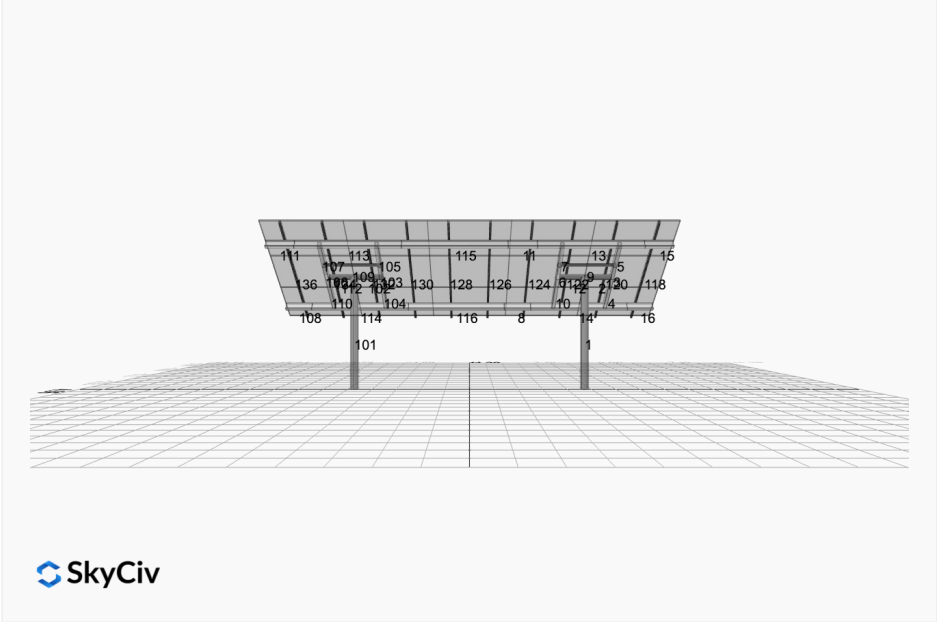
Project Details

Project Name: MTSOLAR_FALAFD4E0D6A
Location: 25 Canal Rd, Buffalo, WY 82834, USA
Unique ID: 2P-17-6TOP-SD-24-L-3Hx5W-9CFG
Dealer: _____

Date: Wed Nov 12 2025
Number of Modules: 15
Number of Poles: 2
Date Sold: _____



Array Dimensions N/S	11.38 ft
Array Dimensions E/W	28.75 ft
Winter Tilt Angle (Degrees)	35
Front Edge Clearance	5

MT Solar Bill of Materials (2P-17-6TOP-SD-24-L-3Hx5W-9CFG)

Part	Short Description	BOM Qty
MTS-PC-6	6IN Pole Cap Assembly	2
MTS-HF-SD	H-Frame Assembly-SD	2
MTS-SD-Wing-24	24IN SD Wing	4
MTS-SD-Splice-57	57IN SD Splice	4
MTS-CLAMP-HOOK-4PK	Hook Clamp	5

Rail Bill of Materials

Part	Qty
Rails (137in Long)	10x
Rail Attachment	20x
Module Mid Clamp	20x
Module End Clamp	20x
Ground Lug	5x

Site Details:

Site Address: 25 Canal Rd, Buffalo, WY 82834, USA

Array Specifications

Duty Classification:	SD
Module Width:	45.00 in
Module Length:	68.00 in
Number of Rows:	3
Number of Columns:	5
Total Number of Modules:	15
Winter Tilt Angle:	35
Front Edge Clearance:	5
Total Array Height at Tilt:	11.52 ft
Total Frame Length:	28.50 ft
Module Info/Notes:	JA 440W
Array Dimensions N/S:	11.38 ft
Array Dimensions E/W:	28.75 ft
Rail Length:	136.50 in
Rail Spacing:	2.88 ft

Support Specifications

Pole Size:	6in Pipe Sch 40
Pole Length above Grade:	8.26 ft
Number of Poles:	2
Pole Spacing:	17 ft

Foundation Specifications

Foundation Type:	round
Foundation Dimensions:	36 in dia.
Foundation Depth (below grade):	7.3 ft
Foundation Volume:	51.25 ft^3

Site Info

Risk Category:	I
Exposure:	C
Soil Classification:	sand
Site Location:	25 Canal Rd, Buffalo, WY 82834, USA
Wind Speed:	103 mph

Snow Load:	15 psf

Design Disclaimer

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

AutoDesigner Input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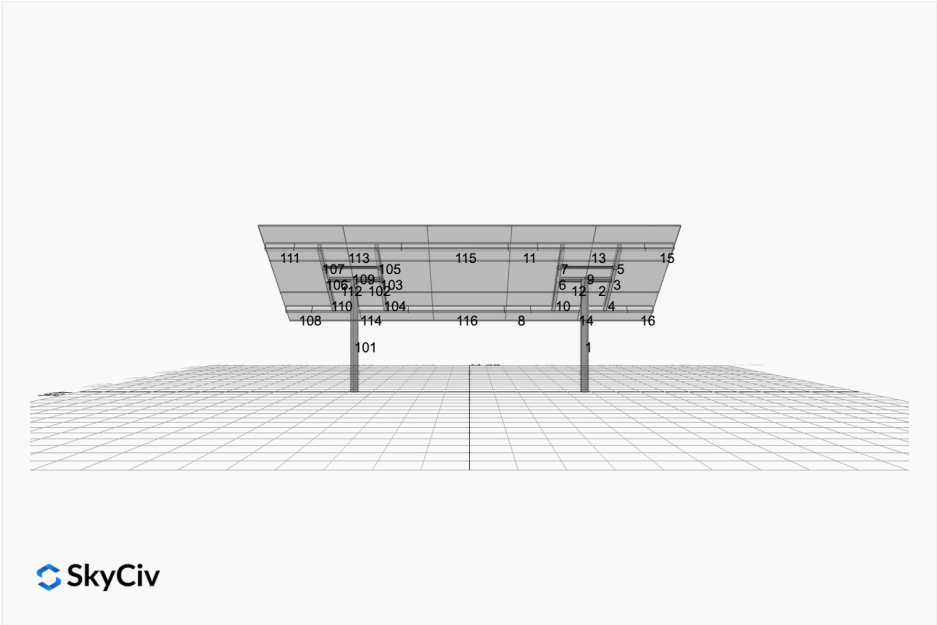
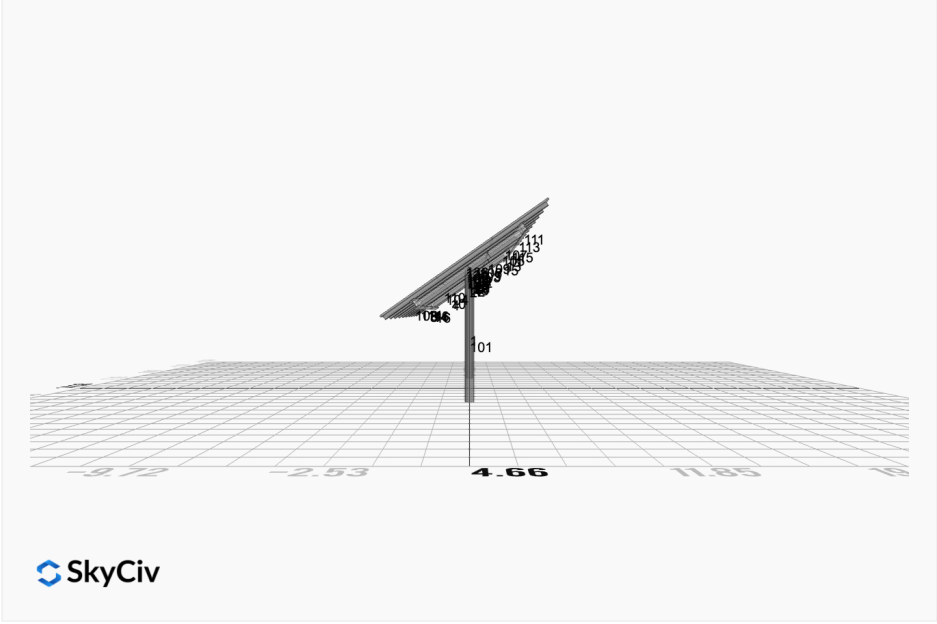
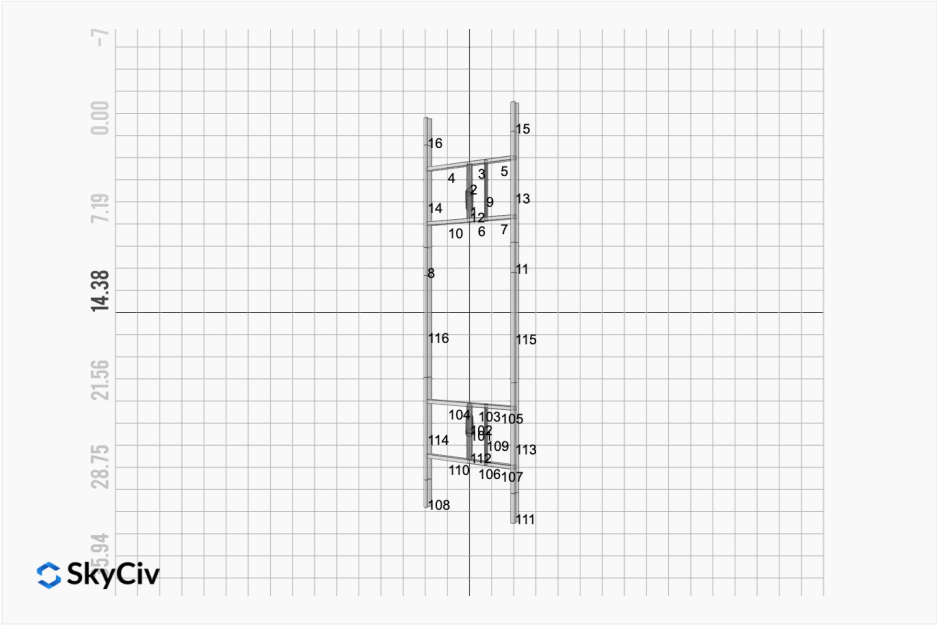
Design Notes:

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



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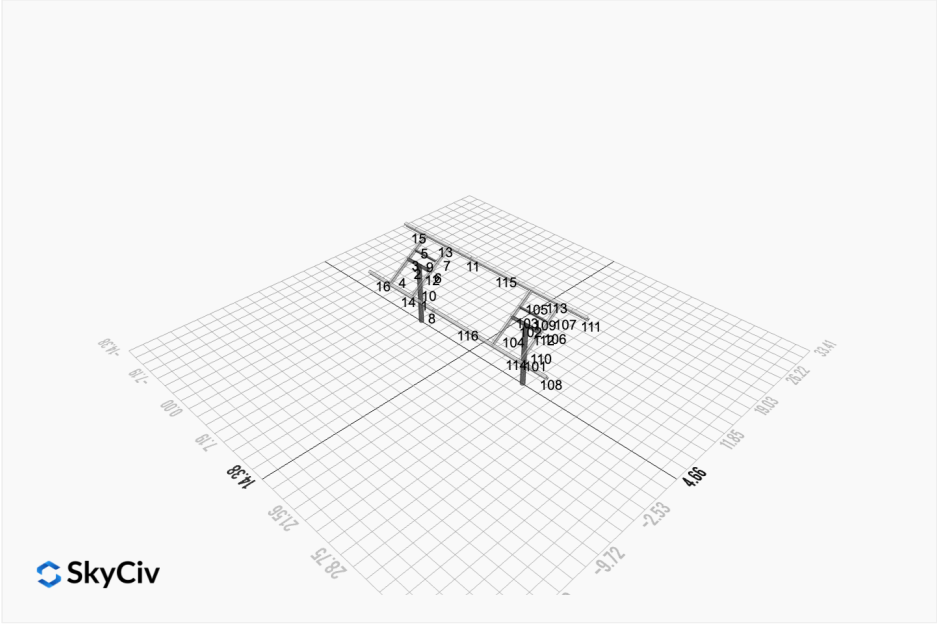
SkyCiv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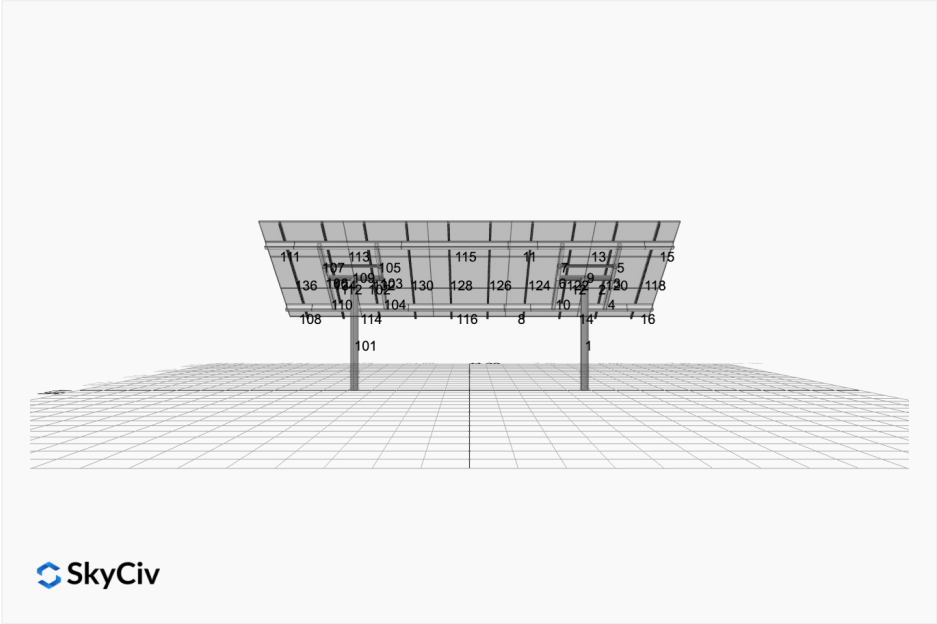
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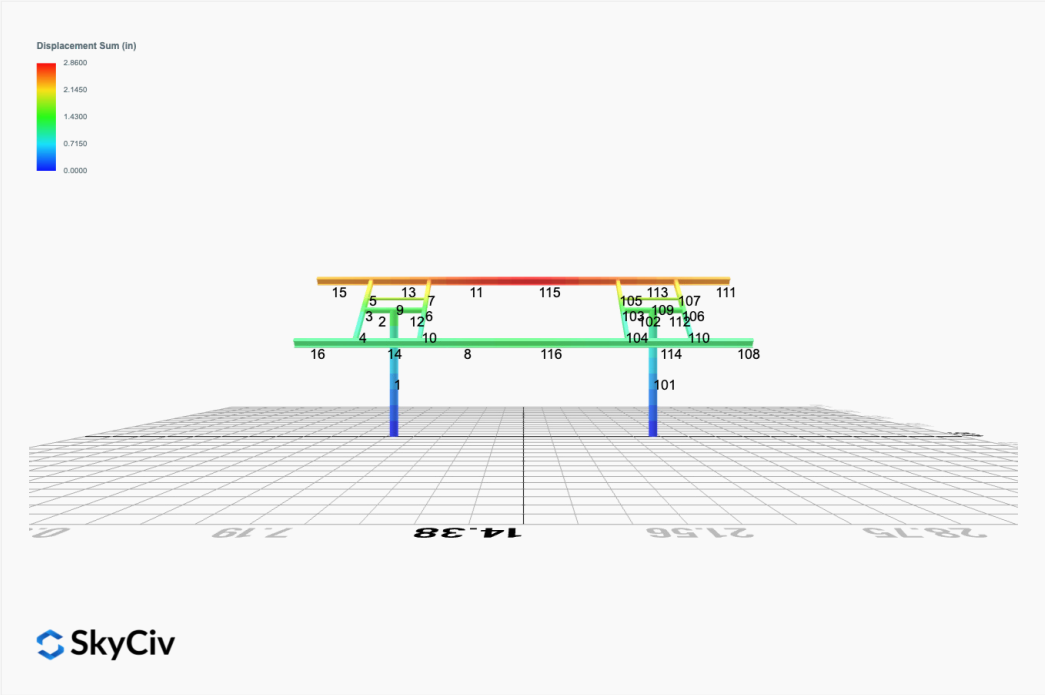
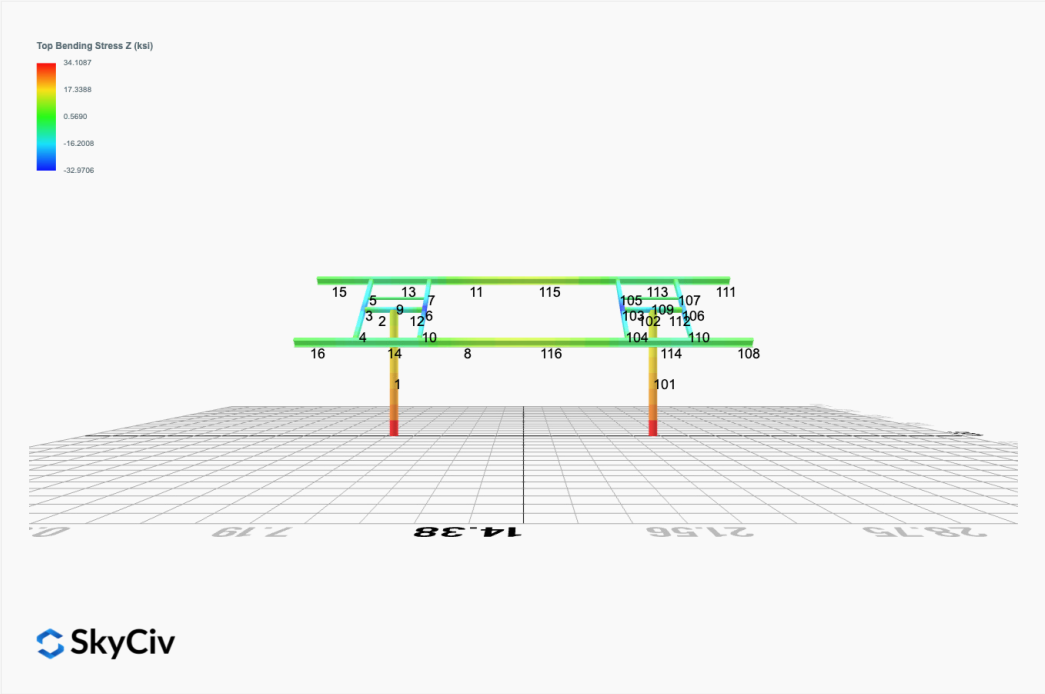
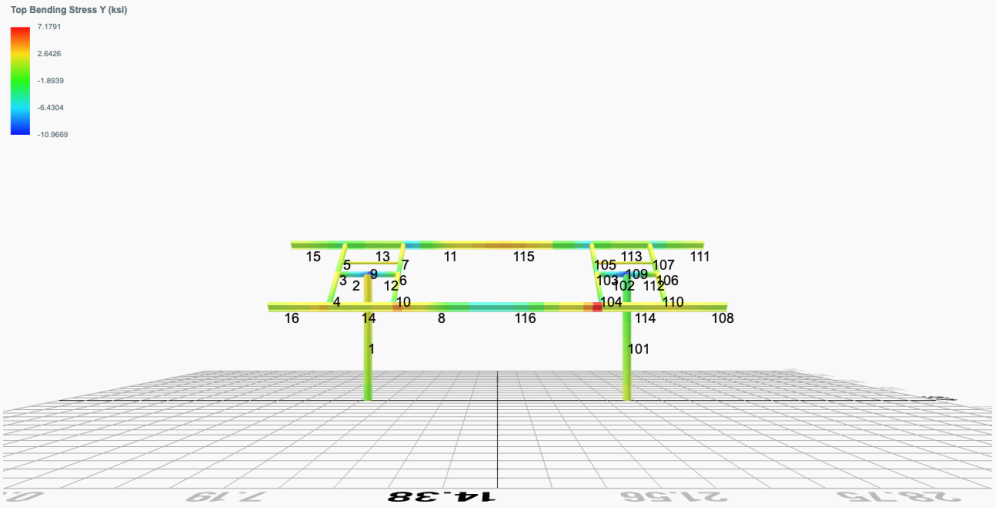
FEM Results (Envelope Worst Case)







