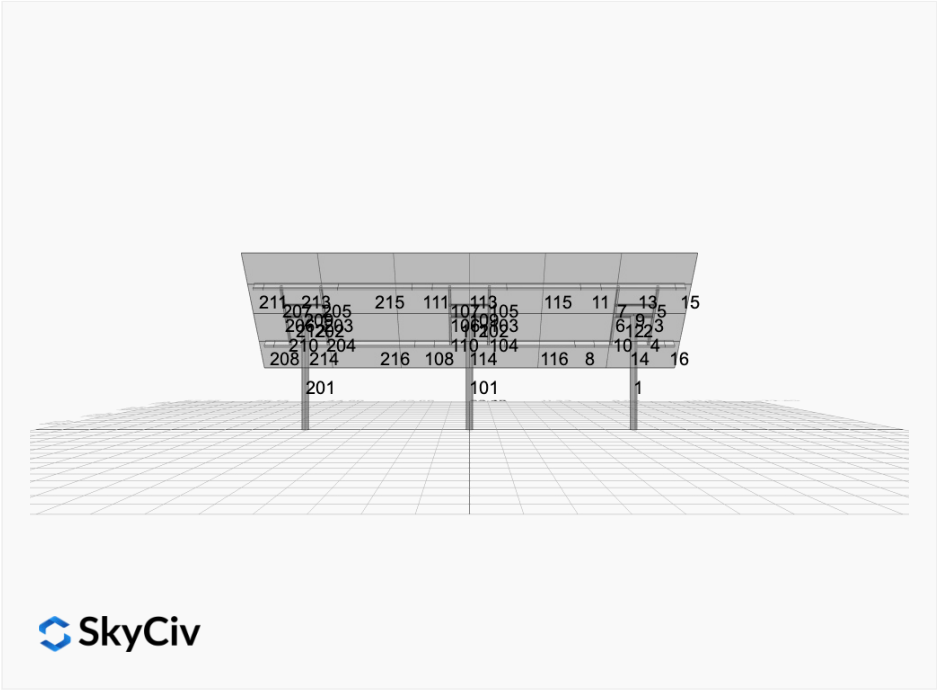
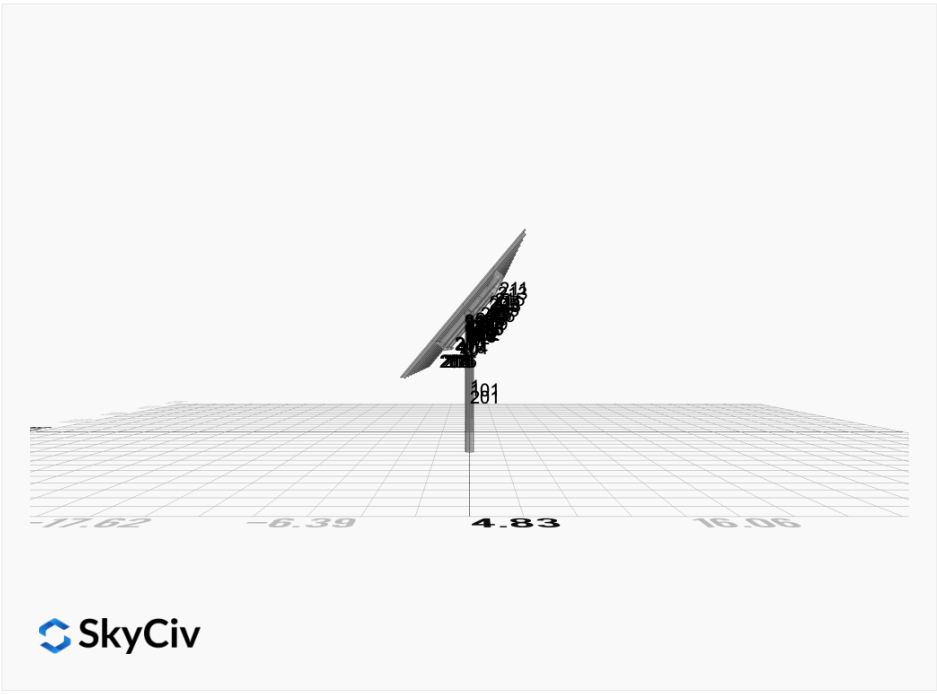
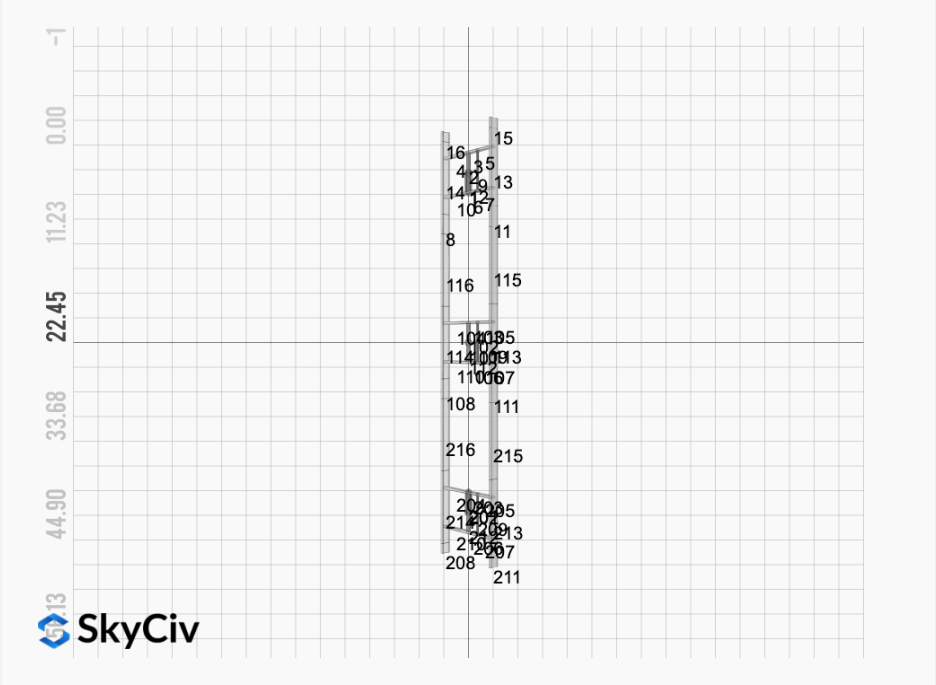
Design Notes:

