

Your Project Calculations



Project Name: MTSOLAR_5HEHFJIALEL

S3D Model Link:

[https://platform.skyciv.com/structural?](https://platform.skyciv.com/structural?preload_name=MTSOLAR_5HEHFJIALEL&preload_path=Shared%20Enterprise%20Folder/MT_Solar_Projects/9_2023)

[preload_name=MTSOLAR_5HEHFJIALEL&preload_path=Shared%20Enterprise%20Folder/MT_Solar_Projects/9_2023](https://platform.skyciv.com/structural?preload_name=MTSOLAR_5HEHFJIALEL&preload_path=Shared%20Enterprise%20Folder/MT_Solar_Projects/9_2023)

Public Model Link:

https://platform.skyciv.com/structural-viewer?project_id=naLRGiaJoc5YyioN6edwOM1vVHYbBh7loglCxM6FwzgzOKVhTCHKa6NBfKJKSfC

Array Specification

Product:	Beam
Unique ID:	3P-19.75-8TOP-HD-57-L-5Hx8W-E8B6
Duty Classification:	HD
Module Width:	41.15 in
Module Length:	87.25in
Number of Rows:	5
Number of Columns:	8
Total Number of Modules:	40
Desired Tilt Angle:	60
Front Edge Clearance:	5
Total Array Height at Tilt:	19.94 ft
Total Frame Length:	56.50 ft
Frame Weight:	3404 lbs
Array Dimensions N/S:	17.35 ft
Array Dimensions E/W:	58.83 ft
Rail Length:	208.25 in
Rail Spacing:	3.64 ft
Rail Check:	Not Checked

Support Specifications

Pole Size:	8in Pipe Sch 80
Pole Length above Grade:	12.51 ft
Number of Poles:	3
Pole Spacing:	19.75 ft

Foundation Specifications

Foundation Type:	Round
Foundation Dimensions:	Ø36 in
Foundation Depth (below grade):	Pile 1: 15.00 ft Pile 2: 15.00 ft Pile 3: 15.00 ft
Foundation Volume:	11.781 y ³
Foundation Result:	FAILED Try increasing foundation size and/or type and re-running foundation design check on right panel.
Mount Twist:	0.130311 kip

Site Info

Risk Category:	I
Exposure:	C
Soil Classification:	sand
Site Location:	Columbus, MT 59019, USA
Wind Speed:	102 mph
Snow Load:	41 psf
Design Uplift Pressure:	0.023308 ksf
Design Downforce Pressure:	-0.023308 ksf
Design Snow Pressure:	0.004509 ksf



Design Disclaimer

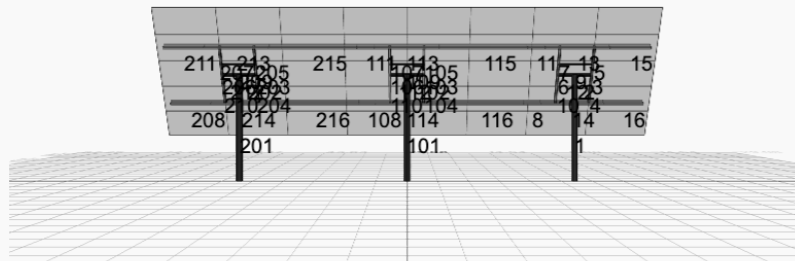
This software should be used for preliminary designs and should not be used as a final design unless reviewed, verified and designed by a qualified structural engineer.

AutoDesigner Input

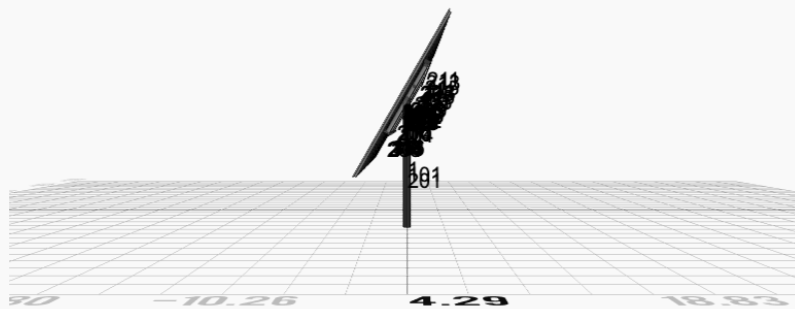
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Design Notes:

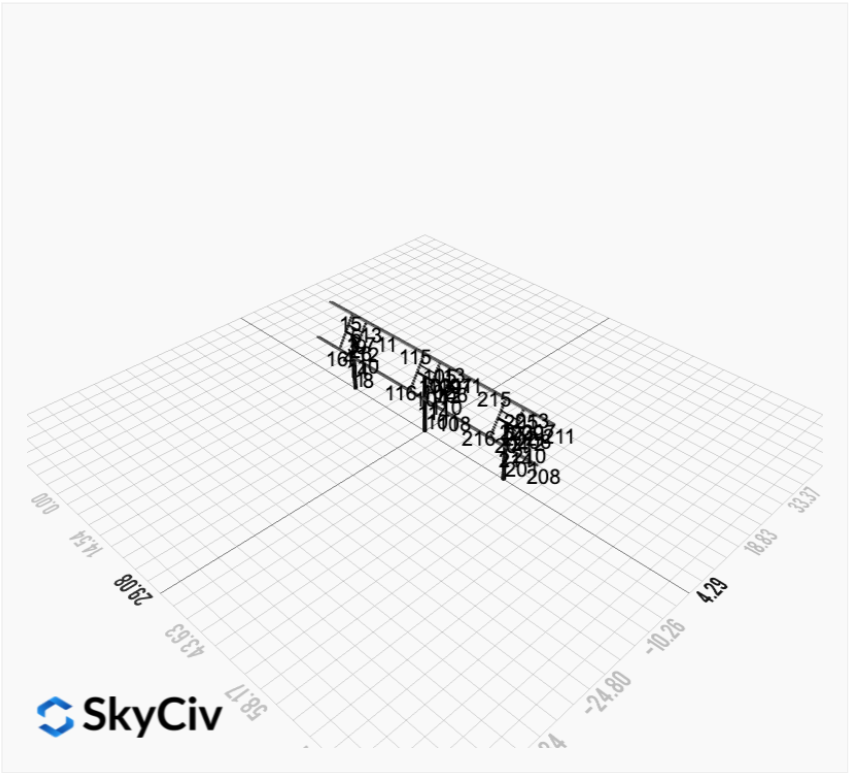
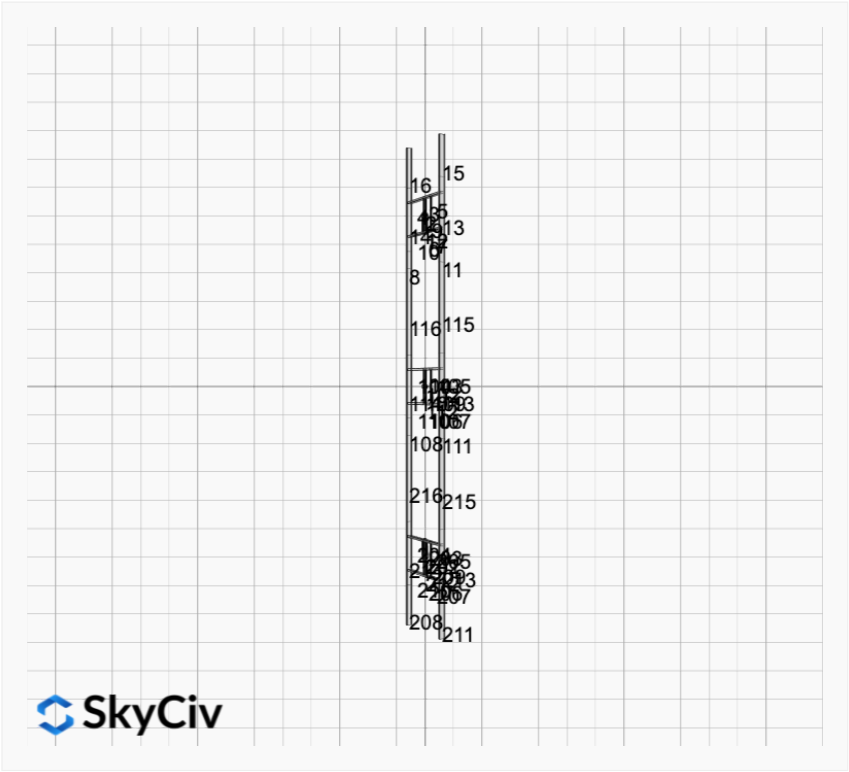
- AISC Deflection checks are set to L/1 due to structure design intent
- Foundation Design and Sizing is approximate only

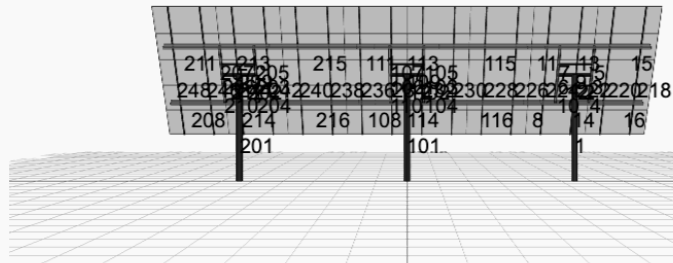


 SkyCiv

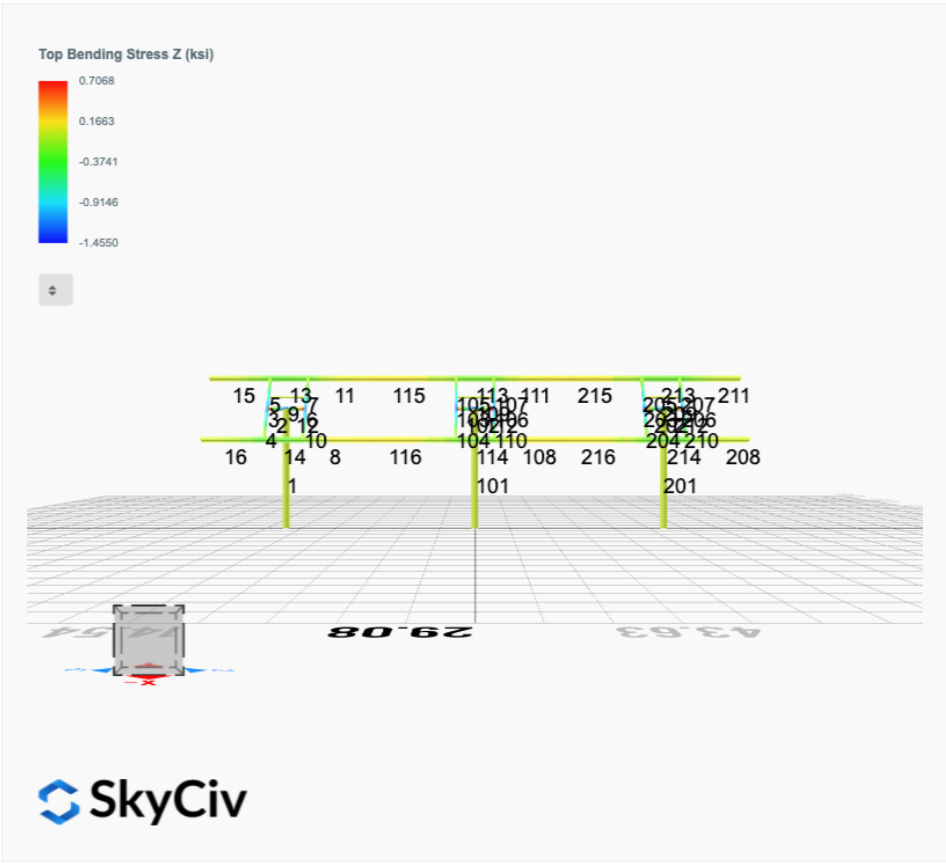
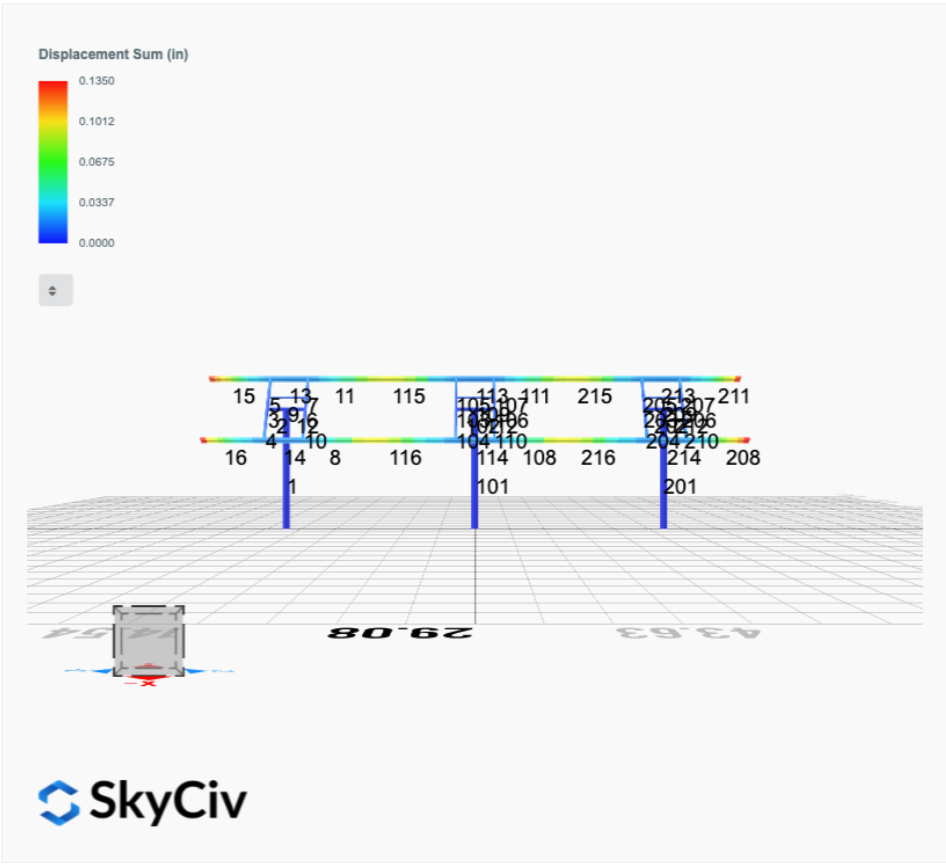


 SkyCiv

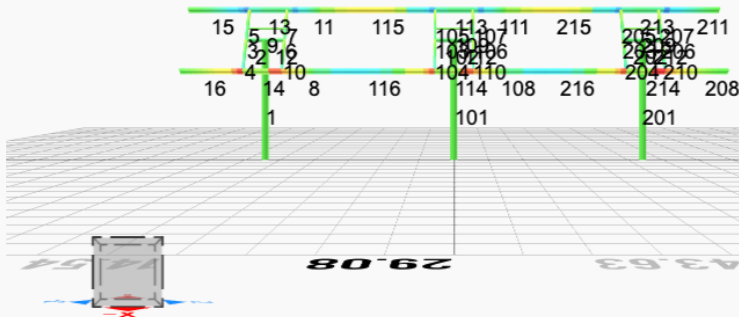
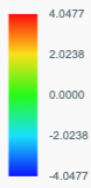




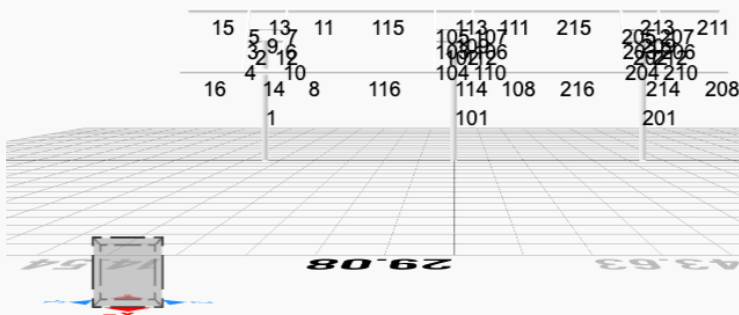
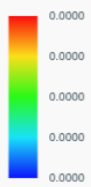
FEM Results (Envelope Worst Case for each member)

