

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

May 7, 2008

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

RE: **EM-VER-107-080311** – Cellco Partnership d/b/a Verizon Wireless notice of intent to modify an existing telecommunications facility located at 525 Orange Center Road, Orange, Connecticut.

Dear Attorney Baldwin:

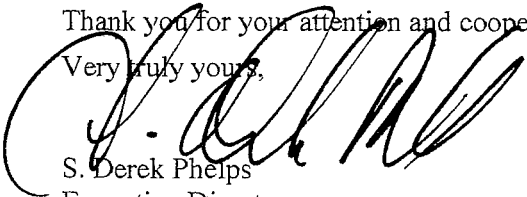
The Connecticut Siting Council (Council) hereby acknowledges your notice to modify this existing telecommunications facility, pursuant to Section 16-50j-73 of the Regulations of Connecticut State Agencies.

The proposed modifications are to be implemented as specified here and in your notice dated March 11, 2008, 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,


S. Derek Phelps
Executive Director

SDP/MP

c: Honorable James M. Zeoli, First Selectman, Town of Orange
Paul Dinice, Zoning Enforcement Officer, Town of Orange



Affirmative Action : Equal Opportunity Employer



Daniel F. Caruso
Chairman

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Ten Franklin Square, New Britain, CT 06051

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Internet: ct.gov/csc

March 12, 2008

The Honorable James M. Zeoli
First Selectman
Town of Orange
Town Hall
617 Orange Center Road
Orange, CT 06477-2423

RE: **EM-VER-107-080311** – Cellco Partnership d/b/a Verizon Wireless notice of intent to modify an existing telecommunication facility located at 525 Orange Center Road, Orange, Connecticut.

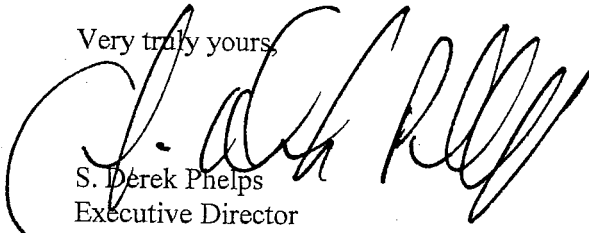
Dear Mr. Zeoli:

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.

If you have any questions or comments regarding this proposal, please call me or inform the Council by March 26, 2008.

Thank you for your cooperation and consideration.

Very truly yours,


S. Derek Phelps
Executive Director

SDP/jb

Enclosure: Notice of Intent

c: Paul Dinice, Zoning Enforcement Officer, Town of Orange

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

EM-VER-107-080311

ORIGINAL

March 11, 2008

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**
525 Orange Center Road, Orange, Connecticut

Dear Mr. Phelps:

Cellco Partnership d/b/a Verizon Wireless ("Cellco") currently maintains a wireless telecommunications facility at the above referenced location. The Council approved Cellco's shared use of this facility in Docket 117A. On February 18, 2004, the Council granted Cellco's request to replace six (6) cellular antennas with six (6) PCS antennas at the 155-foot level of the tower. Cellco now intends to modify its installation further by replacing its six (6) cellular antennas with six (6) newer model cellular antennas (LPA-80063/6CF) at the same 155-foot level on the tower. The tower is owned by the Town of Orange. 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 James Zeoli, First Selectman of the Town of Orange.

The planned modifications to the facility fall 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 structure. Cellco's replacement antennas will be located at the 155-foot level of the 160-foot tower.

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



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S. Derek Phelps
March 11, 2008
Page 2

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 Structural Analysis Report 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:

James Zeoli, Orange First Selectman
Sandy M. Carter



LPA-80063/6CF

When ordering replace "___" with connector type.

Mechanical specifications

Length	1800 mm	70.9 in
Width	380 mm	15.0 in
Depth	332 mm	13.1 in
Depth with z-bracket	372 mm	14.6 in
4) Weight	12.3 kg	27.0 lbs
Wind Area		
Fore/Aft	0.68 m ²	7.4 ft ²
Side	0.60 m ²	6.5 ft ²
Rated Wind Velocity (Safety factor 2.0)	>235 km/hr >146 mph	
Wind Load @ 100 mph (161 km/hr)		
Fore/Aft	993 N	223.3 lbs
Side	872 N	196.1 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

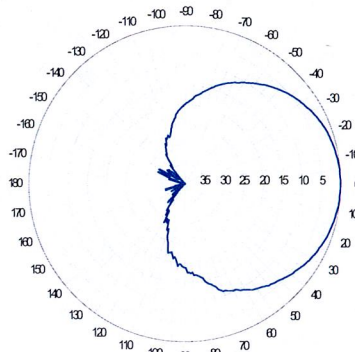
Electrical specifications

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	14.5 dBd
2) Power Rating	500 W
1) Half Power Angle	
H-Plane	63°
E-Plane	10°
1) Electrical Downtilt	0°
1) Null Fill	10%
Lightning Protection	Direct Ground

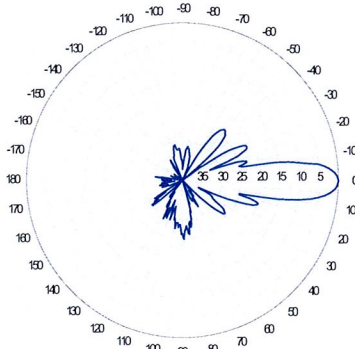
- 1) Typical values.
2) Power rating limited by connector only.
3) NE indicates an elongated N connector.
E-DIN indicates an elongated DIN connector.
4) The antenna weight listed above does not include the bracket weight.

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

Radiation pattern¹⁾



Horizontal

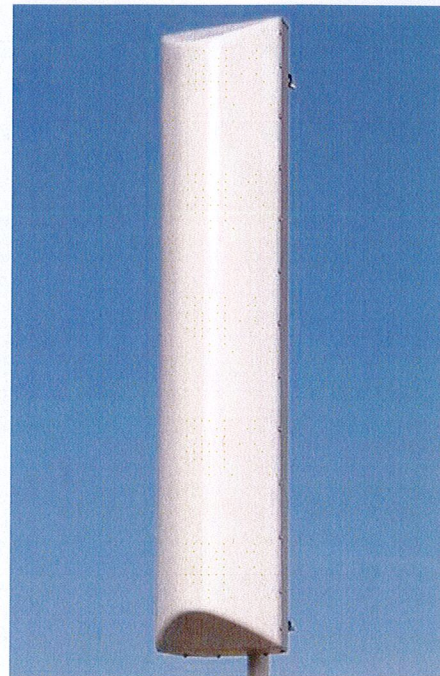


Vertical

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 bandwidth 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.

CF Denotes a Center-Fed Connector.

806-960 MHz



Revision Date: 7/5/07



Structural Analysis Report

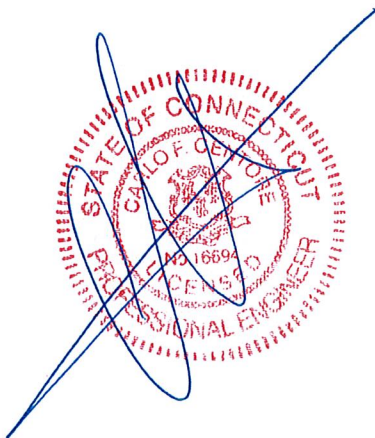
160' Existing Monopole

*525 Orange Center Road
Orange, CT*

Natcomm Project No. 08032

~~Date: February 28, 2008~~

Rev. 1: March 7, 2008



Prepared for:

Verizon Wireless
99 East River Road, 9th Floor
East Hartford, CT 06108

p: 203.488.0580
f: 203.488.8587
w: nat-eng.com
63-2 N. Branford Rd.
Branford, CT 06405

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Introduction

The purpose of this report is to summarize the results of the non-linear, P- Δ structural analysis of the antenna exchange proposed by Verizon Wireless on the existing monopole (tower) located in Orange, Connecticut. The host tower is a 160-ft, four section, twelve sided, tapered monopole originally designed and manufactured by Valmont Structures; job no. 16632-97 dated February 25, 1998. The manufacturer's drawings and calculations were unavailable for use in this report. The tower geometry and section sizes were taken from a previous structural analysis report prepared by URS Corporation; job no. 36931037.00008, dated August 15, 2006. URS's structural analysis report is available for reference in Section 4 of this report.

Verizon Wireless is proposing the replacement of six (6) existing Cellular antennas on their platform with railings. Refer to the Antenna and Appurtenance Summary below and "Antenna Replacement Details" drawing "ANT-1" available for reference in Section 4 of this report for a detailed description and layout of the Verizon Wireless existing and proposed antenna configuration.

Antenna and Appurtenance Summary

The existing tower was designed to support several communication antennas. The existing, proposed and future loads considered in this analysis consist of the following:

- **NEXTEL (Existing):**
Antennas: Twelve (12) Decibel DB844H90E-XY panel antennas pipe mounted to Verizon's platform with rails with a RAD center elevation of 167-ft above the existing tower base plate.
Coax Cables: Twelve (12) 1-1/4" $\varnothing$ coax cables running on the inside of the existing tower.
- **NEXTEL (Future):**
Antennas: One (1) Andrew VHLP1 dish antenna pipe mounted to Verizon's platform with rails with a RAD center elevation of 169-ft above the existing tower base plate.
Coax Cables: One (1) 1-5/8" $\varnothing$ coax cable running on the inside of the existing tower.
- **VERIZON (Existing Removed/Reconfigured):**
Antennas: Twelve (12) Decibel DB948F85T2E-M panel antennas mounted on a 13-ft platform with rails with a RAD center elevation of 155.2-ft above the existing tower base plate.
Coax Cables: Twelve (12) 1-5/8" $\varnothing$ coax cables running on the inside of the existing tower.
- **VERIZON (Proposed/Reconfigured):**
Antennas: Six (6) Antel LPA-80063/6CF (proposed) and six (6) Decibel DB948F85T2E-M (existing to remain) panel antennas mounted on a 13-ft platform with rails with a RAD center elevation of 155.2-ft above the existing tower base plate.
Coax Cables: Twelve (12) 1-5/8" $\varnothing$ coax cables running on the inside of the existing tower.

- AT&T (Existing):
Antennas: Nine (9) DUO1417-8686 panel antennas, six (6) 10" by 8" by 3" TMA's and three (3) diplexers mounted on a 13-ft platform with rails with a RAD center elevation of 145.7-ft above the existing tower base plate.
Coax Cables: Nine (9) 1-1/4" Ø coax cables running on the inside of the existing tower.
- SPRINT (Existing):
Antennas: Six (6) Decibel DB980H90E-M panel antennas mounted on a 13-ft platform with rails with a RAD center elevation of 134.1-ft above the existing tower base plate.
Coax Cables: Six (6) 1-5/8" Ø coax cables running on the inside of the existing tower.
- T-MOBILE (Existing):
Antennas: Six (6) RR90-17-02DP panel antennas and six (6) 10" by 8" by 3" TMA's mounted on a 13-ft platform with rails with a RAD center elevation of 121.9-ft above the existing tower base plate.
Coax Cables: Twelve (12) 1-5/8" Ø coax cables running on the inside of the existing tower.
- FUTURE WIRELESS CARRIER (Future):
Antennas: Twelve (12) Decibel DB844H90 panel antennas mounted on a 13-ft low-profile platform with a RAD center elevation of 110-ft above the existing tower base plate.
Coax Cables: Twelve (12) 1-1/4" Ø coax cables running on the inside of the existing tower.
- SPRINT (Existing):
Antennas: One (1) GPS antenna on a GPS Stand-off mount with a RAD center elevation of 83.4-ft above the existing tower base plate.
Coax Cables: One (1) 1/2"Ø coax cable running on the inside of the existing tower.

Primary Assumptions Used in the Analysis

- The tower structure's theoretical capacity not including any assessment of the condition of the tower.
- The tower carries the horizontal and vertical loads due to the weight of antennas, ice load and wind.
- Tower is properly installed and maintained.
- Tower is in plumb condition.
- Tower loading for antennas and mounts as listed in this report.
- All bolts are appropriately tightened providing the necessary connection continuity.
- All welds are fabricated with ER-70S-6 electrodes.
- All members are assumed to be as specified in the original tower design documents or reinforcement drawings.
- All members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
- All member protective coatings are in good condition.
- All tower members were properly designed, detailed, fabricated, installed and have been properly maintained since erection.
- Any deviation from the analyzed antenna loading will require a new analysis for verification of structural adequacy.
- All coax cables to be installed within tower.
- A new porthole will not be required.

A n a l y s i s

The existing tower was analyzed using a comprehensive computer program entitled RISATower. The program analyzes the tower, considering the worst case loading condition. The tower is considered as loaded by concentric forces along the tower shaft, and the model assumes that the shaft members are subjected to bending, axial, and shear forces.

The existing tower was analyzed for 90 mph basic wind speed (fastest mile) with no ice and 75% reduction of wind force with ½ inch accumulative ice to determine stresses in members as per guidelines of TIA/EIA-222-F-96 entitled "Structural Standards for Steel Antenna Towers and Antenna Supporting Structures", the American Institute of Steel Construction (AISC) and the Manual of Steel Construction; Allowable Stress Design (ASD).

T o w e r L o a d i n g

Tower loading was determined by the basic wind speed as applied to projected surface areas with modification factors per TIA/EIA-222-F, gravity loads of the tower structure and its components, and the application of ½" radial ice tower structure and its components.

Basic Wind Speed:	New Haven; v = 85 mph (fastest mile)	[Section 16 of TIA/EIA-222-F-96]
	Orange; v = 110 mph (3 second gust) equivalent to v = 90 mph (fastest mile)	[Appendix K of the 2005 CT Building Code Supplement]
	CT Building Code wind speed controls	
Load Cases:	<u>Load Case 1</u> ; 90 mph wind speed w/ no ice plus gravity load – used in calculation of tower stresses and rotation. This load case typically controls the design.	[Section 2.3.16 of TIA/EIA-222-F-96]
	<u>Load Case 2</u> ; 78 mph wind speed w/ ½" radial ice plus gravity load – used in calculation of tower stresses. The 78 mph wind speed velocity represents 75% of the wind pressure generated by the 90 mph wind speed.	[Section 2.3.16 of TIA/EIA-222-F-96]
	<u>Load Case 3</u> ; Seismic – not checked	[Section 1610.1.3 of State Bldg. Code 1999] does not control in the design of this structure type

Tower Capacity

Tower stresses were calculated utilizing the structural analysis software RISATower. Allowable stresses were determined based on Table 5 of the TIA/EIA code with a 1/3 increase per Section 3.1.1.1 of the same code.

Calculated stresses were found to be within allowable limits. In Load Case 1, per RISATower "Section Capacity Table", this tower was found to be at **80.0%** of its total capacity.

Foundation and Anchors

The existing foundation consists of an 8-ft square reinforced concrete pedestal with a 22-ft square reinforced concrete pad bearing directly on the existing sub grade. The sub grade conditions used in the foundation analysis were derived from the aforementioned URS structural analysis available for reference in Section 4 of this report. The monopole tower is connected to the pedestal by means of twenty-four (24) 2.25" diameter, A615-GR75 anchor bolts embedded approximately 10.2-ft into the concrete foundation structure.

Review of the foundation and anchor design consisted of verification of applied loads obtained from the tower design calculations and code checks of allowable stresses:

- The tower base reactions developed from the governing Load Case 1 were used in the verification of the foundation and its anchors:
 - Shear Force @ top of pedestal = **44.5 kips**
 - Moment @ top of pedestal = **4,730.0 ft-kips**
 - Axial Force @ top of pedestal = **51.4 kips**
- The base plate, anchor bolts and the foundation are within allowable limits.
- Foundation resists two times the calculated wind load per the requirements of section 3108.4.2 of the 2005 CT State Building Code Supplement to the 2003 International Building Code (IBC).

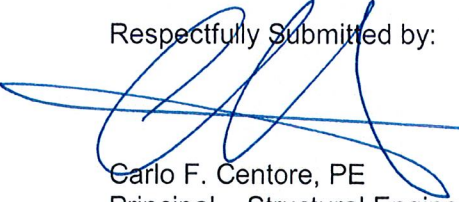
Conclusions

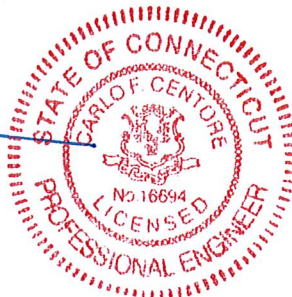
This analysis shows that the subject tower **is adequate** to support the proposed modified antenna configuration.

The analysis is based, in part, on the information provided to this office by Verizon Wireless. If the existing conditions are different than the information in this report, Natcomm, Inc. must be contacted for resolution of any potential issues.

Please feel free to call with any questions or comments.

Respectfully Submitted by:


Carlo F. Centore, PE
Principal ~ Structural Engineer



REPORT

SECTION 1-5

*Standard Conditions for Furnishing of
Professional Engineering Services on
Existing Structures*

All engineering services are performed on the basis that the information used is current and correct. This information may consist of, but is not necessarily limited to:

- Information supplied by the client regarding the structure itself, its foundations, the soil conditions, the antenna and feed line loading on the structure and its components, or other relevant information.
- Information from the field and/or drawings in the possession of Natcomm, Inc. or generated by field inspections or measurements of the structure.
- It is the responsibility of the client to ensure that the information provide to Natcomm, Inc. and used in the performance of our engineering services is correct and complete. In the absence of information to the contrary, we assume that all structures were constructed in accordance with the drawings and specifications and are in an un-corroded condition and have not deteriorated. It is therefore assumed that its capacity has not significantly changed from the "as new" condition.
- All services will be performed to the codes specified by the client, and we do not imply to meet any other codes or requirements unless explicitly agreed in writing. If wind and ice loads or other relevant parameters are to be different from the minimum values recommended by the codes, the client shall specify the exact requirement. In the absence of information to the contrary, all work will be performed in accordance with the latest revision of ANSI/ASCE10 & ANSI/EIA-222
- All services performed, results obtained, and recommendations made are in accordance with generally accepted engineering principles and practices. Natcomm, Inc. is not responsible for the conclusions, opinions and recommendations made by others based on the information we supply.

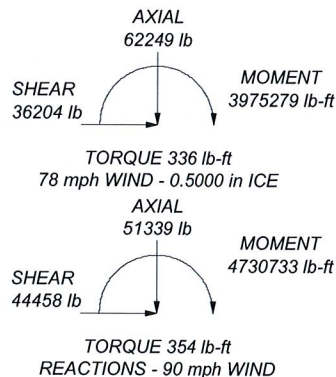
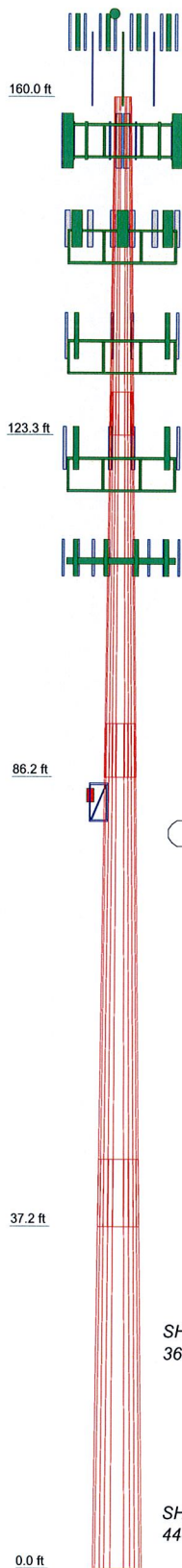
GENERAL DESCRIPTION OF STRUCTURAL ANALYSIS PROGRAM

RISATower, is an integrated structural analysis and design software package for Designed specifically for the telecommunications industry, RISATower, formerly ERITower, automates much of the tower analysis and design required by the TIA/EIA 222 Standard.

RISATower Features:

- RISATower can analyze and design 3- and 4-sided guyed towers, 3- and 4-sided self-supporting towers and either round or tapered ground mounted poles with or without guys.
- The program analyzes towers using the TIA-222-G (2005) standard or any of the previous TIA/EIA standards back to RS-222 (1959). Steel design is checked using the AISC ASD 9th Edition or the AISC LRFD specifications.
- Linear and non-linear (P-delta) analyses can be used in determining displacements and forces in the structure. Wind pressures and forces are automatically calculated.
- Extensive graphics plots include material take-off, shear-moment, leg compression, displacement, twist, feed line, guy anchor and stress plots.
- RISATower contains unique features such as True Cable behavior, hog rod take-up, foundation stiffness and much more.

Section	1	2	3	4
Length (ft)	36.67	41.83	54.83	44.50
Number of Sides	12	12	12	12
Thickness (in)	0.2190	0.3440	0.4380	0.4690
Lap Splice (ft)		4.67	7.33	
Top Dia (in)	21.2000	29.7154	39.1179	51.5330
Bot Dia (in)	31.4600	41.4400	54.4600	64.0000
Grade			A572-65	
Weight (lb)	2297.6	5555.1	12196.6	13102.6



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
Andrew VHL P1 15.3" Dish (Nextel)	169	(2) TMA 10"x8"x3" (ATT)	145.7
(4) DB844H90E-XY (Nextel)	167	Diplexer (ATT)	145.7
(4) DB844H90E-XY (Nextel)	167	(3) DUO1417-8686 (ATT)	145.7
(4) DB844H90E-XY (Nextel)	167	(2) TMA 10"x8"x3" (ATT)	145.7
(4) 8"x2 1/2" Pipe Mount (Nextel)	163	Diplexer (ATT)	145.7
(4) 8"x2 1/2" Pipe Mount (Nextel)	163	13' Platform w/ Rails (ATT)	143.7
(4) 8"x2 1/2" Pipe Mount (Nextel)	163	(2) DB980H90E-M (Sprint)	134.1
DB948F85T2E-M (Verizon)	155.2	(2) DB980H90E-M (Sprint)	134.1
DB948F85T2E-M (Verizon)	155.2	(2) DB980H90E-M (Sprint)	134.1
DB948F85T2E-M (Verizon)	155.2	13' Platform w/ Rails (Sprint)	131.8
DB948F85T2E-M (Verizon)	155.2	(2) RR90-17-02DP (T-Mobile)	121.9
DB948F85T2E-M (Verizon)	155.2	(2) RR90-17-02DP (T-Mobile)	121.9
DB948F85T2E-M (Verizon)	155.2	(2) RR90-17-02DP (T-Mobile)	121.9
LPA-80063-6CF (Verizon)	155.2	(2) TMA 10"x8"x3" (T-Mobile)	121.9
LPA-80063-6CF (Verizon)	155.2	(2) TMA 10"x8"x3" (T-Mobile)	121.9
LPA-80063-6CF (Verizon)	155.2	(2) TMA 10"x8"x3" (T-Mobile)	121.9
LPA-80063-6CF (Verizon)	155.2	13' Platform w/ Rails (T-Mobile)	119
LPA-80063-6CF (Verizon)	155.2	13' Low Profile Platform (Future)	110
LPA-80063-6CF (Verizon)	155.2	(4) DB844H90 (Future)	110
13' Platform w/ Rails (Verizon)	155.2	(4) DB844H90 (Future)	110
(3) DUO1417-8686 (ATT)	145.7	(4) DB844H90 (Future)	110
(2) TMA 10"x8"x3" (ATT)	145.7	Standoff Mount	83.4
Diplexer (ATT)	145.7	GPS (Sprint)	83.4
(3) DUO1417-8686 (ATT)	145.7	Standoff Mount	83.4

MATERIAL STRENGTH

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

TOWER DESIGN NOTES

1. Tower designed for a 90 mph basic wind in accordance with the TIA/EIA-222-F Standard.
2. Tower is also designed for a 78 mph basic wind with 0.50 in ice.
3. Deflections are based upon a 50 mph wind.
4. Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
5. Welds are fabricated with ER-70S-6 electrodes.
6. TOWER RATING: 80%

NATCOMM

63-2 N. Branford Rd.
Branford, CT 06405
Phone: (203) 488-0580
FAX: (203) 488-8587

Job: **160' Valmont Monopole**

Project: **08032 - 525 Orange Center Rd, Orange, CT**

Client: Verizon

Drawn by: Staff

App'd:

Code: TIA/EIA-222-F

Date: 02/26/08

Scale: NTS

Path: C:\Users\kierian214\Documents\Natcomm\08032 Orange\ERI Files\160 Valmont Orange.dwg
Dwg No. E-1

RISATower NATCOMM 63-2 N. Branford Rd. Branford, CT 06405 Phone: (203) 488-0580 FAX: (203) 488-8587	Job	160' Valmont Monopole	Page	1 of 19
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Tower Input Data

There is a pole section.

This tower is designed using the TIA/EIA-222-F standard.

The following design criteria apply:

Basic wind speed of 90 mph.

Nominal ice thickness of 0.5000 in.

Ice density of 56 pcf.

A wind speed of 78 mph is used in combination with ice.

Temperature drop of 50 °F.

Deflections calculated using a wind speed of 50 mph.

Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards..

Welds are fabricated with ER-70S-6 electrodes..

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	160.00-123.33	36.67	4.67	12	21.2000	31.4600	0.2190	0.8760	A572-65 (65 ksi)
L2	123.33-86.17	41.83	5.83	12	29.7154	41.4400	0.3440	1.3760	A572-65 (65 ksi)
L3	86.17-37.17	54.83	7.33	12	39.1179	54.4600	0.4380	1.7520	A572-65 (65 ksi)
L4	37.17-0.00	44.50		12	51.5330	64.0000	0.4690	1.8760	A572-65 (65 ksi)

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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	21.9479	14.7954	831.3128	7.5112	10.9816	75.7005	1684.4652	7.2818	5.0947	23.263
	32.5698	22.0305	2744.4841	11.1843	16.2963	168.4117	5561.0688	10.8428	7.8444	35.819
L2	32.1188	32.5341	3582.3893	10.5149	15.3926	232.7351	7258.8920	16.0123	7.0418	20.47
	42.9018	45.5212	9812.9350	14.7124	21.4659	457.1402	19883.6668	22.4042	10.1840	29.605
L3	42.1867	54.5526	10417.6988	13.8474	20.2631	514.1224	21109.0822	26.8491	9.3098	21.255
	56.3811	76.1905	28381.0140	19.3399	28.2103	1006.0522	57507.6289	37.4986	13.4214	30.643
L4	55.4769	77.1158	25666.0216	18.2809	26.6941	961.4873	52006.3181	37.9540	12.5539	26.767
	66.2577	95.9432	49427.8521	22.7441	33.1520	1490.9463	100154.228	47.2203	15.8951	33.891
9										

Tower Elevation	Gusset Area (per face)	Gusset Thickness	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
ft	ft ²	in						
L1 160.00- 123.33				1	1	1		
L2 123.33- 86.17				1	1	1		
L3 86.17-37.17				1	1	1		
L4 37.17-0.00				1	1	1		

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number		C _A A _A ft ² /ft	Weight plf
1 1/4 (Nextel)	A	No	Inside Pole	160.00 - 3.00	12	No Ice	0.00	0.66
						1/2" Ice	0.00	0.66
1 5/8 (Verizon)	B	No	Inside Pole	156.00 - 3.00	12	No Ice	0.00	1.04
						1/2" Ice	0.00	1.04
1 1/4 (ATT)	C	No	Inside Pole	146.00 - 3.00	9	No Ice	0.00	0.66
						1/2" Ice	0.00	0.66
1 5/8 (Sprint)	A	No	Inside Pole	132.00 - 3.00	6	No Ice	0.00	1.04
						1/2" Ice	0.00	1.04
1 5/8 (T-Mobile)	B	No	Inside Pole	122.00 - 3.00	12	No Ice	0.00	1.04
						1/2" Ice	0.00	1.04
1 1/4 (Future)	C	No	Inside Pole	110.00 - 3.00	12	No Ice	0.00	0.66
						1/2" Ice	0.00	0.66
1/2 (Sprint)	A	No	Inside Pole	83.50 - 3.00	1	No Ice	0.00	0.25
						1/2" Ice	0.00	0.25
1 5/8 (Nextel)	A	No	Inside Pole	160.00 - 3.00	1	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 _A A _A In Face ft ²	C _A A _A Out Face ft ²	Weight lb
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RISATower

NATCOMM
 63-2 N. Branford Rd.
 Branford, CT 06405
 Phone: (203) 488-0580
 FAX: (203) 488-8587

Job

160' Valmont Monopole

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Project

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Client

Verizon

Designed by
 Staff

Tower Section	Tower Elevation ft	Face	A_R ft ²	A_F ft ²	C_{AA} In Face ft ²	C_{AA} Out Face ft ²	Weight lb
L1	160.00-123.33	A	0.000	0.000	0.000	0.000	382.66
		B	0.000	0.000	0.000	0.000	407.72
		C	0.000	0.000	0.000	0.000	134.66
L2	123.33-86.17	A	0.000	0.000	0.000	0.000	564.83
		B	0.000	0.000	0.000	0.000	910.92
		C	0.000	0.000	0.000	0.000	409.46
L3	86.17-37.17	A	0.000	0.000	0.000	0.000	756.38
		B	0.000	0.000	0.000	0.000	1223.04
		C	0.000	0.000	0.000	0.000	679.14
L4	37.17-0.00	A	0.000	0.000	0.000	0.000	527.93
		B	0.000	0.000	0.000	0.000	852.88
		C	0.000	0.000	0.000	0.000	473.60

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} In Face ft ²	C_{AA} Out Face ft ²	Weight lb
L1	160.00-123.33	A	0.500	0.000	0.000	0.000	0.000	382.66
		B		0.000	0.000	0.000	0.000	407.72
		C		0.000	0.000	0.000	0.000	134.66
L2	123.33-86.17	A	0.500	0.000	0.000	0.000	0.000	564.83
		B		0.000	0.000	0.000	0.000	910.92
		C		0.000	0.000	0.000	0.000	409.46
L3	86.17-37.17	A	0.500	0.000	0.000	0.000	0.000	756.38
		B		0.000	0.000	0.000	0.000	1223.04
		C		0.000	0.000	0.000	0.000	679.14
L4	37.17-0.00	A	0.500	0.000	0.000	0.000	0.000	527.93
		B		0.000	0.000	0.000	0.000	852.88
		C		0.000	0.000	0.000	0.000	473.60

Feed Line Center of Pressure

Section	Elevation ft	CP_X in	CP_Z in	CP_X Ice in	CP_Z Ice in
L1	160.00-123.33	0.0000	0.0000	0.0000	0.0000
L2	123.33-86.17	0.0000	0.0000	0.0000	0.0000
L3	86.17-37.17	0.0000	0.0000	0.0000	0.0000
L4	37.17-0.00	0.0000	0.0000	0.0000	0.0000

Discrete Tower Loads

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Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C _{AA} Front ft ²	C _{AA} Side ft ²	Weight lb
(4) DB844H90E-XY (Nextel)	A	From Face	3.00 0.00 0.00	0.0000	167.00	No Ice 1/2" Ice	2.87 3.18	3.73 4.10	10.00 35.38
(4) DB844H90E-XY (Nextel)	B	From Face	3.00 0.00 0.00	0.0000	167.00	No Ice 1/2" Ice	2.87 3.18	3.73 4.10	10.00 35.38
(4) DB844H90E-XY (Nextel)	C	From Face	3.00 0.00 0.00	0.0000	167.00	No Ice 1/2" Ice	2.87 3.18	3.73 4.10	10.00 35.38
(4) 8'x2 1/2" Pipe Mount (Nextel)	A	From Face	3.00 0.00 0.00	0.0000	163.00	No Ice 1/2" Ice	2.30 3.13	2.30 3.13	40.50 57.38
(4) 8'x2 1/2" Pipe Mount (Nextel)	B	From Face	3.00 0.00 0.00	0.0000	163.00	No Ice 1/2" Ice	2.30 3.13	2.30 3.13	40.50 57.38
(4) 8'x2 1/2" Pipe Mount (Nextel)	C	From Face	3.00 0.00 0.00	0.0000	163.00	No Ice 1/2" Ice	2.30 3.13	2.30 3.13	40.50 57.38
13' Platform w/ Rails (Verizon)	C	None		0.0000	155.20	No Ice 1/2" Ice	23.90 30.80	23.90 30.80	2000.00 3000.00
DB948F85T2E-M (Verizon)	A	From Face	3.00 -4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	A	From Face	3.00 4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	B	From Face	3.00 -4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	B	From Face	3.00 4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	C	From Face	3.00 -4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	C	From Face	3.00 4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
LPA-80063-6CF (Verizon)	A	From Face	3.00 -6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
LPA-80063-6CF (Verizon)	A	From Face	3.00 6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
LPA-80063-6CF (Verizon)	B	From Face	3.00 -6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
LPA-80063-6CF (Verizon)	B	From Face	3.00 6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
LPA-80063-6CF (Verizon)	C	From Face	3.00 -6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
LPA-80063-6CF (Verizon)	C	From Face	3.00 6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
13' Platform w/ Rails	C	None		0.0000	143.70	No Ice	17.20	17.20	2000.00

