Sabre Industries™
INNOVATION DELIVERED

Structural Design Report

190' Monopole

Site: TI-OPP-16496/RED HILL CHURCH, NC

Prepared for: TILLMAN INFRASTRUCTURE, LLC
by: Sabre Industries ™

Job Number: 21-1791-TJH

August 24, 2020

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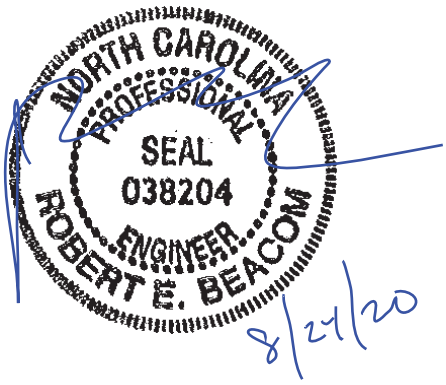
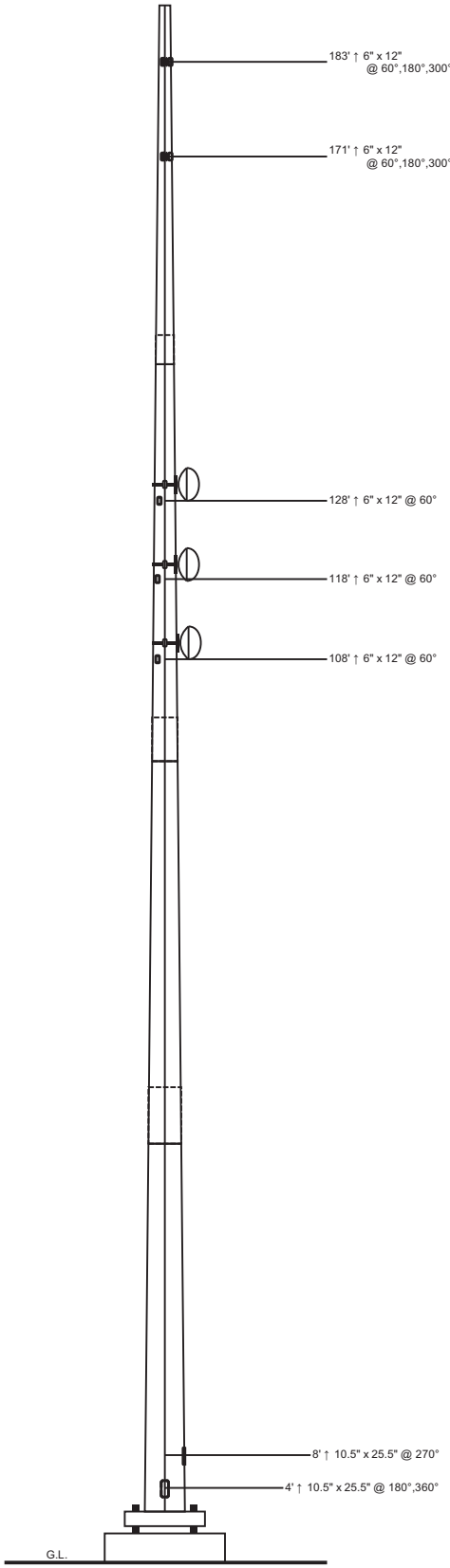


Digitally Signed By Robert Beacom
DN: c=US, st=Texas, l=Alvarado, o=SABRE INDUSTRIES, INC., cn=Robert Beacom, email=rebeacom@sabreindustries.com Date: 2020.08.24 15:44:11

Length (ft)	45'-0"	53'-6"	53'-6"	53'-3"
Number Of Sides	18			
Thickness (in)	5/16"	3/8"	7/16"	
Lap Splice (ft)	A	5' - 6"	7' - 0"	
Top Diameter (in)	16"	25.68"	36.92"	47.66"
Bottom Diameter (in)	27.24"	39.04"	50.28"	60.96"
Taper (in/ft)	0.2498			
Grade	A572-65			
Weight (lbs)	3600	7434	11563	16168
Overall Steel Height (ft)	189			



Designed Appurtenance Loading

Elev	Description	Tx-Line
185	(1) 278 sq. ft. EPA 6000# (no Ice)	(9) 1 1/4"
173	(1) 208 sq. ft. EPA 4000# (no ice)	(9) 1 1/4"
130	(1) Dish Mount (Monopole Only) - Pipe Mount (up to 6' Dish)	
130	(1) 4' Solid Dish w/ Radome	(1) 1 1/4"
120	(1) Dish Mount (Monopole Only) - Pipe Mount (up to 6' Dish)	
120	(1) 4' Solid Dish w/ Radome	(1) 1 1/4"
110	(1) Dish Mount (Monopole Only) - Pipe Mount (up to 6' Dish)	
110	(1) 4' Solid Dish w/ Radome	(1) 1 1/4"

Design Criteria - ANSI/TIA-222-G

ASCE 7-16 Ultimate Wind Speed (No Ice)	119 mph
Wind Speed (Ice)	30 mph
Design Ice Thickness	1.50 in
Structure Class	II
Risk Category	II
Exposure Category	C
Topographic Category	1

Load Case Reactions

Description	Axial (kips)	Shear (kips)	Moment (ft-k)	Deflection (ft)	Sway (deg)
3s Gusted Wind	56.77	43.64	6480.73	20.75	13.69
3s Gusted Wind 0.9 Dead	42.68	43.58	6352.88	20.22	13.3
3s Gusted Wind&Ice	90.32	5.97	989.12	3.48	2.28
Service Loads	47.39	10.36	1542.62	5.15	3.33

Base Plate Dimensions

Shape	Diameter	Thickness	Bolt Circle	Bolt Qty	Bolt Diameter
Round	73.75"	2.25"	68"	20	2.25"

Anchor Bolt Dimensions

Length	Diameter	Hole Diameter	Weight	Type	Finish
84"	2.25"	2.625"	2422	A615-75	Galv

Material List

Display	Value
A	3' - 9"

Notes

1) Antenna Feed Lines Run Inside Pole
2) All dimensions are above ground level, unless otherwise specified.
3) Weights shown are estimates. Final weights may vary.
4) Full Height Step Bolts
5) This tower design and, if applicable, the foundation design(s) shown on the following page(s) also meet or exceed the requirements of the 2015 International Building Code.
6) Tower Rating: 99.1%

Sabre Industries
INNOVATION DELIVERED

Sabre Industries
7101 Southbridge Drive
P.O. Box 658
Sioux City, IA 51102-0658
Phone: (712) 258-6690
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Job:	**21-1791-TJH**
Customer:	TILLMAN INFRASTRUCTURE, LLC
Site Name:	TI-OPP-16496/RED HILL CHURCH, NC
Description:	190' Monopole
Date:	8/24/2020 By: DO

No.: 21-1791-TJH
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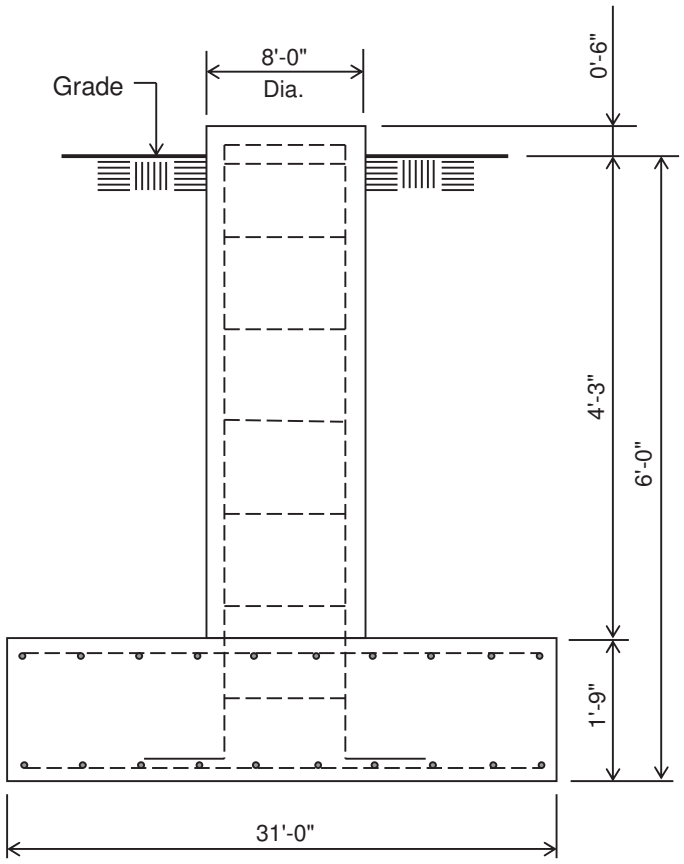
Site: TI-OPP-16496/RED HILL CHURCH, NC
190' Monopole



ELEVATION VIEW
(71.13 Cu. Yds.)
(1 REQUIRED; NOT TO SCALE)

Notes:

1) Concrete shall have a minimum 28-day compressive strength of 4,500 psi, in accordance with ACI 318-11.

2) Rebar to conform to ASTM specification A615 Grade 60.

3) All rebar to have a minimum of 3" concrete cover.

4) All exposed concrete corners to be chamfered 3/4".

5) The foundation design is based on the geotechnical report by ECA Project No: W3413, Date:08/14/20

6) See the geotechnical report for compaction requirements, if specified.

7) 4.25 ft of soil cover is required over the entire area of the foundation slab.

