STATE OF CONNECTICUT

CONNECTICUT SITING COUNCIL

Ten Franklin Square, New Britain, CT 06051
Phone: (860) 827-2935 Fax: (860) 827-2950
E-Mail: siting.council@ct.gov
Internet: ct.gov/csc

Daniel F. Caruso
Chairman

December 11, 2007

Kenneth C. Baldwin, Esq.
Robinson & Cole LLP
280 Trumbull Street
Hartford, CT 06103-3597

RE: **EM-VER-023-071107** - Cellco Partnership d/b/a Verizon Wireless notice of intent to modify an existing telecommunications facility located at 650 Albany Turnpike, Canton, Connecticut.

Dear Attorney Baldwin:

At a public meeting held on November 29, 2007, the Connecticut Siting Council (Council) acknowledged your notice to modify this existing telecommunications facility, pursuant to Section 16-50j-73 of the Regulations of Connecticut State Agencies.

The proposed modifications are to be implemented as specified here and in your notice dated November 7, 2007, including the placement of all necessary equipment and shelters within the tower compound. The modifications are in compliance with the exception criteria in Section 16-50j-72 (b) of the Regulations of Connecticut State Agencies as changes to an existing facility site that would not increase tower height, extend the boundaries of the tower site, increase noise levels at the tower site boundary by six decibels, and increase the total radio frequencies electromagnetic radiation power density measured at the tower site boundary to or above the standard adopted by the State Department of Environmental Protection pursuant to General Statutes § 22a-162. This facility has also been carefully modeled to ensure that radio frequency emissions are conservatively below State and federal standards applicable to the frequencies now used on this tower.

This decision is under the exclusive jurisdiction of the Council. Please be advised that the validity of this action shall expire one year from the date of this letter. Any additional change to this facility will require explicit notice to this agency pursuant to Regulations of Connecticut State Agencies Section 16-50j-73. Such notice shall include all relevant information regarding the proposed change with cumulative worst-case modeling of radio frequency exposure at the closest point of uncontrolled access to the tower base, consistent with Federal Communications Commission, Office of Engineering and Technology, Bulletin 65. Any deviation from this format may result in the Council implementing enforcement proceedings pursuant to General Statutes § 16-50u including, without limitation, imposition of expenses resulting from such failure and of civil penalties in an amount not less than one thousand dollars per day for each day of construction or operation in material violation.

Thank you for your attention and cooperation.

Very truly yours,

Daniel F. Caruso
Chairman

DFC/MP/laf

c: The Honorable Richard J. Barlow, First Selectman, Town of Canton
Neil Pade, Town Planner, Town of Canton

STATE OF CONNECTICUT

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Daniel F. Caruso
Chairman

November 7, 2007

The Honorable Mary B. Tomolonius
First Selectman
Town of Canton
4 Market Street
P. O. Box 168
Collinsville, CT 06022-0168

RE: **EM-VER-023-071107** - Cellco Partnership d/b/a Verizon Wireless notice of intent to modify an existing telecommunications facility located at 650 Albany Turnpike, Canton, Connecticut.

Dear Ms. Tomolonius:

The Connecticut Siting Council (Council) received this request to modify an existing telecommunications facility, pursuant to Regulations of Connecticut State Agencies Section 16-50j-72.

The Council will consider this item at the next meeting scheduled for November 29, 2007, at 1:30 p.m. in Hearing Room One, Ten Franklin Square, New Britain, Connecticut.

If you have any questions or comments regarding this proposal, please call me or inform the Council by November 28, 2007.

Thank you for your cooperation and consideration.

Very truly yours,

S. Derek Phelps
Executive Director

SDP/cm

Enclosure: Notice of Intent

c: Neil Pade, Town Planner, Town of Canton

ROBINSON & COLE LLP

KENNETH C. BALDWIN

280 Trumbull Street
Hartford, CT 06103-3597
Main (860) 275-8200
Fax (860) 275-8299
kbaldwin@rc.com
Direct (860) 275-8345

EM-VER-023-071107

November 7, 2007

Via Hand Delivery

S. Derek Phelps
Executive Director
Connecticut Siting Council
10 Franklin Square
New Britain, CT 06051

Re: **Notice of Exempt Modification – Antenna Swap**
650 Albany Turnpike, Canton, Connecticut

Dear Mr. Phelps:

Cellco Partnership d/b/a Verizon Wireless ("Cellco") currently maintains a wireless telecommunications facility at the above referenced location. In its continuing effort to improve the quality and reliability of its wireless service, Cellco intends to replace and upgrade its antenna system at this existing facility.

The Council approved this facility in Docket No. 204. The Council then approved Petition No. 648 permitting Cellco to extend the tower by 120 feet and to install twelve (12) PCS antennas. Cellco now intends to modify its installation by replacing six (6) PCS antennas with six (6) cellular antennas at the same 120-foot level on the tower. Attached behind Tab 1 are the specifications for the proposed replacement antennas.

Please accept this letter as notification pursuant to R.C.S.A. § 16-50j-73, for construction that constitutes an exempt modification pursuant to R.C.S.A. § 16-50j-72(b)(2). In accordance with R.C.S.A. § 16-50j-73, a copy of this letter is being sent to Mary B. Tomolonius, First Selectman of the Town of Canton. Pursuant to a Council directive, a copy of this letter is also being sent to Edward T. Lally, Jr., the owner of the property on which the facility is located.

The planned modifications to the facility falls squarely within those activities explicitly provided for in R.C.S.A. § 16-50j-72(b)(2).

1. The proposed modifications will not result in any increase in the overall height of the existing structures. Cellco's replacement antennas will be located at the same height and location as the existing antennas.

2. The proposed modifications will not involve any ground-mounted equipment and, therefore, will not require the extension of the site boundaries.

3. The proposed modifications will not increase noise levels at the facility by six decibels or more.

4. The operation of the replacement antennas will not increase radio frequency (RF) power density levels at the facility to a level at or above the Federal Communications Commission (FCC) adopted safety standard. A cumulative power density table for the facility is included behind Tab 2.

Also attached is a Detailed Structural Analysis confirming that the tower can support the proposed modifications. (See Tab 3).

For the foregoing reasons, Cellco respectfully submits that the proposed modifications to the above-referenced telecommunications facility constitutes an exempt modification under R.C.S.A. § 16-50j-72(b)(2).

Sincerely,

Kenneth C. Baldwin

Enclosures
Copy to:
Mary B. Tomolonius, Canton First Selectman
Edward T. Lally, Jr.
Sandy M. Carter

Vertically Polarized, Log Periodic 80° / 14 dBd

LPA-80080/6CF ___

When ordering replace "___" with connector type.

Mechanical specifications

Length	1800	mm	70.9	in
Width	140	mm	5.5	in
Depth	335	mm	13.2	in
Depth with z-bracket	375	mm	14.8	in
[4] Weight	9.5	kg	21.0	lbs
Wind Area				
Fore/Aft	0.25	m^2	2.7	ft^2
Side	0.60	m^2	6.5	ft^2
Rated Wind Velocity (Safety factor 2.0)	>295	km/hr	>183	mph
Wind Load @ 100 mph (161 km/hr)				
Fore/Aft	415	N	93.3	lbs
Side	870	N	195.6	lbs

Antenna consisting of aluminum alloy with brass feedlines covered by a UV safe fiberglass radome.

Mounting and Downtilting

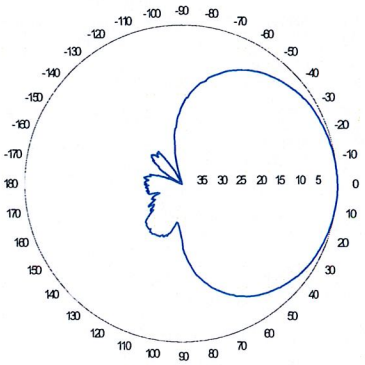
Mounting brackets attach to a pipe diameter of Ø50-102 mm (2.0-4.0 in). If the lock-down brace is used, the maximum diameter is Ø88.9 mm (3.5 in)

Mounting Bracket & Downtilt Bracket Kit #21699999

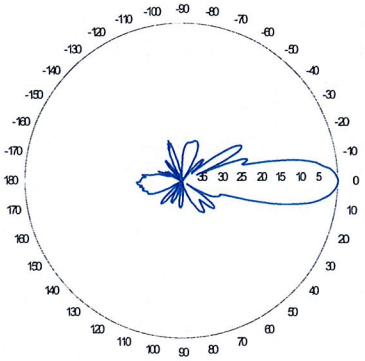
Electrical specifications

	Frequency Range	806-960 MHz
	Impedance	50Ω
[3]	Connector(s)	NE or E-DIN 1 port / center
[1]	VSWR	≤ 1.4:1
	Polarization	Vertical
[1]	Gain	14 dBd
[2]	Power Rating	500 W
[1]	Half Power Angle	
	H-Plane	80°
	E-Plane	10°
[1]	Electrical Downtilt	0°
[1]	Null Fill	10%
	Lightning Protection	Direct Ground

Radiation pattern[1]



Horizontal

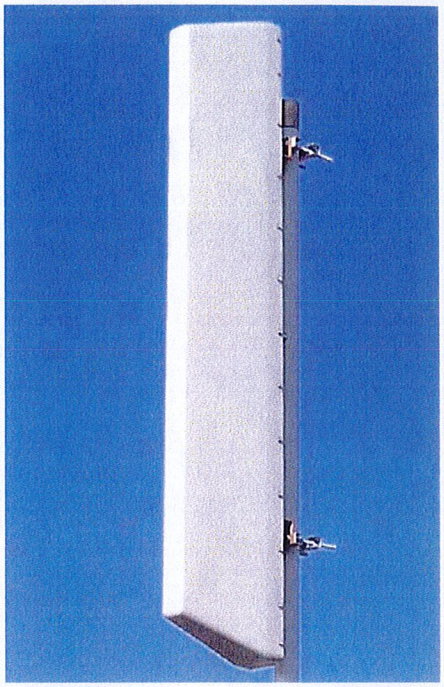


Vertical

Featuring upper side lobe suppression.

Radiation patterns for all antennas are measured with the antenna mounted on a fiberglass pole.

Mounting on a metal pole will typically improve the Front-to-Back ratio.



Amphenol Antel's Exclusive 3T (True Transmission Line Technology) Antenna Design:

- True log-periodic design allows for superior front-to-side characteristics to minimize sector overlap.
- Unique feedline design eliminates the need for conventional solder joints in the signal path.
- A non-collinear system with access to every radiating element for broad band-width and superior performance.
- Air as insulation for virtually no internal signal loss.

This Amphenol Antel antenna is under a five-year limited warranty for repair or replacement.

Antenna available with center-fed connector only.

1) Typical values.
2) Power rating limited by connector only.
3) NE indicates an elongated N connector. E-DIN indicates an elongated DIN connector.
4) The antenna weight listed above does not include the bracket weight.

Improvements to mechanical and/or electrical performance of the antenna may be made without notice.

CF Denotes a Center-Fed Connector.

806-960 MHz

Amphenol Antel, Inc. 1300 Capital Drive Rockford, Illinois 61109 USA Tel. (815) 399-0001
Toll-Free (888) 417-9562 Fax. (815) 399-0156 antel@antelinc.com www.antelinc.com

Revision Date: 7/5/07

	General	Power	Density					
Site Name: Collinsville								
Tower Height: Verizon @ 120Ft.								
CARRIER	**# OF CHAN.**	**WATTS ERP**	**HEIGHT**	**CALC. POWER DENS**	**FREQ.**	**MAX. PERMISS. EXP.**	**FRACTION MPE**	**Total**
*AT&T	2	296	110	0.0176	880	0.5867	3.00%	
*AT&T	2	427	110	0.0254	1900	1.0000	2.54%	
VZW PCS	**3**	**485**	**120**	**0.0363**	**1970**	**1.0000**	**3.63%**	
VZW	**3**	**200**	**120**	**0.0450**	**875**	**0.5830**	**7.72%**	
								16.89%
* Source: Siting Council								

DETAILED STRUCTURAL ANALYSIS AND EVALUATION OF AN EXISTING 120' MONOPOLE TOWER AND ITS FOUNDATION FOR NEW ANTENNA ARRANGEMENT

Site Name: Collinsville
650 Albany Turnpike,
Collinsville, CT 06019

prepared for

Verizon Wireless
99 East River Drive
East Hartford, Connecticut 06108

prepared by

URS CORPORATION
500 ENTERPRISE DRIVE, SUITE 3B
ROCKY HILL, CT 06067
TEL. 860-529-8882

36931103.00000
VZ4-027

November 5, 2007

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

This report summarizes the independent structural analysis of the existing 120' steel monopole structure, located at 650 Albany Turnpike in Collinsville, CT. The analysis was conducted in accordance with the 2005 Connecticut State Building Code and the TIA/EIA-222-F standard for a wind velocity of 80 mph (fastest mile) and 69 mph (fastest mile) concurrent with ½" ice. The antenna loading considered in the analysis consists of all existing and proposed antennas, transmission lines, and ancillary items as outlined in the Introduction Section of this report. The proposed Verizon Wireless installation is as follows:

Proposed Antenna and Mount	Carrier	Antenna Center Elevation
<u>On the existing Verizon platform:</u> **<u>Remove:</u>** **(6) Decibel DB950F85E-M antennas**	**Verizon (existing)**	**@ 120'**
<u>Install:</u> **(6) Antel LPA 80080/6F antennas**	**Verizon (Proposed)**	

The results of the analysis indicate that the tower structure has the capacity to support the proposed loading conditions. **The tower and its foundation are considered structurally adequate with the wind load classification specified above and the proposed antenna loading.**

This analysis is based on:

1) The tower structure's theoretical capacity, not including any assessment of the condition of the tower.

2) Tower geometry and structural member sizes obtained from manufacturers design documents for a 120' monopole, extendable to 150', prepared by Engineered Endeavors Incorporated, (EEI), on behalf of Verizon Wireless, EEI Job # 11936-E01, dated September 11, 2003.

3) Geotechnical Engineering Report prepared by Clough, Harbor & Associates, LLP., on behalf of Verizon Wireless, signed and sealed November 20, 2002.

4) Previous structural review prepared by Paul J. Ford on behalf of Cingular Wireless, signed and sealed December 20, 2004.

5) Site documentation conducted by URS during October 2007.

6) Antenna and mount configuration as specified within Section 2 of this report.

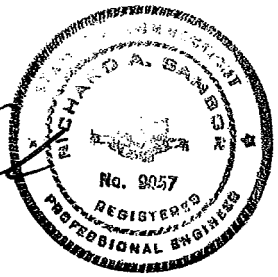
1. EXECUTIVE SUMMARY – *continued*

This report is only valid as per the assumptions and data utilized in this report for antenna inventory, mounts and associated cables. The user of this report shall field verify the assumption of the antenna and mount configuration as well as the physical condition of the tower. Notify the engineer in writing immediately if any of the information in this report is found to be other than specified.

If you should have any questions, please call.

Sincerely,

URS Corporation



Richard A. Sambor, P.E.
Manager Facilities Design

RAS/jrm
cc: AA, DR, ICA – URS, CF/Book

2. INTRODUCTION

The subject tower is located at 650 Albany Turnpike in Collinsville, CT. The structure is an existing 120' steel monopole, extendable to 150', designed and manufactured by Engineered Endeavors Incorporated, (EEI).