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Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C _{AA} Front ft ²	C _{AA} Side ft ²	Weight lb
(ATT)						1/2" Ice	22.30	22.30	3000.00
(3) DUO1417-8686	A	From Face	3.00	0.0000	145.70	No Ice	6.53	4.20	20.30
(ATT)			0.00			1/2" Ice	6.94	4.57	62.49
			0.00						
(2) TMA 10"x8"x3"	A	From Face	3.00	0.0000	145.70	No Ice	0.78	0.29	15.00
(ATT)			0.00			1/2" Ice	0.90	0.38	20.06
			0.00						
Diplexer	A	From Face	3.00	0.0000	145.70	No Ice	0.35	0.12	8.00
(ATT)			0.00			1/2" Ice	0.43	0.17	10.43
			0.00						
(3) DUO1417-8686	B	From Face	3.00	0.0000	145.70	No Ice	6.53	4.20	20.30
(ATT)			0.00			1/2" Ice	6.94	4.57	62.49
			0.00						
(2) TMA 10"x8"x3"	B	From Face	3.00	0.0000	145.70	No Ice	0.78	0.29	15.00
(ATT)			0.00			1/2" Ice	0.90	0.38	20.06
			0.00						
Diplexer	B	From Face	3.00	0.0000	145.70	No Ice	0.35	0.12	8.00
(ATT)			0.00			1/2" Ice	0.43	0.17	10.43
			0.00						
(3) DUO1417-8686	C	From Face	3.00	0.0000	145.70	No Ice	6.53	4.20	20.30
(ATT)			0.00			1/2" Ice	6.94	4.57	62.49
			0.00						
(2) TMA 10"x8"x3"	C	From Face	3.00	0.0000	145.70	No Ice	0.78	0.29	15.00
(ATT)			0.00			1/2" Ice	0.90	0.38	20.06
			0.00						
Diplexer	C	From Face	3.00	0.0000	145.70	No Ice	0.35	0.12	8.00
(ATT)			0.00			1/2" Ice	0.43	0.17	10.43
			0.00						
13' Platform w/ Rails	C	None		0.0000	131.80	No Ice	17.20	17.20	2000.00
(Sprint)						1/2" Ice	22.30	22.30	3000.00
(2) DB980H90E-M	A	From Face	3.00	0.0000	134.10	No Ice	3.80	2.19	8.50
(Sprint)			0.00			1/2" Ice	4.18	2.56	28.62
			0.00						
(2) DB980H90E-M	B	From Face	3.00	0.0000	134.10	No Ice	3.80	2.19	8.50
(Sprint)			0.00			1/2" Ice	4.18	2.56	28.62
			0.00						
(2) DB980H90E-M	C	From Face	3.00	0.0000	134.10	No Ice	3.80	2.19	8.50
(Sprint)			0.00			1/2" Ice	4.18	2.56	28.62
			0.00						
13' Platform w/ Rails	C	None		0.0000	119.00	No Ice	17.20	17.20	2000.00
(T-Mobile)						1/2" Ice	22.30	22.30	3000.00
(2) RR90-17-02DP	A	From Face	3.00	0.0000	121.90	No Ice	4.36	1.97	18.00
(T-Mobile)			0.00			1/2" Ice	4.77	2.31	40.42
			0.00						
(2) RR90-17-02DP	B	From Face	3.00	0.0000	121.90	No Ice	4.36	1.97	18.00
(T-Mobile)			0.00			1/2" Ice	4.77	2.31	40.42
			0.00						
(2) RR90-17-02DP	C	From Face	3.00	0.0000	121.90	No Ice	4.36	1.97	18.00
(T-Mobile)			0.00			1/2" Ice	4.77	2.31	40.42
			0.00						
(2) TMA 10"x8"x3"	A	From Face	3.00	0.0000	121.90	No Ice	0.78	0.29	15.00
(T-Mobile)			0.00			1/2" Ice	0.90	0.38	20.06
			0.00						
(2) TMA 10"x8"x3"	B	From Face	3.00	0.0000	121.90	No Ice	0.78	0.29	15.00
(T-Mobile)			0.00			1/2" Ice	0.90	0.38	20.06
			0.00						
(2) TMA 10"x8"x3"	C	From Face	3.00	0.0000	121.90	No Ice	0.78	0.29	15.00

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Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C _A A _A Front ft ²	C _A A _A Side ft ²	Weight lb
(T-Mobile)			0.00			1/2" Ice	0.90	0.38	20.06
Standoff Mount	C	From Face	0.00	0.0000	83.40	No Ice	0.75	0.75	27.00
			0.00			1/2" Ice	0.95	0.95	36.00
Standoff Mount	A	From Face	0.00	0.0000	83.40	No Ice	0.75	0.75	27.00
			0.00			1/2" Ice	0.95	0.95	36.00
GPS (Sprint)	A	From Face	0.00	0.0000	83.40	No Ice	1.00	1.00	10.00
			0.00			1/2" Ice	1.50	1.50	15.00
13' Low Profile Platform (Future)	C	None	0.00	0.0000	110.00	No Ice	15.70	15.70	1300.00
						1/2" Ice	20.10	20.10	1765.00
(4) DB844H90 (Future)	A	From Face	0.00	0.0000	110.00	No Ice	2.87	3.97	10.00
			0.00			1/2" Ice	3.18	4.34	36.27
(4) DB844H90 (Future)	B	From Face	0.00	0.0000	110.00	No Ice	2.87	3.97	10.00
			0.00			1/2" Ice	3.18	4.34	36.27
(4) DB844H90 (Future)	C	From Face	0.00	0.0000	110.00	No Ice	2.87	3.97	10.00
			0.00			1/2" Ice	3.18	4.34	36.27

Dishes

Description	Face or Leg	Dish Type	Offset Type	Offsets: Horz Lateral Vert ft	Azimuth Adjustment °	3 dB Beam Width °	Elevation ft	Outside Diameter ft	Aperture Area ft ²	Weight lb
Andrew VHLP1 15.3" Dish (Nextel)	C	Paraboloid w/Radome	From Face	0.00	Worst		169.00	1.27	No Ice 1/2" Ice	1.28 1.45
				0.00						27.00

Tower Pressures - No Ice

$$G_H = 1.690$$

Section Elevation ft	z ft	K _Z	q _z psf	A _G ft ²	F a c e	A _F ft ²	A _R ft ²	A _{leg} ft ²	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
L1 160.00- 123.33	140.64	1.513	31	80.460	A	0.000	80.460	80.460	100.00	0.000	0.000
					B	0.000	80.460		100.00		
					C	0.000	80.460		100.00		
L2 123.33- 86.17	104.09	1.389	29	112.199	A	0.000	112.199	112.199	100.00	0.000	0.000
					B	0.000	112.199		100.00		

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Section Elevation	z	K _Z	q _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
ft	ft		psf	ft ²		ft ²	ft ²	ft ²			
L3 86.17-37.17	61.20	1.193	25	194.385	C	0.000	112.199		100.00		
					A	0.000	194.385	194.385	100.00	0.000	0.000
					B	0.000	194.385		100.00		
					C	0.000	194.385		100.00		
L4 37.17-0.00	18.04	1	21	182.112	A	0.000	182.112	182.112	100.00	0.000	0.000
					B	0.000	182.112		100.00		
					C	0.000	182.112		100.00		

Tower Pressure - With Ice

$$G_H = 1.690$$

Section Elevation	z	K _Z	q _z	t _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
ft	ft		psf	in	ft ²		ft ²	ft ²	ft ²			
L1 160.00-123.33	140.64	1.513	24	0.5000	83.516	A	0.000	83.516	83.516	100.00	0.000	0.000
						B	0.000	83.516		100.00		
						C	0.000	83.516		100.00		
L2 123.33-86.17	104.09	1.389	22	0.5000	115.296	A	0.000	115.296	115.296	100.00	0.000	0.000
						B	0.000	115.296		100.00		
						C	0.000	115.296		100.00		
L3 86.17-37.17	61.20	1.193	18	0.5000	198.469	A	0.000	198.469	198.469	100.00	0.000	0.000
						B	0.000	198.469		100.00		
						C	0.000	198.469		100.00		
L4 37.17-0.00	18.04	1	16	0.5000	185.210	A	0.000	185.210	185.210	100.00	0.000	0.000
						B	0.000	185.210		100.00		
						C	0.000	185.210		100.00		

Tower Pressure - Service

$$G_H = 1.690$$

Section Elevation	z	K _Z	q _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
ft	ft		psf	ft ²		ft ²	ft ²	ft ²			
L1 160.00-123.33	140.64	1.513	10	80.460	A	0.000	80.460	80.460	100.00	0.000	0.000
					B	0.000	80.460		100.00		
					C	0.000	80.460		100.00		
L2 123.33-86.17	104.09	1.389	9	112.199	A	0.000	112.199	112.199	100.00	0.000	0.000
					B	0.000	112.199		100.00		
					C	0.000	112.199		100.00		
L3 86.17-37.17	61.20	1.193	8	194.385	A	0.000	194.385	194.385	100.00	0.000	0.000
					B	0.000	194.385		100.00		
					C	0.000	194.385		100.00		
L4 37.17-0.00	18.04	1	6	182.112	A	0.000	182.112	182.112	100.00	0.000	0.000
					B	0.000	182.112		100.00		
					C	0.000	182.112		100.00		

RISATower NATCOMM 63-2 N. Branford Rd. Branford, CT 06405 Phone: (203) 488-0580 FAX: (203) 488-8587	Job	160' Valmont Monopole	Page	8 of 19
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Tower Forces - No Ice - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	925.05	2297.57	A	1	1.03	1	1	1	80.460	4391.19	119.75	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1885.21	5555.12	A	1	1.03	1	1	1	112.199	5615.06	151.10	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2658.56	12196.65	A	1	1.03	1	1	1	194.385	8308.23	169.56	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1854.41	13102.61	A	1	1.03	1	1	1	182.112	6573.37	176.85	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	7323.23	33151.95						OTM	1829090.2 9 lb-ft	24887.84		

Tower Forces - No Ice - Wind 60 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	925.05	2297.57	A	1	1.03	1	1	1	80.460	4391.19	119.75	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1885.21	5555.12	A	1	1.03	1	1	1	112.199	5615.06	151.10	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2658.56	12196.65	A	1	1.03	1	1	1	194.385	8308.23	169.56	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1854.41	13102.61	A	1	1.03	1	1	1	182.112	6573.37	176.85	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	7323.23	33151.95						OTM	1829090.2 9 lb-ft	24887.84		

Tower Forces - No Ice - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	925.05	2297.57	A	1	1.03	1	1	1	80.460	4391.19	119.75	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1885.21	5555.12	A	1	1.03	1	1	1	112.199	5615.06	151.10	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			

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Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L3 86.17- 37.17	2658.56	12196.65	A	1	1.03	1	1	1	194.385	8308.23	169.56	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1854.41	13102.61	A	1	1.03	1	1	1	182.112	6573.37	176.85	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	7323.23	33151.95						OTM	1829090.2 9 lb-ft	24887.84		

Tower Forces - With Ice - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	925.05	2913.57	A	1	1.03	1	1	1	83.516	3418.48	93.22	C
			B	1	1.03	1	1	1	83.516			
			C	1	1.03	1	1	1	83.516			
L2 123.33- 86.17	1885.21	6409.75	A	1	1.03	1	1	1	115.296	4327.53	116.46	C
			B	1	1.03	1	1	1	115.296			
			C	1	1.03	1	1	1	115.296			
L3 86.17- 37.17	2658.56	13672.47	A	1	1.03	1	1	1	198.469	6362.07	129.84	C
			B	1	1.03	1	1	1	198.469			
			C	1	1.03	1	1	1	198.469			
L4 37.17-0.00	1854.41	14482.52	A	1	1.03	1	1	1	185.210	5013.88	134.89	C
			B	1	1.03	1	1	1	185.210			
			C	1	1.03	1	1	1	185.210			
Sum Weight:	7323.23	37478.30						OTM	1411031.8 0 lb-ft	19121.95		

Tower Forces - With Ice - Wind 60 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	925.05	2913.57	A	1	1.03	1	1	1	83.516	3418.48	93.22	C
			B	1	1.03	1	1	1	83.516			
			C	1	1.03	1	1	1	83.516			
L2 123.33- 86.17	1885.21	6409.75	A	1	1.03	1	1	1	115.296	4327.53	116.46	C
			B	1	1.03	1	1	1	115.296			
			C	1	1.03	1	1	1	115.296			
L3 86.17- 37.17	2658.56	13672.47	A	1	1.03	1	1	1	198.469	6362.07	129.84	C
			B	1	1.03	1	1	1	198.469			
			C	1	1.03	1	1	1	198.469			
L4 37.17-0.00	1854.41	14482.52	A	1	1.03	1	1	1	185.210	5013.88	134.89	C
			B	1	1.03	1	1	1	185.210			
			C	1	1.03	1	1	1	185.210			
Sum Weight:	7323.23	37478.30						OTM	1411031.8 0 lb-ft	19121.95		

<i>RISATower</i> <i>NATCOMM</i> 63-2 N. Branford Rd. Branford, CT 06405 Phone: (203) 488-0580 FAX: (203) 488-8587	Job	160' Valmont Monopole	Page	10 of 19
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Tower Forces - With Ice - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	925.05	2913.57	A	1	1.03	1	1	1	83.516	3418.48	93.22	C
			B	1	1.03	1	1	1	83.516			
			C	1	1.03	1	1	1	83.516			
L2 123.33- 86.17	1885.21	6409.75	A	1	1.03	1	1	1	115.296	4327.53	116.46	C
			B	1	1.03	1	1	1	115.296			
			C	1	1.03	1	1	1	115.296			
L3 86.17- 37.17	2658.56	13672.47	A	1	1.03	1	1	1	198.469	6362.07	129.84	C
			B	1	1.03	1	1	1	198.469			
			C	1	1.03	1	1	1	198.469			
L4 37.17-0.00	1854.41	14482.52	A	1	1.03	1	1	1	185.210	5013.88	134.89	C
			B	1	1.03	1	1	1	185.210			
			C	1	1.03	1	1	1	185.210			
Sum Weight:	7323.23	37478.30						OTM	1411031.8 0 lb-ft	19121.95		

Tower Forces - Service - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	925.05	2297.57	A	1	1.03	1	1	1	80.460	1355.31	36.96	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1885.21	5555.12	A	1	1.03	1	1	1	112.199	1733.04	46.64	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2658.56	12196.65	A	1	1.03	1	1	1	194.385	2564.27	52.33	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1854.41	13102.61	A	1	1.03	1	1	1	182.112	2028.82	54.58	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	7323.23	33151.95						OTM	564534.04 lb-ft	7681.43		

Tower Forces - Service - Wind 60 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	925.05	2297.57	A	1	1.03	1	1	1	80.460	1355.31	36.96	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33-	1885.21	5555.12	A	1	1.03	1	1	1	112.199	1733.04	46.64	C

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Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
86.17			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17-37.17	2658.56	12196.65	A	1	1.03	1	1	1	194.385	2564.27	52.33	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1854.41	13102.61	A	1	1.03	1	1	1	182.112	2028.82	54.58	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	7323.23	33151.95						OTM	564534.04 lb-ft	7681.43		

Tower Forces - Service - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	925.05	2297.57	A	1	1.03	1	1	1	80.460	1355.31	36.96	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33-86.17	1885.21	5555.12	A	1	1.03	1	1	1	112.199	1733.04	46.64	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17-37.17	2658.56	12196.65	A	1	1.03	1	1	1	194.385	2564.27	52.33	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1854.41	13102.61	A	1	1.03	1	1	1	182.112	2028.82	54.58	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	7323.23	33151.95						OTM	564534.04 lb-ft	7681.43		

Force Totals

Load Case	Vertical Forces	Sum of Forces X	Sum of Forces Z	Sum of Overturning Moments, M _x	Sum of Overturning Moments, M _z	Sum of Torques
	lb	lb	lb	lb-ft	lb-ft	lb-ft
Leg Weight	33151.95					
Bracing Weight	0.00					
Total Member Self-Weight	33151.95					
Total Weight	51338.87			76.46	111.14	
Wind 0 deg - No Ice		0.00	-44458.44	-4623253.86	111.14	-290.29
Wind 30 deg - No Ice		22229.22	-38502.14	-4003845.05	-2311554.02	-150.70
Wind 60 deg - No Ice		38502.14	-22229.22	-2311588.70	-4003810.36	29.26
Wind 90 deg - No Ice		44458.44	0.00	76.46	-4623219.18	201.38
Wind 120 deg - No Ice		38502.14	22229.22	2311741.62	-4003810.36	319.54
Wind 150 deg - No Ice		22229.22	38502.14	4003997.96	-2311554.02	352.08
Wind 180 deg - No Ice		0.00	44458.44	4623406.78	111.14	290.29
Wind 210 deg - No Ice		-22229.22	38502.14	4003997.96	2311776.30	150.70
Wind 240 deg - No Ice		-38502.14	22229.22	2311741.62	4004032.65	-29.26

RISATower

NATCOMM
 63-2 N. Branford Rd.
 Branford, CT 06405
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Job

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Project

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Date

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Client

Verizon

Designed by
 Staff

Load Case	Vertical Forces lb	Sum of Forces X lb	Sum of Forces Z lb	Sum of Overturning Moments, M_x lb-ft	Sum of Overturning Moments, M_z lb-ft	Sum of Torques lb-ft
Wind 270 deg - No Ice		-44458.44	0.00	76.46	4623441.46	-201.38
Wind 300 deg - No Ice		-38502.14	-22229.22	-2311588.70	4004032.65	-319.54
Wind 330 deg - No Ice		-22229.22	-38502.14	-4003845.05	2311776.30	-352.08
Member Ice	4326.35					
Total Weight Ice	62248.52			126.02	160.57	
Wind 0 deg - Ice		0.00	-36204.01	-3847401.53	160.57	-295.39
Wind 30 deg - Ice		18102.01	-31353.59	-3331930.58	-1923603.20	-179.65
Wind 60 deg - Ice		31353.59	-18102.01	-1923637.76	-3331896.02	-15.77
Wind 90 deg - Ice		36204.01	0.00	126.02	-3847366.97	152.33
Wind 120 deg - Ice		31353.59	18102.01	1923889.79	-3331896.02	279.62
Wind 150 deg - Ice		18102.01	31353.59	3332182.61	-1923603.20	331.98
Wind 180 deg - Ice		0.00	36204.01	3847653.56	160.57	295.39
Wind 210 deg - Ice		-18102.01	31353.59	3332182.61	1923924.35	179.65
Wind 240 deg - Ice		-31353.59	18102.01	1923889.79	3332217.17	15.77
Wind 270 deg - Ice		-36204.01	0.00	126.02	3847688.12	-152.33
Wind 300 deg - Ice		-31353.59	-18102.01	-1923637.76	3332217.17	-279.62
Wind 330 deg - Ice		-18102.01	-31353.59	-3331930.58	1923924.35	-331.98
Total Weight	51338.87			76.46	111.14	
Wind 0 deg - Service		0.00	-13721.74	-1426877.35	111.14	-89.59
Wind 30 deg - Service		6860.87	-11883.38	-1235701.79	-713365.76	-46.51
Wind 60 deg - Service		11883.38	-6860.87	-713400.44	-1235667.10	9.03
Wind 90 deg - Service		13721.74	0.00	76.46	-1426842.66	62.15
Wind 120 deg - Service		11883.38	6860.87	713553.36	-1235667.10	98.62
Wind 150 deg - Service		6860.87	11883.38	1235854.70	-713365.76	108.67
Wind 180 deg - Service		0.00	13721.74	1427030.26	111.14	89.59
Wind 210 deg - Service		-6860.87	11883.38	1235854.70	713588.04	46.51
Wind 240 deg - Service		-11883.38	6860.87	713553.36	1235889.39	-9.03
Wind 270 deg - Service		-13721.74	0.00	76.46	1427064.95	-62.15
Wind 300 deg - Service		-11883.38	-6860.87	-713400.44	1235889.39	-98.62
Wind 330 deg - Service		-6860.87	-11883.38	-1235701.79	713588.04	-108.67

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 60 deg - No Ice
5	Dead+Wind 90 deg - No Ice
6	Dead+Wind 120 deg - No Ice
7	Dead+Wind 150 deg - No Ice
8	Dead+Wind 180 deg - No Ice
9	Dead+Wind 210 deg - No Ice
10	Dead+Wind 240 deg - No Ice
11	Dead+Wind 270 deg - No Ice
12	Dead+Wind 300 deg - No Ice
13	Dead+Wind 330 deg - No Ice
14	Dead+Ice+Temp
15	Dead+Wind 0 deg+Ice+Temp
16	Dead+Wind 30 deg+Ice+Temp
17	Dead+Wind 60 deg+Ice+Temp
18	Dead+Wind 90 deg+Ice+Temp
19	Dead+Wind 120 deg+Ice+Temp
20	Dead+Wind 150 deg+Ice+Temp
21	Dead+Wind 180 deg+Ice+Temp

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Comb. No.	Description
22	Dead+Wind 210 deg+Ice+Temp
23	Dead+Wind 240 deg+Ice+Temp
24	Dead+Wind 270 deg+Ice+Temp
25	Dead+Wind 300 deg+Ice+Temp
26	Dead+Wind 330 deg+Ice+Temp
27	Dead+Wind 0 deg - Service
28	Dead+Wind 30 deg - Service
29	Dead+Wind 60 deg - Service
30	Dead+Wind 90 deg - Service
31	Dead+Wind 120 deg - Service
32	Dead+Wind 150 deg - Service
33	Dead+Wind 180 deg - Service
34	Dead+Wind 210 deg - Service
35	Dead+Wind 240 deg - Service
36	Dead+Wind 270 deg - Service
37	Dead+Wind 300 deg - Service
38	Dead+Wind 330 deg - Service

Maximum Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Force lb	Major Axis Moment lb-ft	Minor Axis Moment lb-ft
L1	160 - 123.33	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-15083.46	27.00	-104.85
			Max. Mx	11	-8574.42	428600.83	-47.39
			Max. My	8	-8574.40	14.53	-428644.36
			Max. Vy	11	-19081.02	428600.83	-47.39
			Max. Vx	8	19081.02	14.53	-428644.36
			Max. Torque	11			243.95
			Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-28162.58	27.00	-104.85
			Max. Mx	11	-18861.66	1323291.75	-54.55
L2	123.33 - 86.17	Pole	Max. My	8	-18861.67	21.49	-
							1323335.31
			Max. Vy	11	-29462.24	1323291.75	-54.55
			Max. Vx	8	29462.23	21.49	-
							1323335.31
			Max. Torque	11			243.57
			Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-43402.07	160.57	-126.02
			Max. Mx	11	-33317.63	2911239.68	-78.57
			Max. My	8	-33317.64	113.50	-
L3	86.17 - 37.17	Pole	Max. Vy	11	-37313.36	2911239.68	-78.57
			Max. Vx	8	37313.35	113.50	-
							2911204.91
			Max. Torque	13			354.30
			Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-62248.52	160.57	-126.02
			Max. Mx	11	-51318.06	4730706.51	-78.97
			Max. My	8	-51318.06	114.08	-
			Max. Vy	11	-44482.47	4730706.51	-78.97
			Max. Vx	8	44482.47	114.08	-
L4	37.17 - 0	Pole					4730671.57
			Max. Vy	11	-44482.47	4730706.51	-78.97
			Max. Vx	8	44482.47	114.08	-
							4730671.57
			Max. Torque	13			353.75

RISATower

NATCOMM
 63-2 N. Branford Rd.
 Branford, CT 06405
 Phone: (203) 488-0580
 FAX: (203) 488-8587

Job

160' Valmont Monopole

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Project

08032 - 525 Orange Center Rd, Orange, CT

Date

18:47:42 02/26/08

Client

Verizon

Designed by

Staff

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical lb	Horizontal, X lb	Horizontal, Z lb
Pole	Max. Vert	21	62248.52	-0.00	-36204.02
	Max. H _x	11	51338.88	44458.44	-0.00
	Max. H _z	2	51338.88	0.00	44458.44
	Max. M _x	2	4730512.20	0.00	44458.44
	Max. M _z	5	4730477.26	-44458.44	-0.00
	Max. Torsion	13	353.61	22229.22	38502.14
	Min. Vert	1	51338.87	0.00	0.00
	Min. H _x	5	51338.88	-44458.44	-0.00
	Min. H _z	8	51338.88	0.00	-44458.44
	Min. M _x	8	-4730671.57	0.00	-44458.44
	Min. M _z	11	-4730706.51	44458.44	-0.00
	Min. Torsion	7	-353.59	-22229.22	-38502.14

Tower Mast Reaction Summary

Load Combination	Vertical lb	Shear _x lb	Shear _z lb	Overturning Moment, M _x lb-ft	Overturning Moment, M _z lb-ft	Torque lb-ft
Dead Only	51338.87	0.00	0.00	76.46	111.14	0.00
Dead+Wind 0 deg - No Ice	51338.88	-0.00	-44458.44	-4730512.20	114.04	-290.34
Dead+Wind 30 deg - No Ice	51338.87	22229.22	-38502.14	-4096735.00	-2365182.60	-149.26
Dead+Wind 60 deg - No Ice	51338.87	38502.14	-22229.22	-2365217.72	-4096699.95	31.78
Dead+Wind 90 deg - No Ice	51338.88	44458.44	0.00	78.94	-4730477.26	204.33
Dead+Wind 120 deg - No Ice	51338.87	38502.14	22229.22	2365375.98	-4096700.60	322.13
Dead+Wind 150 deg - No Ice	51338.87	22229.22	38502.14	4096894.00	-2365183.24	353.59
Dead+Wind 180 deg - No Ice	51338.88	-0.00	44458.44	4730671.57	114.04	290.34
Dead+Wind 210 deg - No Ice	51338.87	-22229.22	38502.14	4096894.51	2365411.62	149.28
Dead+Wind 240 deg - No Ice	51338.87	-38502.14	22229.22	2365376.49	4096929.56	-31.80
Dead+Wind 270 deg - No Ice	51338.88	-44458.44	0.00	78.94	4730706.51	-204.33
Dead+Wind 300 deg - No Ice	51338.87	-38502.14	-22229.22	-2365218.23	4096928.91	-322.11
Dead+Wind 330 deg - No Ice	51338.87	-22229.22	-38502.14	-4096735.51	2365410.97	-353.61
Dead+Ice+Temp	62248.52	0.00	0.00	126.02	160.57	0.00
Dead+Wind 0 deg+Ice+Temp	62248.52	0.00	-36204.02	-3974932.28	167.37	-296.59
Dead+Wind 30 deg+Ice+Temp	62248.52	18102.01	-31353.60	-3442374.19	-1987365.49	-177.43
Dead+Wind 60 deg+Ice+Temp	62248.52	31353.60	-18102.01	-1987399.18	-3442340.47	-10.76
Dead+Wind 90 deg+Ice+Temp	62248.52	36204.02	-0.00	133.66	-3974898.51	158.82
Dead+Wind 120 deg+Ice+Temp	62248.52	31353.60	18102.01	1987666.85	-3442341.07	285.86
Dead+Wind 150 deg+Ice+Temp	62248.52	18102.01	31353.60	3442642.56	-1987366.09	336.25
Dead+Wind 180 deg+Ice+Temp	62248.52	0.00	36204.02	3975200.99	167.37	296.59
Dead+Wind 210 deg+Ice+Temp	62248.52	-18102.01	31353.60	3442643.21	1987701.20	177.46
Dead+Wind 240 deg+Ice+Temp	62248.52	-31353.60	18102.01	1987667.51	3442676.94	10.73
Dead+Wind 270 deg+Ice+Temp	62248.52	-36204.02	-0.00	133.66	3975234.76	-158.82
Dead+Wind 300 deg+Ice+Temp	62248.52	-31353.60	-18102.01	-1987399.84	3442676.34	-285.83
Dead+Wind 330 deg+Ice+Temp	62248.52	-18102.01	-31353.60	-3442374.85	1987700.60	-336.28
Dead+Wind 0 deg - Service	51338.87	-0.00	-13721.74	-1461157.35	114.93	-90.02
Dead+Wind 30 deg - Service	51338.87	6860.87	-11883.38	-1265388.66	-730503.73	-46.13
Dead+Wind 60 deg - Service	51338.87	11883.38	-6860.87	-730538.69	-1265353.70	10.11
Dead+Wind 90 deg - Service	51338.87	13721.74	0.00	79.97	-1461122.40	63.65
Dead+Wind 120 deg - Service	51338.87	11883.38	6860.87	730698.66	-1265353.76	100.13
Dead+Wind 150 deg - Service	51338.87	6860.87	11883.38	1265548.70	-730503.79	109.78
Dead+Wind 180 deg - Service	51338.87	-0.00	13721.74	1461317.42	114.93	90.02

RISATower NATCOMM 63-2 N. Branford Rd. Branford, CT 06405 Phone: (203) 488-0580 FAX: (203) 488-8587	Job	160' Valmont Monopole	Page	15 of 19
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Load Combination	Vertical lb	Shear _x lb	Shear _z lb	Overturning Moment, M _x lb-ft	Overturning Moment, M _z lb-ft	Torque lb-ft
Dead+Wind 210 deg - Service	51338.87	-6860.87	11883.38	1265548.75	730733.68	46.14
Dead+Wind 240 deg - Service	51338.87	-11883.38	6860.87	730698.71	1265583.70	-10.11
Dead+Wind 270 deg - Service	51338.87	-13721.74	0.00	79.97	1461352.37	-63.65
Dead+Wind 300 deg - Service	51338.87	-11883.38	-6860.87	-730538.74	1265583.64	-100.13
Dead+Wind 330 deg - Service	51338.87	-6860.87	-11883.38	-1265388.71	730733.61	-109.78