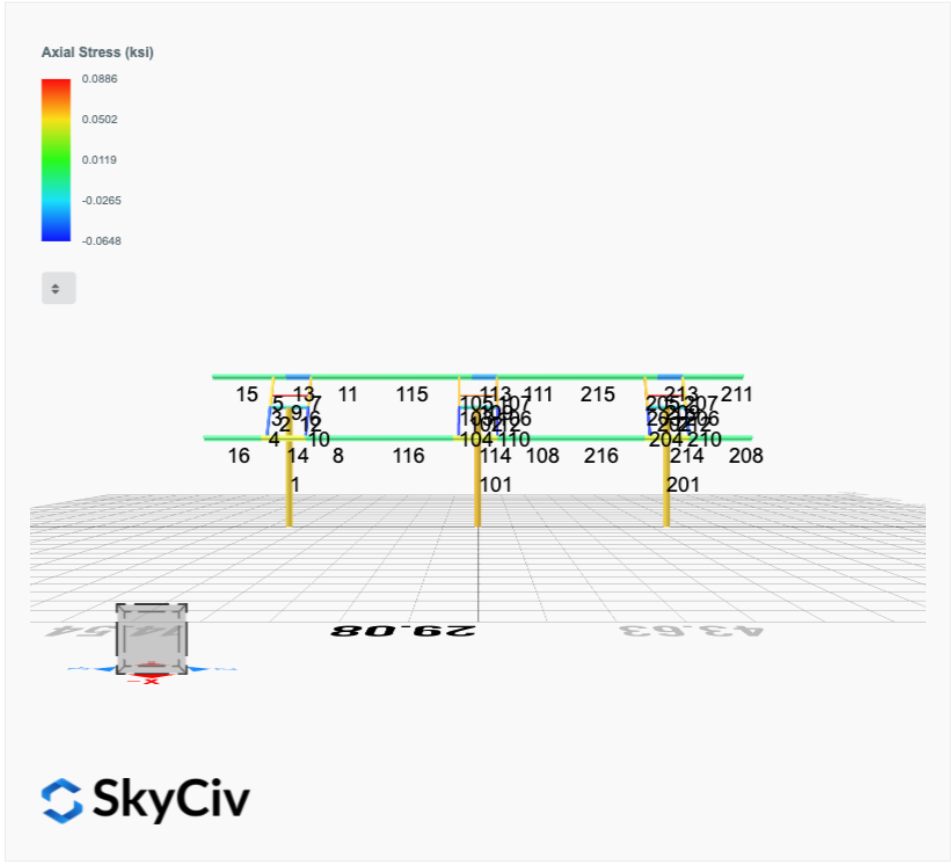


Top Bending Stress Y (ksi)



Shear Stress Y (ksi)





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

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0044	2.6125	0.0043	0.0191	0.0499	0.0679
ULS: 2. D + L	-0.0044	2.6125	0.0043	0.0191	0.0499	0.0679
ULS: 3. D + (S or Lr or R)	-0.0061	3.3325	0.0060	0.0266	0.0690	0.0880
ULS: 3. D + (S or Lr or R)	-0.0044	2.6125	0.0043	0.0191	0.0499	0.0679
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0057	3.1525	0.0056	0.0247	0.0642	0.0830
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0044	2.6125	0.0043	0.0191	0.0499	0.0679
ULS: 5b. D + 0.7E	-0.0044	2.6125	0.0043	0.0191	0.0499	0.0679
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0057	3.1525	0.0056	0.0247	0.0642	0.0830
ULS: 8. 0.6D + 0.7E	-0.0027	1.5675	0.0026	0.0114	0.0299	0.0408
ULS: 5a. D + 0.6W_Wind downforce Case A only	-4.0813	4.9615	0.0078	0.0307	0.0112	51.6284
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.0044	2.6125	0.0043	0.0191	0.0499	0.0679
ULS: 5a. D + 0.6W_Wind uplift Case A only	4.0717	0.2639	0.0012	0.0088	0.0849	-50.5004
ULS: 5a. D + 0.6W_Wind uplift Case B only	-0.0044	2.6125	0.0043	0.0191	0.0499	0.0679
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.0634	4.9142	0.0082	0.0334	0.0352	38.7533
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0057	3.1525	0.0056	0.0247	0.0642	0.0830
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.0514	1.3910	0.0033	0.0170	0.0905	-37.8433
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0057	3.1525	0.0056	0.0247	0.0642	0.0830
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.0621	4.3742	0.0069	0.0278	0.0209	38.7383
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0044	2.6125	0.0043	0.0191	0.0499	0.0679
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.0526	0.8511	0.0020	0.0114	0.0761	-37.8583
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0044	2.6125	0.0043	0.0191	0.0499	0.0679
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-4.0795	3.9164	0.0061	0.0231	-0.0087	51.6012
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.0027	1.5675	0.0026	0.0114	0.0299	0.0408
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	4.0734	-0.7811	-0.0005	0.0012	0.0649	-50.5276
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	-0.0027	1.5675	0.0026	0.0114	0.0299	0.0408

Worst Case Reactions LRFD

These calculations are taken directly from the FEA via SkyCiv and are used in the Concrete Checks of the Foundation Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	7.4102
Shear X	-6.8017
Shear Z	0.0122
Moment X	0.0470
Moment Y (Twist)	0.1305
Moment Z	86.8459

Worst Case Reactions ASD

These results are taken from the worst case values in the above table and are used in the Soil Checks in the Foundation Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	4.9615
Shear X	-4.0813
Shear Z	0.0082
Moment X	0.0334
Moment Y (Twist)	0.0905
Moment Z	51.6284

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

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0089	2.7429	0.0000	0.0000	0.0000	-0.0846
ULS: 2. D + L	0.0089	2.7429	0.0000	0.0000	0.0000	-0.0846
ULS: 3. D + (S or Lr or R)	0.0122	3.5134	0.0000	0.0000	0.0000	-0.1229
ULS: 3. D + (S or Lr or R)	0.0089	2.7429	0.0000	0.0000	0.0000	-0.0846
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0114	3.3208	0.0000	0.0000	0.0000	-0.1134
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0089	2.7429	0.0000	0.0000	0.0000	-0.0846
ULS: 5b. D + 0.7E	0.0089	2.7429	0.0000	0.0000	0.0000	-0.0846

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0114	3.3208	0.0000	0.0000	0.0000	-0.1134
ULS: 8. 0.6D + 0.7E	0.0053	1.6458	0.0000	0.0000	0.0000	-0.0508
ULS: 5a. D + 0.6W_Wind downforce Case A only	-4.2028	5.1842	0.0000	0.0000	0.0000	53.0651
ULS: 5a. D + 0.6W_Wind downforce Case B only	0.0089	2.7429	0.0000	0.0000	0.0000	-0.0846
ULS: 5a. D + 0.6W_Wind uplift Case A only	4.2221	0.3010	0.0000	0.0000	0.0000	-52.2073
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.0089	2.7429	0.0000	0.0000	0.0000	-0.0846
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.1473	5.1518	0.0000	0.0000	0.0000	39.7489
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0114	3.3208	0.0000	0.0000	0.0000	-0.1134
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.1713	1.4893	0.0000	0.0000	0.0000	-39.2054
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0114	3.3208	0.0000	0.0000	0.0000	-0.1134
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.1499	4.5739	0.0000	0.0000	0.0000	39.7777
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0089	2.7429	0.0000	0.0000	0.0000	-0.0846
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.1688	0.9115	0.0000	0.0000	0.0000	-39.1767
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0089	2.7429	0.0000	0.0000	0.0000	-0.0846
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-4.2063	4.0871	0.0000	0.0000	0.0000	53.0990
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	0.0053	1.6458	0.0000	0.0000	0.0000	-0.0508
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	4.2185	-0.7962	0.0000	0.0000	0.0000	-52.1735
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.0053	1.6458	0.0000	0.0000	0.0000	-0.0508

Worst Case Reactions LRFD

These calculations are taken directly from the FEA via SkyCiv and are used in the Concrete Checks of the Foundation Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	7.7450
Shear X	-7.0329
Shear Z	-0.0000
Moment X	0.0000
Moment Y (Twist)	0.0001
Moment Z	89.3148

Worst Case Reactions ASD

These results are taken from the worst case values in the above table and are used in the Soil Checks in the Foundation Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	5.1842
Shear X	-4.2221
Shear Z	0.0000
Moment X	0.0000
Moment Y (Twist)	0.0000
Moment Z	53.0990

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

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0044	2.6125	-0.0043	-0.0190	-0.0499	0.0679
ULS: 2. D + L	-0.0044	2.6125	-0.0043	-0.0190	-0.0499	0.0679
ULS: 3. D + (S or Lr or R)	-0.0061	3.3325	-0.0060	-0.0266	-0.0690	0.0880
ULS: 3. D + (S or Lr or R)	-0.0044	2.6125	-0.0043	-0.0190	-0.0499	0.0679
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0057	3.1525	-0.0056	-0.0247	-0.0642	0.0830
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0044	2.6125	-0.0043	-0.0190	-0.0499	0.0679
ULS: 5b. D + 0.7E	-0.0044	2.6125	-0.0043	-0.0190	-0.0499	0.0679
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0057	3.1525	-0.0056	-0.0247	-0.0642	0.0830
ULS: 8. 0.6D + 0.7E	-0.0027	1.5675	-0.0026	-0.0114	-0.0299	0.0408
ULS: 5a. D + 0.6W_Wind downforce Case A only	-4.0813	4.9615	-0.0078	-0.0307	-0.0112	51.6284
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.0044	2.6125	-0.0043	-0.0190	-0.0499	0.0679
ULS: 5a. D + 0.6W_Wind uplift Case A only	4.0717	0.2639	-0.0012	-0.0088	-0.0849	-50.5004
ULS: 5a. D + 0.6W_Wind uplift Case B only	-0.0044	2.6125	-0.0043	-0.0190	-0.0499	0.0679
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.0634	4.9142	-0.0082	-0.0334	-0.0352	38.7533
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0057	3.1525	-0.0056	-0.0247	-0.0642	0.0830
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.0514	1.3910	-0.0033	-0.0170	-0.0905	-37.8433
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0057	3.1525	-0.0056	-0.0247	-0.0642	0.0830

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-3.0621	4.3742	-0.0069	-0.0278	-0.0209	38.7383
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0044	2.6125	-0.0043	-0.0190	-0.0499	0.0679
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	3.0526	0.8511	-0.0020	-0.0114	-0.0761	-37.8583
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0044	2.6125	-0.0043	-0.0190	-0.0499	0.0679
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-4.0795	3.9164	-0.0061	-0.0230	0.0088	51.6012
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.0027	1.5675	-0.0026	-0.0114	-0.0299	0.0408
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	4.0734	-0.7811	0.0005	-0.0012	-0.0649	-50.5276
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	-0.0027	1.5675	-0.0026	-0.0114	-0.0299	0.0408

Worst Case Reactions LRFD

These calculations are taken directly from the FEA via SkyCiv and are used in the Concrete Checks of the Foundation Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	7.4102
Shear X	-6.8017
Shear Z	-0.0122
Moment X	-0.0470
Moment Y (Twist)	0.1303
Moment Z	86.8470

Worst Case Reactions ASD

These results are taken from the worst case values in the above table and are used in the Soil Checks in the Foundation Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	4.9615
Shear X	-4.0813
Shear Z	-0.0082
Moment X	-0.0334
Moment Y (Twist)	0.0905
Moment Z	51.6284

Project Details

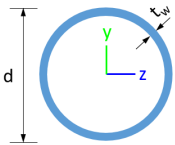
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 Provision: LRFD
 Country: United States
 User Name: sales@mtsolar.us
 Unit System: imperial



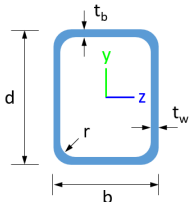
Design Input Information

Design Factors			
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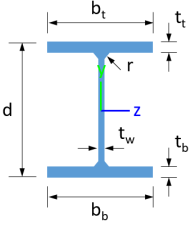
Design Materials			
ID	E (ksi)	F_y (ksi)	F_u (ksi)
1	29000	50	65

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					
10	8in Pipe Sch 80	8.63	0.50					

								
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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		

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

Section Properties								
ID	Name	A (in ²)	J (in ⁴)	I_{yp} (in ⁴)	I_{zp} (in ⁴)	I_w (in ⁶)	S_{yp} (in ³)	S_{zp} (in ³)
2	2in Pipe Sch 80	1.48	1.74	0.87	0.87	0.00	1.02	1.02
5	4in Pipe Sch 80	4.41	19.22	9.61	9.61	0.00	5.85	5.85
10	8in Pipe Sch 80	12.76	211.43	105.72	105.72	0.00	33.05	33.05

16	HSS5x3x3/16	2.58	8.64	3.85	8.53	92.39	2.96	4.21
19	W8x10	2.96	0.04	2.09	30.80	30.90	1.66	8.87

Member Properties									
Member ID	Section ID	K _z L (ft)	K _y L (ft)	L _b (ft)	C _b	L S T	L S C	L D	
1	10	26.28	26.28	12.51	-	300	200	1	
2	5	1.30	1.30	2.00	-	300	200	1	
3	16	0.92	0.92	1.42	1.19,1.19,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19	300	200	1	
4	16	2.44	2.44	3.75	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68	300	200	1	
5	16	1.52	1.52	2.33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68	300	200	1	
6	16	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19	300	200	1	
7	16	1.52	1.52	2.33	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68	300	200	1	
8	19	1.33	1.33	2.05	2.12,2.12	300	200	1	
9	2	2.60	2.60	4.00	-	300	200	1	
10	16	2.44	2.44	3.75	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68	300	200	1	
11	19	1.33	1.33	2.05	2.12,2.12,2.12,2.12,2.12,2.12,2.13,2.12,2.15,2.12,2.13,2.12,2.15,2.12,2.12,2.12,2.19,2.12,2.12,2.12,2.17,2.12,2.13,2.12,2.15,2.12	300	200	1	
12	5	1.30	1.30	2.00	-	300	200	1	
13	19	4.88	4.00	7.50	1.10,1.10,1.10,1.10,1.10,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10	300	200	1	
14	19	4.88	4.00	7.50	1.09,1.09	300	200	1	
15	19	9.97	9.97	4.75	2.33,2.33	300	200	1	
16	19	9.97	9.97	4.75	2.33,2.33	300	200	1	
101	10	26.28	26.28	12.51	-	300	200	1	
102	5	1.30	1.30	2.00	-	300	200	1	
103	16	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19	300	200	1	
104	16	2.44	2.44	3.75	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68	300	200	1	
105	16	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68	300	200	1	
106	16	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.17,1.18,1.18,1.19,1.17,1.19,1.18,1.19	300	200	1	
107	16	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.68	300	200	1	

