

Project Name: Benton REA Solar Carport L 4x14 - VJB **Date:** Thu Oct 16 2025

Location: Cooperative Wy, West Richland, WA 99353, **Number of Modules:** 56

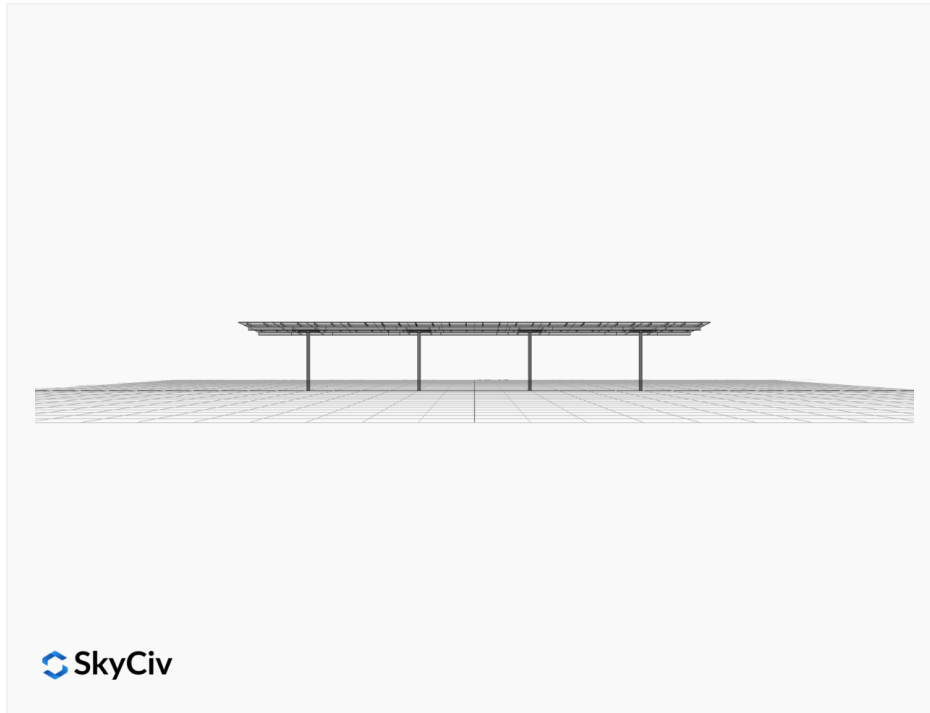
USA

Number of Poles: 4

Unique ID: 4P-19.75-6TOP-HD-72-L-4Hx14W-47CE

Date Sold:

Dealer: _____



Array Dimensions N/S	15.03 ft
Array Dimensions E/W	80.27 ft
Winter Tilt Angle (Degrees)	5
Front Edge Clearance	10

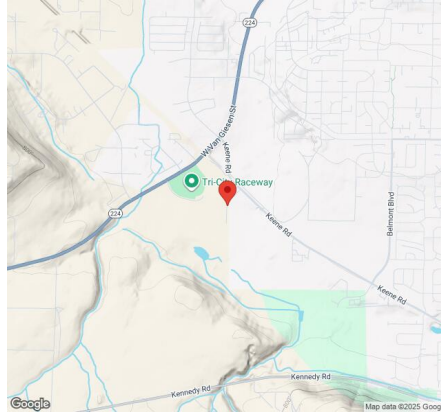
MT Solar Bill of Materials (4P-19.75-6TOP-HD-72-L-4Hx14W-47CE)

Part	Short Description	BOM Qty
MTS-PC-6	6IN Pole Cap Assembly	4
MTS-HF-HD	H-Frame Assembly-HD	4
MTS-HD-Wing-72	72IN HD Wing	4
MTS-HD-Splice-90	90IN HD Splice	6
MTS-HD-Splice-57	57IN HD Splice	6
MTS-CLAMP-HOOK-4PK	Hook Clamp	14

Rail Bill of Materials

Part	Qty
Rails (180in Long)	28x
Rail Attachment	56x
Module Mid Clamp	84x
Module End Clamp	56x
Ground Lug	14x

Site Details:



Site Address: Cooperative Wy, West Richland, WA 99353, USA

Array Specifications

Duty Classification:	HD
Module Width:	44.60 in
Module Length:	67.80 in
Number of Rows:	4
Number of Columns:	14
Total Number of Modules:	56
Winter Tilt Angle:	5
Front Edge Clearance:	10
Total Array Height at Tilt:	11.31 ft
Total Frame Length:	78.75 ft
Module Info/Notes:	QCall 435w
Array Dimensions N/S:	15.03 ft
Array Dimensions E/W:	80.27 ft
Rail Length:	180.40 in
Rail Spacing:	2.87 ft

Support Specifications

Pole Size:	6in Pipe Sch 40
Pole Length above Grade:	10.66 ft
Number of Poles:	4
Pole Spacing:	19.75 ft

Foundation Specifications

Foundation Type:	rectangular
Foundation Dimensions:	48x48 in
Foundation Depth (below grade):	4.8 ft
Foundation Volume:	76.00 ft ³

Site Info

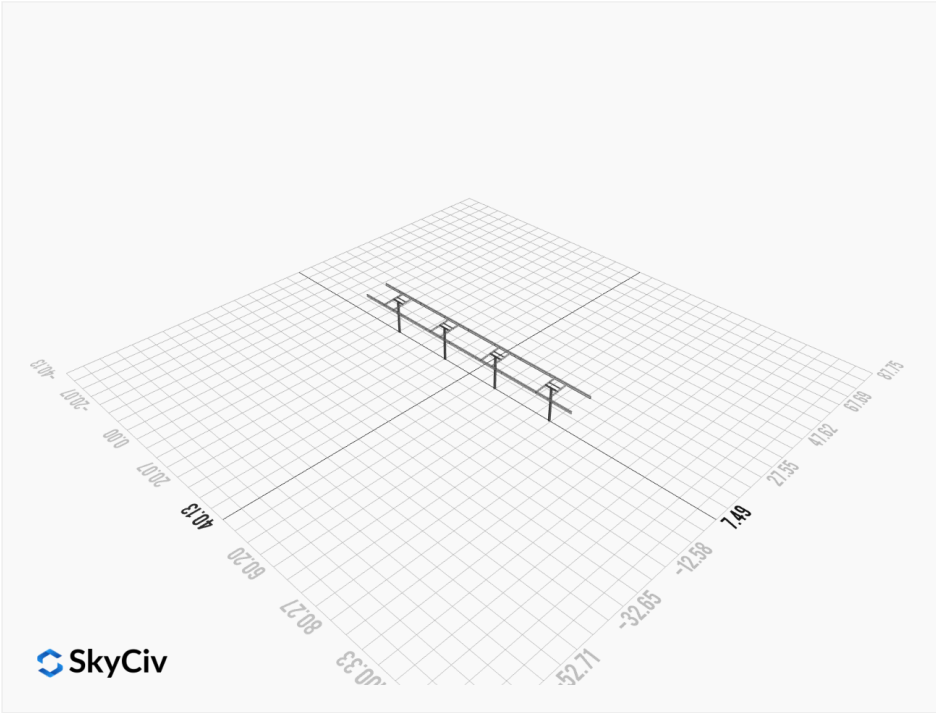
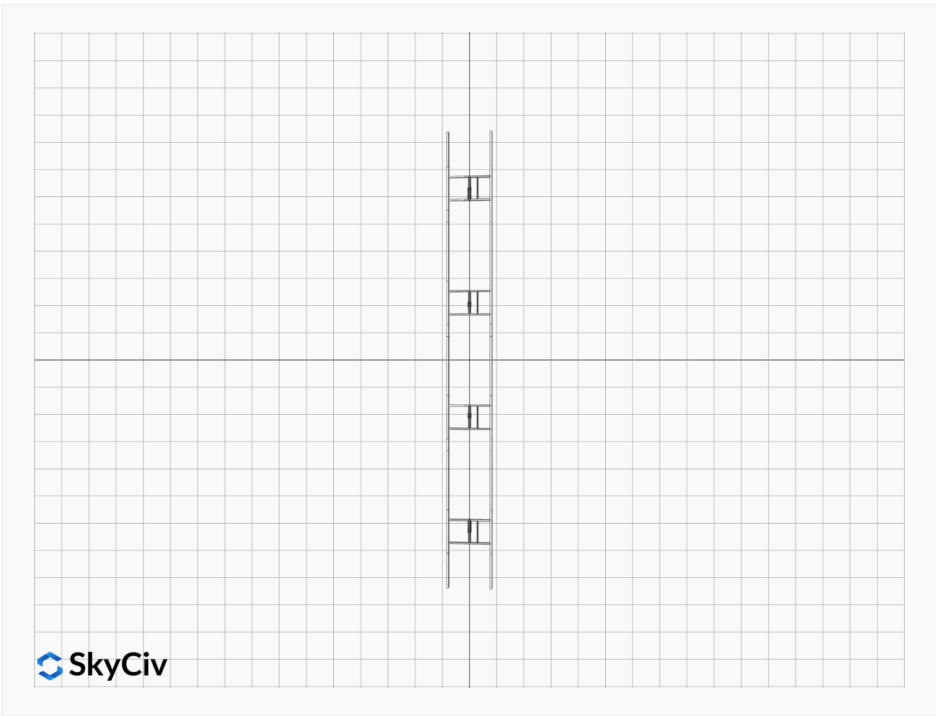
Risk Category:	I
Exposure:	C
Soil Classification:	sand
Site Location:	Cooperative Wy, West Richland, WA 99353, USA
Wind Speed:	100 mph

