Project Details

Project Name: FILTER POND 5x5 36inRound 10in - V1Jb

Location: DuPage County 1 S, 649 Shaffner Rd, Wheaton, IL 60189, USA

Unique ID: 2P-22.5-10TOP-XD-57-L-5Hx5W-3760

Dealer: ______________________________

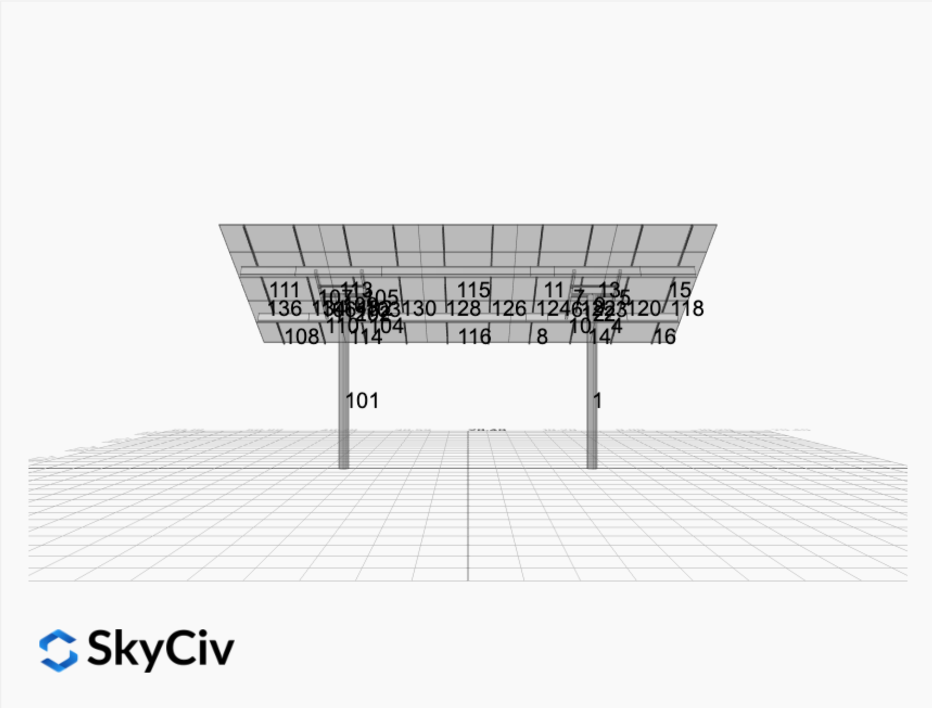
Date: Mon Nov 10 2025

Number of Modules: 25

Number of Poles: 2

Date Sold:

____



Array Dimensions N/S	18.79 ft
Array Dimensions E/W	40.79 ft
Winter Tilt Angle (Degrees)	30
Front Edge Clearance	11

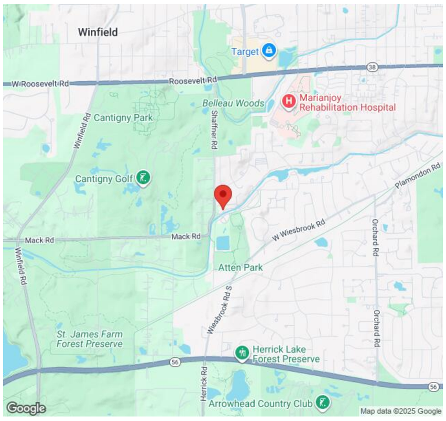
MT Solar Bill of Materials (2P-22.5-10TOP-XD-57-L-5Hx5W-3760)

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	5

Rail Bill of Materials

Part	Qty
Rails (226in Long)	10x
Rail Attachment	40x
Module Mid Clamp	40x
Module End Clamp	20x
Ground Lug	5x

Site Details:



Site Address: DuPage County 1 S, 649 Shaffner Rd, Wheaton, IL 60189, USA

Array Specifications

Duty Classification:	XD
Module Width:	44.60 in
Module Length:	96.90 in
Number of Rows:	5
Number of Columns:	5
Total Number of Modules:	25
Winter Tilt Angle:	30
Front Edge Clearance:	11
Total Array Height at Tilt:	20.40 ft
Total Frame Length:	39.50 ft
Module Info/Notes:	585w
Array Dimensions N/S:	18.79 ft
Array Dimensions E/W:	40.79 ft
Rail Length:	225.50 in
Rail Spacing:	4.08 ft

Support Specifications

Pole Size:	10in Pipe Sch 40
Pole Length above Grade:	15.70 ft
Number of Poles:	2
Pole Spacing:	22.5 ft

Foundation Specifications

Foundation Type:	round
Foundation Dimensions:	36 in dia.
Foundation Depth (below grade):	12.0 ft
Foundation Volume:	84.82 ft^3

Site Info

Risk Category:	I
Exposure:	C
Soil Classification:	sand
Site Location:	DuPage County 1 S, 649 Shaffner Rd, Wheaton, IL 60189, USA
Wind Speed:	101 mph

Snow Load:	25 psf

Design Disclaimer

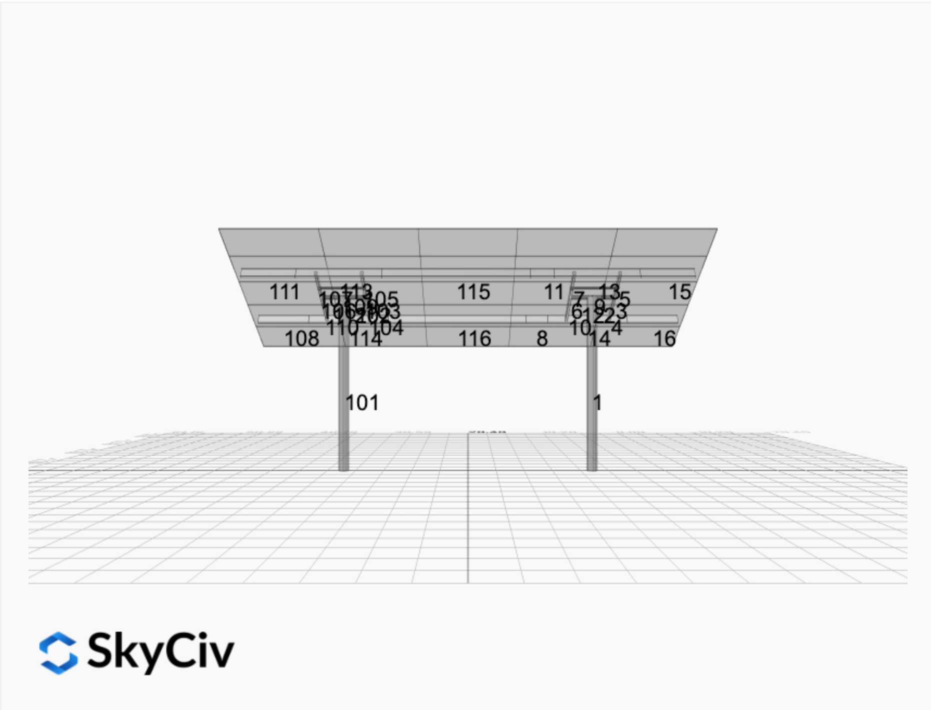
This software should be used for preliminary designs and should not be used as a final design unless reviewed, verified and designed by a qualified structural engineer.

