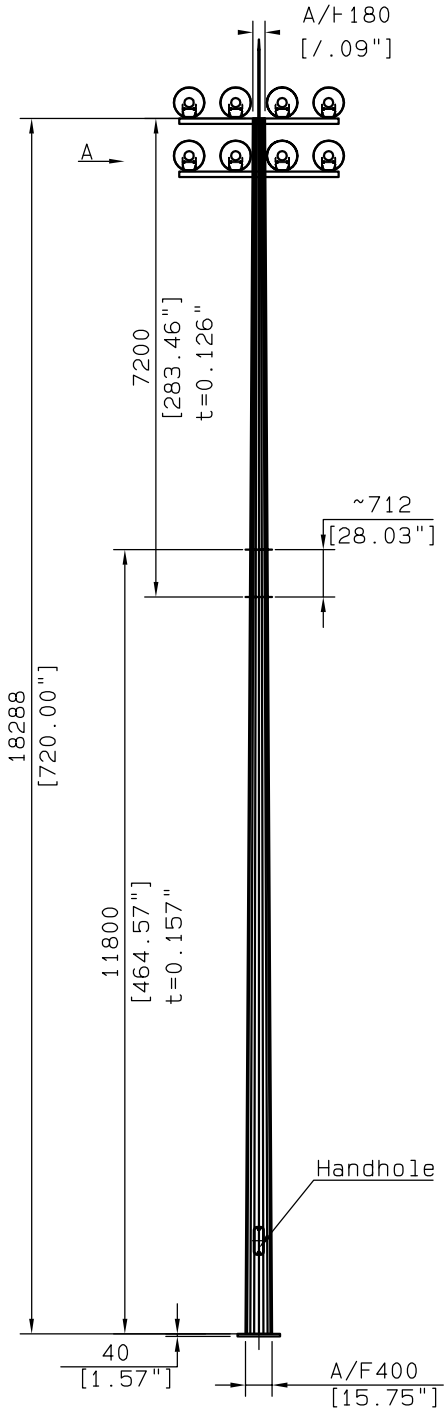
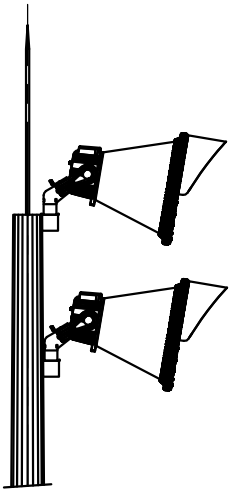
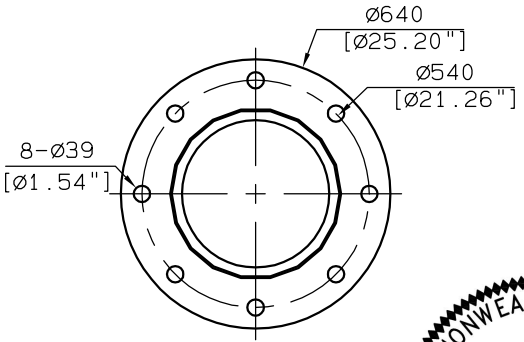
L200010503
QUOTATION #



Notes:
1. Material:
Pole shaft: ASTM A572 GR65
Baseplate: ASTM A572 GR50 or Q345
Anchor bolt: F1554-55 1.25" or 45# M1.3"
2. Design wind speed: 115mph Vult
3. Pole section has 18 sides
4. Finished: Galvanizing per ASTM A123



View A



Base flange

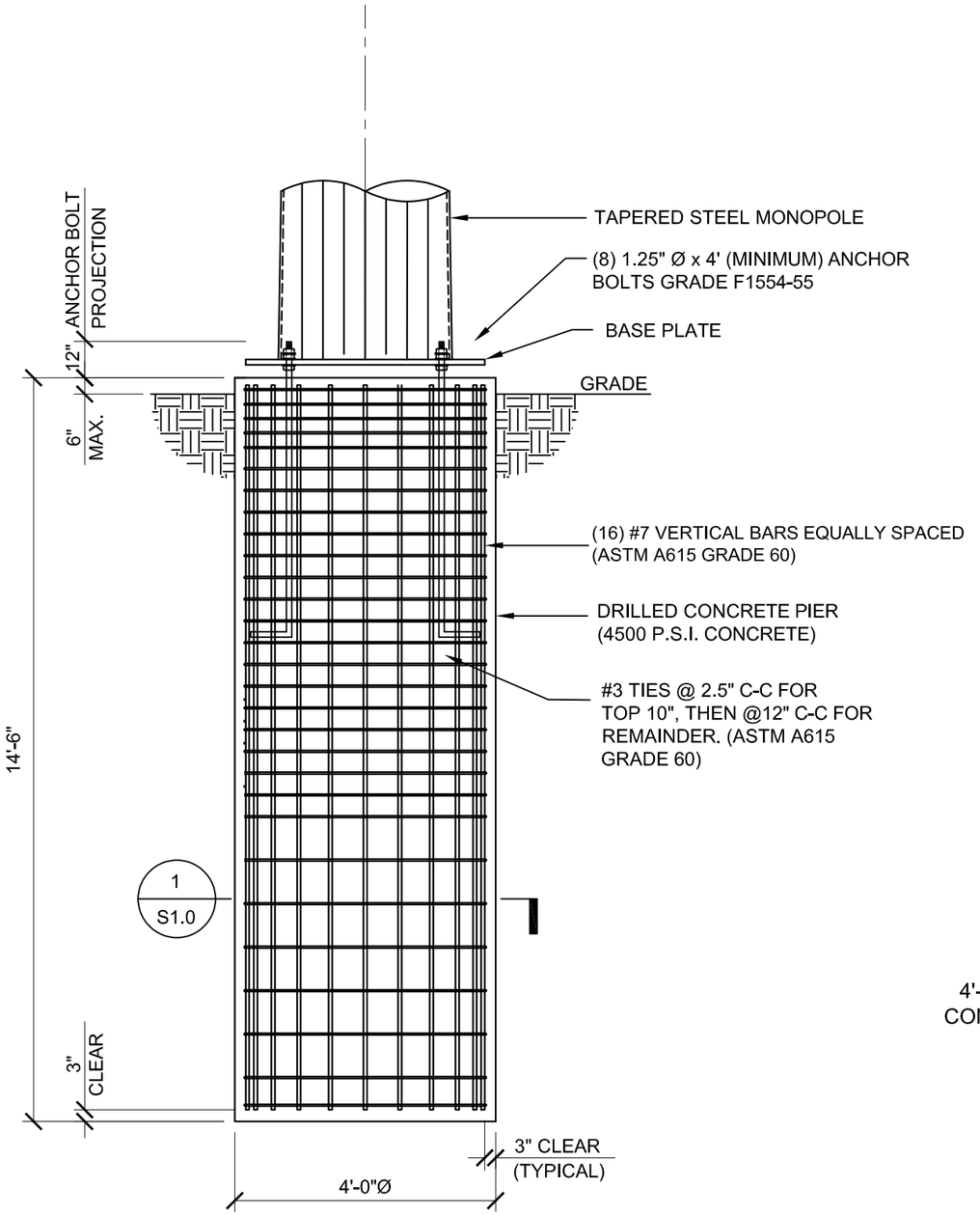
Site Coordinate

COMMONWEALTH OF VIRGINIA
JENNIFER ZABIK
Lic. No. 0402058234
PROFESSIONAL ENGINEER
Jennifer L Zabik
Digitally signed by Jennifer L Zabik
Date: 2022.03.11 14:35:10 -05'00'
03/11/22

