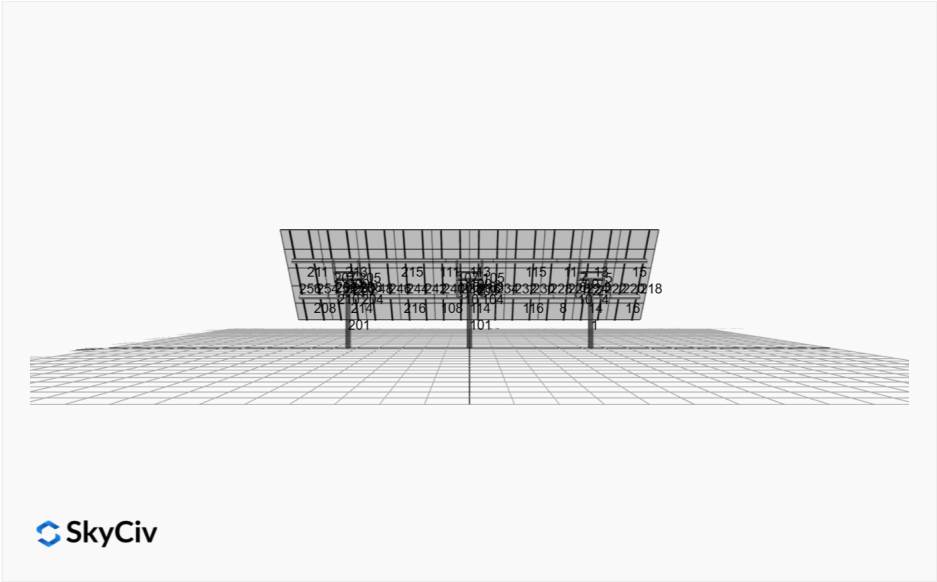
Project Details

Project Name: Oak Grove
Location: 777 Oak Grove Rd, Caddo Gap, AR 71935, USA
Unique ID: 3P-19.75-8TOP-HD-57-L-5Hx10W-4BID
Dealer: _____

Date: Wed Nov 05 2025
Number of Modules: 50
Number of Poles: 3
Date Sold: _____



Array Dimensions N/S	18.79 ft
Array Dimensions E/W	58.67 ft
Winter Tilt Angle (Degrees)	50
Front Edge Clearance	4

MT Solar Bill of Materials (3P-19.75-8TOP-HD-57-L-5Hx10W-4BID)

Part	Short Description	BOM Qty
MTS-PC-8	8IN Pole Cap Assembly	3
MTS-HF-HD	H-Frame Assembly-HD	3
MTS-HD-Wing-57	57IN HD Wing	4
MTS-HD-Splice-90	90IN HD Splice	4
MTS-HD-Splice-57	57IN HD Splice	4
MTS-CLAMP-ANGLE-4PK	Angle Clamp	10

Rail Bill of Materials

Part	Qty
Rails (226in Long)	20x
Rail Attachment	80x
Module Mid Clamp	80x
Module End Clamp	40x
Ground Lug	10x

Site Details:

Site Address: 777 Oak Grove Rd, Caddo Gap, AR 71935, USA

Array Specifications

Duty Classification:	HD
Module Width:	44.60 in
Module Length:	69.40 in
Number of Rows:	5
Number of Columns:	10
Total Number of Modules:	50
Winter Tilt Angle:	50
Front Edge Clearance:	4
Total Array Height at Tilt:	18.40 ft
Total Frame Length:	56.50 ft
Module Info/Notes:	
Array Dimensions N/S:	18.79 ft
Array Dimensions E/W:	58.67 ft
Rail Length:	225.50 in
Rail Spacing:	2.93 ft

Support Specifications

Pole Size:	8in Pipe Sch 40
Pole Length above Grade:	11.20 ft
Number of Poles:	3
Pole Spacing:	19.75 ft

Foundation Specifications

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

Site Info

Risk Category:	I
Exposure:	C
Soil Classification:	sand
Site Location:	777 Oak Grove Rd, Caddo Gap, AR 71935, USA
Wind Speed:	99 mph

Snow Load:	10 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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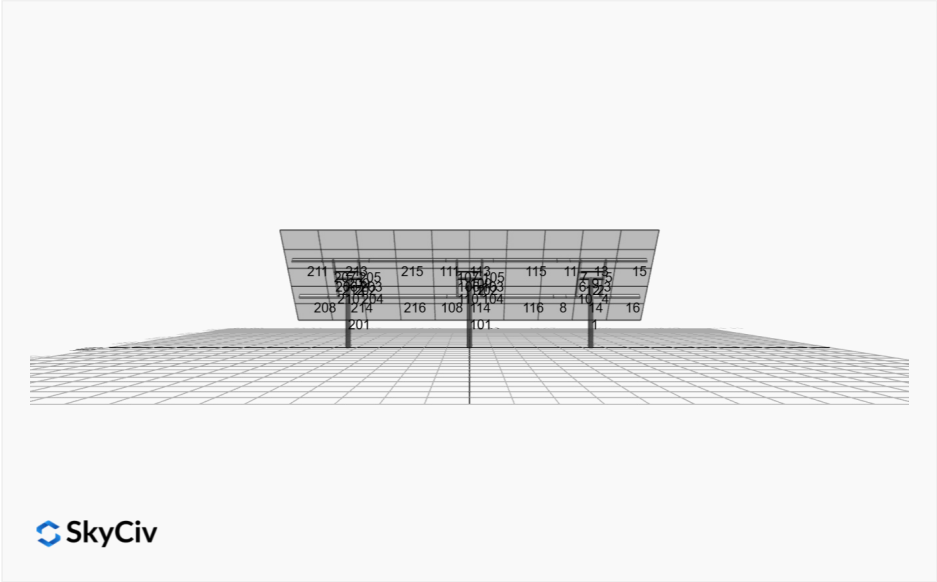
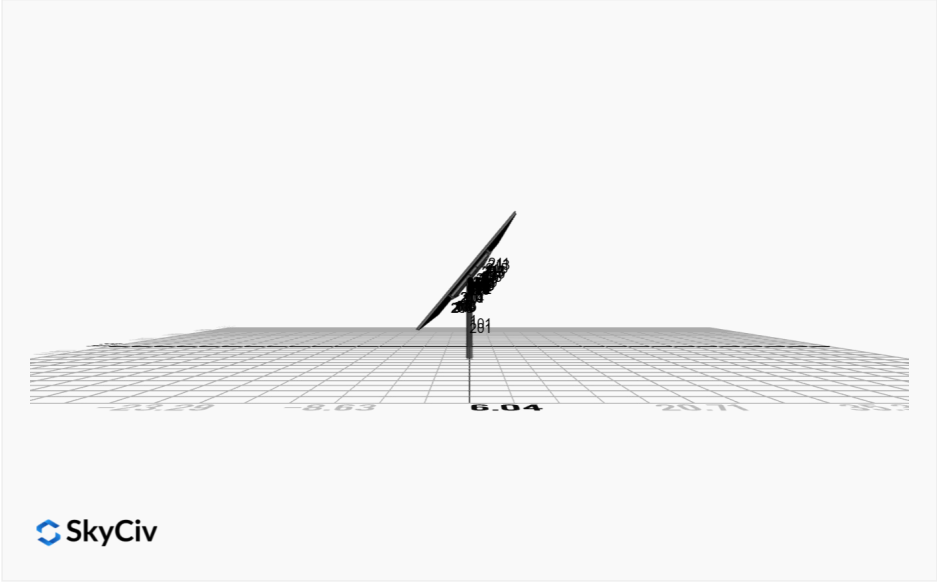
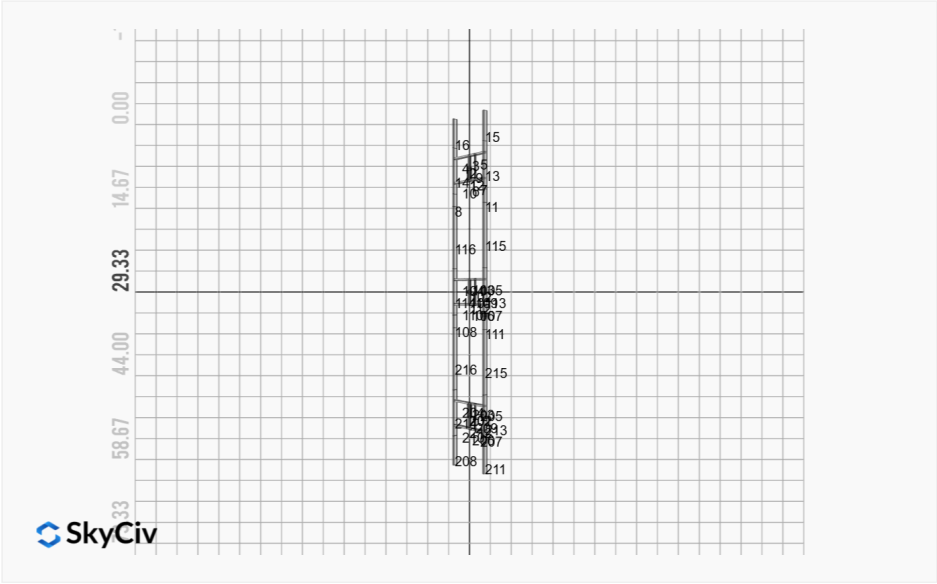
Design Notes:

- 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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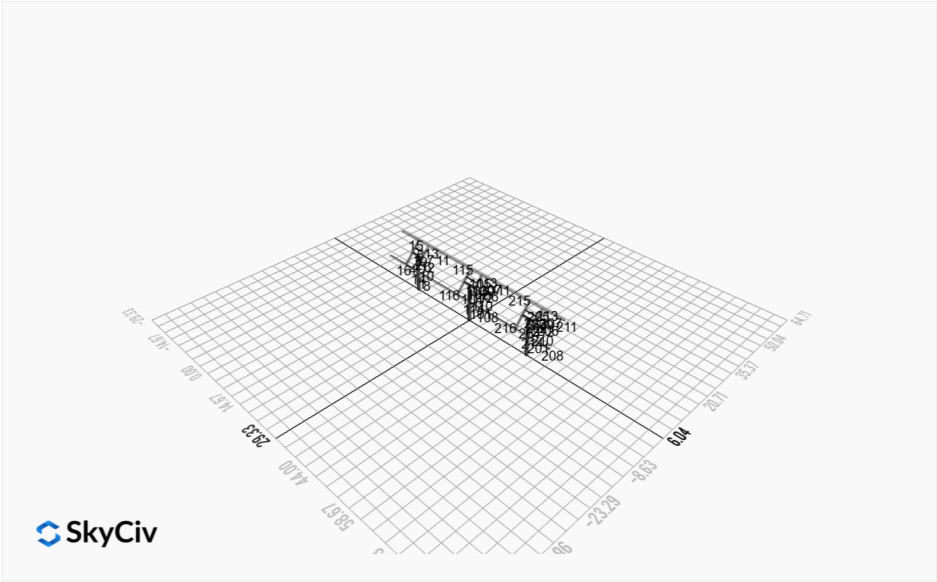
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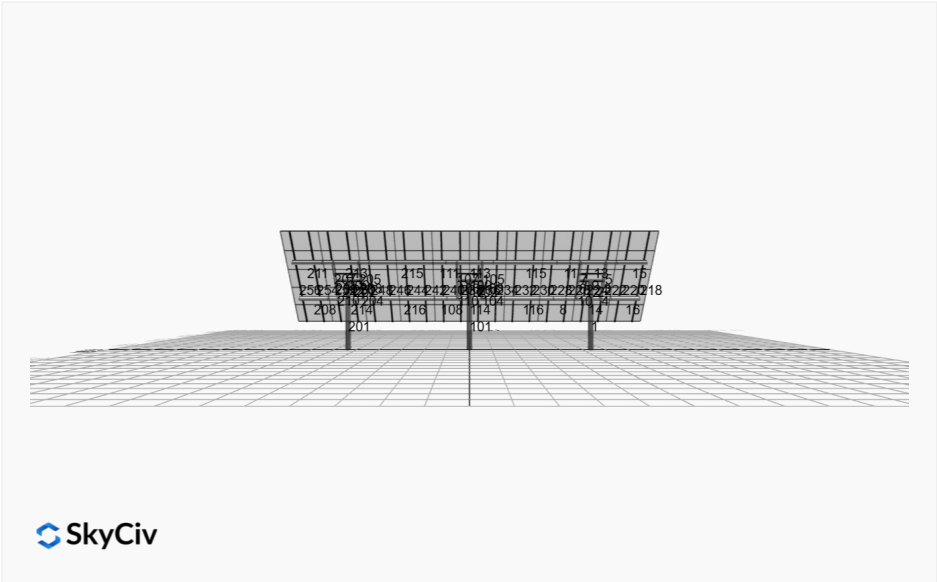
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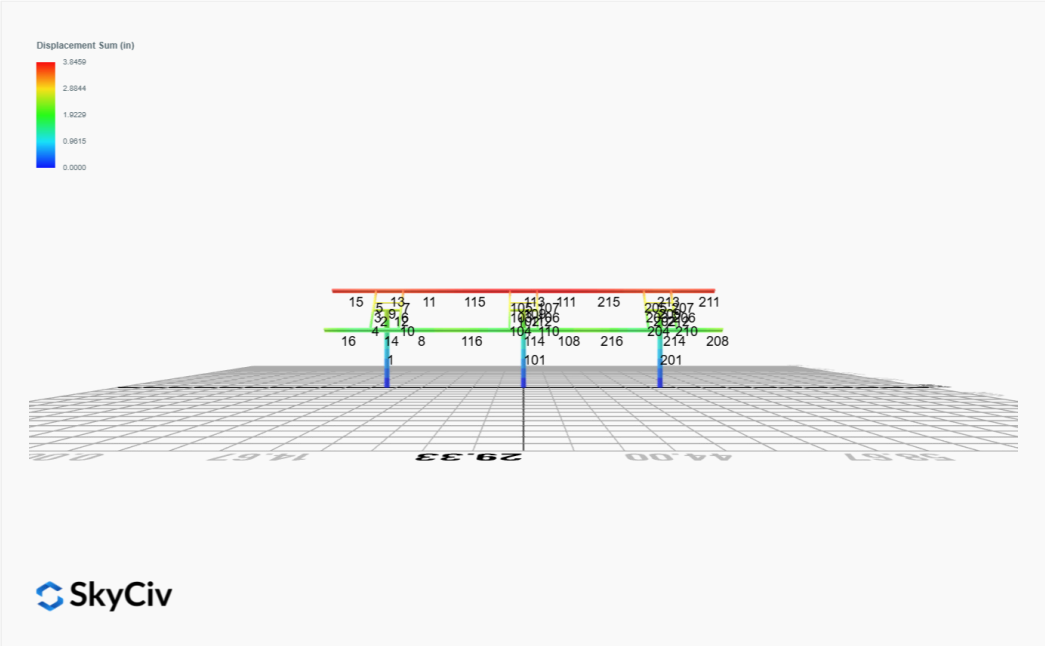
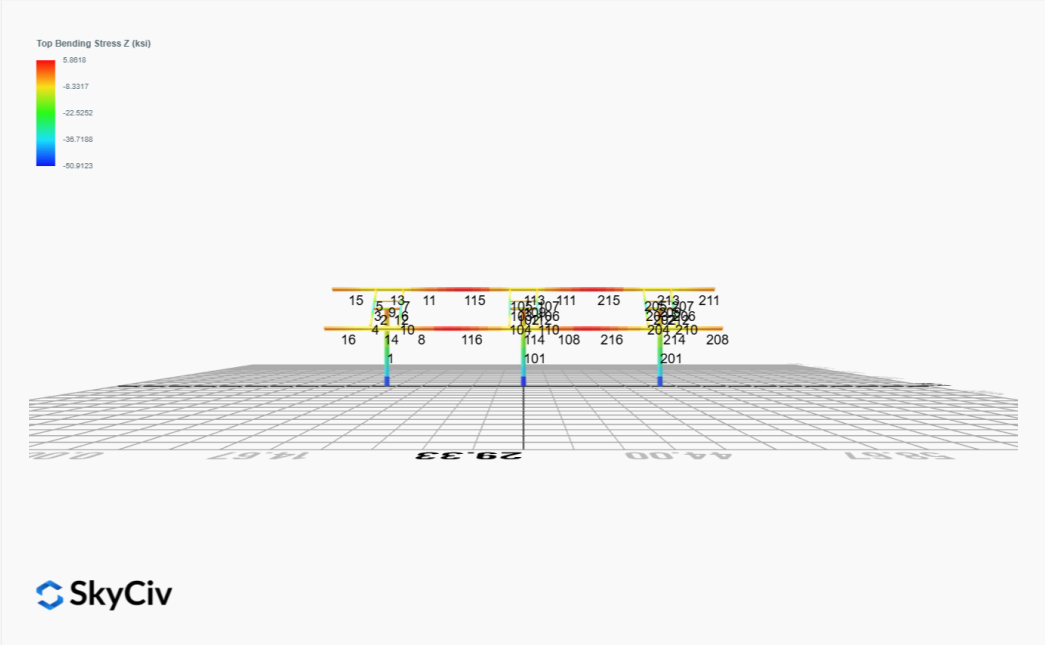
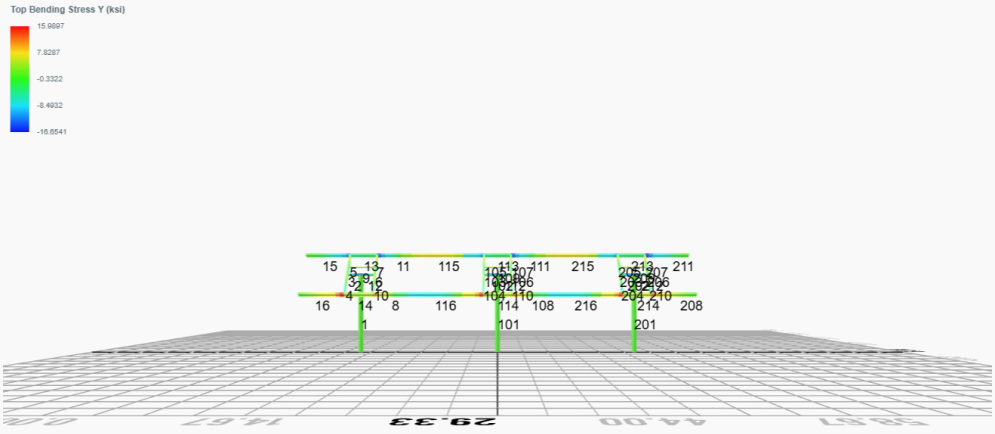
FEM Results (Envelope Worst Case)