- 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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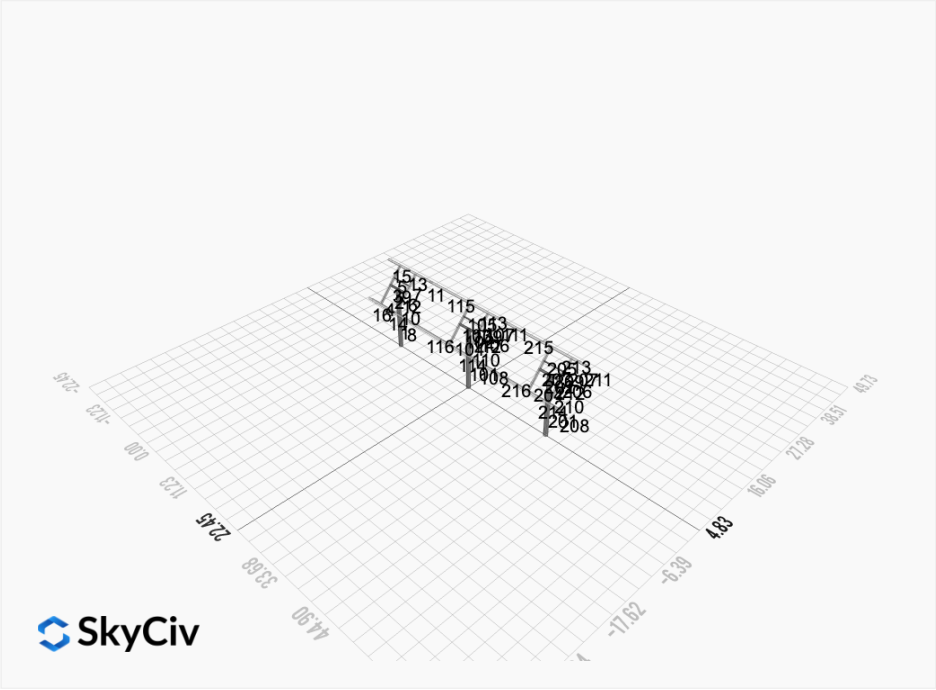
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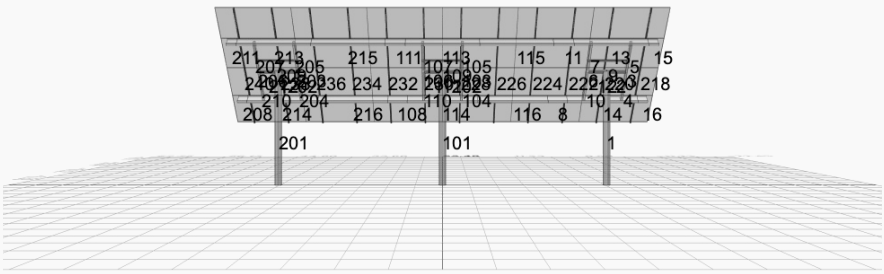
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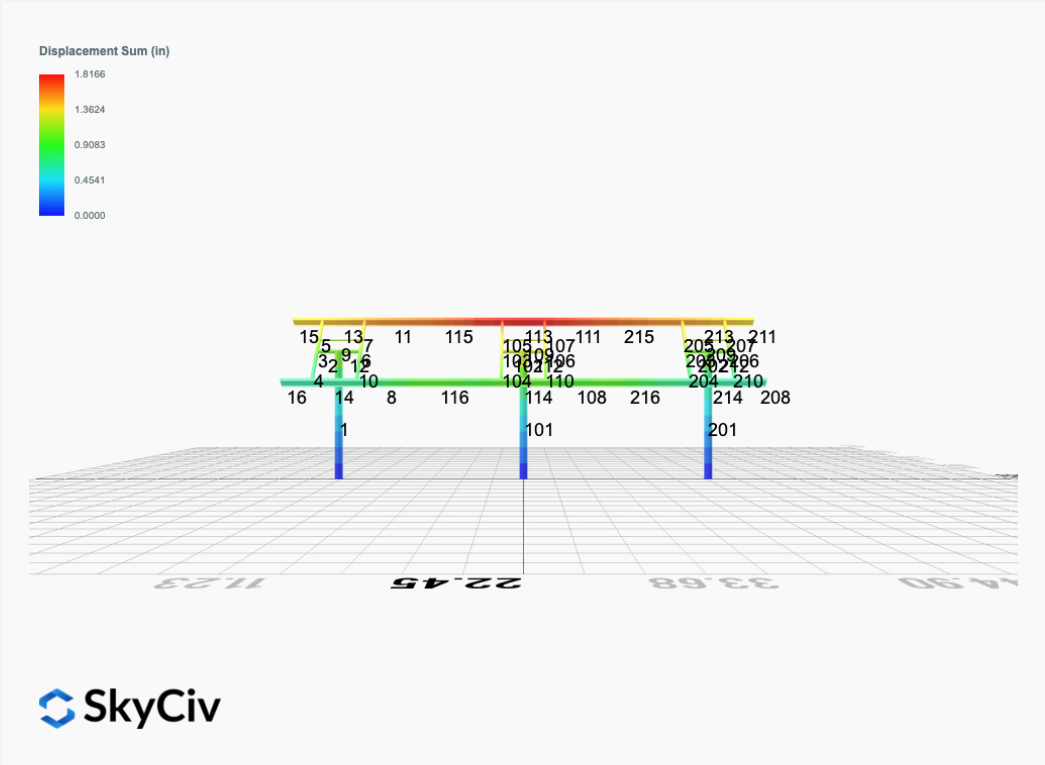
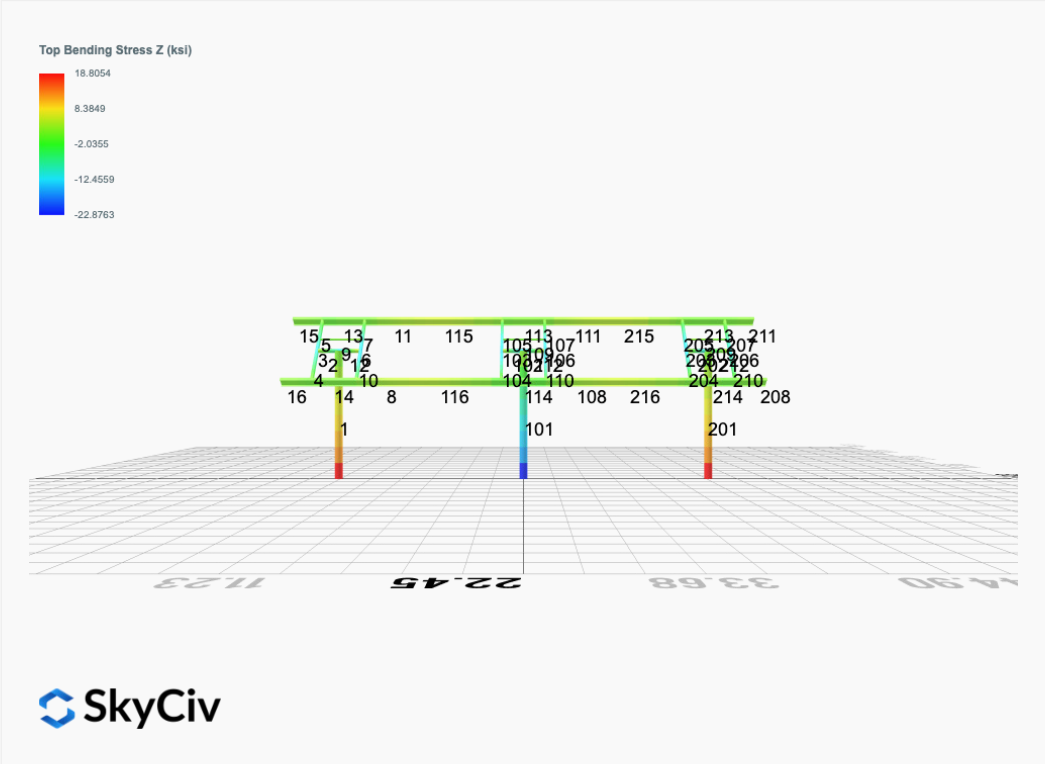
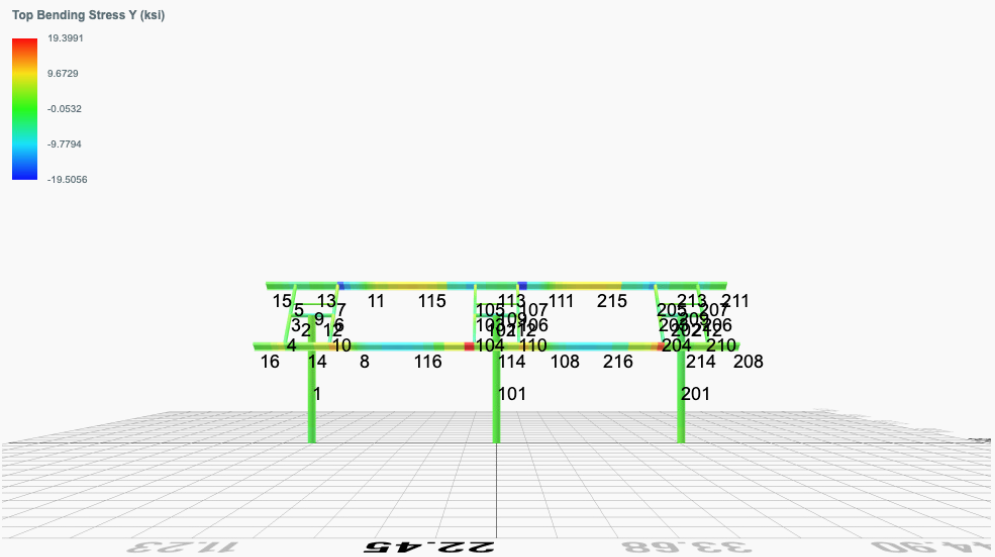
SkyCiv

FEM Results (Envelope Worst Case)







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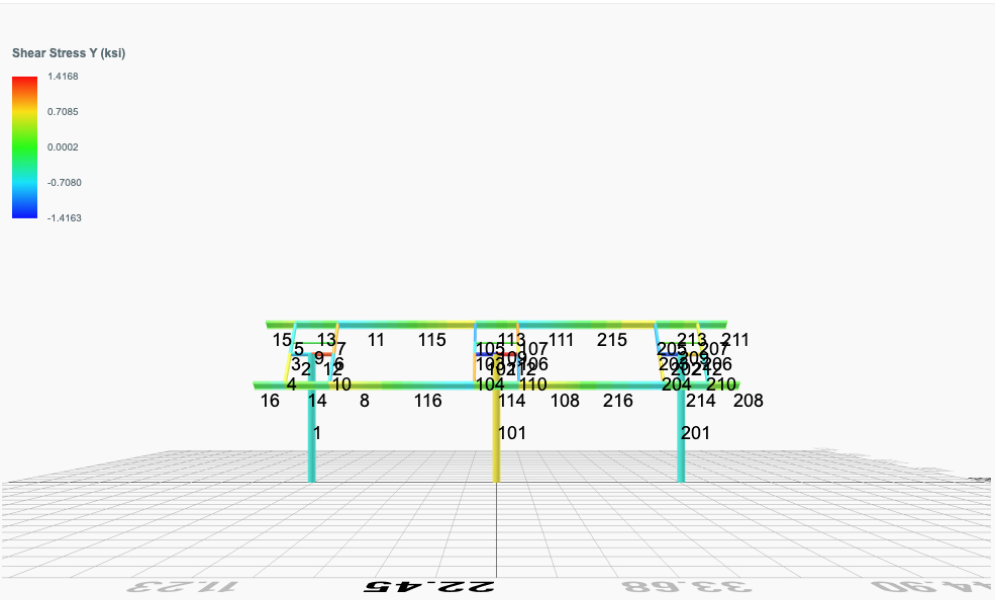