8) The foundation is based on the following factored loads:
   Moment = 6,480.73 k-ft
   Axial = 56.77 k
   Shear = 43.64 k

9) This foundation is designed for an increase in base reactions of 10%.

Rebar Schedule for Pad and Pier	
Pier	(50) #8 vertical rebar w/ hooks at bottom w/ #5 ties, (2) within top 5" of pier, then 12" C/C
Pad	(71) #8 horizontal rebar evenly spaced each way top and bottom (284 total)

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Customer: TILLMAN INFRASTRUCTURE, LLC
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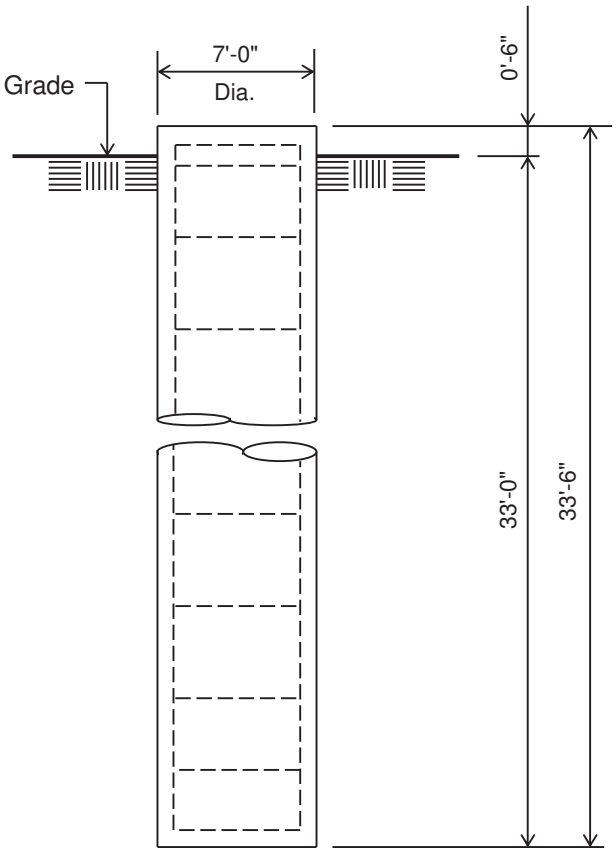
190’ Monopole



ELEVATION VIEW
(47.75 Cu. Yds.)
(1 REQUIRED; NOT TO SCALE)

Notes:

1) Concrete shall have a minimum 28-day compressive strength of 4,500 psi, in accordance with ACI 318-11.

2) Rebar to conform to ASTM specification A615 Grade 60.

3) All rebar to have a minimum of 3” concrete cover.

4) All exposed concrete corners to be chamfered 3/4”.

5) The foundation design is based on the geotechnical report by ECA Project No: W3413, Date:08/14/20

6) See the geotechnical report for drilled pier installation requirements, if specified.

7) The foundation is based on the following factored loads:
   Moment = 6,480.73 k-ft
   Axial = 56.77 k
   Shear = 43.64 k

8) This foundation is designed for an increase in base reactions of 10%.

Rebar Schedule for Pier	
Pier	(46) #10 vertical rebar w/ #5 ties, (2) within top 5" of pier, then 8" C/C

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190' Monopole / TI-OPP-16496/RED HILL CHURCH, NC

* All pole diameters shown on the following pages are across corners.
See profile drawing for widths across flats.

POLE GEOMETRY

ELEV ft	SECTION NAME	No. SIDE	OUTSIDE DIAM in	THICK -NESS in	RESISTANCES ϕ*Pn kip	ϕ*Mn ft-kip	SPLICE TYPE	...OVERLAP... LENGTH ft	RATIO	w/t
189.0										
			16.25	0.312	1156.0	368.7				
	A	18								7.3
			26.70	0.312	1914.6	1019.1				
147.7										
			26.70	0.312	1914.6	1019.1				
	A/B	18					SLIP	3.75	1.69	
			27.04	0.375	2321.3	1245.6				
144.0										
			27.04	0.375	2321.3	1245.6				
	B	18								10.8
			38.24	0.375	3296.9	2522.9				
99.7										
			38.24	0.375	3296.9	2522.9				
	B/C	18					SLIP	5.50	1.72	
			38.90	0.438	3906.7	3032.0				
94.2										
			38.90	0.438	3906.7	3032.0				
	C	18								13.7
			49.27	0.438	4835.9	4777.3				
53.2										
			49.27	0.438	4835.9	4777.3				
	C/D	18					SLIP	7.00	1.70	
			50.19	0.438	4900.3	4932.3				
46.2										
			50.19	0.438	4900.3	4932.3				
	D	18								18.2
			61.90	0.438	5641.0	7027.0				
0.0										

POLE ASSEMBLY

SECTION NAME	BASE ELEV ft	.....BOLTS AT BASE OF SECTION..... NUMBER	TYPE	DIAM in	STRENGTH ksi	THREADS IN SHEAR PLANE	CALC BASE ELEV ft
A	144.000	0	A325	0.00	92.0	0	144.000
B	94.250	0	A325	0.00	92.0	0	94.250
C	46.250	0	A325	0.00	92.0	0	46.250
D	0.000	0	A325	0.00	92.0	0	0.000

POLE SECTIONS

SECTION NAME	No.of SIDES	LENGTH ft	OUTSIDE.DIAMETER BOT * in	TOP * in	BEND RAD in	MAT-ERIAL ID	FLANGE.ID BOT	TOP	FLANGE.WELD ..GROUP.ID.. BOT	TOP
A	18	45.00	27.66	16.25	0.000	1	0	0	0	0
B	18	53.50	39.65	26.08	0.000	2	0	0	0	0
C	18	53.50	51.06	37.49	0.000	3	0	0	0	0
D	18	53.25	61.90	48.40	0.000	4	0	0	0	0

* - Diameter of circumscribed circle

MATERIAL TYPES
==============

TYPE OF SHAPE	TYPE NO	NO OF ELEM.	ORIENT &	HEIGHT	WIDTH	.THICKNESS. WEB	FLANGE	IRREGULARITY .PROJECTION. % OF AREA	ORIENT
			deg	in	in	in	in		deg
PL	1	1	0.0	27.66	0.31	0.312	0.312	0.00	0.0
PL	2	1	0.0	39.65	0.38	0.375	0.375	0.00	0.0
PL	3	1	0.0	51.06	0.44	0.438	0.438	0.00	0.0
PL	4	1	0.0	61.90	0.44	0.438	0.438	0.00	0.0

& - With respect to vertical

MATERIAL PROPERTIES
==================

MATERIAL TYPE NO.	ELASTIC MODULUS ksi	UNIT WEIGHT pcf	.. STRENGTH .. Fu ksi	Fy ksi	THERMAL COEFFICIENT /deg
1	29000.0	490.0	80.0	65.0	0.00001170
2	29000.0	490.0	80.0	65.0	0.00001170
3	29000.0	490.0	80.0	65.0	0.00001170
4	29000.0	490.0	80.0	65.0	0.00001170

* Only 3 condition(s) shown in full
* Some concentrated wind loads may have been derived from full-scale wind tunnel testing

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LOADING CONDITION A ==========

119 mph Ultimate wind with no ice. Wind Azimuth: 0♦

LOADS ON POLE
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LOAD TYPE	ELEV ft	APPLY..LOAD..AT RADIUS ft	AZI	LOAD AZI	.....FORCES..... HORIZ kip	DOWN kip	.....MOMENTS..... VERTICAL ft-kip	TORSNAL ft-kip
C	184.000	0.00	0.0	0.0	0.0000	1.3116	0.0000	0.0000
C	184.000	0.00	0.0	0.0	14.5093	7.2000	0.0000	0.0000
C	172.000	0.00	0.0	0.0	0.0000	1.2260	0.0000	0.0000
C	172.000	0.00	0.0	0.0	10.7037	4.8000	0.0000	0.0000
C	129.000	0.00	0.0	0.0	0.0000	0.1022	0.0000	0.0000
C	119.000	0.00	0.0	0.0	0.0000	0.0942	0.0000	0.0000
C	109.000	0.00	0.0	0.0	0.0000	0.0863	0.0000	0.0000
D	189.000	0.00	180.0	0.0	0.0508	0.0707	0.0000	0.0000
D	175.250	0.00	180.0	0.0	0.0508	0.0707	0.0000	0.0000
D	175.250	0.00	180.0	0.0	0.0596	0.0844	0.0000	0.0000
D	161.500	0.00	180.0	0.0	0.0596	0.0844	0.0000	0.0000
D	161.500	0.00	180.0	0.0	0.0681	0.0982	0.0000	0.0000
D	147.750	0.00	180.0	0.0	0.0681	0.0982	0.0000	0.0000
D	147.750	0.00	180.0	0.0	0.0732	0.2325	0.0000	0.0000
D	144.000	0.00	180.0	0.0	0.0732	0.2325	0.0000	0.0000
D	144.000	0.00	180.0	0.0	0.0768	0.1367	0.0000	0.0000
D	129.250	0.00	180.0	0.0	0.0768	0.1367	0.0000	0.0000
D	129.250	0.00	180.0	0.0	0.0847	0.1544	0.0000	0.0000
D	114.500	0.00	180.0	0.0	0.0847	0.1544	0.0000	0.0000
D	114.500	0.00	180.0	0.0	0.0919	0.1721	0.0000	0.0000
D	99.750	0.00	180.0	0.0	0.0919	0.1721	0.0000	0.0000
D	99.750	0.00	180.0	0.0	0.0963	0.3954	0.0000	0.0000
D	94.250	0.00	180.0	0.0	0.0963	0.3954	0.0000	0.0000
D	94.250	0.00	180.0	0.0	0.0983	0.2246	0.0000	0.0000
D	80.583	0.00	180.0	0.0	0.0983	0.2246	0.0000	0.0000
D	80.583	0.00	180.0	0.0	0.1030	0.2437	0.0000	0.0000
D	66.917	0.00	180.0	0.0	0.1030	0.2437	0.0000	0.0000
D	66.917	0.00	180.0	0.0	0.1065	0.2629	0.0000	0.0000

