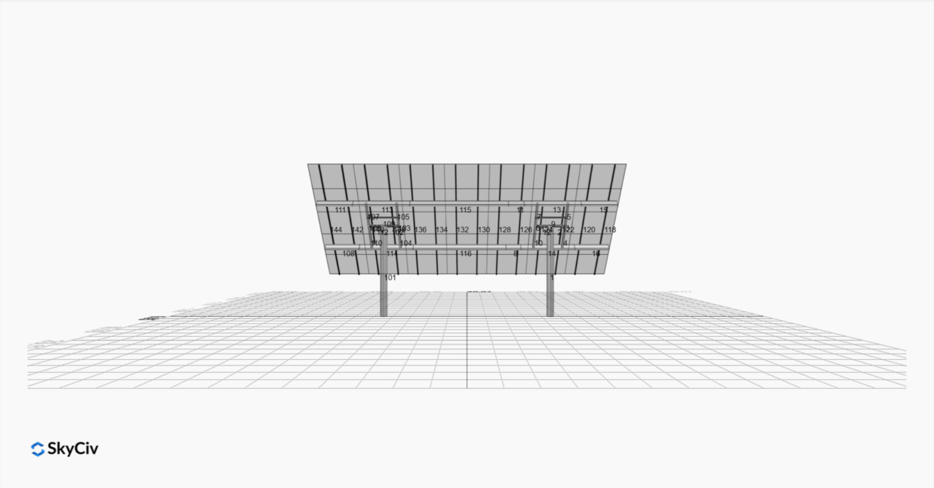
Project Details

Project Name: MTSOLAR_ADB9498061EF
Date: Sat Nov 08 2025
Location: 20 Sherry Rd, Harvard, MA 01451, USA
Number of Modules: 35
Unique ID: 2P-22.5-10TOP-XD-57-L-5Hx7W-E7LL
Number of Poles: 2
Dealer: ______________________________
Date Sold: ______________________________



Array Dimensions N/S	18.83 ft
Array Dimensions E/W	40.13 ft
Winter Tilt Angle (Degrees)	50
Front Edge Clearance	5

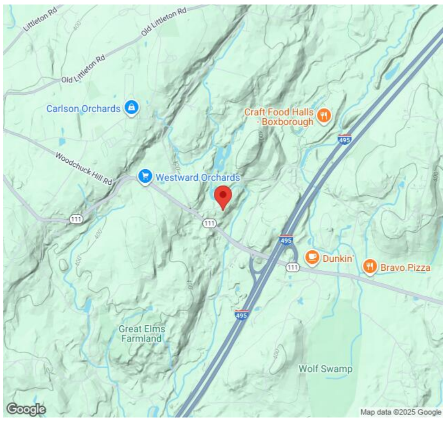
MT Solar Bill of Materials (2P-22.5-10TOP-XD-57-L-5Hx7W-E7LL)

Part	Short Description	BOM Qty
MTS-PC-10	10IN Pole Cap Assembly	2
MTS-HF-XD	H-Frame Assembly-XD	2
MTS-XD-Wing-57	57IN XD Wing	4
MTS-XD-Splice-90	90IN XD Splice	4
MTS-CLAMP-ANGLE-4PK	Angle Clamp	7

Rail Bill of Materials

Part	Qty
Rails (226in Long)	14x
Rail Attachment	56x
Module Mid Clamp	56x
Module End Clamp	28x
Ground Lug	7x

Site Details:



Site Address: 20 Sherry Rd, Harvard, MA 01451, USA

Array Specifications

Duty Classification:	XD
Module Width:	44.70 in
Module Length:	67.80 in
Number of Rows:	5
Number of Columns:	7
Total Number of Modules:	35
Winter Tilt Angle:	50
Front Edge Clearance:	5
Total Array Height at Tilt:	19.43 ft
Total Frame Length:	39.50 ft
Module Info/Notes:	ts
Array Dimensions N/S:	18.83 ft
Array Dimensions E/W:	40.13 ft
Rail Length:	226.00 in
Rail Spacing:	2.87 ft

Support Specifications

Pole Size:	10in Pipe Sch 40
Pole Length above Grade:	12.21 ft
Number of Poles:	2
Pole Spacing:	22.5 ft

Foundation Specifications

Foundation Type:	rectangular
Foundation Dimensions:	48x48 in
Foundation Depth (below grade):	8.3 ft
Foundation Volume:	132.00 ft^3

Site Info

Risk Category:	I
Exposure:	C
Soil Classification:	sand
Site Location:	20 Sherry Rd, Harvard, MA 01451, USA
Wind Speed:	116 mph

Snow Load:	50 psf

Design Disclaimer

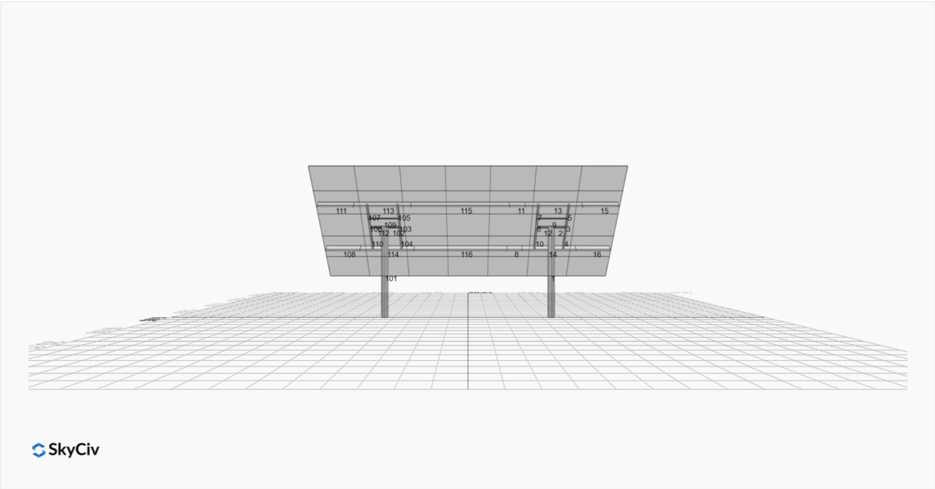
This software should be used for preliminary designs and should not be used as a final design unless reviewed, verified and designed by a qualified structural engineer.