AccessFixtures
High-Performance Lighting Solutions

CLIENT
TITLE

			DRAWN	JW	2022/03/11	MATERIAL		MANUFACTURING ORDER
			ENGR	JW	2022/03/11	THK (mm)		
A			CHECKED	ZHJ	2022/03/11	WT (kg)		VERSION: A
REV ID	DATE	REVISION DESCRIPTION	SPECIFICATIONS			SCALE		

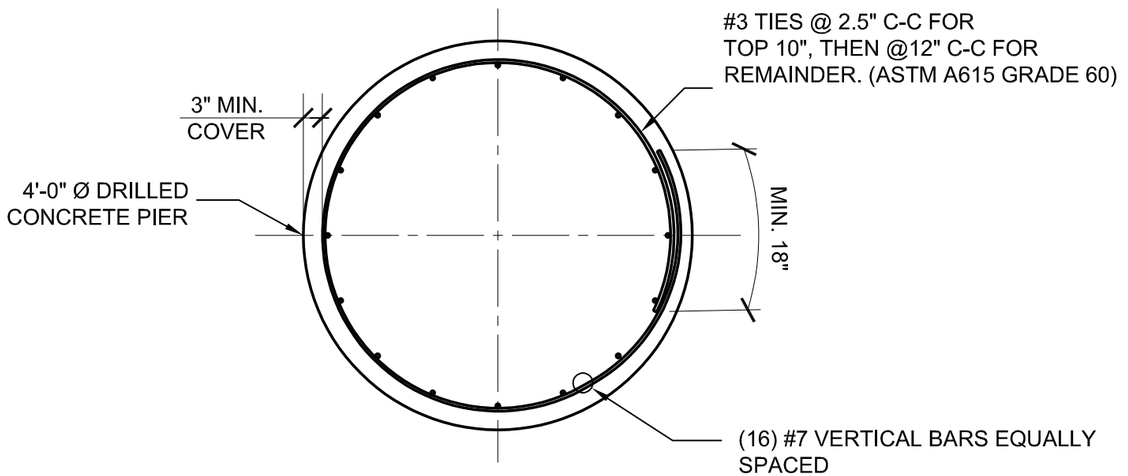


DRILLED PIER FOUNDATION

NOT TO SCALE

GENERAL NOTES:

1. FOUNDATION DESIGN PER 2018 INTERNATIONAL BUILDING CODE WITH AND BASED ON PRESUMPTIVE SOIL PARAMETERS PER IBC 2018 TABLE 1806.2.
2. FOUNDATION DESIGN BASED ON THE MAXIMUM REACTIONS PER AMBOR STRUCTURES ORIGINAL POLE DESIGN DATED MARCH 10, 2022.
   MOMENT: 143 KIP-FT
   AXIAL: 3 KIPS
   SHEAR: 3 KIPS
2. CONCRETE SHALL BE 4500 P.S.I. (MINIMUM) @ 28 DAYS COMPRESSIVE STRENGTH.
3. FOUNDATION INSTALLATION SHALL BE OBSERVED BY A CERTIFIED GEOTECHNICAL ENGINEER.
4. CAISSON INSTALLATION SHALL BE OBSERVED IN ACCORDANCE WITH ACI 336 "STANDARD SPECIFICATIONS FOR THE CONSTRUCTION OF DRILLED PIERS". LATEST EDITION.
5. ALL REINFORCING SHALL BE A.S.T.M. A615 GRADE 60.
6. TOP OF CONCRETE CAISSON TO BOTTOM OF LEVELING NUT SHALL NOT EXCEED 1.0 TIMES BOLT DIAMETER.
7. SPECIAL INSPECTIONS SHALL BE PERFORMED DURING INSTALLATION AND TESTING OF CAST-IN-PLACE DEEP FOUNDATION ELEMENTS AS REQUIRED BY IBC 2018.
8. CONTRACTOR IS RESPONSIBLE FOR SHORING WORK ETC.



NOTE: ANCHOR BOLTS ARE NOT SHOWN FOR CLARITY.

SECTION

1 / S1.0

NOT TO SCALE

AccessFixtures
High-Performance Lighting Solutions

COMMONWEALTH OF VIRGINIA
JENNIFER ZABIK
Lic. No. 0402058234
PROFESSIONAL ENGINEER
03/11/22

Revisions:

NO:	DESCRIPTION:	DATE:

DATE: 03/11/2022

DRAWING TITLE: DRILLED PIER FOUNDATION DETAIL AND SECTION

SCALE: NOT TO SCALE

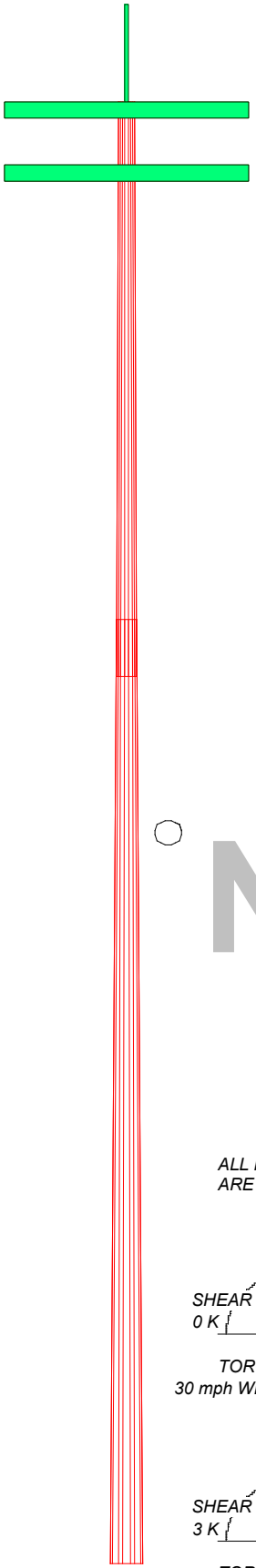
REVIEWED BY: JZ

DRAWN BY: KK

SHEET NUMBER:

S-1.0

Section	Length (ft)	Number of Sides	Thickness (in)	Socket Length (ft)	Top Dia (in)	Bot Dia (in)	Grade	Weight (K)
1	23.622	18	0.126	2.336	7.087	10.598	A572-65	0.3
2	38.714	18	0.157		9.999	15.748		0.8



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
Lightning Rod	60	Cross arm with (4)	57.38
Cross arm with (4)	60		

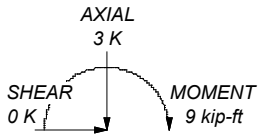
MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-65	65 ksi	80 ksi			

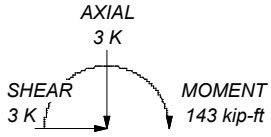
TOWER DESIGN NOTES

1. Tower designed for Exposure C to the TIA-222-H Standard.
2. Tower designed for a 115 mph basic wind in accordance with the TIA-222-H Standard.
3. Tower is also designed for a 30 mph basic wind with 1.50 in ice. Ice is considered to increase in thickness with height.
4. Deflections are based upon a 115 mph wind.
5. Tower Risk Category II.
6. Topographic Category 1 with Crest Height of 0.000 ft
7. Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications.
8. Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
9. TOWER RATING: 78.5%

ALL REACTIONS ARE FACTORED



TORQUE 0 kip-ft
30 mph WIND - 1.500 in ICE



TORQUE 0 kip-ft
REACTIONS - 115 mph WIND

COMMONWEALTH OF VIRGINIA
JENNIFER ZABIK
Lic. No. 0402058234
PROFESSIONAL ENGINEER
03/11/22

AccessFixtures
High-Performance Lighting Solutions

Job:
Path:

Drawn by: kkadam	App'd:
Date: 03/10/22	Scale: NTS
	Dwg No. E-1

Tower Input Data

The tower is a monopole.
This tower is designed using the TIA-222-H standard.
The following design criteria apply:

Tower base elevation above sea level: 0.000 ft.
Basic wind speed of 115 mph.
Risk Category II.
Exposure Category C.
Simplified Topographic Factor Procedure for wind speed-up calculations is used.
Topographic Category: 1.
Crest Height: 0.000 ft.
Nominal ice thickness of 1.500 in.
Ice thickness is considered to increase with height.
Ice density of 56 pcf.
A wind speed of 30 mph is used in combination with ice.
Temperature drop of 50 °F.
Deflections calculated using a wind speed of 115 mph.
Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications..
Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards..
A non-linear (P-delta) analysis was used.
Pressures are calculated at each section.
Stress ratio used in pole design is 1.
Local bending stresses due to climbing loads, feed line supports, and appurtenance mounts are not considered.