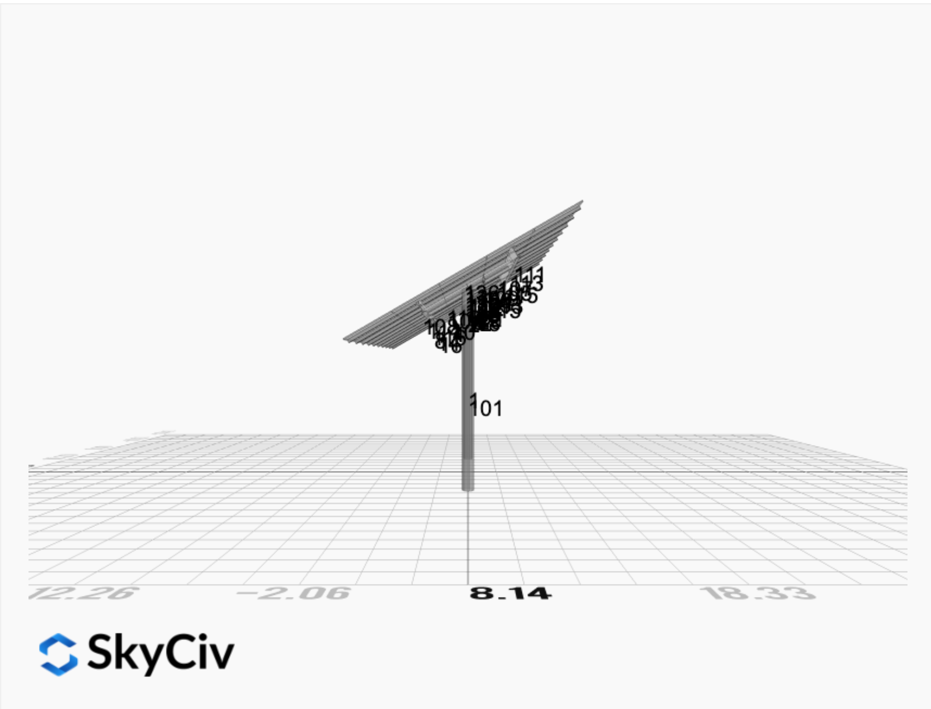
AutoDesigner Input

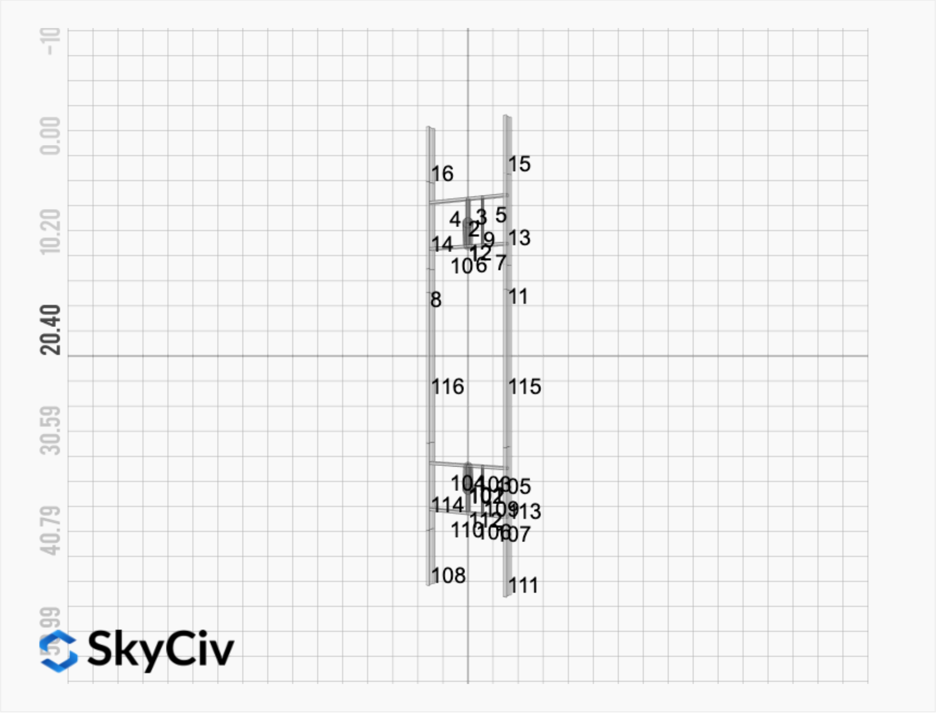

```
{"wind_speed_override":null,"snow_load_override":null,"direct_snow_load":false,"add_angle_brace":false,"product_type":"Beam","designer_name":"","designer_email":"","designer_phone":"","project_id":"FILTER POND 5x5 36inRound 10in - V1Jb","site_address":"DuPage County 1 S, 649 Shaffner Rd, Wheaton, IL 60189, USA","module_info":"585w","module_width":44.6,"module_length":96.9,"number_rows":"5","number_columns":5,"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":30,"ground_clearance":11,"risk_category":"I","exposure_category":"C","frame_duty_override":"XD","pole_override":"10_40","soil_type":"sand","customer_foundation_override":"48_Square","foundation_type":"Round","foundation_size":36,"check_rails":true}
```


Design Notes:

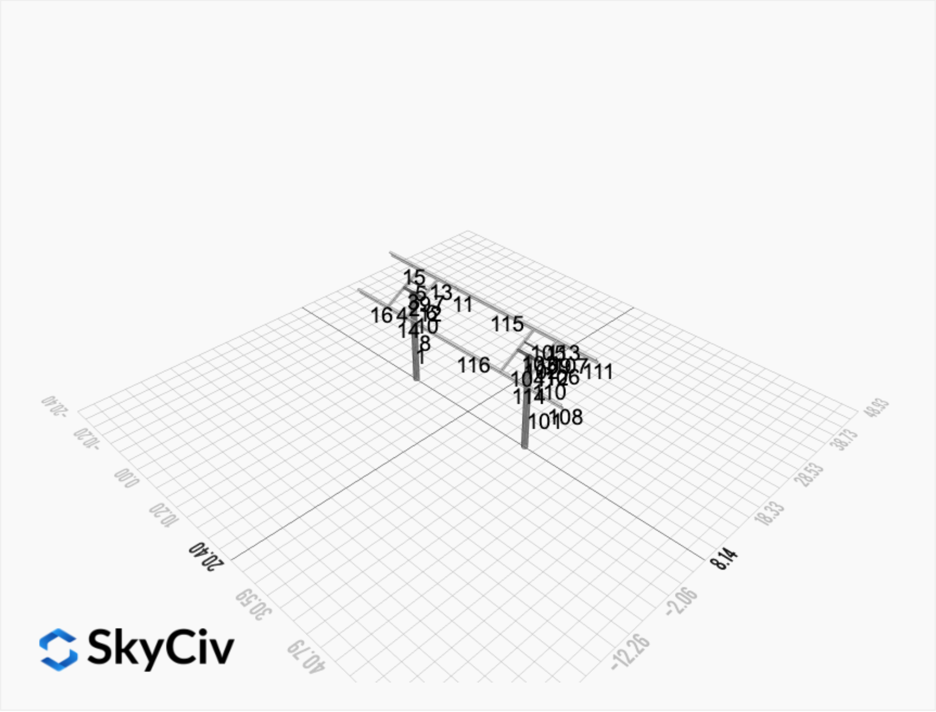
- Deflection checks are set to L/1 due to manufacturer structural design intent
- Foundation Soil Parameters used in this Autodesign are all estimates, proper geotechnical reports are required to confirm soil profiles
- Wind speeds, snow loads and other site specific results are based on ASCE 7-16
- 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.



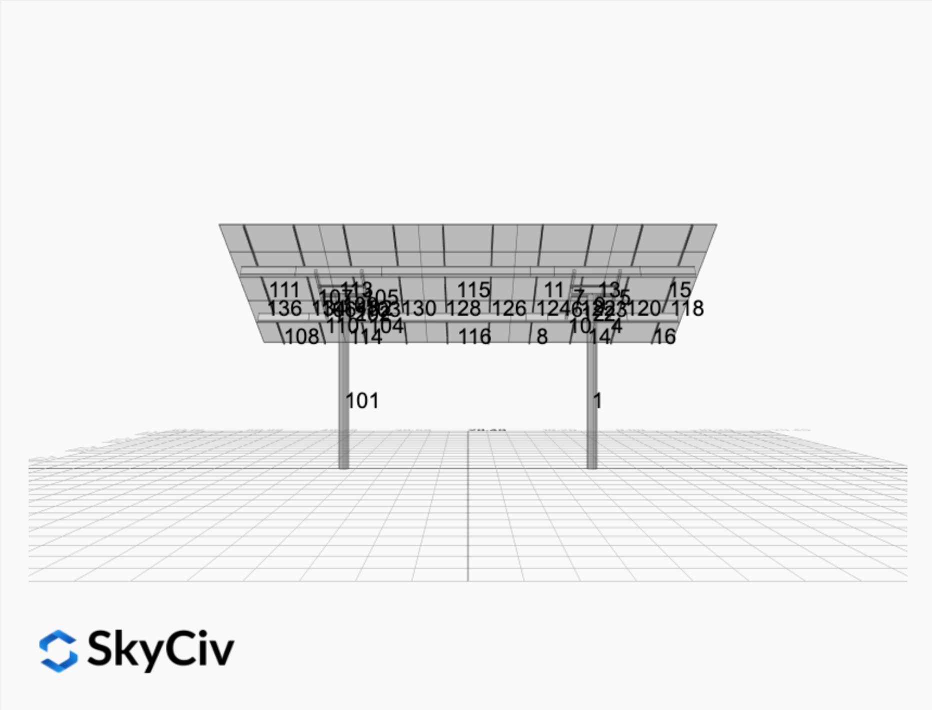




-10
0.00
10.20
20.40
30.59
40.79
16
15
4
3
5
2
14
9
13
12
106
7
8
11
116
115
114
113
108
111
SkyCiv



15
13
11
16
115
116
111
108
-20.40
-10.20
0.00
10.20
20.40
30.59
40.79
48.93
38.73
28.53
18.33
8.14
-2.06
-12.26
SkyCiv