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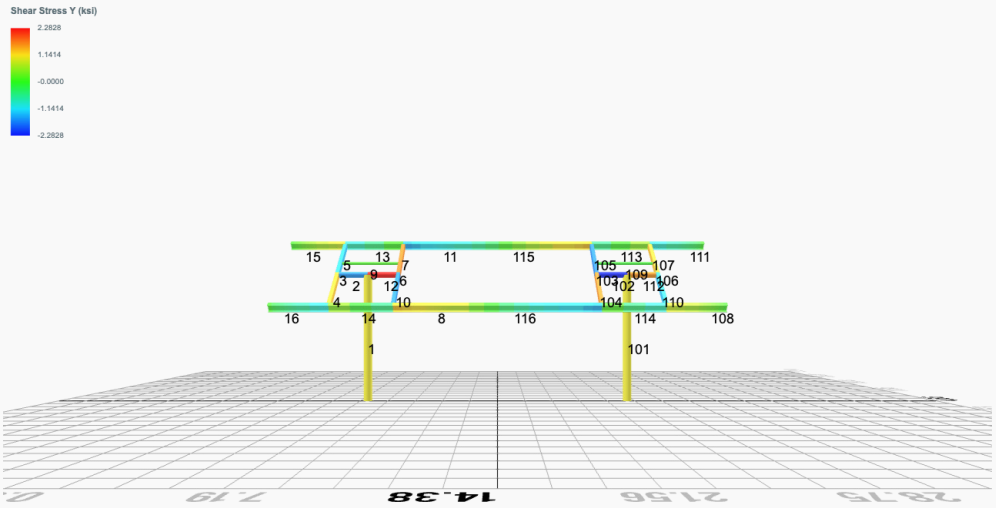

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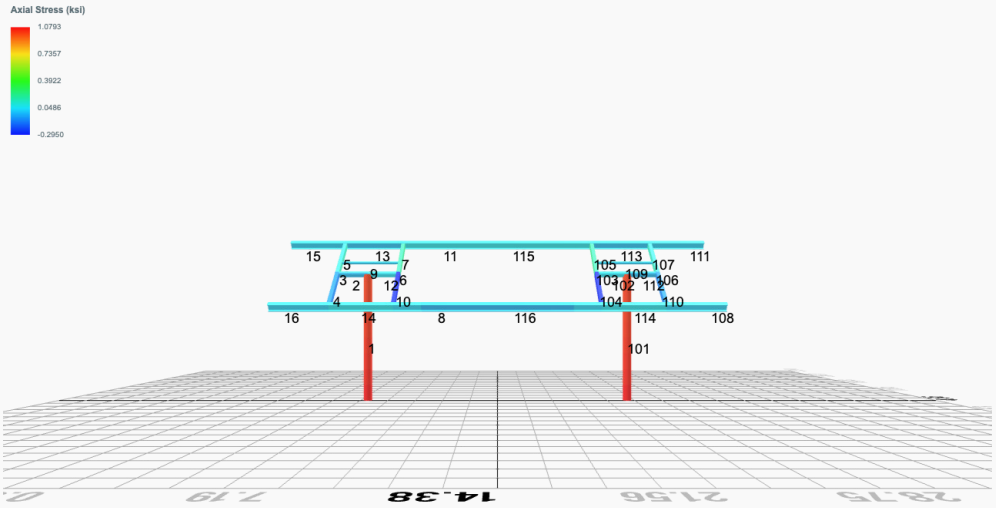
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9
109
2
12
6
103
102
112
106
4
10
104
110
16
14
8
116
114
108
1
101