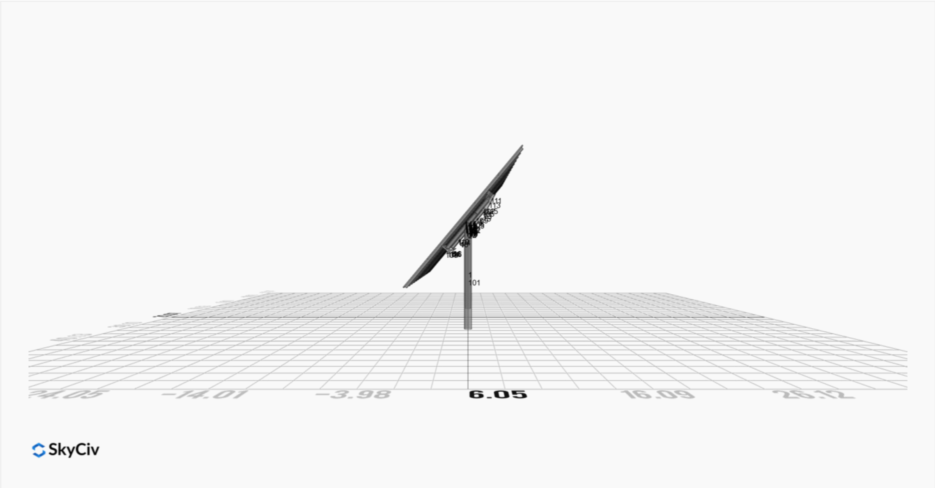
AutoDesigner Input

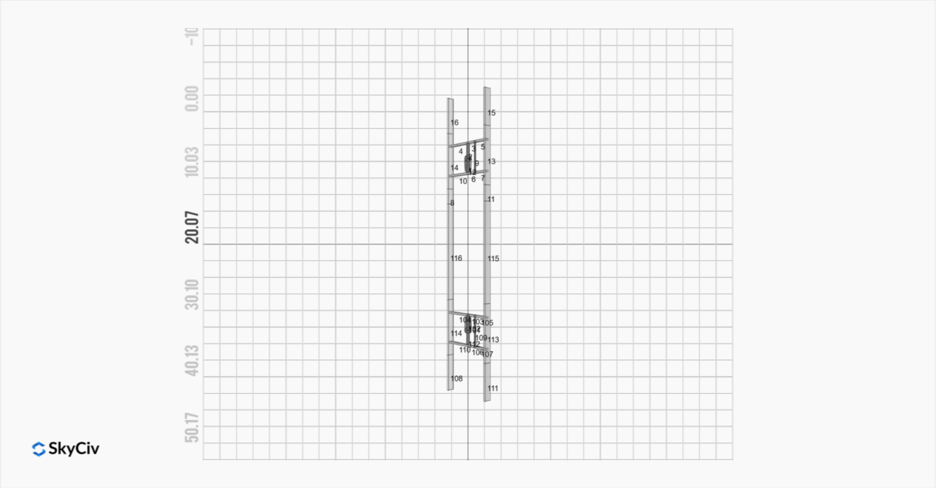
{"product_type":"Beam","designer_name":"Jeff","designer_email":"jbfeddersen@gmail.com","designer_phone":"3472770806","project_id":"MTSOLAR_ADB9498061EF","site_address":"20 Sherry Rd, Harvard, MA 01451, USA","module_info":"ts","module_width":44.7,"module_length":67.8,"number_rows":"5","number_columns":7,"pole_mount_section":"4_40","core_pipe_width":65,"core_pipe_section":"2_40","adjuster_section":"2_40","core_beam_height":65,"core_beam_section":"HSS3x2x1/8","main_pipe_section":"2_12GA","pole_spacing":"15","tilt_angle":50,"ground_clearance":5,"risk_category":"I","exposure_category":"C","frame_duty_override":"auto","pole_override":"auto","soil_type":"sand","customer_foundation_override":"48_Square","foundation_type":"Square","foundation_size":48,"check_rails":false,"wind_speed_override":116,"snow_load_override":50,"direct_snow_load":false,"add_angle_brace":false}

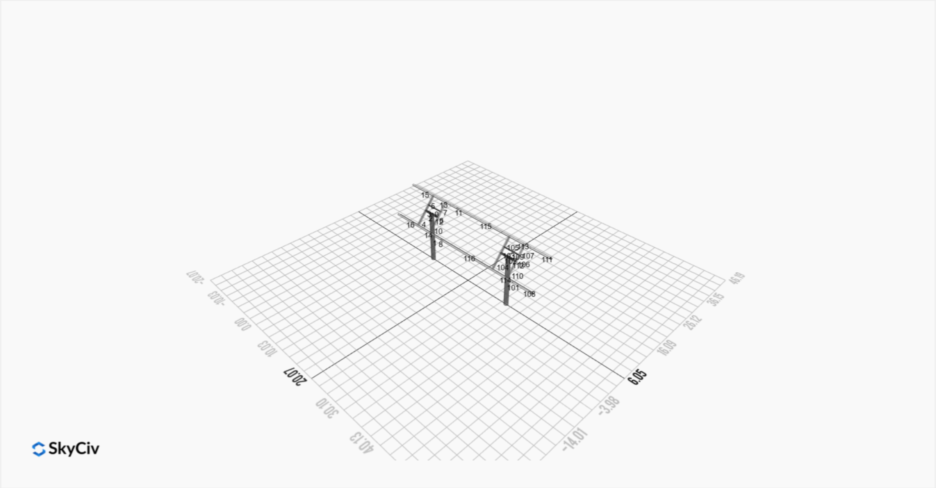
Design Notes:

- Deflection checks are set to L/1 due to manufacturer structural design intent
- Foundation Soil Parameters used in this Autodesign are all estimates, proper geotechnical reports are required to confirm soil profiles
- Wind speeds, snow loads and other site specific results are based on ASCE 7-16
- Steel frame design checks are based on AISC 360-16 LRFD
- Design / analysis of fixings and connections are not carried out by this module.
- Impacts of eccentrically applied, partial or pattern loading are not considered by this module.
- Foundation Design and Sizing is approximate only