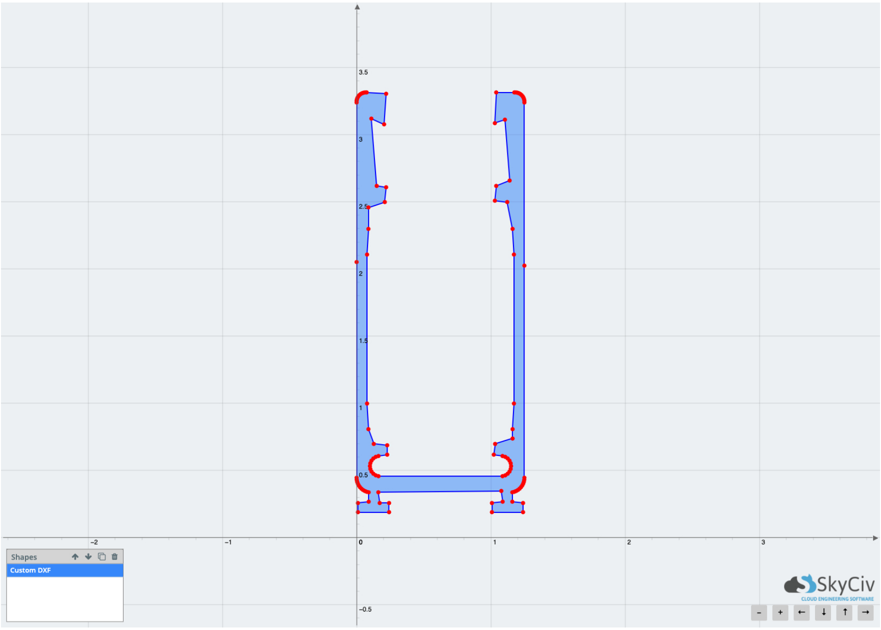


111
136
108
115
128
126
116
130
8
15
118
120
16
101
1
SkyCiv

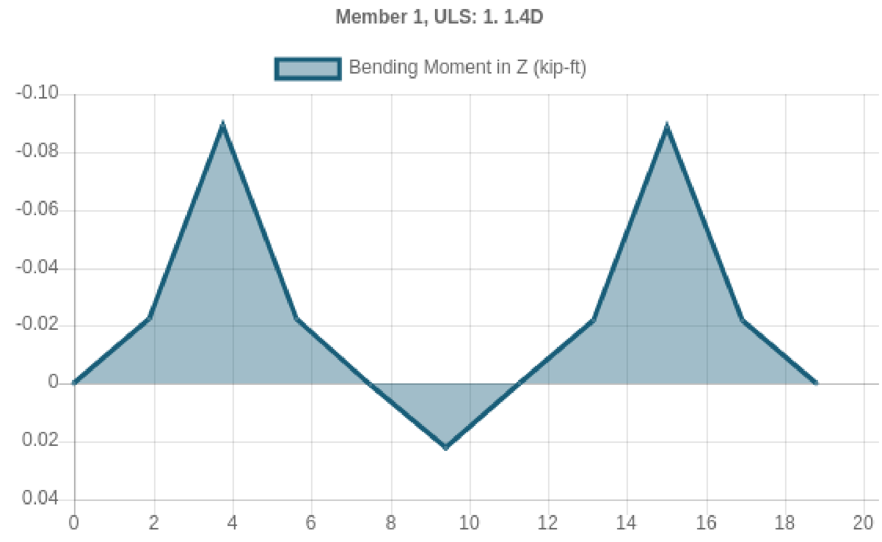
Rail Design Check

Rail Length: 18.79 ft
Additional Restraints Required: 4ft Spread Clamps
Tributary Width: 4.08 ft
Material: Aluminium
Density: 169.00 lb/ft^3
Elastic Modulus: 10000.00 ksi
Fy: 34.50 ksi
Fu: 37.00 ksi

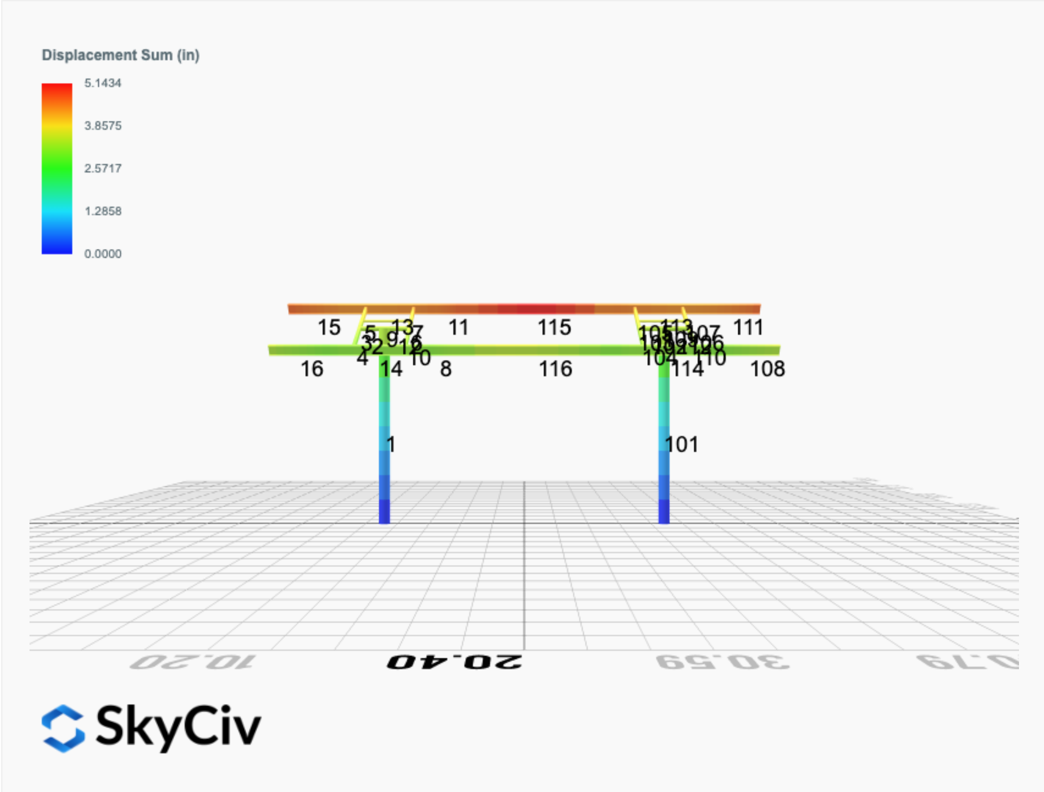
Rail Distributed Loading:
Note, gravity loading is resolved into member local X and Y axes.
Snow (X): 0.0388 kip/ft
Snow (Y): -0.0224 kip/ft
Wind uplift Case A (Y): 0.1157 kip/ft
Wind uplift Case A (Y): 0.1157 kip/ft
Wind uplift Case B (Y): 0.1606 kip/ft
Wind uplift Case B (Y): 0.1606 kip/ft
Wind downforce Case A (Y): -0.1349 kip/ft
Wind downforce Case A (Y): -0.1349 kip/ft
Wind downforce Case B (Y): -0.1349 kip/ft
Wind downforce Case B (Y): -0.1349 kip/ft
Dead (Panel load) (X): 0.0155 kip/ft
Dead (Panel load) (Y): -0.0090 kip/ft