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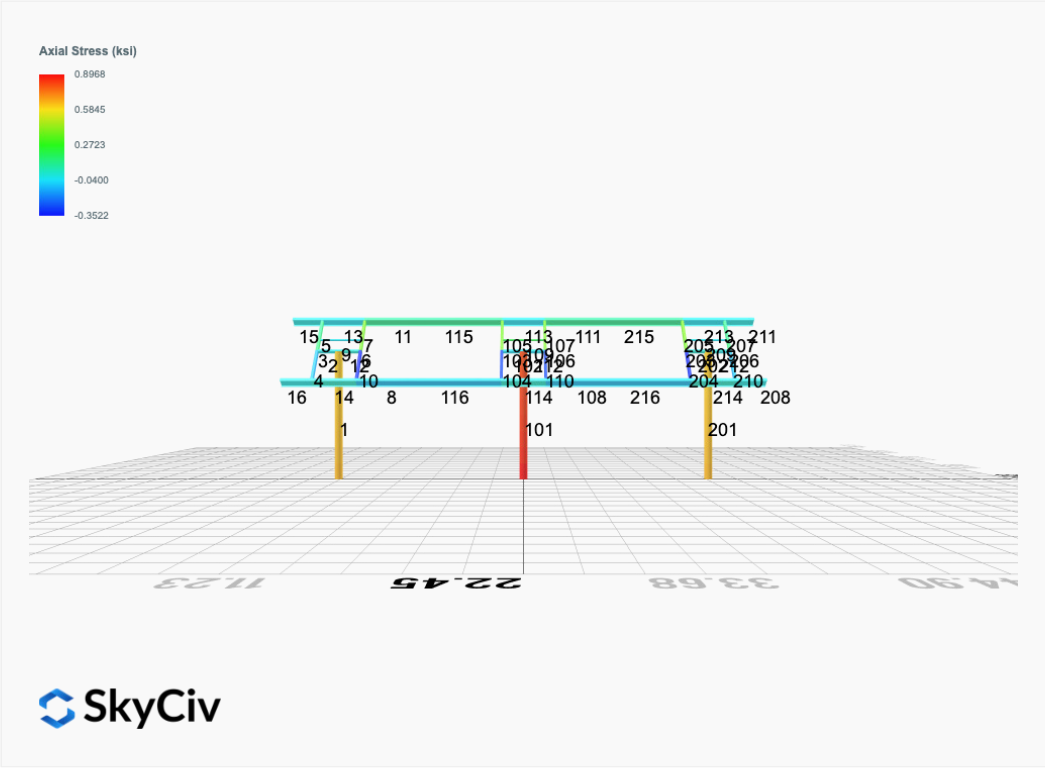
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-0.0400
-0.3522
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13
11
115
113
111
215
213
211
5
9
7
3
2
12
4
10
16
14
8
116
114
108
216
214
208
1
101
201
22.45

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	0.0234	2.5745	0.0725	0.2622	-0.0776	-0.1992
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0318	3.0654	0.0984	0.3561	-0.1056	-0.2834
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0201	2.2067	0.0621	0.2247	-0.0665	-0.1712
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0573	4.9545	0.1784	0.6465	-0.1923	-0.5235
ULS: 5. 1.2D + E + L + 0.2S	0.0248	2.5502	0.0766	0.2772	-0.0821	-0.2163
ULS: 7. 0.9D + 1.0E	0.0151	1.6550	0.0466	0.1684	-0.0498	-0.1290
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-2.1501	4.8490	0.2501	0.8786	-0.8203	26.1126
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0318	3.0654	0.0984	0.3561	-0.1056	-0.2834
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.2112	1.2834	-0.0520	-0.1612	0.6029	-26.3417
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0318	3.0654	0.0984	0.3561	-0.1056	-0.2834
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-2.1610	3.9899	0.2136	0.7461	-0.7799	26.1374
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0201	2.2067	0.0621	0.2247	-0.0665	-0.1712
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.1988	0.4251	-0.0880	-0.2915	0.6408	-26.1449
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0201	2.2067	0.0621	0.2247	-0.0665	-0.1712
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.0341	5.8466	0.2544	0.9084	-0.5502	12.7284
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0573	4.9545	0.1784	0.6465	-0.1923	-0.5235
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.1481	4.0629	0.1027	0.3860	0.1642	-13.6896
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0573	4.9545	0.1784	0.6465	-0.1923	-0.5235
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.0702	3.0981	0.1377	0.4847	-0.4224	12.9407
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0201	2.2067	0.0621	0.2247	-0.0665	-0.1712
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.1098	1.3157	-0.0131	-0.0341	0.2879	-13.1995
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0201	2.2067	0.0621	0.2247	-0.0665	-0.1712
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-2.1657	3.4381	0.1979	0.6892	-0.7625	26.1260
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	0.0151	1.6550	0.0466	0.1684	-0.0498	-0.1290
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	2.1934	-0.1264	-0.1034	-0.3473	0.6568	-26.0506
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	0.0151	1.6550	0.0466	0.1684	-0.0498	-0.1290

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0168	1.8389	0.0517	0.1871	-0.0554	-0.1431
ULS: 2. D + L	0.0168	1.8389	0.0517	0.1871	-0.0554	-0.1431
ULS: 3. D + (S or Lr or R)	0.0401	3.5563	0.1243	0.4501	-0.1337	-0.3667
ULS: 3. D + (S or Lr or R)	0.0168	1.8389	0.0517	0.1871	-0.0554	-0.1431
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0343	3.1269	0.1061	0.3842	-0.1141	-0.3115
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0168	1.8389	0.0517	0.1871	-0.0554	-0.1431
ULS: 5b. D + 0.7E	0.0168	1.8389	0.0517	0.1871	-0.0554	-0.1431
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0343	3.1269	0.1061	0.3842	-0.1141	-0.3115
ULS: 8. 0.6D + 0.7E	0.0101	1.1034	0.0310	0.1122	-0.0332	-0.0864
ULS: 5a. D + 0.6W_Wind downforce Case A only	-1.2915	2.9086	0.1424	0.4991	-0.4824	15.5800
ULS: 5a. D + 0.6W_Wind downforce Case B only	0.0168	1.8389	0.0517	0.1871	-0.0554	-0.1431
ULS: 5a. D + 0.6W_Wind uplift Case A only	1.3241	0.7699	-0.0384	-0.1230	0.3695	-15.7461
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.0168	1.8389	0.0517	0.1871	-0.0554	-0.1431
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-0.9473	3.9294	0.1743	0.6188	-0.4350	11.5279
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0343	3.1269	0.1061	0.3842	-0.1141	-0.3115
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.0154	2.3248	0.0383	0.1507	0.2056	-12.0825
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0343	3.1269	0.1061	0.3842	-0.1141	-0.3115

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	-0.9643	2.6411	0.1197	0.4210	-0.3754	11.6379
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0168	1.8389	0.0517	0.1871	-0.0554	-0.1431
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	0.9974	1.0371	-0.0159	-0.0456	0.2635	-11.8565
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0168	1.8389	0.0517	0.1871	-0.0554	-0.1431
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-1.2979	2.1728	0.1216	0.4237	-0.4597	15.5943
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	0.0101	1.1034	0.0310	0.1122	-0.0332	-0.0864
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	1.3172	0.0344	-0.0590	-0.1975	0.3911	-15.6476
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.0101	1.1034	0.0310	0.1122	-0.0332	-0.0864

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	5.8466
Shear X	-2.2112
Shear Z	0.2544
Moment X	0.9084
Moment Y (Twist)	0.8203
Moment Z	26.3417

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	3.9294
Shear X	-1.3241
Shear Z	0.1743
Moment X	0.6188
Moment Y (Twist)	0.4824
Moment Z	15.7461

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	-0.0469	3.1503	0.0001	0.0000	-0.0003	0.5000
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0636	3.8456	0.0001	0.0000	-0.0004	0.6667
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0402	2.7003	0.0001	0.0000	-0.0003	0.4278
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	-0.1146	6.3652	0.0002	0.0000	-0.0007	1.2019
ULS: 5. 1.2D + E + L + 0.2S	-0.0496	3.1584	0.0001	0.0000	-0.0003	0.5230
ULS: 7. 0.9D + 1.0E	-0.0302	2.0252	0.0000	0.0000	-0.0002	0.3199
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-2.7334	6.1803	0.0003	0.0008	-0.0017	32.0442
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.0636	3.8456	0.0001	0.0000	-0.0004	0.6667
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.6113	1.5078	-0.0001	-0.0007	0.0009	-30.3206
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0636	3.8456	0.0001	0.0000	-0.0004	0.6667
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-2.7115	5.0357	0.0003	0.0008	-0.0016	31.7031
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.0402	2.7003	0.0001	0.0000	-0.0003	0.4278
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.6361	0.3616	-0.0002	-0.0007	0.0010	-30.4602
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0402	2.7003	0.0001	0.0000	-0.0003	0.4278
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.4485	7.5320	0.0003	0.0004	-0.0014	16.9545
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.1146	6.3652	0.0002	0.0000	-0.0007	1.2019
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.2207	5.1976	0.0000	-0.0004	-0.0001	-14.4514
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.1146	6.3652	0.0002	0.0000	-0.0007	1.2019
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.3765	3.8684	0.0002	0.0004	-0.0009	16.0165
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.0402	2.7003	0.0001	0.0000	-0.0003	0.4278
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.2973	1.5313	-0.0001	-0.0004	0.0004	-15.0641
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.0402	2.7003	0.0001	0.0000	-0.0003	0.4278
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-2.7022	4.3611	0.0003	0.0008	-0.0015	31.5343
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-0.0302	2.0252	0.0000	0.0000	-0.0002	0.3199
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	2.6468	-0.3138	-0.0002	-0.0007	0.0011	-30.5089
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	-0.0302	2.0252	0.0000	0.0000	-0.0002	0.3199