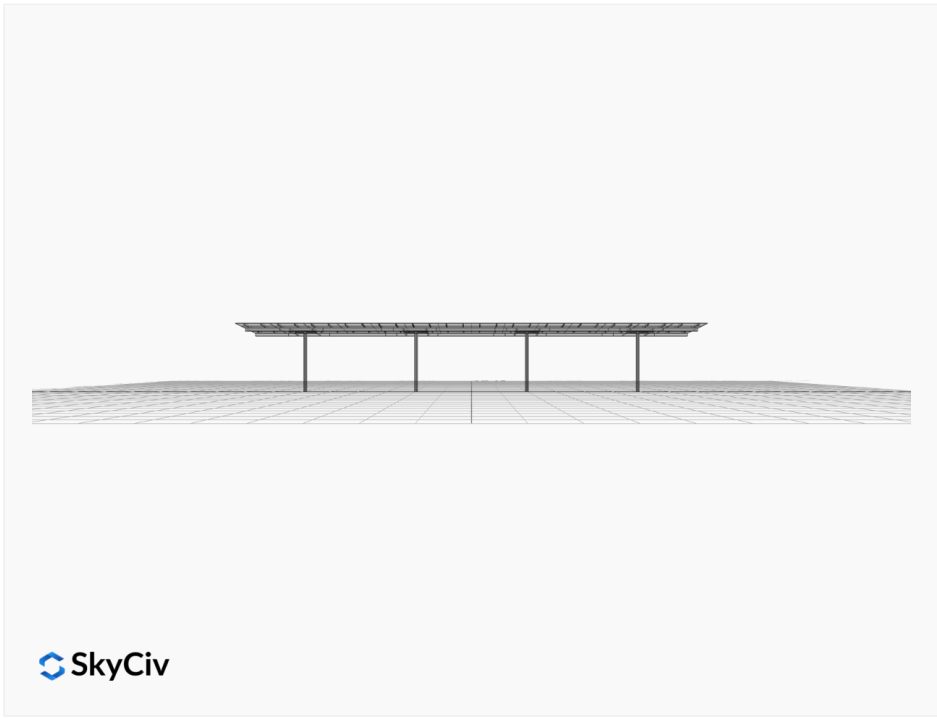
Snow Load:

20 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.





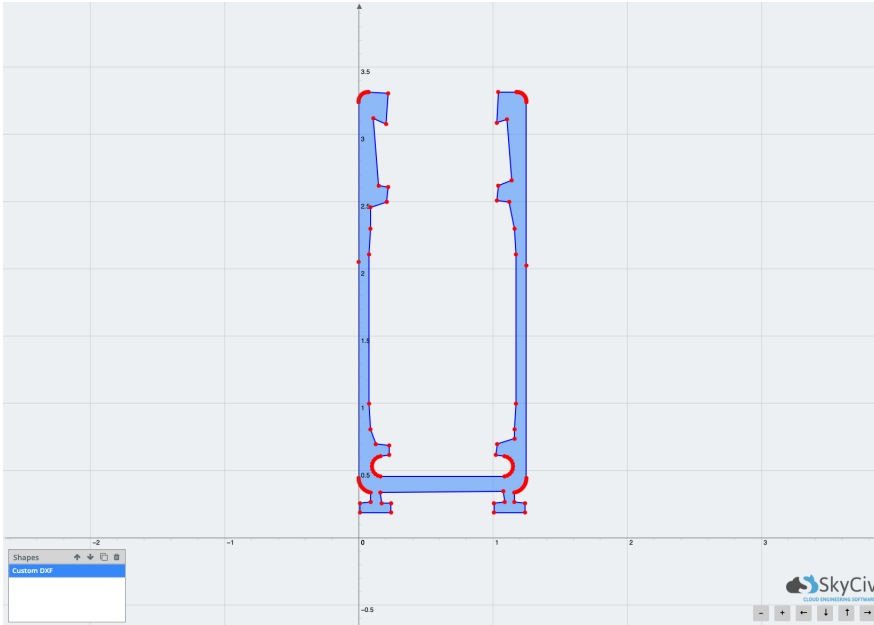
Rail Design Check

Rail Length: 15.03 ft
Additional Restraints Required: None
Tributary Width: 2.87 ft
Material: Aluminium
Density: 169.00 lb/ft³
Elastic Modulus: 10000.00 ksi
Fy: 34.50 ksi
Fu: 37.00 ksi

Rail Distributed Loading:

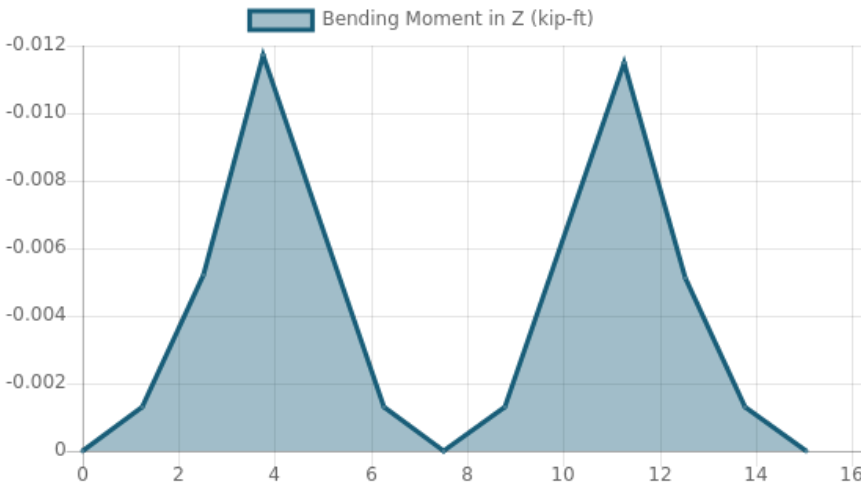
Note, gravity loading is resolved into member local X and Y axes.

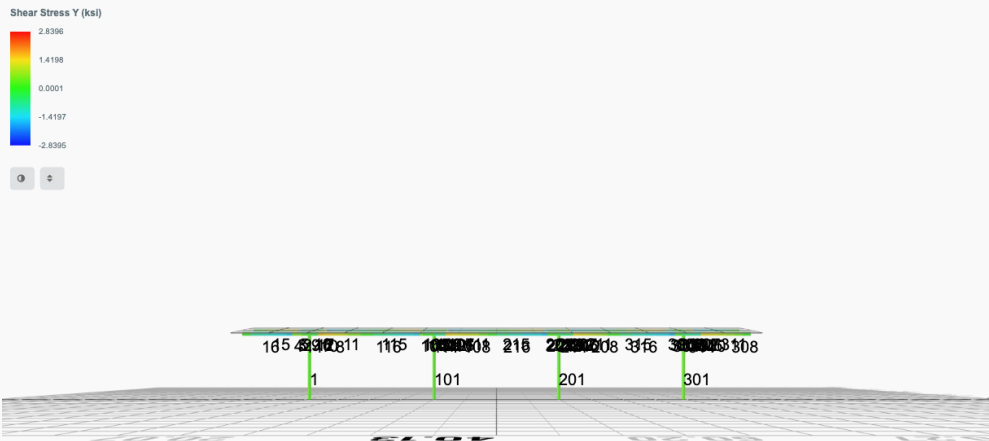
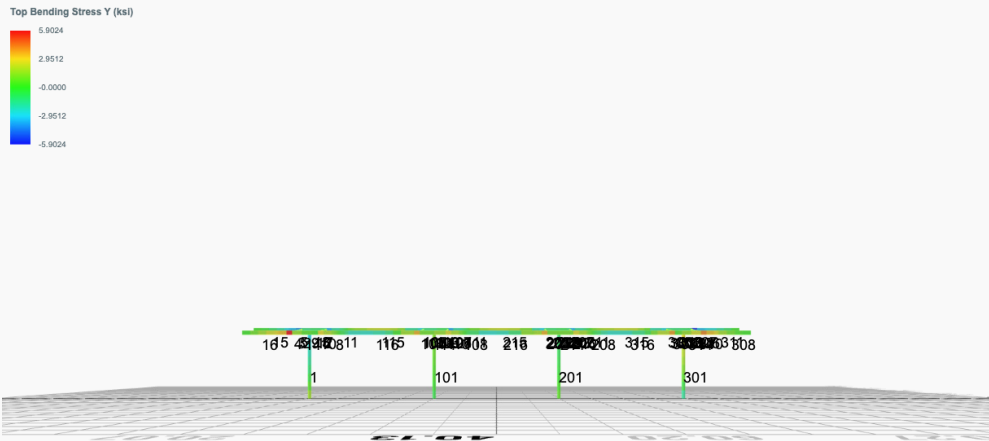
Snow (X): 0.0345 kip/ft
Snow (Y): -0.0030 kip/ft
Wind uplift Case A (Y): 0.0250 kip/ft
Wind uplift Case A (Y): 0.0000 kip/ft
Wind uplift Case B (Y): 0.0574 kip/ft
Wind uplift Case B (Y): 0.0574 kip/ft
Wind downforce Case A (Y): -0.0486 kip/ft
Wind downforce Case A (Y): -0.0442 kip/ft
Wind downforce Case B (Y): -0.0486 kip/ft
Wind downforce Case B (Y): -0.0442 kip/ft
Dead (Panel load) (X): 0.0134 kip/ft
Dead (Panel load) (Y): -0.0012 kip/ft