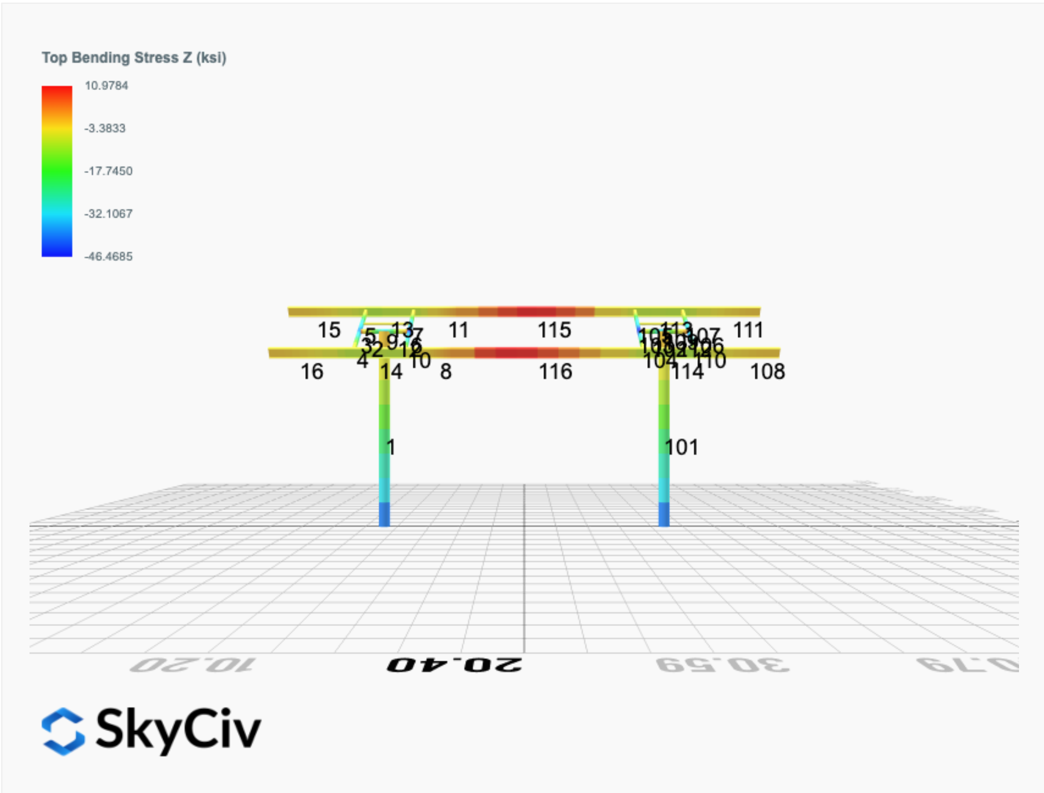


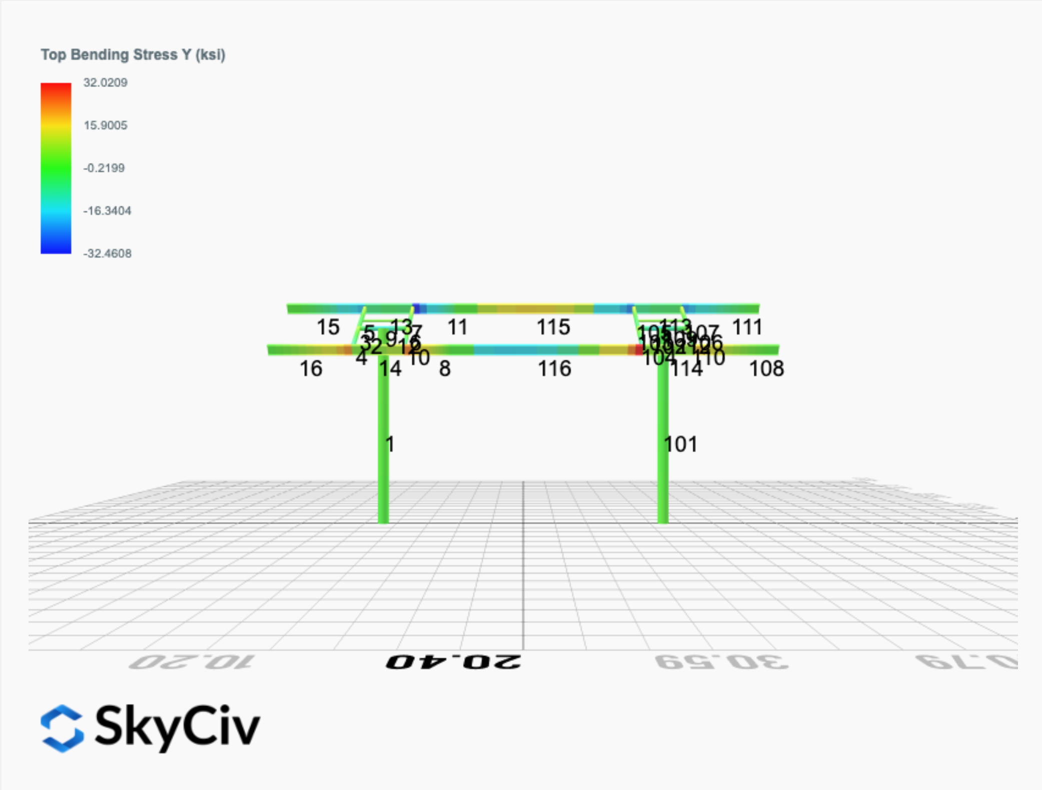
Result Check	Max Limit	Max Value	Utility	Status
Custom Stress Limit	34.50	24.14	0.700	PASS
Material Yield	34.50	24.14	0.700	PASS
Material Strength	37.00	24.14	0.652	PASS

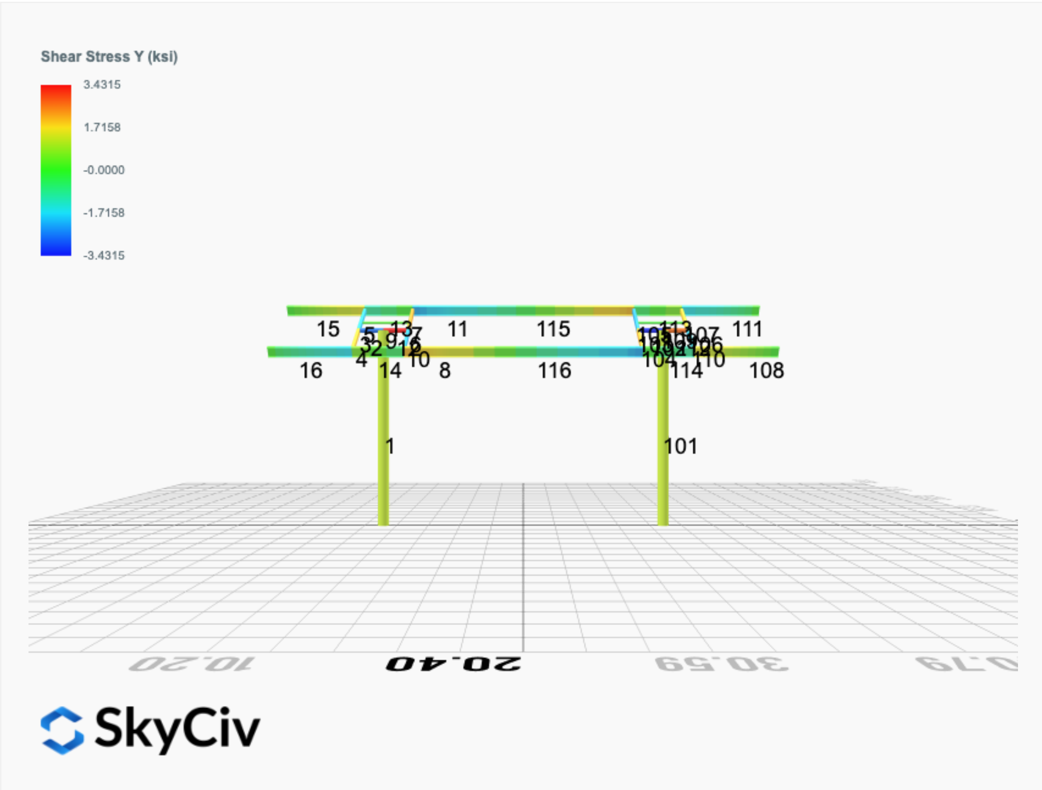


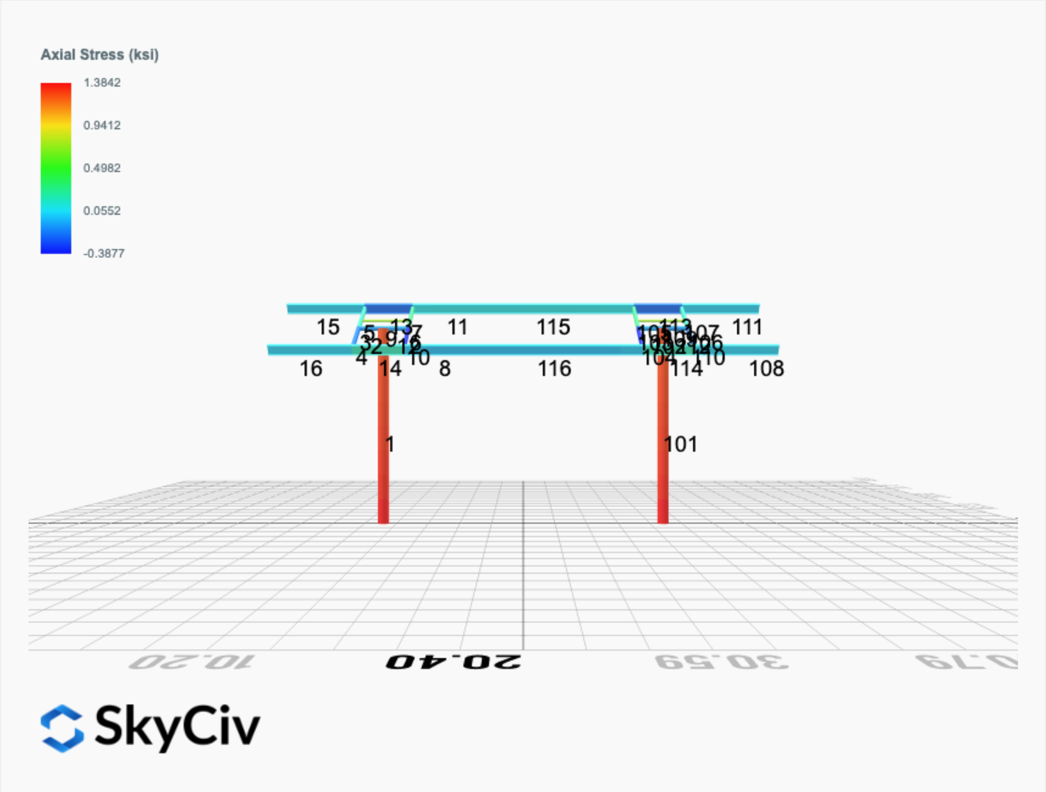
FEM Results (Envelope Worst Case)






Top Bending Stress Y (ksi)
32.0209
15.9005
-0.2199
-16.3404
-32.4608
15
11
115
111
16
14
8
116
114
108
1
101
20.40
SkyCiv


Shear Stress Y (ksi)
3.4315
1.7158
-0.0000
-1.7158
-3.4315
15
11
115
111
16
14
8
116
114
108
1
101
20.40
SkyCiv


Axial Stress (ksi)
1.3842
0.9412
0.4982
0.0552
-0.3877
15
11
115
111
16
8
116
108
1
101
20.40
30.59
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	4.2919	0.0457	0.2223	-0.0169	0.0485
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	5.5037	0.0669	0.3260	-0.0251	0.0526
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	3.6788	0.0392	0.1904	-0.0145	0.0404
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0000	9.5187	0.1282	0.6262	-0.0483	0.1016
ULS: 5. 1.2D + E + L + 0.2S	0.0000	4.4088	0.0503	0.2446	-0.0188	0.0445
ULS: 7. 0.9D + 1.0E	0.0000	2.7591	0.0294	0.1427	-0.0109	0.0290
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-6.3391	16.4834	0.2453	1.1618	-0.6381	104.0114
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-6.3391	16.4834	0.2453	1.1618	-0.6381	104.0114
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	5.4335	-3.9074	-0.0851	-0.3836	0.4996	-84.4584
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	4.5280	-2.3389	-0.0603	-0.2677	0.4139	-93.0912
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-6.3391	14.6585	0.2176	1.0260	-0.6280	103.4650
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-6.3391	14.6585	0.2176	1.0260	-0.6280	103.4650
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	5.4335	-5.7324	-0.1129	-0.5188	0.5107	-84.0661
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	4.5280	-4.1639	-0.0883	-0.4041	0.4257	-92.6089
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.1695	15.0085	0.2173	1.0434	-0.3540	51.9045
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-3.1695	15.0085	0.2173	1.0434	-0.3540	51.9045
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	2.7168	4.8131	0.0521	0.2702	0.2136	-43.1253
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	2.2640	5.5974	0.0649	0.3300	0.1697	-47.5600
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.1696	9.1686	0.1282	0.6071	-0.3212	51.0058
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-3.1696	9.1686	0.1282	0.6071	-0.3212	51.0058
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	2.7168	-1.0268	-0.0370	-0.1650	0.2481	-42.5121
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	2.2640	-0.2425	-0.0246	-0.1073	0.2055	-46.8000
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-6.3391	13.7388	0.2078	0.9781	-0.6246	103.1899
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-6.3391	13.7388	0.2078	0.9781	-0.6246	103.1899
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	5.4335	-6.6521	-0.1227	-0.5664	0.5144	-83.8778
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	4.5279	-5.0836	-0.0982	-0.4522	0.4298	-92.3754