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0335	2.2502	0.0000	0.0000	-0.0002	0.3558
ULS: 2. D + L	-0.0335	2.2502	0.0000	0.0000	-0.0002	0.3558
ULS: 3. D + (S or Lr or R)	-0.0802	4.5410	0.0001	0.0000	-0.0005	0.8346
ULS: 3. D + (S or Lr or R)	-0.0335	2.2502	0.0000	0.0000	-0.0002	0.3558
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0686	3.9683	0.0001	0.0000	-0.0004	0.7139
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0335	2.2502	0.0000	0.0000	-0.0002	0.3558
ULS: 5b. D + 0.7E	-0.0335	2.2502	0.0000	0.0000	-0.0002	0.3558
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0686	3.9683	0.0001	0.0000	-0.0004	0.7139
ULS: 8. 0.6D + 0.7E	-0.0202	1.3502	0.0000	0.0000	-0.0001	0.2127
ULS: 5a. D + 0.6W_Wind downforce Case A only	-1.6372	3.6521	0.0002	0.0005	-0.0010	19.0497
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.0335	2.2502	0.0000	0.0000	-0.0002	0.3558
ULS: 5a. D + 0.6W_Wind uplift Case A only	1.5719	0.8473	-0.0001	-0.0004	0.0006	-18.1991
ULS: 5a. D + 0.6W_Wind uplift Case B only	-0.0335	2.2502	0.0000	0.0000	-0.0002	0.3558
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.2705	5.0192	0.0002	0.0004	-0.0010	14.7896
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0686	3.9683	0.0001	0.0000	-0.0004	0.7139
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.1344	2.9167	-0.0000	-0.0003	0.0001	-13.2827
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0686	3.9683	0.0001	0.0000	-0.0004	0.7139
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.2365	3.3017	0.0001	0.0003	-0.0008	14.3631
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0335	2.2502	0.0000	0.0000	-0.0002	0.3558
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.1704	1.1981	-0.0001	-0.0003	0.0004	-13.5733
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0335	2.2502	0.0000	0.0000	-0.0002	0.3558
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-1.6244	2.7523	0.0002	0.0005	-0.0009	18.8584
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.0202	1.3502	0.0000	0.0000	-0.0001	0.2127
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	1.5858	-0.0531	-0.0001	-0.0004	0.0006	-18.2948
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	-0.0202	1.3502	0.0000	0.0000	-0.0001	0.2127

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	7.5320
Shear X	-2.7334
Shear Z	0.0003
Moment X	0.0008
Moment Y (Twist)	0.0017
Moment Z	32.0442

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	5.0192
Shear X	-1.6372
Shear Z	0.0002
Moment X	0.0005
Moment Y (Twist)	0.0010
Moment Z	19.0497

Reaction Forces for Foundation 3 (Node ID#201), (kip, kip-ft)

LRFD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. 1.4D	0.0234	2.5745	-0.0726	-0.2629	0.0782	-0.1990
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0318	3.0653	-0.0985	-0.3569	0.1065	-0.2831
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0201	2.2067	-0.0622	-0.2252	0.0670	-0.1711
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0573	4.9545	-0.1785	-0.6481	0.1938	-0.5230
ULS: 5. 1.2D + E + L + 0.2S	0.0248	2.5502	-0.0767	-0.2779	0.0828	-0.2161
ULS: 7. 0.9D + 1.0E	0.0151	1.6550	-0.0466	-0.1688	0.0502	-0.1289
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-2.1501	4.8490	-0.2504	-0.8802	0.8219	26.1133

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0318	3.0653	-0.0985	-0.3569	0.1065	-0.2831
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.2111	1.2833	0.0521	0.1611	-0.6028	-26.3418
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0318	3.0653	-0.0985	-0.3569	0.1065	-0.2831
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-2.1610	3.9899	-0.2138	-0.7474	0.7812	26.1380
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0201	2.2067	-0.0622	-0.2252	0.0670	-0.1711
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.1987	0.4251	0.0881	0.2917	-0.6410	-26.1450
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0201	2.2067	-0.0622	-0.2252	0.0670	-0.1711
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.0341	5.8465	-0.2547	-0.9103	0.5522	12.7291
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0573	4.9545	-0.1785	-0.6481	0.1938	-0.5230
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.1480	4.0628	-0.1028	-0.3872	-0.1630	-13.6892
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0573	4.9545	-0.1785	-0.6481	0.1938	-0.5230
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.0702	3.0981	-0.1378	-0.4856	0.4233	12.9411
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0201	2.2067	-0.0622	-0.2252	0.0670	-0.1711
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.1097	1.3157	0.0131	0.0339	-0.2878	-13.1994
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0201	2.2067	-0.0622	-0.2252	0.0670	-0.1711
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-2.1657	3.4380	-0.1981	-0.6904	0.7637	26.1264
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	0.0151	1.6550	-0.0466	-0.1688	0.0502	-0.1289
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	2.1934	-0.1264	0.1035	0.3476	-0.6572	-26.0507
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	0.0151	1.6550	-0.0466	-0.1688	0.0502	-0.1289

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0168	1.8389	-0.0518	-0.1876	0.0558	-0.1430
ULS: 2. D + L	0.0168	1.8389	-0.0518	-0.1876	0.0558	-0.1430
ULS: 3. D + (S or Lr or R)	0.0401	3.5562	-0.1244	-0.4512	0.1348	-0.3663
ULS: 3. D + (S or Lr or R)	0.0168	1.8389	-0.0518	-0.1876	0.0558	-0.1430
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0343	3.1269	-0.1062	-0.3851	0.1150	-0.3112
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0168	1.8389	-0.0518	-0.1876	0.0558	-0.1430
ULS: 5b. D + 0.7E	0.0168	1.8389	-0.0518	-0.1876	0.0558	-0.1430
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0343	3.1269	-0.1062	-0.3851	0.1150	-0.3112
ULS: 8. 0.6D + 0.7E	0.0101	1.1033	-0.0311	-0.1125	0.0334	-0.0863
ULS: 5a. D + 0.6W_Wind downforce Case A only	-1.2915	2.9086	-0.1426	-0.5000	0.4833	15.5803
ULS: 5a. D + 0.6W_Wind downforce Case B only	0.0168	1.8389	-0.0518	-0.1876	0.0558	-0.1430
ULS: 5a. D + 0.6W_Wind uplift Case A only	1.3241	0.7698	0.0385	0.1230	-0.3695	-15.7461
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.0168	1.8389	-0.0518	-0.1876	0.0558	-0.1430
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-0.9473	3.9293	-0.1745	-0.6200	0.4363	11.5283
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0343	3.1269	-0.1062	-0.3851	0.1150	-0.3112
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.0153	2.3247	-0.0383	-0.1513	-0.2050	-12.0823
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0343	3.1269	-0.1062	-0.3851	0.1150	-0.3112
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-0.9643	2.6411	-0.1198	-0.4217	0.3762	11.6381
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0168	1.8389	-0.0518	-0.1876	0.0558	-0.1430
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	0.9974	1.0370	0.0160	0.0455	-0.2634	-11.8565
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0168	1.8389	-0.0518	-0.1876	0.0558	-0.1430
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-1.2979	2.1728	-0.1217	-0.4244	0.4604	15.5944
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	0.0101	1.1033	-0.0311	-0.1125	0.0334	-0.0863
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	1.3171	0.0344	0.0591	0.1977	-0.3914	-15.6476
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.0101	1.1033	-0.0311	-0.1125	0.0334	-0.0863

Worst Case Reactions (LRFD)

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	5.8465
Shear X	-2.2111
Shear Z	-0.2547
Moment X	-0.9103
Moment Y (Twist)	0.8219
Moment Z	26.3418

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

Result	Value (kip, kip-ft)
Axial	3.9293
Shear X	-1.3241
Shear Z	-0.1745
Moment X	-0.6200
Moment Y (Twist)	0.4833
Moment Z	15.7461

Project Details

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

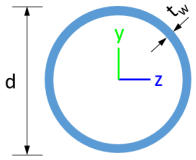
User Name: sales@mtsolar.us
Unit System: imperial

Design Input Information

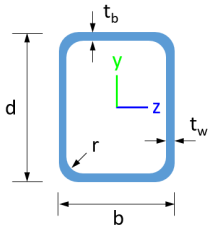
Design Factors			
Φ_t	Φ_c	Φ_b	Φ_v
0.9	0.9	0.9	0.9

Design Materials			
ID	E (ksi)	F_y (ksi)	F_u (ksi)
1	29000	50	65
2	29000	46	62
4	29000	50	62

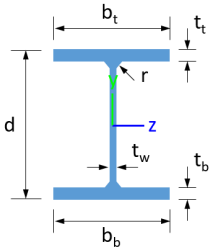
Section Dimensions



ID	Name	d (in)	t_w (in)					
3	2in Pipe Sch 120	2.38	0.25					
6	4in Pipe Sch 120	4.50	0.44					
9	8in Pipe Sch 40	8.63	0.32					



ID	Name	d (in)	b (in)	t_w (in)	t_b (in)	r (in)		
17	HSS5x3x1/4	5.00	3.00	0.23	0.23	0.23		



ID	Name	d (in)	t_w (in)	b_t (in)	b_b (in)	t_t (in)	t_b (in)	r (in)
20	W10x12	9.87	0.19	3.96	3.96	0.21	0.21	0.30

Section Properties

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)
3	2in Pipe Sch 120	1.67	1.91	0.96	0.96	0.00	1.13	1.13
6	4in Pipe Sch 120	5.58	23.29	11.64	11.64	0.00	7.24	7.24
9	8in Pipe Sch 40	8.40	144.98	72.49	72.49	0.00	22.21	22.21
17	HSS5x3x1/4	3.37	11.00	4.81	10.70	0.93	3.77	5.38
20	W10x12	3.54	0.05	2.18	53.80	50.90	1.74	12.60