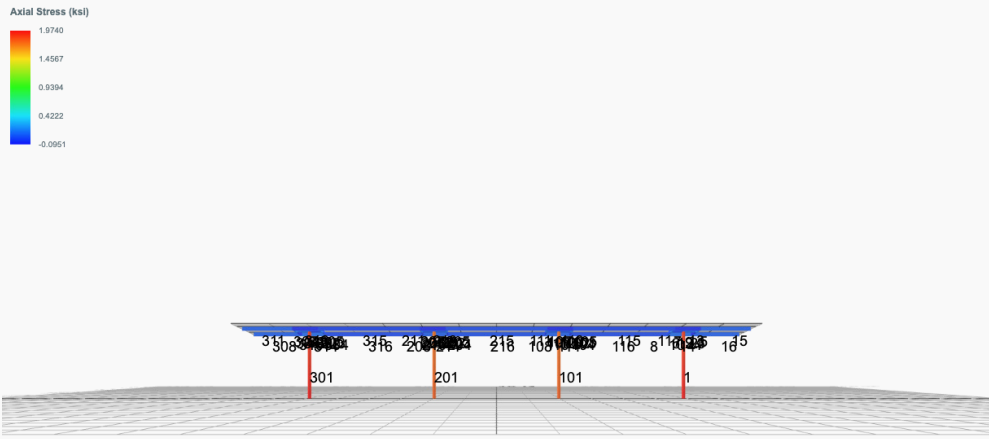


Result Check	Max Limit	Max Value	Utility	Status
Custom Stress Limit	34.50	8.68	0.252	PASS
Material Yield	34.50	8.68	0.252	PASS
Material Strength	37.00	8.68	0.235	PASS

Member 1, ULS: 1. 1.4D







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	-0.0054	3.1506	-0.0702	-0.2333	0.0140	0.0931
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0084	4.5332	-0.1101	-0.3664	0.0220	0.1192
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0046	2.7005	-0.0601	-0.1999	0.0120	0.0794
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	-0.0167	8.5652	-0.2203	-0.7350	0.0440	0.2146
ULS: 5. 1.2D + E + L + 0.2S	-0.0062	3.4336	-0.0801	-0.2664	0.0160	0.0950
ULS: 7. 0.9D + 1.0E	-0.0035	2.0254	-0.0451	-0.1498	0.0090	0.0590
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-0.4343	9.4380	-0.2450	-0.8175	0.0575	5.9194
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.4343	9.4380	-0.2450	-0.8175	0.0575	5.9194
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	0.1099	3.2091	-0.0749	-0.2490	0.0142	3.9337
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.2556	1.4202	-0.0226	-0.0757	-0.0037	-13.9172
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-0.4306	7.6053	-0.1948	-0.6493	0.0474	5.7958
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.4306	7.6053	-0.1948	-0.6493	0.0474	5.7958
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	0.1137	1.3764	-0.0250	-0.0830	0.0042	3.8178
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.2597	-0.4125	0.0272	0.0897	-0.0136	-13.7201
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-0.2296	11.0177	-0.2879	-0.9619	0.0618	3.1542
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.2296	11.0177	-0.2879	-0.9619	0.0618	3.1542
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	0.0425	7.9032	-0.2026	-0.6757	0.0402	2.2252
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.1149	7.0087	-0.1764	-0.5882	0.0310	-7.1871
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-0.2177	5.1529	-0.1274	-0.4240	0.0297	2.8854
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.2177	5.1529	-0.1274	-0.4240	0.0297	2.8854
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	0.0545	2.0385	-0.0425	-0.1414	0.0081	1.9623
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.1274	1.1440	-0.0164	-0.0548	-0.0008	-6.9200
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-0.4295	6.9301	-0.1797	-0.5986	0.0444	5.7449
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-0.4295	6.9301	-0.1797	-0.5986	0.0444	5.7449
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	0.1148	0.7013	-0.0100	-0.0331	0.0012	3.7700
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	0.2609	-1.0876	0.0422	0.1394	-0.0165	-13.6546

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0039	2.2504	-0.0501	-0.1665	0.0100	0.0658
ULS: 2. D + L	-0.0039	2.2504	-0.0501	-0.1665	0.0100	0.0658
ULS: 3. D + (S or Lr or R)	-0.0115	5.9158	-0.1501	-0.4999	0.0300	0.1464
ULS: 3. D + (S or Lr or R)	-0.0039	2.2504	-0.0501	-0.1665	0.0100	0.0658
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0096	4.9995	-0.1250	-0.4163	0.0250	0.1254
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0039	2.2504	-0.0501	-0.1665	0.0100	0.0658
ULS: 5b. D + 0.7E	-0.0039	2.2504	-0.0501	-0.1665	0.0100	0.0658
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0096	4.9995	-0.1250	-0.4163	0.0250	0.1254
ULS: 8. 0.6D + 0.7E	-0.0023	1.3502	-0.0300	-0.0998	0.0060	0.0390
ULS: 5a. D + 0.6W_Wind downforce Case A only	-0.2595	5.1932	-0.1308	-0.4353	0.0312	3.4335
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.2595	5.1932	-0.1308	-0.4353	0.0312	3.4335
ULS: 5a. D + 0.6W_Wind uplift Case A only	0.0671	1.4560	-0.0290	-0.0964	0.0053	2.3109
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.1547	0.3826	0.0023	0.0074	-0.0054	-8.2742
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-0.2013	7.2066	-0.1857	-0.6189	0.0409	2.6917
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.2013	7.2066	-0.1857	-0.6189	0.0409	2.6917
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	0.0437	4.4036	-0.1092	-0.3634	0.0215	1.8651
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.1091	3.5987	-0.0856	-0.2850	0.0134	-6.3210

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-0.1956	4.4575	-0.1106	-0.3680	0.0259	2.5779
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.1956	4.4575	-0.1106	-0.3680	0.0259	2.5779
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	0.0494	1.6546	-0.0343	-0.1139	0.0065	1.7533
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.1150	0.8496	-0.0108	-0.0360	-0.0015	-6.2162
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-0.2580	4.2931	-0.1107	-0.3682	0.0272	3.3833
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.2580	4.2931	-0.1107	-0.3682	0.0272	3.3833
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	0.0686	0.5558	-0.0090	-0.0298	0.0013	2.2622
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.1563	-0.5175	0.0223	0.0738	-0.0093	-8.2315

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	11.0177
Shear X	-0.4343
Shear Z	-0.2879
Moment X	-0.9619
Moment Y (Twist)	0.0618
Moment Z	13.9172

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	7.2066
Shear X	-0.2595
Shear Z	-0.1857
Moment X	-0.6189
Moment Y (Twist)	0.0409
Moment Z	8.2742

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	0.0054	3.0114	0.0189	0.0629	-0.0047	-0.0079
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0084	4.3149	0.0297	0.0987	-0.0073	-0.0402
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0046	2.5812	0.0162	0.0539	-0.0040	-0.0071
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0167	8.1292	0.0594	0.1979	-0.0146	-0.1090
ULS: 5. 1.2D + E + L + 0.2S	0.0061	3.2747	0.0216	0.0718	-0.0053	-0.0204
ULS: 7. 0.9D + 1.0E	0.0035	1.9359	0.0122	0.0404	-0.0030	-0.0056
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-0.4005	8.9527	0.0660	0.2201	-0.0150	5.5419
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.4005	8.9527	0.0660	0.2201	-0.0150	5.5419
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	0.1154	3.0641	0.0195	0.0649	-0.0038	3.7055
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.2745	1.3691	0.0074	0.0243	-0.0052	-13.7079
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-0.4042	7.2189	0.0525	0.1749	-0.0118	5.4971
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.4042	7.2189	0.0525	0.1749	-0.0118	5.4971
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	0.1116	1.3303	0.0061	0.0203	-0.0005	3.6656
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.2704	-0.3646	-0.0061	-0.0204	-0.0017	-13.4502
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-0.1878	10.4481	0.0776	0.2589	-0.0184	2.7178
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.1878	10.4481	0.0776	0.2589	-0.0184	2.7178
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	0.0701	7.5038	0.0542	0.1808	-0.0128	1.8626
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.1501	6.6563	0.0482	0.1606	-0.0137	-7.3065
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-0.1997	4.9001	0.0344	0.1143	-0.0079	2.6958
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.1997	4.9001	0.0344	0.1143	-0.0079	2.6958
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	0.0581	1.9557	0.0111	0.0371	-0.0022	1.8424
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.1376	1.1082	0.0051	0.0168	-0.0029	-6.8234
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-0.4053	6.5737	0.0485	0.1613	-0.0108	5.4699
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-0.4053	6.5737	0.0485	0.1613	-0.0108	5.4699
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	0.1105	0.6850	0.0020	0.0068	0.0005	3.6406
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	0.2692	-1.0099	-0.0102	-0.0338	-0.0007	-13.3668