Solution Summary

Load Comb.	Sum of Applied Forces			Sum of Reactions			% Error
	PX lb	PY lb	PZ lb	PX lb	PY lb	PZ lb	
1	0.00	-51338.87	0.00	0.00	51338.87	0.00	0.000%
2	0.00	-51338.87	-44458.44	0.00	51338.88	44458.44	0.000%
3	22229.22	-51338.87	-38502.14	-22229.22	51338.87	38502.14	0.000%
4	38502.14	-51338.87	-22229.22	-38502.14	51338.87	22229.22	0.000%
5	44458.44	-51338.87	0.00	-44458.44	51338.88	-0.00	0.000%
6	38502.14	-51338.87	22229.22	-38502.14	51338.87	-22229.22	0.000%
7	22229.22	-51338.87	38502.14	-22229.22	51338.87	-38502.14	0.000%
8	0.00	-51338.87	44458.44	0.00	51338.88	-44458.44	0.000%
9	-22229.22	-51338.87	38502.14	22229.22	51338.87	-38502.14	0.000%
10	-38502.14	-51338.87	22229.22	38502.14	51338.87	-22229.22	0.000%
11	-44458.44	-51338.87	0.00	44458.44	51338.88	-0.00	0.000%
12	-38502.14	-51338.87	-22229.22	38502.14	51338.87	22229.22	0.000%
13	-22229.22	-51338.87	-38502.14	22229.22	51338.87	38502.14	0.000%
14	0.00	-62248.52	0.00	0.00	62248.52	0.00	0.000%
15	0.00	-62248.52	-36204.01	-0.00	62248.52	36204.02	0.000%
16	18102.01	-62248.52	-31353.59	-18102.01	62248.52	31353.60	0.000%
17	31353.59	-62248.52	-18102.01	-31353.60	62248.52	18102.01	0.000%
18	36204.01	-62248.52	0.00	-36204.02	62248.52	0.00	0.000%
19	31353.59	-62248.52	18102.01	-31353.60	62248.52	-18102.01	0.000%
20	18102.01	-62248.52	31353.59	-18102.01	62248.52	-31353.60	0.000%
21	0.00	-62248.52	36204.01	-0.00	62248.52	-36204.02	0.000%
22	-18102.01	-62248.52	31353.59	18102.01	62248.52	-31353.60	0.000%
23	-31353.59	-62248.52	18102.01	31353.60	62248.52	-18102.01	0.000%
24	-36204.01	-62248.52	0.00	36204.02	62248.52	0.00	0.000%
25	-31353.59	-62248.52	-18102.01	31353.60	62248.52	18102.01	0.000%
26	-18102.01	-62248.52	-31353.59	18102.01	62248.52	31353.60	0.000%
27	0.00	-51338.87	-13721.74	0.00	51338.87	13721.74	0.000%
28	6860.87	-51338.87	-11883.38	-6860.87	51338.87	11883.38	0.000%
29	11883.38	-51338.87	-6860.87	-11883.38	51338.87	6860.87	0.000%
30	13721.74	-51338.87	0.00	-13721.74	51338.87	-0.00	0.000%
31	11883.38	-51338.87	6860.87	-11883.38	51338.87	-6860.87	0.000%
32	6860.87	-51338.87	11883.38	-6860.87	51338.87	-11883.38	0.000%
33	0.00	-51338.87	13721.74	0.00	51338.87	-13721.74	0.000%
34	-6860.87	-51338.87	11883.38	6860.87	51338.87	-11883.38	0.000%
35	-11883.38	-51338.87	6860.87	11883.38	51338.87	-6860.87	0.000%
36	-13721.74	-51338.87	0.00	13721.74	51338.87	-0.00	0.000%
37	-11883.38	-51338.87	-6860.87	11883.38	51338.87	6860.87	0.000%
38	-6860.87	-51338.87	-11883.38	6860.87	51338.87	11883.38	0.000%

Non-Linear Convergence Results

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<i>Load Combination</i>	<i>Converged?</i>	<i>Number of Cycles</i>	<i>Displacement Tolerance</i>	<i>Force Tolerance</i>
1	Yes	4	0.00000001	0.00000001
2	Yes	4	0.00000001	0.00005647
3	Yes	5	0.00000001	0.00013964
4	Yes	5	0.00000001	0.00013941
5	Yes	4	0.00000001	0.00006302
6	Yes	5	0.00000001	0.00014044
7	Yes	5	0.00000001	0.00013909
8	Yes	4	0.00000001	0.00005648
9	Yes	5	0.00000001	0.00013981
10	Yes	5	0.00000001	0.00014004
11	Yes	4	0.00000001	0.00006303
12	Yes	5	0.00000001	0.00013902
13	Yes	5	0.00000001	0.00014037
14	Yes	4	0.00000001	0.00000001
15	Yes	5	0.00000001	0.00010196
16	Yes	5	0.00000001	0.00034910
17	Yes	5	0.00000001	0.00034887
18	Yes	5	0.00000001	0.00010197
19	Yes	5	0.00000001	0.00035055
20	Yes	5	0.00000001	0.00034831
21	Yes	5	0.00000001	0.00010198
22	Yes	5	0.00000001	0.00034965
23	Yes	5	0.00000001	0.00034988
24	Yes	5	0.00000001	0.00010198
25	Yes	5	0.00000001	0.00034822
26	Yes	5	0.00000001	0.00035046
27	Yes	4	0.00000001	0.00002468
28	Yes	4	0.00000001	0.00026951
29	Yes	4	0.00000001	0.00026844
30	Yes	4	0.00000001	0.00002505
31	Yes	4	0.00000001	0.00027320
32	Yes	4	0.00000001	0.00026709
33	Yes	4	0.00000001	0.00002469
34	Yes	4	0.00000001	0.00027035
35	Yes	4	0.00000001	0.00027145
36	Yes	4	0.00000001	0.00002505
37	Yes	4	0.00000001	0.00026679
38	Yes	4	0.00000001	0.00027287

Maximum Tower Deflections - Service Wind

<i>Section No.</i>	<i>Elevation ft</i>	<i>Horz. Deflection in</i>	<i>Gov. Load Comb.</i>	<i>Tilt °</i>	<i>Twist °</i>
L1	160 - 123.33	26.047	33	1.5793	0.0009
L2	128 - 86.17	16.205	35	1.2807	0.0003
L3	92 - 37.17	8.019	35	0.8559	0.0001
L4	44.5 - 0	1.822	35	0.3726	0.0000

Critical Deflections and Radius of Curvature - Service Wind

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<i>Elevation</i>	<i>Appurtenance</i>	<i>Gov. Load</i>	<i>Deflection</i>	<i>Tilt</i>	<i>Twist</i>	<i>Radius of Curvature</i>
<i>ft</i>		<i>Comb.</i>	<i>in</i>	<i>°</i>	<i>°</i>	<i>ft</i>
169.00	Andrew VHLP1 15.3" Dish	33	26.047	1.5793	0.0009	25961
167.00	(4) DB844H90E-XY	33	26.047	1.5793	0.0009	25961
163.00	(4) 8"x2 1/2" Pipe Mount	33	26.047	1.5793	0.0009	25961
155.20	13' Platform w/ Rails	33	24.496	1.5372	0.0008	25961
145.70	(3) DUO1417-8686	33	21.468	1.4523	0.0006	9077
143.70	13' Platform w/ Rails	33	20.843	1.4340	0.0006	7963
134.10	(2) DB980H90E-M	35	17.940	1.3426	0.0004	5011
131.80	13' Platform w/ Rails	35	17.274	1.3197	0.0003	4604
121.90	(2) RR90-17-02DP	35	14.576	1.2151	0.0002	4246
119.00	13' Platform w/ Rails	35	13.838	1.1827	0.0002	4343
110.00	13' Low Profile Platform	35	11.696	1.0780	0.0002	4676
83.40	Standoff Mount	35	6.521	0.7477	0.0001	5438

Maximum Tower Deflections - Design Wind

<i>Section No.</i>	<i>Elevation</i>	<i>Horz. Deflection</i>	<i>Gov. Load</i>	<i>Tilt</i>	<i>Twist</i>
	<i>ft</i>	<i>in</i>	<i>Comb.</i>	<i>°</i>	<i>°</i>
L1	160 - 123.33	84.199	8	5.1059	0.0030
L2	128 - 86.17	52.408	11	4.1418	0.0010
L3	92 - 37.17	25.944	11	2.7690	0.0005
L4	44.5 - 0	5.898	11	1.2058	0.0001

Critical Deflections and Radius of Curvature - Design Wind

<i>Elevation</i>	<i>Appurtenance</i>	<i>Gov. Load</i>	<i>Deflection</i>	<i>Tilt</i>	<i>Twist</i>	<i>Radius of Curvature</i>
<i>ft</i>		<i>Comb.</i>	<i>in</i>	<i>°</i>	<i>°</i>	<i>ft</i>
169.00	Andrew VHLP1 15.3" Dish	8	84.199	5.1059	0.0030	8142
167.00	(4) DB844H90E-XY	8	84.199	5.1059	0.0030	8142
163.00	(4) 8"x2 1/2" Pipe Mount	8	84.199	5.1059	0.0030	8142
155.20	13' Platform w/ Rails	8	79.191	4.9712	0.0026	8142
145.70	(3) DUO1417-8686	8	69.410	4.6991	0.0019	2845
143.70	13' Platform w/ Rails	8	67.391	4.6402	0.0018	2496
134.10	(2) DB980H90E-M	11	58.014	4.3444	0.0012	1569
131.80	13' Platform w/ Rails	11	55.863	4.2695	0.0011	1441
121.90	(2) RR90-17-02DP	11	47.144	3.9257	0.0008	1326
119.00	13' Platform w/ Rails	11	44.761	3.8188	0.0007	1356
110.00	13' Low Profile Platform	11	37.835	3.4750	0.0005	1457
83.40	Standoff Mount	11	21.100	2.4427	0.0004	1687

Compression Checks

Pole Design Data

RISATower NATCOMM 63-2 N. Branford Rd. Branford, CT 06405 Phone: (203) 488-0580 FAX: (203) 488-8587	Job	160' Valmont Monopole	Page	18 of 19
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Section No.	Elevation ft	Size	L ft	L _u ft	Kl/r	F _a ksi	A in ²	Actual P lb	Allow. P _a lb	Ratio P P _a
L1	160 - 123.33 (1)	TP31.46x21.2x0.219	36.67	160.00	179.2	4.652	21.1091	-8574.35	98203.10	0.087
L2	123.33 - 86.17 (2)	TP41.44x29.7154x0.344	41.83	160.00	135.9	8.085	43.7112	-18861.60	353397.00	0.053
L3	86.17 - 37.17 (3)	TP54.46x39.1179x0.438	54.83	160.00	103.2	14.023	73.2978	-33317.60	1027840.00	0.032
L4	37.17 - 0 (4)	TP64x51.533x0.469	44.50	160.00	84.4	20.231	95.9432	-51318.10	1940990.00	0.026

Pole Bending Design Data

Section No.	Elevation ft	Size	Actual M _s lb-ft	Actual f _{bx} ksi	Allow. F _{bx} ksi	Ratio f _{bx} F _{bx}	Actual M _y lb-ft	Actual f _{by} ksi	Allow. F _{by} ksi	Ratio f _{by} F _{by}
L1	160 - 123.33 (1)	TP31.46x21.2x0.219	428644.17	33.277	36.424	0.914	0.00	0.000	36.424	0.000
L2	123.33 - 86.17 (2)	TP41.44x29.7154x0.344	1323333.33	37.687	39.000	0.966	0.00	0.000	39.000	0.000
L3	86.17 - 37.17 (3)	TP54.46x39.1179x0.438	2911266.67	37.532	39.000	0.962	0.00	0.000	39.000	0.000
L4	37.17 - 0 (4)	TP64x51.533x0.469	4730733.33	38.076	36.617	1.040	0.00	0.000	36.617	0.000

Pole Shear Design Data

Section No.	Elevation ft	Size	Actual V lb	Actual f _v ksi	Allow. F _v ksi	Ratio f _v F _v	Actual T lb-ft	Actual f _{vt} ksi	Allow. F _{vt} ksi	Ratio f _{vt} F _{vt}
L1	160 - 123.33 (1)	TP31.46x21.2x0.219	19081.20	0.904	26.000	0.071	67.52	0.002	26.000	0.000
L2	123.33 - 86.17 (2)	TP41.44x29.7154x0.344	29462.30	0.674	26.000	0.053	67.52	0.001	26.000	0.000
L3	86.17 - 37.17 (3)	TP54.46x39.1179x0.438	37313.30	0.509	26.000	0.040	31.81	0.000	26.000	0.000
L4	37.17 - 0 (4)	TP64x51.533x0.469	44482.50	0.464	26.000	0.036	31.80	0.000	26.000	0.000

Pole Interaction Design Data

Section No.	Elevation ft	Ratio P P _a	Ratio f _{bx} F _{bx}	Ratio f _{by} F _{by}	Ratio f _v F _v	Ratio f _{vt} F _{vt}	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	160 - 123.33 (1)	0.087	0.914	0.000	0.071	0.000	1.002 ✓	1.333	H1-3+VT ✓
L2	123.33 - 86.17 (2)	0.053	0.966	0.000	0.053	0.000	1.020 ✓	1.333	H1-3+VT ✓
L3	86.17 - 37.17 (3)	0.032	0.962	0.000	0.040	0.000	0.995 ✓	1.333	H1-3+VT ✓
L4	37.17 - 0 (4)	0.026	1.040	0.000	0.036	0.000	1.067 ✓	1.333	H1-3+VT ✓

RISATower NATCOMM 63-2 N. Branford Rd. Branford, CT 06405 Phone: (203) 488-0580 FAX: (203) 488-8587	Job	160' Valmont Monopole	Page	19 of 19
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	Client	Verizon	Designed by	Staff

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
-------------	-----------------	--------------------------	----------------------------------	----------------------------------	----------------------------	----------------------------------	--------------------------	---------------------------	----------

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P lb	SF* P_{allow} lb	% Capacity	Pass Fail
L1	160 - 123.33	Pole	TP31.46x21.2x0.219	1	-8574.35	130904.73	75.2	Pass
L2	123.33 - 86.17	Pole	TP41.44x29.7154x0.344	2	-18861.60	471078.18	76.5	Pass
L3	86.17 - 37.17	Pole	TP54.46x39.1179x0.438	3	-33317.60	1370110.66	74.7	Pass
L4	37.17 - 0	Pole	TP64x51.533x0.469	4	-51318.10	2587339.56	80.0	Pass
							Summary	
							Pole (L4)	Pass
							RATING = 80.0	Pass

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ANCHOR BOLT AND BASE PLATE ANALYSIS

Input Data

Tower Reactions:

Overturing Moment:	OM := 4750·ft·kips	user input
Shear Force:	Shear := 44.5·kips	user input
Axial Force:	Axial := 51.4·kips	user input

Anchor Bolt Data:

Use ASTM A615 Grade 75		user input
Number of Anchor Bolts = N	$N_w := 24$	user input
Diameter of Bolt Circle:	$D_{bc} := 72.76\text{in}$	user input
Bolt "Column" Distance:	$l_w := 3.0\text{in}$	user input
Bolt Ultimate Strength:	$F_u := 100\text{ksi}$	user input
Bolt Yield Strength:	$F_y := 75\text{ksi}$	user input
Bolt Modulus:	$E := 29000\text{ksi}$	user input
Anchor Bolt Diameter	$D := 2.25\text{in}$	user input
Threads per Inch:	$n := 4.5$	user input

Base Plate Data:

Use ASTM A572 (60 ksi)		user input
Plate Yield Strength:	$F_{y_{bp}} := 60\text{ksi}$	user input
Base Plate Thickness:	PlateThickness := 3·in	user input
Base Plate Diameter:	$D_{bp} := 78.76\text{in}$	user input
Outer Pole Diameter:	$D_{pole} := 64\text{in}$	user input

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Geometric Layout Data:

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

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

Distance to Bolts: $i := 1..N$

$$d_i := \begin{cases} \theta \leftarrow 2 \cdot \pi \cdot \left(\frac{i}{N} \right) \\ d \leftarrow R_{bc} \cdot \sin(\theta) \end{cases}$$

$d_1 = 9.42 \cdot \text{in}$	$d_7 = 35.14 \cdot \text{in}$
$d_2 = 18.19 \cdot \text{in}$	$d_8 = 31.51 \cdot \text{in}$
$d_3 = 25.72 \cdot \text{in}$	$d_9 = 25.72 \cdot \text{in}$
$d_4 = 31.51 \cdot \text{in}$	$d_{10} = 18.19 \cdot \text{in}$
$d_5 = 35.14 \cdot \text{in}$	$d_{11} = 9.42 \cdot \text{in}$
$d_6 = 36.38 \cdot \text{in}$	etc.

Critical Distances For Bending in Plate:

Outer Pole Radius: $R_{pole} := \frac{D_{pole}}{2}$ $R_{pole} = 32.00 \cdot \text{in}$

Moment Arms of Bolts about Neutral Axis: $MA_i := \text{if}(d_i \geq R_{pole}, d_i - R_{pole}, 0 \text{ in})$

$MA_1 = 0.00 \cdot \text{in}$	$MA_7 = 3.14 \cdot \text{in}$
$MA_2 = 0.00 \cdot \text{in}$	$MA_8 = 0.00 \cdot \text{in}$
$MA_3 = 0.00 \cdot \text{in}$	$MA_9 = 0.00 \cdot \text{in}$
$MA_4 = 0.00 \cdot \text{in}$	$MA_{10} = 0.00 \cdot \text{in}$
$MA_5 = 3.14 \cdot \text{in}$	$MA_{11} = 0.00 \cdot \text{in}$
$MA_6 = 4.38 \cdot \text{in}$	etc.

Effective Width of Baseplate for Bending: $\text{EffectiveWidth} := .8 \cdot 2 \cdot \sqrt{\left(\frac{D_{bp}}{2} \right)^2 - \left(\frac{D_{pole}}{2} \right)^2}$ $\text{EffectiveWidth} = 36.72 \cdot \text{in}$

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Anchor Bolt Analysis:

Polar Moment of Inertia I_p :

$$I_p := \sum_i (d_i)^2 \quad I_p = 1.588 \times 10^4 \cdot \text{in}^2$$

Gross Area of Bolt:

$$A_g := \frac{\pi}{4} \cdot D^2 \quad A_g = 3.976 \cdot \text{in}^2$$

Net Area of Bolt:

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

Net Diameter:

$$D_n := \frac{2 \cdot \sqrt{A_n}}{\sqrt{\pi}} \quad D_n = 2.03 \cdot \text{in}$$

Radius of Gyration of Bolt:

$$r := \frac{D_n}{4} \quad r = 0.51 \cdot \text{in}$$

Section Modulus of Bolt:

$$S_x := \frac{\pi \cdot D_n^3}{32} \quad S_x = 0.826 \cdot \text{in}^3$$

Anchor Bolt Bending Stress:

Maximum Applied Bending:

$$M_x := \left(\frac{\text{Shear}}{N} \right) \cdot l \quad M_x = 0.464 \cdot \text{ft} \cdot \text{kips}$$

$$f_{bx} := \frac{M_x}{S_x} \quad f_{bx} = 6.7 \cdot \text{ksi}$$

Allowable Bending

$$F_{bx} := 1.333 \cdot 0.60 \cdot F_y \quad F_{bx} = 60.0 \cdot \text{ksi}$$

Note: 1.333 increase allowed per TIA/EIA

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Check Tensile Forces:

Maximum Tensile Force (Gross Area):

$$\text{AllowableTension} := 1.333 \cdot (0.33 \cdot A_g \cdot F_u) \quad \text{AllowableTension} = 174.9 \cdot \text{kips}$$

Note: 1.333 increase allowed per TIA/EIA

Maximum Tensile Force (Net Area):

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

Note: 1.333 increase allowed per TIA/EIA

Applied Tension:

$$\text{MaxTension} := \frac{\text{OM} \cdot R_{bc}}{I_p} - \frac{\text{Axial}}{N} \quad \text{MaxTension} = 128.4 \cdot \text{kips}$$

Check Stresses:

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

$$\frac{\text{MaxTension}}{F_{\text{net.area}}} = 0.66$$

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

Condition = "OK"

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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:

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

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

Allowable Compressive Force:

$$K := 0.65$$

$$C_c := \sqrt{\frac{2 \cdot \pi^2 \cdot E}{F_y}} \quad C_c = 87.36$$

$$F_a := \begin{cases} \frac{\left[1 - \frac{\left(\frac{K \cdot l}{r} \right)^2}{2 \cdot C_c^2} \right] \cdot F_y}{\frac{5}{3} + \frac{3 \cdot \left(\frac{K \cdot l}{r} \right)}{8 \cdot C_c} - \frac{\left(\frac{K \cdot l}{r} \right)^3}{8 \cdot C_c^3}} & \text{if } \frac{K \cdot l}{r} \leq C_c \\ \frac{12 \cdot \pi^2 \cdot E}{23 \cdot \left(\frac{K \cdot l}{r} \right)^2} & \text{if } \frac{K \cdot l}{r} > C_c \end{cases} \quad F_a = 45.0 \text{ ksi}$$

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

Applied Compressive Force:

$$\text{MaxCompression} := \frac{OM \cdot R_{bc}}{I_p} + \frac{\text{Axial}}{N} \quad \text{MaxCompression} = 132.7 \text{ kips}$$

$$f_a := \frac{\text{MaxCompression}}{A_n} \quad f_a = 40.9 \text{ ksi}$$

Check Combined Stresses:

$$\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} = 0.68$$

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

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Base Plate Analysis:

Force from Bolt(s):

$$C_i := \frac{OM \cdot d_i}{I_p} + \frac{Axial}{N}$$

$$C_1 = 35.9 \cdot \text{kips}$$

$$C_7 = 128.3 \cdot \text{kips}$$

$$C_2 = 67.4 \cdot \text{kips}$$

$$C_8 = 115.2 \cdot \text{kips}$$

$$C_3 = 94.5 \cdot \text{kips}$$

$$C_9 = 94.5 \cdot \text{kips}$$

$$C_4 = 115.2 \cdot \text{kips}$$

$$C_{10} = 67.4 \cdot \text{kips}$$

$$C_5 = 128.3 \cdot \text{kips}$$

$$C_{11} = 35.9 \cdot \text{kips}$$

$$C_6 = 132.7 \cdot \text{kips}$$

etc.

Bending Stress in Plate:

$$f_{bp} := \sum_i \frac{6 \cdot C_i \cdot MA_i}{EffectiveWidth \cdot PlateThickness^2}$$

$$f_{bp} = 25.2 \cdot \text{ksi}$$

Check Stresses:

$$\frac{f_{bp}}{1.333 \cdot 0.75 F_{y_{bp}}} = 0.42$$

$$Condition := \text{if} \left(\frac{f_{bp}}{1.333 \cdot 0.75 F_{y_{bp}}} < 1.00, "OK", "Overstressed" \right)$$

Condition = "OK"

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MONOPOLE FOUNDATION ANALYSIS

TOWER FORCES:

Moment Caused by Tower $M_t := 4750 \cdot \text{ft} \cdot \text{kips}$
Shear at Base of Tower $S_t := 45 \text{ kip}$
Max Compressive Force $C_t := 52 \cdot \text{kip}$
Height of Tower $H_t := 160 \cdot \text{ft}$
Base Plate Bolt Circle $MP := 72.76 \text{ in}$

FOOTING DIMENSIONS:

Overall Depth of Footing $D_f := 14 \text{ ft}$
Length of Pier $L_p := 10 \cdot \text{ft}$
Extension of Pier Above Grade $L_{pag} := 0.5 \cdot \text{ft}$
Diameter of Pier $d_p := 8 \cdot \text{ft}$
Thickness of Footing $T_f := 4 \cdot \text{ft}$
Width of Footing: $W_f := 22 \text{ ft}$
Length of Anchor Bolts: $L_{st} := 132 \text{ in}$
Projection of anchor bolts above pier $A_{BP} := 10 \cdot \text{in}$

PIER REINFORCEMENT:

Bar Size $BS_{pier} := 11$ Bar Diameter $d_{bpier} := 1.41 \cdot \text{in}$
Number of Bars $NB_{pier} := 31$ Bar Area $A_{bpier} := 1.56 \cdot \text{in}^2$

PAD REINFORCEMENT:

TOP:	Bar Size	$BS_{top} := 9$	Bar Diameter	$d_{btop} := 1.128 \cdot \text{in}$
	Number of Bars	$NB_{top} := 35$	Bar Area	$A_{btop} := 1.00 \cdot \text{in}^2$
BOTTOM:	Bar Size	$BS_{bot} := 10$	Bar Diameter	$d_{bbot} := 1.27 \cdot \text{in}$
	Number of Bars	$NB_{bot} := 35$	Bar Area	$A_{bot} := 1.27 \cdot \text{in}^2$

Coefficient of Lateral Soil Pressure: $K_p := \frac{1 + \sin(\phi_s)}{1 - \sin(\phi_s)} K_p = 3.8518$

Load Factor (EIA 3.1.1): $LF := \text{if} \left[H_t \leq 700 \cdot \text{ft}, 1.3, \text{if} \left[H_t \geq 1200, 1.7, 1.3 + \left(\frac{H_t - 700}{1200 - 700} \right) \cdot 0.4 \right] \right]$ $LF = 1.3$

PROPERTIES:

Compressive Strength of Concrete $f_c := 4000 \text{ psi}$
Yield Strength of Steel Reinforcement $f_y := 60000 \cdot \text{psi}$
Yield Strength of Anchor Bolt $f_{ya} := 75000 \cdot \text{psi}$
Internal Friction Angle of Soil $\phi_s := 36 \cdot \text{deg}$
Allowable Bearing Capacity $q_s := 10000 \cdot \text{psf}$
Unit Weight of Soil $\gamma_s := 125 \cdot \text{pcf}$
Unit Weight of Concrete $\gamma_c := 150 \cdot \text{pcf}$
Depth to Neglect $n := 0 \text{ ft}$
Cohesion of Clay Type Soil $c := 0 \cdot \text{ksf}$
Note: Use 0 for Sandy Soil
Seismic Zone Factor: $Z := 2$
UBC Fig 23-2
Coefficient of Friction between Concrete: $\mu := 0.45$
Clear Cover of Reinforcement Pier: $C_{vr_{pier}} := 3 \cdot \text{in}$
Clear Cover of Reinforcement Pad: $C_{vr_{pad}} := 3 \cdot \text{in}$
Anchor Bolt Diameter $d_{anchor} := 2.25 \text{ in}$
Anchor bolt area $A_{anchor} := 3.97 \cdot \text{in}^2$

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CHECK ANCHOR STEEL EMBEDMENT

Depth: $D_{ab} := L_{st} - A_{BP}$ $D_{ab} = 10.17 \cdot \text{ft}$ $L_{anchor} := \frac{(0.11 \cdot f_y) \cdot \text{in}}{\sqrt{f_c \cdot \text{psi}}}$ $L_{anchor} = 8.7 \cdot \text{ft}$

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

DepthCheck = "Okay" **Note: anchor plate is provided**

STABILITY OF FOOTING

Passive Pressure: $P_{pn} := K_p \cdot \gamma_s \cdot n + c \cdot 2 \cdot \sqrt{K_p}$ $P_{pn} = 0 \cdot \text{ksf}$
 $P_{pt} := K_p \cdot \gamma_s \cdot (D_f - T_f) + c \cdot 2 \cdot \sqrt{K_p}$ $P_{pt} = 4.8148 \cdot \text{ksf}$
 $P_{top} := \text{if}[n < (D_f - T_f), P_{pt}, P_{pn}]$ $P_{top} = 4.8148 \cdot \text{ksf}$
 $P_{bot} := K_p \cdot \gamma_s \cdot D_f + c \cdot 2 \cdot \sqrt{K_p}$ $P_{bot} = 6.7407 \cdot \text{ksf}$
 $P_{ave} := \frac{P_{top} + P_{bot}}{2}$ $P_{ave} = 5.7778 \cdot \text{ksf}$
 $T_p := \text{if}[n < (D_f - T_f), T_f, (D_f - n)]$ $T_p = 4 \cdot \text{ft}$

$A_p := W_f \cdot T_p$ $A_p = 88 \cdot \text{ft}^2$

Ultimate Shear: $S_u := P_{ave} \cdot A_p$ $S_u = 508.44 \cdot \text{kip}$

Weight of Concrete Pad: $WT_c := \left[(W_f^2 \cdot T_f) + \frac{d_p^2 \cdot \pi}{4} \cdot L_p \right] \cdot \gamma_c$ $WT_c = 365.8 \cdot \text{kip}$

Weight of Soil above Footing: $WT_{s1} := \left[W_f^2 \cdot (|L_p - L_{pag}|) - \frac{d_p^2 \cdot \pi}{4} \cdot (|L_p - L_{pag}|) \right] \cdot \gamma_s$ $WT_{s1} = 515.06 \cdot \text{kip}$

Weight of Soil Wedge at back face: $WT_{s2} := \left(\frac{D_f^2 \cdot \tan(\phi_s)}{2} \cdot W_f \right) \cdot \gamma_s$ $WT_{s2} = 195.8 \cdot \text{kip}$

Total Weight: $WT_{tot} := WT_c + WT_{s1} + C_t$ $WT_{tot} = 932.86 \cdot \text{kip}$

Resisting Moment: $M_r := (WT_{tot}) \cdot \frac{W_f}{2} + S_u \cdot \frac{T_f}{3} + WT_{s2} \cdot \left(W_f + \frac{D_f \cdot \tan(\phi_s)}{3} \right)$ $M_r = 15910.91 \cdot \text{kip} \cdot \text{ft}$

Overturning Moment: $M_{ot} := M_t + S_t \cdot (L_p + T_f)$ $M_{ot} = 5380 \cdot \text{kip} \cdot \text{ft}$

Factor of Safety: $FS := \frac{M_r}{M_{ot}}$ $FS_{req} := 2$ $FS = 2.96$

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

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SHEAR CAPACITY IN PIER

FS := 2

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

$$S_p = 464.11 \cdot \text{kips}$$

$$\text{ShearCheck} := \text{if}(S_p > S_t, \text{"Okay"}, \text{"No Good"})$$

$$\text{ShearCheck} = \text{"Okay"}$$

BEARING PRESSURE CAUSED BY FOOTING

$$A_{mat} := W_f^2$$

$$A_{mat} = 484 \cdot \text{ft}^2$$

$$S := \frac{W_f^3}{6}$$

$$S = 1774.67 \cdot \text{ft}^3$$

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

$$P_{max} = 4.96 \cdot \text{ksf}$$

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

$$P_{min} = -1.1 \cdot \text{ksf}$$

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

$$\text{MaxPressure} = \text{"Okay"}$$

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

$$\text{MinPressure} = \text{"No Good"}$$

Distance to Resultant of Pressure Distribution:

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

$$X_p = 6 \cdot \text{ft}$$

Distance to Kern:

$$X_k := \frac{W_f}{6}$$

$$X_k = 3.67 \cdot \text{ft}$$

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

Eccentricity:

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

$$e = 5.77$$

Adjusted Soil Pressure:

$$P_a := \frac{2 \cdot WT_{tot}}{3 \cdot W_f \cdot \left(\frac{W_f}{2} - e \right)}$$

$$P_a = 5.4 \cdot \text{ksf}$$

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

$$q_{adj} = 5.4 \cdot \text{ksf}$$

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

$$\text{PressureCheck} = \text{"Okay"}$$

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CONCRETE BEARING CAPACITY (ACI 10.17)

$$\phi_c := 0.75 \quad (\text{ACI 9.3.2.2})$$

$$P_b := \phi_c \cdot 0.85 \cdot f_c \cdot \frac{d_p^2 \cdot \pi}{4} \quad P_b = 18457.49 \cdot \text{kip}$$

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

SHEAR STRENGTH OF CONCRETE

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

$$\phi_{\text{shear}} := .85 \quad (\text{ACI 9.3.2.3})$$

$$d := T_f - C_{\text{vrpad}} - d_{\text{bbot}} \quad d = 43.73 \cdot \text{in}$$

$$d_1 := \frac{W_f}{2} - \frac{d_p}{2} \quad d_1 = 7 \cdot \text{ft}$$

$$d_2 := d_1 - d \quad d_2 = 3.36 \cdot \text{ft}$$

$$L_{\text{w}} := \left(\frac{W_f}{2} - e \right) \cdot 3 \quad L = 15.7 \cdot \text{ft}$$

$$\text{Slope} := \text{if} \left(L > W_f, \frac{P_{\text{max}} - P_{\text{min}}}{W_f}, \frac{q_{\text{adj}}}{L} \right) \quad \text{Slope} = 0.3441 \cdot \text{kef}$$

$$V_{\text{req}} := LF \cdot \left[(q_{\text{adj}} - \text{Slope} \cdot d_1) + \left(\frac{\text{Slope} \cdot d_1}{2} \right) \right] \cdot W_f \cdot d_1 \quad V_{\text{req}} = 840.39 \cdot \text{kip}$$