Member Properties								
Member ID	Section ID	K_z L (ft)	K_y L (ft)	L_b (ft)	C_b	LST	LSC	LD
1	9	7.64	7.64	11.76	-	300	200	250
2	6	1.30	1.30	2.00	-	300	200	250
3	17	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.15,1.18,1.18,1.19,1.16,1.19,1.18,1.18,1.19,1.18,1.18,1.19,1.12,1.19,1.17,1.19,1.16,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.15,1.19,1.18,1.18,1.22,1.18,1.18,1.19,1.13,1.19,1.18,1.19,1.16,1.19	300	200	250
4	17	2.44	2.44	3.75	1.70,1.69,1.70,1.68,1.70,1.70,1.68,1.69,1.64,1.69,1.68,1.70,1.65,1.70,1.68,1.68,1.69,1.68,1.68,1.70,1.57,1.70,1.67,1.70,1.65,1.70,1.70,1.70,1.68,1.70,1.69,1.70,1.70,1.69,1.70,1.68,1.70,1.63,1.70,1.68,1.69,1.74,1.69,1.68,1.70,1.59,1.70,1.68,1.70,1.65,1.70	300	200	250
5	17	1.52	1.52	2.33	1.69,1.68,1.69,1.67,1.69,1.69,1.67,1.68,1.65,1.68,1.67,1.69,1.65,1.69,1.67,1.67,1.68,1.67,1.68,1.69,1.61,1.69,1.67,1.69,1.66,1.69,1.69,1.69,1.68,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.69,1.64,1.69,1.67,1.68,1.72,1.68,1.68,1.69,1.62,1.69,1.67,1.69,1.66,1.69	300	200	250
6	17	0.92	0.92	1.42	1.19,1.19,1.20,1.19,1.19,1.20,1.19,1.19,1.17,1.19,1.19,1.20,1.18,1.20,1.19,1.19,1.19,1.19,1.19,1.20,1.16,1.20,1.19,1.20,1.18,1.20,1.20,1.20,1.19,1.20,1.19,1.20,1.20,1.19,1.20,1.19,1.20,1.17,1.20,1.19,1.19,1.21,1.19,1.19,1.20,1.16,1.20,1.19,1.20,1.18,1.20	300	200	250
7	17	1.52	1.52	2.33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.68,1.67,1.67,1.68,1.63,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.65,1.68,1.67,1.67,1.72,1.67,1.67,1.68,1.64,1.68,1.67,1.68,1.66,1.68	300	200	250
8	20	1.33	1.33	2.05	1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.19,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.19,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.20,1.19,1.20,1.20,1.20,1.21,1.20,1.20,1.20,1.19,1.20,1.20,1.20,1.20,1.20	300	200	250
9	3	2.60	2.60	4.00	-	300	200	250
10	17	2.44	2.44	3.75	1.70,1.69,1.70,1.68,1.69,1.70,1.67,1.69,1.65,1.69,1.67,1.70,1.65,1.70,1.67,1.68,1.69,1.68,1.68,1.70,1.60,1.70,1.67,1.70,1.66,1.70,1.70,1.70,1.68,1.70,1.68,1.70,1.70,1.68,1.70,1.68,1.70,1.64,1.70,1.68,1.68,1.73,1.68,1.68,1.70,1.62,1.70,1.67,1.70,1.66,1.70	300	200	250
11	20	1.33	1.33	2.05	1.22,1.22,1.22,1.22,1.22,1.22,1.24,1.22,1.27,1.22,1.24,1.22,1.26,1.22,1.23,1.22,1.19,1.22,1.24,1.22,1.28,1.22,1.24,1.22,1.25,1.22,1.22,1.22,1.22,1.22,1.22,1.22,1.22,1.22,1.22,1.24,1.22,1.26,1.22,1.23,1.22,1.06,1.22,1.24,1.22,1.28,1.22,1.24,1.22,1.25,1.22	300	200	250
12	6	1.30	1.30	2.00	-	300	200	250
13	20	4.88	4.00	7.50	1.44,1.45,1.44,1.47,1.44,1.44,1.44,1.45,1.43,1.45,1.43,1.44,1.44,1.44,1.46,1.47,1.50,1.47,1.44,1.44,1.45,1.44,1.43,1.44,1.44,1.44,1.44,1.44,1.46,1.44,1.46,1.44,1.44,1.46,1.44,1.44,1.44,1.44,1.44,1.45,1.46,1.57,1.46,1.44,1.44,1.45,1.44,1.44,1.44,1.44,1.44	300	200	250
14	20	4.88	4.00	7.50	1.53,1.55,1.53,1.57,1.54,1.53,1.70,1.55,2.07,1.55,1.72,1.53,1.92,1.53,1.65,1.57,1.39,1.57,1.68,1.53,2.43,1.53,1.73,1.53,1.87,1.53,1.53,1.53,1.57,1.53,1.56,1.53,1.53,1.56,1.53,1.70,1.53,2.04,1.53,1.66,1.56,1.34,1.56,1.68,1.53,2.29,1.53,1.72,1.53,1.89,1.53	300	200	250
15	20	2.10	2.10	1.00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
16	20	2.10	2.10	1.00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
101	9	7.64	7.64	11.76	-	300	200	250
102	6	1.30	1.30	2.00	-	300	200	250
103	17	0.92	0.92	1.42	1.19,1.19,1.19,1.18,1.19,1.19,1.18,1.19,1.17,1.19,1.18,1.19,1.17,1.19,1.18,1.18,1.19,1.18,1.18,1.19,1.13,1.19,1.18,1.19,1.17,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.16,1.19,1.18,1.18,1.20,1.18,1.18,1.19,1.15,1.19,1.18,1.19,1.17,1.19	300	200	250
104	17	2.4	2.4	3.	1.69,1.68,1.69,1.67,1.68,1.69,1.67,1.68,1.65,1.68,1.67,1.69,1.65,1.69,1.67,1.67,1.68,1.67,1.68,1.69,1.60,1.69,1.67,1.69,1.66,1.69,1.69,1.69,1.68,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.69,1.64,1.69,1.67,1.68,1.71,1.68,1.68,1.69,1.62,1.69,1.67,1.6	30	20	25