Options

	Consider Moments - Legs		Distribute Leg Loads As Uniform		Use ASCE 10 X-Brace Ly Rules
	Consider Moments - Horizontals		Assume Legs Pinned	√	Calculate Redundant Bracing Forces
	Consider Moments - Diagonals	√	Assume Rigid Index Plate		Ignore Redundant Members in FEA
	Use Moment Magnification	√	Use Clear Spans For Wind Area		SR Leg Bolts Resist Compression
√	Use Code Stress Ratios	√	Use Clear Spans For KL/r	√	All Leg Panels Have Same Allowable
√	Use Code Safety Factors - Guys	√	Retension Guys To Initial Tension		Offset Girt At Foundation
	Escalate Ice	√	Bypass Mast Stability Checks		Consider Feed Line Torque
	Always Use Max Kz	√	Use Azimuth Dish Coefficients		Include Angle Block Shear Check
	Use Special Wind Profile	√	Project Wind Area of Appurt.		Use TIA-222-H Bracing Resist. Exemption
√	Include Bolts In Member Capacity	√	Autocalc Torque Arm Areas	√	Use TIA-222-H Tension Splice Exemption
√	Leg Bolts Are At Top Of Section		Add IBC .6D+W Combination		Poles
√	Secondary Horizontal Braces Leg		Sort Capacity Reports By Component	√	Include Shear-Torsion Interaction
	Use Diamond Inner Bracing (4 Sided)	√	Triangulate Diamond Inner Bracing		Always Use Sub-Critical Flow
	SR Members Have Cut Ends		Treat Feed Line Bundles As Cylinder		Use Top Mounted Sockets
	SR Members Are Concentric		Ignore KL/ry For 60 Deg. Angle Legs		Pole Without Linear Attachments
					Pole With Shroud Or No Appurtenances
					Outside and Inside Corner Radii Are Known

Tapered Pole Section Geometry

Section	Elevation ft	Section Length ft	Splice Length ft	Number of Sides	Top Diameter in	Bottom Diameter in	Wall Thickness in	Bend Radius in	Pole Grade
L1	60.000-36.378	23.622	2	18	7.087	10.598	0.126	0.504	A572-65 (65 ksi)
L2	36.378-0.000	38.714		18	9.999	15.748	0.157	0.630	A572-65 (65 ksi)

Tapered Pole Properties

Section	Tip Dia. in	Area in^2	I in^4	r in	C in	I/C in^3	J in^4	It/Q in^2	w in	w/t
L1	7.177	2.783	17.037	2.471	3.600	4.733	34.097	1.392	1.026	8.14
	10.742	4.188	58.023	3.718	5.384	10.777	116.123	2.094	1.644	13.046
L2	10.481	4.919	60.198	3.494	5.080	11.851	120.475	2.460	1.483	9.415
	15.967	7.793	239.306	5.535	8.000	29.913	478.928	3.897	2.494	15.84

Tower Elevation ft	Gusset Area (per face) ft^2	Gusset Thickness in	Gusset Grade	Adjust. Factor A_f	Adjust. Factor A_r	Weight Mult.	Double Angle Stitch Bolt Spacing Diagonals in	Double Angle Stitch Bolt Spacing Horizontals in	Double Angle Stitch Bolt Spacing Redundants in
L1 60.000-36.378				1	1	1			
L2 36.378-0.000				1	1	1			

Monopole Base Plate Data

Base Plate Data	
Base plate is square	
Base plate is grouted	√
Anchor bolt grade	F1554-55
Anchor bolt size	1.250 in
Number of bolts	8
Embedment length	43.307 in
f'_c	4.00 ksi
Grout space	2.000 in
Base plate grade	A572-50
Base plate thickness	1.575 in
Bolt circle diameter	21.260 in
Outer diameter	25.197 in
Inner diameter	13.780 in
Base plate type	Plain Plate

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Exclude From Torque Calculation	Component Type	Placement ft	Total Number	C_AA_A ft^2/ft	Weight klf

Description	Face or Leg	Allow Shield	Exclude From Torque Calculation	Component Type	Placement ft	Total Number		C_AA_A ft^2/ft	Weight klf
LDF-50A (1 5/8 FOAM)	C	No	Yes	Inside Pole	60.000 - 0.000	1	No Ice	0.000	0.00
							1/2" Ice	0.000	0.00
							1" Ice	0.000	0.00
							2" Ice	0.000	0.00
Step Bolts	C	No	Yes	CaAa (Out Of Face)	60.000 - 0.000	1	No Ice	0.049	0.00
							1/2" Ice	0.000	0.00
							1" Ice	0.000	0.00
							2" Ice	0.000	0.00
Safety cable	C	No	Yes	CaAa (Out Of Face)	60.000 - 0.000	1	No Ice	0.037	0.00
							1/2" Ice	0.137	0.00
							1" Ice	0.237	0.00
							2" Ice	0.438	0.01

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
L1	60.000-36.378	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	0.000	2.048	0.06
L2	36.378-0.000	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	0.000	3.154	0.09

Feed Line/Linear Appurtenances Section Areas - With Ice

Tower Section	Tower Elevation ft	Face or Leg	Ice Thickness in	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
L1	60.000-36.378	A	1.555	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	0.000	8.234	0.12
L2	36.378-0.000	A	1.408	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	0.000	12.680	0.18

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral ft / Vert ft / ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
Lightning Rod	C	From Face	0.000	0.00	60.000	No Ice	3.000	3.000	0.05

Description	Face or Leg	Offset Type	Offsets: Horz Lateral ft / Vert ft / ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
			0 2			1/2" Ice 1" Ice 2" Ice	4.033 5.027 6.257	4.033 5.027 6.257	0.07 0.10 0.18
******									
Cross arm with (4)	B	None		0.00	60.000	No Ice 1/2" Ice 1" Ice 2" Ice	17.600 0.000 0.000 0.000	10.000 0.000 0.000 0.000	0.42 0.00 0.00 0.00
******									
Cross arm with (4)	B	None		0.00	54.380	No Ice 1/2" Ice 1" Ice 2" Ice	17.600 0.000 0.000 0.000	10.000 0.000 0.000 0.000	0.42 0.00 0.00 0.00
******									