SkyCiv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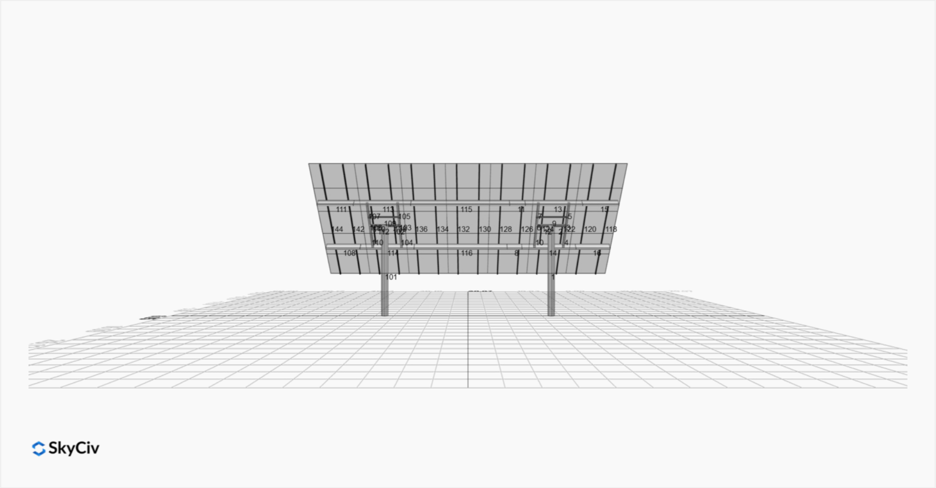
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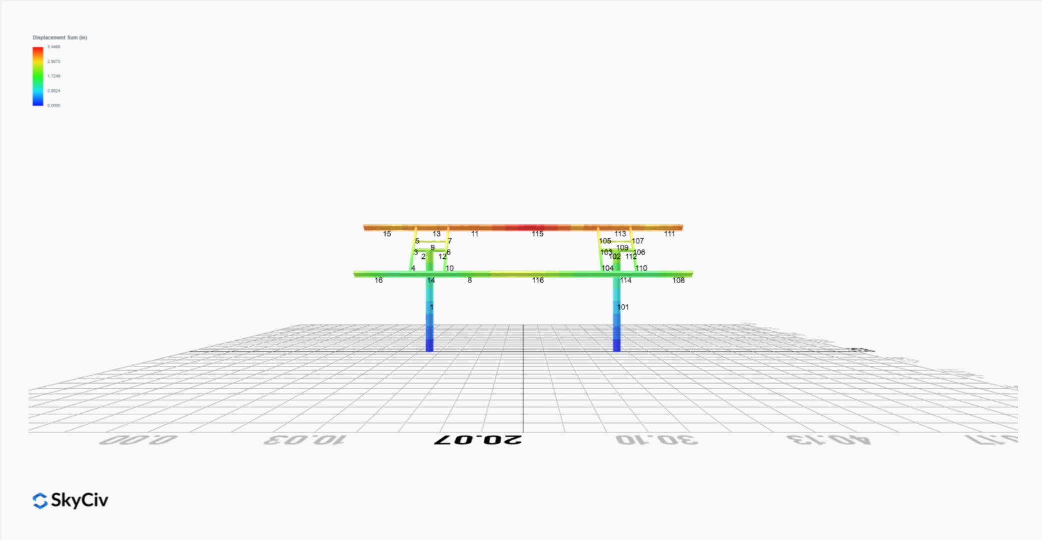
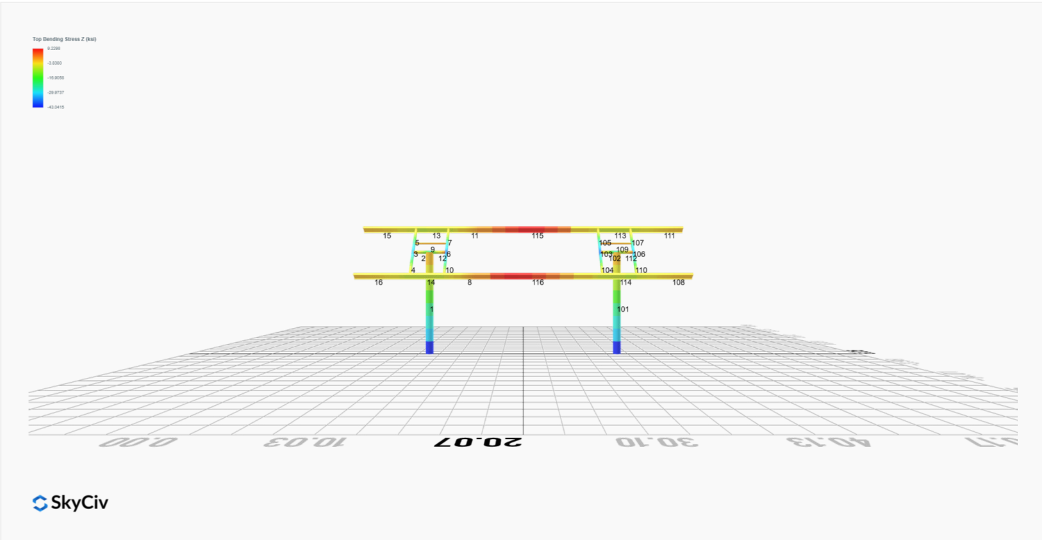
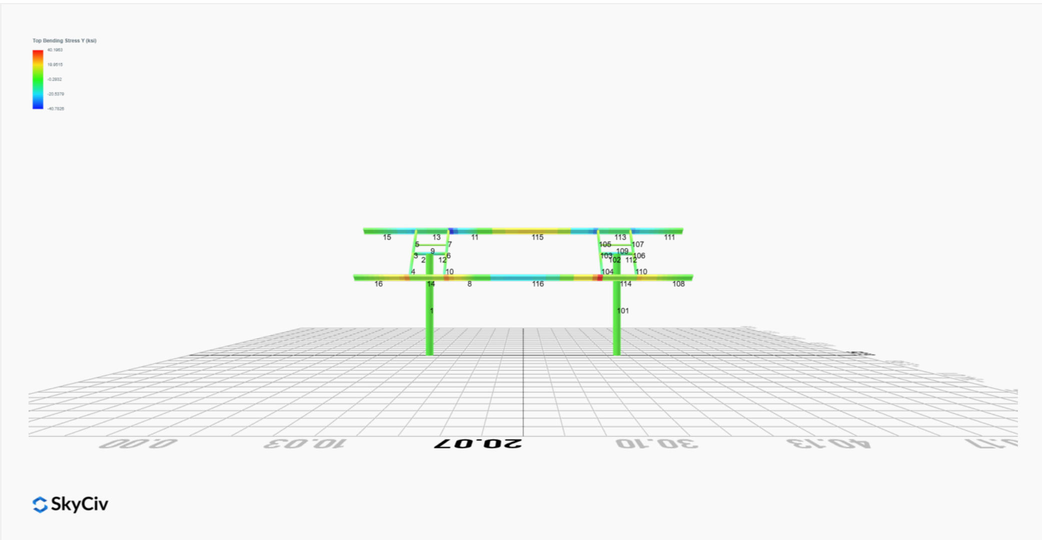
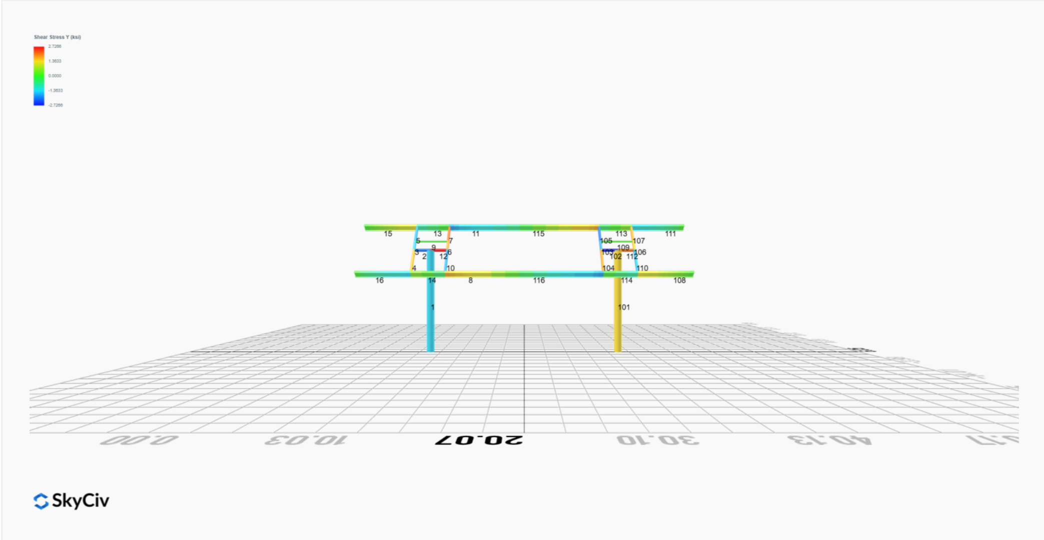
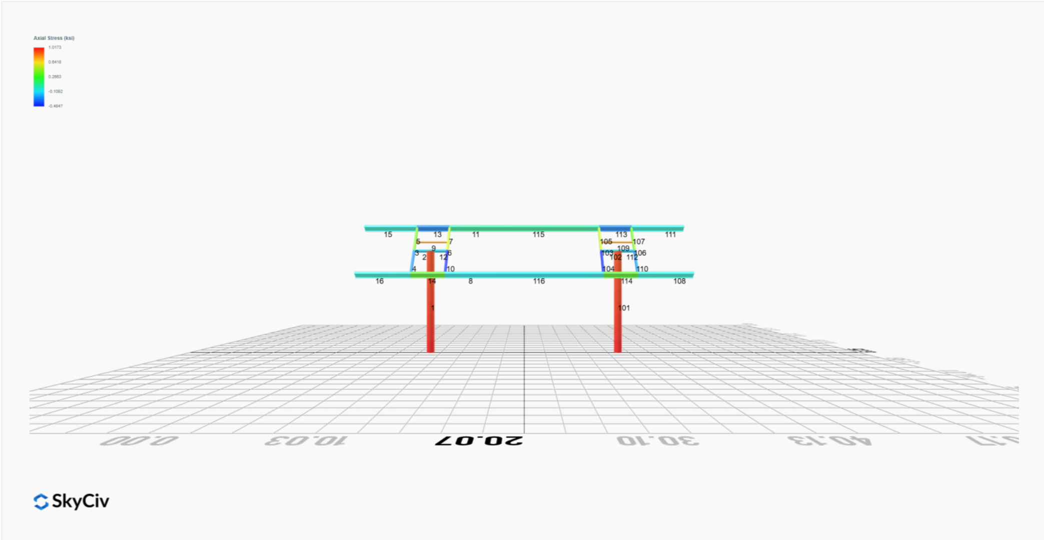
FEM Results (Envelope Worst Case)