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	1.9167	0.0701	0.1651	-0.0497	0.0282
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	2.0295	0.0784	0.1846	-0.0557	0.0258
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0000	1.6429	0.0601	0.1415	-0.0426	0.0237
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0000	2.8801	0.1186	0.2795	-0.0844	0.0324
ULS: 5. 1.2D + E + L + 0.2S	0.0000	1.7975	0.0674	0.1587	-0.0478	0.0244
ULS: 7. 0.9D + 1.0E	0.0000	1.2321	0.0451	0.1061	-0.0320	0.0171
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-2.7969	6.0239	0.3114	0.7095	-0.4877	24.0258
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-2.7969	6.0239	0.3114	0.7095	-0.4877	24.0258
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.3599	-1.3408	-0.1172	-0.2551	0.3080	-19.3832
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	1.9666	-0.7791	-0.0856	-0.1840	0.2492	-24.1476
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-2.7969	5.6372	0.2930	0.6662	-0.4747	23.9807
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-2.7969	5.6372	0.2930	0.6662	-0.4747	23.9807
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.3599	-1.7274	-0.1355	-0.2980	0.3211	-19.3520
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	1.9666	-1.1657	-0.1039	-0.2271	0.2624	-24.1034
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.3984	4.8773	0.2350	0.5417	-0.3002	11.9798
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-1.3984	4.8773	0.2350	0.5417	-0.3002	11.9798
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.1799	1.1950	0.0207	0.0591	0.0976	-9.7753
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.9833	1.4758	0.0367	0.0952	0.0678	-12.1860
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.3984	3.6401	0.1764	0.4033	-0.2585	11.9033
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-1.3984	3.6401	0.1764	0.4033	-0.2585	11.9033
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.1799	-0.0423	-0.0378	-0.0786	0.1393	-9.7297
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.9833	0.2386	-0.0219	-0.0430	0.1099	-12.1192
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-2.7969	5.2265	0.2780	0.6306	-0.4641	23.9295
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-2.7969	5.2265	0.2780	0.6306	-0.4641	23.9295
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	2.3599	-2.1381	-0.1504	-0.3333	0.3318	-19.3239
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	1.9666	-1.5764	-0.1190	-0.2626	0.2732	-24.0614

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0000	1.3691	0.0501	0.1179	-0.0355	0.0193
ULS: 2. D + L	0.0000	1.3691	0.0501	0.1179	-0.0355	0.0193
ULS: 3. D + (S or Lr or R)	0.0000	2.1423	0.0866	0.2041	-0.0616	0.0234
ULS: 3. D + (S or Lr or R)	0.0000	1.3691	0.0501	0.1179	-0.0355	0.0193
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	1.9490	0.0775	0.1825	-0.0551	0.0222
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0000	1.3691	0.0501	0.1179	-0.0355	0.0193
ULS: 5b. D + 0.7E	0.0000	1.3691	0.0501	0.1179	-0.0355	0.0193
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0000	1.9490	0.0775	0.1825	-0.0551	0.0222
ULS: 8. 0.6D + 0.7E	0.0000	0.8214	0.0300	0.0707	-0.0213	0.0110
ULS: 5a. D + 0.6W_Wind downforce Case A only	-1.6781	3.7657	0.1897	0.4321	-0.2947	14.2807
ULS: 5a. D + 0.6W_Wind downforce Case B only	-1.6781	3.7657	0.1897	0.4321	-0.2947	14.2807
ULS: 5a. D + 0.6W_Wind uplift Case A only	1.4159	-0.6531	-0.0674	-0.1461	0.1828	-11.6549
ULS: 5a. D + 0.6W_Wind uplift Case B only	1.1799	-0.3161	-0.0484	-0.1035	0.1476	-14.5134
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.2586	3.7465	0.1822	0.4182	-0.2494	10.7203
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-1.2586	3.7465	0.1822	0.4182	-0.2494	10.7203
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.0619	0.4324	-0.0106	-0.0157	0.1087	-8.7740
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.8850	0.6852	0.0037	0.0165	0.0821	-10.9305

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.2586	3.1665	0.1547	0.3534	-0.2298	10.6890
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-1.2586	3.1665	0.1547	0.3534	-0.2298	10.6890
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.0619	-0.1476	-0.0380	-0.0802	0.1283	-8.7541
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.8850	0.1052	-0.0238	-0.0482	0.1018	-10.9017
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-1.6781	3.2181	0.1696	0.3848	-0.2805	14.2374
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-1.6781	3.2181	0.1696	0.3848	-0.2805	14.2374
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	1.4159	-1.2007	-0.0874	-0.1932	0.1970	-11.6352
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	1.1799	-0.8637	-0.0685	-0.1507	0.1619	-14.4825

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	6.0239
Shear X	-2.7969
Shear Z	0.3114
Moment X	0.7095
Moment Y (Twist)	0.4877
Moment Z	24.1476

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	3.7657
Shear X	-1.6781
Shear Z	0.1897
Moment X	0.4321
Moment Y (Twist)	0.2947
Moment Z	14.5134

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	1.9167	-0.0701	-0.1651	0.0498	0.0283
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0000	2.0295	-0.0784	-0.1846	0.0557	0.0258
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0000	1.6429	-0.0601	-0.1415	0.0426	0.0237
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	-0.0000	2.8801	-0.1186	-0.2795	0.0844	0.0324
ULS: 5. 1.2D + E + L + 0.2S	-0.0000	1.7975	-0.0674	-0.1587	0.0479	0.0245
ULS: 7. 0.9D + 1.0E	-0.0000	1.2322	-0.0451	-0.1061	0.0320	0.0171
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-2.7969	6.0239	-0.3114	-0.7094	0.4877	24.0263
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-2.7969	6.0239	-0.3114	-0.7094	0.4877	24.0263
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.3599	-1.3408	0.1172	0.2552	-0.3080	-19.3835
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	1.9666	-0.7790	0.0856	0.1841	-0.2490	-24.1482
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-2.7969	5.6372	-0.2930	-0.6662	0.4747	23.9812
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-2.7969	5.6372	-0.2930	-0.6662	0.4747	23.9812
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	2.3599	-1.7274	0.1355	0.2981	-0.3210	-19.3523
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	1.9666	-1.1657	0.1039	0.2273	-0.2622	-24.1040
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.3984	4.8773	-0.2350	-0.5417	0.3002	11.9801
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-1.3984	4.8773	-0.2350	-0.5417	0.3002	11.9801
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.1799	1.1950	-0.0207	-0.0591	-0.0975	-9.7754
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.9833	1.4758	-0.0367	-0.0951	-0.0677	-12.1862
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-1.3984	3.6401	-0.1764	-0.4033	0.2585	11.9035
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-1.3984	3.6401	-0.1764	-0.4033	0.2585	11.9035
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	1.1799	-0.0423	0.0378	0.0787	-0.1393	-9.7298
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.9833	0.2386	0.0219	0.0431	-0.1098	-12.1195
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-2.7969	5.2265	-0.2780	-0.6306	0.4640	23.9298
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-2.7969	5.2265	-0.2780	-0.6306	0.4640	23.9298
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	2.3599	-2.1381	0.1504	0.3333	-0.3317	-19.3241
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	1.9666	-1.5764	0.1190	0.2627	-0.2731	-24.0619

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0000	1.3691	-0.0501	-0.1179	0.0355	0.0193
ULS: 2. D + L	-0.0000	1.3691	-0.0501	-0.1179	0.0355	0.0193
ULS: 3. D + (S or Lr or R)	-0.0000	2.1423	-0.0866	-0.2040	0.0616	0.0234
ULS: 3. D + (S or Lr or R)	-0.0000	1.3691	-0.0501	-0.1179	0.0355	0.0193
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0000	1.9490	-0.0775	-0.1825	0.0551	0.0222
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0000	1.3691	-0.0501	-0.1179	0.0355	0.0193
ULS: 5b. D + 0.7E	-0.0000	1.3691	-0.0501	-0.1179	0.0355	0.0193
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0000	1.9490	-0.0775	-0.1825	0.0551	0.0222
ULS: 8. 0.6D + 0.7E	-0.0000	0.8214	-0.0300	-0.0707	0.0213	0.0110
ULS: 5a. D + 0.6W_Wind downforce Case A only	-1.6781	3.7657	-0.1897	-0.4321	0.2946	14.2810
ULS: 5a. D + 0.6W_Wind downforce Case B only	-1.6781	3.7657	-0.1897	-0.4321	0.2946	14.2810
ULS: 5a. D + 0.6W_Wind uplift Case A only	1.4159	-0.6531	0.0674	0.1461	-0.1828	-11.6550
ULS: 5a. D + 0.6W_Wind uplift Case B only	1.1799	-0.3161	0.0484	0.1035	-0.1475	-14.5137
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.2586	3.7465	-0.1822	-0.4182	0.2494	10.7204
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-1.2586	3.7465	-0.1822	-0.4182	0.2494	10.7204
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.0619	0.4324	0.0106	0.0157	-0.1087	-8.7741
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.8849	0.6852	-0.0037	-0.0164	-0.0820	-10.9307
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.2586	3.1665	-0.1547	-0.3534	0.2298	10.6891
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-1.2586	3.1665	-0.1547	-0.3534	0.2298	10.6891
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.0619	-0.1476	0.0380	0.0802	-0.1282	-8.7542
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.8850	0.1052	0.0238	0.0482	-0.1017	-10.9019
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-1.6781	3.2181	-0.1696	-0.3848	0.2804	14.2375
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-1.6781	3.2181	-0.1696	-0.3848	0.2804	14.2375
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	1.4159	-1.2007	0.0874	0.1932	-0.1970	-11.6353
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	1.1799	-0.8637	0.0685	0.1508	-0.1618	-14.4827