Force Totals

Load Case	Vertical Forces K	Sum of Forces X K	Sum of Forces Z K	Sum of Overturning Moments, M_x kip-ft	Sum of Overturning Moments, M_z kip-ft	Sum of Torques kip-ft
Leg Weight	1.12					
Bracing Weight	0.00					
Total Member Self-Weight	1.12			0.01	0.00	
Total Weight	2.15			0.01	0.00	
Wind 0 deg - No Ice		0.00	-3.13	-135.31	0.00	0.00
Wind 30 deg - No Ice		1.57	-2.71	-117.18	-67.66	0.02
Wind 60 deg - No Ice		2.71	-1.57	-67.65	-117.20	0.03
Wind 90 deg - No Ice		3.13	0.00	0.01	-135.33	0.04
Wind 120 deg - No Ice		2.71	1.57	67.68	-117.20	0.03
Wind 150 deg - No Ice		1.57	2.71	117.21	-67.66	0.02
Wind 180 deg - No Ice		0.00	3.13	135.34	0.00	0.00
Wind 210 deg - No Ice		-1.57	2.71	117.21	67.66	-0.02
Wind 240 deg - No Ice		-2.71	1.57	67.68	117.20	-0.03
Wind 270 deg - No Ice		-3.13	0.00	0.01	135.33	-0.04
Wind 300 deg - No Ice		-2.71	-1.57	-67.65	117.20	-0.03
Wind 330 deg - No Ice		-1.57	-2.71	-117.18	67.66	-0.02
Member Ice	1.39					
Total Weight Ice	2.95			0.04	0.00	
Wind 0 deg - Ice		0.00	-0.27	-8.17	0.00	0.00
Wind 30 deg - Ice		0.13	-0.23	-7.07	-4.10	0.00
Wind 60 deg - Ice		0.23	-0.13	-4.06	-7.11	0.00
Wind 90 deg - Ice		0.27	0.00	0.04	-8.21	0.00
Wind 120 deg - Ice		0.23	0.13	4.15	-7.11	0.00
Wind 150 deg - Ice		0.13	0.23	7.15	-4.10	0.00
Wind 180 deg - Ice		0.00	0.27	8.25	0.00	0.00
Wind 210 deg - Ice		-0.13	0.23	7.15	4.10	-0.00
Wind 240 deg - Ice		-0.23	0.13	4.15	7.11	-0.00
Wind 270 deg - Ice		-0.27	0.00	0.04	8.21	-0.00
Wind 300 deg - Ice		-0.23	-0.13	-4.06	7.11	-0.00
Wind 330 deg - Ice		-0.13	-0.23	-7.07	4.10	-0.00

Load Case	Vertical Forces K	Sum of Forces X K	Sum of Forces Z K	Sum of Overturning Moments, M_x kip-ft	Sum of Overturning Moments, M_z kip-ft	Sum of Torques kip-ft
Total Weight	2.15			0.01	0.00	
Wind 0 deg - Service		0.00	-2.80	-121.07	0.00	0.00
Wind 30 deg - Service		1.40	-2.43	-104.85	-60.54	0.02
Wind 60 deg - Service		2.43	-1.40	-60.53	-104.86	0.03
Wind 90 deg - Service		2.80	0.00	0.01	-121.08	0.03
Wind 120 deg - Service		2.43	1.40	60.56	-104.86	0.03
Wind 150 deg - Service		1.40	2.43	104.88	-60.54	0.02
Wind 180 deg - Service		0.00	2.80	121.10	0.00	0.00
Wind 210 deg - Service		-1.40	2.43	104.88	60.54	-0.02
Wind 240 deg - Service		-2.43	1.40	60.56	104.86	-0.03
Wind 270 deg - Service		-2.80	0.00	0.01	121.08	-0.03
Wind 300 deg - Service		-2.43	-1.40	-60.53	104.86	-0.03
Wind 330 deg - Service		-1.40	-2.43	-104.85	60.54	-0.02

Load Combinations

Comb. No.	Description
1	Dead Only
2	1.2 Dead+1.0 Wind 0 deg - No Ice
3	0.9 Dead+1.0 Wind 0 deg - No Ice
4	1.2 Dead+1.0 Wind 30 deg - No Ice
5	0.9 Dead+1.0 Wind 30 deg - No Ice
6	1.2 Dead+1.0 Wind 60 deg - No Ice
7	0.9 Dead+1.0 Wind 60 deg - No Ice
8	1.2 Dead+1.0 Wind 90 deg - No Ice
9	0.9 Dead+1.0 Wind 90 deg - No Ice
10	1.2 Dead+1.0 Wind 120 deg - No Ice
11	0.9 Dead+1.0 Wind 120 deg - No Ice
12	1.2 Dead+1.0 Wind 150 deg - No Ice
13	0.9 Dead+1.0 Wind 150 deg - No Ice
14	1.2 Dead+1.0 Wind 180 deg - No Ice
15	0.9 Dead+1.0 Wind 180 deg - No Ice
16	1.2 Dead+1.0 Wind 210 deg - No Ice
17	0.9 Dead+1.0 Wind 210 deg - No Ice
18	1.2 Dead+1.0 Wind 240 deg - No Ice
19	0.9 Dead+1.0 Wind 240 deg - No Ice
20	1.2 Dead+1.0 Wind 270 deg - No Ice
21	0.9 Dead+1.0 Wind 270 deg - No Ice
22	1.2 Dead+1.0 Wind 300 deg - No Ice
23	0.9 Dead+1.0 Wind 300 deg - No Ice
24	1.2 Dead+1.0 Wind 330 deg - No Ice
25	0.9 Dead+1.0 Wind 330 deg - No Ice
26	1.2 Dead+1.0 Ice+1.0 Temp
27	1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp
28	1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp
29	1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp
30	1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp
31	1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp
32	1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp
33	1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp
34	1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp
35	1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp
36	1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp
37	1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp
38	1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp

Comb. No.	Description
39	Dead+Wind 0 deg - Service
40	Dead+Wind 30 deg - Service
41	Dead+Wind 60 deg - Service
42	Dead+Wind 90 deg - Service
43	Dead+Wind 120 deg - Service
44	Dead+Wind 150 deg - Service
45	Dead+Wind 180 deg - Service
46	Dead+Wind 210 deg - Service
47	Dead+Wind 240 deg - Service
48	Dead+Wind 270 deg - Service
49	Dead+Wind 300 deg - Service
50	Dead+Wind 330 deg - Service

Maximum Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
L1	60 - 36.378	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	1	-1.19	0.00	-0.01
			Max. Mx	8	-1.16	-39.40	-0.02
			Max. My	14	-1.16	0.00	-39.42
			Max. Vy	8	2.20	-39.40	-0.02
			Max. Vx	14	2.20	0.00	-39.42
			Max. Torque	8			-0.04
L2	36.378 - 1.1e-005	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	26	-3.44	0.00	-0.05
			Max. Mx	8	-2.57	-142.75	-0.02
			Max. My	14	-2.57	0.00	-142.77
			Max. Vy	8	3.14	-142.75	-0.02
			Max. Vx	14	3.14	0.00	-142.77
			Max. Torque	8			-0.04

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
Pole	Max. Vert	33	3.44	0.00	-0.27
	Max. H_x	21	1.94	3.13	0.00
	Max. H_z	3	1.94	0.00	3.13
	Max. M_x	2	142.73	0.00	3.13
	Max. M_z	8	142.75	-3.13	0.00
	Max. Torsion	20	0.04	3.13	0.00
	Min. Vert	13	1.94	-1.57	-2.71
	Min. H_x	9	1.94	-3.13	0.00
	Min. H_z	15	1.94	0.00	-3.13
	Min. M_x	14	-142.77	0.00	-3.13
	Min. M_z	20	-142.75	3.13	0.00
	Min. Torsion	8	-0.04	-3.13	0.00