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0039	2.1510	0.0135	0.0449	-0.0033	-0.0061
ULS: 2. D + L	0.0039	2.1510	0.0135	0.0449	-0.0033	-0.0061
ULS: 3. D + (S or Lr or R)	0.0115	5.6185	0.0405	0.1347	-0.0100	-0.0719
ULS: 3. D + (S or Lr or R)	0.0039	2.1510	0.0135	0.0449	-0.0033	-0.0061
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0096	4.7516	0.0337	0.1122	-0.0083	-0.0559
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0039	2.1510	0.0135	0.0449	-0.0033	-0.0061
ULS: 5b. D + 0.7E	0.0039	2.1510	0.0135	0.0449	-0.0033	-0.0061
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0096	4.7516	0.0337	0.1122	-0.0083	-0.0559
ULS: 8. 0.6D + 0.7E	0.0023	1.2906	0.0081	0.0269	-0.0020	-0.0039
ULS: 5a. D + 0.6W_Wind downforce Case A only	-0.2414	4.9337	0.0353	0.1173	-0.0080	3.2378
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.2414	4.9337	0.0353	0.1173	-0.0080	3.2378
ULS: 5a. D + 0.6W_Wind uplift Case A only	0.0680	1.4004	0.0074	0.0247	-0.0012	2.1994
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.1634	0.3835	0.0001	0.0004	-0.0020	-8.1293
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-0.1744	6.8386	0.0501	0.1667	-0.0118	2.4144
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.1744	6.8386	0.0501	0.1667	-0.0118	2.4144
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	0.0577	4.1888	0.0291	0.0969	-0.0067	1.6517
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.1294	3.4260	0.0237	0.0787	-0.0074	-6.3298
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-0.1801	4.2380	0.0298	0.0992	-0.0069	2.4139
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.1801	4.2380	0.0298	0.0992	-0.0069	2.4139
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	0.0520	1.5881	0.0089	0.0298	-0.0017	1.6515
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.1235	0.8253	0.0035	0.0115	-0.0024	-6.1242
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-0.2429	4.0733	0.0299	0.0993	-0.0067	3.2180
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.2429	4.0733	0.0299	0.0993	-0.0067	3.2180
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	0.0665	0.5401	0.0020	0.0068	0.0001	2.1804
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.1618	-0.4769	-0.0053	-0.0176	-0.0007	-8.0608

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	10.4481
Shear X	-0.4053
Shear Z	0.0776
Moment X	0.2589
Moment Y (Twist)	0.0184
Moment Z	13.7079

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	6.8386
Shear X	-0.2429
Shear Z	0.0501
Moment X	0.1667
Moment Y (Twist)	0.0118
Moment Z	8.1293

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

LRFD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. 1.4D	0.0054	3.0112	-0.0188	-0.0634	0.0045	-0.0081
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0084	4.3147	-0.0295	-0.0995	0.0071	-0.0405
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	0.0046	2.5810	-0.0161	-0.0543	0.0039	-0.0072
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	0.0168	8.1287	-0.0589	-0.1994	0.0142	-0.1097
ULS: 5. 1.2D + E + L + 0.2S	0.0062	3.2745	-0.0215	-0.0723	0.0052	-0.0207
ULS: 7. 0.9D + 1.0E	0.0035	1.9358	-0.0121	-0.0407	0.0029	-0.0057
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-0.4005	8.9521	-0.0656	-0.2218	0.0147	5.5414

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.4005	8.9521	-0.0656	-0.2218	0.0147	5.5414
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	0.1154	3.0639	-0.0194	-0.0654	0.0036	3.7056
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.2745	1.3692	-0.0073	-0.0244	0.0052	-13.7089
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-0.4042	7.2185	-0.0521	-0.1763	0.0115	5.4968
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.4042	7.2185	-0.0521	-0.1763	0.0115	5.4968
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	0.1116	1.3302	-0.0060	-0.0204	0.0004	3.6659
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.2704	-0.3645	0.0060	0.0206	0.0019	-13.4511
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-0.1878	10.4474	-0.0770	-0.2609	0.0179	2.7170
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.1878	10.4474	-0.0770	-0.2609	0.0179	2.7170
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	0.0701	7.5033	-0.0539	-0.1822	0.0124	1.8622
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.1502	6.6559	-0.0479	-0.1617	0.0134	-7.3075
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-0.1997	4.8998	-0.0341	-0.1151	0.0077	2.6955
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.1997	4.8998	-0.0341	-0.1151	0.0077	2.6955
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	0.0581	1.9556	-0.0111	-0.0373	0.0021	1.8424
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.1376	1.1082	-0.0051	-0.0169	0.0029	-6.8239
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-0.4053	6.5732	-0.0481	-0.1625	0.0105	5.4696
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-0.4053	6.5732	-0.0481	-0.1625	0.0105	5.4696
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	0.1105	0.6850	-0.0020	-0.0069	-0.0006	3.6409
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	0.2692	-1.0098	0.0101	0.0341	0.0008	-13.3677

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0039	2.1509	-0.0134	-0.0452	0.0033	-0.0062
ULS: 2. D + L	0.0039	2.1509	-0.0134	-0.0452	0.0033	-0.0062
ULS: 3. D + (S or Lr or R)	0.0115	5.6182	-0.0402	-0.1357	0.0097	-0.0723
ULS: 3. D + (S or Lr or R)	0.0039	2.1509	-0.0134	-0.0452	0.0033	-0.0062
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0096	4.7514	-0.0335	-0.1130	0.0081	-0.0562
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0039	2.1509	-0.0134	-0.0452	0.0033	-0.0062
ULS: 5b. D + 0.7E	0.0039	2.1509	-0.0134	-0.0452	0.0033	-0.0062
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0096	4.7514	-0.0335	-0.1130	0.0081	-0.0562
ULS: 8. 0.6D + 0.7E	0.0023	1.2905	-0.0080	-0.0271	0.0020	-0.0040
ULS: 5a. D + 0.6W_Wind downforce Case A only	-0.2414	4.9333	-0.0350	-0.1182	0.0078	3.2376
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.2414	4.9333	-0.0350	-0.1182	0.0078	3.2376
ULS: 5a. D + 0.6W_Wind uplift Case A only	0.0681	1.4004	-0.0074	-0.0249	0.0011	2.1995
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.1634	0.3835	-0.0002	-0.0003	0.0021	-8.1298
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-0.1744	6.8382	-0.0497	-0.1680	0.0115	2.4140
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.1744	6.8382	-0.0497	-0.1680	0.0115	2.4140
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	0.0577	4.1885	-0.0289	-0.0976	0.0065	1.6515
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.1294	3.4259	-0.0235	-0.0792	0.0073	-6.3304
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-0.1800	4.2377	-0.0296	-0.0999	0.0067	2.4137
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.1800	4.2377	-0.0296	-0.0999	0.0067	2.4137
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	0.0520	1.5880	-0.0089	-0.0300	0.0017	1.6516
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.1235	0.8254	-0.0035	-0.0116	0.0024	-6.1246
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-0.2429	4.0730	-0.0296	-0.1000	0.0065	3.2178
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.2429	4.0730	-0.0296	-0.1000	0.0065	3.2178
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	0.0665	0.5400	-0.0020	-0.0068	-0.0002	2.1806
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.1618	-0.4768	0.0052	0.0177	0.0007	-8.0614

Worst Case Reactions (LRFD)

Worst Case Reactions (ASD)

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

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

Result	Value (kip, kip-ft)
Axial	10.4474
Shear X	-0.4053
Shear Z	-0.0770
Moment X	-0.2609
Moment Y (Twist)	0.0179
Moment Z	13.7089

Result	Value (kip, kip-ft)
Axial	6.8382
Shear X	-0.2429
Shear Z	-0.0497
Moment X	-0.1680
Moment Y (Twist)	0.0115
Moment Z	8.1298

Reaction Forces for Foundation 4 (Node ID#301), (kip, kip-ft)