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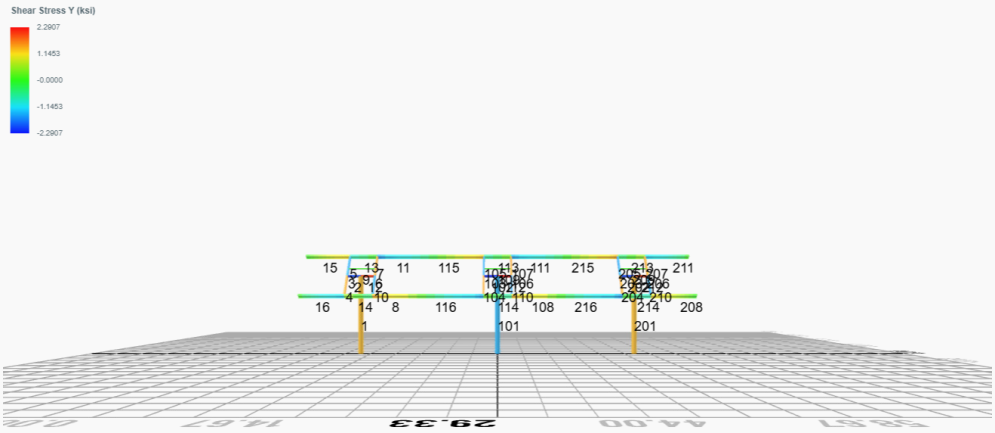

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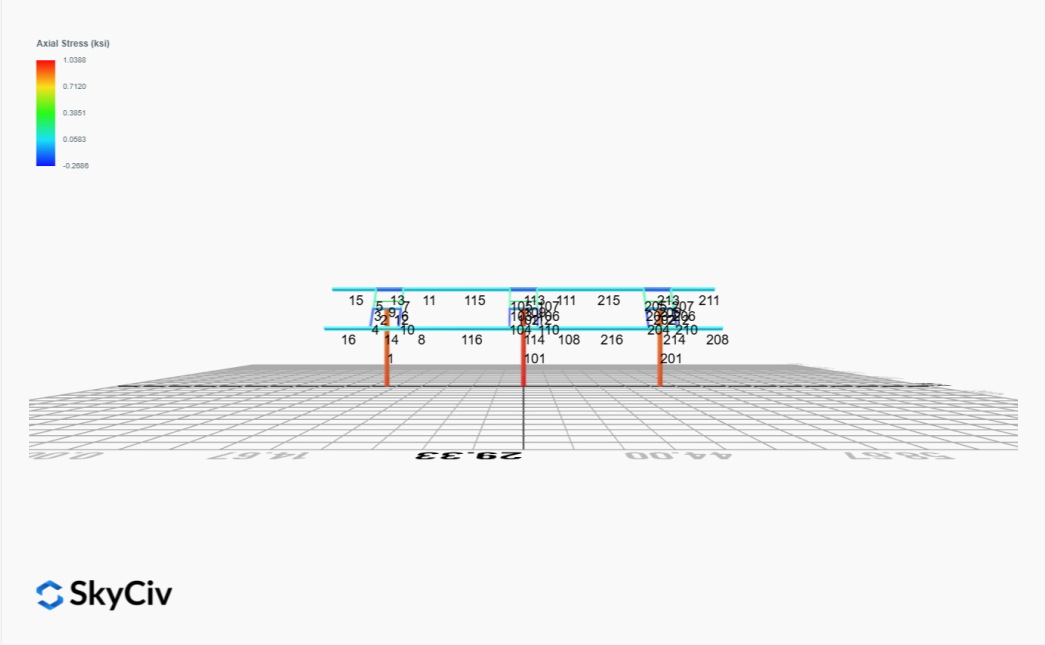
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0.0583
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115
111
215
211
16
8
116
108
216
208
1
101
201
29.33

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	-0.0079	3.5512	0.0015	0.0098	0.0687	0.1166
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0075	3.2979	0.0015	0.0093	0.0651	0.1074
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0068	3.0439	0.0013	0.0084	0.0589	0.0985
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	-0.0090	3.8569	0.0018	0.0114	0.0786	0.1276
ULS: 5. 1.2D + E + L + 0.2S	-0.0070	3.1455	0.0014	0.0087	0.0614	0.1020
ULS: 7. 0.9D + 1.0E	-0.0051	2.2829	0.0010	0.0063	0.0442	0.0722
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-6.0302	8.3402	0.0053	0.0205	0.0345	69.3333
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.0075	3.2979	0.0015	0.0093	0.0651	0.1074
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	6.0136	-1.7434	-0.0012	0.0018	0.0894	-67.0977
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0075	3.2979	0.0015	0.0093	0.0651	0.1074
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-6.0294	8.0861	0.0051	0.0195	0.0285	69.2671
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.0068	3.0439	0.0013	0.0084	0.0589	0.0985
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	6.0142	-1.9974	-0.0013	0.0010	0.0830	-67.0532
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0068	3.0439	0.0013	0.0084	0.0589	0.0985
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.0202	6.3780	0.0036	0.0166	0.0640	34.5433
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.0090	3.8569	0.0018	0.0114	0.0786	0.1276
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	3.0018	1.3361	0.0003	0.0071	0.0917	-33.7808
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.0090	3.8569	0.0018	0.0114	0.0786	0.1276
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.0179	5.5648	0.0031	0.0135	0.0445	34.4239
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.0068	3.0439	0.0013	0.0084	0.0589	0.0985
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	3.0040	0.5231	-0.0002	0.0042	0.0717	-33.7228
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.0068	3.0439	0.0013	0.0084	0.0589	0.0985
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-6.0276	7.3250	0.0047	0.0171	0.0143	69.0727
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-0.0051	2.2829	0.0010	0.0063	0.0442	0.0722
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	6.0158	-2.7583	-0.0016	-0.0009	0.0679	-66.9225
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	-0.0051	2.2829	0.0010	0.0063	0.0442	0.0722