ACI 11.3.1.1 $V_{\text{Avail}} := \phi_c \cdot 2 \cdot \sqrt{f_c \cdot \text{psi}} \cdot W_f \cdot d \quad V_{\text{Avail}} = 1241.26 \cdot \text{kip}$

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

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

$$b_o := (d_p + d) \cdot \pi \quad b_o = 36.58 \cdot \text{ft}$$

Area included inside bo: $A_{\text{bo}} := \frac{\pi \cdot (d_p + d)^2}{4} \quad A_{\text{bo}} = 106.49 \cdot \text{ft}^2$

Area outside of bo: $A_{\text{out}} := A_{\text{mat}} - A_{\text{bo}} \quad A_{\text{out}} = 377.51 \cdot \text{ft}^2$

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Guess Value: $v_u := 1 \text{ ksf}$

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

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

$v_u := \text{Find}(v_u)$

$v_u = 7 \cdot \text{ksf}$

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

$V_u = 561 \cdot \text{kips}$

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

$V_{req} = 729.3 \cdot \text{kips}$

$V_{Avail} := \phi_c \cdot 4 \cdot \sqrt{f_c \cdot \text{psi}} \cdot b_o \cdot d$

$V_{Avail} = 4127.9 \cdot \text{kips}$

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

$\text{PunchingShearCheck} = \text{"Okay"}$

STEEL REINFORCEMENT IN THE PAD

$\phi_m := .90$ ACI 9.3.2.2

Take Maximum Bending at face of Pier:

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

$q_b = 2.99 \cdot \text{ksf}$

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

$M_n = 3580.8 \cdot \text{kip} \cdot \text{ft}$

ACI 10.2.7.3

$\beta := \text{if} \left[f_c \leq 4000 \cdot \text{psi}, .85, \text{if} \left[f_c \geq 8000 \cdot \text{psi}, .65, .85 - \left(\frac{\frac{f_c}{\text{psi}} - 4000}{1000} \right) \cdot .05 \right] \right]$ $\beta = 0.85$

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

$R_u = 13618 \text{ lbf}$

$\rho := \frac{0.85 \cdot f_c}{f_y} \left(1 - \sqrt{1 - \frac{2 \cdot R_u}{0.85 \cdot f_c}} \right)$

$\rho = 0.0016$

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

$\rho_{min} = 0.0021$

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Job 160' Valmont Monopole – Orange, CT
Description Foundation Analysis

Project No. 08032
Computed by JEK

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

$$\rho_{sh} = 0.0018$$

(ACI 7.12.2.1b)

FOR BOTTOM BARS:

$$A_s := \max(\rho, \rho_{min}, \rho_{sh}) \cdot W_f \cdot d$$

$$A_s = 24.6 \cdot \text{in}^2$$

$$A_{s_{prov}} := A_{bot} \cdot NB_{bot}$$

$$A_{s_{prov}} = 44.45 \cdot \text{in}^2$$

$$\text{PadReinforcement} := \text{if}(A_{s_{prov}} > A_s, \text{"Okay"}, \text{"No Good"})$$

$$\text{PadReinforcement} = \text{"Okay"}$$

FOR TOP BARS:

$$A_s := \rho_{sh} \cdot (W_f \cdot d)$$

$$A_s = 20.78 \cdot \text{in}^2$$

$$A_{s_{prov}} := A_{top} \cdot NB_{top}$$

$$A_{s_{prov}} = 35 \cdot \text{in}^2$$

$$\text{PadReinforcement} := \text{if}(A_{s_{prov}} > A_s, \text{"Okay"}, \text{"No Good"})$$

$$\text{PadReinforcement} = \text{"Okay"}$$

TENSION (ACI 12.2.3)

DEVELOPMENT LENGTH OF PAD REINFORCEMENT

Bar Spacing:

$$B_{sPad} := \frac{W_f - 2 \cdot C_{vr_{pad}} - NB_{bot} \cdot d_{bbot}}{NB_{bot} - 1}$$

$$B_{sPad} = 6.28 \cdot \text{in}$$

Development Length Factors:

Reinforcement Location Factor

$$\alpha := 1.0$$

Coating Factor

$$\beta := 1.0$$

Concrete strength Factor

$$\lambda := 1.0$$

Reinforcement Size Factor

$$\gamma := 1.0$$

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

Transverse Reinforcement Index: A_s allowed by ACI 12.2.4

$$k_{tr} := 0$$

$$L_{dbt} := \frac{3}{40} \cdot \frac{f_y}{\sqrt{f_c \cdot \text{psi}}} \cdot \frac{\alpha \cdot \beta \cdot \gamma \cdot \lambda}{\frac{c + k_{tr}}{d_{bbot}}} \cdot d_{bbot}$$

$$L_{dbt} = 38.25 \cdot \text{in}$$

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

Minimum Development Length:
(ACI 12.2.1)

$$L_{dbtCheck} := \text{if}(L_{dbt} \geq L_{dbmin}, \text{"Use } L_{dbt}\text{"}, \text{"Use } L_{dbmin}\text{"})$$

$$L_{dbtCheck} = \text{"Use } L_{dbt}\text{"}$$

Available Length in Pad:

$$L_{Pad} := \frac{W_f}{2} - \frac{d_p}{2} - C_{vr_{pad}}$$

$$L_{Pad} = 81 \cdot \text{in}$$

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

$$L_{padTension} = \text{"Okay"}$$

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Project No. 08032
Computed by JEK

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REINFORCEMENT IN PIER

Pier Area: $A_p := \frac{\pi \cdot d_p^2}{4}$ $A_p = 7238.23 \cdot \text{in}^2$

(ACI 10.8.4 and 10.9.1) $A_{smin} := 0.01 \cdot 0.05 \cdot A_p$ $A_{smin} = 3.62 \cdot \text{in}^2$

$A_{sprov} := NB_{pier} \cdot A_{bpier}$ $A_{sprov} = 48.36 \cdot \text{in}^2$

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: $B_{SPier} := \frac{d_p \cdot \pi}{NB_{pier}} - d_{bpier}$ $B_{SPier} = 8.32 \cdot \text{in}$

Diameter of Reinforcement Cage: $Diam_{cage} := d_p - 2 \cdot C_{vr_{pier}}$ $Diam_{cage} = 90 \cdot \text{in}$

Maximum Moment in Pier: $M_p := \left[M_t + S_t \cdot \left(L_p + \frac{A_{BP}}{2} \right) \right] \cdot LF$ $M_p = 81412.5 \cdot \text{in} \cdot \text{kips}$

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

(defined variables)

$$(f_c \ f_y \ c_l \ \text{Spiral}) = (3 \ 60 \ 3 \ 0)$$

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:

$$(D \ N \ n \ P_u \ M_{xu}) := (96 \ 31 \ 11 \ 52 \ 82000)$$

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:

$$(\phi P_n \ \phi M_{xn} \ f_{sp} \ \rho) = (66.9552 \ 105583.1461 \ -60 \ 0.0067)$$

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

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

AxialLoadCheck = "Okay"

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

BendingCheck = "Okay"

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Job 160' Valmont Monopole – Orange, CT
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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 $\gamma := 1.0$
Reinforcement Size Factor $\lambda := 1.0$

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

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

$$L_{dbt} := \frac{3}{40} \cdot \frac{f_y}{\sqrt{f_c \cdot \text{psi}}} \cdot \frac{\alpha \cdot \beta \cdot \gamma \cdot \lambda}{\frac{c + k_{tr}}{d_{bpier}}} \cdot d_{bpier} \quad L_{dbt} = 47.15 \cdot \text{in}$$

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

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

$$L_{dh} := \frac{1200 \cdot d_{bpier}}{\sqrt{\frac{f_c}{\text{psi}}}} \cdot .7 \quad L_{dh} = 18.73 \cdot \text{in}$$

$$L_{db} := \max(L_{dbt}, L_{dbmin}) \quad L_{db} = 47.15 \cdot \text{in}$$

COMPRESSION: (ACI 12.3.2)

$$L_{dbc1} := \frac{.02 \cdot d_{bpier} \cdot f_y}{\sqrt{f_c \cdot \text{psi}}} \quad L_{dbc1} = 26.75 \cdot \text{in}$$

$$L_{dbmin} := 0.0003 \cdot \frac{\text{in}^2}{\text{lb}} \cdot (d_{bpier} \cdot f_y) \quad L_{dbmin} = 25.38 \cdot \text{in}$$

$$L_{dbc} := \text{if}(L_{dbc1} \geq L_{dbmin}, L_{dbc1}, L_{dbmin}) \quad L_{dbc} = 26.75 \cdot \text{in}$$

Available Length in Foundation:

$$L_{pier} := L_p - C_{vr_pier} \quad L_{pier} = 117 \cdot \text{in}$$

$$L_{pad} := T_f - C_{vr_pad} \quad L_{pad} = 45 \cdot \text{in}$$

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

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

NOTE: Anchor bolts and plate provided, OK

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Job 160' Valmont Monopole – Orange, CT
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TIE SIZE AND SPACING IN COLUMN

Minimum Tie Size:

$$Tie_{min} := \text{if}(BS_{pier} \leq 10, 3, 4)$$

$$Tie_{min} = 4$$

Used #4 Ties

$$d_{Tie} := 4$$

Seismic factor:
(ACI 21.10.5)

$$z := \text{if}(Z \leq 2, 1, 0.5)$$

$$z = 1$$

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

$$s_{lim1} = 22.56 \cdot \text{in}$$

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

$$s_{lim2} = 24 \cdot \text{in}$$

$$s_{lim3} := D_f \cdot z$$

$$s_{lim3} = 168 \cdot \text{in}$$

$$s_{lim4} := 18 \text{in}$$

$$s_{lim4} = 18 \cdot \text{in}$$

Maximum Spacing:

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

$$s_{tie} = 18 \cdot \text{in}$$

Number of Ties Required:

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

$$n_{tie} = 7.3$$

REVISIONS	
NO.	DATE
1	02/28/08
2	03/04/08
3	03/04/08
4	03/04/08
5	03/04/08
6	03/04/08
7	03/04/08
8	03/04/08
9	03/04/08
10	03/04/08

Calica Partnership
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Branford, CT 06405

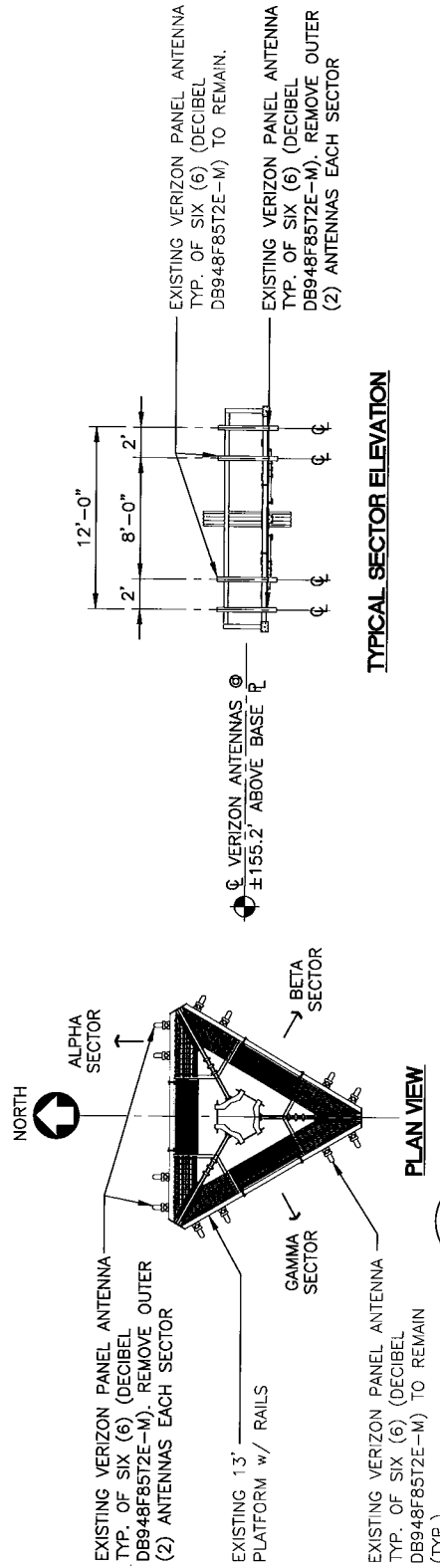


ORANGE CENTER ROAD
SSS ORANGE CENTER ROAD
ORANGE, CT

PROJECT NO:	08032
DRAWN BY:	DEB
CHECKED BY:	CFC
SCALE:	AS NOTED
DATE:	02/27/08

ANTENNA REPLACEMENT DETAILS

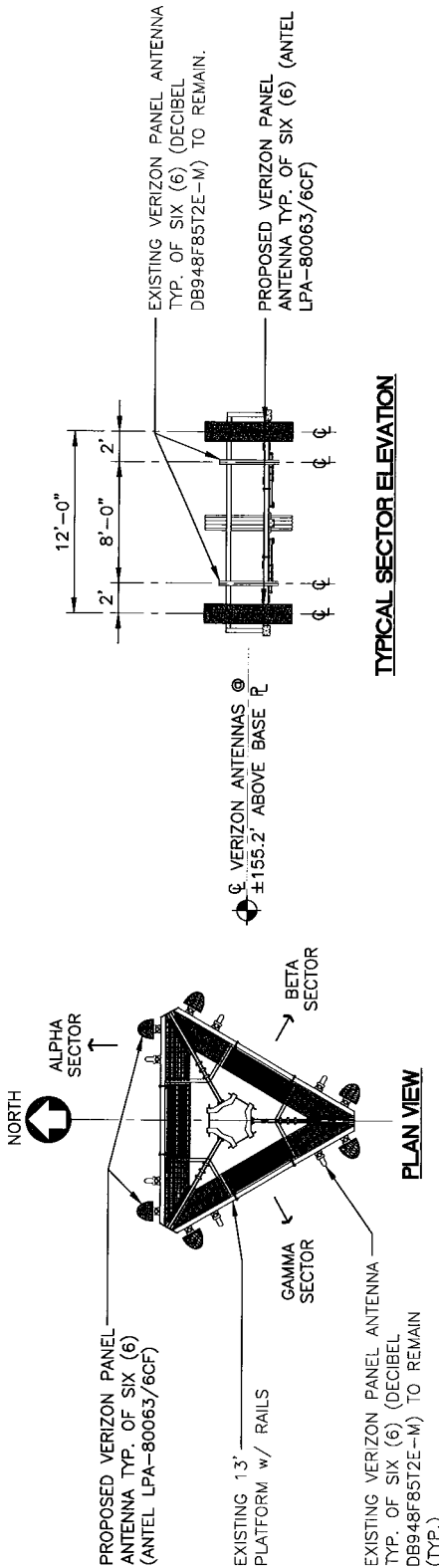
ANT-1
DWG. 1 OF 1



1 EXISTING ANTENNA MOUNTING CONFIGURATION

NOT TO SCALE

ANT-1



2 PROPOSED ANTENNA MOUNTING CONFIGURATION

NOT TO SCALE

ANT-1

DETAILED STRUCTURAL ANALYSIS AND EVALUATION OF 160' MONOPOLE FOR NEW ANTENNA ARRANGEMENT

525 Orange Center Road
Orange, Connecticut

prepared for



Verizon Wireless
99 East River Drive
East Hartford, Connecticut 06108

prepared by



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VZ1-212

August 15, 2006

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- **RISA TOWER INPUT / OUTPUT SUMMARY**
- **RISA TOWER DETAILED OUTPUT**
- **ANCHOR BOLT AND BASE PLATE ANALYSIS**
- **FOUNDATION ANALYSIS**

1. EXECUTIVE SUMMARY

This report summarizes the structural analysis of the existing 160' steel monopole structure located at 525 Orange Center Road in Orange, Connecticut. The analysis was conducted in accordance with the 2005 Connecticut State Building Code and the TIA/EIA-222-F standard for wind velocity of 90 mph (fastest mile) and 78 mph (fastest mile) concurrent with 1/2" 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 modification is as follows:

Proposed Antenna and Mount	Carrier	Antenna Center Elevation
Remove: (6) existing Decibel DB844H90-XY antennas Install: (6) Antel LPA-80063/6CF antennas on the (1) existing platform with handrails with (6) existing 1 5/8" coax cables within the monopole	Verizon (Proposed)	@ 155.2'

The results of the analysis indicate that the tower and foundation are not in compliance with the proposed loading conditions. **The tower is not considered structurally adequate with the wind load classification specified above and all the existing and 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 taken from original construction drawings and structural calculations prepared by Valmont Industries, Inc., job number 16632-97, dated February 25, 1998.
- 3) Antenna and mount configuration as specified on the following page of this report.

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/jek

cc: AA, DR, IA, CF/Book - URS



2. INTRODUCTION

The subject tower is located at 525 Orange Center Road in Orange, Connecticut. The structure is a 160' steel monopole designed and manufactured by Valmont Industries, Inc.

The inventory is summarized in the table below:

Antenna Type	Carrier	Mount	Antenna Centerline Elevation	Cable
(9) Decibel DB944H90E-XY antennas	Nextel (existing)	Pipe Mounts (off platform below)	167'	(9) 1 1/4" coax cables (within monopole)
(6) Antel LPA-80063/6CF antennas	Verizon (proposed)	Platform w/handrails	155.2'	(6) existing 1 5/8" coax cables (within monopole)
(6) Decibel DB948F85T2E-M antennas	Verizon (existing)	Platform w/handrails (listed above)	155.2'	(6) 1 5/8" coax cables (within monopole)
(9) CSS DUO1417-8686 antennas	Cingular (existing)	Platform w/handrails	145.7'	(9) 1 1/4" coax cables (within monopole)
(6) Decibel DB980H90E-M antennas	Sprint (existing)	Platform w/handrails	134.1'	(6) 1 5/8" coax cables (within monopole)
(6) EMS RR90-17-02DP antennas	T-Mobile (existing)	Platform w/handrails	121.9'	(12) 1 5/8" coax cables (within monopole)
(12) Allgon 7184.14 antennas	Cingular Blue (existing)	Platform w/handrails	109.4'	(12) 1 1/4" coax cables (outside of monopole)
(1) GPS antenna	Sprint (existing)	Standoff Mount	83.4'	(1) 1/2" coax cable (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 done 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 4.6. Two load conditions were evaluated as shown below which were compared to allowable stresses according to AISC and TIA/EIA.

Load Condition 1 = 90 mph (fastest mile) Wind Load (without ice) + Tower Dead Load
Load Condition 2 = 78 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 existing and proposed loading were above the allowable limits. Detailed analysis and calculations for the load conditions are provided in section 6 of this report. The base plate was found to be within allowable limits. The anchor bolts and foundation were found to be above the allowable limits.

Please note that as of January 1, 2006 the basic wind speed for this site has increased from 85 mph (fastest mile) to 90 mph (fastest mile).

5. CONCLUSIONS AND RECOMMENDATIONS

The results of the analysis indicate that the tower and foundation are not in compliance with the proposed loading conditions. **The tower is not structurally adequate under the wind load classification specified above and all the existing and proposed antenna loadings.**

Due to the magnitude and location of predicted overstress on the tower structure, URS recommends that the current loading on the tower be reduced to bring the tower into compliance. Replacing all existing platforms with low profile platforms should be considered. Replacing or reinforcing the tower should also be considered. Any option will require a new structural analysis.

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.

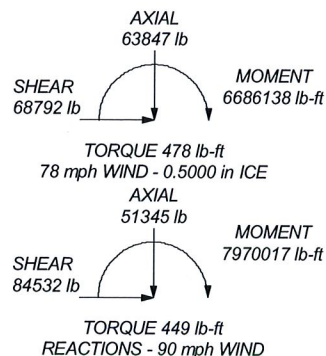
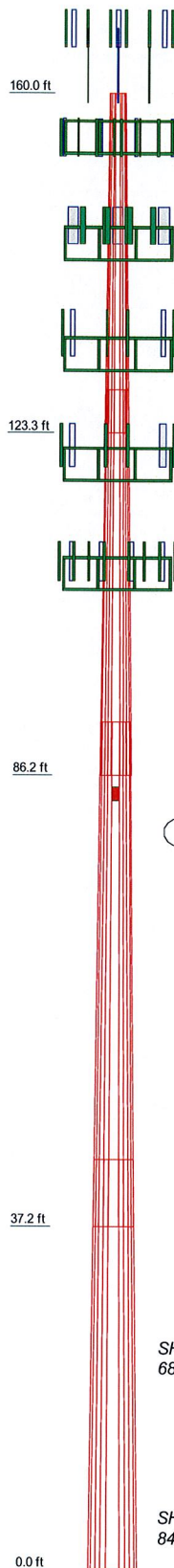
The owner shall refer to TIA/EIA-222-F for recommendations for maintenance and inspection. The frequency of the inspection and maintenance intervals is to be determined by the owner based upon actual site and environmental conditions. It is recommended that a complete and thorough inspection of the entire 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

EXISTING TOWER CONDITIONS

RISA TOWER INPUT/OUTPUT SUMMARY

Section	1	2	3	4
Length (ft)	36.67	41.83	54.83	44.50
Number of Sides	12	12	12	12
Thickness (in)	0.2190	0.3440	0.4380	0.4680
Lap Splice (ft)		4.67	5.83	7.33
Top Dia (in)	21.2000	29.7154	39.1179	51.5330
Bot Dia (in)	31.4600	41.4400	54.4600	64.0000
Grade			A572-65	
Weight (lb)	2297.6	5555.1	12196.6	13102.6



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
(3) DB844H90E-XY (Nextel)	167	(3) DUO1417-8686 (Cingular)	145.7
(3) DB844H90E-XY (Nextel)	167	(3) DUO1417-8686 (Cingular)	145.7
(3) DB844H90E-XY (Nextel)	167	Valmont 13' Platform w/Rails (Cingular)	143.7
(4) 8'x2 1/2" Pipe Mount (Nextel)	163	(2) DB980H90E-M (SPRINT)	134.1
(4) 8'x2 1/2" Pipe Mount (Nextel)	163	(2) DB980H90E-M (SPRINT)	134.1
(4) 8'x2 1/2" Pipe Mount (Nextel)	163	(2) DB980H90E-M (SPRINT)	134.1
DB844H90-XY (Verizon)	155.2	Valmont 13' Platform w/Rails (SPRINT)	131.8
DB844H90-XY (Verizon)	155.2	(2) RR90-17-02DP (T-Mobile)	121.9
DB844H90-XY (Verizon)	155.2	(2) RR90-17-02DP (T-Mobile)	121.9
DB844H90-XY (Verizon)	155.2	(2) RR90-17-02DP (T-Mobile)	121.9
DB844H90-XY (Verizon)	155.2	Valmont 13' Platform w/Rails (T-Mobile)	119.9
DB844H90-XY (Verizon)	155.2	(4) 7184.14 (Cingular Blue)	109.4
DB948F85T2E-M (Verizon)	155.2	(4) 7184.14 (Cingular Blue)	109.4
DB948F85T2E-M (Verizon)	155.2	(4) 7184.14 (Cingular Blue)	109.4
DB948F85T2E-M (Verizon)	155.2	Valmont 13' Platform w/Rails (Cingular Blue)	108
DB948F85T2E-M (Verizon)	155.2	GPS (Sprint)	83.4
DB948F85T2E-M (Verizon)	155.2	Standoff Mount	83.4
Valmont 13' Platform w/Rails (Verizon)	155.2	Standoff Mount	83.4
(3) DUO1417-8686 (Cingular)	145.7		

MATERIAL STRENGTH

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

TOWER DESIGN NOTES

1. Tower designed for a 90 mph basic wind in accordance with the TIA/EIA-222-F Standard.
2. Tower is also designed for a 78 mph basic wind with 0.50 in ice.
3. Deflections are based upon a 50 mph wind.
4. Weld together tower sections have flange connections.
5. Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications.
6. Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
7. Welds are fabricated with ER-70S-6 electrodes.
8. TOWER RATING: 133.5%

URS Corporation

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FAX: (860) 529-3991

Job:	160 Ft. Valmont Monopole - Orange, CT
Project:	525 Orange Center Road
Client:	Verizon Wireless
Code:	TIA/EIA-222-F
Path:	P:\08\ERFiles\160' Valmont Monopole - Existing.etl
Drawn by:	Staff
Date:	08/15/06
Scale:	NTS
Dwg No:	E-1

RISA TOWER DETAILED OUTPUT

RISATower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	160 Ft. Valmont Monopole - Orange, CT	Page	1 of 20
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	Client	Verizon Wireless	Designed by	Staff

Tower Input Data

There is a pole section.

This tower is designed using the TIA/EIA-222-F standard.

The following design criteria apply:

Basic wind speed of 90 mph.

Nominal ice thickness of 0.5000 in.

Ice density of 56 pcf.

A wind speed of 78 mph is used in combination with ice.

Temperature drop of 50 °F.

Deflections calculated using a wind speed of 50 mph.

Weld together tower sections have flange connections..

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..

Welds are fabricated with ER-70S-6 electrodes..

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	160.00-123.33	36.67	4.67	12	21.2000	31.4600	0.2190	0.8760	A572-65 (65 ksi)
L2	123.33-86.17	41.83	5.83	12	29.7154	41.4400	0.3440	1.3760	A572-65 (65 ksi)
L3	86.17-37.17	54.83	7.33	12	39.1179	54.4600	0.4380	1.7520	A572-65 (65 ksi)

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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 (65 ksi)
L4	37.17-0.00	44.50		12	51.5330	64.0000	0.4690	1.8760	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	21.9479	14.7954	831.3128	7.5112	10.9816	75.7005	1684.4652	7.2818	5.0947	23.263
	32.5698	22.0305	2744.4841	11.1843	16.2963	168.4117	5561.0688	10.8428	7.8444	35.819
L2	32.1188	32.5341	3582.3894	10.5149	15.3926	232.7351	7258.8921	16.0123	7.0418	20.47
	42.9018	45.5212	9812.9350	14.7124	21.4659	457.1402	19883.6668	22.4042	10.1840	29.605
L3	42.1867	54.5526	10417.6987	13.8474	20.2631	514.1224	21109.0819	26.8491	9.3098	21.255
	56.3811	76.1905	28381.0140	19.3399	28.2103	1006.0522	57507.6289	37.4986	13.4214	30.643
L4	55.4769	77.1158	25666.0211	18.2809	26.6941	961.4873	52006.3171	37.9540	12.5539	26.767
	66.2577	95.9432	49427.8521	22.7441	33.1520	1490.9463	100154.228	47.2203	15.8951	33.891
							9			

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 160.00- 123.33				1	1	1		
L2 123.33- 86.17				1	1	1		
L3 86.17-37.17				1	1	1		
L4 37.17-0.00				1	1	1		

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number		C _A A _A ft ² /ft	Weight plf
1 1/4 (Nextel)	C	No	Inside Pole	0.00 - 160.00	9	No Ice	0.00	0.66
1 5/8 (Verizon)	C	No	Inside Pole	0.00 - 155.20	12	1/2" Ice	0.00	0.66
1 1/4 (Cingular)	C	No	Inside Pole	0.00 - 145.70	9	No Ice	0.00	1.04
1 5/8 (Sprint)	C	No	Inside Pole	0.00 - 131.80	6	1/2" Ice	0.00	1.04
1 5/8 (T-Mobile)	C	No	Inside Pole	0.00 - 121.90	12	No Ice	0.00	1.04
1 1/4 (Cingular Blue)	C	No	CaAa (Out Of Face)	0.00 - 109.40	1	1/2" Ice	0.00	1.04
1 1/4 (Cingular Blue)	C	No	CaAa (Out Of Face)	0.00 - 109.40	11	No Ice	0.16	0.66
1/2 (Sprint)	C	No	Inside Pole	0.00 - 83.40	1	1/2" Ice	0.25	1.91
						No Ice	0.00	0.66
						1/2" Ice	0.00	1.91
						No Ice	0.00	0.25
						1/2" Ice	0.00	0.25

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Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft ²	A_F ft ²	$C_A A_A$ In Face ft ²	$C_A A_A$ Out Face ft ²	Weight lb
L1	160.00-123.33	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	801.29
L2	123.33-86.17	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	3.601	1766.99
L3	86.17-37.17	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	7.595	2510.56
L4	37.17-0.00	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	5.761	1904.96

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	$C_A A_A$ In Face ft ²	$C_A A_A$ Out Face ft ²	Weight lb
L1	160.00-123.33	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	801.29
L2	123.33-86.17	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	5.924	2115.44
L3	86.17-37.17	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	12.495	3245.56
L4	37.17-0.00	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	9.478	2462.51

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft	$C_A A_A$ Front ft ²	$C_A A_A$ Side ft ²	Weight lb
(3) DB844H90E-XY (Nextel)	A	From Leg	3.00	0.0000	167.00	No Ice	2.87	10.00
			0.00			1/2" Ice	3.18	35.38
			0.00					
(3) DB844H90E-XY (Nextel)	B	From Leg	3.00	0.0000	167.00	No Ice	2.87	10.00
			0.00			1/2" Ice	3.18	35.38
			0.00					
(3) DB844H90E-XY (Nextel)	C	From Leg	3.00	0.0000	167.00	No Ice	2.87	10.00
			0.00			1/2" Ice	3.18	35.38
			0.00					

RISATower

URS Corporation
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Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C _{AA} Front ft ²	C _{AA} Side ft ²	Weight lb
(4) 8'x2 1/2" Pipe Mount (Nextel)	A	From Leg	3.00 0.00 0.00	0.0000	163.00	No Ice 1/2" Ice	2.30 3.13	2.30 3.13	40.50 57.38
(4) 8'x2 1/2" Pipe Mount (Nextel)	B	From Leg	3.00 0.00 0.00	0.0000	163.00	No Ice 1/2" Ice	2.30 3.13	2.30 3.13	40.50 57.38
(4) 8'x2 1/2" Pipe Mount (Nextel)	C	From Leg	3.00 0.00 0.00	0.0000	163.00	No Ice 1/2" Ice	2.30 3.13	2.30 3.13	40.50 57.38
DB844H90-XY (Verizon)	A	From Leg	3.00 6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	2.87 3.18	3.97 4.34	10.00 36.27
DB844H90-XY (Verizon)	B	From Leg	3.00 6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	2.87 3.18	3.97 4.34	10.00 36.27
DB844H90-XY (Verizon)	C	From Leg	3.00 6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	2.87 3.18	3.97 4.34	10.00 36.27
DB844H90-XY (Verizon)	A	From Leg	3.00 -2.00 0.00	0.0000	155.20	No Ice 1/2" Ice	2.87 3.18	3.97 4.34	10.00 36.27
DB844H90-XY (Verizon)	B	From Leg	3.00 -2.00 0.00	0.0000	155.20	No Ice 1/2" Ice	2.87 3.18	3.97 4.34	10.00 36.27
DB844H90-XY (Verizon)	C	From Leg	3.00 -2.00 0.00	0.0000	155.20	No Ice 1/2" Ice	2.87 3.18	3.97 4.34	10.00 36.27
DB948F85T2E-M (Verizon)	A	From Leg	3.00 2.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	B	From Leg	3.00 2.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	C	From Leg	3.00 2.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	A	From Leg	3.00 -6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	B	From Leg	3.00 -6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	C	From Leg	3.00 -6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
Valmont 13' Platform w/Rails (Verizon)	C	None		0.0000	155.20	No Ice 1/2" Ice	25.00 30.00	25.00 30.00	2000.00 3000.00
(3) DUO1417-8686 (Cingular)	A	From Leg	0.50 0.00 0.00	0.0000	145.70	No Ice 1/2" Ice	6.53 6.94	4.20 4.57	20.30 62.49
(3) DUO1417-8686 (Cingular)	B	From Leg	0.50 0.00 0.00	0.0000	145.70	No Ice 1/2" Ice	6.53 6.94	4.20 4.57	20.30 62.49
(3) DUO1417-8686 (Cingular)	C	From Leg	0.50 0.00 0.00	0.0000	145.70	No Ice 1/2" Ice	6.53 6.94	4.20 4.57	20.30 62.49
Valmont 13' Platform w/Rails	C	None		0.0000	143.70	No Ice	25.00	25.00	2000.00