108	19	1.33	1.33	2.0 5	2.07,2.07,2.07,2.07,2.07,2.07,2.05,2.07,1.99,2.07,2.05,2.07,2.00,2.07,2.06,2.07,1.87,2.07,2.0 5,2.07,1.95,2.07,2.05,2.07,2.01,2.07	3 0 0	2 0 0	1
109	2	2.60	2.60	4.0 0	-	3 0 0	2 0 0	1
110	16	2.44	2.44	3.7 5	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.6 7,1.68,1.66,1.68,1.67,1.68,1.67,1.68	3 0 0	2 0 0	1
111	19	1.33	1.33	2.0 5	2.08,2.08,2.08,2.08,2.08,2.08,1.90,2.08,1.77,2.08,1.89,2.08,1.78,2.08,1.98,2.08,1.60,2.08,1.9 4,2.08,1.70,2.08,1.88,2.08,1.80,2.08	3 0 0	2 0 0	1
112	5	1.30	1.30	2.0 0	-	3 0 0	2 0 0	1
113	19	4.88	4.00	7.5 0	1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.05,1.04,1.04,1.04,1.05,1.04,1.04,1.05,1.04,1.0 4,1.04,1.05,1.04,1.04,1.04,1.05,1.04	3 0 0	2 0 0	1
114	19	4.88	4.00	7.5 0	1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.04,1.0 4,1.04,1.04,1.04,1.04,1.04,1.04,1.04	3 0 0	2 0 0	1
115	19	6.63	6.63	10. 20	1.15,1.15,1.15,1.15,1.15,1.15,1.13,1.15,1.12,1.15,1.13,1.15,1.12,1.15,1.13,1.15,1.11,1.15,1.1 3,1.15,1.12,1.15,1.13,1.15,1.12,1.15	3 0 0	2 0 0	1
116	19	6.63	6.63	10. 20	1.15,1.15,1.15,1.15,1.15,1.15,1.14,1.15,1.13,1.15,1.14,1.15,1.13,1.15,1.14,1.15,1.13,1.15,1.1 4,1.15,1.13,1.15,1.14,1.15,1.14,1.15	3 0 0	2 0 0	1
201	10	26.2 8	26.2 8	12. 51	-	3 0 0	2 0 0	1
202	5	1.30	1.30	2.0 0	-	3 0 0	2 0 0	1
203	16	0.92	0.92	1.4 2	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.18,1.17,1.18,1.1 8,1.19,1.17,1.19,1.18,1.19,1.18,1.19	3 0 0	2 0 0	1
204	16	2.44	2.44	3.7 5	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.6 7,1.68,1.66,1.68,1.67,1.68,1.67,1.68	3 0 0	2 0 0	1
205	16	1.52	1.52	2.3 3	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.6 7,1.68,1.66,1.68,1.67,1.68,1.67,1.68	3 0 0	2 0 0	1
206	16	0.92	0.92	1.4 2	1.19,1.19,1.19,1.18,1.19,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.17,1.18,1.1 8,1.19,1.17,1.19,1.18,1.19,1.18,1.19	3 0 0	2 0 0	1
207	16	1.52	1.52	2.3 3	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.66,1.67,1.6 7,1.68,1.66,1.68,1.67,1.68,1.67,1.68	3 0 0	2 0 0	1
208	19	9.97	9.97	4.7 5	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.3 3,2.33,2.33,2.33,2.33,2.33,2.33,2.33	3 0 0	2 0 0	1
209	2	2.60	2.60	4.0 0	-	3 0 0	2 0 0	1
210	16	2.44	2.44	3.7 5	1.68,1.68,1.68,1.68,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.6 7,1.68,1.66,1.68,1.67,1.68,1.67,1.68	3 0 0	2 0 0	1
211	19	9.97	9.97	4.7 5	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.3 3,2.33,2.33,2.33,2.33,2.33,2.33,2.33	3 0 0	2 0 0	1
212	5	1.30	1.30	2.0 0	-	3 0 0	2 0 0	1
213	19	4.88	4.00	7.5 0	1.10,1.10,1.10,1.10,1.10,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.09,1.10,1.0 9,1.10,1.09,1.10,1.09,1.10,1.09,1.10	3 0 0	2 0 0	1
214	19	4.88	4.00	7.5 0	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.0 9,1.09,1.09,1.09,1.09,1.09,1.09,1.09	3 0 0	2 0 0	1
215	19	6.63	6.63	10. 20	1.17,1.17,1.17,1.17,1.17,1.17,1.18,1.17,1.18,1.17,1.18,1.17,1.18,1.17,1.17,1.17,1.18,1.17,1.1 7,1.17,1.18,1.17,1.18,1.17,1.18,1.17	3 0 0	2 0 0	1
216	19	6.63	6.63	10. 20	1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.17,1.1 7,1.17,1.17,1.17,1.17,1.17,1.17,1.17	3 0 0	2 0 0	1

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	574.32	238.72	123.94	123.94	172.30	172.30
2	198.33	196.72	21.95	21.95	59.50	59.50
3	116.10	115.41	15.79	11.10	42.08	23.28
4	116.10	111.33	15.79	11.10	42.08	23.28
5	116.10	114.23	15.79	11.10	42.08	23.28
6	116.10	115.41	15.79	11.10	42.08	23.28
7	116.10	114.23	15.79	11.10	42.08	23.28
8	133.20	126.01	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	126.01	32.87	6.12	40.24	43.62
12	198.33	196.72	21.95	21.95	59.50	59.50
13	133.20	104.94	24.98	6.12	40.24	43.62
14	133.20	104.94	24.98	6.12	40.24	43.62
15	133.20	32.95	32.87	6.12	40.24	43.62
16	133.20	32.95	32.87	6.12	40.24	43.62
101	574.32	238.72	123.94	123.94	172.30	172.30
102	198.33	196.72	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	126.01	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	126.01	32.87	6.12	40.24	43.62
112	198.33	196.72	21.95	21.95	59.50	59.50
113	133.20	104.94	23.83	6.12	40.24	43.62
114	133.20	104.94	23.83	6.12	40.24	43.62
115	133.20	69.16	17.18	6.12	40.24	43.62
116	133.20	69.16	17.49	6.12	40.24	43.62
201	574.32	238.72	123.94	123.94	172.30	172.30
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	32.95	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	32.95	32.87	6.12	40.24	43.62
212	198.33	196.72	21.95	21.95	59.50	59.50
213	133.20	104.94	24.98	6.12	40.24	43.62
214	133.20	104.94	24.98	6.12	40.24	43.62
215	133.20	69.16	18.11	6.12	40.24	43.62
216	133.20	69.16	18.11	6.12	40.24	43.62

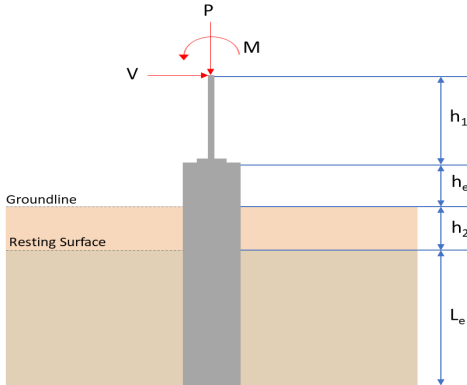
Design Ratio

Member ID	P	M _z	M _y	V _y	V _z	(P,M _z ,M _y)	Worst LC	KL/r	δ	Status
1	0.031	0.701	0.001	0.039	0.000	0.717	#13	0.548	Not Required	Pass
2	0.002	0.244	0.294	0.056	0.057	0.539	#13	0.035	Not Required	Pass
3	0.007	0.548	0.036	0.055	0.004	0.580	#13	0.045	Not Required	Pass
4	0.006	0.546	0.112	0.055	0.023	0.604	#13	0.080	Not Required	Pass
5	0.006	0.340	0.116	0.054	0.029	0.361	#13	0.074	Not Required	Pass
6	0.007	0.554	0.041	0.055	0.005	0.589	#13	0.045	Not Required	Pass
7	0.007	0.344	0.117	0.055	0.030	0.369	#13	0.074	Not Required	Pass
8	0.000	0.042	0.100	0.039	0.011	0.121	#21	0.095	Not Required	Pass
9	0.010	0.029	0.056	0.001	0.000	0.087	#13	0.204	Not Required	Pass
10	0.007	0.547	0.113	0.055	0.024	0.607	#13	0.080	Not Required	Pass
11	0.000	0.041	0.102	0.039	0.011	0.123	#21	0.095	Not Required	Pass
12	0.002	0.249	0.294	0.057	0.058	0.544	#13	0.035	Not Required	Pass
13	0.005	0.219	0.275	0.050	0.014	0.418	#13	0.286	Not Required	Pass
14	0.005	0.223	0.275	0.049	0.014	0.418	#13	0.190	Not Required	Pass
15	0.000	0.084	0.147	0.029	0.009	0.199	#21	Not Required	Not Required	Pass
16	0.000	0.084	0.147	0.029	0.009	0.199	#21	Not Required	Not Required	Pass
101	0.032	0.721	0.000	0.041	0.000	0.737	#13	0.548	Not Required	Pass
102	0.002	0.256	0.299	0.060	0.059	0.556	#13	0.035	Not Required	Pass
103	0.007	0.569	0.045	0.057	0.007	0.606	#13	0.045	Not Required	Pass
104	0.007	0.571	0.109	0.057	0.023	0.631	#13	0.080	Not Required	Pass
105	0.007	0.353	0.113	0.056	0.028	0.376	#13	0.074	Not Required	Pass
106	0.007	0.569	0.045	0.057	0.007	0.606	#13	0.045	Not Required	Pass
107	0.007	0.353	0.113	0.056	0.028	0.376	#13	0.074	Not Required	Pass
108	0.000	0.053	0.100	0.036	0.011	0.114	#21	0.095	Not Required	Pass
109	0.008	0.026	0.053	0.001	0.000	0.082	#13	0.204	Not Required	Pass
110	0.007	0.571	0.109	0.057	0.023	0.631	#13	0.080	Not Required	Pass
111	0.000	0.057	0.101	0.036	0.011	0.113	#21	0.095	Not Required	Pass
112	0.002	0.256	0.299	0.060	0.059	0.556	#13	0.035	Not Required	Pass
113	0.005	0.162	0.261	0.046	0.014	0.353	#21	0.286	Not Required	Pass
114	0.005	0.173	0.260	0.047	0.014	0.355	#13	0.286	Not Required	Pass
115	0.000	0.204	0.144	0.036	0.011	0.318	#13	0.473	Not Required	Pass
116	0.000	0.201	0.145	0.036	0.011	0.314	#13	0.473	Not Required	Pass
201	0.031	0.701	0.001	0.039	0.000	0.717	#13	0.548	Not Required	Pass
202	0.002	0.249	0.294	0.057	0.058	0.544	#13	0.035	Not Required	Pass
203	0.007	0.554	0.041	0.055	0.005	0.589	#13	0.045	Not Required	Pass
204	0.007	0.547	0.113	0.055	0.024	0.607	#13	0.080	Not Required	Pass
205	0.007	0.344	0.117	0.055	0.030	0.369	#13	0.074	Not Required	Pass
206	0.007	0.549	0.036	0.055	0.004	0.580	#13	0.045	Not Required	Pass
207	0.006	0.340	0.116	0.054	0.029	0.361	#13	0.074	Not Required	Pass
208	0.000	0.084	0.147	0.029	0.009	0.199	#21	Not Required	Not Required	Pass
209	0.010	0.029	0.056	0.001	0.000	0.087	#13	0.204	Not Required	Pass
210	0.006	0.546	0.112	0.055	0.023	0.604	#13	0.080	Not Required	Pass
211	0.000	0.084	0.147	0.029	0.009	0.199	#21	Not Required	Not Required	Pass
212	0.002	0.244	0.294	0.056	0.057	0.539	#13	0.035	Not Required	Pass
213	0.005	0.219	0.275	0.050	0.014	0.418	#13	0.190	Not Required	Pass
214	0.005	0.223	0.275	0.049	0.014	0.418	#13	0.286	Not Required	Pass
215	0.000	0.202	0.144	0.039	0.011	0.310	#13	0.473	Not Required	Pass
216	0.000	0.199	0.145	0.039	0.011	0.310	#13	0.473	Not Required	Pass

Definitions

Φ_t Safety factor for tensile

Φ_c	Safety factor for compression
Φ_b	Safety factor for flexure
Φ_v	Safety factor for shear
E	Modulus of elasticity
F_y	Specified minimum yield stress
F_u	Specified minimum tensile strength
A	Cross-sectional area
J	Torsional constant
I_{yp}	Moment of inertia about the Y axes
I_{zp}	Moment of inertia about the Z axes
I_w	Warping constant
S_{yp}	Plastic section modulus about the Y axis
S_{zp}	Plastic section modulus about the Z axis
KL	Effective length
C_b	Buckling modification factor (from all load combinations)
L_b	Length between braced points
LST	Limited slenderness for tension
LSC	Limited slenderness for compression
LD	Limited deflection
P_n	Nominal axial strength (tension/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

REFERENCES	CALCULATIONS	RESULTS																										
	SkyCiv Foundation Design Pile Foundation Design Information : Design code : IBC 2021 (International Building Code) Unit System : Imperial																											
	Pile Input  Geometry Pile shape: round D = 36 in - Pile diameter Le = 15 ft - Total pile length h1 = 0 ft - Lateral load height from the top of the pile, h2 = 0 ft - Depth to resisting surface he = 0 ft - Length of pile above the ground Tabulation of Soil Parameters <table><tr><th>Layer</th><th>Label</th><th>Allowable Bearing Pressure (qa) (psf)</th><th>Allowable Lateral Pressure (R) (psf/ft)</th></tr><tr><td>1</td><td>Sand, silty sand, clayey sand, silty gravel & clayey gravel</td><td>2000.000</td><td>150.000</td></tr></table> Tabulation of Loads <table><tr><th>Load Component</th><th>ASD</th><th>LRFD</th></tr><tr><td>P (kip)</td><td>4.961</td><td>7.410</td></tr><tr><td>Vx (kip)</td><td>-4.081</td><td>-6.802</td></tr><tr><td>Vz (kip)</td><td>0.008</td><td>0.012</td></tr><tr><td>Mx (kipft)</td><td>0.033</td><td>0.047</td></tr><tr><td>Mz (kipft)</td><td>51.628</td><td>86.846</td></tr></table> Material Properties f'ck = 2.5 ksi - Concrete strength,	Layer	Label	Allowable Bearing Pressure (qa) (psf)	Allowable Lateral Pressure (R) (psf/ft)	1	Sand, silty sand, clayey sand, silty gravel & clayey gravel	2000.000	150.000	Load Component	ASD	LRFD	P (kip)	4.961	7.410	Vx (kip)	-4.081	-6.802	Vz (kip)	0.008	0.012	Mx (kipft)	0.033	0.047	Mz (kipft)	51.628	86.846	
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Mx (kipft)	0.033	0.047																										
Mz (kipft)	51.628	86.846																										
	Required depth to resist lateral loads (ASD) H - Point of application of the lateral load $H = h_1 + h_2 + h_e$ $H = (0\text{ ft}) + (0\text{ ft}) + (0\text{ ft})$ $H = 0\text{ ft}$ Considering x-direction: H_o - Lateral force per length of pile, $H_o = \frac{V_x}{D}$ $H_o = \frac{(-4.081\text{ kip})}{(36\text{ in})}$ $H_o = -1.3603\text{ kip/ft}$ M_o - Moment per length of pile, $M_o = \frac{M_z + (V_x H)}{D}$																											

	$M_o = \frac{(51.628 \text{ kipft}) + ((-4.081 \text{ kip}) \times (0 \text{ ft}))}{(36 \text{ in})}$ $M_o = 17.209 \text{ kipft/ft}$ 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: $L_{e,x} = 9.7148 \text{ ft}$ - Required depth in x-direction, Considering z-direction: H_o - Lateral force per length of pile, $H_o = \frac{V_z}{D}$ $H_o = \frac{(0.008 \text{ kip})}{(36 \text{ in})}$ $H_o = 0.0026667 \text{ kip/ft}$ M_o - Moment per length of pile, $M_o = \frac{M_x + (V_z H)}{D}$ $M_o = \frac{(0.033 \text{ kipft}) + ((0.008 \text{ kip}) \times (0 \text{ ft}))}{(36 \text{ in})}$ $M_o = 0.011 \text{ kipft/ft}$ 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: $L_{e,z} = 1.1892 \text{ ft}$ - Required depth in z-direction, Minimum embedded depth required: $L_{e,req}$ - Depth of pile required, $L_{e,req} = \text{MAX}[L_{e,x}, L_{e,z}]$ $L_{e,req} = \text{MAX}[(9.7148 \text{ ft}), (1.1892 \text{ ft})]$ $L_{e,req} = 9.715 \text{ ft}$ L_e - Actual embedded length of pile, $L_e = L - h_c - h_2$ $L_e = (15 \text{ ft}) - (0 \text{ ft}) - (0 \text{ ft})$ $L_e = 15 \text{ ft}$ Ratio - Embedded depth $\text{Ratio} = \frac{L_{e,req}}{L_e}$ $\text{Ratio} = \frac{(9.715 \text{ ft})}{(15 \text{ ft})}$ $\text{Ratio} = 0.64767$	Status: PASS Ratio: 0.650
	End-bearing Capacity (ASD) A - Pile cross-section area $A = \pi \left(\frac{D}{2}\right)^2$ $A = \pi \times \left(\frac{(36 \text{ in})}{2}\right)^2$ $A = 7.0686 \text{ ft}^2$ q - End-bearing pressure $q = \frac{P_o}{A}$ $q = \frac{(4.961 \text{ kip})}{(7.0686 \text{ ft}^2)}$	