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0056	2.5365	0.0011	0.0070	0.0491	0.0809
ULS: 2. D + L	-0.0056	2.5365	0.0011	0.0070	0.0491	0.0809
ULS: 3. D + (S or Lr or R)	-0.0070	3.0447	0.0014	0.0088	0.0614	0.0983
ULS: 3. D + (S or Lr or R)	-0.0056	2.5365	0.0011	0.0070	0.0491	0.0809
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0067	2.9177	0.0013	0.0084	0.0583	0.0939
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0056	2.5365	0.0011	0.0070	0.0491	0.0809
ULS: 5b. D + 0.7E	-0.0056	2.5365	0.0011	0.0070	0.0491	0.0809
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0067	2.9177	0.0013	0.0084	0.0583	0.0939
ULS: 8. 0.6D + 0.7E	-0.0034	1.5219	0.0007	0.0042	0.0294	0.0471
ULS: 5a. D + 0.6W_Wind downforce Case A only	-3.6190	5.5617	0.0032	0.0131	0.0318	41.2666
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.0056	2.5365	0.0011	0.0070	0.0491	0.0809
ULS: 5a. D + 0.6W_Wind uplift Case A only	3.6071	-0.4883	-0.0006	0.0022	0.0641	-40.3817
ULS: 5a. D + 0.6W_Wind uplift Case B only	-0.0056	2.5365	0.0011	0.0070	0.0491	0.0809
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-2.7167	5.1866	0.0029	0.0129	0.0455	30.9519
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0067	2.9177	0.0013	0.0084	0.0583	0.0939
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	2.7030	0.6490	-0.0000	0.0046	0.0699	-30.3562
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0067	2.9177	0.0013	0.0084	0.0583	0.0939

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	-2.7156	4.8054	0.0026	0.0114	0.0363	30.9011
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0056	2.5365	0.0011	0.0070	0.0491	0.0809
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	2.7040	0.2679	-0.0002	0.0032	0.0606	-30.3326
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0056	2.5365	0.0011	0.0070	0.0491	0.0809
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-3.6166	4.5470	0.0027	0.0101	0.0125	41.1008
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.0034	1.5219	0.0007	0.0042	0.0294	0.0471
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	3.6092	-1.5029	-0.0010	-0.0004	0.0441	-40.2888
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	-0.0034	1.5219	0.0007	0.0042	0.0294	0.0471

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	8.3402
Shear X	-6.0302
Shear Z	0.0053
Moment X	0.0205
Moment Y (Twist)	0.0917
Moment Z	69.3333

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	5.5617
Shear X	-3.6190
Shear Z	0.0032
Moment X	0.0131
Moment Y (Twist)	0.0699
Moment Z	41.2666

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	0.0158	3.7384	-0.0000	0.0000	0.0000	-0.1217
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0149	3.4754	-0.0000	0.0000	0.0000	-0.1182
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0135	3.2044	-0.0000	0.0000	0.0000	-0.1057
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0180	4.0718	-0.0000	0.0000	0.0000	-0.1450
ULS: 5. 1.2D + E + L + 0.2S	0.0141	3.3128	-0.0000	0.0000	0.0000	-0.1107
ULS: 7. 0.9D + 1.0E	0.0101	2.4033	-0.0000	0.0000	0.0000	-0.0808
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-6.2143	8.7253	-0.0000	-0.0000	-0.0000	71.3158
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0149	3.4754	-0.0000	0.0000	0.0000	-0.1182
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	6.2476	-1.7762	-0.0000	0.0000	0.0001	-69.4541
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0149	3.4754	-0.0000	0.0000	0.0000	-0.1182
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-6.2159	8.4543	-0.0000	-0.0000	-0.0000	71.2684
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0135	3.2044	-0.0000	0.0000	0.0000	-0.1057
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	6.2463	-2.0474	-0.0000	0.0000	0.0001	-69.3857
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0135	3.2044	-0.0000	0.0000	0.0000	-0.1057
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.0969	6.6969	-0.0000	0.0000	0.0000	35.3677
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0180	4.0718	-0.0000	0.0000	0.0000	-0.1450
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	3.1338	1.4462	-0.0000	0.0000	0.0001	-35.1310
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0180	4.0718	-0.0000	0.0000	0.0000	-0.1450
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.1016	5.8296	-0.0000	0.0000	-0.0000	35.3125
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0135	3.2044	-0.0000	0.0000	0.0000	-0.1057
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	3.1295	0.5787	-0.0000	0.0000	0.0001	-35.0006
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0135	3.2044	-0.0000	0.0000	0.0000	-0.1057
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-6.2196	7.6534	-0.0000	-0.0000	-0.0000	71.1181
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	0.0101	2.4033	-0.0000	0.0000	0.0000	-0.0808
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	6.2432	-2.8486	-0.0000	0.0000	0.0001	-69.1974
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	0.0101	2.4033	-0.0000	0.0000	0.0000	-0.0808

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0113	2.6703	-0.0000	0.0000	0.0000	-0.0892
ULS: 2. D + L	0.0113	2.6703	-0.0000	0.0000	0.0000	-0.0892
ULS: 3. D + (S or Lr or R)	0.0141	3.2124	-0.0000	0.0000	0.0000	-0.1145
ULS: 3. D + (S or Lr or R)	0.0113	2.6703	-0.0000	0.0000	0.0000	-0.0892
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0134	3.0769	-0.0000	0.0000	0.0000	-0.1083
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0113	2.6703	-0.0000	0.0000	0.0000	-0.0892
ULS: 5b. D + 0.7E	0.0113	2.6703	-0.0000	0.0000	0.0000	-0.0892
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0134	3.0769	-0.0000	0.0000	0.0000	-0.1083
ULS: 8. 0.6D + 0.7E	0.0068	1.6022	-0.0000	0.0000	0.0000	-0.0549
ULS: 5a. D + 0.6W_Wind downforce Case A only	-3.7269	5.8206	-0.0000	0.0000	-0.0000	42.4075
ULS: 5a. D + 0.6W_Wind downforce Case B only	0.0113	2.6703	-0.0000	0.0000	0.0000	-0.0892
ULS: 5a. D + 0.6W_Wind uplift Case A only	3.7507	-0.4806	-0.0000	0.0000	0.0000	-41.8351
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.0113	2.6703	-0.0000	0.0000	0.0000	-0.0892
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-2.7903	5.4396	-0.0000	0.0000	-0.0000	31.7322
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0134	3.0769	-0.0000	0.0000	0.0000	-0.1083
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	2.8177	0.7138	-0.0000	0.0000	0.0000	-31.5251
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0134	3.0769	-0.0000	0.0000	0.0000	-0.1083
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-2.7925	5.0331	-0.0000	0.0000	-0.0000	31.7116
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0113	2.6703	-0.0000	0.0000	0.0000	-0.0892
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	2.8157	0.3072	-0.0000	0.0000	0.0000	-31.4677
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0113	2.6703	-0.0000	0.0000	0.0000	-0.0892
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-3.7317	4.7526	-0.0000	-0.0000	-0.0000	42.3044
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	0.0068	1.6022	-0.0000	0.0000	0.0000	-0.0549
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	3.7464	-1.5488	-0.0000	0.0000	0.0000	-41.6688
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.0068	1.6022	-0.0000	0.0000	0.0000	-0.0549

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	8.7253
Shear X	-6.2476
Shear Z	-0.0000
Moment X	0.0000
Moment Y (Twist)	0.0001
Moment Z	71.3158

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	5.8206
Shear X	-3.7507
Shear Z	-0.0000
Moment X	0.0000
Moment Y (Twist)	0.0000
Moment Z	42.4075

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	-0.0079	3.5512	-0.0015	-0.0097	-0.0687	0.1166
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0075	3.2980	-0.0015	-0.0093	-0.0650	0.1074
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0068	3.0439	-0.0013	-0.0083	-0.0589	0.0985
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	-0.0090	3.8569	-0.0018	-0.0113	-0.0786	0.1277
ULS: 5. 1.2D + E + L + 0.2S	-0.0070	3.1455	-0.0014	-0.0087	-0.0613	0.1021
ULS: 7. 0.9D + 1.0E	-0.0051	2.2829	-0.0010	-0.0062	-0.0441	0.0722
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-6.0302	8.3402	-0.0053	-0.0205	-0.0346	69.3343