The inventory is summarized in the table below:

Antenna Type	***Carrier***	***Mount***	***Antenna Centerline Elevation***	***Cable***
(6) Decibel DB950F85E-M antennas	Verizon (existing)	(1) 14' Low-Profile Platform	120'	(12) 1 5/8" coax cables (within monopole)
(6) Antel LPA 80080/6CF antennas	**Verizon (proposed)**	(1) 14' Low-Profile Platform (same as above)	120'	Existing coax to be re-used (same as above)
(12) Katherein AP14/17-880/1940 antennas and (12) TMA's	AT&T (existing)	(1) 13' Low Profile Platform	110'	(12) 1 5/8" coax cables (within monopole)

This structural analysis of the communications tower was performed by URS Corporation (URS) for Verizon Wireless. The purpose of this analysis was to investigate the structural integrity of the existing tower with its existing and proposed antenna loads. This analysis was conducted to evaluate stress on the tower and the effect of forces to the foundation of the tower resulting from existing and proposed antenna arrangements.

3. ANALYSIS METHODOLOGY AND LOADING CONDITIONS

The structural analysis was conducted in accordance with the 2005 Connecticut State Building Code, TIA/EIA-222-F—Structural Standard for Steel Antenna Towers and Antenna Supporting Structures, and the American Institute of Steel Construction (AISC) Manual of Steel Construction—Allowable Stress Design (ASD).

The analysis was conducted using RISA Tower 5.0. Two load conditions were evaluated as shown below which were compared to allowable stresses according to AISC and TIA/EIA.

Load Condition 1 = 80 mph (fastest mile) Wind Load (without ice) + Tower Dead Load
Load Condition 2 = 69 mph (fastest mile) Wind Load (with ice) + Ice Load + Tower Dead Load

Please note that wind pressure is a function of velocity squared. Under Load Condition 2, a 25 percent reduction in wind pressure is allowed by code to account for the unlikelihood of the full wind pressure and ice load occurring at the same time. The same results may be achieved by utilizing a lower wind pressure without taking the 25 percent reduction, as shown above.

The TIA/EIA standard permits a one-third increase in allowable stresses for towers and monopoles less than 700 feet tall. For the purposes of this analysis, in computing the load capacity the allowable stresses of the tower members were increased by one-third.

4. FINDINGS AND EVALUATION

Combined axial and bending stresses on the monopole structure were evaluated to compare with allowable stresses in accordance with AISC. The calculated stresses under the proposed loading were below the allowable stresses. Detailed analysis and calculations for the proposed load condition are provided in section 6 of this report. Additionally, the anchor bolts, base plate, and foundation were found to be structurally adequate.

Tower Component Stress vs. Capacity Summary

Component/Member	Controlling Component / Elevation	Stress Ratio (% capacity)	Pass/Fail	Notes:
Pole Shaft	0'-46.2'	30.2%	Pass	
Anchor Bolts	Tension	25.0%	Pass	
Base Plate		36.0%	Pass	

Foundation	Vector	Overturning Factor (F.O.S)	Pass/Fail	Comments:
Reinf. Concrete Pad and Pier	OTM	7.85	Pass	Min of 2.0 F.O.S reqd.

Note: Overturning Moment (OTM) controls foundation design

5. CONCLUSIONS

The results of the analysis indicate that the tower structure is in compliance with the proposed loading conditions. **The tower and its foundation are considered structurally adequate with the wind load classification specified above and the proposed antenna loading.**

Limitations/Assumptions:

This report is based on the following:

1. Tower inventory as listed in this report.
2. Tower is properly installed and maintained.
3. All members are as specified in the original design documents and are in good condition.
4. All required members are in place.
5. All bolts are in place and are properly tightened.
6. Tower is in plumb condition.
7. All member protective coatings are in good condition.
8. All tower members were properly designed, detailed, fabricated, and installed and have been properly maintained since erection.
9. Foundations were properly constructed to support original design loads as specified in the original design documents.
10. All coaxial cable is installed within the monopole unless specified otherwise.

URS is not responsible for any modifications completed prior to or hereafter in which URS is not or was not directly involved. Modifications include but are not limited to:

A. Adding antennas
B. Removing/replacing antennas
C. Adding coaxial cables

URS hereby states that this document represents the entire report and that it assumes no liability for any factual changes that may occur after the date of this report. All representations, recommendations, and conclusions are based upon information contained and set forth herein. If you are aware of any information which conflicts with that which is contained herein, or you are aware of any defects arising from original design, material, fabrication, or erection deficiencies, you should disregard this report and immediately contact URS. URS disclaims all liability for any representation, recommendation, or conclusion not expressly stated herein.

Ongoing and Periodic Inspection and Maintenance:

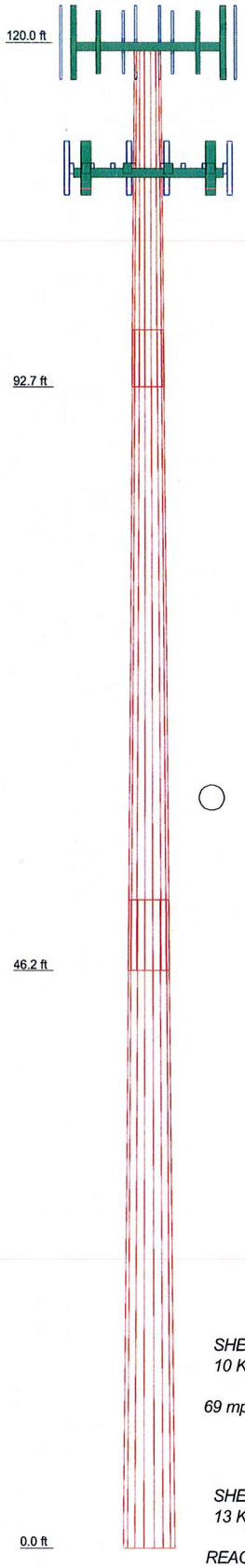
After the Contractor has successfully completed the installation and the work has been accepted, the owner will be responsible for the ongoing and periodic inspection and maintenance of the tower.

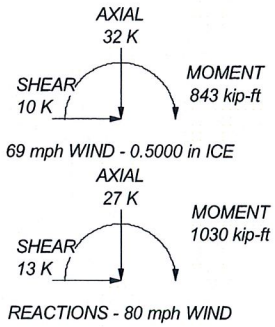
The owner shall refer to TIA/EIA-222-F for recommendations for maintenance and inspection. The frequency of the inspection and maintenance intervals is to be determined by the owner based upon actual site and environmental conditions. It is recommended that a complete and thorough inspection of the entire tower structural system be performed at least yearly and more frequently as conditions warrant. According to TIA/EIA-222-F section 14.1, Note 1: It is recommended that the structure be inspected after severe wind and/or ice storms or other extreme loading conditions.

6. DRAWINGS AND DATA

RISA TOWER INPUT/OUTPUT SUMMARY

Section	Length (ft)	Number of Sides	Thickness (in)	Lap Splice (ft)	Top Dia (in)	Bot Dia (in)	Grade	Weight (K)
1	27.29	18	0.2500	4.58	26.9000	32.2700		2.2
2	51.13	18	0.3750	5.67	30.8688	40.8000	A572-65	7.3
3	51.83	18	0.4375		38.9487	49.0000		10.7
								20.2





69 mph WIND - 0.5000 in ICE

REACTIONS - 80 mph WIND

DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
14' Low Profile Platform (VERIZON)	120	AP14/17-880/1940/065D/ADT/XXP (ATI)	110
LPA-80080/6CF (VERIZON - proposed)	120	AP14/17-880/1940/065D/ADT/XXP (ATI)	110
LPA-80080/6CF (VERIZON - proposed)	120	AP14/17-880/1940/065D/ADT/XXP (ATI)	110
LPA-80080/6CF (VERIZON - proposed)	120	AP14/17-880/1940/065D/ADT/XXP (ATI)	110
LPA-80080/6CF (VERIZON - proposed)	120	AP14/17-880/1940/065D/ADT/XXP (ATI)	110
LPA-80080/6CF (VERIZON - proposed)	120	AP14/17-880/1940/065D/ADT/XXP (ATI)	110
DB950F85E-M (VERIZON)	120	AP14/17-880/1940/065D/ADT/XXP (ATI)	110
DB950F85E-M (VERIZON)	120	AP14/17-880/1940/065D/ADT/XXP (ATI)	110
DB950F85E-M (VERIZON)	120	AP14/17-880/1940/065D/ADT/XXP (ATI)	110
DB950F85E-M (VERIZON)	120	AP14/17-880/1940/065D/ADT/XXP (ATI)	110
DB950F85E-M (VERIZON)	120	(4) TMA 10"x8"x3" (ATI)	110
DB950F85E-M (VERIZON)	120	(4) TMA 10"x8"x3" (ATI)	110
Andrew 12'-6" Low Profile Platform (ATI)	110	(4) TMA 10"x8"x3" (ATI)	110

MATERIAL STRENGTH

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

TOWER DESIGN NOTES

1. Tower is located in Hartford County, Connecticut.
2. Tower designed for a 80 mph basic wind in accordance with the TIA/EIA-222-F Standard.
3. Tower is also designed for a 69 mph basic wind with 0.50 in ice.
4. Deflections are based upon a 50 mph wind.
5. TOWER RATING: 30.2%

URS Corporation
500 Enterprise Drive, Suite 3B
Rocky Hill, CT 06067
Phone: (860) 529-8882
FAX: (860) 529-3991

Job: ***Existing 120' EEI Monopole***			
Project: ***650 Albany Turnpike, Collinsville, CT***			
Client: Verizon Wireless	Drawn by: Staff	App'd:	
Code: TIA/EIA-222-F	Date: 11/05/07	Scale: NTS	
Path: P:\08\ERI Files\VZ4-027 Collinsville 36931103.eri		Dwg No. E-1	

RISA TOWER DETAILED OUTPUT

Tower Input Data

There is a pole section.
This tower is designed using the TIA/EIA-222-F standard.
The following design criteria apply:

Tower is located in Hartford County, Connecticut.
Basic wind speed of 80 mph.
Nominal ice thickness of 0.5000 in.
Ice density of 56 pcf.
A wind speed of 69 mph is used in combination with ice.
Temperature drop of 50 °F.
Deflections calculated using a wind speed of 50 mph.
A non-linear (P-delta) analysis was used.
Pressures are calculated at each section.
Stress ratio used in pole design is 1.333.
Local bending stresses due to climbing loads, feedline supports, and appurtenance mounts are not considered.

Options

	Consider Moments - Legs		Distribute Leg Loads As Uniform		Treat Feedline Bundles As Cylinder
	Consider Moments - Horizontals		Assume Legs Pinned		Use ASCE 10 X-Brace Ly Rules
	Consider Moments - Diagonals	√	Assume Rigid Index Plate		Calculate Redundant Bracing Forces
	Use Moment Magnification		Use Clear Spans For Wind Area		Ignore Redundant Members in FEA
√	Use Code Stress Ratios		Use Clear Spans For KL/r		SR Leg Bolts Resist Compression
√	Use Code Safety Factors - Guys		Retension Guys To Initial Tension		All Leg Panels Have Same Allowable
	Escalate Ice	√	Bypass Mast Stability Checks		Offset Girt At Foundation
	Always Use Max Kz		Use Azimuth Dish Coefficients		Consider Feedline Torque
	Use Special Wind Profile	√	Project Wind Area of Appurt.		Include Angle Block Shear Check
	Include Bolts In Member Capacity		Autocalc Torque Arm Areas		Poles
	Leg Bolts Are At Top Of Section		SR Members Have Cut Ends	√	Include Shear-Torsion Interaction
	Secondary Horizontal Braces Leg	√	Sort Capacity Reports By Component		Always Use Sub-Critical Flow
	Use Diamond Inner Bracing (4 Sided)		Triangulate Diamond Inner Bracing		Use Top Mounted Sockets
	Add IBC .6D+W Combination				

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	120.00-92.71	27.29	4.58	18	26.9000	32.2700	0.2500	1.0000	A572-65 (65 ksi)
L2	92.71-46.16	51.13	5.67	18	30.8688	40.8000	0.3750	1.5000	A572-65 (65 ksi)
L3	46.16-0.00	51.83		18	38.9487	49.0000	0.4375	1.7500	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	27.3150	21.1468	1897.4748	9.4608	13.6652	138.8545	3797.4464	10.5754	4.2944	17.178
	32.7678	25.4079	3291.1552	11.3671	16.3932	200.7639	6586.6410	12.7063	5.2395	20.958
L2	32.2483	36.2952	4263.9191	10.8253	15.6813	271.9105	8533.4488	18.1511	4.7729	12.728
	41.4294	48.1159	9934.0359	14.3509	20.7264	479.2938	19881.1433	24.0625	6.5208	17.389
L3	40.6661	53.4776	10020.3566	13.6715	19.7859	506.4384	20053.8983	26.7439	6.0850	13.909
	49.7559	67.4351	20092.1096	17.2397	24.8920	807.1714	40210.6569	33.7240	7.8540	17.952

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
L1 120.00-92.71				1	1	1		
L2 92.71-46.16				1	1	1		
L3 46.16-0.00				1	1	1		

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number		C_AA_A ft^2/ft	Weight plf
1 5/8 (Verizon)	C	No	Inside Pole	120.00 - 3.00	12	No Ice	0.00	1.04
						1/2" Ice	0.00	1.04
1 5/8 (AT&T)	C	No	Inside Pole	110.00 - 3.00	12	No Ice	0.00	1.04
						1/2" Ice	0.00	1.04

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	120.00-92.71	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	0.000	0.56
L2	92.71-46.16	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	0.000	1.16
L3	46.16-0.00	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	0.000	1.08

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	120.00-92.71	A	0.500	0.000	0.000	0.000	0.000	0.00

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
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	0.000	0.000	0.56
L2	92.71-46.16	A	0.500	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	0.000	1.16
L3	46.16-0.00	A	0.500	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	0.000	1.08