D	53.250	0.00	180.0	0.0	0.1065	0.2629	0.0000	0.0000
D	53.250	0.00	180.0	0.0	0.1080	0.5504	0.0000	0.0000
D	46.250	0.00	180.0	0.0	0.1080	0.5504	0.0000	0.0000
D	46.250	0.00	180.0	0.0	0.1066	0.2861	0.0000	0.0000
D	34.687	0.00	180.0	0.0	0.1066	0.2861	0.0000	0.0000
D	34.687	0.00	180.0	0.0	0.1051	0.3023	0.0000	0.0000
D	23.125	0.00	180.0	0.0	0.1051	0.3023	0.0000	0.0000
D	23.125	0.00	180.0	0.0	0.0999	0.3185	0.0000	0.0000
D	0.000	0.00	180.0	0.0	0.1008	0.3348	0.0000	0.0000

ANTENNA LOADING

.....ANTENNA.....			ATTACHMENT		.....ANTENNA FORCES.....			
TYPE	ELEV	AZI	RAD	AZI	AXIAL	SHEAR	GRAVITY	TORSION
	ft		ft		kip	kip	kip	ft-kip
STD+R	109.0	0.0	2.2	0.0	0.51	0.00	0.16	0.00
STD+R	119.0	0.0	2.1	0.0	0.52	0.00	0.16	0.00
STD+R	129.0	0.0	2.0	0.0	0.53	0.00	0.16	0.00

LOADING CONDITION M

119 mph Ultimate wind with no ice. Wind Azimuth: 0◆

LOADS ON POLE

LOAD	ELEV	APPLY..LOAD..AT		LOAD	.....FORCES.....		.....MOMENTS.....	
TYPE		RADIUS	AZI	AZI	HORIZ	DOWN	VERTICAL	TORSNAL
	ft	ft			kip	kip	ft-kip	ft-kip
C	184.000	0.00	0.0	0.0	0.0000	0.9837	0.0000	0.0000
C	184.000	0.00	0.0	0.0	14.5093	5.4000	0.0000	0.0000
C	172.000	0.00	0.0	0.0	0.0000	0.9195	0.0000	0.0000
C	172.000	0.00	0.0	0.0	10.7037	3.6000	0.0000	0.0000
C	129.000	0.00	0.0	0.0	0.0000	0.0766	0.0000	0.0000
C	119.000	0.00	0.0	0.0	0.0000	0.0707	0.0000	0.0000
C	109.000	0.00	0.0	0.0	0.0000	0.0647	0.0000	0.0000
D	189.000	0.00	180.0	0.0	0.0508	0.0531	0.0000	0.0000
D	175.250	0.00	180.0	0.0	0.0508	0.0531	0.0000	0.0000
D	175.250	0.00	180.0	0.0	0.0596	0.0633	0.0000	0.0000
D	161.500	0.00	180.0	0.0	0.0596	0.0633	0.0000	0.0000
D	161.500	0.00	180.0	0.0	0.0681	0.0736	0.0000	0.0000
D	147.750	0.00	180.0	0.0	0.0681	0.0736	0.0000	0.0000
D	147.750	0.00	180.0	0.0	0.0732	0.1744	0.0000	0.0000
D	144.000	0.00	180.0	0.0	0.0732	0.1744	0.0000	0.0000
D	144.000	0.00	180.0	0.0	0.0768	0.1025	0.0000	0.0000
D	129.250	0.00	180.0	0.0	0.0768	0.1025	0.0000	0.0000
D	129.250	0.00	180.0	0.0	0.0847	0.1158	0.0000	0.0000
D	114.500	0.00	180.0	0.0	0.0847	0.1158	0.0000	0.0000
D	114.500	0.00	180.0	0.0	0.0919	0.1291	0.0000	0.0000
D	99.750	0.00	180.0	0.0	0.0919	0.1291	0.0000	0.0000
D	99.750	0.00	180.0	0.0	0.0963	0.2966	0.0000	0.0000
D	94.250	0.00	180.0	0.0	0.0963	0.2966	0.0000	0.0000
D	94.250	0.00	180.0	0.0	0.0983	0.1684	0.0000	0.0000
D	80.583	0.00	180.0	0.0	0.0983	0.1684	0.0000	0.0000
D	80.583	0.00	180.0	0.0	0.1030	0.1828	0.0000	0.0000
D	66.917	0.00	180.0	0.0	0.1030	0.1828	0.0000	0.0000
D	66.917	0.00	180.0	0.0	0.1065	0.1972	0.0000	0.0000
D	53.250	0.00	180.0	0.0	0.1065	0.1972	0.0000	0.0000
D	53.250	0.00	180.0	0.0	0.1080	0.4128	0.0000	0.0000
D	46.250	0.00	180.0	0.0	0.1080	0.4128	0.0000	0.0000
D	46.250	0.00	180.0	0.0	0.1066	0.2145	0.0000	0.0000
D	34.687	0.00	180.0	0.0	0.1066	0.2145	0.0000	0.0000
D	34.687	0.00	180.0	0.0	0.1051	0.2267	0.0000	0.0000
D	23.125	0.00	180.0	0.0	0.1051	0.2267	0.0000	0.0000
D	23.125	0.00	180.0	0.0	0.0999	0.2389	0.0000	0.0000
D	0.000	0.00	180.0	0.0	0.1008	0.2511	0.0000	0.0000

ANTENNA LOADING

.....ANTENNA.....			ATTACHMENT		.....ANTENNA FORCES.....			
TYPE	ELEV	AZI	RAD	AZI	AXIAL	SHEAR	GRAVITY	TORSION
	ft		ft		kip	kip	kip	ft-kip

STD+R	109.0	0.0	2.2	0.0	0.51	0.00	0.12	0.00
STD+R	119.0	0.0	2.1	0.0	0.52	0.00	0.12	0.00
STD+R	129.0	0.0	2.0	0.0	0.53	0.00	0.12	0.00

LOADING CONDITION Y

30 mph wind with 1.5 ice. Wind Azimuth: 0◆

LOADS ON POLE

LOAD TYPE	ELEV ft	APPLY..LOAD..AT RADIUS ft	AZI	LOAD AZI	.....FORCES..... HORIZ kip	DOWN kip	.....MOMENTS..... VERTICAL ft-kip	TORSNAL ft-kip
C	184.000	0.00	0.0	0.0	0.0000	1.3116	0.0000	0.0000
C	184.000	0.00	0.0	0.0	1.6566	17.8932	0.0000	0.0000
C	172.000	0.00	0.0	0.0	0.0000	1.2260	0.0000	0.0000
C	172.000	0.00	0.0	0.0	1.9706	11.8812	0.0000	0.0000
C	129.000	0.00	0.0	0.0	0.0000	0.1022	0.0000	0.0000
C	119.000	0.00	0.0	0.0	0.0000	0.0942	0.0000	0.0000
C	109.000	0.00	0.0	0.0	0.0000	0.0863	0.0000	0.0000
D	189.000	0.00	180.0	0.0	0.0075	0.1137	0.0000	0.0000
D	175.250	0.00	180.0	0.0	0.0075	0.1137	0.0000	0.0000
D	175.250	0.00	180.0	0.0	0.0085	0.1346	0.0000	0.0000
D	161.500	0.00	180.0	0.0	0.0085	0.1346	0.0000	0.0000
D	161.500	0.00	180.0	0.0	0.0095	0.1553	0.0000	0.0000
D	147.750	0.00	180.0	0.0	0.0095	0.1553	0.0000	0.0000
D	147.750	0.00	180.0	0.0	0.0101	0.2941	0.0000	0.0000
D	144.000	0.00	180.0	0.0	0.0101	0.2941	0.0000	0.0000
D	144.000	0.00	180.0	0.0	0.0105	0.2015	0.0000	0.0000
D	129.250	0.00	180.0	0.0	0.0105	0.2015	0.0000	0.0000
D	129.250	0.00	180.0	0.0	0.0115	0.2262	0.0000	0.0000
D	114.500	0.00	180.0	0.0	0.0115	0.2262	0.0000	0.0000
D	114.500	0.00	180.0	0.0	0.0123	0.2507	0.0000	0.0000
D	99.750	0.00	180.0	0.0	0.0123	0.2507	0.0000	0.0000
D	99.750	0.00	180.0	0.0	0.0128	0.4784	0.0000	0.0000
D	94.250	0.00	180.0	0.0	0.0128	0.4784	0.0000	0.0000
D	94.250	0.00	180.0	0.0	0.0130	0.3101	0.0000	0.0000
D	80.583	0.00	180.0	0.0	0.0130	0.3101	0.0000	0.0000
D	80.583	0.00	180.0	0.0	0.0136	0.3346	0.0000	0.0000
D	66.917	0.00	180.0	0.0	0.0136	0.3346	0.0000	0.0000
D	66.917	0.00	180.0	0.0	0.0139	0.3587	0.0000	0.0000
D	53.250	0.00	180.0	0.0	0.0139	0.3587	0.0000	0.0000
D	53.250	0.00	180.0	0.0	0.0141	0.6494	0.0000	0.0000
D	46.250	0.00	180.0	0.0	0.0141	0.6494	0.0000	0.0000
D	46.250	0.00	180.0	0.0	0.0139	0.3861	0.0000	0.0000
D	11.562	0.00	180.0	0.0	0.0129	0.4207	0.0000	0.0000
D	11.562	0.00	180.0	0.0	0.0129	0.4313	0.0000	0.0000
D	0.000	0.00	180.0	0.0	0.0129	0.4313	0.0000	0.0000