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	-0.0075	3.2980	-0.0015	-0.0093	-0.0650	0.1074
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	6.0136	-1.7434	0.0012	-0.0017	-0.0892	-67.0985
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0075	3.2980	-0.0015	-0.0093	-0.0650	0.1074
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-6.0294	8.0861	-0.0051	-0.0195	-0.0286	69.2681
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.0068	3.0439	-0.0013	-0.0083	-0.0589	0.0985
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	6.0142	-1.9974	0.0013	-0.0009	-0.0829	-67.0541
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0068	3.0439	-0.0013	-0.0083	-0.0589	0.0985
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.0202	6.3780	-0.0036	-0.0166	-0.0640	34.5438
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.0090	3.8569	-0.0018	-0.0113	-0.0786	0.1277
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	3.0018	1.3361	-0.0003	-0.0070	-0.0916	-33.7812
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.0090	3.8569	-0.0018	-0.0113	-0.0786	0.1277
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.0179	5.5648	-0.0031	-0.0134	-0.0445	34.4244
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.0068	3.0439	-0.0013	-0.0083	-0.0589	0.0985
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	3.0039	0.5231	0.0002	-0.0041	-0.0716	-33.7232
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.0068	3.0439	-0.0013	-0.0083	-0.0589	0.0985
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-6.0276	7.3250	-0.0047	-0.0172	-0.0143	69.0734
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-0.0051	2.2829	-0.0010	-0.0062	-0.0441	0.0722
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	6.0158	-2.7583	0.0016	0.0010	-0.0678	-66.9232
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	-0.0051	2.2829	-0.0010	-0.0062	-0.0441	0.0722

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0056	2.5366	-0.0011	-0.0069	-0.0490	0.0809
ULS: 2. D + L	-0.0056	2.5366	-0.0011	-0.0069	-0.0490	0.0809
ULS: 3. D + (S or Lr or R)	-0.0070	3.0447	-0.0014	-0.0088	-0.0614	0.0983
ULS: 3. D + (S or Lr or R)	-0.0056	2.5366	-0.0011	-0.0069	-0.0490	0.0809
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0067	2.9177	-0.0013	-0.0083	-0.0583	0.0939
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0056	2.5366	-0.0011	-0.0069	-0.0490	0.0809
ULS: 5b. D + 0.7E	-0.0056	2.5366	-0.0011	-0.0069	-0.0490	0.0809
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0067	2.9177	-0.0013	-0.0083	-0.0583	0.0939
ULS: 8. 0.6D + 0.7E	-0.0034	1.5219	-0.0007	-0.0042	-0.0294	0.0471
ULS: 5a. D + 0.6W_Wind downforce Case A only	-3.6190	5.5617	-0.0032	-0.0131	-0.0318	41.2671
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.0056	2.5366	-0.0011	-0.0069	-0.0490	0.0809
ULS: 5a. D + 0.6W_Wind uplift Case A only	3.6071	-0.4883	0.0006	-0.0021	-0.0640	-40.3821
ULS: 5a. D + 0.6W_Wind uplift Case B only	-0.0056	2.5366	-0.0011	-0.0069	-0.0490	0.0809
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-2.7167	5.1866	-0.0029	-0.0129	-0.0455	30.9523
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0067	2.9177	-0.0013	-0.0083	-0.0583	0.0939
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	2.7030	0.6490	0.0000	-0.0045	-0.0698	-30.3565
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0067	2.9177	-0.0013	-0.0083	-0.0583	0.0939
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-2.7156	4.8054	-0.0026	-0.0114	-0.0364	30.9015
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0056	2.5366	-0.0011	-0.0069	-0.0490	0.0809
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	2.7040	0.2679	0.0002	-0.0032	-0.0605	-30.3329
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0056	2.5366	-0.0011	-0.0069	-0.0490	0.0809
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-3.6166	4.5470	-0.0027	-0.0101	-0.0126	41.1011
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.0034	1.5219	-0.0007	-0.0042	-0.0294	0.0471
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	3.6092	-1.5029	0.0010	0.0005	-0.0441	-40.2891
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	-0.0034	1.5219	-0.0007	-0.0042	-0.0294	0.0471

Worst Case Reactions (LRFD)

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	8.3402
Shear X	-6.0302
Shear Z	-0.0053
Moment X	-0.0205
Moment Y (Twist)	0.0916
Moment Z	69.3343

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

Result	Value (kip, kip-ft)
Axial	5.5617
Shear X	-3.6190
Shear Z	-0.0032
Moment X	-0.0131
Moment Y (Twist)	0.0698
Moment Z	41.2671

Project Details

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

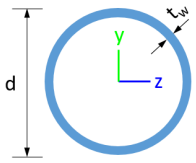
User Name: sales@mtsolar.us
Project Name: Oak Grove
Unit System: imperial

Design Input Information

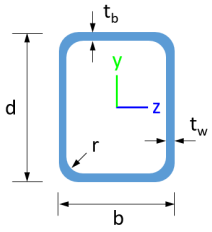
Design Factors			
Φ_t	Φ_c	Φ_b	Φ_v
0.9	0.9	0.9	0.9

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

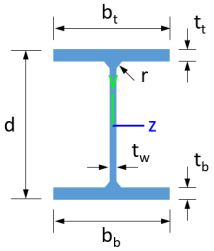
Section Dimensions



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



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



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

Section Properties								
ID	Name	A (in^2)	J (in^4)	I_{yp} (in^4)	I_{zp} (in^4)	I_w (in^6)	S_{yp} (in^3)	S_{zp} (in^3)
2	2in Pipe Sch 80	1.48	1.74	0.87	0.87	0.00	1.02	1.02
5	4in Pipe Sch 80	4.41	19.22	9.61	9.61	0.00	5.85	5.85
9	8in Pipe Sch 40	8.40	144.98	72.49	72.49	0.00	22.21	22.21
16	HSS5x3x3/16	2.58	8.64	3.85	8.53	0.73	2.96	4.21
19	W8x10	2.96	0.04	2.09	30.80	30.90	1.66	8.87

Member Properties								
Member ID	Section ID	$K_z L$ (ft)	$K_y L$ (ft)	L_b (ft)	C_b	LST	LSC	LD
1	9	7.28	7.28	11.20	-	300	200	250
2	5	1.30	1.30	2.00	-	300	200	250
3	16	0.92	0.92	1.42	1.19,1.19,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.17,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19	300	200	250
4	16	2.44	2.44	3.75	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
5	16	1.52	1.52	2.33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
6	16	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19	300	200	250
7	16	1.52	1.52	2.33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
8	19	1.33	1.33	2.05	2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.11,2.12,2.12,2.12,2.11,2.12,2.12,2.12,2.11,2.12,2.12,2.12,2.11,2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.12,2.11,2.12,2.12,2.12,2.11,2.12,2.12,2.12,2.11,2.12,2.12,2.12,2.11,2.12	300	200	250
9	2	2.60	2.60	4.00	-	300	200	250
10	16	2.44	2.44	3.75	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
11	19	1.33	1.33	2.05	2.11,2.11,2.11,2.11,2.11,2.11,2.12,2.11,2.15,2.11,2.12,2.11,2.15,2.11,2.12,2.11,2.21,2.11,2.12,2.11,2.18,2.11,2.12,2.11,2.14,2.11,2.11,2.11,2.11,2.11,2.11,2.11,2.11,2.11,2.11,2.12,2.11,2.16,2.11,2.12,2.11,2.19,2.11,2.12,2.11,2.17,2.11,2.12,2.11,2.14,2.11	300	200	250
12	5	1.30	1.30	2.00	-	300	200	250
13	19	4.88	4.00	7.50	1.10,1.10,1.10,1.10,1.10,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10	300	200	250
14	19	4.88	4.00	7.50	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09	300	200	250
15	19	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
16	19	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
101	9	7.28	7.28	11.20	-	300	200	250
102	5	1.30	1.30	2.00	-	300	200	250
103	16	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.17,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19	300	200	250