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0000	3.0656	0.0326	0.1586	-0.0121	0.0327
ULS: 2. D + L	0.0000	3.0656	0.0326	0.1586	-0.0121	0.0327
ULS: 3. D + (S or Lr or R)	0.0000	6.7156	0.0882	0.4299	-0.0333	0.0601
ULS: 3. D + (S or Lr or R)	0.0000	3.0656	0.0326	0.1586	-0.0121	0.0327
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	5.8031	0.0743	0.3619	-0.0280	0.0509
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	3.0656	0.0326	0.1586	-0.0121	0.0327
ULS: 5b. D + 0.7E	0.0000	3.0656	0.0326	0.1586	-0.0121	0.0327
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0000	5.8031	0.0743	0.3619	-0.0280	0.0509
ULS: 8. 0.6D + 0.7E	0.0000	1.8394	0.0196	0.0951	-0.0073	0.0184
ULS: 5a. D + 0.6W_Wind downforce Case A only	-3.8035	9.6534	0.1395	0.6588	-0.3802	61.2653
ULS: 5a. D + 0.6W_Wind downforce Case B only	-3.8035	9.6534	0.1395	0.6588	-0.3802	61.2653
ULS: 5a. D + 0.6W_Wind uplift Case A only	3.2601	-2.5810	-0.0587	-0.2676	0.3031	-50.8274
ULS: 5a. D + 0.6W_Wind uplift Case B only	2.7168	-1.6399	-0.0440	-0.1987	0.2522	-55.9509
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-2.8526	10.7440	0.1544	0.7370	-0.3037	46.1246
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-2.8526	10.7440	0.1544	0.7370	-0.3037	46.1246
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	2.4451	1.5681	0.0058	0.0417	0.2081	-38.5114
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	2.0376	2.2739	0.0170	0.0944	0.1693	-42.4193

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	-2.8526	8.0065	0.1128	0.5335	-0.2882	45.7594
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-2.8526	8.0065	0.1128	0.5335	-0.2882	45.7594
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	2.4451	-1.1694	-0.0359	-0.1613	0.2243	-38.2484
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	2.0376	-0.4635	-0.0248	-0.1095	0.1861	-42.0952
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-3.8035	8.4272	0.1265	0.5951	-0.3755	61.0468
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-3.8035	8.4272	0.1265	0.5951	-0.3755	61.0468
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	3.2601	-3.8073	-0.0718	-0.3311	0.3081	-50.6791
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	2.7168	-2.8662	-0.0571	-0.2625	0.2573	-55.7664

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	16.4834
Shear X	-6.3391
Shear Z	0.2453
Moment X	1.1618
Moment Y (Twist)	0.6381
Moment Z	104.0114

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	10.7440
Shear X	-3.8035
Shear Z	0.1544
Moment X	0.7370
Moment Y (Twist)	0.3802
Moment Z	61.2653

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	4.2919	-0.0457	-0.2223	0.0170	0.0486
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0000	5.5038	-0.0669	-0.3259	0.0253	0.0528
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0000	3.6788	-0.0392	-0.1904	0.0146	0.0405
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	-0.0000	9.5187	-0.1282	-0.6263	0.0488	0.1022
ULS: 5. 1.2D + E + L + 0.2S	-0.0000	4.4088	-0.0503	-0.2445	0.0189	0.0446
ULS: 7. 0.9D + 1.0E	-0.0000	2.7591	-0.0294	-0.1427	0.0110	0.0290
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-6.3391	16.4834	-0.2453	-1.1620	0.6384	104.0128
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-6.3391	16.4834	-0.2453	-1.1620	0.6384	104.0128
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	5.4335	-3.9074	0.0851	0.3838	-0.4996	-84.4592
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	4.5279	-2.3388	0.0603	0.2683	-0.4136	-93.0924
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-6.3391	14.6584	-0.2176	-1.0261	0.6282	103.4661
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-6.3391	14.6584	-0.2176	-1.0261	0.6282	103.4661
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	5.4335	-5.7324	0.1129	0.5189	-0.5107	-84.0668
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	4.5279	-4.1638	0.0883	0.4046	-0.4255	-92.6101
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.1696	15.0085	-0.2173	-1.0437	0.3547	51.9059
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-3.1696	15.0085	-0.2173	-1.0437	0.3547	51.9059
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	2.7168	4.8131	-0.0521	-0.2702	-0.2133	-43.1253
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	2.2639	5.5974	-0.0649	-0.3297	-0.1692	-47.5601
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-3.1696	9.1686	-0.1282	-0.6071	0.3213	51.0064
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-3.1696	9.1686	-0.1282	-0.6071	0.3213	51.0064
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	2.7168	-1.0268	0.0370	0.1651	-0.2481	-42.5124
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	2.2640	-0.2425	0.0246	0.1075	-0.2054	-46.8006
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-6.3391	13.7387	-0.2078	-0.9782	0.6247	103.1908
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-6.3391	13.7387	-0.2078	-0.9782	0.6247	103.1908
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	5.4335	-6.6521	0.1227	0.5665	-0.5144	-83.8784
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	4.5279	-5.0835	0.0982	0.4526	-0.4296	-92.3763

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0000	3.0656	-0.0326	-0.1586	0.0122	0.0327
ULS: 2. D + L	-0.0000	3.0656	-0.0326	-0.1586	0.0122	0.0327
ULS: 3. D + (S or Lr or R)	-0.0000	6.7156	-0.0882	-0.4300	0.0336	0.0605
ULS: 3. D + (S or Lr or R)	-0.0000	3.0656	-0.0326	-0.1586	0.0122	0.0327
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0000	5.8031	-0.0743	-0.3619	0.0282	0.0512
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0000	3.0656	-0.0326	-0.1586	0.0122	0.0327
ULS: 5b. D + 0.7E	-0.0000	3.0656	-0.0326	-0.1586	0.0122	0.0327
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0000	5.8031	-0.0743	-0.3619	0.0282	0.0512
ULS: 8. 0.6D + 0.7E	-0.0000	1.8394	-0.0196	-0.0950	0.0073	0.0185
ULS: 5a. D + 0.6W_Wind downforce Case A only	-3.8035	9.6534	-0.1395	-0.6589	0.3803	61.2659
ULS: 5a. D + 0.6W_Wind downforce Case B only	-3.8035	9.6534	-0.1395	-0.6589	0.3803	61.2659
ULS: 5a. D + 0.6W_Wind uplift Case A only	3.2601	-2.5810	0.0587	0.2677	-0.3031	-50.8277
ULS: 5a. D + 0.6W_Wind uplift Case B only	2.7168	-1.6399	0.0440	0.1989	-0.2520	-55.9515
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-2.8526	10.7440	-0.1544	-0.7371	0.3040	46.1254
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-2.8526	10.7440	-0.1544	-0.7371	0.3040	46.1254
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	2.4451	1.5681	-0.0058	-0.0417	-0.2080	-38.5116
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	2.0376	2.2739	-0.0170	-0.0942	-0.1691	-42.4196
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-2.8526	8.0065	-0.1128	-0.5335	0.2882	45.7598
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-2.8526	8.0065	-0.1128	-0.5335	0.2882	45.7598
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	2.4451	-1.1694	0.0359	0.1614	-0.2243	-38.2486
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	2.0376	-0.4635	0.0248	0.1097	-0.1859	-42.0957
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-3.8035	8.4272	-0.1265	-0.5952	0.3756	61.0472
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-3.8035	8.4272	-0.1265	-0.5952	0.3756	61.0472
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	3.2601	-3.8073	0.0718	0.3311	-0.3081	-50.6793
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	2.7168	-2.8662	0.0571	0.2626	-0.2572	-55.7667

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	16.4834
Shear X	-6.3391
Shear Z	-0.2453
Moment X	-1.1620
Moment Y (Twist)	0.6384
Moment Z	104.0128

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	10.7440
Shear X	-3.8035
Shear Z	-0.1544
Moment X	-0.7371
Moment Y (Twist)	0.3803
Moment Z	61.2659

Project Details

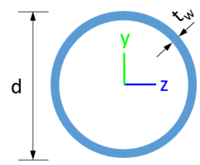
Design Code:	AISC 360-16 LRFD
Provision:	LRFD
Country:	United States
User Name:	sales@mtsolar.us
Unit System:	imperial