Tower Mast Reaction Summary

Load Combination	*Vertical*	*Shear$_x$*	*Shear$_z$*	*Overturning Moment, M$_x$*	*Overturning Moment, M$_z$*	*Torque*
	K	*K*	*K*	*kip-ft*	*kip-ft*	*kip-ft*
Dead Only	2.15	0.00	0.00	0.01	0.00	0.00
1.2 Dead+1.0 Wind 0 deg - No Ice	2.58	0.00	-3.13	-142.73	0.00	0.00
0.9 Dead+1.0 Wind 0 deg - No Ice	1.94	0.00	-3.13	-140.62	0.00	0.00
1.2 Dead+1.0 Wind 30 deg - No Ice	2.58	1.57	-2.71	-123.60	-71.37	0.02
0.9 Dead+1.0 Wind 30 deg - No Ice	1.94	1.57	-2.71	-121.78	-70.32	0.02
1.2 Dead+1.0 Wind 60 deg - No Ice	2.58	2.71	-1.57	-71.35	-123.62	0.03
0.9 Dead+1.0 Wind 60 deg - No Ice	1.94	2.71	-1.57	-70.30	-121.80	0.03
1.2 Dead+1.0 Wind 90 deg - No Ice	2.58	3.13	0.00	0.02	-142.75	0.04
0.9 Dead+1.0 Wind 90 deg - No Ice	1.94	3.13	0.00	0.01	-140.64	0.04
1.2 Dead+1.0 Wind 120 deg - No Ice	2.58	2.71	1.57	71.39	-123.62	0.03
0.9 Dead+1.0 Wind 120 deg - No Ice	1.94	2.71	1.57	70.33	-121.80	0.03
1.2 Dead+1.0 Wind 150 deg - No Ice	2.58	1.57	2.71	123.64	-71.37	0.02
0.9 Dead+1.0 Wind 150 deg - No Ice	1.94	1.57	2.71	121.81	-70.32	0.02
1.2 Dead+1.0 Wind 180 deg - No Ice	2.58	0.00	3.13	142.77	0.00	0.00
0.9 Dead+1.0 Wind 180 deg - No Ice	1.94	0.00	3.13	140.65	0.00	0.00
1.2 Dead+1.0 Wind 210 deg - No Ice	2.58	-1.57	2.71	123.64	71.37	-0.02
0.9 Dead+1.0 Wind 210 deg - No Ice	1.94	-1.57	2.71	121.81	70.32	-0.02
1.2 Dead+1.0 Wind 240 deg - No Ice	2.58	-2.71	1.57	71.39	123.62	-0.03
0.9 Dead+1.0 Wind 240 deg - No Ice	1.94	-2.71	1.57	70.33	121.80	-0.03
1.2 Dead+1.0 Wind 270 deg - No Ice	2.58	-3.13	0.00	0.02	142.75	-0.04
0.9 Dead+1.0 Wind 270 deg - No Ice	1.94	-3.13	0.00	0.01	140.64	-0.04
1.2 Dead+1.0 Wind 300 deg - No Ice	2.58	-2.71	-1.57	-71.35	123.62	-0.03
0.9 Dead+1.0 Wind 300 deg - No Ice	1.94	-2.71	-1.57	-70.30	121.80	-0.03
1.2 Dead+1.0 Wind 330 deg - No Ice	2.58	-1.57	-2.71	-123.60	71.37	-0.02
0.9 Dead+1.0 Wind 330 deg - No Ice	1.94	-1.57	-2.71	-121.78	70.32	-0.02
1.2 Dead+1.0 Ice+1.0 Temp	3.44	0.00	0.00	0.05	0.00	0.00
1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp	3.44	0.00	-0.27	-8.50	0.00	0.00
1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp	3.44	0.13	-0.23	-7.36	-4.28	0.00
1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp	3.44	0.23	-0.13	-4.23	-7.41	0.00
1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp	3.44	0.27	0.00	0.05	-8.55	0.01

Load Combination	Vertical K	$Shear_x$ K	$Shear_z$ K	Overturning Moment, M_x kip-ft	Overturning Moment, M_z kip-ft	Torque kip-ft
1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp	3.44	0.23	0.13	4.33	-7.41	0.00
1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp	3.44	0.13	0.23	7.46	-4.28	0.00
1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp	3.44	0.00	0.27	8.60	0.00	0.00
1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp	3.44	-0.13	0.23	7.46	4.28	-0.00
1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp	3.44	-0.23	0.13	4.33	7.41	-0.00
1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp	3.44	-0.27	0.00	0.05	8.55	-0.01
1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp	3.44	-0.23	-0.13	-4.23	7.41	-0.00
1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp	3.44	-0.13	-0.23	-7.36	4.28	-0.00
Dead+Wind 0 deg - Service	2.15	0.00	-2.80	-126.56	0.00	0.00
Dead+Wind 30 deg - Service	2.15	1.40	-2.43	-109.60	-63.29	0.02
Dead+Wind 60 deg - Service	2.15	2.43	-1.40	-63.27	-109.62	0.03
Dead+Wind 90 deg - Service	2.15	2.80	0.00	0.02	-126.58	0.03
Dead+Wind 120 deg - Service	2.15	2.43	1.40	63.30	-109.62	0.03
Dead+Wind 150 deg - Service	2.15	1.40	2.43	109.63	-63.29	0.02
Dead+Wind 180 deg - Service	2.15	0.00	2.80	126.59	0.00	0.00
Dead+Wind 210 deg - Service	2.15	-1.40	2.43	109.63	63.29	-0.02
Dead+Wind 240 deg - Service	2.15	-2.43	1.40	63.30	109.62	-0.03
Dead+Wind 270 deg - Service	2.15	-2.80	0.00	0.02	126.58	-0.03
Dead+Wind 300 deg - Service	2.15	-2.43	-1.40	-63.27	109.62	-0.03
Dead+Wind 330 deg - Service	2.15	-1.40	-2.43	-109.60	63.29	-0.02

Solution Summary

	Sum of Applied Forces			Sum of Reactions			
Load Comb.	PX K	PY K	PZ K	PX K	PY K	PZ K	% Error
1	0.00	-2.15	0.00	0.00	2.15	0.00	0.000%
2	0.00	-2.58	-3.13	0.00	2.58	3.13	0.000%
3	0.00	-1.94	-3.13	0.00	1.94	3.13	0.000%
4	1.57	-2.58	-2.71	-1.57	2.58	2.71	0.000%
5	1.57	-1.94	-2.71	-1.57	1.94	2.71	0.000%
6	2.71	-2.58	-1.57	-2.71	2.58	1.57	0.000%
7	2.71	-1.94	-1.57	-2.71	1.94	1.57	0.000%
8	3.13	-2.58	0.00	-3.13	2.58	0.00	0.000%
9	3.13	-1.94	0.00	-3.13	1.94	0.00	0.000%
10	2.71	-2.58	1.57	-2.71	2.58	-1.57	0.000%
11	2.71	-1.94	1.57	-2.71	1.94	-1.57	0.000%
12	1.57	-2.58	2.71	-1.57	2.58	-2.71	0.000%
13	1.57	-1.94	2.71	-1.57	1.94	-2.71	0.000%
14	0.00	-2.58	3.13	0.00	2.58	-3.13	0.000%
15	0.00	-1.94	3.13	0.00	1.94	-3.13	0.000%
16	-1.57	-2.58	2.71	1.57	2.58	-2.71	0.000%
17	-1.57	-1.94	2.71	1.57	1.94	-2.71	0.000%
18	-2.71	-2.58	1.57	2.71	2.58	-1.57	0.000%
19	-2.71	-1.94	1.57	2.71	1.94	-1.57	0.000%
20	-3.13	-2.58	0.00	3.13	2.58	0.00	0.000%
21	-3.13	-1.94	0.00	3.13	1.94	0.00	0.000%
22	-2.71	-2.58	-1.57	2.71	2.58	1.57	0.000%
23	-2.71	-1.94	-1.57	2.71	1.94	1.57	0.000%
24	-1.57	-2.58	-2.71	1.57	2.58	2.71	0.000%