	$q = 0.70184 \text{ kip/ft}^2$ Check bearing capacity ratio: Ratio - Capacity $Ratio = \frac{q}{q_a}$ $Ratio = \frac{(0.70184 \text{ kip/ft}^2)}{(2000 \text{ psf})}$ $Ratio = 0.35092$	Status: PASS Ratio: 0.350
Czerniak	Lateral Soil Pressure (ASD): L/D - Length to least lateral dimension ratio, $L/D = \frac{L}{D}$ $L/D = \frac{(15 \text{ ft})}{(36 \text{ in})}$ $L/D = 5$ Since $L/D \leq 10$, Pile is short. Considering x-direction: $H_o = -1.3603 \text{ kip/ft}$ - Lateral force per length of pile, $M_o = 17.209 \text{ kipft/ft}$ - Overturning moment per length of pile, a - Distance from resting surface to pivot point, $a = \frac{(4 M_o L_e) + (3 H_o L_e^2)}{(6 M_o) + (4 H_o L_e)}$ $a = \frac{(4 \times (17.209 \text{ kipft/ft}) \times (15 \text{ ft})) + (3 \times (-1.3603 \text{ kip/ft}) \times (15 \text{ ft})^2)}{(6 \times (17.209 \text{ kipft/ft})) + (4 \times (-1.3603 \text{ kip/ft}) \times (15 \text{ ft}))}$ $a = 10.552 \text{ ft}$ p - Earth pressure against the pile at distance $a/2$ from resting surface, $p = \frac{1.178 [(4 M_o) + (3 H_o L_e)]^2}{L_e^2 [(3 M_o) + (2 H_o L_e)]}$ $p = \frac{1.178 \times [(4 \times (17.209 \text{ kipft/ft})) + (3 \times (-1.3603 \text{ kip/ft}) \times (15 \text{ ft}))]^2}{(15 \text{ ft})^2 \times [(3 \times (17.209 \text{ kipft/ft})) + (2 \times (-1.3603 \text{ kip/ft}) \times (15 \text{ ft}))]}$ $p = 0.028118 \text{ kip/ft}^2$ s - Earth pressure against the pile at distance L_e, $s = \frac{9.425 [(2 M_o) + (H_o L_e)]}{L_e^2}$ $s = \frac{9.425 \times [(2 \times (17.209 \text{ kipft/ft})) + ((-1.3603 \text{ kip/ft}) \times (15 \text{ ft}))]}{(15 \text{ ft})^2}$ $s = 0.58702 \text{ kip/ft}^2$ Check lateral soil pressure capacity: p_a - Allowable lateral soil pressure at depth $a/2$, $p_a = R \frac{a}{2}$ $p_a = (150 \text{ psf/ft}) \times \frac{(10.552 \text{ ft})}{2}$ $p_a = 0.79139 \text{ kip/ft}^2$ Ratio - Lateral soil capacity $Ratio = \frac{p}{p_a}$ $Ratio = \frac{(0.028118 \text{ kip/ft}^2)}{(0.79139 \text{ kip/ft}^2)}$ $Ratio = 0.035531$	Status: PASS Ratio: 0.040

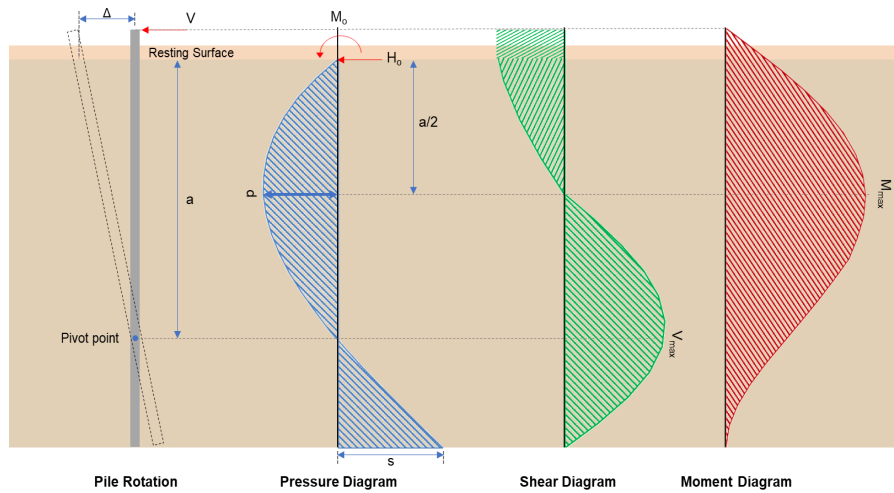
	p_s - Allowable lateral soil pressure at depth L_e, $p_s = R L_e$ $p_s = (150 \text{ psf/ft}) \times (15 \text{ ft})$ $p_s = 2.25 \text{ kip/ft}^2$ Ratio - Lateral soil capacity $\text{Ratio} = \frac{s}{p_s}$ $\text{Ratio} = \frac{(0.58702 \text{ kip/ft}^2)}{(2.25 \text{ kip/ft}^2)}$ $\text{Ratio} = 0.2609$	Status: PASS Ratio: 0.260
	Considering z-direction: $H_o = 0.0026667 \text{ kip/ft}$ - Lateral force per length of pile, $M_o = 0.011 \text{ kipft/ft}$ - Overturning moment per length of pile, a - Distance from resting surface to pivot point, $a = \frac{(4 M_o L_e) + (3 H_o L_e^2)}{(6 M_o) + (4 H_o L_e)}$ $a = \frac{(4 \times (0.011 \text{ kipft/ft}) \times (15 \text{ ft})) + (3 \times (0.0026667 \text{ kip/ft}) \times (15 \text{ ft})^2)}{(6 \times (0.011 \text{ kipft/ft})) + (4 \times (0.0026667 \text{ kip/ft}) \times (15 \text{ ft}))}$ $a = 10.885 \text{ ft}$ p - Earth pressure against the pile at distance $a/2$ from resting surface, $p = \frac{1.178 [(4 M_o) + (3 H_o L_e)]^2}{L_e^2 [(3 M_o) + (2 H_o L_e)]}$ $p = \frac{1.178 \times [(4 \times (0.011 \text{ kipft/ft})) + (3 \times (0.0026667 \text{ kip/ft}) \times (15 \text{ ft}))]^2}{(15 \text{ ft})^2 \times [(3 \times (0.011 \text{ kipft/ft})) + (2 \times (0.0026667 \text{ kip/ft}) \times (15 \text{ ft}))]}$ $p = 0.0012462 \text{ kip/ft}^2$ s - Earth pressure against the pile at distance L_e, $s = \frac{9.425 [(2 M_o) + (H_o L_e)]}{L_e^2}$ $s = \frac{9.425 \times [(2 \times (0.011 \text{ kipft/ft})) + ((0.0026667 \text{ kip/ft}) \times (15 \text{ ft}))]}{(15 \text{ ft})^2}$ $s = 0.0025971 \text{ kip/ft}^2$ Check lateral soil pressure capacity: p_a - Allowable lateral soil pressure at depth $a/2$, $p_a = R \frac{a}{2}$ $p_a = (150 \text{ psf/ft}) \times \frac{(10.885 \text{ ft})}{2}$ $p_a = 0.81637 \text{ kip/ft}^2$ Ratio - Lateral soil capacity $\text{Ratio} = \frac{p}{p_a}$ $\text{Ratio} = \frac{(0.0012462 \text{ kip/ft}^2)}{(0.81637 \text{ kip/ft}^2)}$ $\text{Ratio} = 0.0015265$ p_s - Allowable lateral soil pressure at depth L_e, $p_s = R L_e$ $p_s = (150 \text{ psf/ft}) \times (15 \text{ ft})$ $p_s = 2.25 \text{ kip/ft}^2$ Ratio - Lateral soil capacity	Status: PASS Ratio: 0.000

$$Ratio = \frac{M_o}{p_s}$$

$$Ratio = \frac{(0.0025971 \text{ kip/ft}^2)}{(2.25 \text{ kip/ft}^2)}$$

$$Ratio = 0.0011543$$

Status: **PASS**
Ratio: **0.000**



Shear force and Bending moment (x-direction, LRFD)

H_o - Lateral force per length of pile,

$$H_o = \frac{V_x}{D}$$

$$H_o = \frac{(-6.802 \text{ kip})}{(36 \text{ in})}$$

$$H_o = -2.2673 \text{ kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_x + (V_x H)}{D}$$

$$M_o = \frac{(86.846 \text{ kipft}) + ((-6.802 \text{ kip}) \times (0 \text{ ft}))}{(36 \text{ in})}$$

$$M_o = 28.949 \text{ kipft/ft}$$

E - Distance from lateral load to resisting surface,

$$E = \frac{M_o}{H_o}$$

$$E = \frac{(28.949 \text{ kipft/ft})}{(-2.2673 \text{ kip/ft})}$$

$$E = 12.768 \text{ ft}$$

a - Distance from resting surface to pivot point,

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

$$a = \frac{(4 \times (28.949 \text{ kipft/ft}) \times (15 \text{ ft})) + (3 \times (-2.2673 \text{ kip/ft}) \times (15 \text{ ft})^2)}{(6 \times (28.949 \text{ kipft/ft})) + (4 \times (-2.2673 \text{ kip/ft}) \times (15 \text{ ft}))}$$

$$a = 10.549 \text{ ft}$$

V_{max} - Max shear force located at depth a ,

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

$$V_{max} = ((-2.2673 \text{ kip/ft}) \times (36 \text{ in})) \times \left[1 - \left[3 \times \left(\frac{4 \times (12.768 \text{ ft})}{(15 \text{ ft})} + 3 \right) \times \left(\frac{(10.549 \text{ ft})}{(15 \text{ ft})} \right)^2 + 4 \times \left(\frac{3 \times (12.768 \text{ ft})}{(15 \text{ ft})} + 2 \right) \times \left(\frac{(10.549 \text{ ft})}{(15 \text{ ft})} \right)^3 \right] \right]$$

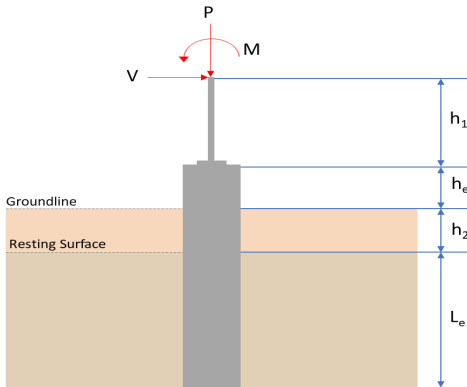
	$V_{max} = 14.745 \text{ kip}$ M_{max} - Max bending moment located at depth $a/2$, $M_{max} = (H_o D L_e) \left[\left(\frac{E}{L_e} + \frac{a}{2 L_e} \right) - \left[\left(\frac{4E}{L_e} + 3 \right) \left(\frac{a}{2 L_e} \right)^3 \right] + \left[\left(\frac{3E}{L_e} + 2 \right) \left(\frac{a}{2 L_e} \right)^4 \right] \right]$ $M_{max} = ((-2.2673 \text{ kip/ft}) \times (36 \text{ in}) \times (15 \text{ ft})) \times \left[\left(\frac{(12.768 \text{ ft})}{(15 \text{ ft})} + \frac{(10.549 \text{ ft})}{2 \times (15 \text{ ft})} \right) - \left[\left(\frac{4 \times (12.768 \text{ ft})}{(15 \text{ ft})} + 3 \right) \times \left(\frac{(10.549 \text{ ft})}{2 \times (15 \text{ ft})} \right)^3 \right] + \left[\left(\frac{3 \times (12.768 \text{ ft})}{(15 \text{ ft})} + 2 \right) \times \left(\frac{(10.549 \text{ ft})}{2 \times (15 \text{ ft})} \right)^4 \right] \right]$ $M_{max} = 101.41 \text{ kipft}$	
	Shear force and Bending moment (z-direction, LRFD) H_o - Lateral force per length of pile, $H_o = \frac{V_z}{D}$ $H_o = \frac{(0.012 \text{ kip})}{(36 \text{ in})}$ $H_o = 0.004 \text{ kip/ft}$ M_o - Moment per length of pile, $M_o = \frac{M_x + (V_z H)}{D}$ $M_o = \frac{(0.047 \text{ kipft}) + ((0.012 \text{ kip}) \times (0 \text{ ft}))}{(36 \text{ in})}$ $M_o = 0.015667 \text{ kipft/ft}$ E - Distance from lateral load to resisting surface, $E = \frac{M_o}{H_o}$ $E = \frac{(0.015667 \text{ kipft/ft})}{(0.004 \text{ kip/ft})}$ $E = 3.9167 \text{ ft}$ a - Distance from resting surface to pivot point, $a = \frac{(4 M_o L_e) + (3 H_o L_e^2)}{(6 M_o) + (4 H_o L_e)}$ $a = \frac{(4 \times (0.015667 \text{ kipft/ft}) \times (15 \text{ ft})) + (3 \times (0.004 \text{ kip/ft}) \times (15 \text{ ft})^2)}{(6 \times (0.015667 \text{ kipft/ft})) + (4 \times (0.004 \text{ kip/ft}) \times (15 \text{ ft}))}$ $a = 10.898 \text{ ft}$ V_{max} - Max shear force located at depth a, $V_{max} = (H_o b) \left[1 - \left[3 \left(\frac{4E}{L_e} + 3 \right) \left(\frac{a}{L_e} \right)^2 \right] + \left[4 \left(\frac{3E}{L_e} + 2 \right) \left(\frac{a}{L_e} \right)^3 \right] \right]$ $V_{max} = ((0.004 \text{ kip/ft}) \times (36 \text{ in})) \times \left[1 - \left[3 \times \left(\frac{4 \times (3.9167 \text{ ft})}{(15 \text{ ft})} + 3 \right) \times \left(\frac{(10.898 \text{ ft})}{(15 \text{ ft})} \right)^2 \right] + \left[4 \times \left(\frac{3 \times (3.9167 \text{ ft})}{(15 \text{ ft})} + 2 \right) \times \left(\frac{(10.898 \text{ ft})}{(15 \text{ ft})} \right)^3 \right] \right]$ $V_{max} = 0.013619 \text{ kip}$ M_{max} - Max bending moment located at depth $a/2$, $M_{max} = (H_o b L_e) \left[\left(\frac{E}{L_e} + \frac{a}{2 L_e} \right) - \left[\left(\frac{4E}{L_e} + 3 \right) \left(\frac{a}{2 L_e} \right)^3 \right] + \left[\left(\frac{3E}{L_e} + 2 \right) \left(\frac{a}{2 L_e} \right)^4 \right] \right]$ $M_{max} = ((0.004 \text{ kip/ft}) \times (36 \text{ in}) \times (15 \text{ ft})) \times \left[\left(\frac{(3.9167 \text{ ft})}{(15 \text{ ft})} + \frac{(10.898 \text{ ft})}{2 \times (15 \text{ ft})} \right) - \left[\left(\frac{4 \times (3.9167 \text{ ft})}{(15 \text{ ft})} + 3 \right) \times \left(\frac{(10.898 \text{ ft})}{2 \times (15 \text{ ft})} \right)^3 \right] + \left[\left(\frac{3 \times (3.9167 \text{ ft})}{(15 \text{ ft})} + 2 \right) \times \left(\frac{(10.898 \text{ ft})}{2 \times (15 \text{ ft})} \right)^4 \right] \right]$	