Design Input Information

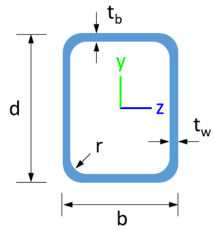
Design Factors			
Φ_t	Φ_c	Φ_b	Φ_v
0.9	0.9	0.9	0.9

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

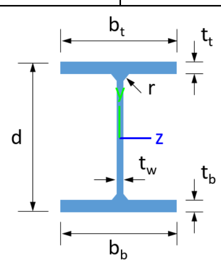
Section Dimensions



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 (in²)	J (in⁴)	I_{yp} (in⁴)	I_{zp} (in⁴)	I_w (in⁶)	S_{yp} (in³)	S_{zp} (in³)
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	10.20	10.20	15.70	-	300	200	250
2	6	1.30	1.30	2.00	-	300	200	250
3	17	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.17,1.17,1.18,1.18,1.19,1.12,1.18,1.18,1.17,1.17,1.18,1.18,1.17,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.15,1.17,1.18,1.18,1.17,1.17,1.18,1.18,1.17,1.18	300	200	250
4	17	2.44	2.44	3.75	1.69,1.68,1.69,1.67,1.68,1.69,1.67,1.67,1.66,1.71,1.67,1.67,1.66,1.59,1.67,1.67,1.69,1.67,1.67,1.67,1.65,1.72,1.67,1.67,1.66,1.64,1.69,1.69,1.67,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.67,1.66,1.85,1.67,1.67,1.61,1.68,1.67,1.67,1.65,1.73,1.67,1.67,1.66,1.63	300	200	250
5	17	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.68,1.60,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.63,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66	300	200	250
6	17	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.19,1.02,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.18,1.18,1.18,1.18,1.18,1.15,1.17,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18	300	200	250
7	17	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.68,1.54,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.63,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.67	300	200	250
8	20	1.33	1.33	2.05	2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.26,2.08,2.08,2.08,1.74,2.08,2.08,2.10,2.09,2.08,2.08,2.08,2.12,2.08,2.08,2.08,1.88,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,1.28,2.08,2.08,1.90,2.09,2.08,2.08,2.08,2.13,2.08,2.08,2.08,1.84	300	200	250
9	3	2.60	2.60	4.00	-	300	200	250
10	17	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.73,1.67,1.67,1.66,1.62,1.67,1.67,1.69,1.67,1.67,1.67,1.65,1.73,1.67,1.67,1.66,1.65,1.68,1.68,1.67,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.67,1.66,1.13,1.67,1.67,1.61,1.68,1.67,1.67,1.66,1.74,1.67,1.67,1.66,1.64	300	200	250
11	20	1.33	1.33	2.05	2.09,2.09,2.09,2.09,2.09,2.09,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.10,1.67,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.09,2.09,2.09,2.09,2.09,2.09,2.09,2.09,2.09,2.08,2.08,2.08,2.08,2.08,2.08,1.91,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08,2.08	300	200	250
12	6	1.30	1.30	2.00	-	300	200	250
13	20	4.88	4.00	7.50	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.11,1.09,1.09,1.09,1.11,1.09,1.09,1.08,1.50,1.09,1.09,1.09,1.11,1.09,1.09,1.09,1.11,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.11,1.09,1.09,1.11,1.14,1.09,1.09,1.09,1.11,1.09,1.09,1.09,1.11	300	200	250
14	20	4.88	4.00	7.50	1.08,1.09,1.08,1.09,1.09,1.08,1.09,1.09,1.09,2.97,1.09,1.09,1.09,1.07,1.09,1.09,1.08,1.10,1.09,1.09,1.09,1.62,1.09,1.09,1.09,1.05,1.08,1.08,1.09,1.08,1.09,1.08,1.08,1.09,1.08,1.09,1.09,1.09,1.21,1.09,1.09,1.11,1.12,1.09,1.09,1.09,1.99,1.09,1.09,1.09,1.05	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	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.32,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
101	11	10.20	10.20	15.70	-	300	200	250
102	6	1.30	1.30	2.00	-	300	200	250
103	17	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.19,1.02,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.18,1.18,1.18,1.18,1.18,1.15,1.17,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18	300	200	250

104	17	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.73,1.67,1.67,1.66,1.62,1.67,1.67,1.69,1.67,1.67,1.67,1.65,1.73,1.67,1.67,1.66,1.65,1.68,1.68,1.67,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.67,1.66,1.13,1.67,1.67,1.61,1.68,1.67,1.67,1.66,1.74,1.67,1.67,1.66,1.64	300	200	250
105	17	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.68,1.54,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.63,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.67	300	200	250
106	17	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.17,1.17,1.18,1.18,1.19,1.12,1.18,1.18,1.17,1.17,1.18,1.18,1.17,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.15,1.17,1.18,1.18,1.17,1.17,1.18,1.18,1.17,1.18	300	200	250
107	17	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.68,1.60,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.63,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66	300	200	250
108	20	9.97	9.97	4.75	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.32,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
109	3	2.60	2.60	4.00	-	300	200	250
110	17	2.44	2.44	3.75	1.69,1.68,1.69,1.67,1.68,1.69,1.67,1.67,1.66,1.71,1.67,1.67,1.66,1.59,1.67,1.67,1.69,1.67,1.67,1.67,1.65,1.72,1.67,1.67,1.66,1.64,1.69,1.69,1.67,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.67,1.66,1.85,1.67,1.67,1.61,1.68,1.67,1.67,1.65,1.73,1.67,1.67,1.66,1.63	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	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.11,1.09,1.09,1.09,1.11,1.09,1.09,1.08,1.49,1.09,1.09,1.09,1.11,1.09,1.09,1.09,1.11,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.11,1.09,1.09,1.11,1.14,1.09,1.09,1.09,1.11,1.09,1.09,1.09,1.11	300	200	250
114	20	4.88	4.00	7.50	1.08,1.09,1.08,1.09,1.09,1.08,1.09,1.09,1.09,2.98,1.09,1.09,1.09,1.07,1.09,1.09,1.07,1.10,1.09,1.09,1.09,1.61,1.09,1.09,1.09,1.05,1.08,1.08,1.09,1.08,1.09,1.08,1.08,1.09,1.08,1.09,1.09,1.09,1.20,1.09,1.09,1.11,1.12,1.09,1.09,1.09,1.99,1.09,1.09,1.09,1.05	300	200	250
115	20	8.42	8.42	12.95	1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.14,1.12,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13	300	200	250
116	20	8.42	8.42	12.95	1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.15,1.13,1.13,1.13,1.12,1.13,1.13,1.14,1.14,1.13,1.13,1.13,1.14,1.13,1.13,1.13,1.12,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,1.13,3.50,1.13,1.13,1.13,1.14,1.13,1.13,1.13,1.15,1.13,1.13,1.13,1.12	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	457.51	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	32.92	6.46	56.26	44.91
14	159.30	97.43	32.00	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	457.51	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	32.93	6.46	56.26	44.91
114	159.30	97.43	31.98	6.46	56.26	44.91
115	159.30	48.27	14.83	6.46	56.26	44.91
116	159.30	48.27	14.85	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	0.036	0.766	0.020	0.043	0.002	0.792	#13	0.167	Not Required	Pass
2	0.004	0.485	0.234	0.105	0.045	0.720	#13	0.036	Not Required	Pass
3	0.006	0.729	0.036	0.072	0.005	0.739	#13	0.046	Not Required	Pass
4	0.006	0.727	0.132	0.073	0.029	0.783	#13	0.082	Not Required	Pass
5	0.006	0.453	0.129	0.072	0.034	0.470	#13	0.076	Not Required	Pass
6	0.008	0.822	0.054	0.082	0.006	0.856	#13	0.046	Not Required	Pass
7	0.008	0.509	0.173	0.081	0.045	0.535	#13	0.076	Not Required	Pass
8	0.002	0.082	0.213	0.056	0.018	0.244	#21	0.102	Not Required	Pass
9	0.018	0.089	0.067	0.002	0.002	0.159	#13	0.206	Not Required	Pass
10	0.009	0.819	0.165	0.082	0.035	0.862	#13	0.082	Not Required	Pass
11	0.002	0.081	0.218	0.056	0.018	0.251	#21	0.102	Not Required	Pass
12	0.004	0.592	0.260	0.122	0.047	0.853	#13	0.036	Not Required	Pass
13	0.006	0.293	0.461	0.069	0.022	0.659	#21	0.306	Not Required	Pass
14	0.008	0.297	0.455	0.069	0.022	0.651	#21	0.204	Not Required	Pass
15	0.000	0.100	0.186	0.035	0.011	0.269	#21	Not Required	Not Required	Pass
16	0.000	0.100	0.186	0.035	0.011	0.269	#21	Not Required	Not Required	Pass
101	0.036	0.766	0.020	0.043	0.002	0.792	#13	0.167	Not Required	Pass
102	0.004	0.592	0.260	0.122	0.047	0.853	#13	0.036	Not Required	Pass
103	0.008	0.822	0.054	0.082	0.006	0.856	#13	0.046	Not Required	Pass
104	0.009	0.819	0.165	0.082	0.035	0.862	#13	0.082	Not Required	Pass
105	0.008	0.509	0.173	0.081	0.045	0.535	#13	0.076	Not Required	Pass
106	0.006	0.729	0.036	0.072	0.005	0.739	#13	0.046	Not Required	Pass
107	0.006	0.453	0.129	0.072	0.034	0.470	#13	0.076	Not Required	Pass
108	0.000	0.100	0.186	0.035	0.011	0.269	#21	Not Required	Not Required	Pass
109	0.018	0.089	0.067	0.002	0.002	0.159	#13	0.206	Not Required	Pass
110	0.006	0.727	0.132	0.073	0.029	0.783	#13	0.082	Not Required	Pass
111	0.000	0.100	0.186	0.035	0.011	0.269	#21	Not Required	Not Required	Pass
112	0.004	0.485	0.234	0.105	0.045	0.720	#13	0.036	Not Required	Pass
113	0.006	0.293	0.461	0.069	0.022	0.659	#21	0.204	Not Required	Pass
114	0.008	0.297	0.455	0.069	0.022	0.651	#21	0.306	Not Required	Pass
115	0.007	0.660	0.248	0.056	0.018	0.795	#21	0.644	Not Required	Pass
116	0.002	0.663	0.248	0.056	0.018	0.794	#21	0.644	Not Required	Pass