	Sum of Applied Forces			Sum of Reactions			
Load Comb.	PX K	PY K	PZ K	PX K	PY K	PZ K	% Error
25	-1.57	-1.94	-2.71	1.57	1.94	2.71	0.000%
26	0.00	-3.44	0.00	0.00	3.44	0.00	0.000%
27	0.00	-3.44	-0.27	0.00	3.44	0.27	0.000%
28	0.13	-3.44	-0.23	-0.13	3.44	0.23	0.000%
29	0.23	-3.44	-0.13	-0.23	3.44	0.13	0.000%
30	0.27	-3.44	0.00	-0.27	3.44	-0.00	0.000%
31	0.23	-3.44	0.13	-0.23	3.44	-0.13	0.000%
32	0.13	-3.44	0.23	-0.13	3.44	-0.23	0.000%
33	0.00	-3.44	0.27	0.00	3.44	-0.27	0.000%
34	-0.13	-3.44	0.23	0.13	3.44	-0.23	0.000%
35	-0.23	-3.44	0.13	0.23	3.44	-0.13	0.000%
36	-0.27	-3.44	0.00	0.27	3.44	-0.00	0.000%
37	-0.23	-3.44	-0.13	0.23	3.44	0.13	0.000%
38	-0.13	-3.44	-0.23	0.13	3.44	0.23	0.000%
39	0.00	-2.15	-2.80	0.00	2.15	2.80	0.000%
40	1.40	-2.15	-2.43	-1.40	2.15	2.43	0.000%
41	2.43	-2.15	-1.40	-2.43	2.15	1.40	0.000%
42	2.80	-2.15	0.00	-2.80	2.15	0.00	0.000%
43	2.43	-2.15	1.40	-2.43	2.15	-1.40	0.000%
44	1.40	-2.15	2.43	-1.40	2.15	-2.43	0.000%
45	0.00	-2.15	2.80	0.00	2.15	-2.80	0.000%
46	-1.40	-2.15	2.43	1.40	2.15	-2.43	0.000%
47	-2.43	-2.15	1.40	2.43	2.15	-1.40	0.000%
48	-2.80	-2.15	0.00	2.80	2.15	0.00	0.000%
49	-2.43	-2.15	-1.40	2.43	2.15	1.40	0.000%
50	-1.40	-2.15	-2.43	1.40	2.15	2.43	0.000%

Non-Linear Convergence Results

Load Combination	Converged?	Number of Cycles	Displacement Tolerance	Force Tolerance
1	Yes	4	0.00000001	0.00000001
2	Yes	5	0.00000001	0.00000001
3	Yes	5	0.00000001	0.00000001
4	Yes	6	0.00000001	0.00032336
5	Yes	6	0.00000001	0.00007935
6	Yes	6	0.00000001	0.00031718
7	Yes	6	0.00000001	0.00007734
8	Yes	5	0.00000001	0.00009901
9	Yes	5	0.00000001	0.00000001
10	Yes	6	0.00000001	0.00032533
11	Yes	6	0.00000001	0.00007994
12	Yes	6	0.00000001	0.00009901
13	Yes	6	0.00000001	0.00000001
14	Yes	5	0.00000001	0.00000001
15	Yes	5	0.00000001	0.00000001
16	Yes	6	0.00000001	0.00031909
17	Yes	6	0.00000001	0.00007792
18	Yes	6	0.00000001	0.00032533
19	Yes	6	0.00000001	0.00007994
20	Yes	5	0.00000001	0.00009901
21	Yes	5	0.00000001	0.00000001
22	Yes	6	0.00000001	0.00031718
23	Yes	6	0.00000001	0.00007734
24	Yes	6	0.00000001	0.00032336
25	Yes	6	0.00000001	0.00007935

26	es	4	0.00000001	0.00019351
27	Yes	4	0.00000001	0.00018712
28	Yes	4	0.00000001	0.00019773
29	Yes	4	0.00000001	0.00019801
30	Yes	4	0.00000001	0.00018961
31	Yes	4	0.00000001	0.00019801
32	Yes	4	0.00000001	0.00019773
33	Yes	4	0.00000001	0.00018712
34	Yes	4	0.00000001	0.00019351
35	Yes	4	0.00000001	0.00019296
36	Yes	5	0.00000001	0.00000001
37	Yes	6	0.00000001	0.00013373
38	Yes	6	0.00000001	0.00013095
39	Yes	5	0.00000001	0.00005401
40	Yes	6	0.00000001	0.00013460
41	Yes	6	0.00000001	0.00013179
42	Yes	5	0.00000001	0.00000001
43	Yes	6	0.00000001	0.00013179
44	Yes	6	0.00000001	0.00013460
45	Yes	5	0.00000001	0.00005401
46	Yes	6	0.00000001	0.00013095
47	Yes	6	0.00000001	0.00013373

Maximum Tower Deflections - Service Wind

Section No.	*Elevation* ft	*Horz. Deflection* ft	*Gov. Load Comb.*	*Tilt* °	*Twist* °
L1	60 - 36.378	5.00	45	8.80	0.01
L2	38.7139 - 1.1e-005	2.11	45	6.19	0.00

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	*Appurtenance*	*Gov. Load Comb.*	*Deflection* ft	*Tilt* °	*Twist* °	*Radius of Curvature* ft
60.000	Lightning Rod	45	5.00	8.80	0.01	1075
57.380	Cross arm with (4)	45	4.61	8.49	0.01	1075

Maximum Tower Deflections - Design Wind

Section No.	*Elevation* ft	*Horz. Deflection* ft	*Gov. Load Comb.*	*Tilt* °	*Twist* °
L1	60 - 36.378	5.66	14	9.96	0.01
L2	38.7139 - 1.1e-005	2.38	14	7.00	0.00

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection ft	Tilt °	Twist °	Radius of Curvature ft
60.000	Lightning Rod	14	5.66	9.96	0.01	959
57.380	Cross arm with (4)	14	5.21	9.62	0.01	959

Base Plate Design Data

Plate Thickness in	Number of Anchor Bolts	Anchor Bolt Size in	Actual / Allowable Ratio Bolt Tension K	Actual / Allowable Ratio Concrete Stress ksi	Actual / Allowable Ratio Plate Stress ksi	Actual / Allowable Ratio Stiffener Stress ksi	Controlling Condition	Critical Ratio
1.575	8	1.250	30.70 54.51 0.56	1.79 4.08 0.44	32.24 45.00 0.72		Plate	0.72 ✔

Compression Checks

Pole Design Data

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
L1	60 - 36.378 (1)	TP10.598x7.087x0.126	23.622	0.000	0.0	4.049	-1.16	236.85	0.005
L2	36.378 - 1.1e-005 (2)	TP15.748x9.999x0.157	38.714	0.000	0.0	7.793	-2.57	455.88	0.006

Pole Bending Design Data

Section No.	Elevation ft	Size	M_{ux} kip-ft	ϕM_{nx} kip-ft	Ratio $\frac{M_{ux}}{\phi M_{nx}}$	M_{uy} kip-ft	ϕM_{ny} kip-ft	Ratio $\frac{M_{uy}}{\phi M_{ny}}$
L1	60 - 36.378 (1)	TP10.598x7.087x0.126	39.42	62.35	0.632	0.00	62.35	0.000
L2	36.378 - 1.1e-005 (2)	TP15.748x9.999x0.157	142.77	183.37	0.779	0.00	183.37	0.000