ANTENNA LOADING

.....ANTENNA..... TYPE	ELEV ft	AZI	ATTACHMENT RAD ft	AZI	.....ANTENNA FORCES..... AXIAL kip	SHEAR kip	GRAVITY kip	TORSION ft-kip
STD+R	109.0	0.0	2.2	0.0	0.04	0.00	0.40	0.00
STD+R	119.0	0.0	2.1	0.0	0.04	0.00	0.40	0.00
STD+R	129.0	0.0	2.0	0.0	0.04	0.00	0.40	0.00

MAXIMUM POLE DEFORMATIONS CALCULATED(w.r.t. wind direction)

MAST ELEV ft	DEFLECTIONS (ft) HORIZONTAL ALONG	HORIZONTAL ACROSS	DOWN	ROTATIONS (deg) TILT ALONG	TILT ACROSS	TWIST
189.0	20.75B	-0.12F	3.38L	13.69B	-0.06F	-0.01U
175.2	17.65B	-0.11F	2.64B	13.47B	-0.06F	-0.01U
161.5	14.68B	-0.10F	1.97B	12.48B	-0.06F	-0.01U
147.7	11.97B	-0.08F	1.41B	11.00B	-0.06F	-0.01U
144.0	11.28B	-0.08F	1.28B	10.64B	-0.06F	-0.01U
129.2	8.81B	-0.06F	0.86B	9.10B	-0.06F	-0.01U
114.5	6.71B	-0.05F	0.55B	7.63B	-0.05F	-0.01U
99.7	4.95B	-0.04F	0.34L	6.25B	-0.05F	-0.01U
94.2	4.38B	-0.03F	0.28L	5.83B	-0.04F	-0.01U
80.6	3.12B	-0.02F	0.17L	4.78B	-0.04F	-0.01W
66.9	2.10B	-0.02F	0.09L	3.82B	-0.03F	0.00W
53.2	1.30B	-0.01F	0.04L	2.94B	-0.02F	0.00W
46.2	0.97B	-0.01F	0.03L	2.52B	-0.02F	0.00W
34.7	0.53B	0.00F	0.01L	1.82B	-0.01F	0.00W
23.1	0.23B	0.00F	0.00L	1.17B	-0.01F	0.00W
11.6	0.06B	0.00F	0.00B	0.57B	0.00F	0.00W
0.0	0.00A	0.00A	0.00A	0.00A	0.00A	0.00A

MAXIMUM ANTENNA AND REFLECTOR ROTATIONS

ELEV ft	ANT AZI deg	ANT TYPE	BEAM DEFLECTIONS (deg) ROLL	YAW	PITCH	TOTAL
129.0	0.0	STD+R	-8.990 J	0.627 B	9.024 A	9.024 A
119.0	0.0	STD+R	-7.990 J	0.496 B	8.026 A	8.026 A
109.0	0.0	STD+R	-7.028 J	0.385 B	7.065 A	7.065 A

MAXIMUM POLE FORCES CALCULATED(w.r.t. to wind direction)

MAST ELEV ft	TOTAL AXIAL kip	SHEAR.w.r.t.WIND.DIR ALONG kip	SHEAR.w.r.t.WIND.DIR ACROSS kip	MOMENT.w.r.t.WIND.DIR ALONG ft-kip	MOMENT.w.r.t.WIND.DIR ACROSS ft-kip	TORSION ft-kip
189.0	-0.01 J	0.00 G	0.00 B	-0.01 O	0.01 B	0.00 X
	20.77 AG	15.19 G	0.00 B	-142.92 L	0.06 L	0.11 L
175.2	20.77 AG	15.20 C	0.00 H	-142.91 L	-0.06 B	0.12 L
	35.73 AG	26.70 C	0.00 H	-497.28 A	0.25 L	0.39 L
161.5	35.72 Y	26.71 C	0.01 K	-497.27 A	0.24 L	0.39 L

	37.86 Y	27.63 C	0.01 K	-902.42 L	0.43 L	0.72 L
147.7						
	37.86 AJ	27.85 A	0.19 O	-902.37 L	-0.40 C	0.74 L
	38.97 AJ	28.12 A	0.19 O	-1016.16 A	0.78 L	0.75 L
144.0						
	38.97 AJ	28.13 B	-0.26 F	-1016.15 A	0.72 H	0.77 L
	41.94 AJ	29.24 B	-0.26 F	-1474.87 B	4.10 F	1.41 K
129.2						
	41.94 AJ	29.32 B	0.30 B	-1474.90 B	4.10 F	1.43 K
	46.27 AJ	31.60 B	0.38 C	-1963.48 B	8.92 F	-2.39 U
114.5						
	46.27 AJ	31.61 B	0.34 C	-1963.46 B	8.95 F	-2.39 U
	50.45 AJ	33.46 B	0.41 C	-2480.95 B	13.64 F	-3.48 U
99.7						
	50.45 Z	33.33 B	-0.39 F	-2481.18 B	13.52 F	-3.49 U
	53.08 Z	33.85 B	-0.39 F	-2679.75 B	15.67 F	-3.56 U
94.2						
	53.08 AJ	33.88 B	0.38 B	-2679.78 B	15.88 F	-3.55 U
	57.32 AJ	35.21 B	0.38 B	-3185.47 B	20.95 F	-3.79 U
80.6						
	57.32 Z	35.21 B	-0.38 F	-3185.42 B	20.96 F	-3.79 U
	61.89 Z	36.61 B	-0.38 F	-3707.19 B	26.22 F	-3.98 U
66.9						
	61.89 Z	36.60 B	-0.38 F	-3707.14 B	26.21 F	-3.98 U
	66.79 Z	38.05 B	-0.38 F	-4244.88 B	31.46 F	-4.23 W
53.2						
	66.79 Z	38.07 B	0.43 C	-4244.92 B	31.49 F	-4.23 W
	71.34 Z	38.83 B	0.43 C	-4526.93 B	34.30 F	-4.33 W
46.2						
	71.34 AJ	38.88 B	0.43 C	-4527.00 B	34.27 F	-4.33 W
	75.87 AJ	40.11 B	0.43 C	-5002.10 B	38.97 F	-4.46 W
34.7						
	75.87 AJ	40.11 B	0.43 C	-5002.12 B	38.96 F	-4.46 W
	80.53 AJ	41.33 B	0.43 C	-5486.79 B	43.70 F	-4.55 W
23.1						
	80.53 AJ	41.31 B	0.43 C	-5486.79 B	43.70 F	-4.55 W
	85.33 AJ	42.47 B	0.43 C	-5979.89 B	48.48 F	-4.60 W
11.6						
	85.33 AJ	42.47 B	0.43 C	-5979.88 B	48.48 F	-4.60 W
	90.32 AJ	43.64 B	0.43 C	-6480.73 B	53.24 F	-4.62 W
base reaction	90.32 AJ	-43.64 B	-0.43 C	6480.73 B	-53.24 F	4.62 W

COMPLIANCE WITH 4.8.2 & 4.5.4

ELEV ft	AXIAL	BENDING	SHEAR + TORSIONAL	TOTAL	SATISFIED	D/t(w/t)	MAX ALLOWED
189.00	0.00J	0.00X	0.00B	0.00X	YES	7.26A	45.2
	0.01AG	0.26L	0.02G	0.27L	YES	9.20A	45.2
175.25	0.01AG	0.26L	0.02C	0.27L	YES	9.20A	45.2
	0.02AG	0.65A	0.03C	0.66A	YES	11.14A	45.2
161.50	0.02Y	0.65A	0.03C	0.66A	YES	11.14A	45.2
	0.02Y	0.88L	0.03C	0.90A	YES	13.08A	45.2
147.75	0.02AJ	0.74L	0.02A	0.75L	YES	10.61A	45.2