		$M_{max} = 0.086214 \text{ kipft}$	
		Minimum Reinforcement Check (LRFD) Parameters: $f'_{ck} = 2.5 \text{ ksi}$ - Concrete strength, $f_{yk} = 60 \text{ ksi}$ - Longitudinal reinforcement strength, $\phi = 0.65$ - Reduction factor for axial strength, $\alpha = 0.85$ - Alpha factor for axial strength, $A_g = 1017.9 \text{ in}^2$ - Gross area of concrete, Longitudinal reinforcement: Required reinforcement due to axial load, $A_{st,required}$ 22.4.2.2, 10.6.1.1 $A_{st,required} = \text{Min} \left[\frac{\frac{P}{\phi \alpha} - (0.85 f'_{ck} A_g)}{f_{yk} - (0.85 f'_{ck})}, (0.08 A_g) \right]$ $A_{st,required} = \text{Min} \left[\frac{\frac{(7.41 \text{ kip})}{(0.65) \times (0.85)} - (0.85 \times (2.5 \text{ ksi}) \times (1017.9 \text{ in}^2))}{(60 \text{ ksi}) - (0.85 \times (2.5 \text{ ksi}))}, (0.08 \times (1017.9 \text{ in}^2)) \right]$ $A_{st,required} = -37.142 \text{ in}^2$ A_{min} - Governing minimum reinforcement area, $A_{min} = \text{Max} [A_{st,required}, (0.0018 A_g)]$ $A_{min} = \text{Max} [(-37.142 \text{ in}^2), (0.0018 \times (1017.9 \text{ in}^2))]$ $A_{min} = 1.8322 \text{ in}^2$ n_{rebar} - Required number of reinforcement, $n_{rebar} = \frac{A_{min}}{A_{rebar}}$ $n_{rebar} = \frac{(1.8322 \text{ in}^2)}{(0.3068 \text{ in}^2)}$ $n_{rebar} = 6$ A_{st} - Actual total reinforcement area, $A_{st} = n_{rebar} \frac{\pi d_{bar}^2}{4}$ $A_{st} = (6) \times \frac{\pi \times (0.625 \text{ in})^2}{4}$ $A_{st} = 1.8408 \text{ in}^2$ Ratio - Capacity $\text{Ratio} = \frac{A_{min}}{A_{st}}$ $\text{Ratio} = \frac{(1.8322 \text{ in}^2)}{(1.8408 \text{ in}^2)}$ $\text{Ratio} = 0.99533$ 25.2.3 s_{rebar} - Minimum spacing of reinforcement, $s_{rebar} = \text{Max} [1.5, (1.5 d_{bar})]$ $s_{rebar} = \text{Max} [1.5, (1.5 \times (0.625 \text{ in}))]$ $s_{rebar} = 1.5 \text{ in}$ Ties: 25.7.2.2 Since longitudinal reinforcement is $\leq \text{No. } 10\phi$: Use #3(0.375 in) 25.7.2.1 s_{ties} - Maximum center-to-center spacing of ties, $s_{ties} = \text{Min} [(16 d_{bar}), (48 d_{ties}), D]$ $s_{ties} = \text{Min} [(16 \times (0.625 \text{ in})), (48 \times (0.375 \text{ in})), (36 \text{ in})]$ $s_{ties} = 10 \text{ in}$ Summary:	Status: PASS Ratio: 1.000

	Main reinforcement: 6 - #5 (0.625 in) Ties: #3(0.375 in) - 10 in	
22.4.2.2	Axial Compression Strength (ACI 318-19, LRFD) ϕP_N - Allowable axial compressive strength $\phi P_N = \phi 0.85 \left[(0.85 f'_{ck} [A_g - A_{st}]) + (f_{yk} A_{st}) \right]$ $\phi P_N = (0.65) \times 0.85 \times \left[(0.85 \times (2.5 \text{ ksi}) \times [(1017.9 \text{ in}^2) - (1.8408 \text{ in}^2)]) + ((60 \text{ ksi}) \times (1.8408 \text{ in}^2)) \right]$ $\phi P_N = 1253.9 \text{ kip}$ Ratio - Capacity $Ratio = \frac{P}{\phi P_N}$ $Ratio = \frac{(7.41 \text{ kip})}{(1253.9 \text{ kip})}$ $Ratio = 0.0059095$	Status: PASS Ratio: 0.010
22.5.2.2	Shear Strength (ACI 318-19, LRFD) Parameters: $b_w = 36 \text{ in}$ - Effective width, d - Effective depth $d = 0.80 D$ $d = 0.80 \times (36 \text{ in})$ $d = 28.8 \text{ in}$	
22.5.5.1.3	λ_s - size effect modification factor $\lambda_s = MIN \left[\sqrt{\frac{2}{1 + \frac{d}{10}}}, 1 \right]$ $\lambda_s = MIN \left[\sqrt{\frac{2}{1 + \frac{(28.8 \text{ in})}{10}}}, 1 \right]$ $\lambda_s = 0.71796$	
22.5.5.1.1	The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $V_{c,max}$ - Max shear strength of concrete $V_{c,max} = 5 \lambda_s \sqrt{f'_{ck}} b_w d$ $V_{c,max} = 5 \times (0.71796) \times \sqrt{(2500 \text{ psi})} \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{c,max} = 186.09 \text{ kip}$	
22.5.5.1.1(a)	The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $P = 7.41 \text{ kip} \rightarrow 7410 \text{ lbf}$, $V_{c,a}$ - Shear strength of concrete (a) $V_{c,a} = \left[2 \lambda_s \sqrt{f'_{ck}} + \frac{P}{6 A_g} \right] b_w d$ $V_{c,a} = \left[2 \times (0.71796) \times \sqrt{(2500 \text{ psi})} + \frac{(7410 \text{ lbf})}{6 \times (1017.9 \text{ in}^2)} \right] \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{c,a} = 75.696 \text{ kip}$	
22.5.5.1.2	The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $V_{c,b}$ - Shear strength of concrete (b) $V_{c,b} = \left[2 \lambda_s \sqrt{f'_{ck}} + (0.05 f'_{ck}) \right] b_w d$ $V_{c,b} = \left[2 \times (0.71796) \times \sqrt{(2500 \text{ psi})} + (0.05 \times (2500 \text{ psi})) \right] \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{c,b} = 204.04 \text{ kip}$ V_c - Governing shear strength of concrete $V_c = Min [V_{c,max}, V_{c,a}, V_{c,b}]$ $V_c = Min [(186.09 \text{ kip}), (75.696 \text{ kip}), (204.04 \text{ kip})]$	

	$V_c = 75.696 \text{ kip}$ The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, 22.5.1.2 $V_{s,a}$ - Shear strength of steel (a) $V_{s,a} = 8 \sqrt{f'_{ck}} b_w d$ $V_{s,a} = 8 \times \sqrt{(2500 \text{ psi})} \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{s,a} = 414.72 \text{ kip}$ A_v - Ties rebar area, $A_v = \frac{\pi d_{ties}^2}{4}$ $A_v = \frac{\pi \times (0.375 \text{ in})^2}{4}$ $A_v = 0.11045 \text{ in}^2$ 22.5.8.5.3 $V_{s,b}$ - Shear strength of steel (b) $V_{s,b} = \frac{2 A_v f_{yw} d}{s_{ties}}$ $V_{s,b} = \frac{2 \times (0.11045 \text{ in}^2) \times (60 \text{ ksi}) \times (28.8 \text{ in})}{(10 \text{ in})}$ $V_{s,b} = 38.17 \text{ kip}$ V_s - Governing shear strength of steel $V_s = MIN[V_{s,a}, V_{s,b}]$ $V_s = MIN[(414.72 \text{ kip}), (38.17 \text{ kip})]$ $V_s = 38.17 \text{ kip}$ 22.5.1.1 ϕV_n - Allowable shear strength $\phi V_n = \phi (V_c + V_s)$ $\phi V_n = (0.65) \times ((75.696 \text{ kip}) + (38.17 \text{ kip}))$ $\phi V_n = 74.013 \text{ kip}$ Considering x-direction: $V_{max} = 14.745 \text{ kip}$ - Maximum shear force in the x-direction, Ratio - Capacity $Ratio = \frac{V_{max}}{\phi V_n}$ $Ratio = \frac{(14.745 \text{ kip})}{(74.013 \text{ kip})}$ $Ratio = 0.19922$ Considering z-direction: $V_{max} = 0.013619 \text{ kip}$ - Maximum shear force in the z-direction, Ratio - Capacity $Ratio = \frac{V_{max}}{\phi V_n}$ $Ratio = \frac{(0.013619 \text{ kip})}{(74.013 \text{ kip})}$ $Ratio = 0.00018401$	Status: PASS Ratio: 0.200 Status: PASS Ratio: 0.000
	Flexural Strength (ACI 318-19, LRFD) S_m - Section modulus $S_m = \frac{\pi D^3}{32}$ $S_m = \frac{\pi \times (36 \text{ in})^3}{32}$	

	$S_m = 4580.4 \text{ in}^3$ $\lambda = 1$ - Concrete modification factor (Normal concrete), Allowable flexural strength: M_n shall be the lesser of: $\phi M_{n,1}$ $\phi M_{n,1} = \phi \times 5 \times \lambda \times \sqrt{f'_c} \times S_m$ $\phi M_{n,1} = 0.65 \times 5 \times 1 \times \sqrt{(2.5 \text{ ksi})} \times 4580.442 \text{ in}^3$ $\phi M_{n,1} = 62.027 \text{ kipft}$ $\phi M_{n,2}$ $\phi M_{n,2} = \phi \times 0.85 \times f'_{ck} \times S_m$ $\phi M_{n,2} = (0.65) \times 0.85 \times (2.5 \text{ ksi}) \times (4580.4 \text{ in}^3)$ $\phi M_{n,2} = 527.23 \text{ kipft}$ Therefore, ϕM_n - Allowable flexural strength, $\phi M_n = \text{MIN}[\phi M_{n,1}, \phi M_{n,2}]$ $\phi M_n = \text{MIN}[(62.027 \text{ kipft}), (527.23 \text{ kipft})]$ $\phi M_n = 62.027 \text{ kipft}$ Considering x-direction: $M_{max} = 101.41 \text{ kipft}$ - Maximum moment in the x-direction, Ratio - Capacity $\text{Ratio} = \frac{M_{max}}{\phi M_n}$ $\text{Ratio} = \frac{(101.41 \text{ kipft})}{(62.027 \text{ kipft})}$ $\text{Ratio} = 1.635$	Status: FAIL Ratio: 1.640
	Considering z-direction: $M_{max} = 0.086214 \text{ kipft}$ - Maximum moment in the z-direction, Ratio - Capacity $\text{Ratio} = \frac{M_{max}}{\phi M_n}$ $\text{Ratio} = \frac{(0.086214 \text{ kipft})}{(62.027 \text{ kipft})}$ $\text{Ratio} = 0.0013899$	Status: PASS Ratio: 0.000

REFERENCES	CALCULATIONS	RESULTS																										
	SkyCiv Foundation Design Pile Foundation Design Information : Design code : IBC 2021 (International Building Code) Unit System : Imperial																											
	Pile Input  Geometry Pile shape: round D = 36 in - Pile diameter L = 15 ft - Total pile length h1 = 0 ft - Lateral load height from the top of the pile, h2 = 0 ft - Depth to resisting surface he = 0 ft - Length of pile above the ground Tabulation of Soil Parameters <table><tr><th>Layer</th><th>Label</th><th>Allowable Bearing Pressure (qa) (psf)</th><th>Allowable Lateral Pressure (R) (psf/ft)</th></tr><tr><td>1</td><td>Sand, silty sand, clayey sand, silty gravel & clayey gravel</td><td>2000.000</td><td>150.000</td></tr></table> Tabulation of Loads <table><tr><th>Load Component</th><th>ASD</th><th>LRFD</th></tr><tr><td>P (kip)</td><td>5.184</td><td>7.745</td></tr><tr><td>Vx (kip)</td><td>-4.222</td><td>-7.033</td></tr><tr><td>Vz (kip)</td><td>0.000</td><td>0.000</td></tr><tr><td>Mx (kipft)</td><td>0.000</td><td>0.000</td></tr><tr><td>Mz (kipft)</td><td>53.099</td><td>89.315</td></tr></table> Material Properties f'ck = 2.5 ksi - Concrete strength,	Layer	Label	Allowable Bearing Pressure (qa) (psf)	Allowable Lateral Pressure (R) (psf/ft)	1	Sand, silty sand, clayey sand, silty gravel & clayey gravel	2000.000	150.000	Load Component	ASD	LRFD	P (kip)	5.184	7.745	Vx (kip)	-4.222	-7.033	Vz (kip)	0.000	0.000	Mx (kipft)	0.000	0.000	Mz (kipft)	53.099	89.315	
Layer	Label	Allowable Bearing Pressure (qa) (psf)	Allowable Lateral Pressure (R) (psf/ft)																									
1	Sand, silty sand, clayey sand, silty gravel & clayey gravel	2000.000	150.000																									
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Vx (kip)	-4.222	-7.033																										
Vz (kip)	0.000	0.000																										
Mx (kipft)	0.000	0.000																										
Mz (kipft)	53.099	89.315																										
	Required depth to resist lateral loads (ASD) H - Point of application of the lateral load $H = h_1 + h_2 + h_e$ $H = (0\text{ ft}) + (0\text{ ft}) + (0\text{ ft})$ $H = 0\text{ ft}$ Considering x-direction: Ho - Lateral force per length of pile, $H_o = \frac{V_x}{D}$ $H_o = \frac{(-4.222\text{ kip})}{(36\text{ in})}$ $H_o = -1.4073\text{ kip/ft}$ Mo - Moment per length of pile, $M_o = \frac{M_z + (V_x H)}{D}$																											

	$M_o = \frac{(53.099 \text{ kipft}) + ((-4.222 \text{ kip}) \times (0 \text{ ft}))}{(36 \text{ in})}$ $M_o = 17.7 \text{ kipft/ft}$ 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: $L_{e,x} = 9.7594 \text{ ft}$ - Required depth in x-direction, Considering z-direction: $L_{e,z} = 0 \text{ ft}$ - Required depth in z-direction, Minimum embedded depth required: $L_{e,req}$ - Depth of pile required, $L_{e,req} = \text{MAX}[L_{e,x}, L_{e,z}]$ $L_{e,req} = \text{MAX}[(9.7594 \text{ ft}), (0 \text{ ft})]$ $L_{e,req} = 9.759 \text{ ft}$ L_e - Actual embedded length of pile, $L_e = L - h_e - h_2$ $L_e = (15 \text{ ft}) - (0 \text{ ft}) - (0 \text{ ft})$ $L_e = 15 \text{ ft}$ Ratio - Embedded depth $\text{Ratio} = \frac{L_{e,req}}{L_e}$ $\text{Ratio} = \frac{(9.759 \text{ ft})}{(15 \text{ ft})}$ $\text{Ratio} = 0.6506$	Status: PASS Ratio: 0.650
	End-bearing Capacity (ASD) A - Pile cross-section area $A = \pi \left(\frac{D}{2}\right)^2$ $A = \pi \times \left(\frac{(36 \text{ in})}{2}\right)^2$ $A = 7.0686 \text{ ft}^2$ q - End-bearing pressure $q = \frac{P_o}{A}$ $q = \frac{(5.184 \text{ kip})}{(7.0686 \text{ ft}^2)}$ $q = 0.73339 \text{ kip/ft}^2$ Check bearing capacity ratio: Ratio - Capacity $\text{Ratio} = \frac{q}{q_a}$ $\text{Ratio} = \frac{(0.73339 \text{ kip/ft}^2)}{(2000 \text{ psf})}$ $\text{Ratio} = 0.36669$	Status: PASS Ratio: 0.370
Czerniak	Lateral Soil Pressure (ASD): L/D - Length to least lateral dimension ratio, $L/D = \frac{L}{D}$ $L/D = \frac{(15 \text{ ft})}{(36 \text{ in})}$	

$$L/D = 5$$

Since $L/D \leq 10$,

Pile is short.