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Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft	C _{AA} Front ft ²	C _{AA} Side ft ²	Weight lb
(Cingular)						1/2" Ice	30.00	30.00
(2) DB980H90E-M	A	From Leg	3.00	0.0000	134.10	No Ice	3.80	2.19
(SPRINT)			0.00			1/2" Ice	4.18	2.56
			0.00					28.62
(2) DB980H90E-M	B	From Leg	3.00	0.0000	134.10	No Ice	3.80	2.19
(SPRINT)			0.00			1/2" Ice	4.18	2.56
			0.00					28.62
(2) DB980H90E-M	C	From Leg	3.00	0.0000	134.10	No Ice	3.80	2.19
(SPRINT)			0.00			1/2" Ice	4.18	2.56
			0.00					28.62
Valmont 13' Platform w/Rails	C	None		0.0000	131.80	No Ice	25.00	25.00
(SPRINT)						1/2" Ice	30.00	30.00
(2) RR90-17-02DP	A	From Leg	3.00	0.0000	121.90	No Ice	4.36	1.97
(T-Mobile)			0.00			1/2" Ice	4.77	2.31
			0.00					40.42
(2) RR90-17-02DP	B	From Leg	3.00	0.0000	121.90	No Ice	4.36	1.97
(T-Mobile)			0.00			1/2" Ice	4.77	2.31
			0.00					40.42
(2) RR90-17-02DP	C	From Leg	3.00	0.0000	121.90	No Ice	4.36	1.97
(T-Mobile)			0.00			1/2" Ice	4.77	2.31
			0.00					40.42
Valmont 13' Platform w/Rails	C	None		0.0000	119.90	No Ice	25.00	25.00
(T-Mobile)						1/2" Ice	30.00	30.00
(4) 7184.14	A	From Leg	3.00	0.0000	109.40	No Ice	2.85	1.43
(Cingular Blue)			0.00			1/2" Ice	3.18	1.75
			0.00					24.29
(4) 7184.14	B	From Leg	3.00	0.0000	109.40	No Ice	2.85	1.43
(Cingular Blue)			0.00			1/2" Ice	3.18	1.75
			0.00					24.29
(4) 7184.14	C	From Leg	3.00	0.0000	109.40	No Ice	2.85	1.43
(Cingular Blue)			0.00			1/2" Ice	3.18	1.75
			0.00					24.29
Valmont 13' Platform w/Rails	C	None		0.0000	108.00	No Ice	25.00	25.00
(Cingular Blue)						1/2" Ice	30.00	30.00
GPS	A	From Leg	2.00	0.0000	83.40	No Ice	1.00	1.00
(Sprint)			0.00			1/2" Ice	1.50	1.50
			0.00					15.00
Standoff Mount	A	From Leg	1.00	0.0000	83.40	No Ice	0.75	0.75
			0.00			1/2" Ice	0.95	0.95
			0.00					27.00
Standoff Mount	C	From Leg	1.00	0.0000	83.40	No Ice	0.75	0.75
			0.00			1/2" Ice	0.95	0.95
			0.00					35.41

Tower Pressures - No Ice

$$G_H = 1.690$$

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Section Elevation	z	K _Z	q _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
ft	ft		psf	ft ²		ft ²	ft ²	ft ²			
L1 160.00- 123.33	140.47	2.58	53	80.460	A	0.000	80.460	80.460	100.00	0.000	0.000
					B	0.000	80.460		100.00		
					C	0.000	80.460		100.00		
L2 123.33- 86.17	103.86	2.58	53	112.199	A	0.000	112.199	112.199	100.00	0.000	3.601
					B	0.000	112.199		100.00		
					C	0.000	112.199		100.00		
L3 86.17-37.17	60.49	2.58	53	194.385	A	0.000	194.385	194.385	100.00	0.000	7.595
					B	0.000	194.385		100.00		
					C	0.000	194.385		100.00		
L4 37.17-0.00	18.04	2.58	53	182.112	A	0.000	182.112	182.112	100.00	0.000	5.761
					B	0.000	182.112		100.00		
					C	0.000	182.112		100.00		

Tower Pressure - With Ice

$$G_H = 1.690$$

Section Elevation	z	K _Z	q _z	t _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
ft	ft		psf	in	ft ²		ft ²	ft ²	ft ²			
L1 160.00- 123.33	140.47	2.58	40	0.5000	83.516	A	0.000	83.516	83.516	100.00	0.000	0.000
						B	0.000	83.516		100.00		
						C	0.000	83.516		100.00		
L2 123.33-86.17	103.86	2.58	40	0.5000	115.296	A	0.000	115.296	115.296	100.00	0.000	5.924
						B	0.000	115.296		100.00		
						C	0.000	115.296		100.00		
L3 86.17-37.17	60.49	2.58	40	0.5000	198.469	A	0.000	198.469	198.469	100.00	0.000	12.495
						B	0.000	198.469		100.00		
						C	0.000	198.469		100.00		
L4 37.17-0.00	18.04	2.58	40	0.5000	185.210	A	0.000	185.210	185.210	100.00	0.000	9.478
						B	0.000	185.210		100.00		
						C	0.000	185.210		100.00		

Tower Pressure - Service

$$G_H = 1.690$$

Section Elevation	z	K _Z	q _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
ft	ft		psf	ft ²		ft ²	ft ²	ft ²			
L1 160.00- 123.33	140.47	2.58	17	80.460	A	0.000	80.460	80.460	100.00	0.000	0.000
					B	0.000	80.460		100.00		
					C	0.000	80.460		100.00		
L2 123.33- 86.17	103.86	2.58	17	112.199	A	0.000	112.199	112.199	100.00	0.000	3.601
					B	0.000	112.199		100.00		
					C	0.000	112.199		100.00		
L3 86.17-37.17	60.49	2.58	17	194.385	A	0.000	194.385	194.385	100.00	0.000	7.595
					B	0.000	194.385		100.00		
					C	0.000	194.385		100.00		
L4 37.17-0.00	18.04	2.58	17	182.112	A	0.000	182.112	182.112	100.00	0.000	5.761

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Section Elevation	z	K _Z	q _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
ft	ft		psf	ft ²		ft ²	ft ²	ft ²			
					B	0.000	182.112		100.00		
					C	0.000	182.112		100.00		

Tower Forces - No Ice - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	7492.89	204.33	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	10774.14	289.94	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	18788.95	383.45	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	17480.20	470.28	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	3623454.0 7 lb-ft	54536.17		

Tower Forces - No Ice - Wind 45 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	7492.89	204.33	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	10774.14	289.94	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	18788.95	383.45	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	17480.20	470.28	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	3623454.0 7 lb-ft	54536.17		

Tower Forces - No Ice - Wind 60 To Face

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	Project	Date
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	Verizon Wireless	Staff

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	7492.89	204.33	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	10774.14	289.94	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	18788.95	383.45	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	17480.20	470.28	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	3623454.0 7 lb-ft	54536.17		

Tower Forces - No Ice - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	7492.89	204.33	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	10774.14	289.94	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	18788.95	383.45	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	17480.20	470.28	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	3623454.0 7 lb-ft	54536.17		

Tower Forces - With Ice - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2913.57	A	1	1.03	1	1	1	83.516	5833.10	159.07	C
			B	1	1.03	1	1	1	83.516			
			C	1	1.03	1	1	1	83.516			
L2 123.33- 86.17	2115.44	6409.75	A	1	1.03	1	1	1	115.296	8454.41	227.51	C
			B	1	1.03	1	1	1	115.296			
			C	1	1.03	1	1	1	115.296			
L3 86.17- 37.17	3245.56	13672.47	A	1	1.03	1	1	1	198.469	14709.17	300.19	C
			B	1	1.03	1	1	1	198.469			
			C	1	1.03	1	1	1	198.469			

RISATower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	160 Ft. Valmont Monopole - Orange, CT	Page	9 of 20
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Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L4 37.17-0.00	2462.51	14482.52	A	1	1.03	1	1	1	185.210	13578.54	365.31	C
			B	1	1.03	1	1	1	185.210			
			C	1	1.03	1	1	1	185.210			
Sum Weight:	8624.80	37478.30						OTM	2832196.0 0 lb-ft	42575.21		

Tower Forces - With Ice - Wind 45 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2913.57	A	1	1.03	1	1	1	83.516	5833.10	159.07	C
			B	1	1.03	1	1	1	83.516			
			C	1	1.03	1	1	1	83.516			
L2 123.33-86.17	2115.44	6409.75	A	1	1.03	1	1	1	115.296	8454.41	227.51	C
			B	1	1.03	1	1	1	115.296			
			C	1	1.03	1	1	1	115.296			
L3 86.17-37.17	3245.56	13672.47	A	1	1.03	1	1	1	198.469	14709.17	300.19	C
			B	1	1.03	1	1	1	198.469			
			C	1	1.03	1	1	1	198.469			
L4 37.17-0.00	2462.51	14482.52	A	1	1.03	1	1	1	185.210	13578.54	365.31	C
			B	1	1.03	1	1	1	185.210			
			C	1	1.03	1	1	1	185.210			
Sum Weight:	8624.80	37478.30						OTM	2832196.0 0 lb-ft	42575.21		

Tower Forces - With Ice - Wind 60 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2913.57	A	1	1.03	1	1	1	83.516	5833.10	159.07	C
			B	1	1.03	1	1	1	83.516			
			C	1	1.03	1	1	1	83.516			
L2 123.33-86.17	2115.44	6409.75	A	1	1.03	1	1	1	115.296	8454.41	227.51	C
			B	1	1.03	1	1	1	115.296			
			C	1	1.03	1	1	1	115.296			
L3 86.17-37.17	3245.56	13672.47	A	1	1.03	1	1	1	198.469	14709.17	300.19	C
			B	1	1.03	1	1	1	198.469			
			C	1	1.03	1	1	1	198.469			
L4 37.17-0.00	2462.51	14482.52	A	1	1.03	1	1	1	185.210	13578.54	365.31	C
			B	1	1.03	1	1	1	185.210			
			C	1	1.03	1	1	1	185.210			
Sum Weight:	8624.80	37478.30						OTM	2832196.0 0 lb-ft	42575.21		

RISATower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	Page
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	Verizon Wireless	Staff

Tower Forces - With Ice - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2913.57	A	1	1.03	1	1	1	83.516	5833.10	159.07	C
			B	1	1.03	1	1	1	83.516			
			C	1	1.03	1	1	1	83.516			
L2 123.33-86.17	2115.44	6409.75	A	1	1.03	1	1	1	115.296	8454.41	227.51	C
			B	1	1.03	1	1	1	115.296			
			C	1	1.03	1	1	1	115.296			
L3 86.17-37.17	3245.56	13672.47	A	1	1.03	1	1	1	198.469	14709.17	300.19	C
			B	1	1.03	1	1	1	198.469			
			C	1	1.03	1	1	1	198.469			
L4 37.17-0.00	2462.51	14482.52	A	1	1.03	1	1	1	185.210	13578.54	365.31	C
			B	1	1.03	1	1	1	185.210			
			C	1	1.03	1	1	1	185.210			
Sum Weight:	8624.80	37478.30						OTM	2832196.0 0 lb-ft	42575.21		

Tower Forces - Service - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	2312.62	63.07	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33-86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	3325.35	89.49	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17-37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	5799.06	118.35	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	5395.12	145.15	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	1118350.0 2 lb-ft	16832.15		

Tower Forces - Service - Wind 45 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	2312.62	63.07	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33-86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	3325.35	89.49	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			

<i>RISATower</i> URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	160 Ft. Valmont Monopole - Orange, CT	Page	11 of 20
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Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L3 86.17-37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	5799.06	118.35	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	5395.12	145.15	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	1118350.0 2 lb-ft	16832.15		

Tower Forces - Service - Wind 60 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	2312.62	63.07	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33-86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	3325.35	89.49	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17-37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	5799.06	118.35	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	5395.12	145.15	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	1118350.0 2 lb-ft	16832.15		

Tower Forces - Service - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	2312.62	63.07	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33-86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	3325.35	89.49	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17-37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	5799.06	118.35	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	5395.12	145.15	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	1118350.0 2 lb-ft	16832.15		

RISATower

URS Corporation
500 Enterprise Drive, Suite 3B
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FAX: (860) 529-3991

Job

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Project

525 Orange Center Road

Date

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Client

Verizon Wireless

Designed by

Staff

Force Totals

Load Case	Vertical Forces lb	Sum of Forces X lb	Sum of Forces Z lb	Sum of Overturning Moments, M_x lb-ft	Sum of Overturning Moments, M_z lb-ft	Sum of Torques lb-ft
Leg Weight	33151.95					
Bracing Weight	0.00					
Total Member Self-Weight	33151.95					
Total Weight	51344.85			-74.16	63.84	
Wind 0 deg - No Ice		0.00	-84532.06	-7809193.16	63.84	-160.33
Wind 30 deg - No Ice		42266.03	-73206.91	-6762969.59	-3904495.66	-353.76
Wind 45 deg - No Ice		59773.19	-59773.19	-5521955.16	-5521817.16	-417.30
Wind 60 deg - No Ice		73206.91	-42266.03	-3904633.66	-6762831.60	-452.40
Wind 90 deg - No Ice		84532.06	0.00	-74.16	-7809055.16	-429.82
Wind 120 deg - No Ice		73206.91	42266.03	3904485.34	-6762831.60	-292.07
Wind 135 deg - No Ice		59773.19	59773.19	5521806.84	-5521817.16	-190.56
Wind 150 deg - No Ice		42266.03	73206.91	6762821.28	-3904495.66	-76.06
Wind 180 deg - No Ice		0.00	84532.06	7809044.84	63.84	160.33
Wind 210 deg - No Ice		-42266.03	73206.91	6762821.28	3904623.34	353.76
Wind 225 deg - No Ice		-59773.19	59773.19	5521806.84	5521944.84	417.30
Wind 240 deg - No Ice		-73206.91	42266.03	3904485.34	6762959.27	452.40
Wind 270 deg - No Ice		-84532.06	0.00	-74.16	7809182.84	429.82
Wind 300 deg - No Ice		-73206.91	-42266.03	-3904633.66	6762959.27	292.07
Wind 315 deg - No Ice		-59773.19	-59773.19	-5521955.16	5521944.84	190.56
Wind 330 deg - No Ice		-42266.03	-73206.91	-6762969.59	3904623.34	76.06
Member Ice	4326.35					
Total Weight Ice	63846.96			-104.28	83.71	
Wind 0 deg - Ice		0.00	-68791.55	-6489708.01	83.71	-151.87
Wind 30 deg - Ice		34395.77	-59575.23	-5620265.97	-3244718.15	-365.07
Wind 45 deg - Ice		48642.97	-48642.97	-4588947.09	-4588759.09	-437.67
Wind 60 deg - Ice		59575.23	-34395.77	-3244906.15	-5620077.97	-480.45
Wind 90 deg - Ice		68791.55	0.00	-104.28	-6489520.01	-467.10
Wind 120 deg - Ice		59575.23	34395.77	3244697.58	-5620077.97	-328.58
Wind 135 deg - Ice		48642.97	48642.97	4588738.52	-4588759.09	-222.90
Wind 150 deg - Ice		34395.77	59575.23	5620057.40	-3244718.15	-102.03
Wind 180 deg - Ice		0.00	68791.55	6489499.44	83.71	151.87
Wind 210 deg - Ice		-34395.77	59575.23	5620057.40	3244885.58	365.07
Wind 225 deg - Ice		-48642.97	48642.97	4588738.52	4588926.51	437.67
Wind 240 deg - Ice		-59575.23	34395.77	3244697.58	5620245.40	480.45
Wind 270 deg - Ice		-68791.55	0.00	-104.28	6489687.44	467.10
Wind 300 deg - Ice		-59575.23	-34395.77	-3244906.15	5620245.40	328.58
Wind 315 deg - Ice		-48642.97	-48642.97	-4588947.09	4588926.51	222.90
Wind 330 deg - Ice		-34395.77	-59575.23	-5620265.97	3244885.58	102.03
Total Weight	51344.85			-74.16	63.84	
Wind 0 deg - Service		0.00	-26090.14	-2410296.07	63.84	-49.48
Wind 30 deg - Service		13045.07	-22594.72	-2087387.56	-1205047.12	-109.19
Wind 45 deg - Service		18448.52	-18448.52	-1704358.42	-1704220.42	-128.80
Wind 60 deg - Service		22594.72	-13045.07	-1205185.12	-2087249.57	-139.63
Wind 90 deg - Service		26090.14	0.00	-74.16	-2410158.07	-132.66
Wind 120 deg - Service		22594.72	13045.07	1205036.80	-2087249.57	-90.15
Wind 135 deg - Service		18448.52	18448.52	1704210.10	-1704220.42	-58.82
Wind 150 deg - Service		13045.07	22594.72	2087239.25	-1205047.12	-23.48
Wind 180 deg - Service		0.00	26090.14	2410147.75	63.84	49.48
Wind 210 deg - Service		-13045.07	22594.72	2087239.25	1205174.80	109.19
Wind 225 deg - Service		-18448.52	18448.52	1704210.10	1704348.10	128.80
Wind 240 deg - Service		-22594.72	13045.07	1205036.80	2087377.24	139.63
Wind 270 deg - Service		-26090.14	0.00	-74.16	2410285.75	132.66
Wind 300 deg - Service		-22594.72	-13045.07	-1205185.12	2087377.24	90.15
Wind 315 deg - Service		-18448.52	-18448.52	-1704358.42	1704348.10	58.82

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Load Case	Vertical Forces	Sum of Forces X lb	Sum of Forces Z lb	Sum of Overturning Moments, M_x lb-ft	Sum of Overturning Moments, M_z lb-ft	Sum of Torques lb-ft
Wind 330 deg - Service		-13045.07	-22594.72	-2087387.56	1205174.80	23.48

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
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

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Comb. No.	Description
50	Dead+Wind 330 deg - Service

Maximum Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Force lb	Major Axis Moment lb-ft	Minor Axis Moment lb-ft
L1	160 - 123.33	Pole	Max Tension	17	34.14	17653.38	30576.41
			Max. Compression	18	-14302.60	0.00	0.00
			Max. Mx	14	-6414.00	584814.98	5.25
			Max. My	2	-6413.99	2.05	584815.00
			Max. Vy	14	-28489.09	584814.98	5.25
			Max. Vx	2	-28489.10	2.05	584815.00
L2	123.33 - 86.17	Pole	Max. Torque	30			0.10
			Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-28530.99	0.00	0.00
			Max. Mx	14	-16749.70	1985744.93	17.94
			Max. My	2	-16749.69	7.08	1985745.02
			Max. Vy	14	-47590.19	1985744.93	17.94
L3	86.17 - 37.17	Pole	Max. Vx	2	-47590.19	7.08	1985745.02
			Max. Torque	13			0.72
			Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-44304.60	83.71	104.28
			Max. Mx	14	-31799.55	4650199.19	73.93
			Max. My	2	-31799.54	64.64	4650209.71
L4	37.17 - 0	Pole	Max. Vy	14	-65071.17	4650199.19	73.93
			Max. Vx	2	-65071.17	64.64	4650209.71
			Max. Torque	22			479.31
			Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-63846.96	83.71	104.28
			Max. Mx	14	-51278.23	7969979.84	74.76
			Max. My	2	-51278.23	65.13	7969990.41
			Max. Vy	14	-84572.49	7969979.84	74.76
			Max. Vx	2	-84572.49	65.13	7969990.41
			Max. Torque	22			477.99

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical lb	Horizontal, X lb	Horizontal, Z lb
Pole	Max. Vert	31	63846.96	68791.56	-0.00
	Max. H _x	14	51344.85	84532.06	0.00
	Max. H _z	2	51344.85	0.00	84532.06
	Max. M _x	2	7969990.41	0.00	84532.06
	Max. M _z	6	7969849.10	-84532.06	0.00
	Max. Torsion	22	477.63	-59575.23	34395.78
	Min. Vert	1	51344.85	0.00	0.00
	Min. H _x	6	51344.85	-84532.06	0.00
	Min. H _z	10	51344.85	0.00	-84532.06
	Min. M _x	10	-7969838.53	0.00	-84532.06
	Min. M _z	14	-7969979.84	84532.06	0.00
	Min. Torsion	30	-477.51	59575.23	-34395.78

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Tower Mast Reaction Summary

Load Combination	Vertical lb	Shear _x lb	Shear _z lb	Overturning Moment, M _x lb-ft	Overturning Moment, M _z lb-ft	Torque lb-ft
Dead Only	51344.85	0.00	0.00	-74.16	63.84	0.00
Dead+Wind 0 deg - No Ice	51344.85	-0.00	-84532.06	-7969990.41	65.09	-159.07
Dead+Wind 30 deg - No Ice	51344.85	42266.03	-73206.91	-6902225.80	-3984893.73	-350.76
Dead+Wind 45 deg - No Ice	51344.85	59773.19	-59773.19	-5635657.29	-5635517.53	-413.75
Dead+Wind 60 deg - No Ice	51344.85	73206.91	-42266.03	-3985033.21	-6902085.55	-448.54
Dead+Wind 90 deg - No Ice	51344.85	84532.06	-0.00	-74.66	-7969849.10	-426.07
Dead+Wind 120 deg - No Ice	51344.85	73206.91	42266.03	3984883.24	-6902084.44	-289.42
Dead+Wind 135 deg - No Ice	51344.85	59773.19	59773.19	5635506.69	-5635516.26	-188.80
Dead+Wind 150 deg - No Ice	51344.85	42266.03	73206.91	6902074.56	-3984892.63	-75.30
Dead+Wind 180 deg - No Ice	51344.85	-0.00	84532.06	7969838.53	65.09	159.07
Dead+Wind 210 deg - No Ice	51344.85	-42266.03	73206.91	6902074.80	3985022.96	350.82
Dead+Wind 225 deg - No Ice	51344.85	-59773.19	59773.19	5635506.96	5635646.72	413.75
Dead+Wind 240 deg - No Ice	51344.85	-73206.91	42266.03	3984883.48	6902215.05	448.49
Dead+Wind 270 deg - No Ice	51344.85	-84532.06	-0.00	-74.66	7969979.84	426.07
Dead+Wind 300 deg - No Ice	51344.85	-73206.91	-42266.03	-3985033.45	6902216.15	289.48
Dead+Wind 315 deg - No Ice	51344.85	-59773.19	-59773.19	-5635657.57	5635648.00	188.80
Dead+Wind 330 deg - No Ice	51344.85	-42266.03	-73206.91	-6902226.04	3985024.06	75.25
Dead+Ice+Temp	63846.96	0.00	0.00	-104.28	83.71	0.00
Dead+Wind 0 deg+Ice+Temp	63846.96	0.00	-68791.56	-6686108.58	86.55	-151.09
Dead+Wind 30 deg+Ice+Temp	63846.96	34395.78	-59575.23	-5790353.81	-3342914.34	-362.90
Dead+Wind 45 deg+Ice+Temp	63846.96	48642.97	-48642.97	-4727823.40	-4727630.35	-435.09
Dead+Wind 60 deg+Ice+Temp	63846.96	59575.23	-34395.78	-3343106.99	-5790160.07	-477.63
Dead+Wind 90 deg+Ice+Temp	63846.96	68791.56	0.00	-106.49	-6685913.34	-464.21
Dead+Wind 120 deg+Ice+Temp	63846.96	59575.23	34395.78	3342893.09	-5790158.50	-326.41
Dead+Wind 135 deg+Ice+Temp	63846.96	48642.97	48642.97	4727608.61	-4727628.55	-221.41
Dead+Wind 150 deg+Ice+Temp	63846.96	34395.78	59575.23	5790138.11	-3342912.78	-101.32
Dead+Wind 180 deg+Ice+Temp	63846.96	0.00	68791.56	6685891.98	86.55	151.09
Dead+Wind 210 deg+Ice+Temp	63846.96	-34395.78	59575.23	5790138.44	3343086.07	363.02
Dead+Wind 225 deg+Ice+Temp	63846.96	-48642.97	48642.97	4727608.99	4727802.04	435.09
Dead+Wind 240 deg+Ice+Temp	63846.96	-59575.23	34395.78	3342893.43	5790332.18	477.51
Dead+Wind 270 deg+Ice+Temp	63846.96	-68791.56	0.00	-106.49	6686087.22	464.21
Dead+Wind 300 deg+Ice+Temp	63846.96	-59575.23	-34395.78	-3343107.32	5790333.75	326.53
Dead+Wind 315 deg+Ice+Temp	63846.96	-48642.97	-48642.97	-4727823.78	4727803.84	221.41
Dead+Wind 330 deg+Ice+Temp	63846.96	-34395.78	-59575.23	-5790354.14	3343087.64	101.20
Dead+Wind 0 deg - Service	51344.85	-0.00	-26090.14	-2464347.52	65.81	-49.52
Dead+Wind 30 deg - Service	51344.85	13045.07	-22594.73	-2134197.77	-1232069.79	-109.19
Dead+Wind 45 deg - Service	51344.85	18448.52	-18448.52	-1742579.19	-1742437.03	-128.80
Dead+Wind 60 deg - Service	51344.85	22594.73	-13045.07	-1232211.92	-2134055.57	-139.63
Dead+Wind 90 deg - Service	51344.85	26090.14	-0.00	-76.35	-2464205.21	-132.63
Dead+Wind 120 deg - Service	51344.85	22594.73	13045.07	1232059.15	-2134055.46	-90.09
Dead+Wind 135 deg - Service	51344.85	18448.52	18448.52	1742426.36	-1742436.91	-58.77
Dead+Wind 150 deg - Service	51344.85	13045.07	22594.73	2134044.88	-1232069.68	-23.44
Dead+Wind 180 deg - Service	51344.85	-0.00	26090.14	2464194.57	65.81	49.52
Dead+Wind 210 deg - Service	51344.85	-13045.07	22594.73	2134044.91	1232201.31	109.21
Dead+Wind 225 deg - Service	51344.85	-18448.52	18448.52	1742426.39	1742568.55	128.80
Dead+Wind 240 deg - Service	51344.85	-22594.73	13045.07	1232059.18	2134187.11	139.61
Dead+Wind 270 deg - Service	51344.85	-26090.14	-0.00	-76.35	2464336.87	132.63
Dead+Wind 300 deg - Service	51344.85	-22594.73	-13045.07	-1232211.94	2134187.22	90.12
Dead+Wind 315 deg - Service	51344.85	-18448.52	-18448.52	-1742579.22	1742568.67	58.77
Dead+Wind 330 deg - Service	51344.85	-13045.07	-22594.73	-2134197.79	1232201.41	23.42

Solution Summary

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Load Comb.	Sum of Applied Forces			Sum of Reactions			% Error
	PX lb	PY lb	PZ lb	PX lb	PY lb	PZ lb	
1	0.00	-51344.85	0.00	0.00	51344.85	0.00	0.000%
2	0.00	-51344.85	-84532.06	0.00	51344.85	84532.06	0.000%
3	42266.03	-51344.85	-73206.91	-42266.03	51344.85	73206.91	0.000%
4	59773.19	-51344.85	-59773.19	-59773.19	51344.85	59773.19	0.000%
5	73206.91	-51344.85	-42266.03	-73206.91	51344.85	42266.03	0.000%
6	84532.06	-51344.85	0.00	-84532.06	51344.85	0.00	0.000%
7	73206.91	-51344.85	42266.03	-73206.91	51344.85	-42266.03	0.000%
8	59773.19	-51344.85	59773.19	-59773.19	51344.85	-59773.19	0.000%
9	42266.03	-51344.85	73206.91	-42266.03	51344.85	-73206.91	0.000%
10	0.00	-51344.85	84532.06	0.00	51344.85	-84532.06	0.000%
11	-42266.03	-51344.85	73206.91	42266.03	51344.85	-73206.91	0.000%
12	-59773.19	-51344.85	59773.19	59773.19	51344.85	-59773.19	0.000%
13	-73206.91	-51344.85	42266.03	73206.91	51344.85	-42266.03	0.000%
14	-84532.06	-51344.85	0.00	84532.06	51344.85	0.00	0.000%
15	-73206.91	-51344.85	-42266.03	73206.91	51344.85	42266.03	0.000%
16	-59773.19	-51344.85	-59773.19	59773.19	51344.85	59773.19	0.000%
17	-42266.03	-51344.85	-73206.91	42266.03	51344.85	73206.91	0.000%
18	0.00	-63846.96	0.00	0.00	63846.96	0.00	0.000%
19	0.00	-63846.96	-68791.55	-0.00	63846.96	68791.56	0.000%
20	34395.77	-63846.96	-59575.23	-34395.78	63846.96	59575.23	0.000%
21	48642.97	-63846.96	-48642.97	-48642.97	63846.96	48642.97	0.000%
22	59575.23	-63846.96	-34395.77	-59575.23	63846.96	34395.78	0.000%
23	68791.55	-63846.96	0.00	-68791.56	63846.96	-0.00	0.000%
24	59575.23	-63846.96	34395.77	-59575.23	63846.96	-34395.78	0.000%
25	48642.97	-63846.96	48642.97	-48642.97	63846.96	-48642.97	0.000%
26	34395.77	-63846.96	59575.23	-34395.78	63846.96	-59575.23	0.000%
27	0.00	-63846.96	68791.55	-0.00	63846.96	-68791.56	0.000%
28	-34395.77	-63846.96	59575.23	34395.78	63846.96	-59575.23	0.000%
29	-48642.97	-63846.96	48642.97	48642.97	63846.96	-48642.97	0.000%
30	-59575.23	-63846.96	34395.77	59575.23	63846.96	-34395.78	0.000%
31	-68791.55	-63846.96	0.00	68791.56	63846.96	-0.00	0.000%
32	-59575.23	-63846.96	-34395.77	59575.23	63846.96	34395.78	0.000%
33	-48642.97	-63846.96	-48642.97	48642.97	63846.96	48642.97	0.000%
34	-34395.77	-63846.96	-59575.23	34395.78	63846.96	59575.23	0.000%
35	0.00	-51344.85	-26090.14	0.00	51344.85	26090.14	0.000%
36	13045.07	-51344.85	-22594.72	-13045.07	51344.85	22594.73	0.000%
37	18448.52	-51344.85	-18448.52	-18448.52	51344.85	18448.52	0.000%
38	22594.72	-51344.85	-13045.07	-22594.73	51344.85	13045.07	0.000%
39	26090.14	-51344.85	0.00	-26090.14	51344.85	0.00	0.000%
40	22594.72	-51344.85	13045.07	-22594.73	51344.85	-13045.07	0.000%
41	18448.52	-51344.85	18448.52	-18448.52	51344.85	-18448.52	0.000%
42	13045.07	-51344.85	22594.72	-13045.07	51344.85	-22594.73	0.000%
43	0.00	-51344.85	26090.14	0.00	51344.85	-26090.14	0.000%
44	-13045.07	-51344.85	22594.72	13045.07	51344.85	-22594.73	0.000%
45	-18448.52	-51344.85	18448.52	18448.52	51344.85	-18448.52	0.000%
46	-22594.72	-51344.85	13045.07	22594.73	51344.85	-13045.07	0.000%
47	-26090.14	-51344.85	0.00	26090.14	51344.85	0.00	0.000%
48	-22594.72	-51344.85	-13045.07	22594.73	51344.85	13045.07	0.000%
49	-18448.52	-51344.85	-18448.52	18448.52	51344.85	18448.52	0.000%
50	-13045.07	-51344.85	-22594.72	13045.07	51344.85	22594.73	0.000%

Non-Linear Convergence Results

Load Combination	Converged?	Number of Cycles	Displacement Tolerance	Force Tolerance
1	Yes	4	0.00000001	0.00000001