Shear Stress Y (ksi)
2.7266
1.3633
0.0000
-1.3633
-2.7266
SkyCiv


Axial Stress (ksi)
1.0173
0.6418
0.2663
-0.1092
-0.4847
SkyCiv

Reaction Forces for Foundation 1 (Node ID#1), (kip, kip-ft)

LRFD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. 1.4D	0.0000	4.1483	0.0572	0.2014	-0.0197	0.0395
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	4.8913	0.0740	0.2612	-0.0258	0.0419
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	3.5557	0.0490	0.1724	-0.0169	0.0326
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0000	7.8297	0.1293	0.4592	-0.0450	0.0757
ULS: 5. 1.2D + E + L + 0.2S	0.0000	4.0899	0.0590	0.2078	-0.0205	0.0359
ULS: 7. 0.9D + 1.0E	0.0000	2.6668	0.0367	0.1290	-0.0127	0.0230
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-8.6084	12.1146	0.2283	0.7446	-1.0335	107.2580
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0000	4.8913	0.0740	0.2612	-0.0258	0.0419
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	8.6084	-2.3320	-0.0798	-0.2198	0.9812	-104.7951
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0000	4.8913	0.0740	0.2612	-0.0258	0.0419
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-8.6084	10.7790	0.2034	0.6563	-1.0256	106.9986
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	0.0000	3.5557	0.0490	0.1724	-0.0169	0.0326
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	8.6084	-3.6676	-0.1049	-0.3090	0.9910	-104.5670
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.0000	3.5557	0.0490	0.1724	-0.0169	0.0326
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-4.3042	11.4414	0.2063	0.7001	-0.5476	53.6542
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0000	7.8297	0.1293	0.4592	-0.0450	0.0757
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	4.3042	4.2181	0.0525	0.2188	0.4574	-52.9012
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0000	7.8297	0.1293	0.4592	-0.0450	0.0757
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-4.3042	7.1673	0.1261	0.4140	-0.5212	53.2138
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	0.0000	3.5557	0.0490	0.1724	-0.0169	0.0326
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	4.3042	-0.0560	-0.0280	-0.0686	0.4872	-52.5571
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.0000	3.5557	0.0490	0.1724	-0.0169	0.0326
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-8.6084	9.8901	0.1912	0.6131	-1.0219	106.8271
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	0.0000	2.6668	0.0367	0.1290	-0.0127	0.0230
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	8.6084	-4.5566	-0.1172	-0.3525	0.9957	-104.4229
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	0.0000	2.6668	0.0367	0.1290	-0.0127	0.0230

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0000	2.9631	0.0408	0.1434	-0.0141	0.0261
ULS: 2. D + L	0.0000	2.9631	0.0408	0.1434	-0.0141	0.0261
ULS: 3. D + (S or Lr or R)	0.0000	5.6343	0.0908	0.3212	-0.0318	0.0459
ULS: 3. D + (S or Lr or R)	0.0000	2.9631	0.0408	0.1434	-0.0141	0.0261
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	4.9665	0.0783	0.2765	-0.0274	0.0396
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	2.9631	0.0408	0.1434	-0.0141	0.0261
ULS: 5b. D + 0.7E	0.0000	2.9631	0.0408	0.1434	-0.0141	0.0261
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0000	4.9665	0.0783	0.2765	-0.0274	0.0396
ULS: 8. 0.6D + 0.7E	0.0000	1.7778	0.0244	0.0858	-0.0085	0.0143
ULS: 5a. D + 0.6W_Wind downforce Case A only	-5.1650	7.2970	0.1334	0.4335	-0.6195	63.8514
ULS: 5a. D + 0.6W_Wind downforce Case B only	0.0000	2.9631	0.0408	0.1434	-0.0141	0.0261
ULS: 5a. D + 0.6W_Wind uplift Case A only	5.1650	-1.3709	-0.0516	-0.1457	0.5910	-62.9495
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.0000	2.9631	0.0408	0.1434	-0.0141	0.0261
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.8738	8.2170	0.1477	0.4937	-0.4807	47.9940
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0000	4.9665	0.0783	0.2765	-0.0274	0.0396
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.8738	1.7160	0.0090	0.0598	0.4257	-47.4330
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0000	4.9665	0.0783	0.2765	-0.0274	0.0396

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.8738	6.2135	0.1102	0.3609	-0.4681	47.8143
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0000	2.9631	0.0408	0.1434	-0.0141	0.0261
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.8738	-0.2874	-0.0285	-0.0735	0.4397	-47.2841
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0000	2.9631	0.0408	0.1434	-0.0141	0.0261
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-5.1650	6.1118	0.1171	0.3761	-0.6142	63.7119
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	0.0000	1.7778	0.0244	0.0858	-0.0085	0.0143
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	5.1650	-2.5561	-0.0680	-0.2035	0.5970	-62.8373
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.0000	1.7778	0.0244	0.0858	-0.0085	0.0143