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral ft	Vert ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
14' Low Profile Platform	C	None			0.0000	120.00	No Ice	15.00	15.00	2.10
(VERIZON)							1/2" Ice	18.00	18.00	3.25
LPA-80080/6CF	A	From Face	3.50		0.0000	120.00	No Ice	4.33	9.09	0.02
(VERIZON - proposed)			6.00				1/2" Ice	4.76	9.64	0.07
			0.00							
LPA-80080/6CF	A	From Face	3.50		0.0000	120.00	No Ice	4.33	9.09	0.02
(VERIZON - proposed)			-6.00				1/2" Ice	4.76	9.64	0.07
			0.00							
LPA-80080/6CF	B	From Face	3.50		0.0000	120.00	No Ice	4.33	9.09	0.02
(VERIZON - proposed)			6.00				1/2" Ice	4.76	9.64	0.07
			0.00							
LPA-80080/6CF	B	From Face	3.50		0.0000	120.00	No Ice	4.33	9.09	0.02
(VERIZON - proposed)			-6.00				1/2" Ice	4.76	9.64	0.07
			0.00							
LPA-80080/6CF	C	From Face	3.50		0.0000	120.00	No Ice	4.33	9.09	0.02
(VERIZON - proposed)			6.00				1/2" Ice	4.76	9.64	0.07
			0.00							
LPA-80080/6CF	C	From Face	3.50		0.0000	120.00	No Ice	4.33	9.09	0.02
(VERIZON - proposed)			-6.00				1/2" Ice	4.76	9.64	0.07
			0.00							
DB950F85E-M	A	From Face	3.50		0.0000	120.00	No Ice	2.53	4.19	0.01
(VERIZON)			4.00				1/2" Ice	2.90	4.57	0.03
			0.00							
DB950F85E-M	A	From Face	3.50		0.0000	120.00	No Ice	2.53	4.19	0.01
(VERIZON)			-4.00				1/2" Ice	2.90	4.57	0.03
			0.00							
DB950F85E-M	B	From Face	3.50		0.0000	120.00	No Ice	2.53	4.19	0.01
(VERIZON)			4.00				1/2" Ice	2.90	4.57	0.03
			0.00							
DB950F85E-M	B	From Face	3.50		0.0000	120.00	No Ice	2.53	4.19	0.01
(VERIZON)			-4.00				1/2" Ice	2.90	4.57	0.03
			0.00							
DB950F85E-M	C	From Face	3.50		0.0000	120.00	No Ice	2.53	4.19	0.01
(VERIZON)			4.00				1/2" Ice	2.90	4.57	0.03
			0.00							
DB950F85E-M	C	From Face	3.50		0.0000	120.00	No Ice	2.53	4.19	0.01
(VERIZON)			-4.00				1/2" Ice	2.90	4.57	0.03
			0.00							
Andrew 12'-6" Low Profile	C	None			0.0000	110.00	No Ice	14.45	14.45	1.30

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
Platform						1/2" Ice	19.00	19.00	1.69
(AT&T)									
AP14/17-	A	From Face	3.50	0.0000	110.00	No Ice	5.16	2.50	0.03
880/1940/065D/ADT/XXP			5.00			1/2" Ice	5.56	2.82	0.06
(AT&T)			0.00						
AP14/17-	A	From Face	3.50	0.0000	110.00	No Ice	5.16	2.50	0.03
880/1940/065D/ADT/XXP			-5.00			1/2" Ice	5.56	2.82	0.06
(AT&T)			0.00						
AP14/17-	B	From Face	3.50	0.0000	110.00	No Ice	5.16	2.50	0.03
880/1940/065D/ADT/XXP			5.00			1/2" Ice	5.56	2.82	0.06
(AT&T)			0.00						
AP14/17-	B	From Face	3.50	0.0000	110.00	No Ice	5.16	2.50	0.03
880/1940/065D/ADT/XXP			-5.00			1/2" Ice	5.56	2.82	0.06
(AT&T)			0.00						
AP14/17-	C	From Face	3.50	0.0000	110.00	No Ice	5.16	2.50	0.03
880/1940/065D/ADT/XXP			5.00			1/2" Ice	5.56	2.82	0.06
(AT&T)			0.00						
AP14/17-	C	From Face	3.50	0.0000	110.00	No Ice	5.16	2.50	0.03
880/1940/065D/ADT/XXP			-5.00			1/2" Ice	5.56	2.82	0.06
(AT&T)			0.00						
(4) TMA 10"x8"x3"	A	From Face	3.00	0.0000	110.00	No Ice	0.78	0.29	0.02
(AT&T)			0.00			1/2" Ice	0.90	0.38	0.02
			0.00						
(4) TMA 10"x8"x3"	B	From Face	3.00	0.0000	110.00	No Ice	0.78	0.29	0.02
(AT&T)			0.00			1/2" Ice	0.90	0.38	0.02
			0.00						
(4) TMA 10"x8"x3"	C	From Face	3.00	0.0000	110.00	No Ice	0.78	0.29	0.02
(AT&T)			0.00			1/2" Ice	0.90	0.38	0.02
			0.00						

Tower Pressures - No Ice

$G_H = 1.690$

Section Elevation ft	z ft	K_Z	q_z psf	A_G ft^2	Face	A_F ft^2	A_R ft^2	A_{leg} ft^2	Leg %	C_AA_A In Face ft^2	C_AA_A Out Face ft^2
L1 120.00-92.71	105.94	1.396	23	67.281	A	0.000	67.281	67.281	100.00	0.000	0.000
					B	0.000	67.281		100.00		
					C	0.000	67.281		100.00		
L2 92.71-46.16	69.03	1.235	20	140.733	A	0.000	140.733	140.733	100.00	0.000	0.000
					B	0.000	140.733		100.00		
					C	0.000	140.733		100.00		
L3 46.16-0.00	22.38	1	16	171.269	A	0.000	171.269	171.269	100.00	0.000	0.000
					B	0.000	171.269		100.00		
					C	0.000	171.269		100.00		

Tower Pressure - With Ice

$G_H = 1.690$

Section Elevation ft	z ft	K_Z	q_z psf	t_Z in	A_G ft²	Face	A_F ft²	A_R ft²	A_{leg} ft²	Leg %	C_AA_A In Face ft²	C_AA_A Out Face ft²
L1 120.00-92.71	105.94	1.396	17	0.5000	69.555	A	0.000	69.555	69.555	100.00	0.000	0.000
						B	0.000	69.555		100.00		
						C	0.000	69.555		100.00		
L2 92.71-46.16	69.03	1.235	15	0.5000	144.612	A	0.000	144.612	144.612	100.00	0.000	0.000
						B	0.000	144.612		100.00		
						C	0.000	144.612		100.00		
L3 46.16-0.00	22.38	1	12	0.5000	175.116	A	0.000	175.116	175.116	100.00	0.000	0.000
						B	0.000	175.116		100.00		
						C	0.000	175.116		100.00		

Tower Pressure - Service

$G_H = 1.690$

Section Elevation ft	z ft	K_Z	q_z psf	A_G ft²	Face	A_F ft²	A_R ft²	A_{leg} ft²	Leg %	C_AA_A In Face ft²	C_AA_A Out Face ft²
L1 120.00-92.71	105.94	1.396	9	67.281	A	0.000	67.281	67.281	100.00	0.000	0.000
					B	0.000	67.281		100.00		
					C	0.000	67.281		100.00		
L2 92.71-46.16	69.03	1.235	8	140.733	A	0.000	140.733	140.733	100.00	0.000	0.000
					B	0.000	140.733		100.00		
					C	0.000	140.733		100.00		
L3 46.16-0.00	22.38	1	6	171.269	A	0.000	171.269	171.269	100.00	0.000	0.000
					B	0.000	171.269		100.00		
					C	0.000	171.269		100.00		

Tower Forces - No Ice - Wind Normal To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.16	A	1	0.65	1	1	1	67.281	1.69	61.92	C
			B	1	0.65	1	1	1	67.281			
			C	1	0.65	1	1	1	67.281			
L2 92.71-46.16	1.16	7.34	A	1	0.65	1	1	1	140.733	3.11	66.83	C
			B	1	0.65	1	1	1	140.733			
			C	1	0.65	1	1	1	140.733			
L3 46.16-0.00	1.08	10.66	A	1	0.65	1	1	1	171.269	3.10	67.16	C
			B	1	0.65	1	1	1	171.269			
			C	1	0.65	1	1	1	171.269			
Sum Weight:	2.80	20.17						OTM	463.15 kip-ft	7.90		

Tower Forces - No Ice - Wind 45 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.16	A	1	0.65	1	1	1	67.281	1.69	61.92	C
			B	1	0.65	1	1	1	67.281			
			C	1	0.65	1	1	1	67.281			
L2 92.71-46.16	1.16	7.34	A	1	0.65	1	1	1	140.733	3.11	66.83	C
			B	1	0.65	1	1	1	140.733			
			C	1	0.65	1	1	1	140.733			
L3 46.16-0.00	1.08	10.66	A	1	0.65	1	1	1	171.269	3.10	67.16	C
			B	1	0.65	1	1	1	171.269			
			C	1	0.65	1	1	1	171.269			
Sum Weight:	2.80	20.17						OTM	463.15 kip-ft	7.90		

Tower Forces - No Ice - Wind 60 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.16	A	1	0.65	1	1	1	67.281	1.69	61.92	C
			B	1	0.65	1	1	1	67.281			
			C	1	0.65	1	1	1	67.281			
L2 92.71-46.16	1.16	7.34	A	1	0.65	1	1	1	140.733	3.11	66.83	C
			B	1	0.65	1	1	1	140.733			
			C	1	0.65	1	1	1	140.733			
L3 46.16-0.00	1.08	10.66	A	1	0.65	1	1	1	171.269	3.10	67.16	C
			B	1	0.65	1	1	1	171.269			
			C	1	0.65	1	1	1	171.269			
Sum Weight:	2.80	20.17						OTM	463.15 kip-ft	7.90		

Tower Forces - No Ice - Wind 90 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.16	A	1	0.65	1	1	1	67.281	1.69	61.92	C
			B	1	0.65	1	1	1	67.281			
			C	1	0.65	1	1	1	67.281			
L2 92.71-46.16	1.16	7.34	A	1	0.65	1	1	1	140.733	3.11	66.83	C
			B	1	0.65	1	1	1	140.733			
			C	1	0.65	1	1	1	140.733			
L3 46.16-0.00	1.08	10.66	A	1	0.65	1	1	1	171.269	3.10	67.16	C
			B	1	0.65	1	1	1	171.269			
			C	1	0.65	1	1	1	171.269			
Sum Weight:	2.80	20.17						OTM	463.15	7.90		

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w plf	Ctrl. Face
									kip-ft			

Tower Forces - With Ice - Wind Normal To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.67	A	1	0.65	1	1	1	69.555	1.31	48.01	C
			B	1	0.65	1	1	1	69.555			
			C	1	0.65	1	1	1	69.555			
L2 92.71-46.16	1.16	8.40	A	1	0.65	1	1	1	144.612	2.40	51.51	C
			B	1	0.65	1	1	1	144.612			
			C	1	0.65	1	1	1	144.612			
L3 46.16-0.00	1.08	11.95	A	1	0.65	1	1	1	175.116	2.38	51.50	C
			B	1	0.65	1	1	1	175.116			
			C	1	0.65	1	1	1	175.116			
Sum Weight:	2.80	23.01						OTM	357.51 kip-ft	6.09		

Tower Forces - With Ice - Wind 45 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.67	A	1	0.65	1	1	1	69.555	1.31	48.01	C
			B	1	0.65	1	1	1	69.555			
			C	1	0.65	1	1	1	69.555			
L2 92.71-46.16	1.16	8.40	A	1	0.65	1	1	1	144.612	2.40	51.51	C
			B	1	0.65	1	1	1	144.612			
			C	1	0.65	1	1	1	144.612			
L3 46.16-0.00	1.08	11.95	A	1	0.65	1	1	1	175.116	2.38	51.50	C
			B	1	0.65	1	1	1	175.116			
			C	1	0.65	1	1	1	175.116			
Sum Weight:	2.80	23.01						OTM	357.51 kip-ft	6.09		

Tower Forces - With Ice - Wind 60 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.67	A	1	0.65	1	1	1	69.555	1.31	48.01	C
			B	1	0.65	1	1	1	69.555			
			C	1	0.65	1	1	1	69.555			

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L2 92.71-46.16	1.16	8.40	A	1	0.65	1	1	1	144.612	2.40	51.51	C
			B	1	0.65	1	1	1	144.612			
			C	1	0.65	1	1	1	144.612			
L3 46.16-0.00	1.08	11.95	A	1	0.65	1	1	1	175.116	2.38	51.50	C
			B	1	0.65	1	1	1	175.116			
			C	1	0.65	1	1	1	175.116			
Sum Weight:	2.80	23.01						OTM	357.51 kip-ft	6.09		

Tower Forces - With Ice - Wind 90 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.67	A	1	0.65	1	1	1	69.555	1.31	48.01	C
			B	1	0.65	1	1	1	69.555			
			C	1	0.65	1	1	1	69.555			
L2 92.71-46.16	1.16	8.40	A	1	0.65	1	1	1	144.612	2.40	51.51	C
			B	1	0.65	1	1	1	144.612			
			C	1	0.65	1	1	1	144.612			
L3 46.16-0.00	1.08	11.95	A	1	0.65	1	1	1	175.116	2.38	51.50	C
			B	1	0.65	1	1	1	175.116			
			C	1	0.65	1	1	1	175.116			
Sum Weight:	2.80	23.01						OTM	357.51 kip-ft	6.09		

Tower Forces - Service - Wind Normal To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.16	A	1	0.65	1	1	1	67.281	0.66	24.19	C
			B	1	0.65	1	1	1	67.281			
			C	1	0.65	1	1	1	67.281			
L2 92.71-46.16	1.16	7.34	A	1	0.65	1	1	1	140.733	1.22	26.11	C
			B	1	0.65	1	1	1	140.733			
			C	1	0.65	1	1	1	140.733			
L3 46.16-0.00	1.08	10.66	A	1	0.65	1	1	1	171.269	1.21	26.23	C
			B	1	0.65	1	1	1	171.269			
			C	1	0.65	1	1	1	171.269			
Sum Weight:	2.80	20.17						OTM	180.92 kip-ft	3.09		

Tower Forces - Service - Wind 45 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.16	A	1	0.65	1	1	1	67.281	0.66	24.19	C
			B	1	0.65	1	1	1	67.281			
			C	1	0.65	1	1	1	67.281			
L2 92.71-46.16	1.16	7.34	A	1	0.65	1	1	1	140.733	1.22	26.11	C
			B	1	0.65	1	1	1	140.733			
			C	1	0.65	1	1	1	140.733			
L3 46.16-0.00	1.08	10.66	A	1	0.65	1	1	1	171.269	1.21	26.23	C
			B	1	0.65	1	1	1	171.269			
			C	1	0.65	1	1	1	171.269			
Sum Weight:	2.80	20.17						OTM	180.92 kip-ft	3.09		

Tower Forces - Service - Wind 60 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.16	A	1	0.65	1	1	1	67.281	0.66	24.19	C
			B	1	0.65	1	1	1	67.281			
			C	1	0.65	1	1	1	67.281			
L2 92.71-46.16	1.16	7.34	A	1	0.65	1	1	1	140.733	1.22	26.11	C
			B	1	0.65	1	1	1	140.733			
			C	1	0.65	1	1	1	140.733			
L3 46.16-0.00	1.08	10.66	A	1	0.65	1	1	1	171.269	1.21	26.23	C
			B	1	0.65	1	1	1	171.269			
			C	1	0.65	1	1	1	171.269			
Sum Weight:	2.80	20.17						OTM	180.92 kip-ft	3.09		

Tower Forces - Service - Wind 90 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 120.00-92.71	0.56	2.16	A	1	0.65	1	1	1	67.281	0.66	24.19	C
			B	1	0.65	1	1	1	67.281			
			C	1	0.65	1	1	1	67.281			
L2 92.71-46.16	1.16	7.34	A	1	0.65	1	1	1	140.733	1.22	26.11	C
			B	1	0.65	1	1	1	140.733			
			C	1	0.65	1	1	1	140.733			
L3 46.16-0.00	1.08	10.66	A	1	0.65	1	1	1	171.269	1.21	26.23	C
			B	1	0.65	1	1	1	171.269			
			C	1	0.65	1	1	1	171.269			
Sum Weight:	2.80	20.17						OTM	180.92 kip-ft	3.09		