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2	Yes	4	0.00000001	0.00004349
3	Yes	5	0.00000001	0.00020760
4	Yes	5	0.00000001	0.00020552
5	Yes	5	0.00000001	0.00020845
6	Yes	4	0.00000001	0.00005085
7	Yes	5	0.00000001	0.00020766
8	Yes	5	0.00000001	0.00020551
9	Yes	5	0.00000001	0.00020804
10	Yes	4	0.00000001	0.00004349
11	Yes	5	0.00000001	0.00020834
12	Yes	5	0.00000001	0.00020552
13	Yes	5	0.00000001	0.00020749
14	Yes	4	0.00000001	0.00005085
15	Yes	5	0.00000001	0.00020828
16	Yes	5	0.00000001	0.00020552
17	Yes	5	0.00000001	0.00020789
18	Yes	4	0.00000001	0.00000001
19	Yes	5	0.00000001	0.00009913
20	Yes	5	0.00000001	0.00064039
21	Yes	5	0.00000001	0.00070405
22	Yes	5	0.00000001	0.00064243
23	Yes	5	0.00000001	0.00009915
24	Yes	5	0.00000001	0.00064044
25	Yes	5	0.00000001	0.00070401
26	Yes	5	0.00000001	0.00064147
27	Yes	5	0.00000001	0.00009913
28	Yes	5	0.00000001	0.00064215
29	Yes	5	0.00000001	0.00070405
30	Yes	5	0.00000001	0.00064011
31	Yes	5	0.00000001	0.00009916
32	Yes	5	0.00000001	0.00064210
33	Yes	5	0.00000001	0.00070408
34	Yes	5	0.00000001	0.00064106
35	Yes	4	0.00000001	0.00003354
36	Yes	4	0.00000001	0.00085711
37	Yes	4	0.00000001	0.00098765
38	Yes	4	0.00000001	0.00086279
39	Yes	4	0.00000001	0.00003409
40	Yes	4	0.00000001	0.00085740
41	Yes	4	0.00000001	0.00098747
42	Yes	4	0.00000001	0.00085996
43	Yes	4	0.00000001	0.00003354
44	Yes	4	0.00000001	0.00086207
45	Yes	4	0.00000001	0.00098763
46	Yes	4	0.00000001	0.00085640
47	Yes	4	0.00000001	0.00003409
48	Yes	4	0.00000001	0.00086177
49	Yes	4	0.00000001	0.00098778
50	Yes	4	0.00000001	0.00085919

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	160 - 123.33	40.798	35	2.3723	0.0002
L2	128 - 86.17	25.859	35	1.9813	0.0002
L3	92 - 37.17	13.023	35	1.3649	0.0002
L4	44.5 - 0	3.019	50	0.6127	0.0001

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Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
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Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
167.00	(3) DB844H90E-XY	35	40.798	2.3723	0.0002	19287
163.00	(4) 8"x2 1/2" Pipe Mount	35	40.798	2.3723	0.0002	19287
155.20	DB844H90-XY	35	38.458	2.3187	0.0002	19287
145.70	(3) DUO1417-8686	35	33.879	2.2098	0.0002	6743
143.70	Valmont 13' Platform w/Rails	35	32.932	2.1860	0.0002	5915
134.10	(2) DB980H90E-M	35	28.517	2.0654	0.0002	3722
131.80	Valmont 13' Platform w/Rails	35	27.499	2.0345	0.0002	3420
121.90	(2) RR90-17-02DP	35	23.345	1.8902	0.0002	3102
119.90	Valmont 13' Platform w/Rails	35	22.552	1.8589	0.0002	3133
109.40	(4) 7184.14	35	18.638	1.6839	0.0002	3306
108.00	Valmont 13' Platform w/Rails	35	18.146	1.6594	0.0002	3330
83.40	GPS	35	10.626	1.1999	0.0002	3540

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	160 - 123.33	131.529	2	7.6531	0.0006
L2	128 - 86.17	83.445	2	6.3944	0.0006
L3	92 - 37.17	42.064	2	4.4082	0.0006
L4	44.5 - 0	9.759	2	1.9805	0.0002

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
167.00	(3) DB844H90E-XY	2	131.529	7.6531	0.0006	6168
163.00	(4) 8"x2 1/2" Pipe Mount	2	131.529	7.6531	0.0006	6168
155.20	DB844H90-XY	2	123.997	7.4826	0.0006	6168
145.70	(3) DUO1417-8686	2	109.262	7.1353	0.0006	2154
143.70	Valmont 13' Platform w/Rails	2	106.214	7.0590	0.0006	1889
134.10	(2) DB980H90E-M	2	92.003	6.6692	0.0006	1186
131.80	Valmont 13' Platform w/Rails	2	88.726	6.5685	0.0006	1089
121.90	(2) RR90-17-02DP	2	75.345	6.0942	0.0006	984
119.90	Valmont 13' Platform w/Rails	2	72.791	5.9907	0.0006	993
109.40	(4) 7184.14	2	60.174	5.4166	0.0006	1043
108.00	Valmont 13' Platform w/Rails	2	58.591	5.3371	0.0006	1051
83.40	GPS	2	34.329	3.9145	0.0005	1107

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Compression Checks

Pole Design Data

Section No.	Elevation ft	Size	L ft	L _u ft	Kl/r	F _a ksi	A in ²	Actual P lb	Allow. P _a lb	Ratio $\frac{P}{P_a}$
L1	160 - 123.33 (1)	TP31.46x21.2x0.219	36.67	160.00	179.2	4.652	21.1091	-6414.03	98203.10	0.065
L2	123.33 - 86.17 (2)	TP41.44x29.7154x0.344	41.83	160.00	135.9	8.085	43.7112	-16749.60	353397.00	0.047
L3	86.17 - 37.17 (3)	H1-3+VT (1.50 CR) - 2 TP54.46x39.1179x0.438	54.83	160.00	103.2	14.023	73.2978	-31799.50	1027840.00	0.031
L4	37.17 - 0 (4)	H1-3+VT (1.57 CR) - 3 TP64x51.533x0.469 H1-3+VT (1.78 CR) - 4	44.50	160.00	84.4	20.231	95.9432	-51278.20	1940990.00	0.026

Pole Bending Design Data

Section No.	Elevation ft	Size	Actual M _x lb-ft	Actual f _{bx} ksi	Allow. F _{bx} ksi	Ratio $\frac{f_{bx}}{F_{bx}}$	Actual M _y lb-ft	Actual f _{by} ksi	Allow. F _{by} ksi	Ratio $\frac{f_{by}}{F_{by}}$
L1	160 - 123.33 (1)	TP31.46x21.2x0.219	584815.00	45.401	36.424	1.246	0.00	0.000	36.424	0.000
L2	123.33 - 86.17 (2)	TP41.44x29.7154x0.344	1985750.00	56.552	39.000	1.450	0.00	0.000	39.000	0.000
L3	86.17 - 37.17 (3)	TP54.46x39.1179x0.438	4650233.33	59.950	39.000	1.537	0.00	0.000	39.000	0.000
L4	37.17 - 0 (4)	TP64x51.533x0.469	7970016.67	64.147	36.617	1.752	0.00	0.000	36.617	0.000

Pole Shear Design Data

Section No.	Elevation ft	Size	Actual V lb	Actual f _v ksi	Allow. F _v ksi	Ratio $\frac{f_v}{F_v}$	Actual T lb-ft	Actual f _{vt} ksi	Allow. F _{vt} ksi	Ratio $\frac{f_{vt}}{F_{vt}}$
L1	160 - 123.33 (1)	TP31.46x21.2x0.219	28489.30	1.350	26.000	0.105	0.02	0.000	26.000	0.000
L2	123.33 - 86.17 (2)	TP41.44x29.7154x0.344	47590.50	1.089	26.000	0.085	0.28	0.000	26.000	0.000
L3	86.17 - 37.17 (3)	TP54.46x39.1179x0.438	65071.20	0.888	26.000	0.069	189.07	0.001	26.000	0.000
L4	37.17 - 0 (4)	TP64x51.533x0.469	84572.50	0.881	26.000	0.069	188.80	0.001	26.000	0.000

Pole Interaction Design Data

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Section No.	Elevation ft	Ratio P P_a	Ratio f_{bx} F_{bx}	Ratio f_{by} F_{by}	Ratio f_v F_v	Ratio f_{vt} F_{vt}	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	160 - 123.33 (1)	0.065	1.246	0.000	0.105	0.000	1.314 ✓	1.333	H1-3+VT ✓
L2	123.33 - 86.17 (2)	0.047	1.450	0.000	0.085	0.000	1.499 ✗	1.333	H1-3+VT ✗
L3	86.17 - 37.17 (3)	0.031	1.537	0.000	0.069	0.000	1.569 ✗	1.333	H1-3+VT ✗
L4	37.17 - 0 (4)	0.026	1.752	0.000	0.069	0.000	1.779 ✗	1.333	H1-3+VT ✗

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P lb	SF* P_{allow} lb	% Capacity	Pass Fail
L1	160 - 123.33	Pole	TP31.46x21.2x0.219	1	-6414.03	130904.73	98.6	Pass
L2	123.33 - 86.17	Pole	TP41.44x29.7154x0.344	2	-16749.60	471078.18	112.5	Fail ✗
L3	86.17 - 37.17	Pole	TP54.46x39.1179x0.438	3	-31799.50	1370110.66	117.7	Fail ✗
L4	37.17 - 0	Pole	TP64x51.533x0.469	4	-51278.20	2587339.56	133.5	Fail ✗
							Summary	
							Pole (L4)	133.5 Fail ✗
							RATING =	133.5 Fail ✗

ANCHOR BOLT AND BASE PLATE ANALYSIS

ANCHOR BOLT AND BASE PLATE ANALYSIS

Input Data

Tower Reactions:

Overturning Moment:	OM := 7970·ft·kips	<i>user input</i>
Shear Force:	Shear := 84.5·kips	<i>user input</i>
Axial Force:	Axial := 51.4·kips	<i>user input</i>

Anchor Bolt Data:

Use ASTM A615 Grade 75

Number of Anchor Bolts = N	$N := 24$	<i>user input</i>
Diameter of Bolt Circle:	$D_{bc} := 72.76\text{in}$	<i>user input</i>
Bolt "Column" Distance:	$l_w := 3\text{in}$	<i>user input</i>
Bolt Ultimate Strength:	$F_u := 100\text{-ksi}$	<i>user input</i>
Bolt Yield Strength:	$F_y := 75\text{-ksi}$	<i>user input</i>
Bolt Modulus:	$E := 29000\text{-ksi}$	<i>user input</i>
Thickness Of Anchor Bolts	$D := 2.25\text{in}$	<i>user input</i>
Threads per Inch:	$n := 4.5$	<i>user input</i>

Base Plate Data:

Plate Yield Strength:	$F_{y_{bp}} := 60\text{-ksi}$	<i>user input</i>
Base Plate Thickness:	PlateThickness := 3·in	<i>user input</i>
Base Plate Diameter:	$D_{bp} := 78.76\text{-in}$	<i>user input</i>
Outer Pole Diameter:	$D_{pole} := 64\text{in}$	<i>user input</i>

Geometric Layout Data:

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

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

Distance to Bolts: $i := 1..N$

$$d_i := \begin{cases} \theta \leftarrow 2 \cdot \pi \cdot \left(\frac{i}{N} \right) \\ d \leftarrow R_{bc} \cdot \sin(\theta) \end{cases}$$

$d_1 = 9.42 \text{ in}$	$d_7 = 35.14 \text{ in}$
$d_2 = 18.19 \text{ in}$	$d_8 = 31.51 \text{ in}$
$d_3 = 25.72 \text{ in}$	$d_9 = 25.72 \text{ in}$
$d_4 = 31.51 \text{ in}$	$d_{10} = 18.19 \text{ in}$
$d_5 = 35.14 \text{ in}$	$d_{11} = 9.42 \text{ in}$
$d_6 = 36.38 \text{ in}$	etc.

Critical Distances For Bending in Plate:

Outer Pole Radius: $R_{pole} := \frac{D_{pole}}{2}$ $R_{pole} = 32.00 \text{ in}$

Moment Arms of Bolts about Neutral Axis: $MA_i := \text{if}(d_i \geq R_{pole}, d_i - R_{pole}, 0 \text{ in})$

$MA_1 = 0.00 \text{ in}$	$MA_7 = 3.14 \text{ in}$
$MA_2 = 0.00 \text{ in}$	$MA_8 = 0.00 \text{ in}$
$MA_3 = 0.00 \text{ in}$	$MA_9 = 0.00 \text{ in}$
$MA_4 = 0.00 \text{ in}$	$MA_{10} = 0.00 \text{ in}$
$MA_5 = 3.14 \text{ in}$	$MA_{11} = 0.00 \text{ in}$
$MA_6 = 4.38 \text{ in}$	etc.

Effective Width of Baseplate for Bending: $\text{EffectiveWidth} := .90 \cdot 2 \cdot \sqrt{\left(\frac{D_{bp}}{2} \right)^2 - \left(\frac{D_{pole}}{2} \right)^2}$ $\text{EffectiveWidth} = 41.31 \text{ in}$

Job 160' Monopole - Orange, CT
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Anchor Bolt Analysis:

Polar Moment of Inertia I_p :

$$I_p := \sum_i (d_i)^2 \quad I_p = 1.588 \times 10^4 \text{ in}^2$$

Gross Area of Bolt:

$$A_g := \frac{\pi}{4} \cdot D^2 \quad A_g = 3.976 \text{ in}^2$$

Net Area of Bolt:

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

Net Diameter:

$$D_n := \frac{2 \cdot \sqrt{A_n}}{\sqrt{\pi}} \quad D_n = 2.03 \text{ in}$$

Radius of Gyration of Bolt:

$$r := \frac{D_n}{4} \quad r = 0.51 \text{ in}$$

Section Modulus of Bolt:

$$S_x := \frac{\pi \cdot D_n^3}{32} \quad S_x = 0.826 \text{ in}^3$$

Anchor Bolt Bending Stress:

Maximum Applied Bending:

$$M_x := \left(\frac{\text{Shear}}{N} \right) \cdot l \quad M_x = 0.880 \text{ ft-kips}$$

$$f_{bx} := \frac{M_x}{S_x} \quad f_{bx} = 12.8 \text{ ksi}$$

Allowable Bending

$$F_{bx} := 1.33 \cdot 0.60 \cdot F_y \quad F_{bx} = 59.9 \text{ ksi}$$

Note: 1.33 increase allowed per TIA/EIA

Check Tensile Forces:

Allowable Tensile Force:

$$\text{AllowableTension} := 1.33 \cdot (0.33 \cdot A_g \cdot F_u) \quad \text{AllowableTension} = 174.5 \text{ kips}$$

Note: 1.33 increase allowed per TIA/EIA

Maximum Tensile Force (Net Area):

$$F_{\text{net.area}} := 1.33 \cdot (0.60 \cdot A_n \cdot F_y) \quad F_{\text{net.area}} = 194.4 \text{ kips}$$

Note: 1.33 increase allowed per TIA/EIA

Applied Tension:

$$\text{MaxTension} := \frac{OM \cdot R_{bc}}{I_p} - \frac{\text{Axial}}{N} \quad \text{MaxTension} = 216.9 \text{ kips}$$

Check Stresses:

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

$$\frac{\text{MaxTension}}{F_{\text{net.area}}} = 1.12$$

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

Condition = "Overstressed"

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:

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

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

Allowable Compressive Force:

$$K := 0.65$$

$$C_c := \sqrt{\frac{2 \cdot \pi^2 \cdot E}{F_y}} \quad C_c = 87.36$$

$$F_a := \begin{cases} \frac{\left[1 - \frac{\left(\frac{K \cdot l}{r} \right)^2}{2 \cdot C_c^2} \right] \cdot F_y}{\frac{5}{3} + \frac{3 \cdot \left(\frac{K \cdot l}{r} \right)}{8 \cdot C_c} - \frac{\left(\frac{K \cdot l}{r} \right)^3}{8 \cdot C_c^3}} & \text{if } \frac{K \cdot l}{r} \leq C_c \\ \frac{12 \cdot \pi^2 \cdot E}{23 \cdot \left(\frac{K \cdot l}{r} \right)^2} & \text{if } \frac{K \cdot l}{r} > C_c \end{cases} \quad F_a = 45.0 \text{ ksi}$$

$$F_a := 1.33 \cdot F_a \quad \text{Note: 1.33 increase allowed per TIA/EIA} \quad F_a = 59.9 \text{ ksi}$$

Applied Compressive Force:

$$\text{MaxCompression} := \frac{OM \cdot R_{bc}}{I_p} + \frac{\text{Axial}}{N} \quad \text{MaxCompression} = 221.2 \text{ kips}$$

$$f_a := \frac{\text{MaxCompression}}{A_n} \quad f_a = 68.1 \text{ ksi}$$

Check Combined Stresses:

$$\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} = 1.14$$

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

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Base Plate Analysis:

Force from Bolt(s):

$$C_i := \frac{OM \cdot d_i}{I_p} + \frac{Axial}{N}$$

$$C_1 = 58.8 \text{ kips}$$

$$C_7 = 213.8 \text{ kips}$$

$$C_2 = 111.7 \text{ kips}$$

$$C_8 = 191.9 \text{ kips}$$

$$C_3 = 157.1 \text{ kips}$$

$$C_9 = 157.1 \text{ kips}$$

$$C_4 = 191.9 \text{ kips}$$

$$C_{10} = 111.7 \text{ kips}$$

$$C_5 = 213.8 \text{ kips}$$

$$C_{11} = 58.8 \text{ kips}$$

$$C_6 = 221.2 \text{ kips}$$

etc.

Bending Stress in Plate:

$$f_{bp} := \sum_i \frac{6 \cdot C_i \cdot MA_i}{\text{EffectiveWidth} \cdot \text{PlateThickness}^2}$$

$$f_{bp} = 37.3 \text{ ksi}$$

Check Stresses:

$$\frac{f_{bp}}{1.33 \cdot 0.75 F_{y_{bp}}} = 0.62$$

$$\text{Condition} := \text{if} \left(\frac{f_{bp}}{1.33 \cdot 0.75 F_{y_{bp}}} < 1.00, \text{"OK"}, \text{"Overstressed"} \right)$$

Condition = "OK"

FOUNDATION ANALYSIS

MONOPOLE FOUNDATION ANALYSIS

TOWER FORCES:

Moment Caused by Tower	$M_t := 7970 \cdot \text{ft} \cdot \text{kips}$
Shear at Base of Tower	$S_t := 84.5 \text{ kip}$
Max Compressive Force	$C_t := 51.4 \cdot \text{kip}$
Height of Tower	$H_t := 160 \cdot \text{ft}$
Base Plate Bolt Circle	$MP := 6.06 \text{ ft}$

FOOTING DIMENSIONS:

Overall Depth of Footing	$D_f := 14.0 \text{ ft}$
Length of Pier	$L_p := 10 \cdot \text{ft}$
Extension of Pier Above Grade	$L_{pag} := .5 \cdot \text{ft}$
Diameter of Pier	$d_p := 8 \cdot \text{ft}$
Thickness of Footing	$T_f := 4.0 \cdot \text{ft}$
Width of Footing:	$W_f := 22 \text{ ft}$
Length of Anchor Bolts:	$L_{st} := 132 \text{ in}$
Projection of anchor bolts above pier	$A_{BP} := 10 \cdot \text{in}$
Anchor bolts area	$A_{anchor} := 3.97 \cdot \text{in}^2$

PIER REINFORCEMENT:

Bar Size	$BS_{pier} := 11$	Bar Diameter	$d_{bpier} := 1.41 \cdot \text{in}$
Number of Bars	$NB_{pier} := 31$	Bar Area	$A_{bpier} := 1.56 \cdot \text{in}^2$

PAD REINFORCEMENT:

TOP:	Bar Size	$BS_{top} := 9$	Bar Diameter	$d_{btop} := 1.128 \cdot \text{in}$
	Number of Bars	$NB_{top} := 35$	Bar Area	$A_{btop} := 1.00 \cdot \text{in}^2$
BOTTOM:	Bar Size	$BS_{bot} := 10$	Bar Diameter	$d_{bbot} := 1.27 \cdot \text{in}$
	Number of Bars	$NB_{bot} := 35$	Bar Area	$A_{bot} := 1.27 \cdot \text{in}^2$

Coefficient of Lateral Soil Pressure: $K_p := \frac{1 + \sin(\phi_s)}{1 - \sin(\phi_s)}$ $K_p = 3.8518$

Load Factor (EIA 3.1.1): $LF := \text{if} \left[H_t \leq 700 \cdot \text{ft}, 1.3, \text{if} \left[H_t \geq 1200, 1.7, 1.3 + \left(\frac{H_t - 700}{1200 - 700} \right) 0.4 \right] \right]$ $LF = 1.3$

PROPERTIES:

Compressive Strength of Concrete	$f_c := 4000 \text{ psi}$
Yield Strength of Steel Reinforcement	$f_y := 60000 \cdot \text{psi}$
Yield Strength of Anchor Bolt	$f_{ya} := 75000 \cdot \text{psi}$
Internal Friction Angle of Soil	$\phi_s := 36 \cdot \text{deg}$
Allowable Bearing Capacity	$q_s := 10000 \cdot \text{psf}$
Unit Weight of Soil	$\gamma_s := 125 \cdot \text{pcf}$
Unit Weight of Concrete	$\gamma_c := 150 \cdot \text{pcf}$
Depth to Neglect	$n := 0 \text{ ft}$
Cohesion of Clay Type Soil Note: Use 0 for Sandy Soil	$c := 0 \cdot \text{ksf}$
Seismic Zone Factor: UBC Fig 23-2	$Z := 2$
Coefficient of Friction between soil and Concrete:	$\mu := 0.45$
Clear Cover of Reinforcement Pier:	$C_{vr_{pier}} := 3 \cdot \text{in}$
Clear Cover of Reinforcement Pad:	$C_{vr_{pad}} := 3 \cdot \text{in}$
Anchor Bolt Diameter	$d_{anchor} := 2.25 \text{ in}$

Job 160' Monopole - Orange, CT
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CHECK ANCHOR STEEL EMBEDMENT

Depth: $D_{ab} := L_{st} - A_{BP}$ $D_{ab} = 10.1667 \text{ ft}$ $L_{anchor} := \frac{(0.11 \cdot f_y) \cdot \text{in}}{\sqrt{f_c \cdot \text{psi}}}$ $L_{anchor} = 8.6963 \text{ ft}$

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

DepthCheck = "Okay" **Note: anchor plate is provided**

STABILITY OF FOOTING

Passive Pressure: $P_{pn} := K_p \cdot \gamma_s \cdot n + c \cdot 2 \cdot \sqrt{K_p}$ $P_{pn} = 0 \text{ ksf}$
 $P_{pt} := K_p \cdot \gamma_s \cdot (D_f - T_f) + c \cdot 2 \cdot \sqrt{K_p}$ $P_{pt} = 4.8148 \text{ ksf}$
 $P_{top} := \text{if}[n < (D_f - T_f), P_{pt}, P_{pn}]$ $P_{top} = 4.8148 \text{ ksf}$
 $P_{bot} := K_p \cdot \gamma_s \cdot D_f + c \cdot 2 \cdot \sqrt{K_p}$ $P_{bot} = 6.7407 \text{ ksf}$
 $P_{ave} := \frac{P_{top} + P_{bot}}{2}$ $P_{ave} = 5.7778 \text{ ksf}$
 $T_p := \text{if}[n < (D_f - T_f), T_f, (D_f - n)]$ $T_p = 4 \text{ ft}$
 $A_p := W_f \cdot T_p$ $A_p = 88 \text{ ft}^2$

Ultimate Shear: $S_u := P_{ave} \cdot A_p$ $S_u = 508.4429 \text{ kip}$

Weight of Concrete Pad: $WT_c := \left[(W_f^2 \cdot T_f) + d_p^2 L_p \right] \cdot \gamma_c$ $WT_c = 386.4 \text{ kip}$

Weight of Soil above Footing: $WT_{s1} := \left[W_f^2 \cdot (|L_p - L_{pag}|) - \frac{d_p^2 \cdot \pi}{4} \cdot (|L_p - L_{pag}|) \right] \cdot \gamma_s$ $WT_{s1} = 515.0597 \text{ kip}$

Weight of Soil Wedge at back face: $WT_{s2} := \left(\frac{D_f^2 \cdot \tan(\phi_s)}{2} \cdot W_f \right) \cdot \gamma_s$ $WT_{s2} = 195.8032 \text{ kip}$

Total Weight: $WT_{tot} := WT_c + WT_{s1} + C_t$ $WT_{tot} = 952.8597 \text{ kip}$

Resisting Moment: $M_r := (WT_{tot}) \cdot \frac{W_f}{2} + S_u \cdot \frac{T_f}{3} + WT_{s2} \cdot \left(W_f + \frac{D_f \tan(\phi_s)}{3} \right)$ $M_r = 16130.9286 \text{ kip} \cdot \text{ft}$

Overturning Moment: $M_{ot} := M_t + S_t \cdot (L_p + T_f)$ $M_{ot} = 9153 \text{ kip} \cdot \text{ft}$

Factor of Safety: $FS := \frac{M_r}{M_{ot}}$ **FS_{req} := 2** $FS = 1.76$

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

SHEAR CAPACITY IN PIER

$$FS := 2$$

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

$$S_p = 468.6149 \text{ kips}$$

$$\text{ShearCheck} := \text{if}(S_p > S_t, \text{"Okay"}, \text{"No Good"})$$

$$\text{ShearCheck} = \text{"Okay"}$$

BEARING PRESSURE CAUSED BY FOOTING

$$A_{mat} := W_f^2$$

$$A_{mat} = 484 \text{ ft}^2$$

$$S := \frac{W_f^3}{6}$$

$$S = 1774.6667 \text{ ft}^3$$

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

$$P_{max} = 7.1263 \text{ ksf}$$

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

$$P_{min} = -3.1889 \text{ ksf}$$

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

$$\text{MaxPressure} = \text{"Okay"}$$

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

$$\text{MinPressure} = \text{"No Good"}$$

Distance to Resultant of Pressure Distribution:

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

$$X_p = 5.0663 \text{ ft}$$

Distance to Kern:

$$X_k := \frac{W_f}{6}$$

$$X_k = 3.6667 \text{ ft}$$

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

Eccentricity:

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

$$e = 9.6058$$

Adjusted Soil Pressure:

$$P_a := \frac{2 \cdot WT_{tot}}{3 \cdot W_f \left(\frac{W_f}{2} - e \right)}$$

$$P_a = 20.7108 \text{ ksf}$$

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

$$q_{adj} = 20.7108 \text{ ksf}$$

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

$$\text{PressureCheck} = \text{"No Good"}$$

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CONCRETE BEARING CAPACITY (ACI 10.17)

$$\phi_c := 0.75 \quad (\text{ACI 9.3.2.2})$$

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

$$P_b = 18457.4852 \text{ kip}$$

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

$$\text{BearingCheck} = \text{"Okay"}$$

SHEAR STRENGTH OF CONCRETE

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

$$\phi_{sv} := .85 \quad (\text{ACI 9.3.2.3})$$

$$d := T_f - C_{vrpad} - d_{bbot}$$

$$d = 43.73 \text{ in}$$

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

$$d_1 = 7 \text{ ft}$$

$$d_2 := d_1 - d$$

$$d_2 = 3.3558 \text{ ft}$$

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

$$L = 4.1825 \text{ ft}$$

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

$$\text{Slope} = 4.9517 \text{ kcf}$$

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

$$V_{req} = 676.6236 \text{ kip}$$

ACI 11.3.1.1

$$V_{Avail} := \phi_c \cdot 2 \cdot \sqrt{f_c \cdot \text{psi}} \cdot W_f \cdot d$$

$$V_{Avail} = 1241.2587 \text{ kip}$$

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

$$\text{BeamShearCheck} = \text{"Okay"}$$

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

$$b_o := (d_p + d) \cdot \pi$$

$$b_o = 36.5812 \text{ ft}$$

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

$$A_{bo} = 106.4895 \text{ ft}^2$$

Area outside of bo:
$$A_{out} := A_{mat} - A_{bo}$$

$$A_{out} = 377.5105 \text{ ft}^2$$

Guess Value: $v_u := 1 \text{ ksf}$

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

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

$v_u := \text{Find}(v_u)$

$v_u = 7.1478 \text{ ksf}$

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

$V_u = 573.0531 \text{ kips}$

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

$V_{req} = 744.969 \text{ kips}$

$V_{Avail} := \phi_c \cdot 4 \cdot \sqrt{f_c \cdot \text{psi}} \cdot b_o \cdot d$

$V_{Avail} = 4127.8882 \text{ kips}$

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

$\text{PunchingShearCheck} = \text{"Okay"}$

STEEL REINFORCEMENT IN THE PAD

$\phi_m := .90 \text{ ACI 9.3.2.2}$

Take Maximum Bending at face of Pier:

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

$q_b = -13.9513 \text{ ksf}$

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

$M_n = 7129.0403 \text{ kip} \cdot \text{ft}$

ACI 10.2.7.3

$\beta := \text{if} \left[f_c \leq 4000 \cdot \text{psi}, .85, \text{if} \left[f_c \geq 8000 \cdot \text{psi}, .65, .85 - \left(\frac{f_c - 4000}{1000} \right) \cdot .05 \right] \right] \beta = 0.85$

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

$R_u = 27112.5 \text{ lbf}$

$\rho := \frac{0.85 \cdot f_c}{f_y} \left(1 - \sqrt{1 - \frac{2 \cdot R_u}{0.85 \cdot f_c}} \right)$

$\rho = 0.0032$

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

$\rho_{min} = 0.00431$

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

(ACI 7.12.2.1b)

FOR BOTTOM BARS: $A_s := \max(\rho, \rho_{min}, \rho_{sh}) \cdot W_f \cdot d$ $A_s = 49.7081 \text{ in}^2$

$A_{s_{prov}} := A_{bot} \cdot NB_{bot}$ $A_{s_{prov}} = 44.45 \text{ in}^2$

PadReinforcement := if($A_{s_{prov}} > A_s$, "Okay", "No Good") PadReinforcement = "No Good"

FOR TOP BARS: $A_s := \rho_{sh} \cdot (W_f \cdot d)$ $A_s = 20.7805 \text{ in}^2$

$A_{s_{prov}} := A_{bot} \cdot NB_{top}$ $A_{s_{prov}} = 35 \text{ in}^2$

PadReinforcement := if($A_{s_{prov}} > A_s$, "Okay", "No Good") PadReinforcement = "Okay"

TENSION (ACI 12.2.3)

DEVELOPMENT LENGTH OF PAD REINFORCEMENT

Bar Spacing: $B_{sPad} := \frac{W_f - 2 \cdot C_{vr_{pad}} - NB_{bot} \cdot d_{bbot}}{NB_{bot} - 1}$ $B_{sPad} = 6.2809 \text{ in}$

Development Length Factors:

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

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

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

$L_{dbt} := \frac{3}{40} \cdot \frac{f_y}{\sqrt{f_c \cdot \text{psi}}} \cdot \frac{\alpha \cdot \beta \cdot \gamma \cdot \lambda}{c + k_{tr}} \cdot d_{bbot}$ $L_{dbt} = 38.2533 \text{ in}$

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

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

Available Length in Pad: $L_{Pad} := \frac{W_f}{2} - \frac{d_p}{2} - C_{vr_{pad}}$ $L_{Pad} = 81 \text{ in}$

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

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REINFORCEMENT IN PIER

Pier Area: $A_p = \frac{\pi \cdot d_p^2}{4}$ $A_p = 7238.2295 \text{ in}^2$
 (ACI 10.8.4 and 10.9.1) $A_{smin} := 0.01 \cdot 0.05 \cdot A_p$ $A_{smin} = 3.6191 \text{ in}^2$
 $A_{sprov} := NB_{pier} \cdot A_{bpier}$ $A_{sprov} = 48.36 \text{ in}^2$
 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: $B_{sPier} := \frac{d_p \cdot \pi}{NB_{pier}} - d_{bpier}$ $B_{sPier} = 8.3188 \text{ in}$
 Diameter of Reinforcement Cage: $Diam_{cage} := d_p - 2 \cdot C_{vr_{pier}}$ $Diam_{cage} = 90 \text{ in}$
 Maximum Moment in Pier: $M_p := \left[M_t + S_t \cdot \left(L_p + \frac{A_{BP}}{2} \right) \right] \cdot LF$ $M_p = 138063.25 \text{ in} \cdot \text{kips}$