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	12.1146
Shear X	-8.6084
Shear Z	0.2283
Moment X	0.7446
Moment Y (Twist)	1.0335
Moment Z	107.2580

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	8.2170
Shear X	-5.1650
Shear Z	0.1477
Moment X	0.4937
Moment Y (Twist)	0.6195
Moment Z	63.8514

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

LRFD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. 1.4D	-0.0000	4.1483	-0.0572	-0.2014	0.0199	0.0397
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0000	4.8913	-0.0740	-0.2613	0.0260	0.0422
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0000	3.5557	-0.0490	-0.1724	0.0170	0.0327
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	-0.0000	7.8297	-0.1293	-0.4596	0.0456	0.0762
ULS: 5. 1.2D + E + L + 0.2S	-0.0000	4.0899	-0.0590	-0.2078	0.0206	0.0360
ULS: 7. 0.9D + 1.0E	-0.0000	2.6668	-0.0367	-0.1290	0.0128	0.0230
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-8.6084	12.1146	-0.2283	-0.7450	1.0339	107.2596
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.0000	4.8913	-0.0740	-0.2613	0.0260	0.0422
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	8.6084	-2.3320	0.0798	0.2200	-0.9812	-104.7962
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0000	4.8913	-0.0740	-0.2613	0.0260	0.0422
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-8.6084	10.7790	-0.2034	-0.6565	1.0259	107.0001
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.0000	3.5557	-0.0490	-0.1724	0.0170	0.0327
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	8.6084	-3.6676	0.1049	0.3091	-0.9911	-104.5682
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	-0.0000	3.5557	-0.0490	-0.1724	0.0170	0.0327
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-4.3042	11.4413	-0.2063	-0.7008	0.5484	53.6555
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.0000	7.8297	-0.1293	-0.4596	0.0456	0.0762
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	4.3042	4.2181	-0.0525	-0.2190	-0.4570	-52.9014
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.0000	7.8297	-0.1293	-0.4596	0.0456	0.0762
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-4.3042	7.1673	-0.1261	-0.4141	0.5214	53.2146
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.0000	3.5557	-0.0490	-0.1724	0.0170	0.0327
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	4.3042	-0.0560	0.0280	0.0687	-0.4871	-52.5576
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	-0.0000	3.5557	-0.0490	-0.1724	0.0170	0.0327
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-8.6084	9.8900	-0.1912	-0.6132	1.0221	106.8281
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-0.0000	2.6668	-0.0367	-0.1290	0.0128	0.0230
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	8.6084	-4.5565	0.1172	0.3527	-0.9958	-104.4238
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	-0.0000	2.6668	-0.0367	-0.1290	0.0128	0.0230

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0000	2.9631	-0.0408	-0.1435	0.0142	0.0261
ULS: 2. D + L	-0.0000	2.9631	-0.0408	-0.1435	0.0142	0.0261
ULS: 3. D + (S or Lr or R)	-0.0000	5.6343	-0.0908	-0.3214	0.0321	0.0462
ULS: 3. D + (S or Lr or R)	-0.0000	2.9631	-0.0408	-0.1435	0.0142	0.0261
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0000	4.9665	-0.0783	-0.2766	0.0277	0.0398
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0000	2.9631	-0.0408	-0.1435	0.0142	0.0261
ULS: 5b. D + 0.7E	-0.0000	2.9631	-0.0408	-0.1435	0.0142	0.0261
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0000	4.9665	-0.0783	-0.2766	0.0277	0.0398
ULS: 8. 0.6D + 0.7E	-0.0000	1.7778	-0.0244	-0.0858	0.0085	0.0144
ULS: 5a. D + 0.6W_Wind downforce Case A only	-5.1650	7.2970	-0.1334	-0.4337	0.6196	63.8522
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.0000	2.9631	-0.0408	-0.1435	0.0142	0.0261
ULS: 5a. D + 0.6W_Wind uplift Case A only	5.1650	-1.3709	0.0516	0.1458	-0.5909	-62.9500
ULS: 5a. D + 0.6W_Wind uplift Case B only	-0.0000	2.9631	-0.0408	-0.1435	0.0142	0.0261
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.8738	8.2170	-0.1477	-0.4940	0.4810	47.9948
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0000	4.9665	-0.0783	-0.2766	0.0277	0.0398
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.8738	1.7160	-0.0090	-0.0598	-0.4256	-47.4333
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0000	4.9665	-0.0783	-0.2766	0.0277	0.0398
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.8738	6.2135	-0.1102	-0.3610	0.4682	47.8149
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0000	2.9631	-0.0408	-0.1435	0.0142	0.0261
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.8738	-0.2874	0.0285	0.0736	-0.4397	-47.2845
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0000	2.9631	-0.0408	-0.1435	0.0142	0.0261
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-5.1650	6.1118	-0.1171	-0.3761	0.6143	63.7123
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.0000	1.7778	-0.0244	-0.0858	0.0085	0.0144
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	5.1650	-2.5561	0.0680	0.2036	-0.5970	-62.8377
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	-0.0000	1.7778	-0.0244	-0.0858	0.0085	0.0144

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	12.1146
Shear X	-8.6084
Shear Z	-0.2283
Moment X	-0.7450
Moment Y (Twist)	1.0339
Moment Z	107.2596

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	8.2170
Shear X	-5.1650
Shear Z	-0.1477
Moment X	-0.4940
Moment Y (Twist)	0.6196
Moment Z	63.8522

Project Details

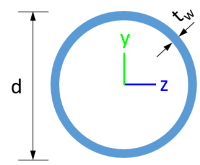
Design Code:	AISC 360-16 LRFD
Provision:	LRFD
Country:	United States
User Name:	sales@mtsolar.us
Unit System:	imperial

Design Input Information

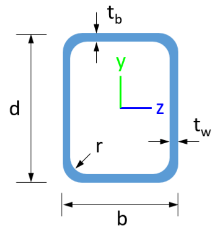
Design Factors			
Φ_t	Φ_c	Φ_b	Φ_v
0.9	0.9	0.9	0.9

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

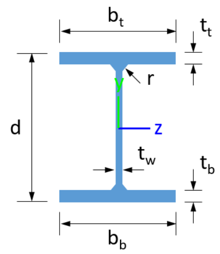
Section Dimensions



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					
11	10in Pipe Sch 40	10.75	0.36					