LRFD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. 1.4D	-0.0054	3.1506	0.0700	0.2320	-0.0141	0.0931
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0084	4.5332	0.1099	0.3643	-0.0221	0.1191
ULS: 2. 1.2D + 1.6L + 0.5(S or Lr or R)	-0.0046	2.7005	0.0600	0.1988	-0.0121	0.0794
ULS: 3. 1.2D + 1.6(S or Lr or R) + L	-0.0167	8.5652	0.2199	0.7307	-0.0443	0.2146
ULS: 5. 1.2D + E + L + 0.2S	-0.0062	3.4336	0.0799	0.2649	-0.0161	0.0950
ULS: 7. 0.9D + 1.0E	-0.0035	2.0254	0.0450	0.1490	-0.0091	0.0590
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-0.4343	9.4380	0.2446	0.8127	-0.0576	5.9196
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.4343	9.4380	0.2446	0.8127	-0.0576	5.9196
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	0.1099	3.2091	0.0747	0.2475	-0.0144	3.9347
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.2556	1.4202	0.0226	0.0754	0.0038	-13.9194
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case A only	-0.4306	7.6052	0.1945	0.6454	-0.0475	5.7959
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind downforce Case B only	-0.4306	7.6052	0.1945	0.6454	-0.0475	5.7959
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case A only	0.1137	1.3764	0.0249	0.0825	-0.0043	3.8187
ULS: 4. 1.2D + W + L + 0.5(S or Lr or R)_Wind uplift Case B only	0.2597	-0.4125	-0.0271	-0.0891	0.0137	-13.7223
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-0.2296	11.0177	0.2874	0.9562	-0.0621	3.1543
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.2296	11.0177	0.2874	0.9562	-0.0621	3.1543
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	0.0425	7.9032	0.2022	0.6718	-0.0404	2.2256
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.1149	7.0087	0.1760	0.5847	-0.0311	-7.1883
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case A only	-0.2177	5.1529	0.1272	0.4215	-0.0298	2.8855
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind downforce Case B only	-0.2177	5.1529	0.1272	0.4215	-0.0298	2.8855
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case A only	0.0545	2.0384	0.0425	0.1406	-0.0082	1.9628
ULS: 3. 1.2D + 1.6(S or Lr or R) + 0.5W_Wind uplift Case B only	0.1274	1.1440	0.0164	0.0545	0.0008	-6.9211
ULS: 6. 0.9D + 1.0W_Wind downforce Case A only	-0.4295	6.9301	0.1794	0.5951	-0.0445	5.7451
ULS: 6. 0.9D + 1.0W_Wind downforce Case B only	-0.4295	6.9301	0.1794	0.5951	-0.0445	5.7451
ULS: 6. 0.9D + 1.0W_Wind uplift Case A only	0.1148	0.7013	0.0099	0.0329	-0.0013	3.7709
ULS: 6. 0.9D + 1.0W_Wind uplift Case B only	0.2609	-1.0876	-0.0421	-0.1386	0.0167	-13.6567

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0039	2.2504	0.0500	0.1656	-0.0101	0.0658
ULS: 2. D + L	-0.0039	2.2504	0.0500	0.1656	-0.0101	0.0658
ULS: 3. D + (S or Lr or R)	-0.0115	5.9158	0.1498	0.4970	-0.0302	0.1464
ULS: 3. D + (S or Lr or R)	-0.0039	2.2504	0.0500	0.1656	-0.0101	0.0658
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0096	4.9995	0.1248	0.4139	-0.0251	0.1254
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0039	2.2504	0.0500	0.1656	-0.0101	0.0658
ULS: 5b. D + 0.7E	-0.0039	2.2504	0.0500	0.1656	-0.0101	0.0658
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0096	4.9995	0.1248	0.4139	-0.0251	0.1254

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 8. 0.6D + 0.7E	-0.0023	1.3502	0.0300	0.0992	-0.0060	0.0390
ULS: 5a. D + 0.6W_Wind downforce Case A only	-0.2595	5.1932	0.1306	0.4328	-0.0313	3.4336
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.2595	5.1932	0.1306	0.4328	-0.0313	3.4336
ULS: 5a. D + 0.6W_Wind uplift Case A only	0.0671	1.4560	0.0290	0.0958	-0.0054	2.3115
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.1547	0.3826	-0.0023	-0.0073	0.0054	-8.2755
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-0.2013	7.2066	0.1853	0.6153	-0.0411	2.6917
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.2013	7.2066	0.1853	0.6153	-0.0411	2.6917
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	0.0437	4.4036	0.1090	0.3612	-0.0216	1.8655
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.1091	3.5986	0.0854	0.2834	-0.0134	-6.3220
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-0.1956	4.4575	0.1104	0.3658	-0.0260	2.5779
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.1956	4.4575	0.1104	0.3658	-0.0260	2.5779
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	0.0494	1.6546	0.0342	0.1133	-0.0066	1.7538
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.1150	0.8496	0.0107	0.0358	0.0016	-6.2172
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-0.2580	4.2931	0.1105	0.3660	-0.0272	3.3834
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.2580	4.2931	0.1105	0.3660	-0.0272	3.3834
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	0.0686	0.5558	0.0090	0.0296	-0.0014	2.2628
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.1563	-0.5175	-0.0223	-0.0734	0.0094	-8.2328

Worst Case Reactions (LRFD)

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

Result	Value (kip, kip-ft)
Axial	11.0177
Shear X	-0.4343
Shear Z	0.2874
Moment X	0.9562
Moment Y (Twist)	0.0621
Moment Z	13.9194

Worst Case Reactions (ASD)

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

Result	Value (kip, kip-ft)
Axial	7.2066
Shear X	-0.2595
Shear Z	0.1853
Moment X	0.6153
Moment Y (Twist)	0.0411
Moment Z	8.2755

Project Details

Design Code: AISC 360-16 LRFD
 Provision: LRFD
 Country: United States
 User Name: sales@mtsolar.us
 Project Name: Benton REA Solar Carport L 4x14 - VJB
 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

Section Dimensions

ID	Name	d (in)	t_w (in)					
2	2in Pipe Sch 80	2.38	0.22					
5	4in Pipe Sch 80	4.50	0.34					
7	6in Pipe Sch 40	6.63	0.28					

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

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

Section Properties								
ID	Name	A (in ²)	J (in ⁴)	I_{y0} (in ⁴)	I_{z0} (in ⁴)	I_w (in ⁶)	S_{y0} (in ³)	S_{z0} (in ³)

5	116.10	114.23	15.79	11.10	42.08	23.28
6	116.10	115.41	15.79	11.10	42.08	23.28
7	116.10	114.23	15.79	11.10	42.08	23.28
8	133.20	123.95	32.87	6.12	40.24	43.62
9	66.48	58.89	3.82	3.82	19.94	19.94
10	116.10	111.33	15.79	11.10	42.08	23.28
11	133.20	123.95	32.87	6.12	40.24	43.62
12	198.33	182.14	21.95	21.95	59.50	59.50
13	133.20	85.85	24.85	6.12	40.24	43.62
14	133.20	85.85	24.81	6.12	40.24	43.62
15	133.20	20.65	32.87	6.12	40.24	43.62
16	133.20	77.87	32.87	6.12	40.24	43.62
101	251.16	227.22	42.30	42.30	75.35	75.35
102	198.33	182.14	21.95	21.95	59.50	59.50
103	116.10	115.41	15.79	11.10	42.08	23.28
104	116.10	111.33	15.79	11.10	42.08	23.28
105	116.10	114.23	15.79	11.10	42.08	23.28
106	116.10	115.41	15.79	11.10	42.08	23.28
107	116.10	114.23	15.79	11.10	42.08	23.28
108	133.20	123.95	32.87	6.12	40.24	43.62
109	66.48	58.89	3.82	3.82	19.94	19.94
110	116.10	111.33	15.79	11.10	42.08	23.28
111	133.20	123.95	32.87	6.12	40.24	43.62
112	198.33	196.72	21.95	21.95	59.50	59.50
113	133.20	85.85	23.91	6.12	40.24	43.62
114	133.20	85.85	23.85	6.12	40.24	43.62
115	133.20	31.52	18.19	6.12	40.24	43.62
116	133.20	31.52	17.58	6.12	40.24	43.62
201	251.16	227.22	42.30	42.30	75.35	75.35
202	198.33	196.72	21.95	21.95	59.50	59.50
203	116.10	115.41	15.79	11.10	42.08	23.28
204	116.10	111.33	15.79	11.10	42.08	23.28
205	116.10	114.23	15.79	11.10	42.08	23.28
206	116.10	115.41	15.79	11.10	42.08	23.28
207	116.10	114.23	15.79	11.10	42.08	23.28
208	133.20	123.95	32.87	6.12	40.24	43.62
209	66.48	58.89	3.82	3.82	19.94	19.94
210	116.10	111.33	15.79	11.10	42.08	23.28
211	133.20	123.95	32.87	6.12	40.24	43.62
212	198.33	182.14	21.95	21.95	59.50	59.50
213	133.20	85.85	23.92	6.12	40.24	43.62
214	133.20	85.85	23.86	6.12	40.24	43.62
215	133.20	31.52	17.73	6.12	40.24	43.62
216	133.20	31.52	17.20	6.12	40.24	43.62
301	251.16	227.22	42.30	42.30	75.35	75.35
302	198.33	182.14	21.95	21.95	59.50	59.50
303	116.10	115.41	15.79	11.10	42.08	23.28
304	116.10	111.33	15.79	11.10	42.08	23.28
305	116.10	114.23	15.79	11.10	42.08	23.28
306	116.10	115.41	15.79	11.10	42.08	23.28
307	116.10	114.23	15.79	11.10	42.08	23.28