Definitions

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	Round
D	Section diameter	36 in

Material Properties

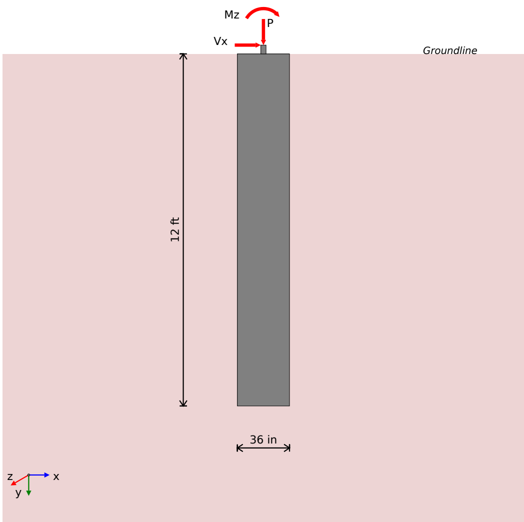
Input	Description	Value
f'_{ck}	Concrete compressive strength	2.5 ksi
f_{yk}	Yield strength of steel	60 ksi
d_b	Rebar diameter	#5 (0.625) in
cover	Concrete cover	3 in

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	10.74 kip	16.48 kip
Vx	-3.803 kip	-6.339 kip
Vz	-0.154 kip	-0.245 kip
Mx	-0.737 kip-ft	-1.162 kip-ft
Mz	61.27 kip-ft	104 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

$$H_o = \frac{V_x}{D} = \frac{-3.803}{36} = -1.268\ \frac{kip}{ft}$$

Moment per section length

$$M = \frac{M_z + (V_x \times H)}{} = \frac{61.27 + (-3.803 \times 0)}{} = 20.42\ \frac{kip - ft}{}$$

SkyCiv

$$M_o = \frac{}{D} = \frac{}{36} = 20.42 \frac{}{ft}$$

Required depth of embedment in earth:

$$L_x^3 - \left(14.14 \times \frac{H_o \times L_x}{R}\right) - \left(18.85 \times \frac{M_o}{R}\right) = 0$$

Solving the cubic equation:

$$L_{e,x} = 10.83\ ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{D} = \frac{-0.154}{36} = -0.051 \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{D} = \frac{-0.737 + (-0.154 \times 0)}{36} = -0.246 \frac{kip - ft}{ft}$$

Required depth of embedment in earth:

$$L_z^3 - \left(14.14 \times \frac{H_o \times L_z}{R}\right) - \left(18.85 \times \frac{M_o}{R}\right) = 0$$

Solving the cubic equation:

$$L_{e,z} = -2.627\ ft$$

Minimum embedded depth

Depth of pile required

$$L_{e,req} = MAX[L_{e,x}, L_{e,z}] = MAX[10.83, -2.627] = 10.83\ ft$$

Actual embedded length

$$L_e = L - h_2 - h_e = 12 - 0 - 0 = 12\ ft$$

Utilisation

$$Ratio = \frac{L_{e,req}}{L_e} = \frac{10.83}{12} = 0.903$$

UTILITY: 0.90

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:

$$A = \frac{\pi \times D^2}{4} = \frac{\pi \times 36^2}{4} = 7.069\ ft^2$$

End-bearing pressure:

$$q = \frac{P}{A} = \frac{10.74}{7.069} = 1520\ psf$$

Utilisation

$$Ratio = \frac{q}{q_a} = \frac{1520}{2000} = 0.76$$

UTILITY: 0.76

Lateral Soil Pressure (ASD)

Allowable lateral pressure	$R =$	150 psf/ft

Length to least lateral dimension ratio:

$$\frac{L}{D} = \frac{12}{3} = 4$$

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

Considering x-direction:

Distance from resting surface to pivot point:

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

SkyCiv

$$a=\frac{(4\times 20.42\times 12)+\left(3\times 1.268\times 12^2\right)}{(6\times 20.42)+(4\times 1.268\times 12)}=8.332\ ft$$

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

$$p=\frac{1.178\times[(4\times M_o)+(3\times H_o\times L_e)]^2}{L_e^2\times[(3\times M_o)+(2\times H_o\times L_e)]}$$

$$p=\frac{1.178\times[(4\times 20.42)+(3\times -1.268\times 12)]^2}{12^2\times[(3\times 20.42)+(2\times -1.268\times 12)]}=0.345\ \frac{kip}{ft^2}$$

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

$$p_a=R\times\frac{a}{2}=0.15\times\frac{8.332}{2}=0.625\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio=\frac{p}{p_a}=\frac{0.345}{0.625}=0.552$$

UTILITY: 0.55

Earth pressure against the pile at distance L_e:

$$s=\frac{9.425\times[(2\times M_o)+(H_o\times L_e)]}{L_e^2}=\frac{9.425\times[(2\times 20.42)+(-1.268\times 12)]}{12^2}=1.678\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

$$p_s=R\times L_e=0.15\times 12=1.8\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of L_e

$$Ratio=\frac{s}{p_s}=\frac{1.678}{1.8}=0.932$$

UTILITY: 0.93

Considering z-direction:

Distance from resting surface to pivot point:

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

$$a=\frac{(4\times 0.246\times 12)+\left(3\times 0.051\times 12^2\right)}{(6\times 0.246)+(4\times 0.051\times 12)}=8.626\ ft$$

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

$$p=\frac{1.178\times[(4\times M_o)+(3\times H_o\times L_e)]^2}{L_e^2\times[(3\times M_o)+(2\times H_o\times L_e)]}$$

$$p=\frac{1.178\times[(4\times -0.246)+(3\times -0.051\times 12)]^2}{12^2\times[(3\times -0.246)+(2\times -0.051\times 12)]}=-0.033\ \frac{kip}{ft^2}$$

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

$$p_a=R\times\frac{a}{2}=0.15\times\frac{8.626}{2}=0.647\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio=\frac{p}{p_a}=\frac{-0.033}{0.647}=-0.052$$

UTILITY: 0.05

Earth pressure against the pile at distance L_e:

$$s=\frac{9.425\times[(2\times M_o)+(H_o\times L_e)]}{L_e^2}=\frac{9.425\times[(2\times -0.246)+(-0.051\times 12)]}{12^2}=-0.073\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

$$p_s=R\times L_e=0.15\times 12=1.8\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{-0.073}{1.8} = -0.04$$

UTILITY: 0.04

REFERENCES	CALCULATIONS	RESULTS

Shear force and bending moment (LRFD)

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{D} = \frac{-6.339}{36} = -2.113\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{D} = \frac{104 + (-6.339 \times 0)}{36} = 34.67\ \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 34.67 \times 12) + \left(3 \times 2.113 \times 12^2\right)}{(6 \times 34.67) + (4 \times 2.113 \times 12)} = 8.328\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{34.67}{-2.113} = 16.41\ ft$$

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

$$V_{max,x} = (-2.113 \times 36) \times [1 - [3 \times \left(\frac{4 \times 16.41}{12} + 3\right) \times \left(\frac{8.328}{12}\right)^2] + [4 \times \left(\frac{3 \times 16.41}{12} + 2\right) \times \left(\frac{8.328}{12}\right)^3]]$$

$$V_{max,x} = 19.52\ kip$$

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

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

$$M_{max,x} = (-2.113 \times 36 \times 12) \times [\left(\frac{16.41}{12} + \frac{8.328}{2 \times 12}\right) - [\left(\frac{4 \times 16.41}{12} + 3\right) \times \left(\frac{8.328}{2 \times 12}\right)^3] + [\left(\frac{3 \times 16.41}{12} + 2\right) \times \left(\frac{8.328}{2 \times 12}\right)^4]]$$

$$M_{max,x} = 110.2\ kip - ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{D} = \frac{-0.245}{36} = -0.082\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{D} = \frac{-1.162 + (-0.245 \times 0)}{36} = -0.387\ \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.387 \times 12) + \left(3 \times 0.082 \times 12^2\right)}{(6 \times 0.387) + (4 \times 0.082 \times 12)} = 8.628\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{-0.387}{-0.082} = 4.737\ ft$$

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

$$V_{max,z} = (-0.082 \times 36) \times [1 - [3 \times \left(\frac{4 \times 4.737}{\ldots} + 3\right) \times \left(\frac{8.628}{\ldots}\right)^2] + [4 \times \left(\frac{3 \times 4.737}{\ldots} + 2\right) \times \left(\frac{8.628}{\ldots}\right)^3]]$$

$$V_{max,z} = (-0.082 \times 36) \times [1 - [3 \times \left(\frac{\quad}{12} + 3\right) \times \left(\frac{\quad}{12}\right)] + [4 \times \left(\frac{\quad}{12} + 2\right) \times \left(\frac{\quad}{12}\right)]]$$