104	17	4 4	4 4	75	66,1.69,1.69,1.69,1.68,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.69,1.64,1.69,1.67,1.68,1.71,1.68,1.68,1.69,1.62,1.69,1.67,1.6 9,1.66,1.69	0 0	0 0	5 0
105	17	1. 5 2	1. 5 2	2. 33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.65,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.67,1.67,1.67,1.68,1.62,1.68,1.67,1.68,1. 66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.65,1.68,1.67,1.67,1.69,1.67,1.67,1.68,1.63,1.68,1.67,1.6 8,1.66,1.68	3 0 0	2 0 0	2 5 0
106	17	0. 9 2	0. 9 2	1. 42	1.19,1.19,1.19,1.18,1.19,1.19,1.18,1.19,1.17,1.19,1.18,1.19,1.17,1.19,1.18,1.18,1.19,1.18,1.18,1.19,1.13,1.19,1.18,1.19,1. 17,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.16,1.19,1.18,1.18,1.20,1.18,1.18,1.19,1.15,1.19,1.18,1.1 9,1.17,1.19	3 0 0	2 0 0	2 5 0
107	17	1. 5 2	1. 5 2	2. 33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.65,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.67,1.67,1.67,1.68,1.62,1.68,1.67,1.68,1. 66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.65,1.68,1.67,1.67,1.69,1.67,1.67,1.68,1.63,1.68,1.67,1.6 8,1.66,1.68	3 0 0	2 0 0	2 5 0
108	20	1. 3 3	1. 3 3	2. 05	1.43,1.43,1.43,1.43,1.43,1.43,1.33,1.43,1.20,1.43,1.32,1.43,1.24,1.43,1.37,1.43,1.79,1.43,1.33,1.43,1.15,1.43,1.31,1.43,1. 26,1.43,1.43,1.43,1.43,1.43,1.43,1.43,1.43,1.43,1.43,1.32,1.43,1.22,1.43,1.36,1.43,2.07,1.43,1.33,1.43,1.17,1.43,1.31,1.4 3,1.25,1.43	3 0 0	2 0 0	2 5 0
109	3	2. 6 0	2. 6 0	4. 00	-	3 0 0	2 0 0	2 5 0
110	17	2. 4 4	2. 4 4	3. 75	1.69,1.68,1.69,1.67,1.68,1.69,1.67,1.68,1.65,1.68,1.67,1.69,1.65,1.69,1.67,1.67,1.68,1.67,1.68,1.69,1.60,1.69,1.67,1.69,1. 66,1.69,1.69,1.69,1.68,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.69,1.64,1.69,1.67,1.68,1.71,1.68,1.68,1.69,1.62,1.69,1.67,1.6 9,1.66,1.69	3 0 0	2 0 0	2 5 0
111	20	1. 3 3	1. 3 3	2. 05	1.31,1.31,1.31,1.31,1.31,1.31,1.18,1.31,1.06,1.31,1.17,1.31,1.10,1.31,1.23,1.31,2.07,1.31,1.19,1.31,1.03,1.31,1.16,1.31,1. 11,1.31,1.31,1.31,1.31,1.31,1.31,1.31,1.31,1.31,1.31,1.18,1.31,1.08,1.31,1.21,1.31,1.37,1.31,1.19,1.31,1.04,1.31,1.17,1.3 1,1.11,1.31	3 0 0	2 0 0	2 5 0
112	6	1. 3 0	1. 3 0	2. 00	-	3 0 0	2 0 0	2 5 0
113	20	4. 8 8	4. 0 0	7. 50	1.09,1.10,1.09,1.10,1.10,1.09,2.99,1.10,1.51,1.10,3.54,1.09,1.97,1.09,1.42,1.10,1.04,1.10,2.50,1.09,1.26,1.09,3.67,1.09,2. 24,1.09,1.09,1.09,1.10,1.09,1.10,1.09,1.09,1.10,1.09,3.11,1.09,1.64,1.09,1.74,1.10,1.02,1.10,2.60,1.09,1.34,1.09,3.60,1.0 9,2.14,1.09	3 0 0	2 0 0	2 5 0
114	20	4. 8 8	4. 0 0	7. 50	1.07,1.07,1.07,1.07,1.07,1.07,1.09,1.07,2.57,1.07,1.09,1.07,1.30,1.07,1.08,1.07,1.05,1.07,1.09,1.07,2.95,1.07,1.10,1.07,1. 13,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.09,1.07,1.93,1.07,1.08,1.07,1.03,1.07,1.09,1.07,3.81,1.07,1.10,1.0 7,1.15,1.07	3 0 0	2 0 0	2 5 0
115	20	7. 4 5	7. 4 5	7. 45	1.10,1.10,1.10,1.10,1.10,1.10,1.06,1.10,1.03,1.10,1.05,1.10,1.04,1.10,1.07,1.10,1.25,1.10,1.06,1.10,1.04,1.10,1.05,1.10,1. 04,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.06,1.10,1.03,1.10,1.07,1.10,2.77,1.10,1.06,1.10,1.04,1.10,1.05,1.1 0,1.04,1.10	3 0 0	2 0 0	2 5 0
116	20	7. 4 5	7. 4 5	7. 45	1.13,1.13,1.13,1.13,1.13,1.13,1.10,1.13,1.07,1.13,1.10,1.13,1.08,1.13,1.11,1.13,1.19,1.13,1.10,1.13,1.05,1.13,1.10,1.13,1. 08,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.10,1.13,1.07,1.13,1.11,1.13,1.45,1.13,1.10,1.13,1.06,1.13,1.10,1.1 3,1.08,1.13	3 0 0	2 0 0	2 5 0
201	9	7. 6 4	7. 6 4	1 1. 76	-	3 0 0	2 0 0	2 5 0
202	6	1. 3 0	1. 3 0	2. 00	-	3 0 0	2 0 0	2 5 0
203	17	0. 9 2	0. 9 2	1. 42	1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.17,1.19,1.19,1.19,1.18,1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.16,1.19,1.19,1.19,1. 18,1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.20,1.19,1.19,1.17,1.19,1.19,1.19,1.21,1.19,1.19,1.19,1.16,1.19,1.19,1.2 0,1.18,1.20	3 0 0	2 0 0	2 5 0
204	17	2. 4 4	2. 4 4	3. 75	1.70,1.69,1.69,1.68,1.69,1.69,1.67,1.69,1.65,1.69,1.67,1.69,1.65,1.69,1.67,1.68,1.69,1.68,1.68,1.69,1.60,1.69,1.67,1.69,1. 66,1.69,1.69,1.69,1.68,1.69,1.68,1.69,1.69,1.68,1.69,1.68,1.69,1.64,1.69,1.67,1.68,1.73,1.68,1.68,1.69,1.62,1.69,1.67,1.6 9,1.65,1.69	3 0 0	2 0 0	2 5 0
205	17	1. 5 2	1. 5 2	2. 33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.68,1.67,1.67,1.68,1.63,1.68,1.67,1.68,1. 66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.65,1.68,1.67,1.67,1.72,1.67,1.67,1.68,1.64,1.68,1.67,1.6 8,1.66,1.68	3 0 0	2 0 0	2 5 0
206	17	0. 9 2	0. 9 2	1. 42	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.15,1.18,1.18,1.19,1.16,1.19,1.18,1.18,1.19,1.18,1.18,1.19,1.12,1.19,1.17,1.19,1. 16,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.15,1.19,1.18,1.18,1.22,1.18,1.18,1.19,1.13,1.19,1.18,1.1 9,1.16,1.19	3 0 0	2 0 0	2 5 0
207	17	1. 5 2	1. 5 2	2. 33	1.69,1.68,1.69,1.67,1.69,1.69,1.67,1.68,1.65,1.68,1.67,1.69,1.65,1.69,1.67,1.67,1.68,1.67,1.68,1.69,1.61,1.69,1.67,1.69,1. 66,1.69,1.69,1.69,1.68,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.69,1.64,1.69,1.67,1.68,1.72,1.68,1.67,1.69,1.62,1.69,1.67,1.6 9,1.66,1.69	3 0 0	2 0 0	2 5 0
208	20	2. 1 0	2. 1 0	1. 00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2. 33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.3 3,2.33,2.33	3 0 0	2 0 0	2 5 0
209	3	2. 6 0	2. 6 0	4. 00	-	3 0 0	2 0 0	2 5 0
210	17	2. 4 4	2. 4 4	3. 75	1.70,1.69,1.70,1.68,1.70,1.70,1.68,1.69,1.64,1.69,1.68,1.70,1.65,1.70,1.68,1.68,1.69,1.68,1.68,1.70,1.57,1.70,1.67,1.70,1. 65,1.70,1.70,1.70,1.68,1.70,1.69,1.70,1.70,1.69,1.70,1.68,1.70,1.63,1.70,1.68,1.69,1.74,1.69,1.68,1.70,1.59,1.70,1.68,1.7 0,1.65,1.70	3 0 0	2 0 0	2 5 0
211	20	2. 1 0	2. 1 0	1. 00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2. 33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.3 3,2.33,2.33	3 0 0	2 0 0	2 5 0
212	6	1. 3 0	1. 3 0	2. 00	-	3 0 0	2 0 0	2 5 0
213	20	4. 8	4. 0	7.	1.43,1.45,1.43,1.47,1.44,1.43,1.44,1.45,1.42,1.45,1.43,1.43,1.44,1.43,1.45,1.47,1.50,1.47,1.43,1.43,1.44,1.43,1.43,1.43,1. 44,1.43,1.43,1.43,1.46,1.43,1.46,1.43,1.43,1.46,1.43,1.43,1.43,1.44,1.43,1.45,1.46,1.58,1.46,1.43,1.43,1.44,1.43,1.43,1.4	3 0	2 0	2 5

213	20	8	0	50	[illegible] 3,1.44,1.43	0	0	0
214	20	4.88	4.00	7.50	1.53,1.55,1.53,1.57,1.54,1.53,1.70,1.55,2.07,1.55,1.72,1.53,1.93,1.53,1.65,1.57,1.39,1.57,1.68,1.53,2.44,1.53,1.73,1.53,1.87,1.53,1.53,1.53,1.57,1.53,1.56,1.53,1.53,1.56,1.53,1.70,1.53,2.04,1.53,1.66,1.56,1.33,1.56,1.68,1.53,2.29,1.53,1.72,1.53,1.89,1.53	300	200	250
215	20	7.45	7.45	7.45	1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.14,1.08,1.08,1.08,1.12,1.08,1.08,1.08,1.07,1.08,1.08,1.08,1.19,1.08,1.09,1.08,1.11,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.13,1.08,1.08,1.08,1.52,1.08,1.08,1.08,1.17,1.08,1.08,1.08,1.11,1.08	300	200	250
216	20	4.84	4.84	7.45	1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.11,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07,1.07	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	347.73	325.66	76.62	76.62	104.32	104.32
2	230.93	229.13	24.98	24.98	69.28	69.28
3	151.65	150.70	20.17	14.14	54.12	28.95
4	151.65	145.15	20.17	14.14	54.12	28.95
5	151.65	149.10	20.17	14.14	54.12	28.95
6	151.65	150.70	20.17	14.14	54.12	28.95
7	151.65	149.10	20.17	14.14	54.12	28.95
8	159.30	140.46	46.90	6.46	56.26	44.91
9	69.10	61.62	3.91	3.91	20.73	20.73
10	151.65	145.15	20.17	14.14	54.12	28.95
11	159.30	140.46	46.90	6.46	56.26	44.91
12	230.93	229.13	24.98	24.98	69.28	69.28
13	159.30	97.43	43.65	6.46	56.26	44.91
14	159.30	97.43	40.86	6.46	56.26	44.91
15	159.30	137.23	46.90	6.46	56.26	44.91
16	159.30	137.23	46.90	6.46	56.26	44.91
101	347.73	325.66	76.62	76.62	104.32	104.32
102	230.93	229.13	24.98	24.98	69.28	69.28
103	151.65	150.70	20.17	14.14	54.12	28.95
104	151.65	145.15	20.17	14.14	54.12	28.95
105	151.65	149.10	20.17	14.14	54.12	28.95
106	151.65	150.70	20.17	14.14	54.12	28.95
107	151.65	149.10	20.17	14.14	54.12	28.95
108	159.30	140.46	46.90	6.46	56.26	44.91
109	69.10	61.62	3.91	3.91	20.73	20.73
110	151.65	145.15	20.17	14.14	54.12	28.95
111	159.30	140.46	46.90	6.46	56.26	44.91
112	230.93	229.13	24.98	24.98	69.28	69.28
113	159.30	97.43	31.17	6.46	56.26	44.91
114	159.30	97.43	31.53	6.46	56.26	44.91
115	159.30	61.62	31.73	6.46	56.26	44.91
116	159.30	61.62	32.32	6.46	56.26	44.91
201	347.73	325.66	76.62	76.62	104.32	104.32
202	230.93	229.13	24.98	24.98	69.28	69.28
203	151.65	150.70	20.17	14.14	54.12	28.95
204	151.65	145.15	20.17	14.14	54.12	28.95
205	151.65	149.10	20.17	14.14	54.12	28.95
206	151.65	150.70	20.17	14.14	54.12	28.95
207	151.65	149.10	20.17	14.14	54.12	28.95
208	159.30	137.23	46.90	6.46	56.26	44.91