104	16	2.44	2.44	3.75	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
105	16	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
106	16	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.17,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19	300	200	250
107	16	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
108	19	1.33	1.33	2.05	2.07,2.07,2.07,2.07,2.07,2.07,2.06,2.07,2.05,2.07,2.06,2.07,2.05,2.07,2.06,2.07,1.92,2.07,2.06,2.07,1.99,2.07,2.06,2.07,2.05,2.07,2.07,2.07,2.07,2.07,2.07,2.07,2.07,2.07,2.07,2.06,2.07,2.03,2.07,2.06,2.07,1.97,2.07,2.06,2.07,2.00,2.07,2.06,2.07,2.05,2.07	300	200	250
109	2	2.60	2.60	4.00	-	300	200	250
110	16	2.44	2.44	3.75	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
111	19	1.33	1.33	2.05	2.08,2.08,2.08,2.08,2.08,2.08,1.94,2.08,1.78,2.08,1.94,2.08,1.79,2.08,2.03,2.08,1.56,2.08,2.00,2.08,1.67,2.08,1.92,2.08,1.81,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,1.96,2.08,1.74,2.08,2.01,2.08,1.64,2.08,1.99,2.08,1.69,2.08,1.93,2.08,1.81,2.08	300	200	250
112	5	1.30	1.30	2.00	-	300	200	250
113	19	4.88	4.00	7.50	1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.05,1.04,1.04,1.04,1.05,1.04,1.04,1.04,1.05,1.04,1.04,1.04,1.05,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.05,1.04,1.04,1.04,1.05,1.04,1.04,1.04,1.05,1.04,1.04,1.04,1.04,1.04	300	200	250
114	19	4.88	4.00	7.50	1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04	300	200	250
115	19	6.63	6.63	10.20	1.15,1.15,1.15,1.15,1.15,1.15,1.13,1.15,1.12,1.15,1.13,1.15,1.12,1.15,1.14,1.15,1.11,1.15,1.13,1.15,1.11,1.15,1.13,1.15,1.12,1.15,1.15,1.15,1.15,1.15,1.15,1.15,1.15,1.15,1.15,1.13,1.15,1.12,1.15,1.13,1.15,1.11,1.15,1.13,1.15,1.11,1.15,1.13,1.15,1.12,1.15	300	200	250
116	19	6.63	6.63	10.20	1.15,1.15,1.15,1.15,1.15,1.15,1.14,1.15,1.14,1.15,1.14,1.15,1.14,1.15,1.14,1.15,1.13,1.15,1.14,1.15,1.13,1.15,1.14,1.15,1.14,1.15,1.15,1.15,1.15,1.15,1.15,1.15,1.15,1.15,1.15,1.14,1.15,1.14,1.15,1.14,1.15,1.13,1.15,1.14,1.15,1.13,1.15,1.14,1.15,1.14,1.15	300	200	250
201	9	7.28	7.28	11.20	-	300	200	250
202	5	1.30	1.30	2.00	-	300	200	250
203	16	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19	300	200	250
204	16	2.44	2.44	3.75	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
205	16	1.52	1.52	2.33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
206	16	0.92	0.92	1.42	1.19,1.19,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.17,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19	300	200	250
207	16	1.52	1.52	2.33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
208	19	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
209	2	2.60	2.60	4.00	-	300	200	250
210	16	2.44	2.44	3.75	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
211	19	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
212	5	1.30	1.30	2.00	-	300	200	250

213	19	4.88	4.00	7.50	1.10,1.10,1.10,1.10,1.10,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10	300	200	250
214	19	4.88	4.00	7.50	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09	300	200	250
215	19	6.63	6.63	10.20	1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.18,1.17,1.17,1.17,1.18,1.17,1.17,1.17,1.18,1.17,1.17,1.17,1.18,1.17,1.18,1.17,1.18,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.18,1.17,1.17,1.17,1.18,1.17,1.17,1.17,1.18,1.17,1.17,1.17,1.18,1.17	300	200	250
216	19	6.63	6.63	10.20	1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17	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	327.66	76.62	76.62	104.32	104.32
2	182.47	181.10	20.19	20.19	54.74	54.74
3	116.10	115.41	15.79	11.10	42.08	23.28
4	116.10	111.33	15.79	11.10	42.08	23.28
5	116.10	114.23	15.79	11.10	42.08	23.28
6	116.10	115.41	15.79	11.10	42.08	23.28
7	116.10	114.23	15.79	11.10	42.08	23.28
8	133.20	123.95	32.87	6.12	40.24	43.62
9	61.16	54.71	3.51	3.51	18.35	18.35
10	116.10	111.33	15.79	11.10	42.08	23.28
11	133.20	123.95	32.87	6.12	40.24	43.62
12	182.47	181.10	20.19	20.19	54.74	54.74
13	133.20	85.85	24.89	6.12	40.24	43.62
14	133.20	85.85	24.93	6.12	40.24	43.62
15	133.20	32.95	32.87	6.12	40.24	43.62
16	133.20	32.95	32.87	6.12	40.24	43.62
101	347.73	327.66	76.62	76.62	104.32	104.32
102	182.47	181.10	20.19	20.19	54.74	54.74
103	116.10	115.41	15.79	11.10	42.08	23.28
104	116.10	111.33	15.79	11.10	42.08	23.28
105	116.10	114.23	15.79	11.10	42.08	23.28
106	116.10	115.41	15.79	11.10	42.08	23.28
107	116.10	114.23	15.79	11.10	42.08	23.28
108	133.20	123.95	32.87	6.12	40.24	43.62
109	61.16	54.71	3.51	3.51	18.35	18.35
110	116.10	111.33	15.79	11.10	42.08	23.28
111	133.20	123.95	32.87	6.12	40.24	43.62
112	182.47	181.10	20.19	20.19	54.74	54.74
113	133.20	85.85	23.78	6.12	40.24	43.62
114	133.20	85.85	23.79	6.12	40.24	43.62
115	133.20	69.16	17.17	6.12	40.24	43.62
116	133.20	69.16	17.50	6.12	40.24	43.62
201	347.73	327.66	76.62	76.62	104.32	104.32
202	182.47	181.10	20.19	20.19	54.74	54.74
203	116.10	115.41	15.79	11.10	42.08	23.28
204	116.10	111.33	15.79	11.10	42.08	23.28
205	116.10	114.23	15.79	11.10	42.08	23.28
206	116.10	115.41	15.79	11.10	42.08	23.28
207	116.10	114.23	15.79	11.10	42.08	23.28

208	133.20	32.95	32.87	6.12	40.24	43.62
209	61.16	54.71	3.51	3.51	18.35	18.35
210	116.10	111.33	15.79	11.10	42.08	23.28
211	133.20	32.95	32.87	6.12	40.24	43.62
212	182.47	181.10	20.19	20.19	54.74	54.74
213	133.20	85.85	24.89	6.12	40.24	43.62
214	133.20	85.85	24.94	6.12	40.24	43.62
215	133.20	69.16	18.10	6.12	40.24	43.62
216	133.20	69.16	18.11	6.12	40.24	43.62