	0.02AJ	0.78A	0.02A	0.79A	YES	11.05A	45.2
144.00	.....						
	0.02AJ	0.82A	0.02B	0.83A	YES	10.75A	45.2
	0.02AJ	0.91B	0.02B	0.92B	YES	12.48A	45.2
129.25	.....						
	0.02AJ	0.91B	0.02B	0.92B	YES	12.48A	45.2
	0.02AJ	0.96B	0.02B	0.97B	YES	14.22A	45.2
114.50	.....						
	0.02AJ	0.96B	0.02B	0.97B	YES	14.22A	45.2
	0.02AJ	0.98B	0.02B	0.99B	YES	15.95A	45.2
99.75	.....						
	0.01Z	0.85B	0.02B	0.85B	YES	13.42A	45.2
	0.01Z	0.85B	0.02B	0.86B	YES	13.97A	45.2
94.25	.....						
	0.01AJ	0.88B	0.02B	0.89B	YES	13.67A	45.2
	0.01AJ	0.88B	0.02B	0.89B	YES	15.05A	45.2
80.58	.....						
	0.01Z	0.88B	0.02B	0.89B	YES	15.05A	45.2
	0.01Z	0.88B	0.02B	0.89B	YES	16.42A	45.2
66.92	.....						
	0.01Z	0.88B	0.02B	0.89B	YES	16.42A	45.2
	0.01Z	0.89B	0.02B	0.90B	YES	17.80A	45.2
53.25	.....						
	0.01Z	0.89B	0.02B	0.90B	YES	17.80A	45.2
	0.01Z	0.89B	0.02B	0.90B	YES	18.50A	45.2
46.25	.....						
	0.01AJ	0.92B	0.02B	0.93B	YES	18.15A	45.2
	0.01AJ	0.92B	0.02B	0.93B	YES	19.31A	45.2
34.69	.....						
	0.01AJ	0.92B	0.02B	0.93B	YES	19.31A	45.2
	0.02AJ	0.92B	0.02B	0.93B	YES	20.48A	45.2
23.12	.....						
	0.02AJ	0.92B	0.02B	0.93B	YES	20.48A	45.2
	0.02AJ	0.92B	0.02B	0.93B	YES	21.64A	45.2
11.56	.....						
	0.02AJ	0.92B	0.02B	0.93B	YES	21.64A	45.2
	0.02AJ	0.92B	0.02B	0.93B	YES	22.81A	45.2
0.00	.....						

MAXIMUM LOADS ONTO FOUNDATION(w.r.t. wind direction)
==========

DOWN	SHEAR.w.r.t.WIND.DIR ALONG	ACROSS	MOMENT.w.r.t.WIND.DIR ALONG	ACROSS	TORSION
kip	kip	kip	ft-kip	ft-kip	ft-kip
90.32	43.64	0.43	-6480.73	53.24	-4.62
AJ	B	C	B	F	W

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190' Monopole / TI-OPP-16496/RED HILL CHURCH, NC

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********************************************************************************
*************************  Service Load Condition  *************************
********************************************************************************

* Only 1 condition(s) shown in full
* Some concentrated wind loads may have been derived from full-scale wind tunnel testing

 LOADING CONDITION  A    ======================================================

60 mph wind with no ice. Wind Azimuth: 0♦


 LOADS ON POLE
 =============

 LOAD       ELEV  APPLY..LOAD..AT   LOAD  .......FORCES......  ......MOMENTS.....
 TYPE             RADIUS    AZI     AZI     HORIZ       DOWN  VERTICAL   TORSNAL
                    ft        ft                kip        kip    ft-kip    ft-kip

 C       184.000      0.00    0.0     0.0    0.0000     1.0930    0.0000    0.0000
 C       184.000      0.00    0.0     0.0    3.4510     6.0000    0.0000    0.0000
 C       172.000      0.00    0.0     0.0    0.0000     1.0217    0.0000    0.0000
 C       172.000      0.00    0.0     0.0    2.5459     4.0000    0.0000    0.0000
 C       129.000      0.00    0.0     0.0    0.0000     0.0851    0.0000    0.0000
 C       119.000      0.00    0.0     0.0    0.0000     0.0785    0.0000    0.0000
 C       109.000      0.00    0.0     0.0    0.0000     0.0719    0.0000    0.0000

 D       189.000      0.00  180.0     0.0    0.0121     0.0589    0.0000    0.0000
 D       175.250      0.00  180.0     0.0    0.0121     0.0589    0.0000    0.0000
 D       175.250      0.00  180.0     0.0    0.0142     0.0704    0.0000    0.0000
 D       161.500      0.00  180.0     0.0    0.0142     0.0704    0.0000    0.0000
 D       161.500      0.00  180.0     0.0    0.0162     0.0818    0.0000    0.0000
 D       147.750      0.00  180.0     0.0    0.0162     0.0818    0.0000    0.0000
 D       147.750      0.00  180.0     0.0    0.0174     0.1938    0.0000    0.0000
 D       144.000      0.00  180.0     0.0    0.0174     0.1938    0.0000    0.0000
 D       144.000      0.00  180.0     0.0    0.0183     0.1139    0.0000    0.0000
 D       129.250      0.00  180.0     0.0    0.0183     0.1139    0.0000    0.0000
 D       129.250      0.00  180.0     0.0    0.0201     0.1287    0.0000    0.0000
 D       114.500      0.00  180.0     0.0    0.0201     0.1287    0.0000    0.0000
 D       114.500      0.00  180.0     0.0    0.0218     0.1434    0.0000    0.0000
 D        99.750      0.00  180.0     0.0    0.0218     0.1434    0.0000    0.0000
 D        99.750      0.00  180.0     0.0    0.0229     0.3295    0.0000    0.0000
 D        94.250      0.00  180.0     0.0    0.0229     0.3295    0.0000    0.0000
 D        94.250      0.00  180.0     0.0    0.0234     0.1871    0.0000    0.0000
 D        80.583      0.00  180.0     0.0    0.0234     0.1871    0.0000    0.0000
 D        80.583      0.00  180.0     0.0    0.0245     0.2031    0.0000    0.0000
 D        66.917      0.00  180.0     0.0    0.0245     0.2031    0.0000    0.0000
 D        66.917      0.00  180.0     0.0    0.0253     0.2191    0.0000    0.0000
 D        53.250      0.00  180.0     0.0    0.0253     0.2191    0.0000    0.0000
 D        53.250      0.00  180.0     0.0    0.0257     0.4587    0.0000    0.0000
 D        46.250      0.00  180.0     0.0    0.0257     0.4587    0.0000    0.0000
 D        46.250      0.00  180.0     0.0    0.0253     0.2384    0.0000    0.0000
 D        34.687      0.00  180.0     0.0    0.0253     0.2384    0.0000    0.0000
 D        34.687      0.00  180.0     0.0    0.0250     0.2519    0.0000    0.0000
 D        23.125      0.00  180.0     0.0    0.0250     0.2519    0.0000    0.0000
 D        23.125      0.00  180.0     0.0    0.0238     0.2655    0.0000    0.0000
 D         0.000      0.00  180.0     0.0    0.0240     0.2790    0.0000    0.0000

 ANTENNA LOADING
 ===============

 .......ANTENNA.................  ATTACHMENT   ...........ANTENNA FORCES......
 TYPE                    ELEV   AZI  RAD    AZI   AXIAL    SHEAR  GRAVITY  TORSION
                           ft         ft            kip      kip      kip   ft-kip

 STD+R                  109.0   0.0  2.2    0.0    0.12     0.00     0.13     0.00
 STD+R                  119.0   0.0  2.1    0.0    0.12     0.00     0.13     0.00
 STD+R                  129.0   0.0  2.0    0.0    0.12     0.00     0.13     0.00

================================================================================

 MAXIMUM POLE DEFORMATIONS CALCULATED(w.r.t. wind direction)
 ===========================================================

   MAST   .......DEFLECTIONS (ft).........   .........ROTATIONS (deg).........
   ELEV   ..... HORIZONTAL ......     DOWN   ........ TILT ..........    TWIST
     ft        ALONG       ACROSS                  ALONG       ACROSS