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

(defined variables)

$$(f_c \ f_y \ c_l \ \text{Spiral}) = (4 \ 60 \ 3 \ 0)$$

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:

$$(D \ N \ n \ P_u \ M_{xu}) := (96 \ 31 \ 11 \ 55 \ 138063)$$

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:

$$(\phi P_n \ \phi M_{xn} \ f_{sp} \ \rho) = (42.9215 \ 107743.0802 \ -60 \ 0.0067)$$

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

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

AxialLoadCheck = "No Good"

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

BendingCheck = "No Good"

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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 $\gamma := 1.0$

Spacing or Cover Dimension: $c := \text{if} \left(C_{vr, \text{pier}} < \frac{B_{s, \text{Pier}}}{2}, C_{vr, \text{pier}}, \frac{B_{s, \text{Pier}}}{2} \right)$ $c = 3 \text{ in}$

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

$$L_{dbt} := \frac{3}{40} \cdot \frac{f_y}{\sqrt{f_c \cdot \text{psi}}} \cdot \frac{\alpha \cdot \beta \cdot \gamma \cdot \lambda}{\frac{c + k_{tr}}{d_{bpier}}} \cdot d_{bpier} \quad L_{dbt} = 47.1519 \text{ in}$$

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

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

$$L_{dh} := \frac{1200 \cdot d_{bpier}}{\sqrt{\frac{f_c}{\text{psi}}}} \cdot .7 \quad L_{dh} = 18.727 \text{ in}$$

$$L_{db} := \max(L_{dbt}, L_{dbmin}) \quad L_{db} = 47.1519 \text{ in}$$

COMPRESSION: (ACI 12.3.2)

$$L_{dbc1} := \frac{.02 \cdot d_{bpier} \cdot f_y}{\sqrt{f_c \cdot \text{psi}}} \quad L_{dbc1} = 26.7529 \text{ in}$$

$$L_{dbmin} := 0.0003 \cdot \frac{\text{in}^2}{\text{lb}} \cdot (d_{bpier} \cdot f_y) \quad L_{dbmin} = 25.38 \text{ in}$$

$$L_{dbc} := \text{if}(L_{dbc1} \geq L_{dbmin}, L_{dbc1}, L_{dbmin}) \quad L_{dbc} = 26.7529 \text{ in}$$

Available Length in Pier: $L_{pier} := L_p - 3 \cdot \text{in}$ $L_{pier} = 117 \text{ in}$

$$L_{piertension} := \text{if}(L_{pier} > L_{dbt}, \text{"Okay"}, \text{"No Good"}) \quad L_{piertension} = \text{"Okay"}$$

$$L_{piercompression} := \text{if}(L_{pier} > L_{dbc}, \text{"Okay"}, \text{"No Good"})$$

NOTE: Anchor bolts and plate provided, OK

Available Length in Pad: $L_{pad} := T_f - 3 \cdot \text{in}$ $L_{pad} = 45 \text{ in}$

$$L_{padtension} := \text{if}(L_{pad} > L_{dh}, \text{"Okay"}, \text{"No Good"}) \quad L_{padtension} = \text{"Okay"}$$

$$L_{padcompression} := \text{if}(L_{pad} > L_{dbc}, \text{"Okay"}, \text{"No Good"})$$

TIE SIZE AND SPACING IN COLUMN

Minimum Tie Size:

$$Tie_{min} := \text{if}(BS_{pier} \leq 10, 3, 4)$$

$$Tie_{min} = 4$$

Used #5 Ties

$$d_{Tie} := 5$$

Seismic factor:
(ACI 21.10.5)

$$z := \text{if}(Z \leq 2, 1, 0.5)$$

$$z = 1$$

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

$$s_{lim1} = 22.56 \text{ in}$$

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

$$s_{lim2} = 30 \text{ in}$$

$$s_{lim3} := D_f \cdot z$$

$$s_{lim3} = 168 \text{ in}$$

$$s_{lim4} := 18 \text{ in}$$

$$s_{lim4} = 18 \text{ in}$$

Maximum Spacing:

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

$$s_{tie} = 18 \text{ in}$$

Number of Ties Required:

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

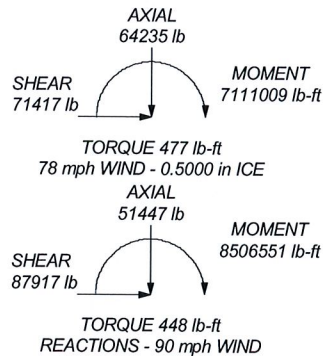
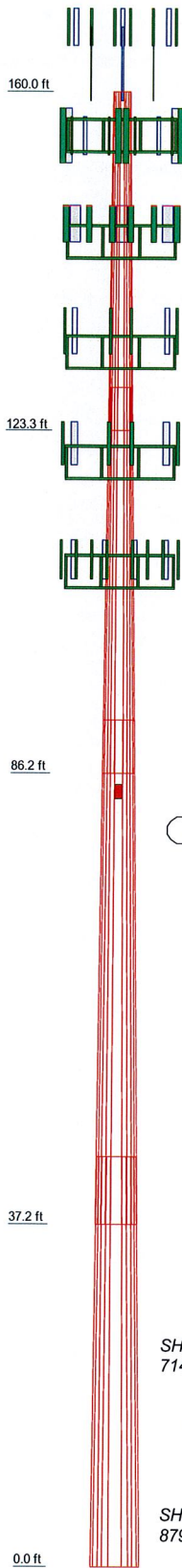
$$n_{tie} = 7.3333$$

Used 21 Ties

PROPOSED TOWER CONDITIONS

RISA TOWER INPUT/OUTPUT SUMMARY

Section	1	2	3	4
Length (ft)	36.67	41.83	54.83	44.50
Number of Sides	12	12	12	12
Thickness (in)	0.2190	0.3440	0.4380	0.4690
Lap Splice (ft)	4.67	5.83	7.33	
Top Dia (in)	21.2000	29.7154	39.1179	51.5330
Bot Dia (in)	31.4800	41.4400	54.4600	64.0000
Grade			A572-65	
Weight (lb)	2297.6	5555.1	12196.6	13102.6
				33151.9



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
(3) DB844H90E-XY (Nextel)	167	(3) DUO1417-8686 (Cingular)	145.7
(3) DB844H90E-XY (Nextel)	167	(3) DUO1417-8686 (Cingular)	145.7
(3) DB844H90E-XY (Nextel)	167	Valmont 13' Platform w/Rails (Cingular)	143.7
(4) 8"x2 1/2" Pipe Mount (Nextel)	163	(2) DB980H90E-M (SPRINT)	134.1
(4) 8"x2 1/2" Pipe Mount (Nextel)	163	(2) DB980H90E-M (SPRINT)	134.1
(4) 8"x2 1/2" Pipe Mount (Nextel)	163	(2) DB980H90E-M (SPRINT)	134.1
LPA-80063/6CF (Verizon)	155.2	Valmont 13' Platform w/Rails (SPRINT)	131.8
LPA-80063/6CF (Verizon)	155.2	(2) RR90-17-02DP (T-Mobile)	121.9
LPA-80063/6CF (Verizon)	155.2	(2) RR90-17-02DP (T-Mobile)	121.9
LPA-80063/6CF (Verizon)	155.2	(2) RR90-17-02DP (T-Mobile)	121.9
LPA-80063/6CF (Verizon)	155.2	Valmont 13' Platform w/Rails (T-Mobile)	119.9
LPA-80063/6CF (Verizon)	155.2	(4) 7184.14 (Cingular Blue)	109.4
DB948F85T2E-M (Verizon)	155.2	(4) 7184.14 (Cingular Blue)	109.4
DB948F85T2E-M (Verizon)	155.2	(4) 7184.14 (Cingular Blue)	109.4
DB948F85T2E-M (Verizon)	155.2	Valmont 13' Platform w/Rails (Cingular Blue)	108
DB948F85T2E-M (Verizon)	155.2	GPS (Sprint)	83.4
DB948F85T2E-M (Verizon)	155.2	Standoff Mount	83.4
Valmont 13' Platform w/Rails (Verizon)	155.2	Standoff Mount	83.4
(3) DUO1417-8686 (Cingular)	145.7		

MATERIAL STRENGTH

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

TOWER DESIGN NOTES

1. Tower designed for a 90 mph basic wind in accordance with the TIA/EIA-222-F Standard.
2. Tower is also designed for a 78 mph basic wind with 0.50 in ice.
3. Deflections are based upon a 50 mph wind.
4. Weld together tower sections have flange connections.
5. Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications.
6. Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
7. Welds are fabricated with ER-70S-6 electrodes.
8. TOWER RATING: 142.3%

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

Job: **160 Ft. Valmont Monopole - Orange, CT**
Project: **525 Orange Center Road**
Client: **Verizon Wireless** Drawn by: **Staff** App'd:
Code: **TIA/EIA-222-F** Date: **08/15/06** Scale: **NTS**
Path: **P:\08\ER\Files\160' Valmont Monopole - Proposed.dwg** Dwg No. **E-1**

RISA TOWER DETAILED OUTPUT

RISATower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	160 Ft. Valmont Monopole - Orange, CT	Page	1 of 20
	Project	525 Orange Center Road	Date	07:42:27 08/15/06
	Client	Verizon Wireless	Designed by	Staff

Tower Input Data

There is a pole section.

This tower is designed using the TIA/EIA-222-F standard.

The following design criteria apply:

Basic wind speed of 90 mph.

Nominal ice thickness of 0.5000 in.

Ice density of 56 pcf.

A wind speed of 78 mph is used in combination with ice.

Temperature drop of 50 °F.

Deflections calculated using a wind speed of 50 mph.

Weld together tower sections have flange connections..

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..

Welds are fabricated with ER-70S-6 electrodes..

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	160.00-123.33	36.67	4.67	12	21.2000	31.4600	0.2190	0.8760	A572-65 (65 ksi)
L2	123.33-86.17	41.83	5.83	12	29.7154	41.4400	0.3440	1.3760	A572-65 (65 ksi)
L3	86.17-37.17	54.83	7.33	12	39.1179	54.4600	0.4380	1.7520	A572-65 (65 ksi)

RISATower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	160 Ft. Valmont Monopole - Orange, CT	Page	2 of 20
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Section	Elevation	Section Length	Splice Length	Number of Sides	Top Diameter	Bottom Diameter	Wall Thickness	Bend Radius	Pole Grade
	ft	ft	ft		in	in	in	in	
L4	37.17-0.00	44.50		12	51.5330	64.0000	0.4690	1.8760	A572-65 (65 ksi)

Tapered Pole Properties

Section	Tip Dia.	Area	I	r	C	I/C	J	It/Q	w	w/t
	in	in ²	in ⁴	in	in	in ³	in ⁴	in ²	in	
L1	21.9479	14.7954	831.3128	7.5112	10.9816	75.7005	1684.4652	7.2818	5.0947	23.263
	32.5698	22.0305	2744.4841	11.1843	16.2963	168.4117	5561.0688	10.8428	7.8444	35.819
L2	32.1188	32.5341	3582.3894	10.5149	15.3926	232.7351	7258.8921	16.0123	7.0418	20.47
	42.9018	45.5212	9812.9350	14.7124	21.4659	457.1402	19883.6668	22.4042	10.1840	29.605
L3	42.1867	54.5526	10417.6987	13.8474	20.2631	514.1224	21109.0819	26.8491	9.3098	21.255
	56.3811	76.1905	28381.0140	19.3399	28.2103	1006.0522	57507.6289	37.4986	13.4214	30.643
L4	55.4769	77.1158	25666.0211	18.2809	26.6941	961.4873	52006.3171	37.9540	12.5539	26.767
	66.2577	95.9432	49427.8521	22.7441	33.1520	1490.9463	100154.228	47.2203	15.8951	33.891
9										

Tower Elevation	Gusset Area	Gusset Thickness	Gusset Grade	Adjust. Factor	Adjust. Factor	Weight Mult.	Double Angle	Double Angle
ft	ft ²	in		A _f	A _r		Stitch Bolt Spacing Diagonals	Stitch Bolt Spacing Horizontals
							in	in
L1 160.00-123.33				1	1	1		
L2 123.33-86.17				1	1	1		
L3 86.17-37.17				1	1	1		
L4 37.17-0.00				1	1	1		

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Component Type	Placement	Total Number		C _A A _A	Weight
				ft			ft ² /ft	plf
1 1/4 (Nextel)	C	No	Inside Pole	0.00 - 160.00	9	No Ice	0.00	0.66
1 5/8 (Verizon)	C	No	Inside Pole	0.00 - 155.20	12	1/2" Ice	0.00	0.66
						No Ice	0.00	1.04
1 1/4 (Cingular)	C	No	Inside Pole	0.00 - 145.70	9	1/2" Ice	0.00	1.04
						No Ice	0.00	0.66
1 5/8 (Sprint)	C	No	Inside Pole	0.00 - 131.80	6	1/2" Ice	0.00	0.66
						No Ice	0.00	1.04
1 5/8 (T-Mobile)	C	No	Inside Pole	0.00 - 121.90	12	1/2" Ice	0.00	1.04
						No Ice	0.00	1.04
1 1/4 (Cingular Blue)	C	No	CaAa (Out Of Face)	0.00 - 109.40	1	1/2" Ice	0.16	0.66
						No Ice	0.25	1.91
1 1/4 (Cingular Blue)	C	No	CaAa (Out Of Face)	0.00 - 109.40	11	1/2" Ice	0.00	0.66
						No Ice	0.00	1.91
1/2 (Sprint)	C	No	Inside Pole	0.00 - 83.40	1	1/2" Ice	0.00	0.25
						No Ice	0.00	0.25

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Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft ²	A_F ft ²	C_{AA} In Face ft ²	C_{AA} Out Face ft ²	Weight lb
L1	160.00-123.33	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	801.29
L2	123.33-86.17	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	3.601	1766.99
L3	86.17-37.17	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	7.595	2510.56
L4	37.17-0.00	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	5.761	1904.96

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} In Face ft ²	C_{AA} Out Face ft ²	Weight lb
L1	160.00-123.33	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	801.29
L2	123.33-86.17	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	5.924	2115.44
L3	86.17-37.17	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	12.495	3245.56
L4	37.17-0.00	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	9.478	2462.51

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft	C_{AA} Front ft ²	C_{AA} Side ft ²	Weight lb
(3) DB844H90E-XY (Nextel)	A	From Leg	3.00	0.0000	167.00	No Ice	2.87	10.00
			0.00			1/2" Ice	3.18	35.38
			0.00					
(3) DB844H90E-XY (Nextel)	B	From Leg	3.00	0.0000	167.00	No Ice	2.87	10.00
			0.00			1/2" Ice	3.18	35.38
			0.00					
(3) DB844H90E-XY (Nextel)	C	From Leg	3.00	0.0000	167.00	No Ice	2.87	10.00
			0.00			1/2" Ice	3.18	35.38
			0.00					

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<i>Description</i>	<i>Face or Leg</i>	<i>Offset Type</i>	<i>Offsets: Horz Lateral Vert ft ft ft</i>	<i>Azimuth Adjustment °</i>	<i>Placement ft</i>		<i>C_AA_A Front ft²</i>	<i>C_AA_A Side ft²</i>	<i>Weight lb</i>
(4) 8'x2 1/2" Pipe Mount (Nextel)	A	From Leg	3.00 0.00 0.00	0.0000	163.00	No Ice 1/2" Ice	2.30 3.13	2.30 3.13	40.50 57.38
(4) 8'x2 1/2" Pipe Mount (Nextel)	B	From Leg	3.00 0.00 0.00	0.0000	163.00	No Ice 1/2" Ice	2.30 3.13	2.30 3.13	40.50 57.38
(4) 8'x2 1/2" Pipe Mount (Nextel)	C	From Leg	3.00 0.00 0.00	0.0000	163.00	No Ice 1/2" Ice	2.30 3.13	2.30 3.13	40.50 57.38
LPA-80063/6CF (Verizon)	A	From Leg	3.00 6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
LPA-80063/6CF (Verizon)	B	From Leg	3.00 6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
LPA-80063/6CF (Verizon)	C	From Leg	3.00 6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
LPA-80063/6CF (Verizon)	A	From Leg	3.00 -6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
LPA-80063/6CF (Verizon)	B	From Leg	3.00 -6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
LPA-80063/6CF (Verizon)	C	From Leg	3.00 -6.00 0.00	0.0000	155.20	No Ice 1/2" Ice	10.31 10.87	9.01 9.55	27.00 100.95
DB948F85T2E-M (Verizon)	A	From Leg	3.00 4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	B	From Leg	3.00 4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	C	From Leg	3.00 4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	A	From Leg	3.00 -4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	B	From Leg	3.00 -4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
DB948F85T2E-M (Verizon)	C	From Leg	3.00 -4.00 0.00	0.0000	155.20	No Ice 1/2" Ice	1.92 2.22	3.26 3.62	8.50 27.57
Valmont 13' Platform w/Rails (Verizon)	C	None		0.0000	155.20	No Ice 1/2" Ice	25.00 30.00	25.00 30.00	2000.00 3000.00
(3) DUO1417-8686 (Cingular)	A	From Leg	3.00 0.00 0.00	0.0000	145.70	No Ice 1/2" Ice	6.53 6.94	4.20 4.57	20.30 62.49
(3) DUO1417-8686 (Cingular)	B	From Leg	3.00 0.00 0.00	0.0000	145.70	No Ice 1/2" Ice	6.53 6.94	4.20 4.57	20.30 62.49
(3) DUO1417-8686 (Cingular)	C	From Leg	3.00 0.00 0.00	0.0000	145.70	No Ice 1/2" Ice	6.53 6.94	4.20 4.57	20.30 62.49
Valmont 13' Platform w/Rails	C	None		0.0000	143.70	No Ice	25.00	25.00	2000.00

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Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C _{AA} Front ft ²	C _{AA} Side ft ²	Weight lb
(Cingular)						1/2" Ice	30.00	30.00	3000.00
(2) DB980H90E-M (SPRINT)	A	From Leg	3.00 0.00 0.00	0.0000	134.10	No Ice 1/2" Ice	3.80 4.18	2.19 2.56	8.50 28.62
(2) DB980H90E-M (SPRINT)	B	From Leg	3.00 0.00 0.00	0.0000	134.10	No Ice 1/2" Ice	3.80 4.18	2.19 2.56	8.50 28.62
(2) DB980H90E-M (SPRINT)	C	From Leg	3.00 0.00 0.00	0.0000	134.10	No Ice 1/2" Ice	3.80 4.18	2.19 2.56	8.50 28.62
Valmont 13' Platform w/Rails (SPRINT)	C	None		0.0000	131.80	No Ice 1/2" Ice	25.00 30.00	25.00 30.00	2000.00 3000.00
(2) RR90-17-02DP (T-Mobile)	A	From Leg	3.00 0.00 0.00	0.0000	121.90	No Ice 1/2" Ice	4.36 4.77	1.97 2.31	18.00 40.42
(2) RR90-17-02DP (T-Mobile)	B	From Leg	3.00 0.00 0.00	0.0000	121.90	No Ice 1/2" Ice	4.36 4.77	1.97 2.31	18.00 40.42
(2) RR90-17-02DP (T-Mobile)	C	From Leg	3.00 0.00 0.00	0.0000	121.90	No Ice 1/2" Ice	4.36 4.77	1.97 2.31	18.00 40.42
Valmont 13' Platform w/Rails (T-Mobile)	C	None		0.0000	119.90	No Ice 1/2" Ice	25.00 30.00	25.00 30.00	2000.00 3000.00
(4) 7184.14 (Cingular Blue)	A	From Leg	3.00 0.00 0.00	0.0000	109.40	No Ice 1/2" Ice	2.85 3.18	1.43 1.75	9.70 24.29
(4) 7184.14 (Cingular Blue)	B	From Leg	3.00 0.00 0.00	0.0000	109.40	No Ice 1/2" Ice	2.85 3.18	1.43 1.75	9.70 24.29
(4) 7184.14 (Cingular Blue)	C	From Leg	3.00 0.00 0.00	0.0000	109.40	No Ice 1/2" Ice	2.85 3.18	1.43 1.75	9.70 24.29
Valmont 13' Platform w/Rails (Cingular Blue)	C	None		0.0000	108.00	No Ice 1/2" Ice	25.00 30.00	25.00 30.00	2000.00 3000.00
GPS (Sprint)	A	From Leg	2.00 0.00 0.00	0.0000	83.40	No Ice 1/2" Ice	1.00 1.50	1.00 1.50	10.00 15.00
Standoff Mount	A	From Leg	1.00 0.00 0.00	0.0000	83.40	No Ice 1/2" Ice	0.75 0.95	0.75 0.95	27.00 35.41
Standoff Mount	C	From Leg	1.00 0.00 0.00	0.0000	83.40	No Ice 1/2" Ice	0.75 0.95	0.75 0.95	27.00 35.41

Tower Pressures - No Ice

$$G_H = 1.690$$

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Section Elevation	z	K _Z	q _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
ft	ft		psf	ft ²		ft ²	ft ²	ft ²			
L1 160.00-123.33	140.47	2.58	53	80.460	A	0.000	80.460	80.460	100.00	0.000	0.000
					B	0.000	80.460		100.00		
					C	0.000	80.460		100.00		
L2 123.33-86.17	103.86	2.58	53	112.199	A	0.000	112.199	112.199	100.00	0.000	3.601
					B	0.000	112.199		100.00		
					C	0.000	112.199		100.00		
L3 86.17-37.17	60.49	2.58	53	194.385	A	0.000	194.385	194.385	100.00	0.000	7.595
					B	0.000	194.385		100.00		
					C	0.000	194.385		100.00		
L4 37.17-0.00	18.04	2.58	53	182.112	A	0.000	182.112	182.112	100.00	0.000	5.761
					B	0.000	182.112		100.00		
					C	0.000	182.112		100.00		

Tower Pressure - With Ice

$$G_H = 1.690$$

Section Elevation	z	K _Z	q _z	t _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
ft	ft		psf	in	ft ²		ft ²	ft ²	ft ²			
L1 160.00-123.33	140.47	2.58	40	0.5000	83.516	A	0.000	83.516	83.516	100.00	0.000	0.000
						B	0.000	83.516		100.00		
						C	0.000	83.516		100.00		
L2 123.33-86.17	103.86	2.58	40	0.5000	115.296	A	0.000	115.296	115.296	100.00	0.000	5.924
						B	0.000	115.296		100.00		
						C	0.000	115.296		100.00		
L3 86.17-37.17	60.49	2.58	40	0.5000	198.469	A	0.000	198.469	198.469	100.00	0.000	12.495
						B	0.000	198.469		100.00		
						C	0.000	198.469		100.00		
L4 37.17-0.00	18.04	2.58	40	0.5000	185.210	A	0.000	185.210	185.210	100.00	0.000	9.478
						B	0.000	185.210		100.00		
						C	0.000	185.210		100.00		

Tower Pressure - Service

$$G_H = 1.690$$

Section Elevation	z	K _Z	q _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
ft	ft		psf	ft ²		ft ²	ft ²	ft ²			
L1 160.00-123.33	140.47	2.58	17	80.460	A	0.000	80.460	80.460	100.00	0.000	0.000
					B	0.000	80.460		100.00		
					C	0.000	80.460		100.00		
L2 123.33-86.17	103.86	2.58	17	112.199	A	0.000	112.199	112.199	100.00	0.000	3.601
					B	0.000	112.199		100.00		
					C	0.000	112.199		100.00		
L3 86.17-37.17	60.49	2.58	17	194.385	A	0.000	194.385	194.385	100.00	0.000	7.595
					B	0.000	194.385		100.00		
					C	0.000	194.385		100.00		
L4 37.17-0.00	18.04	2.58	17	182.112	A	0.000	182.112	182.112	100.00	0.000	5.761

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Section Elevation	z	K _z	q _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
ft	ft		psf	ft ²		ft ²	ft ²	ft ²			
					B	0.000	182.112		100.00		
					C	0.000	182.112		100.00		

Tower Forces - No Ice - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	7492.89	204.33	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	10774.14	289.94	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	18788.95	383.45	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	17480.20	470.28	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	3623454.0 7 lb-ft	54536.17		

Tower Forces - No Ice - Wind 45 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	7492.89	204.33	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	10774.14	289.94	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	18788.95	383.45	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	17480.20	470.28	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	3623454.0 7 lb-ft	54536.17		

Tower Forces - No Ice - Wind 60 To Face

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Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	7492.89	204.33	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	10774.14	289.94	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	18788.95	383.45	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	17480.20	470.28	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	3623454.0 7 lb-ft	54536.17		

Tower Forces - No Ice - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	7492.89	204.33	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	10774.14	289.94	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	18788.95	383.45	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	17480.20	470.28	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	3623454.0 7 lb-ft	54536.17		

Tower Forces - With Ice - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2913.57	A	1	1.03	1	1	1	83.516	5833.10	159.07	C
			B	1	1.03	1	1	1	83.516			
			C	1	1.03	1	1	1	83.516			
L2 123.33- 86.17	2115.44	6409.75	A	1	1.03	1	1	1	115.296	8454.41	227.51	C
			B	1	1.03	1	1	1	115.296			
			C	1	1.03	1	1	1	115.296			
L3 86.17- 37.17	3245.56	13672.47	A	1	1.03	1	1	1	198.469	14709.17	300.19	C
			B	1	1.03	1	1	1	198.469			
			C	1	1.03	1	1	1	198.469			

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Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L4 37.17-0.00	2462.51	14482.52	A	1	1.03	1	1	1	185.210	13578.54	365.31	C
			B	1	1.03	1	1	1	185.210			
			C	1	1.03	1	1	1	185.210			
Sum Weight:	8624.80	37478.30						OTM	2832196.0 0 lb-ft	42575.21		

Tower Forces - With Ice - Wind 45 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2913.57	A	1	1.03	1	1	1	83.516	5833.10	159.07	C
			B	1	1.03	1	1	1	83.516			
			C	1	1.03	1	1	1	83.516			
L2 123.33-86.17	2115.44	6409.75	A	1	1.03	1	1	1	115.296	8454.41	227.51	C
			B	1	1.03	1	1	1	115.296			
			C	1	1.03	1	1	1	115.296			
L3 86.17-37.17	3245.56	13672.47	A	1	1.03	1	1	1	198.469	14709.17	300.19	C
			B	1	1.03	1	1	1	198.469			
			C	1	1.03	1	1	1	198.469			
L4 37.17-0.00	2462.51	14482.52	A	1	1.03	1	1	1	185.210	13578.54	365.31	C
			B	1	1.03	1	1	1	185.210			
			C	1	1.03	1	1	1	185.210			
Sum Weight:	8624.80	37478.30						OTM	2832196.0 0 lb-ft	42575.21		

Tower Forces - With Ice - Wind 60 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2913.57	A	1	1.03	1	1	1	83.516	5833.10	159.07	C
			B	1	1.03	1	1	1	83.516			
			C	1	1.03	1	1	1	83.516			
L2 123.33-86.17	2115.44	6409.75	A	1	1.03	1	1	1	115.296	8454.41	227.51	C
			B	1	1.03	1	1	1	115.296			
			C	1	1.03	1	1	1	115.296			
L3 86.17-37.17	3245.56	13672.47	A	1	1.03	1	1	1	198.469	14709.17	300.19	C
			B	1	1.03	1	1	1	198.469			
			C	1	1.03	1	1	1	198.469			
L4 37.17-0.00	2462.51	14482.52	A	1	1.03	1	1	1	185.210	13578.54	365.31	C
			B	1	1.03	1	1	1	185.210			
			C	1	1.03	1	1	1	185.210			
Sum Weight:	8624.80	37478.30						OTM	2832196.0 0 lb-ft	42575.21		

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Tower Forces - With Ice - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2913.57	A	1	1.03	1	1	1	83.516	5833.10	159.07	C
			B	1	1.03	1	1	1	83.516			
			C	1	1.03	1	1	1	83.516			
L2 123.33-86.17	2115.44	6409.75	A	1	1.03	1	1	1	115.296	8454.41	227.51	C
			B	1	1.03	1	1	1	115.296			
			C	1	1.03	1	1	1	115.296			
L3 86.17-37.17	3245.56	13672.47	A	1	1.03	1	1	1	198.469	14709.17	300.19	C
			B	1	1.03	1	1	1	198.469			
			C	1	1.03	1	1	1	198.469			
L4 37.17-0.00	2462.51	14482.52	A	1	1.03	1	1	1	185.210	13578.54	365.31	C
			B	1	1.03	1	1	1	185.210			
			C	1	1.03	1	1	1	185.210			
Sum Weight:	8624.80	37478.30						OTM	2832196.0 0 lb-ft	42575.21		

Tower Forces - Service - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	2312.62	63.07	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33-86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	3325.35	89.49	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17-37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	5799.06	118.35	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	5395.12	145.15	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	1118350.0 2 lb-ft	16832.15		

Tower Forces - Service - Wind 45 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00-123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	2312.62	63.07	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33-86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	3325.35	89.49	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			

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Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L3 86.17- 37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	5799.06	118.35	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	5395.12	145.15	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	1118350.0 2 lb-ft	16832.15		

Tower Forces - Service - Wind 60 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	2312.62	63.07	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	3325.35	89.49	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	5799.06	118.35	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	5395.12	145.15	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	1118350.0 2 lb-ft	16832.15		

Tower Forces - Service - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb							ft ²	lb	plf	
L1 160.00- 123.33	801.29	2297.57	A	1	1.03	1	1	1	80.460	2312.62	63.07	C
			B	1	1.03	1	1	1	80.460			
			C	1	1.03	1	1	1	80.460			
L2 123.33- 86.17	1766.99	5555.12	A	1	1.03	1	1	1	112.199	3325.35	89.49	C
			B	1	1.03	1	1	1	112.199			
			C	1	1.03	1	1	1	112.199			
L3 86.17- 37.17	2510.56	12196.65	A	1	1.03	1	1	1	194.385	5799.06	118.35	C
			B	1	1.03	1	1	1	194.385			
			C	1	1.03	1	1	1	194.385			
L4 37.17-0.00	1904.96	13102.61	A	1	1.03	1	1	1	182.112	5395.12	145.15	C
			B	1	1.03	1	1	1	182.112			
			C	1	1.03	1	1	1	182.112			
Sum Weight:	6983.80	33151.95						OTM	1118350.0 2 lb-ft	16832.15		