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
11	10in Pipe Sch 40	11.91	321.47	160.73	160.73	0.00	39.38	39.38
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	11	7.94	7.94	12.21	-	300	200	250
2	6	1.30	1.30	2.00	-	300	200	250
3	17	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.18,1.16,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.17,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.17,1.19	300	200	250
4	17	2.44	2.44	3.75	1.69,1.68,1.69,1.67,1.68,1.69,1.67,1.68,1.66,1.68,1.67,1.69,1.66,1.69,1.67,1.67,1.64,1.67,1.67,1.69,1.66,1.69,1.67,1.69,1.66,1.69,1.69,1.69,1.68,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.69,1.66,1.69,1.67,1.68,1.66,1.68,1.67,1.69,1.66,1.69,1.67,1.69,1.66,1.69	300	200	250
5	17	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.65,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
6	17	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19	300	200	250
7	17	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.65,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.67,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.67,1.68	300	200	250
8	20	1.33	1.33	2.05	2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,1.82,2.08,2.08,2.08,2.07,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.01,2.08,2.08,2.08,2.07,2.08,2.08,2.08,2.08,2.08	300	200	250
9	3	2.60	2.60	4.00	-	300	200	250
10	17	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.64,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
11	20	1.33	1.33	2.05	2.09,2.09,2.09,2.09,2.09,2.09,2.08,2.09,2.08,2.09,2.08,2.09,2.08,2.09,2.08,2.09,1.82,2.09,2.08,2.09,2.08,2.09,2.08,2.09,2.08,2.09,2.09,2.09,2.09,2.09,2.09,2.09,2.09,2.09,2.09,2.08,2.09,2.08,2.09,2.08,2.09,2.02,2.09,2.08,2.09,2.08,2.09,2.08,2.09,2.08,2.09	300	200	250
12	6	1.30	1.30	2.00	-	300	200	250
13	20	4.88	4.00	7.50	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.10,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.12,1.09,1.09,1.09,1.10,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.10,1.09,1.09,1.09,1.10,1.09,1.09,1.09,1.10,1.09,1.09,1.09,1.09,1.09	300	200	250
14	20	4.88	4.00	7.50	1.08,1.08,1.08,1.08,1.08,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.12,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.10,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.09,1.08	300	200	250
15	20	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	20	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	11	7.94	7.94	12.21	-	300	200	250
102	6	1.30	1.30	2.00	-	300	200	250
103	17	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19	300	200	250
104	17	2.4	2.4	3.	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.64,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.	3	2	2

104	17	44	44	75	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	00	00	50
105	17	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.65,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.67,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.67,1.68	300	200	250
106	17	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.18,1.16,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.18,1.19,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.17,1.19,1.18,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19,1.17,1.19	300	200	250
107	17	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.65,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	250
108	20	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
109	3	2.60	2.60	4.00	-	300	200	250
110	17	2.44	2.44	3.75	1.69,1.68,1.69,1.67,1.68,1.69,1.67,1.68,1.66,1.68,1.67,1.69,1.66,1.69,1.67,1.67,1.64,1.67,1.67,1.69,1.66,1.69,1.67,1.69,1.66,1.69,1.69,1.69,1.68,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.69,1.66,1.69,1.67,1.68,1.66,1.68,1.67,1.69,1.66,1.69,1.67,1.69,1.66,1.69	300	200	250
111	20	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
112	6	1.30	1.30	2.00	-	300	200	250
113	20	4.88	4.00	7.50	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.10,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.12,1.09,1.09,1.09,1.10,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.10,1.09,1.09,1.09,1.10,1.09,1.09,1.09,1.09,1.09	300	200	250
114	20	4.88	4.00	7.50	1.08,1.08,1.08,1.08,1.08,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.12,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.10,1.08,1.09,1.08,1.09,1.08,1.09,1.08,1.09,1.08	300	200	250
115	20	8.42	8.42	12.95	1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.12,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13	300	200	250
116	20	8.42	8.42	12.95	1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.12,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13	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	493.00	471.20	135.86	135.86	147.90	147.90
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	33.20	6.46	56.26	44.91
14	159.30	97.43	33.14	6.46	56.26	44.91
15	159.30	34.37	46.90	6.46	56.26	44.91
16	159.30	34.37	46.90	6.46	56.26	44.91
101	493.00	471.20	135.86	135.86	147.90	147.90
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	34.37	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	34.37	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	33.20	6.46	56.26	44.91
114	159.30	97.43	33.13	6.46	56.26	44.91
115	159.30	48.27	14.91	6.46	56.26	44.91
116	159.30	48.27	14.90	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	0.026	0.789	0.015	0.058	0.002	0.808	#13	0.130	Not Required	Pass
2	0.005	0.335	0.307	0.076	0.060	0.643	#13	0.036	Not Required	Pass
3	0.008	0.612	0.045	0.060	0.006	0.628	#13	0.046	Not Required	Pass
4	0.008	0.609	0.164	0.061	0.035	0.680	#13	0.082	Not Required	Pass
5	0.008	0.380	0.163	0.061	0.043	0.405	#13	0.076	Not Required	Pass
6	0.010	0.685	0.066	0.069	0.008	0.730	#13	0.046	Not Required	Pass
7	0.011	0.425	0.217	0.068	0.056	0.459	#13	0.076	Not Required	Pass
8	0.002	0.070	0.267	0.047	0.022	0.290	#21	0.102	Not Required	Pass
9	0.023	0.047	0.079	0.002	0.002	0.132	#13	0.206	Not Required	Pass
10	0.011	0.682	0.207	0.068	0.044	0.748	#13	0.082	Not Required	Pass
11	0.003	0.069	0.274	0.047	0.022	0.298	#21	0.102	Not Required	Pass
12	0.005	0.416	0.348	0.090	0.067	0.765	#13	0.036	Not Required	Pass
13	0.008	0.245	0.579	0.057	0.028	0.725	#21	0.306	Not Required	Pass
14	0.010	0.247	0.571	0.057	0.028	0.715	#21	0.204	Not Required	Pass
15	0.000	0.084	0.234	0.029	0.014	0.295	#21	Not Required	Not Required	Pass
16	0.000	0.084	0.234	0.029	0.014	0.295	#21	Not Required	Not Required	Pass
101	0.026	0.789	0.015	0.058	0.002	0.808	#13	0.130	Not Required	Pass
102	0.005	0.416	0.348	0.090	0.067	0.765	#13	0.036	Not Required	Pass
103	0.010	0.685	0.066	0.069	0.008	0.730	#13	0.046	Not Required	Pass
104	0.011	0.682	0.207	0.068	0.044	0.748	#13	0.082	Not Required	Pass
105	0.011	0.425	0.217	0.068	0.056	0.459	#13	0.076	Not Required	Pass
106	0.008	0.612	0.045	0.060	0.006	0.629	#13	0.046	Not Required	Pass
107	0.008	0.380	0.163	0.061	0.043	0.405	#13	0.076	Not Required	Pass
108	0.000	0.084	0.234	0.029	0.014	0.295	#21	Not Required	Not Required	Pass
109	0.023	0.047	0.079	0.002	0.002	0.132	#13	0.206	Not Required	Pass
110	0.008	0.609	0.164	0.061	0.035	0.680	#13	0.082	Not Required	Pass
111	0.000	0.084	0.234	0.029	0.014	0.295	#21	Not Required	Not Required	Pass
112	0.005	0.335	0.307	0.076	0.060	0.643	#13	0.036	Not Required	Pass
113	0.008	0.245	0.579	0.057	0.028	0.725	#21	0.204	Not Required	Pass
114	0.010	0.247	0.571	0.057	0.028	0.715	#21	0.306	Not Required	Pass
115	0.008	0.556	0.312	0.047	0.022	0.736	#13	0.644	Not Required	Pass
116	0.002	0.558	0.310	0.047	0.022	0.737	#13	0.644	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