  189.0        5.15L       -0.01F    0.21B         3.33L       -0.01F    0.00E
```

175.2	4.35L	-0.01F	0.16B	3.28L	-0.01F	0.00E
161.5	3.60L	-0.01F	0.12B	3.03L	-0.01F	0.00E
147.7	2.91L	-0.01F	0.09B	2.66L	-0.01F	0.00E
144.0	2.74L	-0.01F	0.08B	2.57L	-0.01F	0.00J
129.2	2.13L	-0.01F	0.05B	2.19L	-0.01F	0.00J
114.5	1.61L	-0.01J	0.03B	1.83L	-0.01F	0.00J
99.7	1.19L	0.00J	0.02B	1.50L	0.00F	0.00J
94.2	1.05L	0.00J	0.02B	1.39L	0.00F	0.00J
80.6	0.75L	0.00J	0.01B	1.14L	0.00J	0.00J
66.9	0.50L	0.00J	0.01B	0.91L	0.00J	0.00J
53.2	0.31L	0.00J	0.00B	0.70L	0.00J	0.00J
46.2	0.23L	0.00J	0.00B	0.60L	0.00J	0.00J
34.7	0.13L	0.00J	0.00B	0.43L	0.00J	0.00J
23.1	0.06L	0.00J	0.00B	0.28L	0.00J	0.00J
11.6	0.01L	0.00J	0.00B	0.13L	0.00J	0.00J
0.0	0.00A	0.00A	0.00A	0.00A	0.00A	0.00A

MAXIMUM ANTENNA AND REFLECTOR ROTATIONS

ELEV ft	ANT AZI deg	ANT TYPE	.... BEAM DEFLECTIONS (deg) .... ROLL	YAW	PITCH	TOTAL
129.0	0.0	STD+R	2.164 D	0.037 C	-2.176 G	2.176 G
119.0	0.0	STD+R	1.920 D	0.030 C	-1.932 G	1.932 G
109.0	0.0	STD+R	1.686 D	0.023 C	-1.697 G	1.697 G

MAXIMUM POLE FORCES CALCULATED(w.r.t. to wind direction)

MAST ELEV ft	TOTAL AXIAL kip	SHEAR.w.r.t.WIND.DIR ALONG kip	ACROSS kip	MOMENT.w.r.t.WIND.DIR ALONG ft-kip	ACROSS ft-kip	TORSION ft-kip
189.0	0.00 B	0.00 J	0.00 B	0.00 J	0.00 B	0.00 B
175.2	7.90 E	3.62 J	0.00 B	-35.13 G	0.01 F	0.01 F
	7.90 C	3.62 G	0.00 H	-35.14 B	0.01 F	0.01 F
161.5	13.89 C	6.36 G	0.00 H	-121.97 G	0.05 F	0.02 F
	13.89 C	6.36 K	0.00 C	-121.97 G	0.05 F	0.02 F
147.7	15.02 C	6.58 K	0.00 C	-220.54 B	0.11 F	0.04 F
	15.02 H	6.64 H	0.03 B	-220.54 K	0.13 F	0.04 F
144.0	15.75 H	6.70 H	0.03 B	-248.05 B	0.14 F	0.04 F
	15.76 B	6.67 L	0.03 I	-248.07 B	0.19 F	0.04 F
129.2	17.43 B	6.94 L	0.03 I	-358.25 L	-0.48 I	0.06 F
	17.44 B	6.94 C	-0.03 H	-358.26 L	-0.48 I	0.06 F

	19.76 B	7.48 L	-0.04 J	-474.12 L	-1.24 I	0.40 E
114.5	19.76 B	7.48 L	-0.04 J	-474.13 L	-1.24 I	0.40 E
	22.08 B	7.92 L	-0.06 J	-596.52 L	-1.71 I	-0.62 J
99.7	22.08 B	7.93 L	-0.06 K	-596.49 L	-1.72 I	-0.62 J
	23.89 B	8.05 L	-0.06 K	-643.63 L	1.79 F	-0.62 J
94.2	23.89 B	8.04 L	-0.07 K	-643.60 L	1.79 F	-0.62 J
	26.45 B	8.36 L	-0.07 K	-763.20 L	2.22 F	-0.63 J
80.6	26.45 B	8.37 L	-0.06 J	-763.19 L	2.22 F	-0.63 J
	29.22 B	8.70 L	-0.06 J	-886.52 L	2.72 F	-0.64 J
66.9	29.22 B	8.70 L	-0.06 J	-886.52 L	2.72 F	-0.64 J
	32.22 B	9.05 L	-0.06 J	-1013.65 L	3.23 F	-0.64 J
53.2	32.22 B	9.05 L	-0.06 K	-1013.66 L	3.23 F	-0.64 J
	35.43 B	9.23 L	-0.06 K	-1080.26 L	3.50 J	-0.64 J
46.2	35.43 B	9.23 L	-0.06 K	-1080.26 L	3.50 J	-0.64 J
	38.19 B	9.52 L	-0.06 K	-1192.45 L	4.17 J	-0.65 J
34.7	38.19 B	9.52 L	-0.06 K	-1192.45 L	4.17 J	-0.65 J
	41.10 B	9.81 L	-0.06 K	-1307.03 L	4.84 J	-0.65 J
23.1	41.10 B	9.81 L	-0.06 K	-1307.03 L	4.84 J	-0.65 J
	44.21 B	10.09 L	-0.06 K	-1423.82 L	5.51 J	-0.65 J
11.6	44.21 B	10.08 L	-0.06 K	-1423.83 L	5.51 J	-0.65 J
	47.39 B	10.36 L	-0.06 K	-1542.62 L	6.17 J	-0.65 J
base reaction	47.39 B	-10.36 L	0.06 K	1542.62 L	-6.17 J	0.65 J

COMPLIANCE WITH 4.8.2 & 4.5.4

ELEV ft	AXIAL	BENDING	SHEAR + TORSIONAL	TOTAL	SATISFIED	D/t(w/t)	MAX ALLOWED
189.00	0.00B	0.00B	0.00J	0.00B	YES	7.26A	45.2
	0.01E	0.06G	0.01J	0.07G	YES	9.20A	45.2
175.25	0.01C	0.06B	0.01G	0.07B	YES	9.20A	45.2
	0.01C	0.16G	0.01G	0.17G	YES	11.14A	45.2
161.50	0.01C	0.16G	0.01K	0.17G	YES	11.14A	45.2
	0.01C	0.22B	0.01K	0.22B	YES	13.08A	45.2
147.75	0.01H	0.18K	0.01H	0.19K	YES	10.61A	45.2
	0.01H	0.19B	0.01H	0.20B	YES	11.05A	45.2
144.00	0.01B	0.20B	0.01L	0.21B	YES	10.75A	45.2
	0.01B	0.22L	0.01L	0.23L	YES	12.48A	45.2
129.25	0.01B	0.22L	0.01C	0.23L	YES	12.48A	45.2
	0.01B	0.23L	0.01L	0.24L	YES	14.22A	45.2
114.50	0.01B	0.23L	0.01L	0.24L	YES	14.22A	45.2

	0.01B	0.24L	0.00L	0.24L	YES	15.95A	45.2
99.75							
	0.01B	0.20L	0.00L	0.21L	YES	13.42A	45.2
	0.01B	0.20L	0.00L	0.21L	YES	13.97A	45.2
94.25							
	0.01B	0.21L	0.00L	0.22L	YES	13.67A	45.2
	0.01B	0.21L	0.00L	0.22L	YES	15.05A	45.2
80.58							
	0.01B	0.21L	0.00L	0.22L	YES	15.05A	45.2
	0.01B	0.21L	0.00L	0.22L	YES	16.42A	45.2
66.92							
	0.01B	0.21L	0.00L	0.22L	YES	16.42A	45.2
	0.01B	0.21L	0.00L	0.22L	YES	17.80A	45.2
53.25							
	0.01B	0.21L	0.00L	0.22L	YES	17.80A	45.2
	0.01B	0.21L	0.00L	0.22L	YES	18.50A	45.2
46.25							
	0.01B	0.22L	0.00L	0.23L	YES	18.15A	45.2
	0.01B	0.22L	0.00L	0.23L	YES	19.31A	45.2
34.69							
	0.01B	0.22L	0.00L	0.23L	YES	19.31A	45.2
	0.01B	0.22L	0.00L	0.23L	YES	20.48A	45.2
23.12							
	0.01B	0.22L	0.00L	0.23L	YES	20.48A	45.2
	0.01B	0.22L	0.00L	0.23L	YES	21.64A	45.2
11.56							
	0.01B	0.22L	0.00L	0.23L	YES	21.64A	45.2
	0.01B	0.22L	0.00L	0.23L	YES	22.81A	45.2
0.00							

MAXIMUM LOADS ONTO FOUNDATION(w.r.t. wind direction)

DOWN	SHEAR.w.r.t.WIND.DIR ALONG	ACROSS	MOMENT.w.r.t.WIND.DIR ALONG	ACROSS	TORSION
kip	kip	kip	ft-kip	ft-kip	ft-kip
47.39	10.36	-0.06	-1542.62	6.17	-0.65
B	L	K	L	J	J

SO#: 21-1791-TJH
Site Name: TI-OPP-16496/RED HILL CHURCH
Date: 8/24/2020

Round Base Plate and Anchor Rods, per ANSI/TIA 222-G

Pole Data

Diameter:	60.960	in (flat to flat)
Thickness:	0.4375	in
Yield (Fy):	65	ksi
# of Sides:	18	"0" IF Round
Strength (Fu):	80	ksi

Reactions

Moment, Mu:	6480.73	ft-kips
Axial, Pu:	56.77	kips
Shear, Vu:	43.64	kips

Anchor Rod Data

Quantity:	20		
Diameter:	2.25	in	
Rod Material:	A615		
Strength (Fu):	100	ksi	
Yield (Fy):	75	ksi	
BC Diam. (in):	68	BC Override:	

Anchor Rod Results

Maximum Rod (Pu+ Vu/η):	235.9 Kips	
Allowable Φ*Rnt:	260.0 Kips	(per 4.9.9)
Anchor Rod Interaction Ratio:	**90.7%** **Pass**	

Plate Data

Diameter (in):	73.75	Dia. Override:	
Thickness:	2.25	in	
Yield (Fy):	50	ksi	
Eff Width/Rod:	9.67	in	
Drain Hole:	2.625	in. diameter	
Drain Location:	28.25	in. center of pole to center of drain hole	
Center Hole:	48.5	in. diameter	

Base Plate Results

Base Plate (Mu/Z):	42.8 ksi	
Allowable Φ*Fy:	45.0 ksi	(per AISC)
Base Plate Interaction Ratio:	**95.2%** **Pass**	

MAT FOUNDATION DESIGN BY SABRE INDUSTRIES

190' Monopole TILLMAN INFRASTRUCTURE, LLC TI-OPP-16496/RED HILL CHURCH, NC (21-1791-TJH)

Overall Loads:			
Factored Moment (ft-kips)	7128.803		
Factored Axial (kips)	62.447		
Factored Shear (kips)	48.004		
Bearing Design Strength (ksf)	5.625	Max. Net Bearing Press. (ksf)	4.29
Water Table Below Grade (ft)	4		
Width of Mat (ft)	31	Allowable Bearing Pressure (ksf)	2.50
Thickness of Mat (ft)	1.75	Safety Factor	3.00
Depth to Bottom of Slab (ft)	6	Ultimate Bearing Pressure (ksf)	7.50
Quantity of Bolts in Bolt Circle	20	Bearing Φs	0.75
Bolt Circle Diameter (in)	68		
Top of Concrete to Top of Bottom Threads (in)	60		
Diameter of Pier (ft)	8	Minimum Pier Diameter (ft)	7.00
Ht. of Pier Above Ground (ft)	0.5	Equivalent Square b (ft)	7.09
Ht. of Pier Below Ground (ft)	4.25	Square Pier? (Y/N)	N
Quantity of Bars in Mat	71		
Bar Diameter in Mat (in)	1		
Area of Bars in Mat (in^2)	55.76		
Spacing of Bars in Mat (in)	5.21	Recommended Spacing (in)	5 to 12
Quantity of Bars Pier	50		
Bar Diameter in Pier (in)	1		
Tie Bar Diameter in Pier (in)	0.625		
Spacing of Ties (in)	12		
Area of Bars in Pier (in^2)	39.27	Minimum Pier A_s (in^2)	36.19
Spacing of Bars in Pier (in)	5.51	Recommended Spacing (in)	5 to 12
f'c (ksi)	4.5		
fy (ksi)	60		
Unit Wt. of Soil (kcf)	0.105		
Unit Wt. of Concrete (kcf)	0.15		
Volume of Concrete (yd^3)	71.13		
Two-Way Shear Action:			
Average d (in)	17		
ϕv_c (ksi)	0.223	v_u (ksi)	0.216
$\phi v_c = \phi(2 + 4/\beta_c)f'_c{}^{1/2}$	0.342		
$\phi v_c = \phi(\alpha_s d/b_o + 2)f'_c{}^{1/2}$	0.223		
$\phi v_c = \phi 4 f'_c{}^{1/2}$	0.228		
Shear perimeter, b_o (in)	355.00		
β_c	1		
One-Way Shear:			
ϕV_c (kips)	721.2	V_u (kips)	407.2
Stability:			
Overturning Design Strength (ft-k)	8741.0	Total Applied M (ft-k)	7440.8

Pier Design:

ϕV_n (kips)	844.4	V_u (kips)	48.0
$\phi V_c=\phi 2(1+N_u/(2000A_g))f'_c{}^{1/2}b_w d$	844.4		
V_s (kips)	0.0	*** V_s max = 4 $f'_c{}^{1/2}b_w d$ (kips)	1978.3
Maximum Spacing (in)	7.62	(Only if Shear Ties are Required)	
Actual Hook Development (in)	16.00	Req'd Hook Development l_{dh} (in)	12.52
		*** Ref. To Spacing Requirements ACI 11.5.4.3	

Flexure in Slab:

ϕM_n (ft-kips)	3970.9	M_u (ft-kips)	3940.5
a (in)	2.35		
Steel Ratio	0.00882		
β_1	0.825		
Maximum Steel Ratio (ρ_t)	0.0197		
Minimum Steel Ratio	0.0018		
Rebar Development in Pad (in)	140.46	Required Development in Pad (in)	26.83

Condition	1 is OK, 0 Fails
Maximum Soil Bearing Pressure	1
Pier Area of Steel	1
Pier Shear	1
Interaction Diagram	1
Two-Way Shear Action	1
One-Way Shear Action	1
Overturning	1
Flexure	1
Steel Ratio	1
Length of Development in Pad	1
Hook Development	1