Design Ratio

Member ID	P	M_z	M_y	V_y	V_z	(P,M_z,M_y)	Worst LC	KL/r	δ	Status
1	0.025	0.905	0.001	0.058	0.000	0.918	#13	0.149	Not Required	Pass
2	0.002	0.326	0.289	0.072	0.055	0.616	#13	0.035	Not Required	Pass
3	0.006	0.576	0.031	0.058	0.004	0.604	#13	0.045	Not Required	Pass
4	0.005	0.573	0.094	0.057	0.019	0.625	#13	0.080	Not Required	Pass
5	0.005	0.357	0.097	0.057	0.024	0.376	#13	0.074	Not Required	Pass
6	0.006	0.579	0.035	0.058	0.004	0.610	#13	0.045	Not Required	Pass
7	0.006	0.360	0.099	0.058	0.025	0.382	#13	0.074	Not Required	Pass
8	0.000	0.044	0.085	0.040	0.009	0.106	#21	0.095	Not Required	Pass
9	0.009	0.044	0.057	0.001	0.000	0.103	#13	0.204	Not Required	Pass
10	0.006	0.572	0.096	0.057	0.020	0.626	#13	0.080	Not Required	Pass
11	0.000	0.043	0.086	0.041	0.009	0.109	#21	0.095	Not Required	Pass
12	0.002	0.328	0.287	0.073	0.056	0.616	#13	0.035	Not Required	Pass
13	0.004	0.231	0.231	0.052	0.012	0.408	#13	0.286	Not Required	Pass
14	0.005	0.233	0.231	0.051	0.012	0.408	#13	0.190	Not Required	Pass
15	0.000	0.088	0.123	0.030	0.007	0.190	#13	Not Required	Not Required	Pass
16	0.000	0.088	0.123	0.030	0.007	0.190	#13	Not Required	Not Required	Pass
101	0.027	0.931	0.000	0.060	0.000	0.944	#13	0.149	Not Required	Pass
102	0.002	0.339	0.294	0.076	0.057	0.633	#13	0.035	Not Required	Pass
103	0.006	0.597	0.038	0.060	0.006	0.631	#13	0.045	Not Required	Pass
104	0.006	0.599	0.092	0.060	0.020	0.655	#13	0.080	Not Required	Pass
105	0.006	0.371	0.095	0.059	0.024	0.391	#13	0.074	Not Required	Pass
106	0.006	0.597	0.038	0.060	0.006	0.631	#13	0.045	Not Required	Pass
107	0.006	0.371	0.095	0.059	0.024	0.391	#13	0.074	Not Required	Pass
108	0.000	0.055	0.084	0.038	0.009	0.100	#21	0.095	Not Required	Pass
109	0.008	0.040	0.054	0.001	0.000	0.098	#13	0.204	Not Required	Pass
110	0.006	0.599	0.092	0.060	0.020	0.655	#13	0.080	Not Required	Pass
111	0.000	0.059	0.086	0.038	0.009	0.100	#21	0.095	Not Required	Pass
112	0.002	0.339	0.294	0.076	0.057	0.633	#13	0.035	Not Required	Pass
113	0.004	0.172	0.220	0.049	0.012	0.340	#13	0.286	Not Required	Pass
114	0.005	0.184	0.219	0.049	0.012	0.347	#13	0.286	Not Required	Pass
115	0.000	0.216	0.121	0.038	0.009	0.316	#13	0.473	Not Required	Pass
116	0.000	0.212	0.122	0.038	0.009	0.313	#13	0.473	Not Required	Pass
201	0.025	0.905	0.001	0.058	0.000	0.918	#13	0.149	Not Required	Pass
202	0.002	0.328	0.287	0.073	0.056	0.616	#13	0.035	Not Required	Pass
203	0.006	0.579	0.035	0.058	0.004	0.610	#13	0.045	Not Required	Pass
204	0.006	0.572	0.096	0.057	0.020	0.626	#13	0.080	Not Required	Pass
205	0.006	0.359	0.099	0.058	0.025	0.382	#13	0.074	Not Required	Pass
206	0.006	0.576	0.031	0.058	0.004	0.604	#13	0.045	Not Required	Pass

206	0.000	0.370	0.091	0.038	0.004	0.004	#13	0.049	Not Required	Pass
207	0.005	0.357	0.097	0.057	0.024	0.376	#13	0.074	Not Required	Pass
208	0.000	0.088	0.123	0.030	0.007	0.190	#13	Not Required	Not Required	Pass
209	0.009	0.044	0.057	0.001	0.000	0.103	#13	0.204	Not Required	Pass
210	0.005	0.573	0.094	0.057	0.019	0.625	#13	0.080	Not Required	Pass
211	0.000	0.088	0.123	0.030	0.007	0.190	#13	Not Required	Not Required	Pass
212	0.002	0.326	0.289	0.072	0.055	0.616	#13	0.035	Not Required	Pass
213	0.004	0.231	0.231	0.052	0.012	0.408	#13	0.190	Not Required	Pass
214	0.005	0.233	0.231	0.051	0.012	0.408	#13	0.286	Not Required	Pass
215	0.000	0.210	0.121	0.041	0.009	0.310	#13	0.473	Not Required	Pass
216	0.000	0.207	0.122	0.040	0.009	0.308	#13	0.473	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

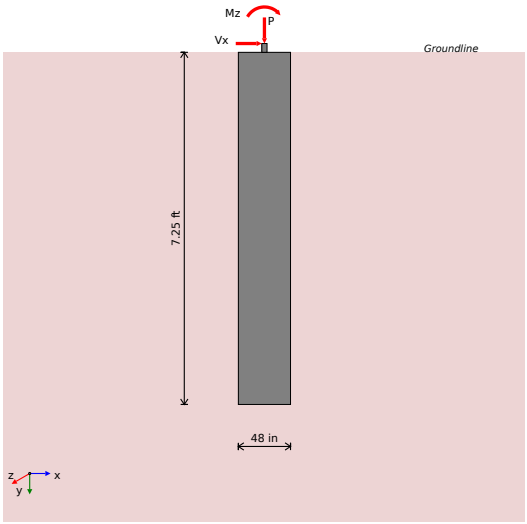
Input	Description	Value
f'_{ck}	Concrete compressive strength	2.5 ksi
f_{yk}	Yield strength of steel	60 ksi
d_b	Rebar diameter	#5 (0.625) in
cover	Concrete cover	3 in

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	5.562 kip	8.34 kip
Vx	-3.619 kip	-6.03 kip
Vz	-0.003 kip	-0.005 kip
Mx	-0.013 kip-ft	-0.021 kip-ft
Mz	41.27 kip-ft	69.33 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

$$H_o = \frac{V_x}{1.57 \times D} = \frac{-3.619}{1.57 \times 48} = -0.576\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{41.27 + (-3.619 \times 0)}{1.57 \times 48} = 6.571 \ \frac{kip - ft}{ft}$$

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:

$$L_{e,x} = 6.66 \ ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{-0.003}{1.57 \times 48} = -0.001 \ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{1.57 \times b} = \frac{-0.013 + (-0.003 \times 0)}{1.57 \times 48} = -0.002 \ \frac{kip - ft}{ft}$$

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:

$$L_{e,z} = -0.531 \ ft$$

Minimum embedded depth

Depth of pile required

$$L_{e,req} = MAX[L_{e,x}, L_{e,z}] = MAX[6.66, -0.531] = 6.66 \ ft$$

Actual embedded length

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

Utilisation

$$Ratio = \frac{L_{e,req}}{L_e} = \frac{6.66}{7.25} = 0.919$$

UTILITY: 0.92

REFERENCES	CALCULATIONS	RESULTS

End-bearing Capacity (ASD)

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

Cross-sectional area:

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

End-bearing pressure:

$$q = \frac{P}{A} = \frac{5.562}{16} = 347.6 \ psf$$

Utilisation

$$Ratio = \frac{q}{q_a} = \frac{347.6}{2000} = 0.174$$

UTILITY: 0.17

Lateral Soil Pressure (ASD)

Allowable lateral pressure	$R =$	150 psf/ft

Length to least lateral dimension ratio:

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

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

Considering x-direction:

Distance from resting surface to pivot point:

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

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

$$a = \frac{(4 \times 6.571 \times 7.25) + (3 \times 0.576 \times 7.25^2)}{(6 \times 6.571) + (4 \times 0.576 \times 7.25)} = 5.013\ ft$$

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

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

$$p = \frac{0.75 \times [(4 \times 6.571) + (3 \times -0.576 \times 7.25)]^2}{7.25^2 \times [(3 \times 6.571) + (2 \times -0.576 \times 7.25)]} = 0.238\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{5.013}{2} = 0.376\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{0.238}{0.376} = 0.632$$

UTILITY: 0.63

Earth pressure against the pile at distance L_e:

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times 6.571) + (-0.576 \times 7.25)]}{7.25^2} = 1.023\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

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

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{1.023}{1.087} = 0.941$$

UTILITY: 0.94

Considering z-direction:

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.002 \times 7.25) + (3 \times 0.001 \times 7.25^2)}{(6 \times 0.002) + (4 \times 0.001 \times 7.25)} = 5.161\ ft$$

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

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

$$p = \frac{0.75 \times [(4 \times -0.002) + (3 \times -0.001 \times 7.25)]^2}{7.25^2 \times [(3 \times -0.002) + (2 \times -0.001 \times 7.25)]} = 0\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{5.161}{2} = 0.387\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{0}{0.387} = -0.001$$

UTILITY: 0.00

Earth pressure against the pile at distance L_e:

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times -0.002) + (-0.001 \times 7.25)]}{7.25^2} = -0.001\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