Considering x-direction:

$H_o = -1.4073$ kip/ft - Lateral force per length of pile,

$M_o = 17.7$ kipft/ft - Overturning moment per length of pile,

a - Distance from resting surface to pivot point,

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

$$a = \frac{(4 \times (17.7 \text{ kipft/ft}) \times (15 \text{ ft})) + (3 \times (-1.4073 \text{ kip/ft}) \times (15 \text{ ft})^2)}{(6 \times (17.7 \text{ kipft/ft})) + (4 \times (-1.4073 \text{ kip/ft}) \times (15 \text{ ft}))}$$

$$a = 10.554 \text{ ft}$$

p - Earth pressure against the pile at distance $a/2$ from resting surface,

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

$$p = \frac{1.178 \times [(4 \times (17.7 \text{ kipft/ft})) + (3 \times (-1.4073 \text{ kip/ft}) \times (15 \text{ ft}))]^2}{(15 \text{ ft})^3 \times [(3 \times (17.7 \text{ kipft/ft})) + (2 \times (-1.4073 \text{ kip/ft}) \times (15 \text{ ft}))]}$$

$$p = 0.026845 \text{ kip/ft}^2$$

s - Earth pressure against the pile at distance L_e ,

$$s = \frac{9.425 [(2 M_o) + (H_o L_e)]}{L_e^2}$$

$$s = \frac{9.425 \times [(2 \times (17.7 \text{ kipft/ft})) + ((-1.4073 \text{ kip/ft}) \times (15 \text{ ft}))]}{(15 \text{ ft})^2}$$

$$s = 0.59856 \text{ kip/ft}^2$$

Check lateral soil pressure capacity:

p_a - Allowable lateral soil pressure at depth $a/2$,

$$p_a = R \frac{a}{2}$$

$$p_a = (150 \text{ psf/ft}) \times \frac{(10.554 \text{ ft})}{2}$$

$$p_a = 0.79153 \text{ kip/ft}^2$$

Ratio - Lateral soil capacity

$$\text{Ratio} = \frac{p}{p_a}$$

$$\text{Ratio} = \frac{(0.026845 \text{ kip/ft}^2)}{(0.79153 \text{ kip/ft}^2)}$$

$$\text{Ratio} = 0.033915$$

p_s - Allowable lateral soil pressure at depth L_e ,

$$p_s = R L_e$$

$$p_s = (150 \text{ psf/ft}) \times (15 \text{ ft})$$

$$p_s = 2.25 \text{ kip/ft}^2$$

Ratio - Lateral soil capacity

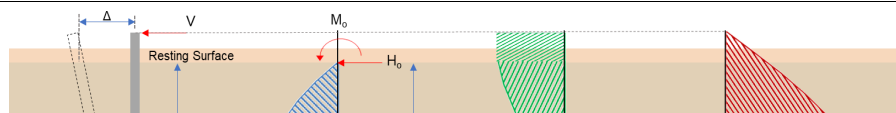
$$\text{Ratio} = \frac{s}{p_s}$$

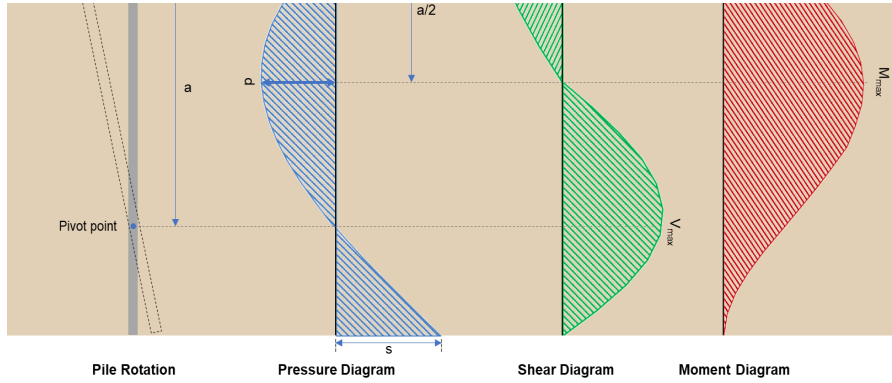
$$\text{Ratio} = \frac{(0.59856 \text{ kip/ft}^2)}{(2.25 \text{ kip/ft}^2)}$$

$$\text{Ratio} = 0.26603$$

Status: **PASS**
Ratio: **0.030**

Status: **PASS**
Ratio: **0.270**





Shear force and Bending moment (x-direction, LRFD)

H_o - Lateral force per length of pile,

$$H_o = \frac{V_x}{D}$$

$$H_o = \frac{(-7.033 \text{ kip})}{(36 \text{ in})}$$

$$H_o = -2.3443 \text{ kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_x + (V_x H)}{D}$$

$$M_o = \frac{(89.315 \text{ kipft}) + ((-7.033 \text{ kip}) \times (0 \text{ ft}))}{(36 \text{ in})}$$

$$M_o = 29.772 \text{ kipft/ft}$$

E - Distance from lateral load to resisting surface,

$$E = \frac{M_o}{H_o}$$

$$E = \frac{(29.772 \text{ kipft/ft})}{(-2.3443 \text{ kip/ft})}$$

$$E = 12.699 \text{ ft}$$

a - Distance from resting surface to pivot point,

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

$$a = \frac{(4 \times (29.772 \text{ kipft/ft}) \times (15 \text{ ft})) + (3 \times (-2.3443 \text{ kip/ft}) \times (15 \text{ ft})^2)}{(6 \times (29.772 \text{ kipft/ft})) + (4 \times (-2.3443 \text{ kip/ft}) \times (15 \text{ ft}))}$$

$$a = 10.551 \text{ ft}$$

V_{max} - Max shear force located at depth a ,

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

$$V_{max} = ((-2.3443 \text{ kip/ft}) \times (36 \text{ in})) \times \left[1 - \left[3 \times \left(\frac{4 \times (12.699 \text{ ft})}{(15 \text{ ft})} + 3 \right) \times \left(\frac{(10.551 \text{ ft})}{(15 \text{ ft})} \right)^2 \right] + \left[4 \times \left(\frac{3 \times (12.699 \text{ ft})}{(15 \text{ ft})} + 2 \right) \times \left(\frac{(10.551 \text{ ft})}{(15 \text{ ft})} \right)^3 \right] \right]$$

$$V_{max} = 15.189 \text{ kip}$$

M_{max} - Max bending moment located at depth $a/2$,

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

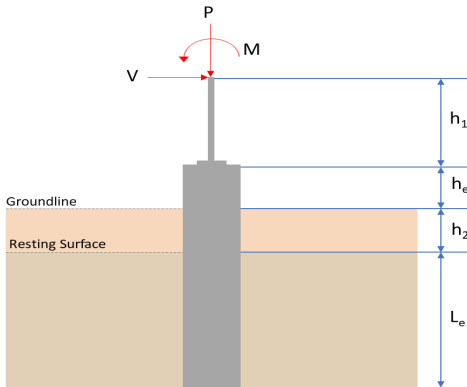
$$M_{max} = ((-2.3443 \text{ kip/ft}) \times (36 \text{ in}) \times (15 \text{ ft})) \times \left[\left(\frac{(12.699 \text{ ft})}{(15 \text{ ft})} + \frac{(10.551 \text{ ft})}{2 \times (15 \text{ ft})} \right) - \left[\left(\frac{4 \times (12.699 \text{ ft})}{(15 \text{ ft})} + 3 \right) \times \left(\frac{(10.551 \text{ ft})}{2 \times (15 \text{ ft})} \right)^3 \right] + \left[\left(\frac{3 \times (12.699 \text{ ft})}{(15 \text{ ft})} + 2 \right) \times \left(\frac{(10.551 \text{ ft})}{2 \times (15 \text{ ft})} \right)^4 \right] \right]$$

		$M_{max} = 104.44 \text{ kipft}$	
Table 22.4.2.1	22.4.2.2, 10.6.1.1	Minimum Reinforcement Check (LRFD) Parameters: $f'_{ck} = 2.5 \text{ ksi}$ - Concrete strength, $f_{yk} = 60 \text{ ksi}$ - Longitudinal reinforcement strength, $\phi = 0.65$ - Reduction factor for axial strength, $\alpha = 0.85$ - Alpha factor for axial strength, $A_g = 1017.9 \text{ in}^2$ - Gross area of concrete, Longitudinal reinforcement: Required reinforcement due to axial load, $A_{st,required}$ $A_{st,required} = \text{Min} \left[\frac{\frac{P}{\phi \alpha} - (0.85 f'_{ck} A_g)}{f_{yk} - (0.85 f'_{ck})}, (0.08 A_g) \right]$ $A_{st,required} = \text{Min} \left[\frac{\frac{(7.745 \text{ kip})}{(0.65) \times (0.85)} - (0.85 \times (2.5 \text{ ksi}) \times (1017.9 \text{ in}^2))}{(60 \text{ ksi}) - (0.85 \times (2.5 \text{ ksi}))}, (0.08 \times (1017.9 \text{ in}^2)) \right]$ $A_{st,required} = -37.131 \text{ in}^2$ A_{min} - Governing minimum reinforcement area, $A_{min} = \text{Max} [A_{st,required}, (0.0018 A_g)]$ $A_{min} = \text{Max} [(-37.131 \text{ in}^2), (0.0018 \times (1017.9 \text{ in}^2))]$ $A_{min} = 1.8322 \text{ in}^2$ n_{rebar} - Required number of reinforcement, $n_{rebar} = \frac{A_{min}}{A_{rebar}}$ $n_{rebar} = \frac{(1.8322 \text{ in}^2)}{(0.3068 \text{ in}^2)}$ $n_{rebar} = 6$ A_{st} - Actual total reinforcement area, $A_{st} = n_{rebar} \frac{\pi d_{bar}^2}{4}$ $A_{st} = (6) \times \frac{\pi \times (0.625 \text{ in})^2}{4}$ $A_{st} = 1.8408 \text{ in}^2$ Ratio - Capacity $\text{Ratio} = \frac{A_{min}}{A_{st}}$ $\text{Ratio} = \frac{(1.8322 \text{ in}^2)}{(1.8408 \text{ in}^2)}$ $\text{Ratio} = 0.99533$ 25.2.3 s_{rebar} - Minimum spacing of reinforcement, $s_{rebar} = \text{Max} [1.5, (1.5 d_{bar})]$ $s_{rebar} = \text{Max} [1.5, (1.5 \times (0.625 \text{ in}))]$ $s_{rebar} = 1.5 \text{ in}$ Ties: 25.7.2.2 Since longitudinal reinforcement is $\leq \text{No. } 10\emptyset$: Use #3(0.375 in) 25.7.2.1 s_{ties} - Maximum center-to-center spacing of ties, $s_{ties} = \text{Min} [(16 d_{bar}), (48 d_{ties}), D]$ $s_{ties} = \text{Min} [(16 \times (0.625 \text{ in})), (48 \times (0.375 \text{ in})), (36 \text{ in})]$ $s_{ties} = 10 \text{ in}$ Summary:	Status: PASS Ratio: 1.000

	Main reinforcement: 6 - #5 (0.625 in) Ties: #3(0.375 in) - 10 in	
22.4.2.2	Axial Compression Strength (ACI 318-19, LRFD) ϕP_N - Allowable axial compressive strength $\phi P_N = \phi 0.85 \left[(0.85 f'_{ck} [A_g - A_{st}]) + (f_{yk} A_{st}) \right]$ $\phi P_N = (0.65) \times 0.85 \times \left[(0.85 \times (2.5 \text{ ksi}) \times [(1017.9 \text{ in}^2) - (1.8408 \text{ in}^2)]) + ((60 \text{ ksi}) \times (1.8408 \text{ in}^2)) \right]$ $\phi P_N = 1253.9 \text{ kip}$ Ratio - Capacity $Ratio = \frac{P}{\phi P_N}$ $Ratio = \frac{(7.745 \text{ kip})}{(1253.9 \text{ kip})}$ $Ratio = 0.0061767$	Status: PASS Ratio: 0.010
22.5.2.2	Shear Strength (ACI 318-19, LRFD) Parameters: $b_w = 36 \text{ in}$ - Effective width, d - Effective depth $d = 0.80 D$ $d = 0.80 \times (36 \text{ in})$ $d = 28.8 \text{ in}$	
22.5.5.1.3	λ_s - size effect modification factor $\lambda_s = MIN \left[\sqrt{\frac{2}{1 + \frac{d}{10}}}, 1 \right]$ $\lambda_s = MIN \left[\sqrt{\frac{2}{1 + \frac{(28.8 \text{ in})}{10}}}, 1 \right]$ $\lambda_s = 0.71796$	
22.5.5.1.1	The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $V_{c,max}$ - Max shear strength of concrete $V_{c,max} = 5 \lambda_s \sqrt{f'_{ck}} b_w d$ $V_{c,max} = 5 \times (0.71796) \times \sqrt{(2500 \text{ psi})} \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{c,max} = 186.09 \text{ kip}$	
22.5.5.1.1(a)	The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $P = 7.745 \text{ kip} \rightarrow 7745 \text{ lbf}$, $V_{c,a}$ - Shear strength of concrete (a) $V_{c,a} = \left[2 \lambda_s \sqrt{f'_{ck}} + \frac{P}{6 A_g} \right] b_w d$ $V_{c,a} = \left[2 \times (0.71796) \times \sqrt{(2500 \text{ psi})} + \frac{(7745 \text{ lbf})}{6 \times (1017.9 \text{ in}^2)} \right] \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{c,a} = 75.753 \text{ kip}$	
22.5.5.1.2	The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $V_{c,b}$ - Shear strength of concrete (b) $V_{c,b} = \left[2 \lambda_s \sqrt{f'_{ck}} + (0.05 f'_{ck}) \right] b_w d$ $V_{c,b} = \left[2 \times (0.71796) \times \sqrt{(2500 \text{ psi})} + (0.05 \times (2500 \text{ psi})) \right] \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{c,b} = 204.04 \text{ kip}$ V_c - Governing shear strength of concrete $V_c = MIN [V_{c,max}, V_{c,a}, V_{c,b}]$ $V_c = MIN [(186.09 \text{ kip}), (75.753 \text{ kip}), (204.04 \text{ kip})]$	

22.5.1.2 22.5.8.5.3 22.5.1.1	$V_c = 75.753 \text{ kip}$ The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $V_{s,a}$ - Shear strength of steel (a) $V_{s,a} = 8 \sqrt{f'_{ck}} b_w d$ $V_{s,a} = 8 \times \sqrt{(2500 \text{ psi})} \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{s,a} = 414.72 \text{ kip}$ A_v - Ties rebar area, $A_v = \frac{\pi d_{ties}^2}{4}$ $A_v = \frac{\pi \times (0.375 \text{ in})^2}{4}$ $A_v = 0.11045 \text{ in}^2$ $V_{s,b}$ - Shear strength of steel (b) $V_{s,b} = \frac{2 A_v f_{yw} d}{s_{ties}}$ $V_{s,b} = \frac{2 \times (0.11045 \text{ in}^2) \times (60 \text{ ksi}) \times (28.8 \text{ in})}{(10 \text{ in})}$ $V_{s,b} = 38.17 \text{ kip}$ V_s - Governing shear strength of steel $V_s = MIN[V_{s,a}, V_{s,b}]$ $V_s = MIN[(414.72 \text{ kip}), (38.17 \text{ kip})]$ $V_s = 38.17 \text{ kip}$ ϕV_n - Allowable shear strength $\phi V_n = \phi (V_c + V_s)$ $\phi V_n = (0.65) \times ((75.753 \text{ kip}) + (38.17 \text{ kip}))$ $\phi V_n = 74.05 \text{ kip}$ Considering x-direction: $V_{max} = 15.189 \text{ kip}$ - Maximum shear force in the x-direction, $Ratio$ - Capacity $Ratio = \frac{V_{max}}{\phi V_n}$ $Ratio = \frac{(15.189 \text{ kip})}{(74.05 \text{ kip})}$ $Ratio = 0.20512$	Status: PASS Ratio: 0.210
14.5.2.1b	Flexural Strength (ACI 318-19, LRFD) S_m - Section modulus $S_m = \frac{\pi D^3}{32}$ $S_m = \frac{\pi \times (36 \text{ in})^3}{32}$ $S_m = 4580.4 \text{ in}^3$ $\lambda = 1$ - Concrete modification factor (Normal concrete), Allowable flexural strength: M_n shall be the lesser of: $\phi M_{n,1}$ $\phi M_{n,1} = \phi \times 5 \times \lambda \times \sqrt{f'_c} \times S_m$ $\phi M_{n,1} = 0.65 \times 5 \times 1 \times \sqrt{(2.5 \text{ ksi})} \times 4580.442 \text{ in}^3$ $\phi M_{n,1} = 62.027 \text{ kipft}$ $\phi M_{n,2}$	