308	133.20	20.65	32.87	6.12	40.24	43.62
309	66.48	58.89	3.82	3.82	19.94	19.94
310	116.10	111.33	15.79	11.10	42.08	23.28
311	133.20	77.87	32.87	6.12	40.24	43.62
312	198.33	196.72	21.95	21.95	59.50	59.50
313	133.20	85.85	24.85	6.12	40.24	43.62
314	133.20	85.85	24.81	6.12	40.24	43.62
315	133.20	31.52	19.83	6.12	40.24	43.62
316	133.20	31.52	19.44	6.12	40.24	43.62

Design Ratio

Member ID	P	M _z	M _y	V _y	V _z	(P,M _z ,M _y)	Worst LC	KL/r	δ	Status
1	0.048	0.329	0.050	0.006	0.004	0.334	#16	0.185	Not Required	Pass
2	0.000	0.492	0.025	0.097	0.004	0.513	#21	0.053	Not Required	Pass
3	0.001	0.683	0.020	0.070	0.003	0.704	#21	0.045	Not Required	Pass
4	0.002	0.667	0.029	0.067	0.005	0.673	#21	0.080	Not Required	Pass
5	0.001	0.423	0.043	0.068	0.012	0.438	#21	0.074	Not Required	Pass
6	0.002	0.591	0.007	0.059	0.004	0.598	#21	0.045	Not Required	Pass
7	0.002	0.367	0.023	0.059	0.005	0.369	#21	0.074	Not Required	Pass
8	0.001	0.088	0.026	0.043	0.003	0.114	#21	0.095	Not Required	Pass
9	0.003	0.095	0.020	0.002	0.001	0.117	#21	0.204	Not Required	Pass
10	0.001	0.578	0.037	0.058	0.009	0.612	#21	0.080	Not Required	Pass
11	0.001	0.089	0.024	0.044	0.002	0.112	#21	0.095	Not Required	Pass
12	0.001	0.396	0.022	0.084	0.003	0.415	#21	0.171	Not Required	Pass
13	0.002	0.321	0.085	0.055	0.003	0.402	#21	0.286	Not Required	Pass
14	0.001	0.321	0.085	0.054	0.003	0.395	#21	0.190	Not Required	Pass
15	0.000	0.144	0.051	0.039	0.002	0.195	#21	0.900	Not Required	Pass
16	0.000	0.140	0.051	0.038	0.002	0.192	#21	0.286	Not Required	Pass
101	0.046	0.324	0.013	0.005	0.001	0.328	#16	0.185	Not Required	Pass
102	0.001	0.398	0.020	0.084	0.003	0.414	#21	0.114	Not Required	Pass
103	0.002	0.590	0.007	0.059	0.001	0.597	#21	0.045	Not Required	Pass
104	0.001	0.574	0.025	0.058	0.006	0.594	#21	0.080	Not Required	Pass
105	0.002	0.366	0.023	0.059	0.006	0.370	#21	0.074	Not Required	Pass
106	0.001	0.617	0.013	0.062	0.002	0.630	#21	0.045	Not Required	Pass
107	0.001	0.382	0.026	0.062	0.007	0.390	#21	0.074	Not Required	Pass
108	0.001	0.063	0.021	0.039	0.002	0.072	#21	0.095	Not Required	Pass
109	0.002	0.067	0.010	0.001	0.000	0.078	#21	0.204	Not Required	Pass
110	0.002	0.601	0.022	0.061	0.004	0.614	#21	0.080	Not Required	Pass
111	0.001	0.063	0.022	0.040	0.002	0.070	#21	0.063	Not Required	Pass
112	0.000	0.424	0.021	0.088	0.003	0.441	#21	0.053	Not Required	Pass
113	0.002	0.181	0.057	0.051	0.003	0.219	#21	0.190	Not Required	Pass
114	0.001	0.178	0.056	0.050	0.003	0.211	#21	0.286	Not Required	Pass
115	0.001	0.164	0.032	0.036	0.002	0.196	#21	0.728	Not Required	Pass
116	0.001	0.162	0.031	0.035	0.002	0.193	#21	0.728	Not Required	Pass
201	0.046	0.324	0.013	0.005	0.001	0.328	#16	0.185	Not Required	Pass
202	0.000	0.423	0.021	0.088	0.003	0.441	#21	0.053	Not Required	Pass
203	0.001	0.617	0.013	0.062	0.002	0.631	#21	0.045	Not Required	Pass
204	0.002	0.602	0.022	0.061	0.004	0.614	#21	0.080	Not Required	Pass
205	0.001	0.383	0.026	0.062	0.007	0.390	#21	0.074	Not Required	Pass
206	0.002	0.591	0.007	0.059	0.001	0.597	#21	0.045	Not Required	Pass

207	0.002	0.366	0.023	0.059	0.006	0.370	#21	0.074	Not Required	Pass
208	0.001	0.044	0.021	0.035	0.002	0.055	#21	0.095	Not Required	Pass
209	0.002	0.067	0.010	0.001	0.000	0.078	#21	0.204	Not Required	Pass
210	0.001	0.574	0.025	0.058	0.006	0.594	#21	0.080	Not Required	Pass
211	0.001	0.043	0.022	0.036	0.002	0.054	#21	0.095	Not Required	Pass
212	0.001	0.398	0.020	0.084	0.003	0.414	#21	0.114	Not Required	Pass
213	0.002	0.181	0.057	0.051	0.003	0.219	#21	0.286	Not Required	Pass
214	0.001	0.178	0.056	0.050	0.003	0.211	#21	0.286	Not Required	Pass
215	0.001	0.236	0.031	0.040	0.003	0.268	#21	0.486	Not Required	Pass
216	0.001	0.236	0.032	0.039	0.002	0.268	#21	0.728	Not Required	Pass
301	0.048	0.329	0.050	0.006	0.004	0.334	#16	0.185	Not Required	Pass
302	0.001	0.396	0.022	0.084	0.003	0.415	#21	0.171	Not Required	Pass
303	0.002	0.591	0.007	0.059	0.004	0.598	#21	0.045	Not Required	Pass
304	0.001	0.578	0.037	0.058	0.009	0.612	#21	0.080	Not Required	Pass
305	0.002	0.367	0.023	0.059	0.005	0.369	#21	0.074	Not Required	Pass
306	0.001	0.683	0.020	0.070	0.003	0.704	#21	0.045	Not Required	Pass
307	0.001	0.423	0.043	0.068	0.012	0.438	#21	0.074	Not Required	Pass
308	0.000	0.140	0.051	0.038	0.002	0.192	#21	0.600	Not Required	Pass
309	0.003	0.095	0.020	0.002	0.001	0.117	#21	0.204	Not Required	Pass
310	0.002	0.667	0.029	0.067	0.005	0.673	#21	0.080	Not Required	Pass
311	0.000	0.144	0.051	0.039	0.002	0.195	#21	0.286	Not Required	Pass
312	0.000	0.492	0.025	0.097	0.004	0.513	#21	0.053	Not Required	Pass
313	0.002	0.321	0.085	0.055	0.003	0.402	#21	0.190	Not Required	Pass
314	0.001	0.321	0.085	0.054	0.003	0.395	#21	0.286	Not Required	Pass
315	0.001	0.147	0.032	0.044	0.003	0.179	#21	0.728	Not Required	Pass
316	0.001	0.144	0.031	0.043	0.003	0.175	#21	0.728	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/compression)
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



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

Cross-section

Input	Description	Value
Shape	Cross-sectional shape	Square
b	Section width	48 in
D	Section depth	48 in

Material Properties

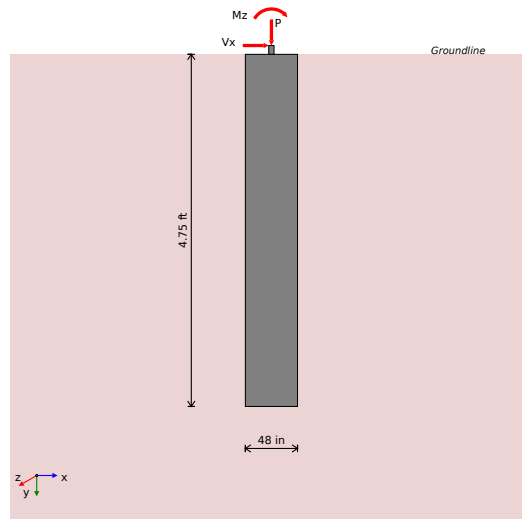
Input	Description	Value
f'_{ck}	Concrete compressive strength	2.5 ksi
f_{yk}	Yield strength of steel	60 ksi
d_b	Rebar diameter	#5 (0.625) in
cover	Concrete cover	3 in

Soil Parameters (IBC 1806)

Input	Description	Value
Soil type	Sand, silty sand, clayey sand, silty gravel & clayey gravel	
q_a	Allowable bearing pressure	2000 psf
R	Allowable lateral pressure	150 psf/ft

Loading

Load	ASD	LRFD
P	7.207 kip	11.02 kip
V _x	-0.26 kip	-0.434 kip
V _z	0.185 kip	0.287 kip
M _x	0.615 kip-ft	0.956 kip-ft
M _z	8.275 kip-ft	13.92 kip-ft