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	6.0239
Shear X	-2.7969
Shear Z	-0.3114
Moment X	-0.7094
Moment Y (Twist)	0.4877
Moment Z	24.1482

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	3.7657
Shear X	-1.6781
Shear Z	-0.1897
Moment X	-0.4321
Moment Y (Twist)	0.2946
Moment Z	14.5137

Project Details

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

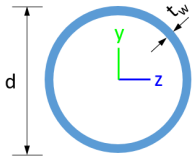
User Name: sales@mtsolar.us
Unit System: imperial

Design Input Information

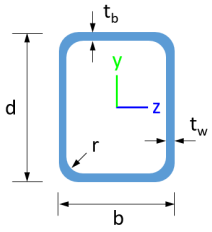
Design Factors			
Φ_t	Φ_c	Φ_b	Φ_v
0.9	0.9	0.9	0.9

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

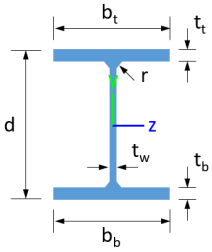
Section Dimensions



ID	Name	d (in)	t_w (in)					
1	2in Pipe Sch 40	2.38	0.15					
4	4in Pipe Sch 40	4.50	0.24					
7	6in Pipe Sch 40	6.63	0.28					



ID	Name	d (in)	b (in)	t_w (in)	t_b (in)	r (in)		
15	HSS5x3x1/8	5.00	3.00	0.12	0.12	0.12		



ID	Name	d (in)	t_w (in)	b_t (in)	b_b (in)	t_t (in)	t_b (in)	r (in)
18	W6x9	5.90	0.17	3.94	3.94	0.21	0.21	0.25

Section Properties

Section Properties

ID	Name	A (in^2)	J (in^4)	I_{yp} (in^4)	I_{zp} (in^4)	I_w (in^6)	S_{yp} (in^3)	S_{zp} (in^3)
1	2in Pipe Sch 40	1.07	1.33	0.67	0.67	0.00	0.76	0.76
4	4in Pipe Sch 40	3.17	14.47	7.23	7.23	0.00	4.31	4.31
7	6in Pipe Sch 40	5.58	56.28	28.14	28.14	0.00	11.28	11.28
15	HSS5x3x1/8	1.77	6.02	2.75	6.03	0.51	2.07	2.93
18	W6x9	2.68	0.04	2.20	16.40	17.70	1.72	6.23

Member Properties

Member ID	Section ID	K_z L (ft)	K_y L (ft)	L_b (ft)	C_b	LST	LSC	LD
1	7	5.37	5.37	8.26	-	300	200	250
2	4	1.30	1.30	2.00	-	300	200	250
3	15	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.17,1.17,1.18,1.18,1.57,1.16,1.18,1.18,1.16,1.17,1.18,1.18,1.17,1.17,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.15,1.17,1.18,1.18,1.16,1.17,1.18,1.18,1.17,1.17	300	200	250
4	15	2.44	2.44	3.75	1.69,1.68,1.69,1.68,1.69,1.69,1.67,1.67,1.66,1.80,1.67,1.67,1.66,1.49,1.67,1.67,2.97,1.68,1.67,1.67,1.64,1.72,1.67,1.67,1.66,1.62,1.69,1.69,1.68,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.67,1.65,1.78,1.67,1.67,1.63,1.69,1.67,1.67,1.65,1.72,1.67,1.67,1.66,1.60	300	200	250
5	15	1.52	1.52	2.33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.67,1.67,2.41,1.65,1.67,1.67,1.65,1.66,1.67,1.67,1.66,1.66,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.64,1.66,1.67,1.67,1.65,1.66,1.67,1.67,1.66,1.66	300	200	250
6	15	0.92	0.92	1.42	1.19,1.19,1.19,1.19,1.19,1.19,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.41,1.16,1.18,1.18,1.17,1.17,1.18,1.18,1.18,1.18,1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.18,1.18,1.18,1.18,1.18,1.18,1.16,1.17,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18	300	200	250
7	15	1.52	1.52	2.33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.67,1.67,2.25,1.65,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.65,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.67	300	200	250
8	18	1.33	1.33	2.05	1.30,1.30,1.30,1.30,1.30,1.30,1.29,1.29,1.29,1.15,1.29,1.29,1.29,1.16,1.29,1.29,1.02,1.33,1.29,1.29,1.28,1.42,1.29,1.29,1.29,1.21,1.30,1.30,1.30,1.30,1.30,1.30,1.30,1.30,1.30,1.29,1.29,1.29,1.66,1.29,1.29,1.27,1.35,1.29,1.29,1.29,1.46,1.29,1.29,1.29,1.20	300	200	250
9	1	2.60	2.60	4.00	-	300	200	250
10	15	2.44	2.44	3.75	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.67,1.66,1.10,1.67,1.67,1.66,1.61,1.67,1.67,2.27,1.68,1.67,1.67,1.65,1.72,1.67,1.67,1.66,1.64,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.67,1.66,1.95,1.67,1.67,1.63,1.69,1.67,1.67,1.65,1.73,1.67,1.67,1.66,1.63	300	200	250
11	18	1.33	1.33	2.05	1.30,1.30,1.30,1.30,1.30,1.30,1.30,1.30,1.29,1.31,1.30,1.30,1.29,1.31,1.30,1.30,1.02,1.31,1.30,1.30,1.29,1.31,1.30,1.30,1.29,1.31,1.30,1.30,1.30,1.30,1.30,1.30,1.30,1.30,1.30,1.30,1.30,1.29,1.31,1.30,1.30,1.28,1.31,1.30,1.30,1.29,1.31,1.30,1.30,1.29,1.31	300	200	250
12	4	1.30	1.30	2.00	-	300	200	250
13	18	4.88	4.00	7.50	1.22,1.22,1.22,1.22,1.22,1.22,1.23,1.23,1.24,1.30,1.23,1.23,1.24,1.29,1.23,1.23,1.35,1.51,1.23,1.23,1.25,1.32,1.23,1.23,1.24,1.29,1.22,1.22,1.22,1.22,1.22,1.22,1.22,1.22,1.22,1.23,1.23,1.24,1.30,1.23,1.23,1.28,1.36,1.23,1.23,1.25,1.31,1.23,1.23,1.24,1.29	300	200	250
14	18	4.88	4.00	7.50	1.21,1.21,1.21,1.21,1.21,1.21,1.22,1.22,1.23,1.43,1.22,1.22,1.23,1.21,1.22,1.22,1.32,1.29,1.22,1.22,1.24,1.73,1.22,1.22,1.23,1.14,1.21,1.21,1.21,1.21,1.21,1.21,1.21,1.21,1.21,1.22,1.22,1.23,1.63,1.22,1.22,1.27,1.36,1.22,1.22,1.24,2.09,1.22,1.22,1.23,1.16	300	200	250
15	18	4.20	4.20	2.00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.25,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
16	18	4.20	4.20	2.00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.32,2.33,2.33,2.33,2.33,2.33,2.33,2.25,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.32,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.32	300	200	250
101	7	5.37	5.37	8.26	-	300	200	250
102	4	1.30	1.30	2.00	-	300	200	250
103	15	0.92	0.92	1.42	1.19,1.19,1.19,1.19,1.19,1.19,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.41,1.16,1.18,1.18,1.17,1.17,1.18,1.18,1.18,1.18,1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.19,1.18,1.18,1.18,1.18,1.18,1.18,1.16,1.17,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18	300	200	250
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104	15	44	44	75	66,1.64,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.67,1.66,1.95,1.67,1.67,1.63,1.69,1.67,1.67,1.65,1.73,1.67,1.67,1.66,1.63	00	00	50
105	15	1.52	1.52	2.33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.67,1.67,2.25,1.65,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.67,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.65,1.66,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.67	300	200	250
106	15	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.17,1.17,1.18,1.18,1.57,1.16,1.18,1.18,1.16,1.17,1.18,1.18,1.17,1.17,1.19,1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.18,1.17,1.17,1.18,1.18,1.15,1.17,1.18,1.18,1.16,1.17,1.18,1.18,1.17,1.17	300	200	250
107	15	1.52	1.52	2.33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.66,1.66,1.67,1.67,2.39,1.65,1.67,1.67,1.65,1.66,1.67,1.67,1.66,1.66,1.68,1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.68,1.67,1.67,1.66,1.66,1.67,1.67,1.64,1.66,1.67,1.67,1.65,1.66,1.67,1.67,1.66,1.66	300	200	250
108	18	4.20	4.20	2.00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.32,2.33,2.33,2.33,2.33,2.33,2.33,2.25,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.32,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.32	300	200	250
109	1	2.60	2.60	4.00	-	300	200	250
110	15	2.44	2.44	3.75	1.69,1.68,1.69,1.68,1.69,1.69,1.67,1.67,1.66,1.80,1.67,1.67,1.66,1.49,1.67,1.67,2.97,1.68,1.67,1.67,1.64,1.72,1.67,1.67,1.66,1.62,1.69,1.69,1.68,1.69,1.68,1.69,1.69,1.68,1.69,1.67,1.67,1.65,1.78,1.67,1.67,1.63,1.69,1.67,1.67,1.65,1.72,1.67,1.67,1.66,1.60	300	200	250
111	18	4.20	4.20	2.00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.25,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	250
112	4	1.30	1.30	2.00	-	300	200	250
113	18	4.88	4.00	7.50	1.22,1.22,1.22,1.22,1.22,1.22,1.23,1.23,1.24,1.30,1.23,1.23,1.24,1.29,1.23,1.23,1.35,1.51,1.23,1.23,1.25,1.31,1.23,1.23,1.24,1.28,1.22,1.22,1.22,1.22,1.22,1.22,1.22,1.22,1.22,1.23,1.23,1.24,1.30,1.23,1.23,1.28,1.35,1.23,1.23,1.25,1.31,1.23,1.23,1.24,1.29	300	200	250
114	18	4.88	4.00	7.50	1.21,1.21,1.21,1.21,1.21,1.21,1.22,1.22,1.23,1.43,1.22,1.22,1.23,1.21,1.22,1.22,1.32,1.29,1.22,1.22,1.24,1.73,1.22,1.22,1.23,1.14,1.21,1.21,1.21,1.21,1.21,1.21,1.21,1.21,1.21,1.22,1.22,1.23,1.64,1.22,1.22,1.27,1.36,1.22,1.22,1.24,2.09,1.22,1.22,1.23,1.16	300	200	250
115	18	4.84	4.84	7.45	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.03,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.08,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09	300	200	250
116	18	4.84	4.84	7.45	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.44,1.09,1.09,1.09,1.06,1.09,1.09,1.04,1.09,1.09,1.09,1.09,1.11,1.09,1.09,1.09,1.07,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,2.61,1.09,1.09,1.08,1.10,1.09,1.09,1.09,1.11,1.09,1.09,1.09,1.07	300	200	250