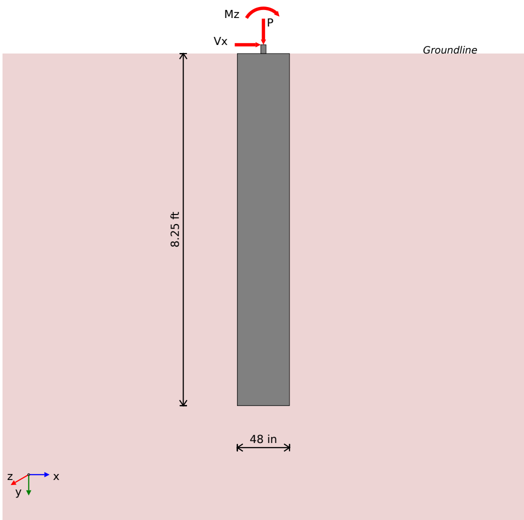
Input	Description	Value
f'_{ck}	Concrete compressive strength	2.5 ksi
f_{yk}	Yield strength of steel	60 ksi
d_b	Rebar diameter	#5 (0.625) in
cover	Concrete cover	3 in

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	8.217 kip	12.11 kip
Vx	-5.165 kip	-8.608 kip
Vz	-0.148 kip	-0.228 kip
Mx	-0.494 kip-ft	-0.745 kip-ft
Mz	63.85 kip-ft	107.3 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

$$H_o = \frac{V_x}{1.57 \times D} = \frac{-5.165}{1.57 \times 48} = -0.822\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{63.85 + (-5.165 \times 0)}{1.57 \times 48} = 10.17 \; \frac{kip - ft}{ft}$$

Required depth of embedment in earth:

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

Solving the cubic equation:

$$L_{e,x} = 7.597 \; ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{-0.148}{1.57 \times 48} = -0.024 \; \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{1.57 \times b} = \frac{-0.494 + (-0.148 \times 0)}{1.57 \times 48} = -0.079 \; \frac{kip - ft}{ft}$$

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:

$$L_{e,z} = -1.593 \; ft$$

Minimum embedded depth

Depth of pile required

$$L_{e,req} = MAX[L_{e,x}, L_{e,z}] = MAX[7.597, -1.593] = 7.597 \; ft$$

Actual embedded length

$$L_e = L - h_2 - h_e = 8.25 - 0 - 0 = 8.25 \; ft$$

Utilisation

$$Ratio = \frac{L_{e,req}}{L_e} = \frac{7.597}{8.25} = 0.921$$

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:

$$q = \frac{P}{A} = \frac{8.217}{16} = 513.6 \; psf$$

Utilisation

$$Ratio = \frac{q}{q_a} = \frac{513.6}{2000} = 0.257$$

UTILITY: 0.26

Lateral Soil Pressure (ASD)

Allowable lateral pressure	$R =$	150 psf/ft

Length to least lateral dimension ratio:

$$\frac{L}{MIN[b, D]} = \frac{8.25}{MIN[4, 4]} = 2.063$$

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

Considering x-direction:

Distance from resting surface to pivot point:

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

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

$$a = \frac{(4 \times 10.17 \times 8.25) + \left(3 \times 0.822 \times 8.25^2\right)}{(6 \times 10.17) + (4 \times 0.822 \times 8.25)} = 5.712\ ft$$

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

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

$$p = \frac{0.75 \times [(4 \times 10.17) + (3 \times -0.822 \times 8.25)]^2}{8.25^2 \times [(3 \times 10.17) + (2 \times -0.822 \times 8.25)]} = 0.269\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{5.712}{2} = 0.428\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{0.269}{0.428} = 0.627$$

UTILITY: 0.63

Earth pressure against the pile at distance L_e:

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times 10.17) + (-0.822 \times 8.25)]}{8.25^2} = 1.194\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

$$p_s = R \times L_e = 0.15 \times 8.25 = 1.238\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{1.194}{1.238} = 0.965$$

UTILITY: 0.97

Considering z-direction:

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.079 \times 8.25) + \left(3 \times 0.024 \times 8.25^2\right)}{(6 \times 0.079) + (4 \times 0.024 \times 8.25)} = 5.927\ ft$$

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

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

$$p = \frac{0.75 \times [(4 \times -0.079) + (3 \times -0.024 \times 8.25)]^2}{8.25^2 \times [(3 \times -0.079) + (2 \times -0.024 \times 8.25)]} = -0.014\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{5.927}{2} = 0.445\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{-0.014}{0.445} = -0.032$$

UTILITY: 0.03

Earth pressure against the pile at distance L_e:

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times -0.079) + (-0.024 \times 8.25)]}{8.25^2} = -0.031\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

$$p_s = R \times L_e = 0.15 \times 8.25 = 1.238\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{-0.031}{1.238} = -0.025$$

UTILITY: 0.03

REFERENCES	CALCULATIONS	RESULTS

Shear force and bending moment (LRFD)

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{1.57 \times D} = \frac{-8.608}{1.57 \times 48} = -1.371\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{1.57 \times D} = \frac{107.3 + (-8.608 \times 0)}{1.57 \times 48} = 17.08\ \frac{kip-ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 17.08 \times 8.25) + \left(3 \times 1.371 \times 8.25^2\right)}{(6 \times 17.08) + (4 \times 1.371 \times 8.25)} = 5.711\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{17.08}{-1.371} = 12.46\ ft$$

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

$$V_{max,x} = (-1.371 \times 48) \times [1 - [3 \times \left(\frac{4 \times 12.46}{8.25} + 3\right) \times \left(\frac{5.711}{8.25}\right)^2] + [4 \times \left(\frac{3 \times 12.46}{8.25} + 2\right) \times \left(\frac{5.711}{8.25}\right)^3]]$$

$$V_{max,x} = 18.27\ kip$$

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

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

$$M_{max,x} = (-1.371 \times 48 \times 8.25) \times [\left(\frac{12.46}{8.25} + \frac{5.711}{2 \times 8.25}\right) - [\left(\frac{4 \times 12.46}{8.25} + 3\right) \times \left(\frac{5.711}{2 \times 8.25}\right)^3] + [\left(\frac{3 \times 12.46}{8.25} + 2\right) \times \left(\frac{5.711}{2 \times 8.25}\right)^4]]$$

$$M_{max,x} = 71.26\ kip-ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{-0.228}{1.57 \times 48} = -0.036\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{1.57 \times b} = \frac{-0.745 + (-0.228 \times 0)}{1.57 \times 48} = -0.119\ \frac{kip-ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.119 \times 8.25) + \left(3 \times 0.036 \times 8.25^2\right)}{(6 \times 0.119) + (4 \times 0.036 \times 8.25)} = 5.932\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{-0.119}{-0.036} = 3.263\ ft$$