Mast Vectors - No Ice

Section No.	Section Elevation ft	Wind Azimuth °	Directionality	F K	V_x K	V_z K	OTM_x kip-ft	OTM_z kip-ft	Torque kip-ft
L1	120.00-92.71	0	Wind Normal	1.69	0.00	-1.69	-179.02	0.00	0.00
		30	Wind 90	1.69	0.84	-1.46	-155.04	-89.51	0.00
		45	Wind 45	1.69	1.19	-1.19	-126.59	-126.59	0.00
		60	Wind 60	1.69	1.46	-0.84	-89.51	-155.04	0.00
		90	Wind 90	1.69	1.69	0.00	0.00	-179.02	0.00
		120	Wind Normal	1.69	1.46	0.84	89.51	-155.04	0.00
		135	Wind 45	1.69	1.19	1.19	126.59	-126.59	0.00
		150	Wind 90	1.69	0.84	1.46	155.04	-89.51	0.00
		180	Wind 60	1.69	0.00	1.69	179.02	0.00	0.00
		210	Wind 90	1.69	-0.84	1.46	155.04	89.51	0.00
		225	Wind 45	1.69	-1.19	1.19	126.59	126.59	0.00
		240	Wind Normal	1.69	-1.46	0.84	89.51	155.04	0.00
		270	Wind 90	1.69	-1.69	0.00	0.00	179.02	0.00
		300	Wind 60	1.69	-1.46	-0.84	-89.51	155.04	0.00
		315	Wind 45	1.69	-1.19	-1.19	-126.59	126.59	0.00
		330	Wind 90	1.69	-0.84	-1.46	-155.04	89.51	0.00
L2	92.71-46.16	0	Wind Normal	3.11	0.00	-3.11	-214.76	0.00	0.00
		30	Wind 90	3.11	1.56	-2.69	-185.99	-107.38	0.00
		45	Wind 45	3.11	2.20	-2.20	-151.86	-151.86	0.00
		60	Wind 60	3.11	2.69	-1.56	-107.38	-185.99	0.00
		90	Wind 90	3.11	3.11	0.00	0.00	-214.76	0.00
		120	Wind Normal	3.11	2.69	1.56	107.38	-185.99	0.00
		135	Wind 45	3.11	2.20	2.20	151.86	-151.86	0.00
		150	Wind 90	3.11	1.56	2.69	185.99	-107.38	0.00
		180	Wind 60	3.11	0.00	3.11	214.76	0.00	0.00
		210	Wind 90	3.11	-1.56	2.69	185.99	107.38	0.00
		225	Wind 45	3.11	-2.20	2.20	151.86	151.86	0.00
		240	Wind Normal	3.11	-2.69	1.56	107.38	185.99	0.00
		270	Wind 90	3.11	-3.11	0.00	0.00	214.76	0.00
		300	Wind 60	3.11	-2.69	-1.56	-107.38	185.99	0.00
		315	Wind 45	3.11	-2.20	-2.20	-151.86	151.86	0.00
		330	Wind 90	3.11	-1.56	-2.69	-185.99	107.38	0.00
L3	46.16-0.00	0	Wind Normal	3.10	0.00	-3.10	-69.37	0.00	0.00
		30	Wind 90	3.10	1.55	-2.68	-60.07	-34.68	0.00
		45	Wind 45	3.10	2.19	-2.19	-49.05	-49.05	0.00
		60	Wind 60	3.10	2.68	-1.55	-34.68	-60.07	0.00
		90	Wind 90	3.10	3.10	0.00	0.00	-69.37	0.00
		120	Wind Normal	3.10	2.68	1.55	34.68	-60.07	0.00
		135	Wind 45	3.10	2.19	2.19	49.05	-49.05	0.00
		150	Wind 90	3.10	1.55	2.68	60.07	-34.68	0.00
		180	Wind 60	3.10	0.00	3.10	69.37	0.00	0.00
		210	Wind 90	3.10	-1.55	2.68	60.07	34.68	0.00
		225	Wind 45	3.10	-2.19	2.19	49.05	49.05	0.00
		240	Wind Normal	3.10	-2.68	1.55	34.68	60.07	0.00
		270	Wind 90	3.10	-3.10	0.00	0.00	69.37	0.00
		300	Wind 60	3.10	-2.68	-1.55	-34.68	60.07	0.00
		315	Wind 45	3.10	-2.19	-2.19	-49.05	49.05	0.00
		330	Wind 90	3.10	-1.55	-2.68	-60.07	34.68	0.00

Mast Totals - No Ice

Wind Azimuth °	V_x K	V_z K	OTM_x kip-ft	OTM_z kip-ft	Torque kip-ft

Wind Azimuth °	V_x K	V_z K	OTM_x kip-ft	OTM_z kip-ft	Torque kip-ft
0	0.00	-7.90	-463.15	0.00	0.00
30	3.95	-6.84	-401.10	-231.58	0.00
45	5.59	-5.59	-327.50	-327.50	0.00
60	6.84	-3.95	-231.58	-401.10	0.00
90	7.90	0.00	0.00	-463.15	0.00
120	6.84	3.95	231.58	-401.10	0.00
135	5.59	5.59	327.50	-327.50	0.00
150	3.95	6.84	401.10	-231.58	0.00
180	0.00	7.90	463.15	0.00	0.00
210	-3.95	6.84	401.10	231.58	0.00
225	-5.59	5.59	327.50	327.50	0.00
240	-6.84	3.95	231.58	401.10	0.00
270	-7.90	0.00	0.00	463.15	0.00
300	-6.84	-3.95	-231.58	401.10	0.00
315	-5.59	-5.59	-327.50	327.50	0.00
330	-3.95	-6.84	-401.10	231.58	0.00

Mast Vectors - With Ice

Section No.	Section Elevation ft	Wind Azimuth °	Directionality	F K	V_x K	V_z K	OTM_x kip-ft	OTM_z kip-ft	Torque kip-ft
L1	120.00-92.71	0	Wind Normal	1.31	0.00	-1.31	-138.81	0.00	0.00
		30	Wind 90	1.31	0.66	-1.13	-120.21	-69.40	0.00
		45	Wind 45	1.31	0.93	-0.93	-98.15	-98.15	0.00
		60	Wind 60	1.31	1.13	-0.66	-69.40	-120.21	0.00
		90	Wind 90	1.31	1.31	0.00	0.00	-138.81	0.00
		120	Wind Normal	1.31	1.13	0.66	69.40	-120.21	0.00
		135	Wind 45	1.31	0.93	0.93	98.15	-98.15	0.00
		150	Wind 90	1.31	0.66	1.13	120.21	-69.40	0.00
		180	Wind 60	1.31	0.00	1.31	138.81	0.00	0.00
		210	Wind 90	1.31	-0.66	1.13	120.21	69.40	0.00
		225	Wind 45	1.31	-0.93	0.93	98.15	98.15	0.00
		240	Wind Normal	1.31	-1.13	0.66	69.40	120.21	0.00
		270	Wind 90	1.31	-1.31	0.00	0.00	138.81	0.00
		300	Wind 60	1.31	-1.13	-0.66	-69.40	120.21	0.00
		315	Wind 45	1.31	-0.93	-0.93	-98.15	98.15	0.00
		330	Wind 90	1.31	-0.66	-1.13	-120.21	69.40	0.00
L2	92.71-46.16	0	Wind Normal	2.40	0.00	-2.40	-165.51	0.00	0.00
		30	Wind 90	2.40	1.20	-2.08	-143.33	-82.75	0.00
		45	Wind 45	2.40	1.70	-1.70	-117.03	-117.03	0.00
		60	Wind 60	2.40	2.08	-1.20	-82.75	-143.33	0.00
		90	Wind 90	2.40	2.40	0.00	0.00	-165.51	0.00
		120	Wind Normal	2.40	2.08	1.20	82.75	-143.33	0.00
		135	Wind 45	2.40	1.70	1.70	117.03	-117.03	0.00
		150	Wind 90	2.40	1.20	2.08	143.33	-82.75	0.00
		180	Wind 60	2.40	0.00	2.40	165.51	0.00	0.00
		210	Wind 90	2.40	-1.20	2.08	143.33	82.75	0.00
		225	Wind 45	2.40	-1.70	1.70	117.03	117.03	0.00
		240	Wind Normal	2.40	-2.08	1.20	82.75	143.33	0.00
		270	Wind 90	2.40	-2.40	0.00	0.00	165.51	0.00
		300	Wind 60	2.40	-2.08	-1.20	-82.75	143.33	0.00
		315	Wind 45	2.40	-1.70	-1.70	-117.03	117.03	0.00
		330	Wind 90	2.40	-1.20	-2.08	-143.33	82.75	0.00
L3	46.16-0.00	0	Wind Normal	2.38	0.00	-2.38	-53.19	0.00	0.00
		30	Wind 90	2.38	1.19	-2.06	-46.07	-26.60	0.00
		45	Wind 45	2.38	1.68	-1.68	-37.61	-37.61	0.00

Section No.	Section Elevation ft	Wind Azimuth °	Directionality	F K	V_x K	V_z K	OTM_x kip-ft	OTM_z kip-ft	Torque kip-ft
		60	Wind 60	2.38	2.06	-1.19	-26.60	-46.07	0.00
		90	Wind 90	2.38	2.38	0.00	0.00	-53.19	0.00
		120	Wind Normal	2.38	2.06	1.19	26.60	-46.07	0.00
		135	Wind 45	2.38	1.68	1.68	37.61	-37.61	0.00
		150	Wind 90	2.38	1.19	2.06	46.07	-26.60	0.00
		180	Wind 60	2.38	0.00	2.38	53.19	0.00	0.00
		210	Wind 90	2.38	-1.19	2.06	46.07	26.60	0.00
		225	Wind 45	2.38	-1.68	1.68	37.61	37.61	0.00
		240	Wind Normal	2.38	-2.06	1.19	26.60	46.07	0.00
		270	Wind 90	2.38	-2.38	0.00	0.00	53.19	0.00
		300	Wind 60	2.38	-2.06	-1.19	-26.60	46.07	0.00
		315	Wind 45	2.38	-1.68	-1.68	-37.61	37.61	0.00
		330	Wind 90	2.38	-1.19	-2.06	-46.07	26.60	0.00

Mast Totals - With Ice

Wind Azimuth °	V_x K	V_z K	OTM_x kip-ft	OTM_z kip-ft	Torque kip-ft
0	0.00	-6.09	-357.51	0.00	0.00
30	3.04	-5.27	-309.61	-178.75	0.00
45	4.30	-4.30	-252.80	-252.80	0.00
60	5.27	-3.04	-178.75	-309.61	0.00
90	6.09	0.00	0.00	-357.51	0.00
120	5.27	3.04	178.75	-309.61	0.00
135	4.30	4.30	252.80	-252.80	0.00
150	3.04	5.27	309.61	-178.75	0.00
180	0.00	6.09	357.51	0.00	0.00
210	-3.04	5.27	309.61	178.75	0.00
225	-4.30	4.30	252.80	252.80	0.00
240	-5.27	3.04	178.75	309.61	0.00
270	-6.09	0.00	0.00	357.51	0.00
300	-5.27	-3.04	-178.75	309.61	0.00
315	-4.30	-4.30	-252.80	252.80	0.00
330	-3.04	-5.27	-309.61	178.75	0.00

Mast Vectors - Service

Section No.	Section Elevation ft	Wind Azimuth °	Directionality	F K	V_x K	V_z K	OTM_x kip-ft	OTM_z kip-ft	Torque kip-ft
L1	120.00-92.71	0	Wind Normal	0.66	0.00	-0.66	-69.93	0.00	0.00
		30	Wind 90	0.66	0.33	-0.57	-60.56	-34.97	0.00
		45	Wind 45	0.66	0.47	-0.47	-49.45	-49.45	0.00
		60	Wind 60	0.66	0.57	-0.33	-34.97	-60.56	0.00
		90	Wind 90	0.66	0.66	0.00	0.00	-69.93	0.00
		120	Wind Normal	0.66	0.57	0.33	34.97	-60.56	0.00
		135	Wind 45	0.66	0.47	0.47	49.45	-49.45	0.00
		150	Wind 90	0.66	0.33	0.57	60.56	-34.97	0.00
		180	Wind 60	0.66	0.00	0.66	69.93	0.00	0.00
		210	Wind 90	0.66	-0.33	0.57	60.56	34.97	0.00
		225	Wind 45	0.66	-0.47	0.47	49.45	49.45	0.00

Section No.	Section Elevation ft	Wind Azimuth °	Directionality	F K	V_x K	V_z K	OTM_x kip-ft	OTM_z kip-ft	Torque kip-ft
		240	Wind Normal	0.66	-0.57	0.33	34.97	60.56	0.00
		270	Wind 90	0.66	-0.66	0.00	0.00	69.93	0.00
		300	Wind 60	0.66	-0.57	-0.33	-34.97	60.56	0.00
		315	Wind 45	0.66	-0.47	-0.47	-49.45	49.45	0.00
		330	Wind 90	0.66	-0.33	-0.57	-60.56	34.97	0.00
L2	92.71-46.16	0	Wind Normal	1.22	0.00	-1.22	-83.89	0.00	0.00
		30	Wind 90	1.22	0.61	-1.05	-72.65	-41.94	0.00
		45	Wind 45	1.22	0.86	-0.86	-59.32	-59.32	0.00
		60	Wind 60	1.22	1.05	-0.61	-41.94	-72.65	0.00
		90	Wind 90	1.22	1.22	0.00	0.00	-83.89	0.00
		120	Wind Normal	1.22	1.05	0.61	41.94	-72.65	0.00
		135	Wind 45	1.22	0.86	0.86	59.32	-59.32	0.00
		150	Wind 90	1.22	0.61	1.05	72.65	-41.94	0.00
		180	Wind 60	1.22	0.00	1.22	83.89	0.00	0.00
		210	Wind 90	1.22	-0.61	1.05	72.65	41.94	0.00
		225	Wind 45	1.22	-0.86	0.86	59.32	59.32	0.00
		240	Wind Normal	1.22	-1.05	0.61	41.94	72.65	0.00
		270	Wind 90	1.22	-1.22	0.00	0.00	83.89	0.00
		300	Wind 60	1.22	-1.05	-0.61	-41.94	72.65	0.00
		315	Wind 45	1.22	-0.86	-0.86	-59.32	59.32	0.00
		330	Wind 90	1.22	-0.61	-1.05	-72.65	41.94	0.00
L3	46.16-0.00	0	Wind Normal	1.21	0.00	-1.21	-27.10	0.00	0.00
		30	Wind 90	1.21	0.61	-1.05	-23.47	-13.55	0.00
		45	Wind 45	1.21	0.86	-0.86	-19.16	-19.16	0.00
		60	Wind 60	1.21	1.05	-0.61	-13.55	-23.47	0.00
		90	Wind 90	1.21	1.21	0.00	0.00	-27.10	0.00
		120	Wind Normal	1.21	1.05	0.61	13.55	-23.47	0.00
		135	Wind 45	1.21	0.86	0.86	19.16	-19.16	0.00
		150	Wind 90	1.21	0.61	1.05	23.47	-13.55	0.00
		180	Wind 60	1.21	0.00	1.21	27.10	0.00	0.00
		210	Wind 90	1.21	-0.61	1.05	23.47	13.55	0.00
		225	Wind 45	1.21	-0.86	0.86	19.16	19.16	0.00
		240	Wind Normal	1.21	-1.05	0.61	13.55	23.47	0.00
		270	Wind 90	1.21	-1.21	0.00	0.00	27.10	0.00
		300	Wind 60	1.21	-1.05	-0.61	-13.55	23.47	0.00
		315	Wind 45	1.21	-0.86	-0.86	-19.16	19.16	0.00
		330	Wind 90	1.21	-0.61	-1.05	-23.47	13.55	0.00