208	159.30	137.23	46.90	6.46	56.26	44.91
209	69.10	61.62	3.91	3.91	20.73	20.73
210	151.65	145.15	20.17	14.14	54.12	28.95
211	159.30	137.23	46.90	6.46	56.26	44.91
212	230.93	229.13	24.98	24.98	69.28	69.28
213	159.30	97.43	43.45	6.46	56.26	44.91
214	159.30	97.43	40.77	6.46	56.26	44.91
215	159.30	61.62	32.87	6.46	56.26	44.91
216	159.30	97.82	32.91	6.46	56.26	44.91

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	0.018	0.344	0.027	0.021	0.002	0.360	#13	0.156	Not Required	Pass
2	0.000	0.119	0.069	0.030	0.014	0.165	#13	0.054	Not Required	Pass
3	0.004	0.173	0.022	0.017	0.005	0.190	#21	0.046	Not Required	Pass
4	0.004	0.168	0.036	0.017	0.008	0.200	#21	0.082	Not Required	Pass
5	0.004	0.106	0.019	0.017	0.004	0.109	#13	0.076	Not Required	Pass
6	0.007	0.246	0.073	0.025	0.023	0.308	#21	0.046	Not Required	Pass
7	0.008	0.152	0.093	0.024	0.023	0.162	#13	0.076	Not Required	Pass
8	0.003	0.050	0.083	0.013	0.013	0.131	#21	0.102	Not Required	Pass
9	0.001	0.022	0.043	0.003	0.002	0.051	#13	0.206	Not Required	Pass
10	0.008	0.229	0.090	0.023	0.021	0.276	#21	0.082	Not Required	Pass
11	0.004	0.052	0.082	0.014	0.013	0.132	#21	0.102	Not Required	Pass
12	0.001	0.202	0.102	0.049	0.020	0.281	#13	0.054	Not Required	Pass
13	0.005	0.026	0.264	0.020	0.018	0.268	#23	0.306	Not Required	Pass
14	0.003	0.026	0.261	0.018	0.018	0.266	#23	0.204	Not Required	Pass
15	0.000	0.002	0.010	0.003	0.003	0.011	#21	Not Required	Not Required	Pass
16	0.000	0.002	0.010	0.003	0.003	0.011	#21	Not Required	Not Required	Pass
101	0.023	0.418	0.000	0.026	0.000	0.428	#13	0.156	Not Required	Pass
102	0.001	0.209	0.111	0.051	0.020	0.289	#21	0.054	Not Required	Pass
103	0.007	0.256	0.054	0.026	0.013	0.310	#21	0.046	Not Required	Pass
104	0.007	0.274	0.097	0.027	0.022	0.340	#21	0.082	Not Required	Pass
105	0.007	0.158	0.099	0.025	0.025	0.181	#21	0.076	Not Required	Pass
106	0.007	0.256	0.054	0.026	0.013	0.311	#21	0.046	Not Required	Pass
107	0.007	0.158	0.099	0.025	0.025	0.181	#21	0.076	Not Required	Pass
108	0.003	0.043	0.082	0.015	0.013	0.108	#21	0.102	Not Required	Pass
109	0.006	0.015	0.024	0.001	0.000	0.040	#21	0.206	Not Required	Pass
110	0.007	0.274	0.097	0.027	0.022	0.340	#21	0.082	Not Required	Pass
111	0.004	0.057	0.084	0.013	0.013	0.119	#21	0.102	Not Required	Pass
112	0.001	0.210	0.111	0.051	0.020	0.289	#21	0.054	Not Required	Pass
113	0.005	0.032	0.277	0.018	0.018	0.291	#21	0.306	Not Required	Pass
114	0.004	0.048	0.276	0.020	0.018	0.314	#21	0.306	Not Required	Pass
115	0.009	0.097	0.146	0.013	0.013	0.235	#21	0.570	Not Required	Pass
116	0.003	0.082	0.145	0.015	0.013	0.221	#21	0.570	Not Required	Pass
201	0.018	0.344	0.027	0.021	0.002	0.360	#13	0.156	Not Required	Pass
202	0.001	0.202	0.102	0.049	0.020	0.281	#13	0.054	Not Required	Pass
203	0.007	0.246	0.073	0.025	0.023	0.308	#21	0.046	Not Required	Pass
204	0.008	0.229	0.090	0.023	0.021	0.276	#21	0.082	Not Required	Pass
205	0.008	0.152	0.093	0.024	0.023	0.162	#13	0.076	Not Required	Pass
206	0.004	0.172	0.022	0.017	0.005	0.190	#21	0.046	Not Required	Pass

207	0.004	0.106	0.019	0.017	0.004	0.109	#13	0.076	Not Required	Pass
208	0.000	0.002	0.010	0.003	0.003	0.011	#21	Not Required	Not Required	Pass
209	0.001	0.022	0.043	0.003	0.002	0.051	#13	0.206	Not Required	Pass
210	0.004	0.168	0.036	0.017	0.008	0.200	#21	0.082	Not Required	Pass
211	0.000	0.002	0.010	0.003	0.003	0.011	#21	Not Required	Not Required	Pass
212	0.000	0.118	0.069	0.030	0.014	0.165	#13	0.054	Not Required	Pass
213	0.005	0.026	0.264	0.020	0.018	0.268	#23	0.204	Not Required	Pass
214	0.003	0.026	0.261	0.018	0.018	0.266	#23	0.306	Not Required	Pass
215	0.009	0.094	0.145	0.014	0.013	0.234	#21	0.570	Not Required	Pass
216	0.003	0.084	0.145	0.013	0.013	0.224	#21	0.370	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

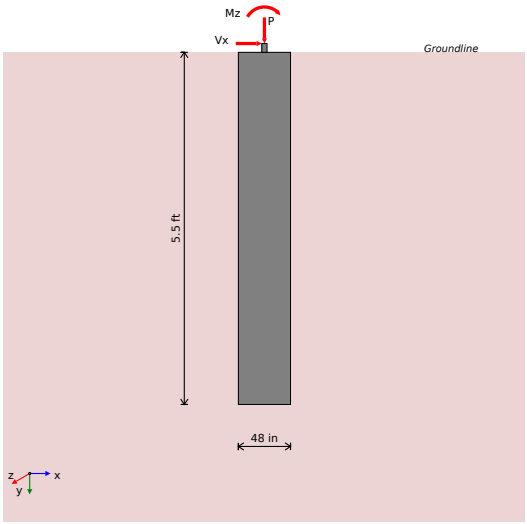
Input	Description	Value
f'_{ck}	Concrete compressive strength	2.5 ksi
f_{yk}	Yield strength of steel	60 ksi
d_b	Rebar diameter	#5 (0.625) in
cover	Concrete cover	3 in

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	3.929 kip	5.847 kip
Vx	-1.324 kip	-2.211 kip
Vz	-0.174 kip	-0.255 kip
Mx	-0.62 kip-ft	-0.91 kip-ft
Mz	15.75 kip-ft	26.34 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

$$H_o = \frac{V_x}{1.57 \times D} = \frac{-1.324}{1.57 \times 48} = -0.211\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{15.75 + (-1.324 \times 0)}{1.57 \times 48} = 2.507 \ \frac{kip - ft}{ft}$$

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:

$$L_{e,x} = 5.137 \ ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{-0.174}{1.57 \times 48} = -0.028 \ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{1.57 \times b} = \frac{-0.62 + (-0.174 \times 0)}{1.57 \times 48} = -0.099 \ \frac{kip - ft}{ft}$$

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:

$$L_{e,z} = -1.715 \ ft$$

Minimum embedded depth

Depth of pile required

$$L_{e,req} = MAX[L_{e,x}, L_{e,z}] = MAX[5.137, -1.715] = 5.137 \ ft$$

Actual embedded length

$$L_e = L - h_2 - h_e = 5.5 - 0 - 0 = 5.5 \ ft$$

Utilisation

$$Ratio = \frac{L_{e,req}}{L_e} = \frac{5.137}{5.5} = 0.934$$

UTILITY: 0.93

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:

$$q = \frac{P}{A} = \frac{3.929}{16} = 245.6 \ psf$$

Utilisation

$$Ratio = \frac{q}{q_a} = \frac{245.6}{2000} = 0.123$$

UTILITY: 0.12

Lateral Soil Pressure (ASD)

Allowable lateral pressure	$R =$	150 psf/ft

Length to least lateral dimension ratio:

$$\frac{L}{MIN[b, D]} = \frac{5.5}{MIN[4, 4]} = 1.375$$

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

Considering x-direction:

Distance from resting surface to pivot point:

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

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

$$a = \frac{(4 \times 2.507 \times 5.5) + (3 \times 0.211 \times 5.5^2)}{(6 \times 2.507) + (4 \times 0.211 \times 5.5)} = 3.775\ ft$$

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

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

$$p = \frac{0.75 \times [(4 \times 2.507) + (3 \times -0.211 \times 5.5)]^2}{5.5^2 \times [(3 \times 2.507) + (2 \times -0.211 \times 5.5)]} = 0.204\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{3.775}{2} = 0.283\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{0.204}{0.283} = 0.722$$

UTILITY: 0.72

Earth pressure against the pile at distance L_e:

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times 2.507) + (-0.211 \times 5.5)]}{5.5^2} = 0.765\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

$$p_s = R \times L_e = 0.15 \times 5.5 = 0.825\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{0.765}{0.825} = 0.927$$

UTILITY: 0.93

Considering z-direction:

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.099 \times 5.5) + (3 \times 0.028 \times 5.5^2)}{(6 \times 0.099) + (4 \times 0.028 \times 5.5)} = 3.899\ ft$$

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

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

$$p = \frac{0.75 \times [(4 \times -0.099) + (3 \times -0.028 \times 5.5)]^2}{5.5^2 \times [(3 \times -0.099) + (2 \times -0.028 \times 5.5)]} = -0.03\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{3.899}{2} = 0.292\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{-0.03}{0.292} = -0.103$$

UTILITY: 0.10

Earth pressure against the pile at distance L_e:

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times -0.099) + (-0.028 \times 5.5)]}{5.5^2} = -0.069\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

$$p_s = R \times L_e = 0.15 \times 5.5 = 0.825\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{-0.069}{0.825} = -0.084$$

UTILITY: 0.08

REFERENCES	CALCULATIONS	RESULTS

Shear force and bending moment (LRFD)

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{1.57 \times D} = \frac{-2.211}{1.57 \times 48} = -0.352\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{26.34 + (-2.211 \times 0)}{1.57 \times 48} = 4.195\ \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 4.195 \times 5.5) + (3 \times 0.352 \times 5.5^2)}{(6 \times 4.195) + (4 \times 0.352 \times 5.5)} = 3.775\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{4.195}{-0.352} = 11.91\ ft$$

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

$$V_{max,x} = (-0.352 \times 48) \times [1 - [3 \times \left(\frac{4 \times 11.91}{5.5} + 3\right) \times \left(\frac{3.775}{5.5}\right)^2] + [4 \times \left(\frac{3 \times 11.91}{5.5} + 2\right) \times \left(\frac{3.775}{5.5}\right)^3]]$$

$$V_{max,x} = 6.329\ kip$$

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

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

$$M_{max,x} = (-0.352 \times 48 \times 5.5) \times [\left(\frac{11.91}{5.5} + \frac{3.775}{2 \times 5.5}\right) - [\left(\frac{4 \times 11.91}{5.5} + 3\right) \times \left(\frac{3.775}{2 \times 5.5}\right)^3] + [\left(\frac{3 \times 11.91}{5.5} + 2\right) \times \left(\frac{3.775}{2 \times 5.5}\right)^4]]$$

$$M_{max,x} = 16.7\ kip - ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{-0.255}{1.57 \times 48} = -0.041\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{1.57 \times b} = \frac{-0.91 + (-0.255 \times 0)}{1.57 \times 48} = -0.145\ \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.145 \times 5.5) + (3 \times 0.041 \times 5.5^2)}{(6 \times 0.145) + (4 \times 0.041 \times 5.5)} = 3.899\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{-0.145}{-0.041} = 3.575\ ft$$

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

$$V_{max,z} = (-0.041 \times 48) \times [1 - [3 \times \left(\frac{4 \times 3.575}{5.5} + 3\right) \times \left(\frac{3.899}{5.5}\right)^{}] + [4 \times \left(\frac{3 \times 3.575}{5.5} + 2\right) \times \left(\frac{3.899}{5.5}\right)^{}]]$$

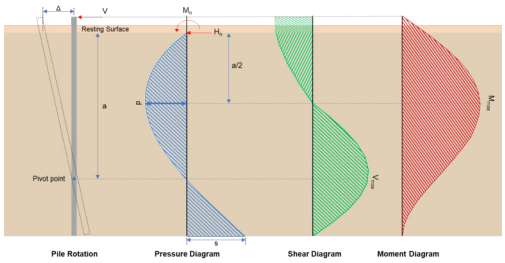
$$V_{max,z} = 0.294\ kip$$

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

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

$$M_{max,z} = (-0.041 \times 48 \times 5.5) \times [\left(\frac{3.575}{5.5} + \frac{3.899}{2 \times 5.5}\right) - [\left(\frac{4 \times 3.575}{5.5} + 3\right) \times \left(\frac{3.899}{2 \times 5.5}\right)^3] + [\left(\frac{3 \times 3.575}{5.5} + 2\right) \times \left(\frac{3.899}{2 \times 5.5}\right)^4]]$$

$$M_{max,z} = 0.729\ kip - ft$$



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:

$$A_{st,req} = \frac{P - (0.85 \times f'_{ck} \times A_g)}{f_{yk} - (0.85 \times f'_{ck})} = \frac{5.847 - (0.85 \times 2.5 \times 2304)}{60 - (0.85 \times 2.5)} = -84.5\ in^2$$

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:

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

Use: $n = 16$pcs at 1.5 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 ≤ 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

$$Ratio = \frac{P}{\phi P_N} = \frac{5.847}{2694} = 0.002$$

UTILITY: 0.00

Shear Strength LRFD)

Effective shear width	$b_w =$	48 in
Effective shear depth	$d =$	44.31 in
Shear reinforcement area	$A_v =$	0.221 in^2
Shear reinforcement spacing	$s =$	10 in
Concrete type factor (Normal concrete)	$\lambda =$	1
Strength reduction factor for shear	$\phi =$	0.75
Maximum shear in the x-direction	$V_{max,x} =$	6.329 kip
Maximum shear in the z-direction	$V_{max,z} =$	0.294 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:

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

$$V_{c,a} = \left(2 \times 1 \times \sqrt{2.5} + MIN[\frac{5.847}{6 \times 2304}, (0.05 \times 2.5)]\right) \times (48 \times 44.31) = 213.6\ kip$$

Governing shear strength of concrete:

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

22.5.1.2 Shear strength of steel (a):

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

22.5.8.5.3 Shear strength of steel (b):

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

Governing shear strength of steel:

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

22.5.1.1 Allowable shear strength:

$$\phi V_n = \phi \times (V_c + V_s) = 0.75 \times (213.6 + 58.73) = 204.2\ kip$$

$$V_{max} = MAX[6.329, 0.294] = 6.329\ kip$$

Utilisation

$$Ratio = \frac{V_{max}}{\phi V_n} = \frac{6.329}{204.2} = 0.031$$

UTILITY: 0.03

Flexural Strength (LRFD)

Concrete type factor (Normal concrete)	$\lambda =$	1
Strength reduction factor for flexure	$\phi =$	0.65
Modulus of steel reinforcement	$E_s =$	200e3 ksi
Maximum concrete strain	$\varepsilon_c =$	0.0030
Yield strain of steel f_y/E_s	$\varepsilon_y =$	0.0003
Section width	$b =$	48 in
Distance to the compression rebar	$d_s =$	3.688 in
Distance to the tension rebar	$d =$	44.31 in
Total bar area	$A_s =$	4.909 in^2
Maximum applied axial load	$P =$	5.847 kip
Maximum moment in the x-direction	$M_{max,x} =$	16.7 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$	0.729 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:

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

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

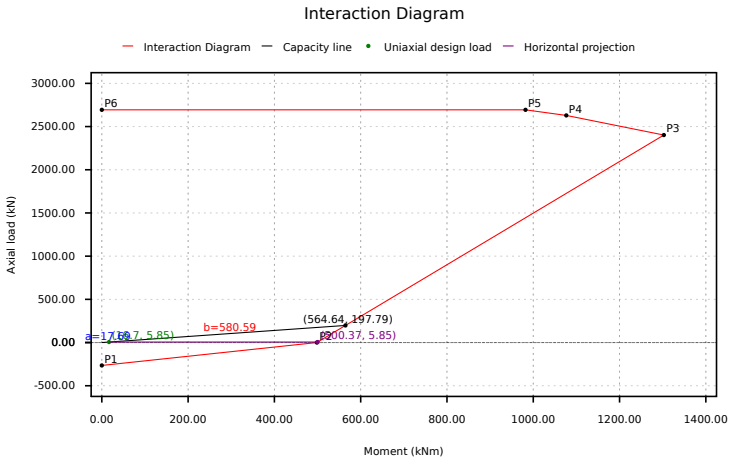
$$f_2 = E_s \times \varepsilon_2 \ (\varepsilon_2 < \varepsilon_{sy}),\ f_2 = \phi_s \times f_y \ (\varepsilon_2 \geq \varepsilon_{sy})$$

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

$$M_f = MAX[16.7, 0.729] = 16.7\ kip - ft$$



Segment	Signed Distance
P1 - P2	231.4
P2 - P3	458.6
P3 - P4	2602
P4 - P5	2763
P5 - P6	2688
Status	PASS: Point lies inside the curve

Utilisation

$$Ratio = \frac{a}{a+b} = \frac{17.69}{17.69 + 580.6} = 0.03$$

UTILITY: 0.03

Biaxial Bending Check

Maximum moment in the x-direction	$M_{max,x} =$ 16.7 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$ 0.729 kip-ft
Nominal uniaxial moment strength about the x-axis	$M_{nox} =$ 500.4 kip-ft
Nominal uniaxial moment strength about the z-axis	$M_{noz} =$ 500.4 kip-ft
Interaction exponent	$\alpha =$ 1

Bresler (1960)

According to Bresler (method B):

$$\left(\frac{M_{max,x}}{M_{nox}}\right)^{\alpha} + \left(\frac{M_{max,z}}{M_{noz}}\right)^{\alpha} = 1.0$$

$$\left(\frac{16.7}{500.4}\right)^{1} + \left(\frac{0.729}{500.4}\right)^{1} = 0.035$$

UTILITY: 0.03

REFERENCES	CALCULATIONS	RESULTS

Results Summary

Result Name	Results
PILE DETAILS	
Length of the pile	5.50 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	0.93
End-bearing capacity	0.12
p_a	0.72
p_s	0.93
Axial compression strength	0.00
Shear strength	0.03
Uniaxial bending strength	0.03
Biaxial bending strength	0.03