Required depth to resist lateral loads (ASD)

Allowable lateral pressure

$$R = 150 \text{ psf/ft}$$

Point of application of lateral load:

$$H = h_1 + h_2 + h_e = 0 + 0 + 0 = 0 \text{ ft}$$

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{1.57 \times D} = \frac{-0.26}{1.57 \times 48} = -0.041 \frac{\text{kip}}{\text{ft}}$$

Moment per section length

$$M_o = \frac{M_z + (V_z \times H)}{1.57 \times D} = \frac{8.275 + (-0.26 \times 0)}{1.57 \times 48} = 1.318 \frac{\text{kip-ft}}{\text{ft}}$$

Required depth of embedment in earth:

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

Solving the cubic equation:

$$L_{e,z} = 4.549 \text{ ft}$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{0.185}{1.57 \times 48} = 0.03 \frac{\text{kip}}{\text{ft}}$$

Moment per section length

$$M_o = \frac{M_z + (V_z \times H)}{1.57 \times b} = \frac{0.615 + (0.185 \times 0)}{1.57 \times 48} = 0.098 \frac{\text{kip-ft}}{\text{ft}}$$

Required depth of embedment in earth:

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

Solving the cubic equation:

$$L_{e,z} = 2.282 \text{ ft}$$

Minimum embedded depth

Depth of pile required

$$L_{e,req} = \text{MAX}[L_{e,x}, L_{e,z}] = \text{MAX}[4.549, 2.282] = 4.549 \text{ ft}$$

Actual embedded length

$$L_e = L - h_2 - h_e = 4.75 - 0 - 0 = 4.75 \text{ ft}$$

Utilisation

$$\text{Ratio} = \frac{L_{e,req}}{L_e} = \frac{4.549}{4.75} = 0.958$$

UTILITY: 0.96

REFERENCES

CALCULATIONS

RESULTS

End-bearing Capacity (ASD)

Allowable bearing pressure
Unit weight of concrete

$q_a = 2000 \text{ psf}$
 $w_c = 0.15 \text{ kip/ft}^3$

Cross-sectional area:

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

End-bearing pressure:

$$q = \frac{P}{A} = \frac{7.207}{16} = 450.4 \text{ psf}$$

Utilisation

$$\text{Ratio} = \frac{q}{q_a} = \frac{450.4}{2000} = 0.225$$

UTILITY: 0.23

Lateral Soil Pressure (ASD)

Allowable lateral pressure

$R = 150 \text{ psf/ft}$

Length to least lateral dimension ratio:

$$\frac{L}{\text{MIN}[b, D]} = \frac{4.75}{\text{MIN}[4, 4]} = 1.188$$

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

Considering x-direction:

Distance from resting surface to pivot point:

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

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

$$a = \frac{(4 \times 1.318 \times 4.75) + (3 \times 0.041 \times 4.75^2)}{(6 \times 1.318) + (4 \times 0.041 \times 4.75)} = 3.202 \text{ ft}$$

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

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

$$p = \frac{0.75 \times [(4 \times 1.318) + (3 \times -0.041 \times 4.75)]^2}{4.75^2 \times [(3 \times 1.318) + (2 \times -0.041 \times 4.75)]} = 0.205 \frac{\text{kip}}{\text{ft}^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{3.202}{2} = 0.24 \frac{\text{kip}}{\text{ft}^2}$$

Utilisation - pressure at a depth of a/2

$$\text{Ratio} = \frac{p}{p_a} = \frac{0.205}{0.24} = 0.852$$

UTILITY: 0.85

Earth pressure against the pile at distance L_e :

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times 1.318) + (-0.041 \times 4.75)]}{4.75^2} = 0.649 \frac{\text{kip}}{\text{ft}^2}$$

Allowable lateral soil pressure at a depth of L_e :

$$p_s = R \times L_e = 0.15 \times 4.75 = 0.713 \frac{\text{kip}}{\text{ft}^2}$$

Utilisation - pressure at a depth of L_e

$$\text{Ratio} = \frac{s}{p_s} = \frac{0.649}{0.713} = 0.91$$

UTILITY: 0.91

Considering z-direction:

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.098 \times 4.75) + (3 \times 0.03 \times 4.75^2)}{(6 \times 0.098) + (4 \times 0.03 \times 4.75)} = 3.36 \text{ ft}$$

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

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

$$p = \frac{0.75 \times [(4 \times 0.098) + (3 \times 0.03 \times 4.75)]^2}{4.75^2 \times [(3 \times 0.098) + (2 \times 0.03 \times 4.75)]} = 0.038 \frac{\text{kip}}{\text{ft}^2}$$

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

$$p_a = R \times \frac{a}{2} = 0.15 \times \frac{3.36}{2} = 0.252 \frac{\text{kip}}{\text{ft}^2}$$

Utilisation - pressure at a depth of a/2

$$\text{Ratio} = \frac{p}{p_a} = \frac{0.038}{0.252} = 0.152$$

UTILITY: 0.15

Earth pressure against the pile at distance L_e :

$$s = \frac{6 \times [(2 \times M_o) + (H_o \times L_e)]}{L_e^2} = \frac{6 \times [(2 \times 0.098) + (0.03 \times 4.75)]}{4.75^2} = 0.089 \frac{\text{kip}}{\text{ft}^2}$$

Allowable lateral soil pressure at a depth of L_e :

$$p_s = R \times L_e = 0.15 \times 4.75 = 0.713 \frac{\text{kip}}{\text{ft}^2}$$

Utilisation - pressure at a depth of L_e

$$\text{Ratio} = \frac{s}{p_s} = \frac{0.089}{0.713} = 0.125$$

UTILITY: 0.13

REFERENCES

CALCULATIONS

RESULTS

Shear force and bending moment (LRFD)

Considering x-direction:

Lateral force per section length

$$H_o = \frac{V_x}{1.57 \times D} = \frac{-0.434}{1.57 \times 48} = -0.069 \frac{\text{kip}}{\text{ft}}$$

Moment per section length

$$M_o = \frac{M_x + (V_x \times H)}{1.57 \times D} = \frac{13.92 + (-0.434 \times 0)}{1.57 \times 48} = 2.216 \frac{\text{kip-ft}}{\text{ft}}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 2.216 \times 4.75) + (3 \times 0.069 \times 4.75^2)}{(6 \times 2.216) + (4 \times 0.069 \times 4.75)} = 3.202 \text{ ft}$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{2.216}{-0.069} = 32.05 \text{ ft}$$

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

$$V_{max,x} = (-0.069 \times 48) \times \left[1 - \left[3 \times \left(\frac{4 \times 32.05}{4.75} + 3 \right) \times \left(\frac{3.202}{4.75} \right)^2 \right] + \left[4 \times \left(\frac{3 \times 32.05}{4.75} + 2 \right) \times \left(\frac{3.202}{4.75} \right)^3 \right] \right]$$

$$V_{max,x} = 3.494 \text{ kip}$$

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

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

$$M_{max,x} = (-0.069 \times 48 \times 4.75) \times \left[\left(\frac{32.05}{4.75} + \frac{3.202}{2 \times 4.75} \right) - \left[\left(\frac{4 \times 32.05}{4.75} + 3 \right) \times \left(\frac{3.202}{2 \times 4.75} \right)^3 \right] + \left[\left(\frac{3 \times 32.05}{4.75} + 2 \right) \times \left(\frac{3.202}{2 \times 4.75} \right)^4 \right] \right]$$

$$M_{max,x} = 8.177 \text{ kip-ft}$$

Considering z-direction:

Lateral force per section length

$$H_o = \frac{V_z}{1.57 \times b} = \frac{0.287}{1.57 \times 48} = 0.046 \frac{\text{kip}}{\text{ft}}$$

Moment per section length

$$M_o = \frac{M_z + (V_z \times H)}{1.57 \times b} = \frac{0.956 + (0.287 \times 0)}{1.57 \times 48} = 0.152 \frac{\text{kip-ft}}{\text{ft}}$$

Distance from resting surface to pivot point:

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

$$a = \frac{(4 \times 0.152 \times 4.75) + (3 \times 0.046 \times 4.75^2)}{(6 \times 0.152) + (4 \times 0.046 \times 4.75)} = 3.36 \text{ ft}$$

Max shear force located at depth a:

$$E = \frac{M_o}{H_o} = \frac{0.152}{0.046} = 3.327 \text{ ft}$$

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

$$V_{max,z} = (0.046 \times 48) \times [1 - [3 \times \left(\frac{4 \times 3.327}{4.75} + 3\right) \times \left(\frac{3.36}{4.75}\right) + [4 \times \left(\frac{3 \times 3.327}{4.75} + 2\right) \times \left(\frac{3.36}{4.75}\right)]]$$