Mast Totals - Service

Wind Azimuth °	V_x K	V_z K	OTM_x kip-ft	OTM_z kip-ft	Torque kip-ft
0	0.00	-3.09	-180.92	0.00	0.00
30	1.54	-2.67	-156.68	-90.46	0.00
45	2.18	-2.18	-127.93	-127.93	0.00
60	2.67	-1.54	-90.46	-156.68	0.00
90	3.09	0.00	0.00	-180.92	0.00
120	2.67	1.54	90.46	-156.68	0.00
135	2.18	2.18	127.93	-127.93	0.00
150	1.54	2.67	156.68	-90.46	0.00
180	0.00	3.09	180.92	0.00	0.00
210	-1.54	2.67	156.68	90.46	0.00
225	-2.18	2.18	127.93	127.93	0.00
240	-2.67	1.54	90.46	156.68	0.00
270	-3.09	0.00	0.00	180.92	0.00
300	-2.67	-1.54	-90.46	156.68	0.00

Wind Azimuth °	V_x K	V_z K	OTM_x kip-ft	OTM_z kip-ft	Torque kip-ft
315	-2.18	-2.18	-127.93	127.93	0.00
330	-1.54	-2.67	-156.68	90.46	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	20.17					
Bracing Weight	0.00					
Total Member Self-Weight	20.17			0.00	0.00	
Total Weight	26.96			0.00	0.00	
Wind 0 deg - No Ice		0.00	-12.63	-1013.85	0.00	0.00
Wind 30 deg - No Ice		6.32	-10.94	-878.02	-506.93	0.00
Wind 45 deg - No Ice		8.93	-8.93	-716.90	-716.90	0.00
Wind 60 deg - No Ice		10.94	-6.32	-506.93	-878.02	0.00
Wind 90 deg - No Ice		12.63	0.00	0.00	-1013.85	0.00
Wind 120 deg - No Ice		10.94	6.32	506.93	-878.02	0.00
Wind 135 deg - No Ice		8.93	8.93	716.90	-716.90	0.00
Wind 150 deg - No Ice		6.32	10.94	878.02	-506.93	0.00
Wind 180 deg - No Ice		0.00	12.63	1013.85	0.00	0.00
Wind 210 deg - No Ice		-6.32	10.94	878.02	506.93	0.00
Wind 225 deg - No Ice		-8.93	8.93	716.90	716.90	0.00
Wind 240 deg - No Ice		-10.94	6.32	506.93	878.02	0.00
Wind 270 deg - No Ice		-12.63	0.00	0.00	1013.85	0.00
Wind 300 deg - No Ice		-10.94	-6.32	-506.93	878.02	0.00
Wind 315 deg - No Ice		-8.93	-8.93	-716.90	716.90	0.00
Wind 330 deg - No Ice		-6.32	-10.94	-878.02	506.93	0.00
Member Ice	2.85					
Total Weight Ice	31.98			0.00	0.00	
Wind 0 deg - Ice		0.00	-10.11	-825.81	0.00	0.00
Wind 30 deg - Ice		5.06	-8.76	-715.17	-412.90	0.00
Wind 45 deg - Ice		7.15	-7.15	-583.93	-583.93	0.00
Wind 60 deg - Ice		8.76	-5.06	-412.90	-715.17	0.00
Wind 90 deg - Ice		10.11	0.00	0.00	-825.81	0.00
Wind 120 deg - Ice		8.76	5.06	412.90	-715.17	0.00
Wind 135 deg - Ice		7.15	7.15	583.93	-583.93	0.00
Wind 150 deg - Ice		5.06	8.76	715.17	-412.90	0.00
Wind 180 deg - Ice		0.00	10.11	825.81	0.00	0.00
Wind 210 deg - Ice		-5.06	8.76	715.17	412.90	0.00
Wind 225 deg - Ice		-7.15	7.15	583.93	583.93	0.00
Wind 240 deg - Ice		-8.76	5.06	412.90	715.17	0.00
Wind 270 deg - Ice		-10.11	0.00	0.00	825.81	0.00
Wind 300 deg - Ice		-8.76	-5.06	-412.90	715.17	0.00
Wind 315 deg - Ice		-7.15	-7.15	-583.93	583.93	0.00
Wind 330 deg - Ice		-5.06	-8.76	-715.17	412.90	0.00
Total Weight	26.96			0.00	0.00	
Wind 0 deg - Service		0.00	-4.93	-396.04	0.00	0.00
Wind 30 deg - Service		2.47	-4.27	-342.98	-198.02	0.00
Wind 45 deg - Service		3.49	-3.49	-280.04	-280.04	0.00
Wind 60 deg - Service		4.27	-2.47	-198.02	-342.98	0.00
Wind 90 deg - Service		4.93	0.00	0.00	-396.04	0.00
Wind 120 deg - Service		4.27	2.47	198.02	-342.98	0.00
Wind 135 deg - Service		3.49	3.49	280.04	-280.04	0.00
Wind 150 deg - Service		2.47	4.27	342.98	-198.02	0.00
Wind 180 deg - Service		0.00	4.93	396.04	0.00	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
Wind 210 deg - Service		-2.47	4.27	342.98	198.02	0.00
Wind 225 deg - Service		-3.49	3.49	280.04	280.04	0.00
Wind 240 deg - Service		-4.27	2.47	198.02	342.98	0.00
Wind 270 deg - Service		-4.93	0.00	0.00	396.04	0.00
Wind 300 deg - Service		-4.27	-2.47	-198.02	342.98	0.00
Wind 315 deg - Service		-3.49	-3.49	-280.04	280.04	0.00
Wind 330 deg - Service		-2.47	-4.27	-342.98	198.02	0.00

Load Combinations

Comb. No.	Description
1	Dead Only
2	Dead+Wind 0 deg - No Ice
3	Dead+Wind 30 deg - No Ice
4	Dead+Wind 45 deg - No Ice
5	Dead+Wind 60 deg - No Ice
6	Dead+Wind 90 deg - No Ice
7	Dead+Wind 120 deg - No Ice
8	Dead+Wind 135 deg - No Ice
9	Dead+Wind 150 deg - No Ice
10	Dead+Wind 180 deg - No Ice
11	Dead+Wind 210 deg - No Ice
12	Dead+Wind 225 deg - No Ice
13	Dead+Wind 240 deg - No Ice
14	Dead+Wind 270 deg - No Ice
15	Dead+Wind 300 deg - No Ice
16	Dead+Wind 315 deg - No Ice
17	Dead+Wind 330 deg - No Ice
18	Dead+Ice+Temp
19	Dead+Wind 0 deg+Ice+Temp
20	Dead+Wind 30 deg+Ice+Temp
21	Dead+Wind 45 deg+Ice+Temp
22	Dead+Wind 60 deg+Ice+Temp
23	Dead+Wind 90 deg+Ice+Temp
24	Dead+Wind 120 deg+Ice+Temp
25	Dead+Wind 135 deg+Ice+Temp
26	Dead+Wind 150 deg+Ice+Temp
27	Dead+Wind 180 deg+Ice+Temp
28	Dead+Wind 210 deg+Ice+Temp
29	Dead+Wind 225 deg+Ice+Temp
30	Dead+Wind 240 deg+Ice+Temp
31	Dead+Wind 270 deg+Ice+Temp
32	Dead+Wind 300 deg+Ice+Temp
33	Dead+Wind 315 deg+Ice+Temp
34	Dead+Wind 330 deg+Ice+Temp
35	Dead+Wind 0 deg - Service
36	Dead+Wind 30 deg - Service
37	Dead+Wind 45 deg - Service
38	Dead+Wind 60 deg - Service
39	Dead+Wind 90 deg - Service
40	Dead+Wind 120 deg - Service
41	Dead+Wind 135 deg - Service
42	Dead+Wind 150 deg - Service
43	Dead+Wind 180 deg - Service
44	Dead+Wind 210 deg - Service

Comb. No.	Description
45	Dead+Wind 225 deg - Service
46	Dead+Wind 240 deg - Service
47	Dead+Wind 270 deg - Service
48	Dead+Wind 300 deg - Service
49	Dead+Wind 315 deg - Service
50	Dead+Wind 330 deg - Service

Maximum Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Force K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
L1	120 - 92.71	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-8.82	0.00	0.00
			Max. Mx	6	-6.10	-107.82	0.00
			Max. My	2	-6.10	0.00	107.82
			Max. Vy	6	6.25	-107.82	0.00
			Max. Vx	2	-6.25	0.00	107.82
			Max. Torque	11			-0.00
L2	92.71 - 46.16	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-17.76	0.00	0.00
			Max. Mx	6	-14.05	-461.35	0.00
			Max. My	2	-14.05	0.00	461.35
			Max. Vy	6	9.31	-461.35	0.00
			Max. Vx	2	-9.31	0.00	461.35
			Max. Torque	11			-0.00
L3	46.16 - 0	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-31.98	0.00	0.00
			Max. Mx	6	-26.96	-1029.95	0.00
			Max. My	10	-26.96	0.00	-1029.95
			Max. Vy	6	12.64	-1029.95	0.00
			Max. Vx	10	12.64	0.00	-1029.95
			Max. Torque	11			-0.00

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
Pole	Max. Vert	19	31.98	0.00	10.11
	Max. H_x	14	26.96	12.63	0.00
	Max. H_z	2	26.96	0.00	12.63
	Max. M_x	2	1029.95	0.00	12.63
	Max. M_z	6	1029.95	-12.63	0.00
	Max. Torsion	13	0.00	10.94	-6.32
	Min. Vert	1	26.96	0.00	0.00
	Min. H_x	6	26.96	-12.63	0.00
	Min. H_z	10	26.96	0.00	-12.63
	Min. M_x	10	-1029.95	0.00	-12.63
	Min. M_z	14	-1029.95	12.63	0.00
	Min. Torsion	11	-0.00	6.32	-10.94

Tower Mast Reaction Summary

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
Dead Only	26.96	0.00	0.00	0.00	0.00	0.00
Dead+Wind 0 deg - No Ice	26.96	0.00	-12.63	-1029.95	0.00	0.00
Dead+Wind 30 deg - No Ice	26.96	6.32	-10.94	-891.96	-514.97	0.00
Dead+Wind 45 deg - No Ice	26.96	8.93	-8.93	-728.28	-728.28	0.00
Dead+Wind 60 deg - No Ice	26.96	10.94	-6.32	-514.97	-891.96	-0.00
Dead+Wind 90 deg - No Ice	26.96	12.63	0.00	0.00	-1029.95	0.00
Dead+Wind 120 deg - No Ice	26.96	10.94	6.32	514.97	-891.96	0.00
Dead+Wind 135 deg - No Ice	26.96	8.93	8.93	728.28	-728.28	0.00
Dead+Wind 150 deg - No Ice	26.96	6.32	10.94	891.96	-514.97	-0.00
Dead+Wind 180 deg - No Ice	26.96	0.00	12.63	1029.95	0.00	0.00
Dead+Wind 210 deg - No Ice	26.96	-6.32	10.94	891.96	514.97	0.00
Dead+Wind 225 deg - No Ice	26.96	-8.93	8.93	728.28	728.28	0.00
Dead+Wind 240 deg - No Ice	26.96	-10.94	6.32	514.97	891.96	-0.00
Dead+Wind 270 deg - No Ice	26.96	-12.63	0.00	0.00	1029.95	0.00
Dead+Wind 300 deg - No Ice	26.96	-10.94	-6.32	-514.97	891.96	0.00
Dead+Wind 315 deg - No Ice	26.96	-8.93	-8.93	-728.28	728.28	0.00
Dead+Wind 330 deg - No Ice	26.96	-6.32	-10.94	-891.96	514.97	-0.00
Dead+Ice+Temp	31.98	0.00	0.00	0.00	0.00	0.00
Dead+Wind 0 deg+Ice+Temp	31.98	0.00	-10.11	-843.07	0.00	0.00
Dead+Wind 30 deg+Ice+Temp	31.98	5.06	-8.76	-730.12	-421.53	0.00
Dead+Wind 45 deg+Ice+Temp	31.98	7.15	-7.15	-596.14	-596.14	0.00
Dead+Wind 60 deg+Ice+Temp	31.98	8.76	-5.06	-421.53	-730.12	-0.00
Dead+Wind 90 deg+Ice+Temp	31.98	10.11	0.00	0.00	-843.07	0.00
Dead+Wind 120 deg+Ice+Temp	31.98	8.76	5.06	421.53	-730.12	0.00
Dead+Wind 135 deg+Ice+Temp	31.98	7.15	7.15	596.14	-596.14	0.00
Dead+Wind 150 deg+Ice+Temp	31.98	5.06	8.76	730.12	-421.53	-0.00
Dead+Wind 180 deg+Ice+Temp	31.98	0.00	10.11	843.07	0.00	0.00
Dead+Wind 210 deg+Ice+Temp	31.98	-5.06	8.76	730.12	421.53	0.00
Dead+Wind 225 deg+Ice+Temp	31.98	-7.15	7.15	596.14	596.14	0.00
Dead+Wind 240 deg+Ice+Temp	31.98	-8.76	5.06	421.53	730.12	-0.00
Dead+Wind 270 deg+Ice+Temp	31.98	-10.11	0.00	0.00	843.07	0.00
Dead+Wind 300 deg+Ice+Temp	31.98	-8.76	-5.06	-421.53	730.12	0.00
Dead+Wind 315 deg+Ice+Temp	31.98	-7.15	-7.15	-596.14	596.14	0.00
Dead+Wind 330 deg+Ice+Temp	31.98	-5.06	-8.76	-730.12	421.53	-0.00
Dead+Wind 0 deg - Service	26.96	0.00	-4.93	-402.35	0.00	0.00
Dead+Wind 30 deg - Service	26.96	2.47	-4.27	-348.45	-201.18	0.00
Dead+Wind 45 deg - Service	26.96	3.49	-3.49	-284.51	-284.51	0.00
Dead+Wind 60 deg - Service	26.96	4.27	-2.47	-201.18	-348.45	-0.00
Dead+Wind 90 deg - Service	26.96	4.93	0.00	0.00	-402.35	0.00
Dead+Wind 120 deg - Service	26.96	4.27	2.47	201.18	-348.45	0.00
Dead+Wind 135 deg - Service	26.96	3.49	3.49	284.51	-284.51	0.00
Dead+Wind 150 deg - Service	26.96	2.47	4.27	348.45	-201.18	-0.00
Dead+Wind 180 deg - Service	26.96	0.00	4.93	402.35	0.00	0.00
Dead+Wind 210 deg - Service	26.96	-2.47	4.27	348.45	201.18	0.00
Dead+Wind 225 deg - Service	26.96	-3.49	3.49	284.51	284.51	0.00
Dead+Wind 240 deg - Service	26.96	-4.27	2.47	201.18	348.45	-0.00
Dead+Wind 270 deg - Service	26.96	-4.93	0.00	0.00	402.35	0.00
Dead+Wind 300 deg - Service	26.96	-4.27	-2.47	-201.18	348.45	0.00
Dead+Wind 315 deg - Service	26.96	-3.49	-3.49	-284.51	284.51	0.00
Dead+Wind 330 deg - Service	26.96	-2.47	-4.27	-348.45	201.18	-0.00