Pole Shear Design Data

Section No.	Elevation ft	Size	Actual V_u K	ϕV_n K	Ratio $\frac{V_u}{\phi V_n}$	Actual T_u kip-ft	ϕT_n kip-ft	Ratio $\frac{T_u}{\phi T_n}$
L1	60 - 36.378 (1)	TP10.598x7.087x0.126	2.20	71.06	0.031	0.00	63.01	0.000
L2	36.378 - 1.1e-005 (2)	TP15.748x9.999x0.157	3.14	136.76	0.023	0.00	186.73	0.000

Pole Interaction Design Data

Section No.	Elevation ft	Ratio $\frac{P_u}{\phi P_n}$	Ratio $\frac{M_{ux}}{\phi M_{nx}}$	Ratio $\frac{M_{uy}}{\phi M_{ny}}$	Ratio $\frac{V_u}{\phi V_n}$	Ratio $\frac{T_u}{\phi T_n}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	60 - 36.378 (1)	0.005	0.632	0.000	0.031	0.000	0.638 ✔	1.000	4.8.2 ✔
L2	36.378 - 1.1e-005 (2)	0.006	0.779	0.000	0.023	0.000	0.785 ✔	1.000	4.8.2 ✔

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	ϕP_{allow} K	% Capacity	Pass Fail
L1	60 - 36.378	Pole	TP10.598x7.087x0.126	1	-1.16	236.85	63.8	Pass
L2	36.378 - 1.1e-005	Pole	TP15.748x9.999x0.157	2	-2.57	455.88	78.5	Pass
							Summary	
						Pole (L2)	78.5	Pass
						Base Plate	71.6	Pass
						RATING =	**78.5**	**Pass**

Base/Flange Plate	Plate Type	***Baseplate***	
	Pole Diameter	15.748	in
	Pole Thickness	0.157	in
	Plate Diameter	25.2	in
	Plate Thickness	1.575	in
	Plate Fy	50	ksi
	Weld Length	0.25	in
	ϕ_s Resistance	172.58	k-in
	Applied	70.21	k-in
Stiffeners	#	***0***	

Bolts	#	***8***	
	Bolt Circle	21.26	in
	(R)adial / (S)quare	R	
●	Diameter	1.25	in
	Hole Diameter	1.56	in
	Type	F1554 Gr. 55	
	Fy	55	ksi
	Fu	75	ksi
	ϕ_s Resistance	58.15	k
	Applied	40.68	k
Reinforcement ●	#	***0***	
Extra Bolts O	#	***0***	

Code Rev.	***H***	**Date**	3/11/2022
		Engineer	KK

Moment	143.0 k-ft
Axial	3.0 k
Shear	3.0 k

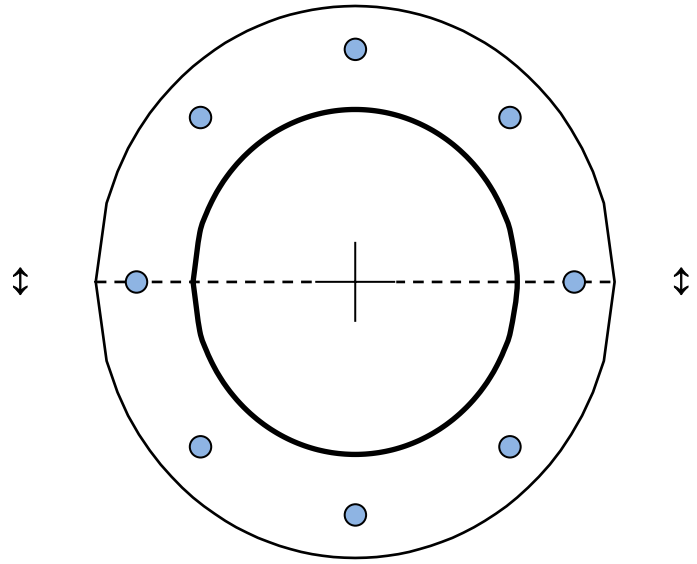


Plate Stress Ratio:
0.41 (Pass)

Bolt Stress Ratio:
0.70 (Pass)

Anchor bolt length calculation

PROJECT/ POLE TYPE: **Monopole**

Reference: According to the code ACI 318-14 (25.4.2.3), for deformed bars, we can get below information:

The user may easily construct simple, useful expressions. For example, in all structures with normalweight concrete ($\lambda = 1.0$), uncoated reinforcement ($\psi_e = 1.0$), No. 7 or larger bottom bars ($\psi_t = 1.0$) with f'_c = 4000 psi and Grade 60 reinforcement, the equations reduce to

$$\ell_d = \frac{(60{,}000)(1.0)(1.0)}{20(1.0)\sqrt{4000}} d_b = 47 d_b$$

or

$$\ell_d = \frac{3(60{,}000)(1.0)(1.0)}{40(1.0)\sqrt{4000}} d_b = 71 d_b$$

Thus, as long as minimum cover of d_b is provided along with a minimum clear spacing of $2d_b$, or a minimum clear cover of d_b and a minimum clear spacing of d_b are provided along with minimum ties or stirrups, then $\ell_d = 47 d_b$. The penalty for spacing bars closer or providing less cover is the requirement that $\ell_d = 71 d_b$.

Many practical combinations of side cover, clear cover, and confining reinforcement can be used with 12.2.3 to produce significantly shorter development lengths than allowed by 12.2.2. For example, bars or wires with minimum clear cover not less than $2d_b$ and minimum clear spacing not less than $4d_b$ and without any confining reinforcement would have a $(c_b + K_{tr})/d_b$ value of 2.5 and would require a development length of only $28 d_b$ for the example above.

So when the project satisfy below requirements:

1. The anchor bolts is for No.7 or larger bottom bars.
2. With minimum clear cover not less than 2db and minimum clear spacing not less than 4db.
3. Compressive strength of the concrete is 4000 psi.
4. Deformed bar is grade 60

The development length Ld should be

$$l_d \geq 28\, d_b$$

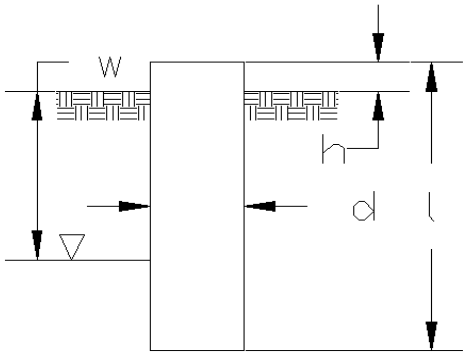
where db is the bar diameter

For this project,

Rebar size	d_b =	0.875	in
Grade of bar	Fy=	60	ksi
Usage of bar	=	1.00	
The required development length of rebars:			
ld= Fy/60*usage*db*28	=	24.5	in
Clear cover	=	3.0	in
Tie size	=	0.375	in
Anchor bolt size	=	1.250	in
Anchor bolt circle diameter	=	21.260	in
Anchor bolt template diameter	=	27.260	in
Seismic Design Category	=	B	
Min. inside bend dia. plus standard/seismic hook length (ACI 318-14 25.3.2)	=	0.000	in, 90 deg hook
Min. Rebar cage diameter	=	32.135	in
Min. Caisson Diameter	=	3.313	ft
Caisson diameter used	=	**4.0**	ft
Clear spacing between rebar and anchor bolt	=	4.375	in
The req'd minimum anchor bolt length with 12" length protrusion	=	**42.56**	in
	Calculate by :	KK	
	Date:	3/11/2022	

Site Name:
Site Number:
Engineer: KK
Engineering Number: 0
Date: 03/11/22

Program Last Updated: *9/10/2015*



Design Base Loads (Factored) - Analysis per TIA-222-H Standards

Analyze or Design a Foundation?	Design	
Foundation Mapped:	N	
Moment (M):	143.0	k-ft
Shear/Leg (V):	3.0	k
Axial Load (P):	3.0	k
Uplift/Leg (U):	0.0	k
Tower Type (GT / SST / MP):	MP	
Diameter of Caisson (d):	4.0	ft
Caisson Embedment (L-h):	14.0	ft
Caisson Height Above Ground (h):	0.5	ft
Depth Below Ground Surface to Water Table (w):	99.0	ft
Unit Weight of Concrete:	150.0	pcf
Unit Weight of Water:	62.4	pcf
Tension Skin Friction/Compression Skin Friction:	1.00	
Pullout Angle:	30.0	degrees

Engineer Notes
#3 ties @ 2.5" c-c for top 10" and @12" c-c for remainder.