Member Design Capacity

Member ID	$\Phi_t P_n$ (kip)	$\Phi_c P_n$ (kip)	$\Phi_b M_{zn}$ (k-ft)	$\Phi_b M_{yn}$ (k-ft)	$\Phi_v V_{yn}$ (kip)	$\Phi_v V_{zn}$ (kip)
1	231.07	218.61	38.92	38.92	69.32	69.32
2	131.41	130.46	14.87	14.87	39.42	39.42
3	79.65	74.89	10.99	6.26	29.14	16.61
4	79.65	72.84	10.99	6.26	29.14	16.61
5	79.65	74.30	10.99	6.26	29.14	16.61
6	79.65	74.89	10.99	6.26	29.14	16.61
7	79.65	74.30	10.99	6.26	29.14	16.61
8	120.60	115.40	23.36	6.45	30.09	45.74
9	44.49	40.02	2.63	2.63	13.35	13.35
10	79.65	72.84	10.99	6.26	29.14	16.61
11	120.60	115.40	23.36	6.45	30.09	45.74
12	131.41	130.46	14.87	14.87	39.42	39.42
13	120.60	84.03	21.42	6.45	30.09	45.74
14	120.60	84.03	20.12	6.45	30.09	45.74
15	120.60	96.18	23.36	6.45	30.09	45.74
16	120.60	96.18	23.36	6.45	30.09	45.74
101	231.07	218.61	38.92	38.92	69.32	69.32
102	131.41	130.46	14.87	14.87	39.42	39.42
103	79.65	74.89	10.99	6.26	29.14	16.61
104	79.65	72.84	10.99	6.26	29.14	16.61
105	79.65	74.30	10.99	6.26	29.14	16.61

106	79.65	74.89	10.99	6.26	29.14	16.61
107	79.65	74.30	10.99	6.26	29.14	16.61
108	120.60	96.18	23.36	6.45	30.09	45.74
109	44.49	40.02	2.63	2.63	13.35	13.35
110	79.65	72.84	10.99	6.26	29.14	16.61
111	120.60	96.18	23.36	6.45	30.09	45.74
112	131.41	130.46	14.87	14.87	39.42	39.42
113	120.60	84.03	21.42	6.45	30.09	45.74
114	120.60	84.03	20.09	6.45	30.09	45.74
115	120.60	84.26	18.26	6.45	30.09	45.74
116	120.60	84.26	18.36	6.45	30.09	45.74

Design Ratio

Member ID	P	M_z	M_y	V_y	V_z	(P,M_z,M_y)	Worst LC	KL/r	δ	Status
1	0.028	0.621	0.048	0.040	0.004	0.649	#13	0.144	Not Required	Pass
2	0.001	0.273	0.165	0.064	0.034	0.438	#13	0.052	Not Required	Pass
3	0.004	0.488	0.029	0.049	0.005	0.496	#13	0.044	Not Required	Pass
4	0.004	0.474	0.057	0.048	0.011	0.531	#13	0.078	Not Required	Pass
5	0.004	0.303	0.033	0.049	0.006	0.309	#13	0.073	Not Required	Pass
6	0.006	0.603	0.072	0.062	0.016	0.661	#13	0.044	Not Required	Pass
7	0.006	0.373	0.083	0.060	0.017	0.392	#13	0.073	Not Required	Pass
8	0.002	0.110	0.034	0.034	0.005	0.134	#13	0.088	Not Required	Pass
9	0.000	0.055	0.056	0.002	0.002	0.112	#13	0.198	Not Required	Pass
10	0.007	0.587	0.077	0.059	0.014	0.595	#13	0.078	Not Required	Pass
11	0.002	0.112	0.033	0.035	0.005	0.132	#13	0.088	Not Required	Pass
12	0.001	0.398	0.198	0.084	0.038	0.596	#13	0.052	Not Required	Pass
13	0.002	0.090	0.106	0.048	0.007	0.150	#21	0.265	Not Required	Pass
14	0.002	0.091	0.104	0.047	0.007	0.144	#21	0.177	Not Required	Pass
15	0.000	0.019	0.016	0.015	0.002	0.029	#13	Not Required	Not Required	Pass
16	0.000	0.019	0.016	0.014	0.002	0.029	#21	Not Required	Not Required	Pass
101	0.028	0.621	0.048	0.040	0.004	0.649	#13	0.144	Not Required	Pass
102	0.001	0.398	0.197	0.084	0.038	0.596	#13	0.052	Not Required	Pass
103	0.006	0.603	0.072	0.062	0.016	0.661	#13	0.044	Not Required	Pass
104	0.007	0.587	0.077	0.059	0.014	0.595	#13	0.078	Not Required	Pass
105	0.006	0.373	0.083	0.060	0.017	0.392	#13	0.073	Not Required	Pass
106	0.004	0.488	0.029	0.049	0.005	0.496	#13	0.044	Not Required	Pass
107	0.004	0.303	0.033	0.049	0.006	0.309	#13	0.073	Not Required	Pass
108	0.000	0.019	0.016	0.014	0.002	0.029	#21	Not Required	Not Required	Pass
109	0.000	0.055	0.056	0.002	0.002	0.112	#13	0.198	Not Required	Pass
110	0.004	0.474	0.057	0.048	0.011	0.531	#13	0.078	Not Required	Pass
111	0.000	0.019	0.016	0.015	0.002	0.029	#13	Not Required	Not Required	Pass
112	0.001	0.273	0.165	0.064	0.034	0.438	#13	0.052	Not Required	Pass
113	0.002	0.090	0.106	0.048	0.007	0.150	#21	0.177	Not Required	Pass
114	0.002	0.091	0.104	0.047	0.007	0.144	#21	0.265	Not Required	Pass
115	0.002	0.178	0.062	0.035	0.005	0.217	#13	0.321	Not Required	Pass
116	0.002	0.175	0.063	0.034	0.005	0.218	#13	0.321	Not Required	Pass