```
================================================================================

                    LPile for Windows, Version 2019-11.005

               Analysis of Individual Piles and Drilled Shafts
              Subjected to Lateral Loading Using the p-y Method
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--------------------------------------------------------------------------------
                             Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:
\Program Files (x86)\Ensoft\Lpile2019\files\

Name of input data file:
21-1791-TJH.lp11d

Name of output report file:
21-1791-TJH.lp11o

Name of plot output file:
21-1791-TJH.lp11p

Name of runtime message file:
21-1791-TJH.lp11r


--------------------------------------------------------------------------------
                           Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  August 24, 2020             Time:  13:29:52


--------------------------------------------------------------------------------
                                  Problem Title
--------------------------------------------------------------------------------

Site         : TI-OPP-16496/RED HILL CHURCH, NC


Tower        : 190' Monopole


Prepared for : TILLMAN INFRASTRUCTURE, LLC


Job Number   : 21-1791-TJH


Engineer     : DO



--------------------------------------------------------------------------------
                         Program Options and Settings
--------------------------------------------------------------------------------

Computational Options:
```

 - Conventional Analysis
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed = 999
 - Deflection tolerance for convergence = 1.0000E-05 in
 - Maximum allowable deflection = 100.0000 in
 - Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
 - Static loading specified

 - Use of p-y modification factors for p-y curves not selected
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Input of moment resistance at the pile tip not selected
 - Input of side resistance moment along pile not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Report only summary tables of pile-head deflection, maximum bending moment,
   and maximum shear force in output report file.
 - No p-y curves to be computed and reported for user-specified depths
 - Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 33.500 ft
Depth of ground surface below top of pile = 0.5000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	84.0000
2	33.500	84.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

   Section 1 is a round drilled shaft, bored pile, or CIDH pile
   Length of section = 33.500000 ft
   Shaft Diameter = 84.000000 in
   Shear capacity of section = 0.0000 lbs

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 10 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	0.500000 ft
Distance from top of pile to bottom of layer	=	2.500000 ft
Effective unit weight at top of layer	=	105.000000 pcf
Effective unit weight at bottom of layer	=	105.000000 pcf
Friction angle at top of layer	=	28.000000 deg.
Friction angle at bottom of layer	=	28.000000 deg.
Subgrade k at top of layer	=	25.000000 pci
Subgrade k at bottom of layer	=	25.000000 pci

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer	=	2.500000 ft
Distance from top of pile to bottom of layer	=	4.500000 ft
Effective unit weight at top of layer	=	105.000000 pcf
Effective unit weight at bottom of layer	=	105.000000 pcf
Undrained cohesion at top of layer	=	750.000000 psf
Undrained cohesion at bottom of layer	=	750.000000 psf
Epsilon-50 at top of layer	=	0.010000
Epsilon-50 at bottom of layer	=	0.010000

Layer 3 is stiff clay without free water

Distance from top of pile to top of layer	=	4.500000 ft
Distance from top of pile to bottom of layer	=	6.500000 ft
Effective unit weight at top of layer	=	42.600000 pcf
Effective unit weight at bottom of layer	=	42.600000 pcf
Undrained cohesion at top of layer	=	1500. psf
Undrained cohesion at bottom of layer	=	1500. psf
Epsilon-50 at top of layer	=	0.007000
Epsilon-50 at bottom of layer	=	0.007000

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	6.500000 ft
Distance from top of pile to bottom of layer	=	9.000000 ft
Effective unit weight at top of layer	=	42.600000 pcf
Effective unit weight at bottom of layer	=	42.600000 pcf
Friction angle at top of layer	=	29.000000 deg.
Friction angle at bottom of layer	=	29.000000 deg.
Subgrade k at top of layer	=	50.000000 pci
Subgrade k at bottom of layer	=	50.000000 pci

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	9.000000 ft
Distance from top of pile to bottom of layer	=	14.000000 ft
Effective unit weight at top of layer	=	42.600000 pcf
Effective unit weight at bottom of layer	=	42.600000 pcf
Friction angle at top of layer	=	29.000000 deg.
Friction angle at bottom of layer	=	29.000000 deg.
Subgrade k at top of layer	=	50.000000 pci
Subgrade k at bottom of layer	=	50.000000 pci

Layer 6 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	14.000000 ft
Distance from top of pile to bottom of layer	=	19.000000 ft
Effective unit weight at top of layer	=	47.600000 pcf
Effective unit weight at bottom of layer	=	47.600000 pcf
Friction angle at top of layer	=	30.000000 deg.
Friction angle at bottom of layer	=	30.000000 deg.
Subgrade k at top of layer	=	50.000000 pci
Subgrade k at bottom of layer	=	50.000000 pci

Layer 7 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	19.000000 ft
Distance from top of pile to bottom of layer	=	24.000000 ft
Effective unit weight at top of layer	=	42.600000 pcf

Effective unit weight at bottom of layer = 42.600000 pcf
Undrained cohesion at top of layer = 400.000000 psf
Undrained cohesion at bottom of layer = 400.000000 psf
Epsilon-50 at top of layer = 0.020000
Epsilon-50 at bottom of layer = 0.020000

Layer 8 is stiff clay without free water

Distance from top of pile to top of layer = 24.000000 ft
Distance from top of pile to bottom of layer = 29.000000 ft
Effective unit weight at top of layer = 57.600000 pcf
Effective unit weight at bottom of layer = 57.600000 pcf
Undrained cohesion at top of layer = 1800. psf
Undrained cohesion at bottom of layer = 1800. psf
Epsilon-50 at top of layer = 0.007000
Epsilon-50 at bottom of layer = 0.007000

Layer 9 is stiff clay without free water

Distance from top of pile to top of layer = 29.000000 ft
Distance from top of pile to bottom of layer = 39.000000 ft
Effective unit weight at top of layer = 57.600000 pcf
Effective unit weight at bottom of layer = 57.600000 pcf
Undrained cohesion at top of layer = 2600. psf
Undrained cohesion at bottom of layer = 2600. psf
Epsilon-50 at top of layer = 0.005000
Epsilon-50 at bottom of layer = 0.005000

Layer 10 is stiff clay without free water

Distance from top of pile to top of layer = 39.000000 ft
Distance from top of pile to bottom of layer = 50.500000 ft
Effective unit weight at top of layer = 57.600000 pcf
Effective unit weight at bottom of layer = 57.600000 pcf
Undrained cohesion at top of layer = 2500. psf
Undrained cohesion at bottom of layer = 2500. psf
Epsilon-50 at top of layer = 0.005000
Epsilon-50 at bottom of layer = 0.005000