Soil Mechanical Properties

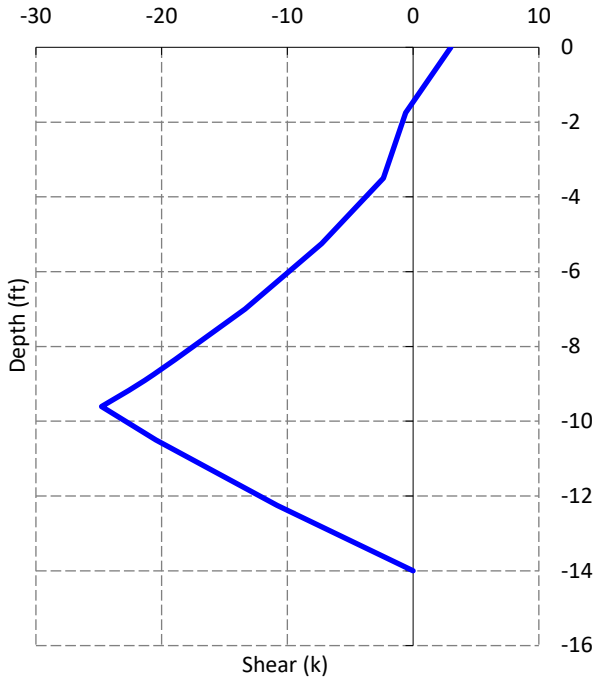
Depth (ft) Top	Depth (ft) Bottom	γ_{Soil} (pcf)	Cohesion (psf)	ϕ (degree)	Ultimate Skin Friction (psf)	Ultimate Bearing Pressure (psf)
0.0	3.0	120	0	0	0	0
3.0	15.0	120	130	0	130	1500

Required Embedment:	11.9	ft - OK, Caisson Embedment Satisfactory
Volume of Concrete:	182.2	ft^3 = 6.7 yd^3
Weight of Concrete (Buoyancy Effect Considered):	27.3	k
Average Soil Unit Weight:	120.0	pcf
Skin Friction Resistance:	18.0	k
Compressive Bearing Resistance:	18.8	k
Pullout Weight (Minus Concrete Weight):	200.3	k
Nominal Uplift Capacity per Leg ($\phi_s T_n$):	34.0	k
Nominal Compressive Capacity per Leg ($\phi_s P_n$):	27.6	k
P_u:	9.3	k
$T_u/\phi_s T_n$:	0.00	Result: OK
$P_u/\phi_s P_n$:	0.34	Result: OK
Total Lateral Resistance:	157.7	k
Inflection Point (Below Ground Surface):	9.6	ft
Design Overturning Moment At Inflection Point (M_D):	173.3	k-ft
Nominal Moment Capacity ($\phi_s M_n$):	324.2	k-ft
$M_D/\phi_s M_n$:	0.53	Result: OK
ϕ_s:	0.75	

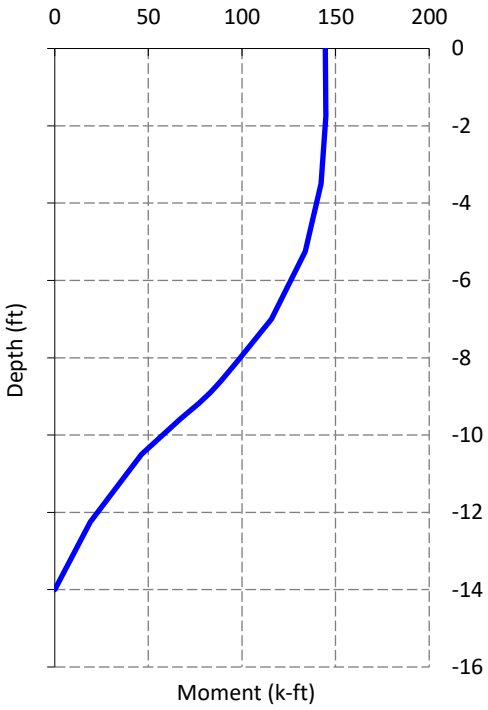
Caisson Strength Capacity

Concrete Compressive Strength (f'_c):	4500	psi
Vertical Steel Rebar Size #:	7	
Vertical Steel Rebar Area:	0.60	in^2
# of Vertical Steel Rebars:	16	Minimum # of vertical rebar met for RR
Vertical Steel Rebar Yield Strength (F_y):	60	ksi
Horizontal Tie / Stirrup Size #:	3	
Horizontal Tie / Stirrup Area:	0.11	in^2
Required Horizontal Tie / Stirrup Spacing:	12.0	in
Design Horizontal Tie / Stirrup Spacing:	12.0	in - Tie Spacing is Satisfactory
Horizontal Tie / Stirrup Steel Yield Strength (F_y):	60	ksi
Rebar Cage Diameter:	40.0	in
Strength Bending/Tension Reduction Factor (ϕ_B):	0.90	ACI318-05 - 9.3.2.1
Strength Shear Reduction Factor (ϕ_V):	0.75	ACI318-05 - 9.3.2.3
Strength Compression Reduction Factor (ϕ_V):	0.65	ACI318-05 - 9.3.2.2
Steel Elastic Modulus:	29000	ksi
Design Moment (M_u):	144.8	k-ft
Nominal Moment Capacity ($\phi_B M_n$):	848.3	k-ft - ACI318-005 - 10.2
$M_u/\phi_B M_n$:	0.17	Result: OK
Design Shear (V_u):	24.8	k
Nominal Shear Capacity ($\phi_V V_n$):	182.2	k - ACI318-05 - 11.3.1.1 or 11.5.7.2
$V_u/\phi_V V_n$:	0.14	Result: OK
Design Tension (T_u):	0.0	k
Nominal Tension Capacity ($\phi_T T_n$):	518.4	k - ACI318-05 - 10.2
$T_u/\phi_T T_n$:	0.00	Result: OK
Design Compression (P_u):	9.3	k
Nominal Compression Capacity ($\phi_P P_n$):	3580.1	k - ACI318-05 - 10.3.6.2
$P_u/\phi_P P_n$:	0.00	Result: OK
Bending Reinforcement Ratio:	0.005	Reinforcement Ratio is Satisfactory - ACI318-05 - 10.8.4 & 10.9.1
$M_u/\phi_B M_n + T_u/\phi_T T_n$:	0.17	Result: OK

Design Factored Shear / Depth



Design Factored Moment / Depth



Nominal and Factored Moment Capacity and Factored Design Loads