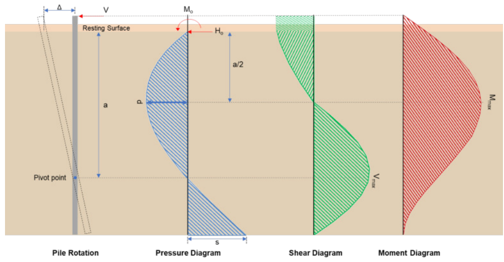
$$V_{max,z} = 0.335\ kip$$

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

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

$$M_{max,z} = (-0.082 \times 36 \times 12) \times [\left(\frac{4.737}{12} + \frac{8.628}{2 \times 12}\right) - [\left(\frac{4 \times 4.737}{12} + 3\right) \times \left(\frac{8.628}{2 \times 12}\right)^3] + [\left(\frac{3 \times 4.737}{12} + 2\right) \times \left(\frac{8.628}{2 \times 12}\right)^4]]$$

$$M_{max,z} = 1.751\ kip - ft$$



Minimum Reinforcement Check (LRFD)

Gross area of concrete:

$$A_g = \frac{\pi \times D^2}{4} = \frac{\pi \times 36^2}{4} = 1018\ in^2$$

Main Reinforcement

22.4.2.2 Required reinforcement:

$$A_{st,req} = \frac{P - (0.85 \times f'_{ck} \times A_g)}{f_{yk} - (0.85 \times f'_{ck})} = \frac{16.48 - (0.85 \times 2.5 \times 1018)}{60 - (0.85 \times 2.5)} = -37.09\ in^2$$

10.6.1.1 Maximum reinforcement:

$$A_{st,max} = 0.08 \times A_g = 0.08 \times 1018 = 81.43 in^2$$

7.6.1.1 Minimum reinforcement:

$$A_{st,min} = 0.0018 \times A_g = 0.0018 \times 1018 = 1.832 in^2$$

Governing minimum reinforcement area:

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

$$A_{min} = 1.832\ in^2$$

Minimum number of reinforcements:

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

$$n_{min} = \frac{A_{min}}{A_{bar}} = \frac{1.832}{0.307} = 6$$

25.2.3 Minimum spacing:

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

$$\text{Use: } n = 6 \text{pcs at } 1.5 \text{ in minimum spacing}$$

Total reinforcement area:

$$A_{st} = 6 \times 0.307 = 1.841\ in^2$$

Shear Reinforcement

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

Maximum spacing of shear Reinforcements:

$$s = MIN[16 \times d_b, 48 \times d_{b,ties}, D] = MIN[(16 \times 0.625), (48 \times 0.375), 36] = 10\ in$$

Detailing Summary	
Main reinforcement	#5 (0.625 in) - 6pcs 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:

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

$$\phi P_N = 0.65 \times 0.85 \times [(0.85 \times 2.5 \times [1018 - 1.841]) + (60 \times 1.841)] = 1254\ kip$$

Utilisation

$$Ratio = \frac{P}{\phi P_N} = \frac{16.48}{1254} = 0.013$$

UTILITY: 0.01

Shear Strength LRFD)

Effective shear width	$b_w =$	36 in
Effective shear depth	$d =$	28.8 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	$V_{max,x} =$	19.52 kip
Maximum shear in the z-direction	$V_{max,z} =$	0.335 kip

22.5.5.1.1 Max shear strength of concrete:

$$V_{c,max} = 5 \times \lambda \times \sqrt{f'_{ck}} \times b_w \times d = 5 \times 1 \times \sqrt{2.5} \times 36 \times 28.8 = 259.2\ kip$$

Table 22.5.5.1 Shear strength of concrete:

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

$$V_{c,a} = \left(2 \times 1 \times \sqrt{2.5} + MIN[\frac{16.48}{6 \times 1018}, (0.05 \times 2.5)]\right) \times (36 \times 28.8) = 106.5\ kip$$

Governing shear strength of concrete:

$$V_c = MIN[V_{c,max}, V_{c,a}] = MIN[259.2, 106.5] = 106.5\ kip$$

22.5.1.2 Shear strength of steel (a):

$$V_{s,a} = 8 \times \sqrt{f'_{ck}} \times b_w \times d = 8 \times \sqrt{2.5} \times 36 \times 28.8 = 414.7\ kip$$

22.5.8.5.3 Shear strength of steel (b):

$$V_{s,b} = \frac{A_v \times f_{yk} \times d}{s} = \frac{0.221 \times 60 \times 28.8}{10} = 38.17\ kip$$

Governing shear strength of steel:

$$V_s = MIN[V_{s,a}, V_{s,b}] = MIN[414.7, 38.17] = 38.17\ kip$$

22.5.1.1 Allowable shear strength:

$$\phi V_n = \phi \times (V_c + V_s) = 0.75 \times (106.5 + 38.17) = 108.5\ kip$$

$$V_{max} = MAX[19.52, 0.335] = 19.52\ kip$$

Utilisation

$$Ratio = \frac{V_{max}}{\phi V_n} = \frac{19.52}{108.5} = 0.18$$

UTILITY: 0.18

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	$b =$	36 in
Distance to the compression rebar	$d_s =$	3.688 in
Distance to the tension rebar	$d =$	28.8 in
Total bar area	$A_s =$	1.841 in^2
Maximum applied axial load	$P =$	16.48 kip
Maximum moment in the x-direction	$M_{max,x} =$	110.2 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$	1.751 kip-ft

Maximum moment in the z-direction $M_{max,z} =$ 1.751 kip-ft

Compressive force due to concrete:

$$\beta_1 = 0.85$$

$$C_{rc} = \beta_1 \times f_c' \times A_c$$

$$A_c = \frac{h^2}{8} \times (\theta - sin\theta)$$

$$\theta = \text{Central angle of the compressive area in radians}$$

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:

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

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

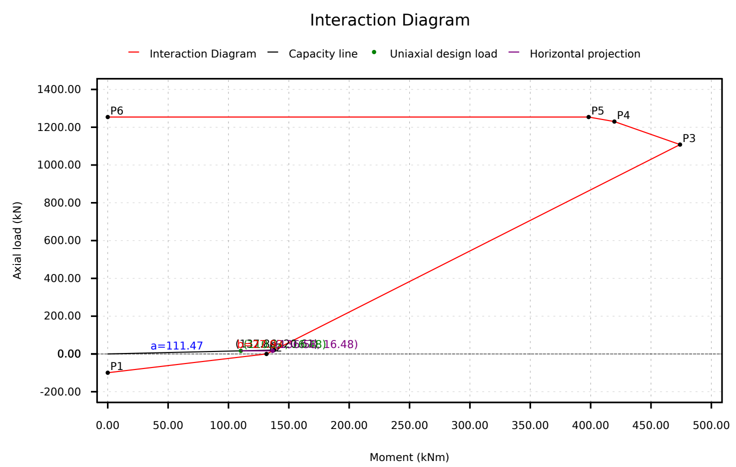
$$f_2 = E_s \times \varepsilon_2 \ (\varepsilon_2 < \varepsilon_{sy}), \ f_2 = \phi_s \times f_y \ (\varepsilon_2 \geq \varepsilon_{sy})$$

Interaction Diagram Summary

Point	Case	M_r	P_r
P1	Pure Tension	0	-99.4
P2	Pure Bending	131.5	0
P3	Balanced Failure	474.1	1108
P4	Decompression	419.7	1230
P5	Compression Limit	398.3	1254
P6	Pure Compression	0	1254

Uniaxial Bending Check

$$M_f = \sqrt{M_{max,x}^2 + M_{max,z}^2} = \sqrt{110.2^2 + 1.751^2} = 110.2 \ kip - ft$$



Segment	Signed Distance
P1 - P2	25.97
P2 - P3	25.17
P3 - P4	777.3
P4 - P5	1037
P5 - P6	1237
Status	PASS: Point lies inside the curve

Utilisation

$$Ratio = \frac{a}{a + b} = \frac{111.5}{111.5 + 27.93} = 0.8$$

UTILITY: 0.80

Biaxial Bending Check

Maximum moment in the x-direction	$M_{max,x} =$	110.2 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$	1.751 kip-ft
Nominal uniaxial moment strength about the x-axis	$M_{nox} =$	136.6 kip-ft
Nominal uniaxial moment strength about the z-axis	$M_{noz} =$	136.6 kip-ft
Interaction exponent	$\alpha =$	1

Bresler (1960)

According to Bresler (method B):

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

$$\left(\frac{110.2}{136.6}\right)^{1} + \left(\frac{1.751}{136.6}\right)^{1} = 0.82$$

UTILITY: 0.82

REFERENCES	CALCULATIONS	RESULTS

Results Summary

Result Name	Results
PILE DETAILS	
Length of the pile	12.00 ft
Dimension	36Ø in
Main bar reinforcement	#5-6pcs at 1.5 in min.
Shear reinforcement	#3 at 10 in max.
UTILISATIONS	
Required depth	0.90
End-bearing capacity	0.76
p_a	0.55
p_s	0.93
Axial compression strength	0.01
Shear strength	0.18
Uniaxial bending strength	0.80
Biaxial bending strength	0.82