	$\phi M_{n,2} = \phi 0.85 f'_{ck} S_m$ $\phi M_{n,2} = (0.65) \times 0.85 \times (2.5 \text{ ksi}) \times (4580.4 \text{ in}^3)$ $\phi M_{n,2} = 527.23 \text{ kipft}$ Therefore, ϕM_n - Allowable flexural strength, $\phi M_n = \text{MIN}[\phi M_{n,1}, \phi M_{n,2}]$ $\phi M_n = \text{MIN}[(62.027 \text{ kipft}), (527.23 \text{ kipft})]$ $\phi M_n = 62.027 \text{ kipft}$ Considering x-direction: $M_{max} = 104.44 \text{ kipft}$ - Maximum moment in the x-direction, <i>Ratio</i> - Capacity $\text{Ratio} = \frac{M_{max}}{\phi M_n}$ $\text{Ratio} = \frac{(104.44 \text{ kipft})}{(62.027 \text{ kipft})}$ $\text{Ratio} = 1.6837$	
		Status: FAIL Ratio: 1.680

REFERENCES	CALCULATIONS	RESULTS																										
	SkyCiv Foundation Design Pile Foundation Design Information : Design code : IBC 2021 (International Building Code) Unit System : Imperial																											
	Pile Input  Geometry Pile shape: round D = 36 in - Pile diameter Le = 15 ft - Total pile length h1 = 0 ft - Lateral load height from the top of the pile, h2 = 0 ft - Depth to resisting surface he = 0 ft - Length of pile above the ground Tabulation of Soil Parameters <table><tr><th>Layer</th><th>Label</th><th>Allowable Bearing Pressure (qa) (psf)</th><th>Allowable Lateral Pressure (R) (psf/ft)</th></tr><tr><td>1</td><td>Sand, silty sand, clayey sand, silty gravel & clayey gravel</td><td>2000.000</td><td>150.000</td></tr></table> Tabulation of Loads <table><tr><th>Load Component</th><th>ASD</th><th>LRFD</th></tr><tr><td>P (kip)</td><td>4.961</td><td>7.410</td></tr><tr><td>Vx (kip)</td><td>-4.081</td><td>-6.802</td></tr><tr><td>Vz (kip)</td><td>-0.008</td><td>-0.012</td></tr><tr><td>Mx (kipft)</td><td>-0.033</td><td>-0.047</td></tr><tr><td>Mz (kipft)</td><td>51.628</td><td>86.847</td></tr></table> Material Properties f'ck = 2.5 ksi - Concrete strength,	Layer	Label	Allowable Bearing Pressure (qa) (psf)	Allowable Lateral Pressure (R) (psf/ft)	1	Sand, silty sand, clayey sand, silty gravel & clayey gravel	2000.000	150.000	Load Component	ASD	LRFD	P (kip)	4.961	7.410	Vx (kip)	-4.081	-6.802	Vz (kip)	-0.008	-0.012	Mx (kipft)	-0.033	-0.047	Mz (kipft)	51.628	86.847	
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Mx (kipft)	-0.033	-0.047																										
Mz (kipft)	51.628	86.847																										
	Required depth to resist lateral loads (ASD) H - Point of application of the lateral load $H = h_1 + h_2 + h_e$ $H = (0\text{ ft}) + (0\text{ ft}) + (0\text{ ft})$ $H = 0\text{ ft}$ Considering x-direction: H_o - Lateral force per length of pile, $H_o = \frac{V_x}{D}$ $H_o = \frac{(-4.081\text{ kip})}{(36\text{ in})}$ $H_o = -1.3603\text{ kip/ft}$ M_o - Moment per length of pile, $M_o = \frac{M_z + (V_x H)}{D}$																											

	$M_o = \frac{(51.628 \text{ kipft}) + ((-4.081 \text{ kip}) \times (0 \text{ ft}))}{(36 \text{ in})}$ $M_o = 17.209 \text{ kipft/ft}$ 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: $L_{e,x} = 9.7148 \text{ ft}$ - Required depth in x-direction, Considering z-direction: H_o - Lateral force per length of pile, $H_o = \frac{V_z}{D}$ $H_o = \frac{(-0.008 \text{ kip})}{(36 \text{ in})}$ $H_o = -0.0026667 \text{ kip/ft}$ M_o - Moment per length of pile, $M_o = \frac{M_x + (V_z H)}{D}$ $M_o = \frac{(0.033 \text{ kipft}) + ((-0.008 \text{ kip}) \times (0 \text{ ft}))}{(36 \text{ in})}$ $M_o = 0.011 \text{ kipft/ft}$ 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: $L_{e,z} = 1.0388 \text{ ft}$ - Required depth in z-direction, Minimum embedded depth required: $L_{e,req}$ - Depth of pile required, $L_{e,req} = MAX[L_{e,x}, L_{e,z}]$ $L_{e,req} = MAX[(9.7148 \text{ ft}), (1.0388 \text{ ft})]$ $L_{e,req} = 9.715 \text{ ft}$ L_e - Actual embedded length of pile, $L_e = L - h_c - h_2$ $L_e = (15 \text{ ft}) - (0 \text{ ft}) - (0 \text{ ft})$ $L_e = 15 \text{ ft}$ Ratio - Embedded depth $Ratio = \frac{L_{e,req}}{L_e}$ $Ratio = \frac{(9.715 \text{ ft})}{(15 \text{ ft})}$ $Ratio = 0.64767$	Status: PASS Ratio: 0.650
	End-bearing Capacity (ASD) A - Pile cros-section area $A = \pi \left(\frac{D}{2}\right)^2$ $A = \pi \times \left(\frac{(36 \text{ in})}{2}\right)^2$ $A = 7.0686 \text{ ft}^2$ q - End-bearing pressure $q = \frac{P_o}{A}$ $q = \frac{(4.961 \text{ kip})}{(7.0686 \text{ ft}^2)}$	

	$q = 0.70184 \text{ kip/ft}^2$ Check bearing capacity ratio: Ratio - Capacity $\text{Ratio} = \frac{q}{q_a}$ $\text{Ratio} = \frac{(0.70184 \text{ kip/ft}^2)}{(2000 \text{ psf})}$ $\text{Ratio} = 0.35092$	Status: PASS Ratio: 0.350
Czerniak	Lateral Soil Pressure (ASD): L/D - Length to least lateral dimension ratio, $L/D = \frac{L}{D}$ $L/D = \frac{(15 \text{ ft})}{(36 \text{ in})}$ $L/D = 5$ Since $L/D \leq 10$, Pile is short. Considering x-direction: $H_o = -1.3603 \text{ kip/ft}$ - Lateral force per length of pile, $M_o = 17.209 \text{ kipft/ft}$ - Overturning moment per length of pile, a - Distance from resting surface to pivot point, $a = \frac{(4 M_o L_e) + (3 H_o L_e^2)}{(6 M_o) + (4 H_o L_e)}$ $a = \frac{(4 \times (17.209 \text{ kipft/ft}) \times (15 \text{ ft})) + (3 \times (-1.3603 \text{ kip/ft}) \times (15 \text{ ft})^2)}{(6 \times (17.209 \text{ kipft/ft})) + (4 \times (-1.3603 \text{ kip/ft}) \times (15 \text{ ft}))}$ $a = 10.552 \text{ ft}$ p - Earth pressure against the pile at distance $a/2$ from resting surface, $p = \frac{1.178 [(4 M_o) + (3 H_o L_e)]^2}{L_e^2 [(3 M_o) + (2 H_o L_e)]}$ $p = \frac{1.178 \times [(4 \times (17.209 \text{ kipft/ft})) + (3 \times (-1.3603 \text{ kip/ft}) \times (15 \text{ ft}))]^2}{(15 \text{ ft})^2 \times [(3 \times (17.209 \text{ kipft/ft})) + (2 \times (-1.3603 \text{ kip/ft}) \times (15 \text{ ft}))]}$ $p = 0.028118 \text{ kip/ft}^2$ s - Earth pressure against the pile at distance L_e, $s = \frac{9.425 [(2 M_o) + (H_o L_e)]}{L_e^2}$ $s = \frac{9.425 \times [(2 \times (17.209 \text{ kipft/ft})) + ((-1.3603 \text{ kip/ft}) \times (15 \text{ ft}))]}{(15 \text{ ft})^2}$ $s = 0.58702 \text{ kip/ft}^2$ Check lateral soil pressure capacity: p_a - Allowable lateral soil pressure at depth $a/2$, $p_a = R \frac{a}{2}$ $p_a = (150 \text{ psf/ft}) \times \frac{(10.552 \text{ ft})}{2}$ $p_a = 0.79139 \text{ kip/ft}^2$ Ratio - Lateral soil capacity $\text{Ratio} = \frac{p}{p_a}$ $\text{Ratio} = \frac{(0.028118 \text{ kip/ft}^2)}{(0.79139 \text{ kip/ft}^2)}$ $\text{Ratio} = 0.035531$	Status: PASS Ratio: 0.040

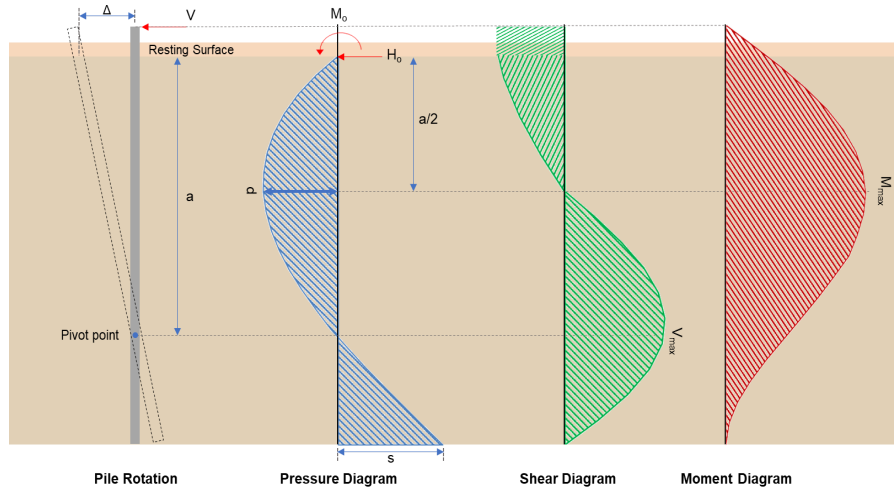
	p_s - Allowable lateral soil pressure at depth L_e, $p_s = R L_e$ $p_s = (150 \text{ psf/ft}) \times (15 \text{ ft})$ $p_s = 2.25 \text{ kip/ft}^2$ Ratio - Lateral soil capacity $\text{Ratio} = \frac{s}{p_s}$ $\text{Ratio} = \frac{(0.58702 \text{ kip/ft}^2)}{(2.25 \text{ kip/ft}^2)}$ $\text{Ratio} = 0.2609$	Status: PASS Ratio: 0.260
	Considering z-direction: $H_o = -0.0026667 \text{ kip/ft}$ - Lateral force per length of pile, $M_o = 0.011 \text{ kipft/ft}$ - Overturning moment per length of pile, a - Distance from resting surface to pivot point, $a = \frac{(4 M_o L_e) + (3 H_o L_e^2)}{(6 M_o) + (4 H_o L_e)}$ $a = \frac{(4 \times (0.011 \text{ kipft/ft}) \times (15 \text{ ft})) + (3 \times (-0.0026667 \text{ kip/ft}) \times (15 \text{ ft})^2)}{(6 \times (0.011 \text{ kipft/ft})) + (4 \times (-0.0026667 \text{ kip/ft}) \times (15 \text{ ft}))}$ $a = 10.885 \text{ ft}$ p - Earth pressure against the pile at distance $a/2$ from resting surface, $p = \frac{1.178 [(4 M_o) + (3 H_o L_e)]^2}{L_e^2 [(3 M_o) + (2 H_o L_e)]}$ $p = \frac{1.178 \times [(4 \times (0.011 \text{ kipft/ft})) + (3 \times (-0.0026667 \text{ kip/ft}) \times (15 \text{ ft}))]^2}{(15 \text{ ft})^2 \times [(3 \times (0.011 \text{ kipft/ft})) + (2 \times (-0.0026667 \text{ kip/ft}) \times (15 \text{ ft}))]}$ $p = -0.00064342 \text{ kip/ft}^2$ s - Earth pressure against the pile at distance L_e, $s = \frac{9.425 [(2 M_o) + (H_o L_e)]}{L_e^2}$ $s = \frac{9.425 \times [(2 \times (0.011 \text{ kipft/ft})) + ((-0.0026667 \text{ kip/ft}) \times (15 \text{ ft}))]}{(15 \text{ ft})^2}$ $s = -0.000754 \text{ kip/ft}^2$ Check lateral soil pressure capacity: p_a - Allowable lateral soil pressure at depth $a/2$, $p_a = R \frac{a}{2}$ $p_a = (150 \text{ psf/ft}) \times \frac{(10.885 \text{ ft})}{2}$ $p_a = 0.81637 \text{ kip/ft}^2$ Ratio - Lateral soil capacity $\text{Ratio} = \frac{p}{p_a}$ $\text{Ratio} = \frac{(-0.00064342 \text{ kip/ft}^2)}{(0.81637 \text{ kip/ft}^2)}$ $\text{Ratio} = -0.00078814$ p_s - Allowable lateral soil pressure at depth L_e, $p_s = R L_e$ $p_s = (150 \text{ psf/ft}) \times (15 \text{ ft})$ $p_s = 2.25 \text{ kip/ft}^2$ Ratio - Lateral soil capacity	Status: PASS Ratio: 0.000

$$Ratio = \frac{M_o}{p_s}$$

$$Ratio = \frac{(-0.000754 \text{ kip/ft}^2)}{(2.25 \text{ kip/ft}^2)}$$

$$Ratio = -0.00033511$$

Status: **PASS**
Ratio: **0.000**



Shear force and Bending moment (x-direction, LRFD)

H_o - Lateral force per length of pile,

$$H_o = \frac{V_x}{D}$$

$$H_o = \frac{(-6.802 \text{ kip})}{(36 \text{ in})}$$

$$H_o = -2.2673 \text{ kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_x + (V_x H)}{D}$$

$$M_o = \frac{(86.847 \text{ kipft}) + ((-6.802 \text{ kip}) \times (0 \text{ ft}))}{(36 \text{ in})}$$

$$M_o = 28.949 \text{ kipft/ft}$$

E - Distance from lateral load to resisting surface,

$$E = \frac{M_o}{H_o}$$

$$E = \frac{(28.949 \text{ kipft/ft})}{(-2.2673 \text{ kip/ft})}$$

$$E = 12.768 \text{ ft}$$

a - Distance from resting surface to pivot point,

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

$$a = \frac{(4 \times (28.949 \text{ kipft/ft}) \times (15 \text{ ft})) + (3 \times (-2.2673 \text{ kip/ft}) \times (15 \text{ ft})^2)}{(6 \times (28.949 \text{ kipft/ft})) + (4 \times (-2.2673 \text{ kip/ft}) \times (15 \text{ ft}))}$$

$$a = 10.549 \text{ ft}$$

V_{max} - Max shear force located at depth a ,

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

$$V_{max} = ((-2.2673 \text{ kip/ft}) \times (36 \text{ in})) \times \left[1 - \left[3 \times \left(\frac{4 \times (12.768 \text{ ft})}{(15 \text{ ft})} + 3 \right) \times \left(\frac{(10.549 \text{ ft})}{(15 \text{ ft})} \right)^2 + 4 \times \left(\frac{3 \times (12.768 \text{ ft})}{(15 \text{ ft})} + 2 \right) \times \left(\frac{(10.549 \text{ ft})}{(15 \text{ ft})} \right)^3 \right] \right]$$