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

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{-0.001}{1.087} = -0.001$$

UTILITY: 0.00

REFERENCES	CALCULATIONS	RESULTS

Shear force and bending moment (LRFD)

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{1.57 \times D} = \frac{-6.03}{1.57 \times 48} = -0.96 \, \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{69.33 + (-6.03 \times 0)}{1.57 \times 48} = 11.04 \, \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 11.04 \times 7.25) + (3 \times 0.96 \times 7.25^2)}{(6 \times 11.04) + (4 \times 0.96 \times 7.25)} = 5.012 \, ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{11.04}{-0.96} = 11.5 \, ft$$

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

$$V_{max,x} = (-0.96 \times 48) \times [1 - [3 \times \left(\frac{4 \times 11.5}{7.25} + 3\right) \times \left(\frac{5.012}{7.25}\right)^2] + [4 \times \left(\frac{3 \times 11.5}{7.25} + 2\right) \times \left(\frac{5.012}{7.25}\right)^3]]$$

$$V_{max,x} = 13.31 \, kip$$

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

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

$$M_{max,x} = (-0.96 \times 48 \times 7.25) \times [\left(\frac{11.5}{7.25} + \frac{5.012}{2 \times 7.25}\right) - [\left(\frac{4 \times 11.5}{7.25} + 3\right) \times \left(\frac{5.012}{2 \times 7.25}\right)^3] + [\left(\frac{3 \times 11.5}{7.25} + 2\right) \times \left(\frac{5.012}{2 \times 7.25}\right)^4]]$$

$$M_{max,x} = 45.73 \, kip - ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{-0.005}{1.57 \times 48} = -0.001 \, \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{1.57 \times b} = \frac{-0.021 + (-0.005 \times 0)}{1.57 \times 48} = -0.003 \, \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.003 \times 7.25) + (3 \times 0.001 \times 7.25^2)}{(6 \times 0.003) + (4 \times 0.001 \times 7.25)} = 5.169 \, ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{-0.003}{-0.001} = 3.861 \, ft$$

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

$$V_{max,z} = (-0.001 \times 48) \times [1 - [3 \times \left(\frac{4 \times 3.861}{7.25} + 3\right) \times \left(\frac{5.169}{7.25}\right)\ ] + [4 \times \left(\frac{3 \times 3.861}{7.25} + 2\right) \times \left(\frac{5.169}{7.25}\right)^{3}\ ]]$$

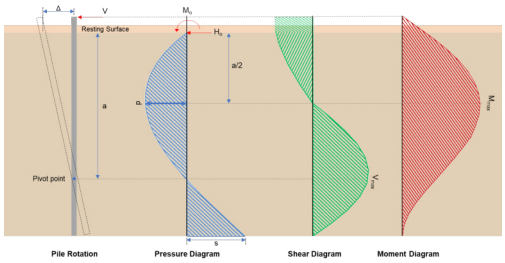
$$V_{max,z} = 0.005\ kip$$

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

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

$$M_{max,z} = (-0.001 \times 48 \times 7.25) \times [\left(\frac{3.861}{7.25} + \frac{5.169}{2 \times 7.25}\right) - [\left(\frac{4 \times 3.861}{7.25} + 3\right) \times \left(\frac{5.169}{2 \times 7.25}\right)^{3}\ ] + [\left(\frac{3 \times 3.861}{7.25} + 2\right) \times \left(\frac{5.169}{2 \times 7.25}\right)^{4}\ ]]$$

$$M_{max,z} = 0.018\ kip - ft$$



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:

$$A_{st,req} = \frac{P - (0.85 \times f'_{ck} \times A_g)}{f_{yk} - (0.85 \times f'_{ck})} = \frac{8.34 - (0.85 \times 2.5 \times 2304)}{60 - (0.85 \times 2.5)} = -84.45\ in^2$$

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

$$Ratio = \frac{P}{\phi P_N} = \frac{8.34}{2694} = 0.003$$

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	$V_{max,x} =$	13.31 kip
Maximum shear in the z-direction	$V_{max,z} =$	0.005 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:

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

$$V_{c,a} = \left(2 \times 1 \times \sqrt{2.5} + MIN[\frac{8.34}{6 \times 2304}, (0.05 \times 2.5)]\right) \times (48 \times 44.31) = 214\ kip$$

Governing shear strength of concrete:

$$V_c = MIN[V_{c,max}, V_{c,a}] = MIN[531.8, 214] = 214\ kip$$

22.5.1.2 Shear strength of steel (a):

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

22.5.8.5.3 Shear strength of steel (b):

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

Governing shear strength of steel:

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

22.5.1.1 Allowable shear strength:

$$\phi V_n = \phi \times (V_c + V_s) = 0.75 \times (214 + 58.73) = 204.5\ kip$$

$$V_{max} = MAX[13.31, 0.005] = 13.31\ kip$$

Utilisation

$$Ratio = \frac{V_{max}}{\phi V_n} = \frac{13.31}{204.5} = 0.065$$

UTILITY: 0.07

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	$P =$	8.34 kip
Maximum moment in the x-direction	$M_{max,x} =$	45.73 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$	0.018 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:

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

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

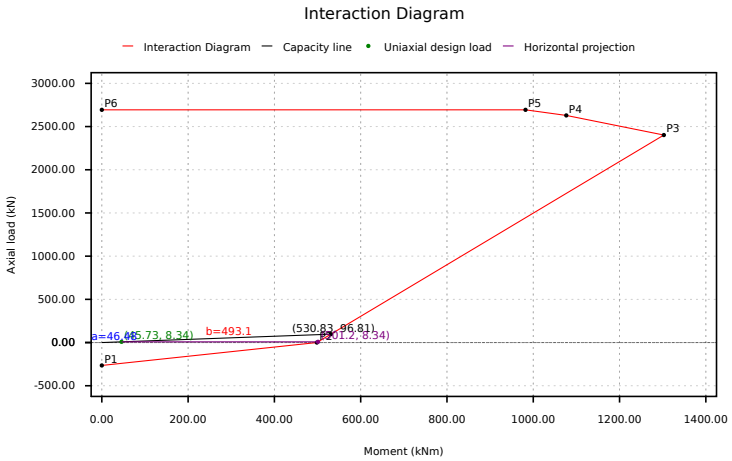
$$f_2 = E_s \times \varepsilon_2 \ (\varepsilon_2 < \varepsilon_{sy}),\ f_2 = \phi_s \times f_y \ (\varepsilon_2 \geq \varepsilon_{sy})$$

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

$$M_f = MAX[45.73, 0.018] = 45.73\ kip - ft$$



Segment	Signed Distance
P1 - P2	219.9
P2 - P3	431.9
P3 - P4	2580
P4 - P5	2744
P5 - P6	2685
Status	PASS: Point lies inside the curve

Utilisation

$$Ratio = \frac{a}{a+b} = \frac{46.48}{46.48 + 493.1} = 0.086$$

UTILITY: 0.09

Biaxial Bending Check

Maximum moment in the x-direction	$M_{max,x} =$	45.73 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$	0.018 kip-ft
Nominal uniaxial moment strength about the x-axis	$M_{nox} =$	501.2 kip-ft
Nominal uniaxial moment strength about the z-axis	$M_{noz} =$	501.2 kip-ft
Interaction exponent	$\alpha =$	1

Bresler (1960)	According to Bresler (method B): $$\left(\frac{M_{max,x}}{M_{nox}}\right)^{\alpha}+\left(\frac{M_{max,z}}{M_{noz}}\right)^{\alpha}=1.0$$ $$\left(\frac{45.73}{501.2}\right)^{1}+\left(\frac{0.018}{501.2}\right)^{1}=0.091$$	**UTILITY: 0.09**

REFERENCES	CALCULATIONS	RESULTS

Results Summary

Result Name	Results
PILE DETAILS	
Length of the pile	7.25 ft
Dimensions	48 x 48 in
Main bar reinforcement	#5-16pcs at 1.5 in min.
Shear reinforcement	#3 at 10 in max.
UTILISATIONS	
Required depth	0.92
End-bearing capacity	0.17
p_a	0.63
p_s	0.94
Axial compression strength	0.00
Shear strength	0.07
Uniaxial bending strength	0.09
Biaxial bending strength	0.09