Definitions

Φ_t	Safety factor for tensile
Φ_c	Safety factor for compression
Φ_b	Safety factor for flexure
Φ_v	Safety factor for shear
E	Modulus of elasticity
F_y	Specified minimum yield stress
F_u	Specified minimum tensile strength
A	Cross-sectional area
J	Torsional constant
I_{yp}	Moment of inertia about the Y axes
I_{zp}	Moment of inertia about the Z axes
I_w	Warping constant
S_{yp}	Plastic section modulus about the Y axis
S_{zp}	Plastic section modulus about the Z axis
KL	Effective length
C_b	Buckling modification factor (from all load combinations)
L_b	Length between braced points
LST	Limited slenderness for tension
LSC	Limited slenderness for compression
LD	Limited deflection
P_n	Nominal axial strength (tension/comression)
M_n	Nominal flexural strength (about Z/Y axis)
V_n	Nominal shear strength (along Z/Y axis)
P	Design ratio in case of axial force
M_z	Design ratio in case of bending about Z axis
M_y	Design ratio in case of bending about Y axis
V_y	Design ratio in case of shear along Y axis
V_z	Design ratio in case of shear along Z axis
(P,M_z,M_y)	Design ratio in case of axial force and bending action
KL/r	Design ratio in case of section slenderness
δ	Design ratio in case of member deflection
OK	Capacity is provided
NG	Capacity is not provided

IBC 2018 Pile Design

Powered by SkyCiv

Input	Description
Region	American Standard
Concrete design code	American Concrete Institute (ACI 318:2019)

Cross-section

Input	Description	Value
Shape	Cross-sectional shape	Round
D	Section diameter	36 in

Material Properties

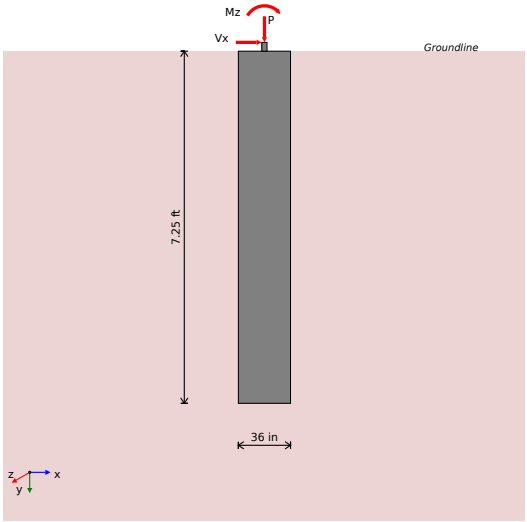
Input	Description	Value
f'_{ck}	Concrete compressive strength	2.5 ksi
f_{yk}	Yield strength of steel	60 ksi
d_b	Rebar diameter	#5 (0.625) in
cover	Concrete cover	3 in

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	3.766 kip	6.024 kip
Vx	-1.678 kip	-2.797 kip
Vz	-0.19 kip	-0.311 kip
Mx	-0.432 kip-ft	-0.709 kip-ft
Mz	14.51 kip-ft	24.15 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

$$H_o = \frac{V_x}{D} = \frac{-1.678}{36} = -0.559\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{D} = \frac{14.51 + (-1.678 \times 0)}{36} = 4.838\ \frac{kip - ft}{ft}$$

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

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:

$$L_{e,x} = 6.447\ ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{D} = \frac{-0.19}{36} = -0.063\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{D} = \frac{-0.432 + (-0.19 \times 0)}{36} = -0.144\ \frac{kip - ft}{ft}$$

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:

$$L_{e,z} = -1.895\ ft$$

Minimum embedded depth

Depth of pile required

$$L_{e,req} = MAX[L_{e,x}, L_{e,z}] = MAX[6.447, -1.895] = 6.447\ ft$$

Actual embedded length

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

Utilisation

$$Ratio = \frac{L_{e,req}}{L_e} = \frac{6.447}{7.25} = 0.889$$

UTILITY: 0.89

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:

$$q = \frac{P}{A} = \frac{3.766}{7.069} = 532.7\ psf$$

Utilisation

$$Ratio = \frac{q}{q_a} = \frac{532.7}{2000} = 0.266$$

UTILITY: 0.27

Lateral Soil Pressure (ASD)

Allowable lateral pressure $R =$ 150 psf/ft

Length to least lateral dimension ratio:

$$\frac{L}{D} = \frac{7.25}{3} = 2.417$$

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

Considering x-direction:

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 4.838 \times 7.25) + \left(3 \times 0.559 \times 7.25^2\right)}{(6 \times 4.838) + (4 \times 0.559 \times 7.25)} = 5.05\ ft$$

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

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

$$p = \frac{1.178 \times [(4 \times 4.838) + (3 \times -0.559 \times 7.25)]^2}{7.25^2 \times [(3 \times 4.838) + (2 \times -0.559 \times 7.25)]} = 0.181\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{5.05}{2} = 0.379\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{0.181}{0.379} = 0.477$$

UTILITY: 0.48

Earth pressure against the pile at distance L_e:

$$s = \frac{9.425 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{9.425 \times [(2 \times 4.838) + (-0.559 \times 7.25)]}{7.25^2} = 1.008\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

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

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{1.008}{1.087} = 0.927$$

UTILITY: 0.93

Considering z-direction:

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.144 \times 7.25) + \left(3 \times 0.063 \times 7.25^2\right)}{(6 \times 0.144) + (4 \times 0.063 \times 7.25)} = 5.244\ ft$$

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

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

$$p = \frac{1.178 \times [(4 \times -0.144) + (3 \times -0.063 \times 7.25)]^2}{7.25^2 \times [(3 \times -0.144) + (2 \times -0.063 \times 7.25)]} = -0.063\ \frac{kip}{ft^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{5.244}{2} = 0.393\ \frac{kip}{ft^2}$$

Utilisation - pressure at a depth of a/2

$$Ratio = \frac{p}{p_a} = \frac{-0.063}{0.393} = -0.161$$

UTILITY: 0.16

Earth pressure against the pile at distance L_e:

$$s = \frac{9.425 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{9.425 \times [(2 \times -0.144) + (-0.063 \times 7.25)]}{7.25^2} = -0.134\ \frac{kip}{ft^2}$$

Allowable lateral soil pressure at a depth of L_e:

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

Utilisation - pressure at a depth of L_e

$$Ratio = \frac{s}{p_s} = \frac{-0.134}{1.087} = -0.123$$

UTILITY: 0.12

REFERENCES	CALCULATIONS	RESULTS

Shear force and bending moment (LRFD)

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{D} = \frac{-2.797}{36} = -0.932\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_z + (V_x \times H)}{D} = \frac{24.15 + (-2.797 \times 0)}{36} = 8.049\ \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 8.049 \times 7.25) + (3 \times 0.932 \times 7.25^2)}{(6 \times 8.049) + (4 \times 0.932 \times 7.25)} = 5.05\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{8.049}{-0.932} = 8.634\ ft$$