	$V_{max} = 14.745 \text{ kip}$ M_{max} - Max bending moment located at depth $a/2$, $M_{max} = (H_o D L_e) \left[\left(\frac{E}{L_e} + \frac{a}{2 L_e} \right) - \left[\left(\frac{4E}{L_e} + 3 \right) \left(\frac{a}{2 L_e} \right)^3 \right] + \left[\left(\frac{3E}{L_e} + 2 \right) \left(\frac{a}{2 L_e} \right)^4 \right] \right]$ $M_{max} = ((-2.2673 \text{ kip/ft}) \times (36 \text{ in}) \times (15 \text{ ft})) \times \left[\left(\frac{(12.768 \text{ ft})}{(15 \text{ ft})} + \frac{(10.549 \text{ ft})}{2 \times (15 \text{ ft})} \right) - \left[\left(\frac{4 \times (12.768 \text{ ft})}{(15 \text{ ft})} + 3 \right) \times \left(\frac{(10.549 \text{ ft})}{2 \times (15 \text{ ft})} \right)^3 \right] + \left[\left(\frac{3 \times (12.768 \text{ ft})}{(15 \text{ ft})} + 2 \right) \times \left(\frac{(10.549 \text{ ft})}{2 \times (15 \text{ ft})} \right)^4 \right] \right]$ $M_{max} = 101.42 \text{ kipft}$	
	Shear force and Bending moment (z-direction, LRFD) H_o - Lateral force per length of pile, $H_o = \frac{V_z}{D}$ $H_o = \frac{(-0.012 \text{ kip})}{(36 \text{ in})}$ $H_o = -0.004 \text{ kip/ft}$ M_o - Moment per length of pile, $M_o = \frac{M_x + (V_z H)}{D}$ $M_o = \frac{(0.047 \text{ kipft}) + ((-0.012 \text{ kip}) \times (0 \text{ ft}))}{(36 \text{ in})}$ $M_o = 0.015667 \text{ kipft/ft}$ E - Distance from lateral load to resisting surface, $E = \frac{M_o}{H_o}$ $E = \frac{(0.015667 \text{ kipft/ft})}{(-0.004 \text{ kip/ft})}$ $E = 3.9167 \text{ ft}$ a - Distance from resting surface to pivot point, $a = \frac{(4 M_o L_e) + (3 H_o L_e^2)}{(6 M_o) + (4 H_o L_e)}$ $a = \frac{(4 \times (0.015667 \text{ kipft/ft}) \times (15 \text{ ft})) + (3 \times (-0.004 \text{ kip/ft}) \times (15 \text{ ft})^2)}{(6 \times (0.015667 \text{ kipft/ft})) + (4 \times (-0.004 \text{ kip/ft}) \times (15 \text{ ft}))}$ $a = 10.898 \text{ ft}$ V_{max} - Max shear force located at depth a, $V_{max} = (H_o b) \left[1 - \left[3 \left(\frac{4E}{L_e} + 3 \right) \left(\frac{a}{L_e} \right)^2 \right] + \left[4 \left(\frac{3E}{L_e} + 2 \right) \left(\frac{a}{L_e} \right)^3 \right] \right]$ $V_{max} = ((-0.004 \text{ kip/ft}) \times (36 \text{ in})) \times \left[1 - \left[3 \times \left(\frac{4 \times (3.9167 \text{ ft})}{(15 \text{ ft})} + 3 \right) \times \left(\frac{(10.898 \text{ ft})}{(15 \text{ ft})} \right)^2 \right] + \left[4 \times \left(\frac{3 \times (3.9167 \text{ ft})}{(15 \text{ ft})} + 2 \right) \times \left(\frac{(10.898 \text{ ft})}{(15 \text{ ft})} \right)^3 \right] \right]$ $V_{max} = 0.013619 \text{ kip}$ M_{max} - Max bending moment located at depth $a/2$, $M_{max} = (H_o b L_e) \left[\left(\frac{E}{L_e} + \frac{a}{2 L_e} \right) - \left[\left(\frac{4E}{L_e} + 3 \right) \left(\frac{a}{2 L_e} \right)^3 \right] + \left[\left(\frac{3E}{L_e} + 2 \right) \left(\frac{a}{2 L_e} \right)^4 \right] \right]$ $M_{max} = ((-0.004 \text{ kip/ft}) \times (36 \text{ in}) \times (15 \text{ ft})) \times \left[\left(\frac{(3.9167 \text{ ft})}{(15 \text{ ft})} + \frac{(10.898 \text{ ft})}{2 \times (15 \text{ ft})} \right) - \left[\left(\frac{4 \times (3.9167 \text{ ft})}{(15 \text{ ft})} + 3 \right) \times \left(\frac{(10.898 \text{ ft})}{2 \times (15 \text{ ft})} \right)^3 \right] + \left[\left(\frac{3 \times (3.9167 \text{ ft})}{(15 \text{ ft})} + 2 \right) \times \left(\frac{(10.898 \text{ ft})}{2 \times (15 \text{ ft})} \right)^4 \right] \right]$	

		$M_{max} = 0.086214 \text{ kipft}$	
		Minimum Reinforcement Check (LRFD) Parameters: $f'_{ck} = 2.5 \text{ ksi}$ - Concrete strength, $f_{yk} = 60 \text{ ksi}$ - Longitudinal reinforcement strength, $\phi = 0.65$ - Reduction factor for axial strength, $\alpha = 0.85$ - Alpha factor for axial strength, $A_g = 1017.9 \text{ in}^2$ - Gross area of concrete, Longitudinal reinforcement: Required reinforcement due to axial load, $A_{st,required}$ $A_{st,required}$ $A_{st,required} = \text{Min} \left[\frac{\frac{P}{\phi \alpha} - (0.85 f'_{ck} A_g)}{f_{yk} - (0.85 f'_{ck})}, (0.08 A_g) \right]$ $A_{st,required} = \text{Min} \left[\frac{\frac{(7.41 \text{ kip})}{(0.65) \times (0.85)} - (0.85 \times (2.5 \text{ ksi}) \times (1017.9 \text{ in}^2))}{(60 \text{ ksi}) - (0.85 \times (2.5 \text{ ksi}))}, (0.08 \times (1017.9 \text{ in}^2)) \right]$ $A_{st,required} = -37.142 \text{ in}^2$ A_{min} - Governing minimum reinforcement area, $A_{min} = \text{Max} [A_{st,required}, (0.0018 A_g)]$ $A_{min} = \text{Max} [(-37.142 \text{ in}^2), (0.0018 \times (1017.9 \text{ in}^2))]$ $A_{min} = 1.8322 \text{ in}^2$ n_{rebar} - Required number of reinforcement, $n_{rebar} = \frac{A_{min}}{A_{rebar}}$ $n_{rebar} = \frac{(1.8322 \text{ in}^2)}{(0.3068 \text{ in}^2)}$ $n_{rebar} = 6$ A_{st} - Actual total reinforcement area, $A_{st} = n_{rebar} \frac{\pi d_{bar}^2}{4}$ $A_{st} = (6) \times \frac{\pi \times (0.625 \text{ in})^2}{4}$ $A_{st} = 1.8408 \text{ in}^2$ Ratio - Capacity $\text{Ratio} = \frac{A_{min}}{A_{st}}$ $\text{Ratio} = \frac{(1.8322 \text{ in}^2)}{(1.8408 \text{ in}^2)}$ $\text{Ratio} = 0.99533$ 25.2.3 s_{rebar} - Minimum spacing of reinforcement, $s_{rebar} = \text{Max} [1.5, (1.5 d_{bar})]$ $s_{rebar} = \text{Max} [1.5, (1.5 \times (0.625 \text{ in}))]$ $s_{rebar} = 1.5 \text{ in}$ Ties: 25.7.2.2 Since longitudinal reinforcement is $\leq \text{No. } 10\phi$: Use #3(0.375 in) 25.7.2.1 s_{ties} - Maximum center-to-center spacing of ties, $s_{ties} = \text{Min} [(16 d_{bar}), (48 d_{ties}), D]$ $s_{ties} = \text{Min} [(16 \times (0.625 \text{ in})), (48 \times (0.375 \text{ in})), (36 \text{ in})]$ $s_{ties} = 10 \text{ in}$ Summary:	Status: PASS Ratio: 1.000

	Main reinforcement: 6 - #5 (0.625 in) Ties: #3(0.375 in) - 10 in	
22.4.2.2	Axial Compression Strength (ACI 318-19, LRFD) ϕP_N - Allowable axial compressive strength $\phi P_N = \phi 0.85 \left[(0.85 f'_{ck} [A_g - A_{st}]) + (f_{yk} A_{st}) \right]$ $\phi P_N = (0.65) \times 0.85 \times \left[(0.85 \times (2.5 \text{ ksi}) \times [(1017.9 \text{ in}^2) - (1.8408 \text{ in}^2)]) + ((60 \text{ ksi}) \times (1.8408 \text{ in}^2)) \right]$ $\phi P_N = 1253.9 \text{ kip}$ Ratio - Capacity $Ratio = \frac{P}{\phi P_N}$ $Ratio = \frac{(7.41 \text{ kip})}{(1253.9 \text{ kip})}$ $Ratio = 0.0059095$	Status: PASS Ratio: 0.010
22.5.2.2	Shear Strength (ACI 318-19, LRFD) Parameters: $b_w = 36 \text{ in}$ - Effective width, d - Effective depth $d = 0.80 D$ $d = 0.80 \times (36 \text{ in})$ $d = 28.8 \text{ in}$	
22.5.5.1.3	λ_s - size effect modification factor $\lambda_s = MIN \left[\sqrt{\frac{2}{1 + \frac{d}{10}}}, 1 \right]$ $\lambda_s = MIN \left[\sqrt{\frac{2}{1 + \frac{(28.8 \text{ in})}{10}}}, 1 \right]$ $\lambda_s = 0.71796$	
22.5.5.1.1	The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $V_{c,max}$ - Max shear strength of concrete $V_{c,max} = 5 \lambda_s \sqrt{f'_{ck}} b_w d$ $V_{c,max} = 5 \times (0.71796) \times \sqrt{(2500 \text{ psi})} \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{c,max} = 186.09 \text{ kip}$	
22.5.5.1.1(a)	The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $P = 7.41 \text{ kip} \rightarrow 7410 \text{ lbf}$, $V_{c,a}$ - Shear strength of concrete (a) $V_{c,a} = \left[2 \lambda_s \sqrt{f'_{ck}} + \frac{P}{6 A_g} \right] b_w d$ $V_{c,a} = \left[2 \times (0.71796) \times \sqrt{(2500 \text{ psi})} + \frac{(7410 \text{ lbf})}{6 \times (1017.9 \text{ in}^2)} \right] \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{c,a} = 75.696 \text{ kip}$	
22.5.5.1.2	The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $V_{c,b}$ - Shear strength of concrete (b) $V_{c,b} = \left[2 \lambda_s \sqrt{f'_{ck}} + (0.05 f'_{ck}) \right] b_w d$ $V_{c,b} = \left[2 \times (0.71796) \times \sqrt{(2500 \text{ psi})} + (0.05 \times (2500 \text{ psi})) \right] \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{c,b} = 204.04 \text{ kip}$ V_c - Governing shear strength of concrete $V_c = MIN [V_{c,max}, V_{c,a}, V_{c,b}]$ $V_c = MIN [(186.09 \text{ kip}), (75.696 \text{ kip}), (204.04 \text{ kip})]$	

	$V_c = 75.696 \text{ kip}$ The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, 22.5.1.2 $V_{s,a}$ - Shear strength of steel (a) $V_{s,a} = 8 \sqrt{f'_{ck}} b_w d$ $V_{s,a} = 8 \times \sqrt{(2500 \text{ psi})} \times (36 \text{ in}) \times (28.8 \text{ in})$ $V_{s,a} = 414.72 \text{ kip}$ A_v - Ties rebar area, $A_v = \frac{\pi d_{ties}^2}{4}$ $A_v = \frac{\pi \times (0.375 \text{ in})^2}{4}$ $A_v = 0.11045 \text{ in}^2$ 22.5.8.5.3 $V_{s,b}$ - Shear strength of steel (b) $V_{s,b} = \frac{2 A_v f_{yw} d}{s_{ties}}$ $V_{s,b} = \frac{2 \times (0.11045 \text{ in}^2) \times (60 \text{ ksi}) \times (28.8 \text{ in})}{(10 \text{ in})}$ $V_{s,b} = 38.17 \text{ kip}$ V_s - Governing shear strength of steel $V_s = MIN[V_{s,a}, V_{s,b}]$ $V_s = MIN[(414.72 \text{ kip}), (38.17 \text{ kip})]$ $V_s = 38.17 \text{ kip}$ 22.5.1.1 ϕV_n - Allowable shear strength $\phi V_n = \phi (V_c + V_s)$ $\phi V_n = (0.65) \times ((75.696 \text{ kip}) + (38.17 \text{ kip}))$ $\phi V_n = 74.013 \text{ kip}$ Considering x-direction: $V_{max} = 14.745 \text{ kip}$ - Maximum shear force in the x-direction, <i>Ratio</i> - Capacity $Ratio = \frac{V_{max}}{\phi V_n}$ $Ratio = \frac{(14.745 \text{ kip})}{(74.013 \text{ kip})}$ $Ratio = 0.19922$ Considering z-direction: $V_{max} = 0.013619 \text{ kip}$ - Maximum shear force in the z-direction, <i>Ratio</i> - Capacity $Ratio = \frac{V_{max}}{\phi V_n}$ $Ratio = \frac{(0.013619 \text{ kip})}{(74.013 \text{ kip})}$ $Ratio = 0.00018401$	Status: PASS Ratio: 0.200 Status: PASS Ratio: 0.000
	Flexural Strength (ACI 318-19, LRFD) S_m - Section modulus $S_m = \frac{\pi D^3}{32}$ $S_m = \frac{\pi \times (36 \text{ in})^3}{32}$	

14.5.2.1b	$S_m = 4580.4 \text{ in}^3$ $\lambda = 1$ - Concrete modification factor (Normal concrete), Allowable flexural strength: M_n shall be the lesser of: $\phi M_{n,1}$ $\phi M_{n,1} = \phi \times 5 \times \lambda \times \sqrt{f'_c} \times S_m$ $\phi M_{n,1} = 0.65 \times 5 \times 1 \times \sqrt{(2.5 \text{ ksi})} \times 4580.442 \text{ in}^3$ $\phi M_{n,1} = 62.027 \text{ kipft}$ $\phi M_{n,2}$ $\phi M_{n,2} = \phi \times 0.85 \times f'_c \times S_m$ $\phi M_{n,2} = (0.65) \times 0.85 \times (2.5 \text{ ksi}) \times (4580.4 \text{ in}^3)$ $\phi M_{n,2} = 527.23 \text{ kipft}$ Therefore, ϕM_n - Allowable flexural strength, $\phi M_n = \text{MIN}[\phi M_{n,1}, \phi M_{n,2}]$ $\phi M_n = \text{MIN}[(62.027 \text{ kipft}), (527.23 \text{ kipft})]$ $\phi M_n = 62.027 \text{ kipft}$ Considering x-direction: $M_{max} = 101.42 \text{ kipft}$ - Maximum moment in the x-direction, Ratio - Capacity $\text{Ratio} = \frac{M_{max}}{\phi M_n}$ $\text{Ratio} = \frac{(101.42 \text{ kipft})}{(62.027 \text{ kipft})}$ $\text{Ratio} = 1.635$	Status: FAIL Ratio: 1.640
	Considering z-direction: $M_{max} = 0.086214 \text{ kipft}$ - Maximum moment in the z-direction, Ratio - Capacity $\text{Ratio} = \frac{M_{max}}{\phi M_n}$ $\text{Ratio} = \frac{(0.086214 \text{ kipft})}{(62.027 \text{ kipft})}$ $\text{Ratio} = 0.0013899$	Status: PASS Ratio: 0.000