(Depth of the lowest soil layer extends 17.000 ft below the pile tip)

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	E50 or krm	kpy pci
1	Sand	0.5000	105.0000	--	28.0000	--	25.0000
	(Reese, et al.)	2.5000	105.0000	--	28.0000	--	25.0000
2	Stiff Clay	2.5000	105.0000	750.0000	--	0.01000	--
	w/o Free Water	4.5000	105.0000	750.0000	--	0.01000	--
3	Stiff Clay	4.5000	42.6000	1500.	--	0.00700	--
	w/o Free Water	6.5000	42.6000	1500.	--	0.00700	--
4	Sand	6.5000	42.6000	--	29.0000	--	50.0000
	(Reese, et al.)	9.0000	42.6000	--	29.0000	--	50.0000
5	Sand	9.0000	42.6000	--	29.0000	--	50.0000
	(Reese, et al.)	14.0000	42.6000	--	29.0000	--	50.0000
6	Sand	14.0000	47.6000	--	30.0000	--	50.0000

	(Reese, et al.)	19.0000	47.6000	--	30.0000	--	50.0000
7	Soft	19.0000	42.6000	400.0000	--	0.02000	--
	Clay	24.0000	42.6000	400.0000	--	0.02000	--
8	Stiff Clay	24.0000	57.6000	1800.	--	0.00700	--
	w/o Free Water	29.0000	57.6000	1800.	--	0.00700	--
9	Stiff Clay	29.0000	57.6000	2600.	--	0.00500	--
	w/o Free Water	39.0000	57.6000	2600.	--	0.00500	--
10	Stiff Clay	39.0000	57.6000	2500.	--	0.00500	--
	w/o Free Water	50.5000	57.6000	2500.	--	0.00500	--

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	1	V = 64005. lbs	M = 114060848. in-lbs	83263.	No	Yes
2	1	V = 11396. lbs	M = 20362584. in-lbs	52129.	No	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Dimensions and Properties of Drilled Shaft (Bored Pile):

Length of Section	=	33.500000 ft
Shaft Diameter	=	84.000000 in
Concrete Cover Thickness (to edge of long. rebar)	=	3.625000 in
Number of Reinforcing Bars	=	46 bars
Yield Stress of Reinforcing Bars	=	60000. psi
Modulus of Elasticity of Reinforcing Bars	=	29000000. psi
Gross Area of Shaft	=	5542. sq. in.
Total Area of Reinforcing Steel	=	58.271360 sq. in.
Area Ratio of Steel Reinforcement	=	1.05 percent
Edge-to-Edge Bar Spacing	=	3.880937 in
Maximum Concrete Aggregate Size	=	0.750000 in
Ratio of Bar Spacing to Aggregate Size	=	5.17

Offset of Center of Rebar Cage from Center of Pile = 0.0000 in

Axial Structural Capacities:

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As = 24470.662 kips
Tensile Load for Cracking of Concrete = -2609.093 kips
Nominal Axial Tensile Capacity = -3496.282 kips

Reinforcing Bar Dimensions and Positions Used in Computations:

Bar Number	Bar Diam. inches	Bar Area sq. in.	X inches	Y inches
1	1.270000	1.266769	37.740000	0.00000
2	1.270000	1.266769	37.388488	5.138929
3	1.270000	1.266769	36.340498	10.182130
4	1.270000	1.266769	34.615555	15.035657
5	1.270000	1.266769	32.245788	19.609098
6	1.270000	1.266769	29.275344	23.817259
7	1.270000	1.266769	25.759556	27.581749
8	1.270000	1.266769	21.763915	30.832444
9	1.270000	1.266769	17.362855	33.508788
10	1.270000	1.266769	12.638357	35.560927
11	1.270000	1.266769	7.678430	36.950633
12	1.270000	1.266769	2.575469	37.652019
13	1.270000	1.266769	-2.575469	37.652019
14	1.270000	1.266769	-7.678430	36.950633
15	1.270000	1.266769	-12.638357	35.560927
16	1.270000	1.266769	-17.362855	33.508788
17	1.270000	1.266769	-21.763915	30.832444
18	1.270000	1.266769	-25.759556	27.581749
19	1.270000	1.266769	-29.275344	23.817259
20	1.270000	1.266769	-32.245788	19.609098
21	1.270000	1.266769	-34.615555	15.035657
22	1.270000	1.266769	-36.340498	10.182130
23	1.270000	1.266769	-37.388488	5.138929
24	1.270000	1.266769	-37.740000	0.00000
25	1.270000	1.266769	-37.388488	-5.138929
26	1.270000	1.266769	-36.340498	-10.182130
27	1.270000	1.266769	-34.615555	-15.035657
28	1.270000	1.266769	-32.245788	-19.609098
29	1.270000	1.266769	-29.275344	-23.817259
30	1.270000	1.266769	-25.759556	-27.581749
31	1.270000	1.266769	-21.763915	-30.832444
32	1.270000	1.266769	-17.362855	-33.508788
33	1.270000	1.266769	-12.638357	-35.560927
34	1.270000	1.266769	-7.678430	-36.950633
35	1.270000	1.266769	-2.575469	-37.652019
36	1.270000	1.266769	2.575469	-37.652019
37	1.270000	1.266769	7.678430	-36.950633
38	1.270000	1.266769	12.638357	-35.560927
39	1.270000	1.266769	17.362855	-33.508788
40	1.270000	1.266769	21.763915	-30.832444
41	1.270000	1.266769	25.759556	-27.581749
42	1.270000	1.266769	29.275344	-23.817259
43	1.270000	1.266769	32.245788	-19.609098
44	1.270000	1.266769	34.615555	-15.035657
45	1.270000	1.266769	36.340498	-10.182130
46	1.270000	1.266769	37.388488	-5.138929

NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero = 3.881 inches
between bars 31 and 32.

Ratio of bar spacing to maximum aggregate size = 5.17

Concrete Properties:

Compressive Strength of Concrete = 4500. psi
Modulus of Elasticity of Concrete = 3823676. psi
Modulus of Rupture of Concrete = -503.115295 psi
Compression Strain at Peak Stress = 0.002001
Tensile Strain at Fracture of Concrete = -0.0001152
Maximum Coarse Aggregate Size = 0.750000 in

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 2

Number	Axial Thrust Force kips
1	52.129
2	83.263

Summary of Results for Nominal Moment Capacity for Section 1

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

Load No.	Axial Thrust kips	Nominal Mom. Cap. in-kip	Max. Comp. Strain
1	52.129	121593.134	0.00300000
2	83.263	122494.031	0.00300000

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial Load No.	Resist. Factor	Nominal Ax. Thrust kips	Nominal Moment Cap in-kips	Ult. (Fac) Ax. Thrust kips	Ult. (Fac) Moment Cap in-kips	Bend. Stiff. at Ult Mom kip-in^2
1	0.65	52.129000	121593.	33.883850	79036.	2.4240E+09
2	0.65	83.262667	122494.	54.120733	79621.	2.4437E+09
1	0.75	52.129000	121593.	39.096750	91195.	2.3400E+09
2	0.75	83.262667	122494.	62.447000	91871.	2.3595E+09
1	0.90	52.129000	121593.	46.916100	109434.	1.5774E+09
2	0.90	83.262667	122494.	74.936400	110245.	1.5929E+09

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.5000	0.00	N.A.	No	0.00	10766.
2	2.5000	0.6679	No	No	10766.	35258.
3	4.5000	1.4140	Yes	No	46025.	69669.
4	6.5000	6.7952	No	No	115694.	97076.
5	9.0000	9.8309	Yes	No	212769.	250967.
6	14.0000	15.1449	Yes	No	463736.	332434.
7	19.0000	40.8948	No	No	796171.	126676.
8	24.0000	18.5733	No	No	922847.	323970.
9	29.0000	17.8962	Yes	No	1246817.	398323.
10	39.0000	38.5000	No	No	1645140.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals
for Layer n. Layering correction equivalent depths are computed only
for soil types with both shallow-depth and deep-depth expressions for
peak lateral load transfer. These soil types are soft and stiff clays,
non-liquefied sands, and cemented c-phi soil.

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	64005.	M, in-lb	1.14E+08	83263.	13.9637	-0.07215	-599371.	1.17E+08
2	V, lb	11396.	M, in-lb	2.04E+07	52129.	0.1628	-7.73E-04	-102857.	2.08E+07

Maximum pile-head deflection = 13.9636513862 inches
Maximum pile-head rotation = -0.0721537806 radians = -4.134107 deg.

The analysis ended normally.

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Moment (ft·k)	7,128.80	
Shear (k)	48.00	
Caisson diameter (ft)	7	
Caisson height above ground (ft)	0.5	
Caisson height below ground (ft)	30	
Lateral soil pressure (lb/ft^2)	**352.50**	
Ground to application of force, h (ft)	149.00	
Applied lateral force, P (lb)	48,004	
Lateral soil bearing pressure, S_1 (lb/ft)	3,525.00	
Diameter, b (ft)	7	
A	4.55	$= (2.34P)/(S_1 b)$
Minimum depth of embedment, d (ft)	29.56	$= 0.5A[\ 1 + (\ 1 + (\ 4.36h\ /\ A\ )\ )^{1/2}\ ]$