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

$$V_{max,x} = (-0.932 \times 36) \times [1 - [3 \times \left(\frac{4 \times 8.634}{7.25} + 3\right) \times \left(\frac{5.05}{7.25}\right)^2] + [4 \times \left(\frac{3 \times 8.634}{7.25} + 2\right) \times \left(\frac{5.05}{7.25}\right)^3]]$$

$$V_{max,x} = 7.739\ kip$$

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

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

$$M_{max,x} = (-0.932 \times 36 \times 7.25) \times [\left(\frac{8.634}{7.25} + \frac{5.05}{2 \times 7.25}\right) - [\left(\frac{4 \times 8.634}{7.25} + 3\right) \times \left(\frac{5.05}{2 \times 7.25}\right)^3] + [\left(\frac{3 \times 8.634}{7.25} + 2\right) \times \left(\frac{5.05}{2 \times 7.25}\right)^4]]$$

$$M_{max,x} = 26.22\ kip - ft$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{D} = \frac{-0.311}{36} = -0.104\ \frac{kip}{ft}$$

Moment per section length

$$M_o = \frac{M_x + (V_z \times H)}{D} = \frac{-0.709 + (-0.311 \times 0)}{36} = -0.236\ \frac{kip - ft}{ft}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.236 \times 7.25) + (3 \times 0.104 \times 7.25^2)}{(6 \times 0.236) + (4 \times 0.104 \times 7.25)} = 5.244\ ft$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{-0.236}{-0.104} = 2.279\ ft$$

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

$$V_{max,z} = (-0.104 \times 36) \times [1 - [3 \times \left(\frac{4 \times 2.279}{} + 3\right) \times \left(\frac{5.244}{}\right)^2] + [4 \times \left(\frac{3 \times 2.279}{} + 2\right) \times \left(\frac{5.244}{}\right)^3]]$$

$$V_{max,z} = (-0.104 \times 36) \times [1 - [3 \times \left(\frac{}{7.25} + 3\right) \times \left(\frac{}{7.25}\right)^3] + [4 \times \left(\frac{}{7.25} + 2\right) \times \left(\frac{}{7.25}\right)^4]]$$

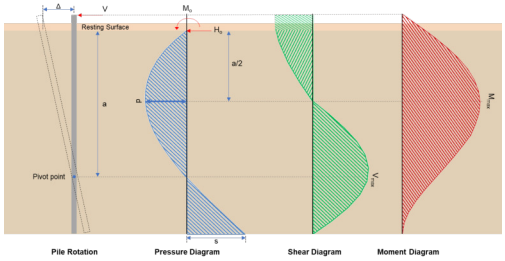
$$V_{max,z} = 0.382\ kip$$

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

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

$$M_{max,z} = (-0.104 \times 36 \times 7.25) \times [\left(\frac{2.279}{7.25} + \frac{5.244}{2 \times 7.25}\right) - [\left(\frac{4 \times 2.279}{7.25} + 3\right) \times \left(\frac{5.244}{2 \times 7.25}\right)^3] + [\left(\frac{3 \times 2.279}{7.25} + 2\right) \times \left(\frac{5.244}{2 \times 7.25}\right)^4]]$$

$$M_{max,z} = 1.185\ kip - ft$$



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:

$$A_{st,req} = \frac{P - (0.85 \times f'_{ck} \times A_g)}{f_{yk} - (0.85 \times f'_{ck})} = \frac{6.024 - (0.85 \times 2.5 \times 1018)}{60 - (0.85 \times 2.5)} = -37.27\ in^2$$

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:

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

Use: $n = 6$pcs at 1.5 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

$$Ratio = \frac{P}{\phi P_N} = \frac{6.024}{1254} = 0.005$$

UTILITY: 0.00

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	$V_{max,x} =$	7.739 kip
Maximum shear in the z-direction	$V_{max,z} =$	0.382 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:

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

$$V_{c,a} = \left(2 \times 1 \times \sqrt{2.5} + MIN[\frac{6.024}{6 \times 1018}, (0.05 \times 2.5)]\right) \times (36 \times 28.8) = 104.7\ kip$$

Governing shear strength of concrete:

$$V_c = MIN[V_{c,max}, V_{c,a}] = MIN[259.2, 104.7] = 104.7\ kip$$

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:

$$\phi V_n = \phi \times (V_c + V_s) = 0.75 \times (104.7 + 38.17) = 107.2\ kip$$

$$V_{max} = MAX[7.739, 0.382] = 7.739\ kip$$

Utilisation

$$Ratio = \frac{V_{max}}{\phi V_n} = \frac{7.739}{107.2} = 0.072$$

UTILITY: 0.07

Flexural Strength (LRFD)

Concrete type factor (Normal concrete)	$\lambda =$	1
Strength reduction factor for flexure	$\phi =$	0.65
Modulus of steel reinforcement	$E_s =$	200e3 ksi
Maximum concrete strain	$\varepsilon_c =$	0.0030
Yield strain of steel f_y/E_s	$\varepsilon_y =$	0.0003
Section width	$b =$	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	$P =$	6.024 kip
Maximum moment in the x-direction	$M_{max,x} =$	26.22 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$	1.185 kip-ft

Maximum moment in the z-direction $M_{max,z} =$ 1.185 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:

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

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

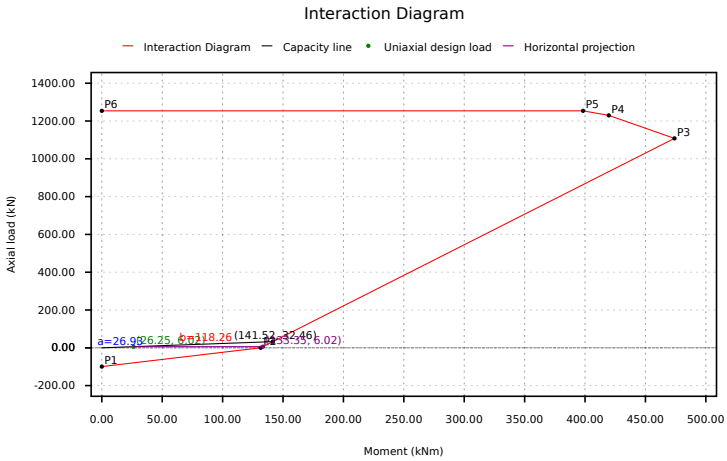
$$f_2 = E_s \times \varepsilon_2 \ (\varepsilon_2 < \varepsilon_{sy}),\ f_2 = \phi_s \times f_y \ (\varepsilon_2 \geq \varepsilon_{sy})$$

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

$$M_f = \sqrt{M_{max,x}^2 + M_{max,z}^2} = \sqrt{26.22^2 + 1.185^2} = 26.25\ kip - ft$$



Segment	Signed Distance
P1 - P2	68.27
P2 - P3	102.3
P3 - P4	858.3
P4 - P5	1107
P5 - P6	1248
Status	PASS: Point lies inside the curve

Utilisation

$$Ratio = \frac{a}{a+b} = \frac{26.93}{26.93 + 118.3} = 0.185$$

UTILITY: 0.19

Biaxial Bending Check

Maximum moment in the x-direction	$M_{max,x} =$ 26.22 kip-ft
Maximum moment in the z-direction	$M_{max,z} =$ 1.185 kip-ft
Nominal uniaxial moment strength about the x-axis	$M_{nox} =$ 133.3 kip-ft
Nominal uniaxial moment strength about the z-axis	$M_{noz} =$ 133.3 kip-ft
Interaction exponent	$\alpha =$ 1

Bresler (1960)

According to Bresler (method B):

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

$$\left(\frac{26.22}{133.3}\right)^{1} + \left(\frac{1.185}{133.3}\right)^{1} = 0.206$$

UTILITY: 0.21

REFERENCES	CALCULATIONS	RESULTS

Results Summary

Result Name	Results
PILE DETAILS	
Length of the pile	7.25 ft
Dimension	36Ø in
Main bar reinforcement	#5-6pcs at 1.5 in min.
Shear reinforcement	#3 at 10 in max.
UTILISATIONS	
Required depth	0.89
End-bearing capacity	0.27
p_a	0.48
p_s	0.93
Axial compression strength	0.00
Shear strength	0.07
Uniaxial bending strength	0.19
Biaxial bending strength	0.21