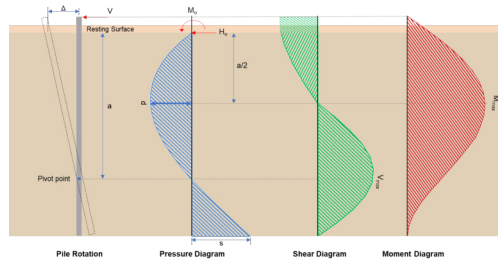
$$V_{max,z} = 0.348 \text{ kip}$$

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

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

$$M_{max,z} = (0.046 \times 48 \times 4.75) \times \left[\left(\frac{3.327}{4.75} + \frac{3.36}{2 \times 4.75} \right) - \left[\left(\frac{4 \times 3.327}{4.75} + 3 \right) \times \left(\frac{3.36}{2 \times 4.75} \right)^3 + \left(\frac{3 \times 3.327}{4.75} + 2 \right) \times \left(\frac{3.36}{2 \times 4.75} \right)^4 \right] \right]$$

$$M_{max,z} = 0.749 \text{ kip-ft}$$



Minimum Reinforcement Check (LRFD)

Gross area of concrete:

$$A_g = b \times D = 48 \times 48 = 2304 \text{ in}^2$$

Main Reinforcement

22.4.2.2 Required reinforcement:

$$A_{st,req} = \frac{P - (0.85 \times f'_{ck} \times A_g)}{f_{yk} - (0.85 \times f'_{ck})} = \frac{11.02 - (0.85 \times 2.5 \times 2304)}{60 - (0.85 \times 2.5)} = -84.41 \text{ in}^2$$

10.6.1.1 Maximum reinforcement:

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

7.6.1.1 Minimum reinforcement:

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

Governing minimum reinforcement area:

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

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

Minimum number of reinforcements:

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

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

25.2.3 Minimum spacing:

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

Use: $n = 16$ pcs at 1.5 in minimum spacing

Total reinforcement area:

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

Shear Reinforcement

25.7.2.2 For main reinforcement ≤ 1.41 in: Use #3(0.375 in)

Maximum spacing of shear Reinforcements:

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

Detailing Summary

Main reinforcement

#5 (0.625 in) - 16pcs at 1.5 in min. spacing

Axial Compression Strength (LRFD)

22.4.2.2 Allowable axial compressive strength:

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

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

Utilisation

$$\text{Ratio} = \frac{P}{\phi P_N} = \frac{11.02}{2694} = 0.004$$

UTILITY: 0.00

Shear Strength LRFD)

Effective shear width	$b_w = 48 \text{ in}$
Effective shear depth	$d = 44.31 \text{ in}$
Shear reinforcement area	$A_v = 0.221 \text{ in}^2$
Shear reinforcement spacing	$s = 10 \text{ in}$
Concrete type factor (Normal concrete)	$\lambda = 1$
Strength reduction factor for shear	$\phi = 0.75$
Maximum shear in the x-direction	$V_{max,x} = 3.494 \text{ kip}$
Maximum shear in the z-direction	$V_{max,z} = 0.348 \text{ kip}$

22.5.5.1.1 Max shear strength of concrete:

$$V_{c,max} = 5 \times \lambda \times \sqrt{f'_{ck}} \times b_w \times d = 5 \times 1 \times \sqrt{2.5} \times 48 \times 44.31 = 531.8 \text{ kip}$$

Table 22.5.5.1 Shear strength of concrete:

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

$$V_{c,a} = \left(2 \times 1 \times \sqrt{2.5} + \text{MIN} \left[\frac{11.02}{6 \times 2304}, (0.05 \times 2.5) \right] \right) \times (48 \times 44.31) = 214.4 \text{ kip}$$

Governing shear strength of concrete:

$$V_c = \text{MIN}[V_{c,max}, V_{c,a}] = \text{MIN}[531.8, 214.4] = 214.4 \text{ kip}$$

22.5.1.2 Shear strength of steel (a):

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

22.5.8.5.3 Shear strength of steel (b):

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

Governing shear strength of steel:

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

22.5.1.1 Allowable shear strength:

$$\phi V_n = \phi \times (V_c + V_s) = 0.75 \times (214.4 + 58.73) = 204.8 \text{ kip}$$

$$V_{max} = \text{MAX}[3.494, 0.348] = 3.494 \text{ kip}$$

Utilisation

$$\text{Ratio} = \frac{V_{max}}{\phi V_n} = \frac{3.494}{204.8} = 0.017$$

UTILITY: 0.02

Flexural Strength (LRFD)

Concrete type factor (Normal concrete)	$\lambda = 1$
Strength reduction factor for flexure	$\phi = 0.65$
Modulus of steel reinforcement	$E_s = 200 \text{e}3 \text{ ksi}$
Maximum concrete strain	$\epsilon_c = 0.0030$
Yield strain of steel f_y/E_s	$\epsilon_y = 0.0003$
Section width	$b = 48 \text{ in}$
Distance to the compression rebar	$d_s = 3.688 \text{ in}$
Distance to the tension rebar	$d = 44.31 \text{ in}$
Total bar area	$A_s = 4.909 \text{ in}^2$
Maximum applied axial load	$P = 11.02 \text{ kip}$
Maximum moment in the x-direction	$M_{max,x} = 8.177 \text{ kip-ft}$
Maximum moment in the z-direction	$M_{max,z} = 0.749 \text{ kip-ft}$

Compressive force due to concrete:

$$\beta_1 = 0.85$$

$$C_{rc} = 0.85 \times \beta_1 \times f'_c \times b \times c$$

Compressive force due to bars in compression:

$$C_{rs} = f_1 \times A_{sc}$$

$$\epsilon_1 = (c - d_s) \times \frac{\epsilon_c}{c}$$

$$f_1 = E_s \times \epsilon_1 \quad (\epsilon_1 < \epsilon_{sy}), \quad f_1 = f_y \quad (\epsilon_1 \geq \epsilon_{sy})$$

Tensile force due to bars in tension:

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

$$\epsilon_2 = (d - c) \times \frac{\epsilon_{cu}}{c}$$

$$f_2 = E_s \times \epsilon_2 \quad (\epsilon_2 < \epsilon_{sy}), \quad f_2 = \phi_s \times f_y \quad (\epsilon_2 \geq \epsilon_{sy})$$

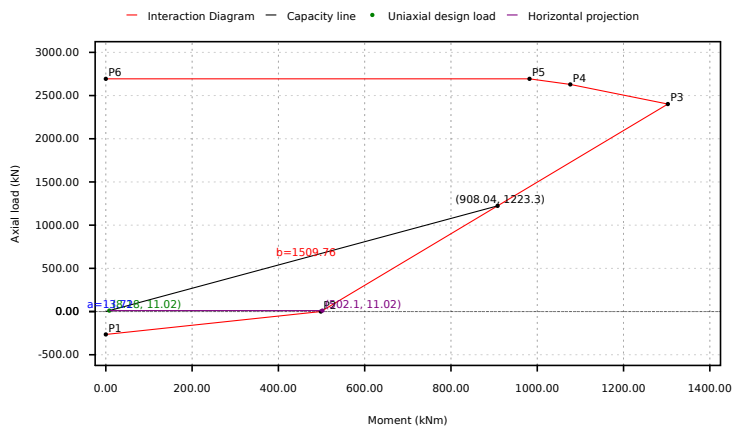
Interaction Diagram Summary

Point	Case	M _r	P _r
P1	Pure Tension	0	-265.1
P2	Pure Bending	498.4	0
P3	Balanced Failure	1303	2402
P4	Decompression	1077	2629
P5	Compression Limit	982	2694
P6	Pure Compression	0	2694

Uniaxial Bending Check

$$M_f = \text{MAX}[8.177, 0.749] = 8.177 \text{ kip-ft}$$

Interaction Diagram



Segment	Signed Distance
P1 - P2	239.9
P2 - P3	468.4
P3 - P4	2604
P4 - P5	2763
P5 - P6	2683
Status	PASS: Point lies inside the curve

Utilisation

$$\text{Ratio} = \frac{a}{a+b} = \frac{13.72}{13.72 + 1510} = 0.009$$

UTILITY: 0.01

Biaxial Bending Check

Maximum moment in the x-direction

$$M_{max,x} = 8.177 \text{ kip-ft}$$

Maximum moment in the z-direction

$$M_{max,z} = 0.749 \text{ kip-ft}$$

Nominal uniaxial moment strength about the x-axis

$$M_{noz} = 502.1 \text{ kip-ft}$$

Nominal uniaxial moment strength about the z-axis

$$M_{noz} = 502.1 \text{ kip-ft}$$

Interaction exponent

$$\alpha = 1$$

Bresler (1960)

According to Bresler (method B):

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

$$\left(\frac{8.177}{502.1}\right)^1 + \left(\frac{0.749}{502.1}\right)^1 = 0.018$$

UTILITY: 0.02

REFERENCES

CALCULATIONS

RESULTS

Results Summary

Result Name	Results
PILE DETAILS	
Length of the pile	4.75 ft
Dimensions	48 x 48 in
Main bar reinforcement	#5-16pcs at 1.5 in min.
Shear reinforcement	#3 at 10 in max.
UTILISATIONS	
Required depth	0.96
End-bearing capacity	0.23
P _a	0.85
P _s	0.91
Axial compression strength	0.00
Shear strength	0.02
Uniaxial bending strength	0.01
Biaxial bending strength	0.02