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

$$V_{max,z} = (-0.036 \times 48) \times [1 - [3 \times \left(\frac{4 \times 3.263}{8.25} + 3\right) \times \left(\frac{5.932}{8.25}\right)] + [4 \times \left(\frac{3 \times 3.263}{8.25} + 2\right) \times \left(\frac{5.932}{8.25}\right)]]$$

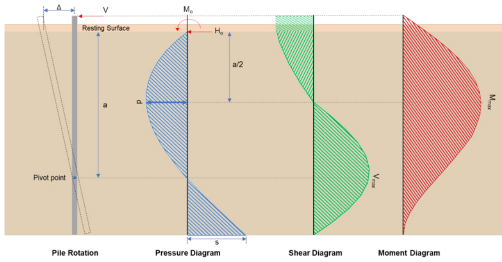
$$V_{max,z} = 0.199\ kip$$

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

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

$$M_{max,z} = (-0.036 \times 48 \times 8.25) \times [\left(\frac{3.263}{8.25} + \frac{5.932}{2 \times 8.25}\right) - [\left(\frac{4 \times 3.263}{8.25} + 3\right) \times \left(\frac{5.932}{2 \times 8.25}\right)^3] + [\left(\frac{3 \times 3.263}{8.25} + 2\right) \times \left(\frac{5.932}{2 \times 8.25}\right)^4]]$$

$$M_{max,z} = 0.714\ kip - ft$$



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:

$$A_{st,req} = \frac{P - (0.85 \times f'_{ck} \times A_g)}{f_{yk} - (0.85 \times f'_{ck})} = \frac{12.11 - (0.85 \times 2.5 \times 2304)}{60 - (0.85 \times 2.5)} = -84.39\ in^2$$

10.6.1.1 Maximum reinforcement:

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

7.6.1.1 Minimum reinforcement:

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

Governing minimum reinforcement area:

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

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

Minimum number of reinforcements:

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

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

25.2.3 Minimum spacing:

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

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

Total reinforcement area:

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

Shear Reinforcement

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

Maximum spacing of shear Reinforcements:

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

Detailing Summary	
Main reinforcement	#5 (0.625 in) - 16pcs at 1.5 in min. spacing

Shear reinforcement	#3 (0.375 in) at 10 in max. spacing

Axial Compression Strength (LRFD)

22.4.2.2 Allowable axial compressive strength:

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

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

Utilisation

$$Ratio = \frac{P}{\phi P_N} = \frac{12.11}{2694} = 0.004$$

UTILITY: 0.00

Shear Strength LRFD)

Effective shear width	$b_w =$	48 in
Effective shear depth	$d =$	44.31 in
Shear reinforcement area	$A_v =$	0.221 in^2
Shear reinforcement spacing	$s =$	10 in
Concrete type factor (Normal concrete)	$\lambda =$	1
Strength reduction factor for shear	$\phi =$	0.75
Maximum shear in the x-direction	$V_{max,x} =$	18.27 kip
Maximum shear in the z-direction	$V_{max,z} =$	0.199 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:

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

$$V_{c,a} = \left(2 \times 1 \times \sqrt{2.5} + MIN[\frac{12.11}{6 \times 2304}, (0.05 \times 2.5)]\right) \times (48 \times 44.31) = 214.6\ kip$$

Governing shear strength of concrete:

$$V_c = MIN[V_{c,max}, V_{c,a}] = MIN[531.8, 214.6] = 214.6\ kip$$

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:

$$\phi V_n = \phi \times (V_c + V_s) = 0.75 \times (214.6 + 58.73) = 205\ kip$$

$$V_{max} = MAX[18.27, 0.199] = 18.27\ kip$$

Utilisation

$$Ratio = \frac{V_{max}}{\phi V_n} = \frac{18.27}{205} = 0.089$$

UTILITY: 0.09

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	$P =$	12.11 kip
Maximum moment in the x-direction	$M_{max,x} =$	71.26 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$	0.714 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:

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

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

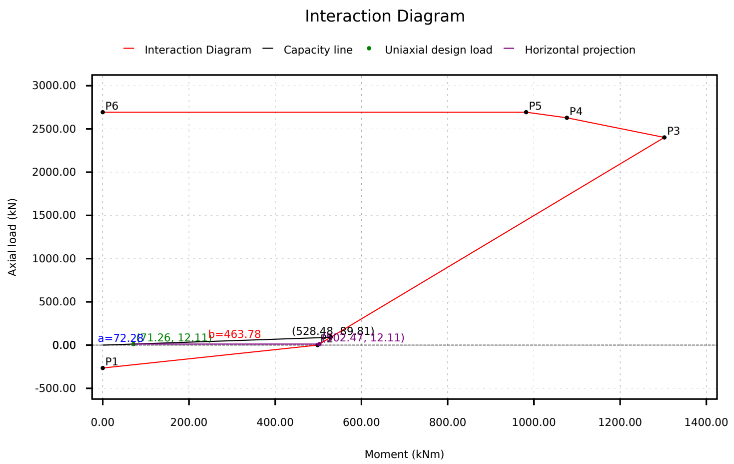
$$f_2 = E_s \times \varepsilon_2 \ (\varepsilon_2 < \varepsilon_{sy}), \ f_2 = \phi_s \times f_y \ (\varepsilon_2 \geq \varepsilon_{sy})$$

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

$$M_f = MAX[71.26, 0.714] = 71.26 \ kip - ft$$



Segment	Signed Distance
P1 - P2	211.3
P2 - P3	408.9
P3 - P4	2559
P4 - P5	2727
P5 - P6	2682
Status	PASS: Point lies inside the curv e

Utilisation

$$Ratio = \frac{a}{a+b} = \frac{72.28}{72.28 + 463.8} = 0.135$$

UTILITY: 0.13

Biaxial Bending Check

Maximum moment in the x-direction	$M_{max,x} =$	71.26 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$	0.714 kip-ft
Nominal uniaxial moment strength about the x-axis	$M_{nox} =$	502.5 kip-ft
Nominal uniaxial moment strength about the z-axis	$M_{noz} =$	502.5 kip-ft
Interaction exponent	$\alpha =$	1

Bresler (1960)	According to Bresler (method B): $$\left(\frac{M_{max,x}}{M_{nox}}\right)^{\alpha} + \left(\frac{M_{max,z}}{M_{noz}}\right)^{\alpha} = 1.0$$ $$\left(\frac{71.26}{502.5}\right)^{1} + \left(\frac{0.714}{502.5}\right)^{1} = 0.143$$	**UTILITY: 0.14**

REFERENCES	CALCULATIONS	RESULTS

Results Summary

Result Name	Results
PILE DETAILS	
Length of the pile	8.25 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	0.26
p_a	0.63
p_s	0.97
Axial compression strength	0.00
Shear strength	0.09
Uniaxial bending strength	0.13
Biaxial bending strength	0.14