Solution Summary

Load Comb.	Sum of Applied Forces PX K	PY K	PZ K	Sum of Reactions PX K	PY K	PZ K	% Error
1	0.00	-26.96	0.00	0.00	26.96	0.00	0.000%
2	0.00	-26.96	-12.63	0.00	26.96	12.63	0.000%
3	6.32	-26.96	-10.94	-6.32	26.96	10.94	0.000%
4	8.93	-26.96	-8.93	-8.93	26.96	8.93	0.000%
5	10.94	-26.96	-6.32	-10.94	26.96	6.32	0.000%
6	12.63	-26.96	0.00	-12.63	26.96	0.00	0.000%
7	10.94	-26.96	6.32	-10.94	26.96	-6.32	0.000%
8	8.93	-26.96	8.93	-8.93	26.96	-8.93	0.000%
9	6.32	-26.96	10.94	-6.32	26.96	-10.94	0.000%
10	0.00	-26.96	12.63	0.00	26.96	-12.63	0.000%
11	-6.32	-26.96	10.94	6.32	26.96	-10.94	0.000%
12	-8.93	-26.96	8.93	8.93	26.96	-8.93	0.000%
13	-10.94	-26.96	6.32	10.94	26.96	-6.32	0.000%
14	-12.63	-26.96	0.00	12.63	26.96	0.00	0.000%
15	-10.94	-26.96	-6.32	10.94	26.96	6.32	0.000%
16	-8.93	-26.96	-8.93	8.93	26.96	8.93	0.000%
17	-6.32	-26.96	-10.94	6.32	26.96	10.94	0.000%
18	0.00	-31.98	0.00	0.00	31.98	0.00	0.000%
19	0.00	-31.98	-10.11	0.00	31.98	10.11	0.000%
20	5.06	-31.98	-8.76	-5.06	31.98	8.76	0.000%
21	7.15	-31.98	-7.15	-7.15	31.98	7.15	0.000%
22	8.76	-31.98	-5.06	-8.76	31.98	5.06	0.000%
23	10.11	-31.98	0.00	-10.11	31.98	0.00	0.000%
24	8.76	-31.98	5.06	-8.76	31.98	-5.06	0.000%
25	7.15	-31.98	7.15	-7.15	31.98	-7.15	0.000%
26	5.06	-31.98	8.76	-5.06	31.98	-8.76	0.000%
27	0.00	-31.98	10.11	0.00	31.98	-10.11	0.000%
28	-5.06	-31.98	8.76	5.06	31.98	-8.76	0.000%
29	-7.15	-31.98	7.15	7.15	31.98	-7.15	0.000%
30	-8.76	-31.98	5.06	8.76	31.98	-5.06	0.000%
31	-10.11	-31.98	0.00	10.11	31.98	0.00	0.000%
32	-8.76	-31.98	-5.06	8.76	31.98	5.06	0.000%
33	-7.15	-31.98	-7.15	7.15	31.98	7.15	0.000%
34	-5.06	-31.98	-8.76	5.06	31.98	8.76	0.000%
35	0.00	-26.96	-4.93	0.00	26.96	4.93	0.000%
36	2.47	-26.96	-4.27	-2.47	26.96	4.27	0.000%
37	3.49	-26.96	-3.49	-3.49	26.96	3.49	0.000%
38	4.27	-26.96	-2.47	-4.27	26.96	2.47	0.000%
39	4.93	-26.96	0.00	-4.93	26.96	0.00	0.000%
40	4.27	-26.96	2.47	-4.27	26.96	-2.47	0.000%
41	3.49	-26.96	3.49	-3.49	26.96	-3.49	0.000%
42	2.47	-26.96	4.27	-2.47	26.96	-4.27	0.000%
43	0.00	-26.96	4.93	0.00	26.96	-4.93	0.000%
44	-2.47	-26.96	4.27	2.47	26.96	-4.27	0.000%
45	-3.49	-26.96	3.49	3.49	26.96	-3.49	0.000%
46	-4.27	-26.96	2.47	4.27	26.96	-2.47	0.000%
47	-4.93	-26.96	0.00	4.93	26.96	0.00	0.000%
48	-4.27	-26.96	-2.47	4.27	26.96	2.47	0.000%
49	-3.49	-26.96	-3.49	3.49	26.96	3.49	0.000%
50	-2.47	-26.96	-4.27	2.47	26.96	4.27	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	4	0.00000001	0.00000857
3	Yes	4	0.00000001	0.00027700
4	Yes	4	0.00000001	0.00031870
5	Yes	4	0.00000001	0.00027700
6	Yes	4	0.00000001	0.00000857
7	Yes	4	0.00000001	0.00027700
8	Yes	4	0.00000001	0.00031870
9	Yes	4	0.00000001	0.00027700
10	Yes	4	0.00000001	0.00000857
11	Yes	4	0.00000001	0.00027700
12	Yes	4	0.00000001	0.00031870
13	Yes	4	0.00000001	0.00027700
14	Yes	4	0.00000001	0.00000857
15	Yes	4	0.00000001	0.00027700
16	Yes	4	0.00000001	0.00031870
17	Yes	4	0.00000001	0.00027700
18	Yes	4	0.00000001	0.00000001
19	Yes	4	0.00000001	0.00061077
20	Yes	4	0.00000001	0.00081677
21	Yes	4	0.00000001	0.00087457
22	Yes	4	0.00000001	0.00081677
23	Yes	4	0.00000001	0.00061077
24	Yes	4	0.00000001	0.00081677
25	Yes	4	0.00000001	0.00087457
26	Yes	4	0.00000001	0.00081677
27	Yes	4	0.00000001	0.00061077
28	Yes	4	0.00000001	0.00081677
29	Yes	4	0.00000001	0.00087457
30	Yes	4	0.00000001	0.00081677
31	Yes	4	0.00000001	0.00061077
32	Yes	4	0.00000001	0.00081677
33	Yes	4	0.00000001	0.00087457
34	Yes	4	0.00000001	0.00081677
35	Yes	4	0.00000001	0.00000001
36	Yes	4	0.00000001	0.00002172
37	Yes	4	0.00000001	0.00002497
38	Yes	4	0.00000001	0.00002172
39	Yes	4	0.00000001	0.00000001
40	Yes	4	0.00000001	0.00002172
41	Yes	4	0.00000001	0.00002497
42	Yes	4	0.00000001	0.00002172
43	Yes	4	0.00000001	0.00000001
44	Yes	4	0.00000001	0.00002172
45	Yes	4	0.00000001	0.00002497
46	Yes	4	0.00000001	0.00002172
47	Yes	4	0.00000001	0.00000001
48	Yes	4	0.00000001	0.00002172
49	Yes	4	0.00000001	0.00002497
50	Yes	4	0.00000001	0.00002172

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	120 - 92.71	7.604	43	0.5150	0.0000
L2	97.29 - 46.16	5.224	43	0.4704	0.0000
L3	51.83 - 0	1.568	43	0.2716	0.0000

Critical Deflections and Radius of Curvature - Service Wind

Elevation	Appurtenance	Gov. Load Comb.	Deflection	Tilt	Twist	Radius of Curvature
ft			in	°	°	ft
120.00	14' Low Profile Platform	43	7.604	0.5150	0.0000	90191
110.00	Andrew 12'-6" Low Profile Platform	43	6.538	0.5004	0.0000	45095

Maximum Tower Deflections - Design Wind

Section No.	Elevation	Horz. Deflection	Gov. Load Comb.	Tilt	Twist
	ft	in		°	°
L1	120 - 92.71	19.463	6	1.3183	0.0000
L2	97.29 - 46.16	13.371	6	1.2042	0.0000
L3	51.83 - 0	4.014	6	0.6952	0.0000

Critical Deflections and Radius of Curvature - Design Wind

Elevation	Appurtenance	Gov. Load Comb.	Deflection	Tilt	Twist	Radius of Curvature
ft			in	°	°	ft
120.00	14' Low Profile Platform	6	19.463	1.3183	0.0000	35271
110.00	Andrew 12'-6" Low Profile Platform	6	16.733	1.2781	0.0000	17635

Compression Checks

Pole Design Data

Section No.	Elevation	Size	L	L_u	Kl/r	F_a	A	Actual P	Allow. P_a	Ratio $\frac{P}{P_a}$
	ft		ft	ft		ksi	in^2	K	K	
L1	120 - 92.71 (1)	TP32.27x26.9x0.25	27.29	0.00	0.0	39.000	24.6927	-6.10	963.02	0.006
L2	92.71 - 46.16 (2)	TP40.8x30.8688x0.375	51.13	0.00	0.0	39.000	46.8050	-14.05	1825.40	0.008
L3	46.16 - 0 (3)	TP49x38.9487x0.4375	51.83	0.00	0.0	39.000	67.4351	-26.96	2629.97	0.010

Pole Bending Design Data

Section No.	Elevation	Size	Actual M_x	Actual f_{bx}	Allow. F_{bx}	Ratio $\frac{f_{bx}}{F_{bx}}$	Actual M_y	Actual f_{by}	Allow. F_{by}	Ratio $\frac{f_{by}}{F_{by}}$
	ft		kip-ft	ksi	ksi		kip-ft	ksi	ksi	

Section No.	Elevation ft	Size	Actual M_x kip-ft	Actual f_{bx} ksi	Allow. F_{bx} ksi	Ratio $\frac{f_{bx}}{F_{bx}}$	Actual M_y kip-ft	Actual f_{by} ksi	Allow. F_{by} ksi	Ratio $\frac{f_{by}}{F_{by}}$
L1	120 - 92.71 (1)	TP32.27x26.9x0.25	107.82	6.825	39.000	0.175	0.00	0.000	39.000	0.000
L2	92.71 - 46.16 (2)	TP40.8x30.8688x0.375	461.35	12.210	39.000	0.313	0.00	0.000	39.000	0.000
L3	46.16 - 0 (3)	TP49x38.9487x0.4375	1029.95	15.312	39.000	0.393	0.00	0.000	39.000	0.000

Pole Shear Design Data

Section No.	Elevation ft	Size	Actual V K	Actual f_v ksi	Allow. F_v ksi	Ratio $\frac{f_v}{F_v}$	Actual T kip-ft	Actual f_{vt} ksi	Allow. F_{vt} ksi	Ratio $\frac{f_{vt}}{F_{vt}}$
L1	120 - 92.71 (1)	TP32.27x26.9x0.25	6.25	0.253	26.000	0.019	0.00	0.000	26.000	0.000
L2	92.71 - 46.16 (2)	TP40.8x30.8688x0.375	9.31	0.199	26.000	0.015	0.00	0.000	26.000	0.000
L3	46.16 - 0 (3)	TP49x38.9487x0.4375	12.64	0.187	26.000	0.015	0.00	0.000	26.000	0.000

Pole Interaction Design Data

Section No.	Elevation ft	Ratio $\frac{P}{P_a}$	Ratio $\frac{f_{bx}}{F_{bx}}$	Ratio $\frac{f_{by}}{F_{by}}$	Ratio $\frac{f_v}{F_v}$	Ratio $\frac{f_{vt}}{F_{vt}}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	120 - 92.71 (1)	0.006	0.175	0.000	0.019	0.000	0.181 ✔	1.333	H1-3+VT ✔
L2	92.71 - 46.16 (2)	0.008	0.313	0.000	0.015	0.000	0.321 ✔	1.333	H1-3+VT ✔
L3	46.16 - 0 (3)	0.010	0.393	0.000	0.015	0.000	0.403 ✔	1.333	H1-3+VT ✔

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	$SF*P_{allow}$ K	% Capacity	Pass Fail
L1	120 - 92.71	Pole	TP32.27x26.9x0.25	1	-6.10	1283.70	13.6	Pass
L2	92.71 - 46.16	Pole	TP40.8x30.8688x0.375	2	-14.05	2433.26	24.1	Pass
L3	46.16 - 0	Pole	TP49x38.9487x0.4375	3	-26.96	3505.75	30.2	Pass
							Summary	
						Pole (L3)	30.2	Pass
						RATING =	**30.2**	**Pass**

ANCHOR BOLT AND BASE PLATE ANALYSIS

URS

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ANCHOR BOLT AND BASEPLATE ANALYSIS

Input Data

Tower Reactions:

Overturning Moment:	$OM := 1030 \cdot ft \cdot kips$	*user input*
Shear Force:	$Shear := 13.0 \cdot kips$	*user input*
Axial Force:	$Axial := 27.0 \cdot kips$	*user input*

Anchor Bolt Data:

Use ASTM A615 Grade 75		*user input*
Number of Anchor Bolts = N	$N := 18$	*user input*
Diameter of Bolt Circle:	$D_{bc} := 58in$	*user input*
Bolt "Column" Distance:	$l := 3.0in$	*user input*
Bolt Ultimate Strength:	$F_u := 100 \cdot ksi$	*user input*
Bolt Yield Strength:	$Fy := 75 \cdot ksi$	*user input*
Bolt Modulus:	$E := 29000 \cdot ksi$	*user input*
Anchor Bolt Diameter	$D := 2.25in$	*user input*
Threads per Inch:	$n := 4.5$	*user input*

Base Plate Data:

Use ASTM A572 Grade 60		*user input*
Plate Yield Strength:	$Fy_{bp} := 60 \cdot ksi$	*user input*
Base Plate Thickness:	$PlateThickness := 2.00 \cdot in$	*user input*
Base Plate Diameter:	$D_{bp} := 64 \cdot in$	*user input*
Outer Pole Diameter:	$D_{pole} := 49.0in$	*user input*

Geometric Layout Data for Bolt Analysis:

Distance from the center of gravity of the group to bolt in question = d(i)

Radius of Bolt Circle: $R_{bc} := \frac{D_{bc}}{2}$

Number of Spaces in Quadrant: $N_q := \frac{N}{4}$

Distance to Bolts: $i := 0 .. N_q$

$$d_i := \left| \begin{array}{l} \theta \leftarrow \frac{360}{N} \cdot \frac{\pi}{180} \\ \text{for } j \in i \\ \quad \left| \begin{array}{l} \theta \leftarrow \frac{\theta}{2} + \theta \cdot i \\ d \leftarrow R_{bc} \cdot \sin(\theta) \end{array} \right. \end{array} \right. \qquad d = \begin{pmatrix} 5.04 \\ 14.50 \\ 22.22 \\ 27.25 \\ 29.00 \end{pmatrix} \cdot \text{in}$$

Critical Distances For Bending in Plate:

$MomentArm_1 := d_4 - \frac{D_{pole}}{2}$ $\qquad MomentArm_1 = 4.5 \cdot \text{in}$

$MomentArm_2 := d_3 - \frac{D_{pole}}{2}$ $\qquad MomentArm_2 = 2.75 \cdot \text{in}$

$EffectiveWidth := 2 \cdot .8 \sqrt{\left(\frac{D_{bp}}{2}\right)^2 - \left(\frac{D_{pole}}{2}\right)^2}$ $\qquad EffectiveWidth = 32.94 \cdot \text{in}$

Anchor Bolt Analysis:

Polar Moment of Inertia I_p

$$I_p := (d_1)^2 \cdot 4 + (d_2)^2 \cdot 4 + (d_3)^2 \cdot 4 + (d_4)^2 \cdot 2 \qquad I_p = 7.47 \times 10^3 \cdot in^2$$

Gross Area of Bolt:

$$A_g := \frac{\pi}{4} \cdot D^2 \qquad A_g = 3.98 \cdot in^2$$

Net Area of Bolt:

$$\left(A_n := \frac{\pi}{4} \cdot \left(D - \frac{0.9743 \cdot in}{n} \right)^2 \right) \qquad (A_n) = 3.248 \cdot in^2$$

Net Diameter:

$$\left(D_n := \frac{2 \cdot \sqrt{A_n}}{\sqrt{\pi}} \right) \qquad (D_n) = 2.03 \cdot in$$

Radius of Gyration of Bolt:

$$\left(r := \frac{D_n}{4} \right) \qquad (r) = 0.51 \cdot in$$

Section Modulus of Bolt:

$$\left(S_x := \frac{\pi \cdot D_n^{\,3}}{32} \right) \qquad (S_x) = 0.826 \cdot in^3$$

Anchor Bolt Bending Stress:

Maximum Applied Bending:

$$\left(M_x := \left(\frac{Shear}{N} \right) \cdot l \right) \qquad (M_x) = 0.181 \cdot ft \cdot kips$$

$$\left(f_{bx} := \frac{M_x}{S_x} \right) \qquad (f_{bx}) = 2.6 \cdot ksi$$

Allowable Bending

$$(F_{bx} := 1.333 \cdot 0.60 \cdot Fy) \qquad (F_{bx}) = 59.98 \cdot ksi$$

Note: 1.333 increase allowed per TIA/EIA

Check Tensile Forces:

Maximum Tensile Force (Gross Area):

$(AllowableTension := 1.333 \cdot (0.33 \cdot A_g \cdot F_u))$ $(AllowableTension) = 174.9 \cdot kips$

Note: 1.333 increase allowed per TIA/EIA

Maximum Tensile Force (Net Area):

$(F_{net.area} := 1.333 \cdot (0.60 \cdot A_n \cdot Fy))$ $(F_{net.area}) = 194.8 \cdot kips$

Note: 1.333 increase allowed per TIA/EIA

Applied Tension:

$\left(MaxTension := \frac{OM \cdot R_{bc}}{I_p} - \frac{Axial}{N}\right)$ $(MaxTension) = 46.5 \cdot kips$

Check Stresses:

Note: Bolts supplied are "upset bolts." Use net area for checking per AISC.

$\left(\frac{MaxTension}{F_{net.area}}\right) = 0.24$

$\left(Condition := if\left(\frac{MaxTension}{F_{net.area}} \le 1.00, "OK", "Overstressed"\right)\right)$

$(Condition) = "OK"$

Check Compression & Combined Stresses (if required):

Check to see if a complete combined stress analysis is required:

Per ASCE Manual 72: "If the clearance between the base plate and concrete does not exceed two times the bolt diameter a bending stress analysis of the bolts is NOT normally required."

Set the clear space between the plate and bolt to zero and remove bending stresses if a combined stress analysis is not required:

$$l := \begin{cases} 1 & \text{if } 1 > 2 \cdot D_n \\ 0.00\text{in} & \text{otherwise} \end{cases} \qquad l = 0.00\cdot\text{in}$$

$$f_{bx} := \begin{cases} f_{bx} & \text{if } 1 > 2 \cdot D_n \\ 0.0\text{ksi} & \text{otherwise} \end{cases} \qquad f_{bx} = 0\cdot\text{ksi}$$

Allowable Compressive Force:

$$K := 0.65$$

$$C_c := \sqrt{\frac{2\cdot\pi^2\cdot E}{Fy}} \qquad C_c = 87.36$$

$$F_a := \begin{cases} \left[1 - \frac{\left(\frac{K\cdot l}{r}\right)^2}{2\cdot C_c^{\,2}}\right]\cdot Fy \Big/ \left(\frac{5}{3} + \frac{3\cdot\left(\frac{K\cdot l}{r}\right)}{8\cdot C_c} - \frac{\left(\frac{K\cdot l}{r}\right)^3}{8\cdot C_c^{\,3}}\right) & \text{if } \frac{K\cdot l}{r} \le C_c \\ \frac{12\cdot\pi^2\cdot E}{23\cdot\left(\frac{K\cdot l}{r}\right)^2} & \text{if } \frac{K\cdot l}{r} > C_c \end{cases} \qquad F_a = 45\cdot\text{ksi}$$

$F_a := 1.333\cdot F_a$ Note: 1.333 increase allowed per TIA/EIA $\qquad F_a = 60.0\cdot\text{ksi}$

Applied Compressive Force:

$$\text{MaxCompression} := \frac{OM\cdot R_{bc}}{I_p} + \frac{\text{Axial}}{N} \qquad \text{MaxCompression} = 49.5\cdot\text{kips}$$

$$f_a := \frac{\text{MaxCompression}}{A_n} \qquad f_a = 15.2\cdot\text{ksi}$$

Check Combined Stresses:

$$\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} = 0.25$$

$$\text{Condition} := \text{if}\left(\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} \le 1.00, \text{"OK"}, \text{"Overstressed"}\right) \qquad \boxed{\text{Condition} = \text{"OK"}}$$

Base Plate Analysis:

Force From Bolt(s):

$$C_1 := \frac{OM \cdot d_4}{I_p} + \frac{Axial}{N} \qquad C_1 = 49.5 \times 10^3 \cdot lb$$

$$C_2 := \frac{OM \cdot d_3}{I_p} + \frac{Axial}{N} \qquad C_2 = 46.6 \times 10^3 \cdot lb$$

Bending Stress In Plate:

$$f_{bp} := \frac{6 \cdot \left(C_1 \cdot MomentArm_1 + 2 \cdot C_2 \cdot MomentArm_2\right)}{EffectiveWidth \cdot PlateThickness^2} \qquad \left(f_{bp}\right) = 21.82 \cdot ksi$$

Check Stresses:

$$\left(BasePlateRatio := \frac{f_{bp}}{1.33 \cdot 0.75 Fy_{bp}}\right) \left(BasePlateRatio\right) = 0.36$$

$$\left(BasePlateStress := if(BasePlateRatio < 1, "Not Over Stress", "Is Over Stress")\right)$$

$$\left(BasePlateStress\right) = "Not Over Stress"$$

FOUNDATION ANALYSIS

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MONOPOLE FOUNDATION ANALYSIS

TOWER FORCES:

Moment Caused by Tower	$M_t := 1030 \cdot ft \cdot kips$
Shear at Base of Tower	$S_t := 13.0 kip$
Max Compressive Force	$C_t := 27.0 \cdot kip$
Height of Tower	$H_t := 120.0 \cdot ft$
Base Plate Bolt Circle	$MP := 58in$

FOOTING DIMENSIONS:

Overall Depth of Footing	$D_f := 8.0ft$
Length of Pier	$L_p := 5.0 \cdot ft$
Extension of Pier Above Grade	$L_{pag} := 1.0 \cdot ft$
Diameter of Pier	$d_p := 7.0 \cdot ft$
Thickness of Footing	$T_f := 3.0 \cdot ft$
Width of Footing:	$W_f := 24.0ft$
Length of Anchor Bolts:	$L_{st} := 96in$
Projection of anchor bolts above pier	$A_{BP} := 12 \cdot in$

PROPERTIES:

Compressive Strength of Concrete	$fc := 4000psi$
Yield Strength of Steel Reinforcement	$fy := 60000 \cdot psi$
Yield Strength of Anchor Bolt	$fya := 75000 \cdot psi$
Internal Friction Angle of Soil	$\phi_s := 33 \cdot deg$
Allowable Bearing Capacity	$q_s := 5000 \cdot psf$
Unit Weight of Soil	$\pi_s := 125 \cdot pcf$
Unit Weight of Concrete	$\pi_c := 150 \cdot pcf$
Depth to Neglect	$n := 1.0ft$
Cohesion of Clay Type Soil Note: Use 0 for Sandy Soil	$c := 0 \cdot ksf$
Seismic Zone Factor: UBC Fig 23-2	$Z := 2$
Coefficient of Friction between Concrete:	$\mu := 0.45$
Clear Cover of Reinforcement Pier:	$Cvr_{pier} := 3 \cdot in$
Clear Cover of Reinforcement Pad:	$Cvr_{pad} := 3 \cdot in$
Anchor Bolt Diameter	$d_{anchor} := 2.25in$
Anchor bolt area	$A_{anchor} := 3.97 \cdot in^2$

PIER REINFORCEMENT:

Bar Size	$BSpier := 9$	Bar Diameter	$d_{bpier} := 1.128 \cdot in$
Number of Bars	$NBpier := 30$	Bar Area	$A_{bpier} := 1.000 \cdot in^2$

PAD REINFORCEMENT:

TOP:	Bar Size	$BS_{top} := 9$	Bar Diameter	$d_{btop} := 1.128 \cdot in$
	Number of Bars	$NB_{top} := 20$	Bar Area	$A_{btop} := 1.000 \cdot in^2$
BOTTOM:	Bar Size	$BS_{bot} := 9$	Bar Diameter	$d_{bbot} := 1.128 \cdot in$
	Number of Bars	$NB_{bot} := 36$	Bar Area	$A_{bot} := 1.000 \cdot in^2$

Coefficient of Lateral Soil Pressure: $K_p := \frac{1 + \sin(\phi_s)}{1 - \sin(\phi_s)}$ $K_p = 3.3921$

Load Factor (EIA 3.1.1): $LF := \text{if}\left[H_t \le 700 \cdot ft, 1.333, \text{if}\left[H_t \ge 1200, 1.7, 1.333 + \left(\frac{H_t - 700}{1200 - 700}\right) \cdot 0.4\right]\right]$ $LF = 1.333$

CHECK ANCHOR STEEL EMBEDMENT

Depth:

$D_{ab} := L_{st} - A_{BP}$ $D_{ab} = 7 \cdot ft$ $L_{anchor} := \frac{(0.11 \cdot fy) \cdot in}{\sqrt{fc \cdot psi}}$ $L_{anchor} = 8.6963 \cdot ft$

$DepthCheck := if(D_{ab} \geq L_{anchor}, "Okay", "No Good")$

$DepthCheck = "No Good"$ **Note:** anchor plate is provided

STABILITY OF FOOTING

Passive Pressure:

$P_{pn} := K_p \cdot \pi_s \cdot n + c \cdot 2 \cdot \sqrt{K_p}$ $P_{pn} = 0.424 \cdot ksf$

$P_{pt} := K_p \cdot \pi_s \cdot (D_f - T_f) + c \cdot 2 \cdot \sqrt{K_p}$ $P_{pt} = 2.1201 \cdot ksf$

$P_{top} := if[n < (D_f - T_f), P_{pt}, P_{pn}]$ $P_{top} = 2.1201 \cdot ksf$

$P_{bot} := K_p \cdot \pi_s \cdot D_f + c \cdot 2 \cdot \sqrt{K_p}$ $P_{bot} = 3.3921 \cdot ksf$

$P_{ave} := \frac{P_{top} + P_{bot}}{2}$ $P_{ave} = 2.7561 \cdot ksf$

$T_p := if[n < (D_f - T_f), T_f, (D_f - n)]$ $T_p = 3 \cdot ft$

$A_p := W_f \cdot T_p$ $A_p = 72 \cdot ft^2$

Ultimate Shear:

$S_u := P_{ave} \cdot A_p$ $S_u = 198.439 \cdot kip$

Weight of Concrete Pad:

$WT_c := \left[\left(W_f^2 \cdot T_f\right) + d_p^2 L_p\right] \cdot \pi_c$ $WT_c = 295.95 \cdot kip$

Weight of Soil: above Footing:

$WT_{s1} := \left[W_f^2 \cdot \left(\left|L_p - L_{pag}\right|\right) - \frac{d_p^2 \cdot \pi}{4} \cdot \left(\left|L_p - L_{pag}\right|\right)\right] \cdot \pi_s$ $WT_{s1} = 268.7577 \cdot kip$

Weight of Soil Wedge at back face:

$WT_{s2} := \left(\frac{D_f^2 \cdot \tan(\phi_s)}{2} \cdot W_f\right) \cdot \pi_s$ $WT_{s2} = 62.3431 \cdot kip$

Total Weight:

$WT_{tot} := WT_c + WT_{s1} + C_t$ $WT_{tot} = 591.7077 \cdot kip$

Resisting Moment:

$M_r := (WT_{tot}) \cdot \frac{W_f}{2} + S_u \cdot \frac{T_f}{3} + WT_{s2} \cdot \left(W_f + \frac{D_f \cdot \tan(\phi_s)}{3}\right)$ $M_r = 8903.13 \cdot kip \cdot ft$

Overturning Moment:

$M_{ot} := M_t + S_t \cdot (L_p + T_f)$ $M_{ot} = 1134 \cdot kip \cdot ft$

Factor of Safety:

$FS := \frac{M_r}{M_{ot}}$ $FS_{req} := 2$ $FS = 7.85$

$SafetyCheck := if(FS > FS_{req}, "Okay", "No Good")$ $SafetyCheck = "Okay"$

SHEAR CAPACITY IN PIER

$FS := 2$

$$S_p := \frac{P_{ave} \cdot A_p + \mu \cdot WT_{tot}}{FS}$$

$S_p = 232.3538 \cdot kips$

$ShearCheck := if(S_p > S_t, "Okay", "No Good")$

$ShearCheck = "Okay"$

BEARING PRESSURE CAUSED BY FOOTING

$A_{mat} := W_f^2$ $\quad A_{mat} = 576 \cdot ft^2$

$S := \frac{W_f^3}{6}$ $\quad S = 2304 \cdot ft^3$

$P_{max} := \frac{WT_{tot}}{A_{mat}} + \frac{M_{ot}}{S}$ $\quad P_{max} = 1.5195 \cdot ksf$

$P_{min} := \frac{WT_{tot}}{A_{mat}} - \frac{M_{ot}}{S}$ $\quad P_{min} = 0.5351 \cdot ksf$

$MaxPressure := if(P_{max} < q_s, "Okay", "No Good")$ $\quad MaxPressure = "Okay"$

$MinPressure := if[(P_{min} \geq 0) \cdot (P_{min} < q_s), "Okay", "No Good"]$ $\quad MinPressure = "Okay"$

Distance to Resultant of Pressure Distribution:

$$X_p := \frac{P_{max}}{\frac{P_{max} - P_{min}}{W_f}} \cdot \frac{1}{3}$$

$X_p = 12.3486 \cdot ft$

Distance to Kern: $X_k := \frac{W_f}{6}$ $\quad X_k = 4 \cdot ft$

Since Resultant Force is Not in Kern, Area to which Pressure is Applied Must be Reduced.

Eccentricity: $e := \frac{M_{ot}}{WT_{tot}}$ $\quad e = 1.9165$

Adjusted Soil Pressure: $P_a := \frac{2 \cdot WT_{tot}}{3 \cdot W_f \cdot \left(\frac{W_f}{2} - e\right)}$ $\quad P_a = 1.63 \cdot ksf$

$q_{adj} := if\left(P_{min} < 0, P_a, \frac{P_{max}}{ft^2}\right)$ $\quad q_{adj} = 1.5195 \cdot ksf$

$PressureCheck := if(q_{adj} < q_s, "Okay", "No Good")$ $\quad PressureCheck = "Okay"$

CONCRETE BEARING CAPACITY (ACI 10.17)

$\phi_c := 0.75$ (ACI 9.3.2.2)

$P_b := \phi_c \cdot 0.85 \cdot fc \cdot \frac{d_p^2 \cdot \pi}{4}$ $P_b = 14131.5121 \cdot kip$

BearingCheck := if($P_b > LF \cdot C_t$, "Okay", "No Good") BearingCheck = "Okay"

SHEAR STRENGTH OF CONCRETE

Beam Shear: (Critical section located at a distance d from the face of Pier) (ACI 11.3.1.1)

$\phi_{vc} := .85$ (ACI 9.3.2.3)

$d := T_f - Cvr_{pad} - d_{bbot}$ $d = 31.872 \cdot in$

$d_1 := \frac{W_f}{2} - \frac{d_p}{2}$ $d_1 = 8.5 \cdot ft$

$d_2 := d_1 - d$ $d_2 = 5.844 \cdot ft$

$L := \left(\frac{W_f}{2} - e\right) \cdot 3$ $L = 30.2505 \cdot ft$

$Slope := if\left(L > W_f, \frac{P_{max} - P_{min}}{W_f}, \frac{q_{adj}}{L}\right)$ $Slope = 0.041 \cdot kcf$

$V_{req} := LF \cdot \left[\left(q_{adj} - Slope \cdot d_1\right) + \left(\frac{Slope \cdot d_1}{2}\right)\right] \cdot W_f \cdot d_1$ $V_{req} = 365.787 \cdot kip$

ACI 11.3.1.1 $V_{Avail} := \phi_c \cdot 2 \cdot \sqrt{fc \cdot psi} \cdot W_f \cdot d$ $V_{Avail} = 986.9172 \cdot kip$

BeamShearCheck := if($V_{req} < V_{Avail}$, "Okay", "No Good") BeamShearCheck = "Okay"

Punching Shear: (Critical Section Located at a distance of d/2 from the face of pier) (ACI 11.12.2.1)

$b_o := \left(d_p + d\right) \cdot \pi$ $b_o = 30.3352 \cdot ft$

Area included inside bo: $A_{bo} := \frac{\pi \cdot \left(d_p + d\right)^2}{4}$ $A_{bo} = 73.2292 \cdot ft^2$

Area outside of bo: $A_{out} := A_{mat} - A_{bo}$ $A_{out} = 502.7708 \cdot ft^2$

Guess Value: $v_u := 1ksf$

(From "Foundation Analysis and design", By Joseph Bowles, Eq. 8-9)

Given $d^2 + d_p \cdot d = \frac{WT_{tot}}{\pi \cdot v_u}$

$v_u := \text{Find}(v_u)$ $v_u = 7.344 \cdot ksf$

$V_u := v_u \cdot d \cdot W_f$ $V_u = 468.1353 \cdot kips$

$V_{req} := LF \cdot V_u$ $V_{req} = 624.0243 \cdot kips$

$V_{Avail} := \phi_c \cdot 4 \cdot \sqrt{f'c \cdot psi} \cdot b_o \cdot d$ $V_{Avail} = 2494.8624 \cdot kips$

$PunchingShearCheck := \text{if}(V_{req} < V_{Avail}, \text{"Okay"}, \text{"No Good"})$ $PunchingShearCheck = \text{"Okay"}$

STEEL REINFORCEMENT IN THE PAD $\phi_m := .90$ ACI 9.3.2.2

Take Maximum Bending at face of Pier:

$q_b := q_{adj} - d_1 \cdot Slope$ $q_b = 1.1708 \cdot ksf$

$M_n := \frac{1}{LF \cdot \phi_m} \cdot \left[(q_{adj} - q_b) \cdot \frac{d_1^2}{3} + q_b \cdot \frac{d_1^2}{2} \right] \cdot W_f$ $M_n = 1014.0994 \cdot kip \cdot ft$

ACI 10.2.7.3 $\beta := \text{if}\left[f'c \le 4000 \cdot psi, .85, \text{if}\left[f'c \ge 8000 \cdot psi, .65, .85 - \left(\frac{\frac{f'c}{psi} - 4000}{1000} \right) \cdot .05 \right] \right]$ $\beta = 0.85$

$R_u := \frac{M_n}{\phi_m \cdot W_f \cdot d^2}$ $R_u = 6655.3\ lbf$

$\rho := \frac{0.85 \cdot f'c}{fy} \left(1 - \sqrt{1 - \frac{2 \cdot R_u}{0.85 \cdot f'c}} \right)$ $\rho = 0.0008$

$\rho_{min} := 1.333 \cdot \rho$ $\rho_{min} = 0.00103$

Temperature and Shrinkage: $\rho_{sh} := if(fy \geq 60000 \cdot psi, 0.0018, 0.0020)$ $\rho_{sh} = 0.0018$

(ACI 7.12.2.1b)

FOR BOTTOM BARS: $As := \max(\rho, \rho_{min}, \rho_{sh}) \cdot W_f \cdot d$ $As = 16.5224 \cdot in^2$

$As_{prov} := A_{bot} \cdot NB_{bot}$ $As_{prov} = 36 \cdot in^2$

$PadReinforcement := if(As_{prov} > As, "Okay", "No Good")$ $PadReinforcement = "Okay"$

FOR TOP BARS: $As := \rho_{sh} \cdot (W_f \cdot d)$ $As = 16.5224 \cdot in^2$

$As_{prov} := A_{btop} \cdot NB_{top}$ $As_{prov} = 20 \cdot in^2$

$PadReinforcement := if(As_{prov} > As, "Okay", "No Good")$ $PadReinforcement = "Okay"$

TENSION (ACI 12.2.3) **DEVELOPMENT LENGTH OF PAD REINFORCEMENT**

Bar Spacing: $B_{sPad} := \frac{W_f - 2 \cdot Cvr_{pad} - NB_{bot} \cdot d_{bbot}}{NB_{bot} - 1}$ $B_{sPad} = 6.8969 \cdot in$

Development Length Factors:

Reinforcement Location Factor	$\alpha := 1.0$
Coating Factor	$\beta := 1.0$
Concrete strength Factor	$\lambda := 1.0$
Reinforcement Size Factor	$\pi := 1.0$

Spacing or Cover Dimension: $c := if\left(Cvr_{pad} < \frac{B_{sPad}}{2}, Cvr_{pad}, \frac{B_{sPad}}{2}\right)$ $c = 3 \cdot in$

Transverse Reinforcement Index As allowed by ACI 12.2.4 $k_{tr} := 0$

$$L_{dbt} := \frac{3}{40} \cdot \frac{fy}{\sqrt{fc \cdot psi}} \cdot \frac{\alpha \cdot \beta \cdot \pi \cdot \lambda}{\frac{c + k_{tr}}{d_{bbot}}} \cdot d_{bbot}$$ $L_{dbt} = 30.1772 \cdot in$

$L_{dbmin} := 12 \cdot in$

Minimum Development Length: (ACI 12.2.1) $L_{dbtCheck} := if(L_{dbt} \geq L_{dbmin}, "Use L.dbt", "Use L.dbmin")$ $L_{dbtCheck} = "Use L.dbt"$

Available Length in Pad: $L_{Pad} := \frac{W_f}{2} - \frac{d_p}{2} - Cvr_{pad}$ $L_{Pad} = 99 \cdot in$

$LpadTension := if(L_{Pad} > L_{dbt}, "Okay", "No Good")$ $LpadTension = "Okay"$

REINFORCEMENT IN PIER

Pier Area: $A_{pv} := \frac{\pi \cdot d_p^2}{4}$ $A_p = 5541.7694 \cdot in^2$

(ACI 10.8.4 and 10.9.1) $A_{smin} := 0.01 \cdot 0.05 \cdot A_p$ $A_{smin} = 2.7709 \cdot in^2$

$A_{sprov} := NBpier \cdot A_{bpier}$ $A_{sprov} = 30 \cdot in^2$

$SteelAreaCheck := if(A_{sprov} > A_{smin}, "Okay", "No Good")$ $SteelAreaCheck = "Okay"$

NOTE: Anchor Bolts are not accounted for in reinforcement calculation and will provide additional reinforcement to satisfy minimum requirement of steel.

Bar Spacing In Pier: $B_{sPier} := \frac{d_p \cdot \pi}{NBpier} - d_{bpier}$ $B_{sPier} = 7.6685 \cdot in$

Diamter of Reinforcement Cage: $Diam_{cage} := d_p - 2 \cdot Cvr_{pier}$ $Diam_{cage} = 78 \cdot in$

Maximum Moment in Pier: $M_p := \left[M_t + S_t \cdot \left(L_p + \frac{A_{BP}}{2}\right)\right] \cdot LF$ $M_p = 17619.594 \cdot in \cdot kips$

Pier Check evaluated from outside program and results are listed below;

(defined variables) $(f_c \ f_y \ cl \ Spiral) = (3 \ 60 \ 3 \ 0)$

The required input is column diameter in inches, number of reinforcing bars, bar size number, factored axial load in kips and moment in kip inches:

$(D \ N \ n \ P_u \ M_{xu}) := (84 \ 30 \ 9 \ 35.6 \ 17620)$

Clears any previous output: $(\phi P_n \ \phi M_{xn} \ f_{sp} \ \rho) := (0 \ 0 \ 0 \ 0)$

$(\phi P_n \ \phi M_{xn} \ f_{sp} \ \rho) := \phi P'_n(D, N, n, P_u, M_{xu})^T$

The Output is given as useable axial load in kips, moment capacity in kip inches, splicing stress in ksi, and reinforcement ratio:

$(\phi P_n \ \phi M_{xn} \ f_{sp} \ \rho) = (121.5951 \ 60182.7579 \ -60 \ 0.0054)$

Column size and reinforcement may be changed to match capacity to the applied load.

$AxialLoadCheck := if(\phi P_n \geq P_u, "Okay", "No Good")$ $AxialLoadCheck = "Okay"$

$BendingCheck := if(\phi M_{xn} \geq M_{xu}, "Okay", "No Good")$ $BendingCheck = "Okay"$

URS

Job	120' EEI Monopole - Collinsville, CT	Project No.	VZ4-027	Page / Sheet	of / 8 of 9
Description	Spread Footing w/ Pier Analysis	Computed by	JRM	Date	11/05/07
		Checked by		Date	

DEVELOPMENT LENGTH OF PIER REINFORCEMENT

TENSION (ACI 12.2.3)

Factors for development:

Reinforcement Location Factor $\alpha := 1.0$

Coating Factor $\beta := 1.0$

Concrete strength Factor $\lambda := 1.0$

Reinforcement Size Factor $\pi := 1.0$

Spacing or Cover Dimension: $c := if\left(Cvr_{pier} < \frac{B_{sPier}}{2}, Cvr_{pier}, \frac{B_{sPier}}{2}\right)$ $c = 3 \cdot in$

Transverse Reinforcement: As allowed by ACI 12.2.4 $k_{tr} := 0$

$$L_{dbt} := \frac{3}{40} \cdot \frac{fy}{\sqrt{f'c \cdot psi}} \cdot \frac{\alpha \cdot \beta \cdot \pi \cdot \lambda}{\frac{c + k_{tr}}{d_{bpier}}} \cdot d_{bpier} \qquad L_{dbt} = 30.1772 \cdot in$$

Minimum Development Length: (ACI 12.2.1) $L_{dbmin} := 12 \cdot in$

Pier reinforcement bars are standard 90 degree hooks and therefore developement in the pad is computed as follows:

$$L_{dh} := \frac{1200 \cdot d_{bpier}}{\sqrt{\frac{f'c}{psi}}} \cdot .7 \qquad L_{dh} = 14.9816 \cdot in$$

$$L_{db} := \max\left(L_{dbt}, L_{dbmin}\right) \qquad L_{db} = 30.1772 \cdot in$$

COMPRESSION: (ACI 12.3.2)

$$L_{dbc1} := \frac{.02 \cdot d_{bpier} \cdot fy}{\sqrt{f'c \cdot psi}} \qquad L_{dbc1} = 21.4023 \cdot in$$

$$L_{dbmin} := 0.0003 \cdot \frac{in^2}{lb} \cdot \left(d_{bpier} \cdot fy\right) \qquad L_{dbmin} = 20.304 \cdot in$$

$$L_{dbc} := if\left(L_{dbc1} \geq L_{dbmin}, L_{dbc1}, L_{dbmin}\right) \qquad L_{dbc} = 21.4023 \cdot in$$

Available Length in Foundation:

$L_{pier} := L_p - Cvr_{pier}$ $L_{pier} = 57 \cdot in$

$L_{pad} := T_f - Cvr_{pad}$ $L_{pad} = 33 \cdot in$

$L_{tension} := if\left(L_{pier} + L_{pad} > L_{dbt}, "Okay", "No Good"\right) = "Okay"$ $L_{tension} = "Okay"$

$L_{compression} := if\left(L_{pier} + L_{pad} > L_{dbc}, "Okay", "No Good"\right)$ $L_{compression} = "Okay"$

NOTE: Anchor bolts and plate provided, OK

TIE SIZE AND SPACING IN COLUMN

Minimum Tie Size:

$Tie_{min} := if(BSpier \le 10, 3, 4)$ $\quad Tie_{min} = 3$

Used #3 Ties

$d_{Tie} := 3$

Seismic factor:
(ACI 21.10.5)

$z := if(Z \le 2, 1, 0.5)$ $\quad z = 1$

$s_{lim1} := 16 \cdot d_{bpier} \cdot z$ $\quad s_{lim1} = 18.048 \cdot in$

$s_{lim2} := \frac{48 \cdot d_{Tie} \cdot in}{8} \cdot z$ $\quad s_{lim2} = 18 \cdot in$

$s_{lim3} := D_f \cdot z$ $\quad s_{lim3} = 96 \cdot in$

$s_{lim4} := 18in$ $\quad s_{lim4} = 18 \cdot in$

Maximum Spacing:

$s_{tie} := \min\left(\begin{pmatrix} s_{lim1} \\ s_{lim2} \\ s_{lim3} \\ s_{lim4} \end{pmatrix}\right)$ $\quad s_{tie} = 18 \cdot in$

Number of Ties Required:

$n_{tie} := \frac{L_{pier} - 3 \cdot in}{s_{tie}} + 1$ $\quad n_{tie} = 4$