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	Verizon Wireless	Staff

Force Totals

Load Case	Vertical Forces lb	Sum of Forces X lb	Sum of Forces Z lb	Sum of Overturning Moments, M_x lb-ft	Sum of Overturning Moments, M_z lb-ft	Sum of Torques lb-ft
Leg Weight	33151.95					
Bracing Weight	0.00					
Total Member Self-Weight	33151.95					
Total Weight	51446.85					
Wind 0 deg - No Ice		0.00	-87917.05	-8334543.98	63.84	-160.33
Wind 30 deg - No Ice		43958.52	-76138.40	-7217936.75	-4167171.07	-353.76
Wind 45 deg - No Ice		62166.74	-62166.74	-5893434.29	-5893296.29	-417.30
Wind 60 deg - No Ice		43958.52	-43958.52	-4167309.07	-7217798.75	-452.40
Wind 90 deg - No Ice		87917.05	0.00	-74.16	-8334405.98	-429.82
Wind 120 deg - No Ice		76138.40	43958.52	4167160.75	-7217798.75	-292.07
Wind 135 deg - No Ice		62166.74	62166.74	5893285.97	-5893296.29	-190.56
Wind 150 deg - No Ice		43958.52	76138.40	7217788.43	-4167171.07	-76.06
Wind 180 deg - No Ice		0.00	87917.05	8334395.66	63.84	160.33
Wind 210 deg - No Ice		-43958.52	76138.40	7217788.43	4167298.75	353.76
Wind 225 deg - No Ice		-62166.74	62166.74	5893285.97	5893423.97	417.30
Wind 240 deg - No Ice		-76138.40	43958.52	4167160.75	7217926.43	452.40
Wind 270 deg - No Ice		-87917.05	0.00	-74.16	8334533.66	429.82
Wind 300 deg - No Ice		-76138.40	-43958.52	-4167309.07	7217926.43	292.07
Wind 315 deg - No Ice		-62166.74	-62166.74	-5893434.29	5893423.97	190.56
Wind 330 deg - No Ice		-43958.52	-76138.40	-7217936.75	4167298.75	76.06
Member Ice	4326.35					
Total Weight Ice	64235.07					
Wind 0 deg - Ice		0.00	-71417.42	-6897243.45	83.71	-151.87
Wind 30 deg - Ice		35708.71	-61849.30	-5973202.01	-3448485.87	-365.07
Wind 45 deg - Ice		50499.74	-50499.74	-4877118.16	-4876930.16	-437.67
Wind 60 deg - Ice		61849.30	-35708.71	-3448673.87	-5973014.01	-480.45
Wind 90 deg - Ice		71417.42	0.00	-104.28	-6897055.45	-467.10
Wind 120 deg - Ice		61849.30	35708.71	3448465.30	-5973014.01	-328.58
Wind 135 deg - Ice		50499.74	50499.74	4876909.59	-4876930.16	-222.90
Wind 150 deg - Ice		35708.71	61849.30	5972993.44	-3448485.87	-102.03
Wind 180 deg - Ice		0.00	71417.42	6897034.88	83.71	151.87
Wind 210 deg - Ice		-35708.71	61849.30	5972993.44	3448653.29	365.07
Wind 225 deg - Ice		-50499.74	50499.74	4876909.59	4877097.59	437.67
Wind 240 deg - Ice		-61849.30	35708.71	3448465.30	5973181.44	480.45
Wind 270 deg - Ice		-71417.42	0.00	-104.28	6897222.88	467.10
Wind 300 deg - Ice		-61849.30	-35708.71	-3448673.87	5973181.44	328.58
Wind 315 deg - Ice		-50499.74	-50499.74	-4877118.16	4877097.59	222.90
Wind 330 deg - Ice		-35708.71	-61849.30	-5973202.01	3448653.29	102.03
Total Weight	51446.85					
Wind 0 deg - Service		0.00	-27134.89	-2572441.39	63.84	-49.48
Wind 30 deg - Service		13567.45	-23499.51	-2227809.53	-1286119.78	-109.19
Wind 45 deg - Service		19187.27	-19187.27	-1819012.47	-1818874.47	-128.80
Wind 60 deg - Service		23499.51	-13567.45	-1286257.77	-2227671.53	-139.63
Wind 90 deg - Service		27134.89	0.00	-74.16	-2572303.39	-132.66
Wind 120 deg - Service		23499.51	13567.45	1286109.46	-2227671.53	-90.15
Wind 135 deg - Service		19187.27	19187.27	1818864.15	-1818874.47	-58.82
Wind 150 deg - Service		13567.45	23499.51	2227661.21	-1286119.78	-23.48
Wind 180 deg - Service		0.00	27134.89	2572293.07	63.84	49.48
Wind 210 deg - Service		-13567.45	23499.51	2227661.21	1286247.45	109.19
Wind 225 deg - Service		-19187.27	19187.27	1818864.15	1819002.15	128.80
Wind 240 deg - Service		-23499.51	13567.45	1286109.46	2227799.21	139.63
Wind 270 deg - Service		-27134.89	0.00	-74.16	2572431.07	132.66
Wind 300 deg - Service		-23499.51	-13567.45	-1286257.77	2227799.21	90.15
Wind 315 deg - Service		-19187.27	-19187.27	-1819012.47	1819002.15	58.82

RISATower

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<i>Load Case</i>	<i>Vertical Forces</i>	<i>Sum of Forces X</i>	<i>Sum of Forces Z</i>	<i>Sum of Overturning Moments, M_x</i>	<i>Sum of Overturning Moments, M_z</i>	<i>Sum of Torques</i>
	<i>lb</i>	<i>lb</i>	<i>lb</i>	<i>lb-ft</i>	<i>lb-ft</i>	<i>lb-ft</i>
Wind 330 deg - Service		-13567.45	-23499.51	-2227809.53	1286247.45	23.48

Load Combinations

<i>Comb. No.</i>	<i>Description</i>
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
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

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Comb. No.	Description
50	Dead+Wind 330 deg - Service

Maximum Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Force lb	Major Axis Moment lb-ft	Minor Axis Moment lb-ft
L1	160 - 123.33	Pole	Max Tension	17	113.82	17651.99	30573.95
			Max. Compression	18	-14690.71	0.00	0.00
			Max. Mx	14	-5778.65	677513.28	6.05
			Max. My	2	-5778.65	2.35	677513.29
			Max. Vy	14	-31930.65	677513.28	6.05
			Max. Vx	2	-31930.65	2.35	677513.29
			Max. Torque	30			0.13
L2	123.33 - 86.17	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-28919.10	0.00	0.00
			Max. Mx	14	-16249.13	2203574.59	19.80
			Max. My	2	-16249.13	7.77	2203574.67
			Max. Vy	14	-51081.83	2203574.59	19.80
			Max. Vx	2	-51081.84	7.77	2203574.67
			Max. Torque	13			0.91
L3	86.17 - 37.17	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-44692.71	83.71	104.28
			Max. Mx	14	-31599.61	5033784.34	73.85
			Max. My	2	-31599.61	64.60	5033794.84
			Max. Vy	14	-68541.51	5033784.34	73.85
			Max. Vx	2	-68541.51	64.60	5033794.84
			Max. Torque	22			479.04
L4	37.17 - 0	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-64235.07	83.71	104.28
			Max. Mx	14	-51372.88	8506514.21	74.59
			Max. My	2	-51372.88	65.06	8506524.77
			Max. Vy	14	-87960.29	8506514.21	74.59
			Max. Vx	2	-87960.29	65.06	8506524.77
			Max. Torque	22			477.49

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical lb	Horizontal, X lb	Horizontal, Z lb
Pole	Max. Vert	31	64235.07	71417.43	-0.00
	Max. H _x	14	51446.85	87917.05	0.00
	Max. H _z	2	51446.85	0.00	87917.05
	Max. M _x	2	8506524.77	0.00	87917.05
	Max. M _z	6	8506383.64	-87917.05	0.00
	Max. Torsion	22	477.08	-61849.31	35708.71
	Min. Vert	1	51446.85	0.00	0.00
	Min. H _x	6	51446.85	-87917.05	0.00
	Min. H _z	10	51446.85	0.00	-87917.05
	Min. M _x	10	-8506373.09	0.00	-87917.05
	Min. M _z	14	-8506514.21	87917.05	0.00
	Min. Torsion	30	-476.91	61849.31	-35708.71

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Tower Mast Reaction Summary

Load Combination	Vertical lb	Shear _x lb	Shear _z lb	Overturning Moment, M _x lb-ft	Overturning Moment, M _z lb-ft	Torque lb-ft
Dead Only	51446.85	0.00	0.00	-74.16	63.84	0.00
Dead+Wind 0 deg - No Ice	51446.85	-0.00	-87917.05	-8506524.77	65.02	-158.79
Dead+Wind 30 deg - No Ice	51446.85	43958.52	-76138.40	-7366878.03	-4253161.01	-350.14
Dead+Wind 45 deg - No Ice	51446.85	62166.74	-62166.74	-6015044.21	-6014904.70	-413.02
Dead+Wind 60 deg - No Ice	51446.85	76138.40	-43958.52	-4253300.21	-7366738.01	-447.75
Dead+Wind 90 deg - No Ice	51446.85	87917.05	-0.00	-74.49	-8506383.64	-425.30
Dead+Wind 120 deg - No Ice	51446.85	76138.40	43958.52	4253150.56	-7366736.84	-288.89
Dead+Wind 135 deg - No Ice	51446.85	62166.74	62166.74	6014893.88	-6014903.35	-188.45
Dead+Wind 150 deg - No Ice	51446.85	43958.52	76138.40	7366727.02	-4253159.83	-75.16
Dead+Wind 180 deg - No Ice	51446.85	-0.00	87917.05	8506373.09	65.02	158.79
Dead+Wind 210 deg - No Ice	51446.85	-43958.52	76138.40	7366727.26	4253290.00	350.20
Dead+Wind 225 deg - No Ice	51446.85	-62166.74	62166.74	6014894.15	6015033.65	413.02
Dead+Wind 240 deg - No Ice	51446.85	-76138.40	43958.52	4253150.80	7366867.28	447.68
Dead+Wind 270 deg - No Ice	51446.85	-87917.05	-0.00	-74.49	8506514.21	425.30
Dead+Wind 300 deg - No Ice	51446.85	-76138.40	-43958.52	-4253300.44	7366868.45	288.95
Dead+Wind 315 deg - No Ice	51446.85	-62166.74	-62166.74	-6015044.48	6015035.01	188.45
Dead+Wind 330 deg - No Ice	51446.85	-43958.52	-76138.40	-7366878.26	4253291.18	75.10
Dead+Ice+Temp	64235.07	0.00	0.00	-104.28	83.71	0.00
Dead+Wind 0 deg+Ice+Temp	64235.07	0.00	-71417.43	-7110979.04	86.51	-150.92
Dead+Wind 30 deg+Ice+Temp	64235.07	35708.71	-61849.31	-6158302.38	-3555349.71	-362.45
Dead+Wind 45 deg+Ice+Temp	64235.07	50499.75	-50499.75	-5028252.11	-5028059.29	-434.57
Dead+Wind 60 deg+Ice+Temp	64235.07	61849.31	-35708.71	-3555542.10	-6158108.82	-477.08
Dead+Wind 90 deg+Ice+Temp	64235.07	71417.43	0.00	-106.31	-7110783.87	-463.65
Dead+Wind 120 deg+Ice+Temp	64235.07	61849.31	35708.71	3555328.51	-6158107.12	-325.99
Dead+Wind 135 deg+Ice+Temp	64235.07	50499.75	50499.75	5028037.54	-5028057.33	-221.13
Dead+Wind 150 deg+Ice+Temp	64235.07	35708.71	61849.31	6158086.83	-3555348.01	-101.21
Dead+Wind 180 deg+Ice+Temp	64235.07	0.00	71417.43	7110762.51	86.51	150.92
Dead+Wind 210 deg+Ice+Temp	64235.07	-35708.71	61849.31	6158087.17	3555521.24	362.62
Dead+Wind 225 deg+Ice+Temp	64235.07	-50499.75	50499.75	5028037.93	5028230.75	434.57
Dead+Wind 240 deg+Ice+Temp	64235.07	-61849.31	35708.71	3555328.85	6158280.74	476.91
Dead+Wind 270 deg+Ice+Temp	64235.07	-71417.43	0.00	-106.31	7110957.69	463.65
Dead+Wind 300 deg+Ice+Temp	64235.07	-61849.31	-35708.71	-3555542.44	6158282.44	326.16
Dead+Wind 315 deg+Ice+Temp	64235.07	-50499.75	-50499.75	-5028252.51	5028232.71	221.13
Dead+Wind 330 deg+Ice+Temp	64235.07	-35708.71	-61849.31	-6158302.73	3555522.94	101.04
Dead+Wind 0 deg - Service	51446.85	-0.00	-27134.89	-2631350.62	65.81	-49.51
Dead+Wind 30 deg - Service	51446.85	13567.45	-23499.51	-2278827.97	-1315572.06	-109.19
Dead+Wind 45 deg - Service	51446.85	19187.27	-19187.27	-1860669.24	-1860527.09	-128.79
Dead+Wind 60 deg - Service	51446.85	23499.51	-13567.45	-1315714.18	-2278685.77	-139.61
Dead+Wind 90 deg - Service	51446.85	27134.89	-0.00	-76.35	-2631208.31	-132.62
Dead+Wind 120 deg - Service	51446.85	23499.51	13567.45	1315561.43	-2278685.66	-90.09
Dead+Wind 135 deg - Service	51446.85	19187.27	19187.27	1860516.42	-1860526.96	-58.76
Dead+Wind 150 deg - Service	51446.85	13567.45	23499.51	2278675.08	-1315571.94	-23.43
Dead+Wind 180 deg - Service	51446.85	-0.00	27134.89	2631197.66	65.81	49.51
Dead+Wind 210 deg - Service	51446.85	-13567.45	23499.51	2278675.11	1315703.58	109.19
Dead+Wind 225 deg - Service	51446.85	-19187.27	19187.27	1860516.44	1860658.60	128.79
Dead+Wind 240 deg - Service	51446.85	-23499.51	13567.45	1315561.45	2278817.31	139.60
Dead+Wind 270 deg - Service	51446.85	-27134.89	-0.00	-76.35	2631339.98	132.62
Dead+Wind 300 deg - Service	51446.85	-23499.51	-13567.45	-1315714.21	2278817.43	90.09
Dead+Wind 315 deg - Service	51446.85	-19187.27	-19187.27	-1860669.27	1860658.73	58.76
Dead+Wind 330 deg - Service	51446.85	-13567.45	-23499.51	-2278828.00	1315703.69	23.43

Solution Summary

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Load Comb.	Sum of Applied Forces			Sum of Reactions			% Error
	PX lb	PY lb	PZ lb	PX lb	PY lb	PZ lb	
1	0.00	-51446.85	0.00	0.00	51446.85	0.00	0.000%
2	0.00	-51446.85	-87917.05	0.00	51446.85	87917.05	0.000%
3	43958.52	-51446.85	-76138.40	-43958.52	51446.85	76138.40	0.000%
4	62166.74	-51446.85	-62166.74	-62166.74	51446.85	62166.74	0.000%
5	76138.40	-51446.85	-43958.52	-76138.40	51446.85	43958.52	0.000%
6	87917.05	-51446.85	0.00	-87917.05	51446.85	0.00	0.000%
7	76138.40	-51446.85	43958.52	-76138.40	51446.85	-43958.52	0.000%
8	62166.74	-51446.85	62166.74	-62166.74	51446.85	-62166.74	0.000%
9	43958.52	-51446.85	76138.40	-43958.52	51446.85	-76138.40	0.000%
10	0.00	-51446.85	87917.05	0.00	51446.85	-87917.05	0.000%
11	-43958.52	-51446.85	76138.40	43958.52	51446.85	-76138.40	0.000%
12	-62166.74	-51446.85	62166.74	62166.74	51446.85	-62166.74	0.000%
13	-76138.40	-51446.85	43958.52	76138.40	51446.85	-43958.52	0.000%
14	-87917.05	-51446.85	0.00	87917.05	51446.85	0.00	0.000%
15	-76138.40	-51446.85	-43958.52	76138.40	51446.85	43958.52	0.000%
16	-62166.74	-51446.85	-62166.74	62166.74	51446.85	62166.74	0.000%
17	-43958.52	-51446.85	-76138.40	43958.52	51446.85	76138.40	0.000%
18	0.00	-64235.07	0.00	0.00	64235.07	0.00	0.000%
19	0.00	-64235.07	-71417.42	-0.00	64235.07	71417.43	0.000%
20	35708.71	-64235.07	-61849.30	-35708.71	64235.07	61849.31	0.000%
21	50499.74	-64235.07	-50499.74	-50499.75	64235.07	50499.75	0.000%
22	61849.30	-64235.07	-35708.71	-61849.31	64235.07	35708.71	0.000%
23	71417.42	-64235.07	0.00	-71417.43	64235.07	-0.00	0.000%
24	61849.30	-64235.07	35708.71	-61849.31	64235.07	-35708.71	0.000%
25	50499.74	-64235.07	50499.74	-50499.75	64235.07	-50499.75	0.000%
26	35708.71	-64235.07	61849.30	-35708.71	64235.07	-61849.31	0.000%
27	0.00	-64235.07	71417.42	-0.00	64235.07	-71417.43	0.000%
28	-35708.71	-64235.07	61849.30	35708.71	64235.07	-61849.31	0.000%
29	-50499.74	-64235.07	50499.74	50499.75	64235.07	-50499.75	0.000%
30	-61849.30	-64235.07	35708.71	61849.31	64235.07	-35708.71	0.000%
31	-71417.42	-64235.07	0.00	71417.43	64235.07	-0.00	0.000%
32	-61849.30	-64235.07	-35708.71	61849.31	64235.07	35708.71	0.000%
33	-50499.74	-64235.07	-50499.74	50499.75	64235.07	50499.75	0.000%
34	-35708.71	-64235.07	-61849.30	35708.71	64235.07	61849.31	0.000%
35	0.00	-51446.85	-27134.89	0.00	51446.85	27134.89	0.000%
36	13567.45	-51446.85	-23499.51	-13567.45	51446.85	23499.51	0.000%
37	19187.27	-51446.85	-19187.27	-19187.27	51446.85	19187.27	0.000%
38	23499.51	-51446.85	-13567.45	-23499.51	51446.85	13567.45	0.000%
39	27134.89	-51446.85	0.00	-27134.89	51446.85	0.00	0.000%
40	23499.51	-51446.85	13567.45	-23499.51	51446.85	-13567.45	0.000%
41	19187.27	-51446.85	19187.27	-19187.27	51446.85	-19187.27	0.000%
42	13567.45	-51446.85	23499.51	-13567.45	51446.85	-23499.51	0.000%
43	0.00	-51446.85	27134.89	0.00	51446.85	-27134.89	0.000%
44	-13567.45	-51446.85	23499.51	13567.45	51446.85	-23499.51	0.000%
45	-19187.27	-51446.85	19187.27	19187.27	51446.85	-19187.27	0.000%
46	-23499.51	-51446.85	13567.45	23499.51	51446.85	-13567.45	0.000%
47	-27134.89	-51446.85	0.00	27134.89	51446.85	0.00	0.000%
48	-23499.51	-51446.85	-13567.45	23499.51	51446.85	13567.45	0.000%
49	-19187.27	-51446.85	-19187.27	19187.27	51446.85	19187.27	0.000%
50	-13567.45	-51446.85	-23499.51	13567.45	51446.85	23499.51	0.000%

Non-Linear Convergence Results

Load Combination	Converged?	Number of Cycles	Displacement Tolerance	Force Tolerance
1	Yes	4	0.00000001	0.00000001

RISATower

URS Corporation
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 Rocky Hill, CT 06067
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 FAX: (860) 529-3991

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2	Yes	4	0.00000001	0.00004230
3	Yes	5	0.00000001	0.00021702
4	Yes	5	0.00000001	0.00020253
5	Yes	5	0.00000001	0.00021789
6	Yes	4	0.00000001	0.00004950
7	Yes	5	0.00000001	0.00021708
8	Yes	5	0.00000001	0.00020253
9	Yes	5	0.00000001	0.00021748
10	Yes	4	0.00000001	0.00004230
11	Yes	5	0.00000001	0.00021778
12	Yes	5	0.00000001	0.00020253
13	Yes	5	0.00000001	0.00021691
14	Yes	4	0.00000001	0.00004950
15	Yes	5	0.00000001	0.00021772
16	Yes	5	0.00000001	0.00020253
17	Yes	5	0.00000001	0.00021732
18	Yes	4	0.00000001	0.00000001
19	Yes	5	0.00000001	0.00010471
20	Yes	5	0.00000001	0.00076644
21	Yes	5	0.00000001	0.00083191
22	Yes	5	0.00000001	0.00076870
23	Yes	5	0.00000001	0.00010473
24	Yes	5	0.00000001	0.00076650
25	Yes	5	0.00000001	0.00083187
26	Yes	5	0.00000001	0.00076764
27	Yes	5	0.00000001	0.00010471
28	Yes	5	0.00000001	0.00076839
29	Yes	5	0.00000001	0.00083191
30	Yes	5	0.00000001	0.00076612
31	Yes	5	0.00000001	0.00010474
32	Yes	5	0.00000001	0.00076833
33	Yes	5	0.00000001	0.00083194
34	Yes	5	0.00000001	0.00076718
35	Yes	4	0.00000001	0.00003640
36	Yes	5	0.00000001	0.00003289
37	Yes	5	0.00000001	0.00003768
38	Yes	5	0.00000001	0.00003308
39	Yes	4	0.00000001	0.00003699
40	Yes	5	0.00000001	0.00003290
41	Yes	5	0.00000001	0.00003767
42	Yes	5	0.00000001	0.00003298
43	Yes	4	0.00000001	0.00003639
44	Yes	5	0.00000001	0.00003305
45	Yes	5	0.00000001	0.00003768
46	Yes	5	0.00000001	0.00003287
47	Yes	4	0.00000001	0.00003699
48	Yes	5	0.00000001	0.00003304
49	Yes	5	0.00000001	0.00003768
50	Yes	5	0.00000001	0.00003296

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	160 - 123.33	44.626	35	2.6322	0.0002
L2	128 - 86.17	28.083	35	2.1788	0.0002
L3	92 - 37.17	14.051	35	1.4817	0.0002
L4	44.5 - 0	3.237	50	0.6584	0.0001

<i>RISATower</i> URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	160 Ft. Valmont Monopole - Orange, CT	Page	18 of 20
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Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
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Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
167.00	(3) DB844H90E-XY	35	44.626	2.6322	0.0002	16591
163.00	(4) 8"x2 1/2" Pipe Mount	35	44.626	2.6322	0.0002	16591
155.20	LPA-80063/6CF	35	42.029	2.5696	0.0002	16591
145.70	(3) DUO1417-8686	35	36.950	2.4428	0.0002	5800
143.70	Valmont 13' Platform w/Rails	35	35.901	2.4152	0.0002	5088
134.10	(2) DB980H90E-M	35	31.015	2.2756	0.0002	3201
131.80	Valmont 13' Platform w/Rails	35	29.892	2.2399	0.0002	2941
121.90	(2) RR90-17-02DP	35	25.317	2.0743	0.0002	2686
119.90	Valmont 13' Platform w/Rails	35	24.447	2.0385	0.0002	2720
109.40	(4) 7184.14	35	20.162	1.8396	0.0002	2908
108.00	Valmont 13' Platform w/Rails	35	19.626	1.8119	0.0002	2935
83.40	GPS	35	11.452	1.2992	0.0002	3213

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	160 - 123.33	143.706	2	8.4825	0.0006
L2	128 - 86.17	90.541	2	7.0252	0.0006
L3	92 - 37.17	45.354	2	4.7823	0.0006
L4	44.5 - 0	10.461	2	2.1270	0.0002

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
167.00	(3) DB844H90E-XY	2	143.706	8.4825	0.0006	5348
163.00	(4) 8"x2 1/2" Pipe Mount	2	143.706	8.4825	0.0006	5348
155.20	LPA-80063/6CF	2	135.360	8.2838	0.0006	5348
145.70	(3) DUO1417-8686	2	119.044	7.8797	0.0006	1867
143.70	Valmont 13' Platform w/Rails	2	115.672	7.7913	0.0006	1637
134.10	(2) DB980H90E-M	2	99.970	7.3408	0.0006	1027
131.80	Valmont 13' Platform w/Rails	2	96.357	7.2249	0.0006	943
121.90	(2) RR90-17-02DP	2	81.643	6.6821	0.0006	857
119.90	Valmont 13' Platform w/Rails	2	78.842	6.5642	0.0006	867
109.40	(4) 7184.14	2	65.049	5.9132	0.0006	922
108.00	Valmont 13' Platform w/Rails	2	63.322	5.8234	0.0006	930
83.40	GPS	2	36.972	4.2352	0.0005	1008

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Compression Checks

Pole Design Data

Section No.	Elevation ft	Size	L ft	L _u ft	Kl/r	F _a ksi	A in ²	Actual P lb	Allow. P _a lb	Ratio $\frac{P}{P_a}$
L1	160 - 123.33 (1)	TP31.46x21.2x0.219 H1-3+VT (1.51 CR) - 1	36.67	160.00	179.2	4.652	21.1091	-5778.69	98203.10	0.059
L2	123.33 - 86.17 (2)	TP41.44x29.7154x0.344 H1-3+VT (1.66 CR) - 2	41.83	160.00	135.9	8.085	43.7112	-16249.10	353397.00	0.046
L3	86.17 - 37.17 (3)	TP54.46x39.1179x0.438 H1-3+VT (1.70 CR) - 3	54.83	160.00	103.2	14.023	73.2978	-31599.60	1027840.00	0.031
L4	37.17 - 0 (4)	TP64x51.533x0.469 H1-3+VT (1.90 CR) - 4	44.50	160.00	84.4	20.231	95.9432	-51372.90	1940990.00	0.026

Pole Bending Design Data

Section No.	Elevation ft	Size	Actual M _x lb-ft	Actual f _{bx} ksi	Allow. F _{bx} ksi	Ratio $\frac{f_{bx}}{F_{bx}}$	Actual M _y lb-ft	Actual f _{by} ksi	Allow. F _{by} ksi	Ratio $\frac{f_{by}}{F_{by}}$
L1	160 - 123.33 (1)	TP31.46x21.2x0.219	677513.33	52.598	36.424	1.444	0.00	0.000	36.424	0.000
L2	123.33 - 86.17 (2)	TP41.44x29.7154x0.344	2203575.00	62.756	39.000	1.609	0.00	0.000	39.000	0.000
L3	86.17 - 37.17 (3)	TP54.46x39.1179x0.438	5033816.67	64.896	39.000	1.664	0.00	0.000	39.000	0.000
L4	37.17 - 0 (4)	TP64x51.533x0.469	8506583.33	68.466	36.617	1.870	0.00	0.000	36.617	0.000

Pole Shear Design Data

Section No.	Elevation ft	Size	Actual V lb	Actual f _v ksi	Allow. F _v ksi	Ratio $\frac{f_v}{F_v}$	Actual T lb-ft	Actual f _{vt} ksi	Allow. F _{vt} ksi	Ratio $\frac{f_{vt}}{F_{vt}}$
L1	160 - 123.33 (1)	TP31.46x21.2x0.219	31930.90	1.513	26.000	0.118	0.03	0.000	26.000	0.000
L2	123.33 - 86.17 (2)	TP41.44x29.7154x0.344	51082.00	1.169	26.000	0.091	0.54	0.000	26.000	0.000
L3	86.17 - 37.17 (3)	TP54.46x39.1179x0.438	68541.50	0.935	26.000	0.073	289.43	0.002	26.000	0.000
L4	37.17 - 0 (4)	TP64x51.533x0.469	87960.30	0.917	26.000	0.072	188.45	0.001	26.000	0.000

Pole Interaction Design Data

RISATower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	160 Ft. Valmont Monopole - Orange, CT	Page	20 of 20
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	Client	Verizon Wireless	Designed by	Staff

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	160 - 123.33 (1)	0.059	1.444	0.000	0.118	0.000	1.506 X	1.333	H1-3+VT X
L2	123.33 - 86.17 (2)	0.046	1.609	0.000	0.091	0.000	1.657 X	1.333	H1-3+VT X
L3	86.17 - 37.17 (3)	0.031	1.664	0.000	0.073	0.000	1.696 X	1.333	H1-3+VT X
L4	37.17 - 0 (4)	0.026	1.870	0.000	0.072	0.000	1.897 X	1.333	H1-3+VT X

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P lb	SF* P_{allow} lb	% Capacity	Pass Fail
L1	160 - 123.33	Pole	TP31.46x21.2x0.219	1	-5778.69	130904.73	113.0	Fail X
L2	123.33 - 86.17	Pole	TP41.44x29.7154x0.344	2	-16249.10	471078.18	124.3	Fail X
L3	86.17 - 37.17	Pole	TP54.46x39.1179x0.438	3	-31599.60	1370110.66	127.2	Fail X
L4	37.17 - 0	Pole	TP64x51.533x0.469	4	-51372.90	2587339.56	142.3	Fail X
							Summary	
							Pole (L4)	142.3 Fail X
							RATING =	142.3 Fail X

ANCHOR BOLT AND BASE PLATE ANALYSIS

ANCHOR BOLT AND BASE PLATE ANALYSIS

Input Data

Tower Reactions:

Overturing Moment:	OM := 8507·ft·kips	<i>user input</i>
Shear Force:	Shear := 88.0·kips	<i>user input</i>
Axial Force:	Axial := 51.5·kips	<i>user input</i>

Anchor Bolt Data:

Use ASTM A615 Grade 75

Number of Anchor Bolts = N	$N := 24$	<i>user input</i>
Diameter of Bolt Circle:	$D_{bc} := 72.76\text{in}$	<i>user input</i>
Bolt "Column" Distance:	$L := 3\text{in}$	<i>user input</i>
Bolt Ultimate Strength:	$F_u := 100\text{-ksi}$	<i>user input</i>
Bolt Yield Strength:	$F_y := 75\text{-ksi}$	<i>user input</i>
Bolt Modulus:	$E := 29000\text{-ksi}$	<i>user input</i>
Thickness Of Anchor Bolts	$D := 2.25\text{in}$	<i>user input</i>
Threads per Inch:	$n := 4.5$	<i>user input</i>

Base Plate Data:

Plate Yield Strength:	$F_{y_{bp}} := 60\text{-ksi}$	<i>user input</i>
Base Plate Thickness:	PlateThickness := 3·in	<i>user input</i>
Base Plate Diameter:	$D_{bp} := 78.76\text{-in}$	<i>user input</i>
Outer Pole Diameter:	$D_{pole} := 64\text{in}$	<i>user input</i>

Geometric Layout Data:

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

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

Distance to Bolts: $i := 1..N$

$$d_i := \begin{cases} \theta \leftarrow 2 \cdot \pi \cdot \left(\frac{i}{N} \right) \\ d \leftarrow R_{bc} \cdot \sin(\theta) \end{cases}$$

$d_1 = 9.42 \text{ in}$	$d_7 = 35.14 \text{ in}$
$d_2 = 18.19 \text{ in}$	$d_8 = 31.51 \text{ in}$
$d_3 = 25.72 \text{ in}$	$d_9 = 25.72 \text{ in}$
$d_4 = 31.51 \text{ in}$	$d_{10} = 18.19 \text{ in}$
$d_5 = 35.14 \text{ in}$	$d_{11} = 9.42 \text{ in}$
$d_6 = 36.38 \text{ in}$	etc.

Critical Distances For Bending in Plate:

Outer Pole Radius: $R_{pole} := \frac{D_{pole}}{2}$ $R_{pole} = 32.00 \text{ in}$

Moment Arms of Bolts about Neutral Axis: $MA_i := \text{if}(d_i \geq R_{pole}, d_i - R_{pole}, 0 \text{ in})$

$MA_1 = 0.00 \text{ in}$	$MA_7 = 3.14 \text{ in}$
$MA_2 = 0.00 \text{ in}$	$MA_8 = 0.00 \text{ in}$
$MA_3 = 0.00 \text{ in}$	$MA_9 = 0.00 \text{ in}$
$MA_4 = 0.00 \text{ in}$	$MA_{10} = 0.00 \text{ in}$
$MA_5 = 3.14 \text{ in}$	$MA_{11} = 0.00 \text{ in}$
$MA_6 = 4.38 \text{ in}$	etc.

Effective Width of Baseplate for Bending: $\text{EffectiveWidth} := .90 \cdot 2 \cdot \sqrt{\left(\frac{D_{bp}}{2} \right)^2 - \left(\frac{D_{pole}}{2} \right)^2}$ $\text{EffectiveWidth} = 41.31 \text{ in}$

Anchor Bolt Analysis:

Polar Moment of Inertia I_p :

$$I_p := \sum_i (d_i)^2 \quad I_p = 1.588 \times 10^4 \text{ in}^2$$

Gross Area of Bolt:

$$A_g := \frac{\pi}{4} \cdot D^2 \quad A_g = 3.976 \text{ in}^2$$

Net Area of Bolt:

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

Net Diameter:

$$D_n := \frac{2 \cdot \sqrt{A_n}}{\sqrt{\pi}} \quad D_n = 2.03 \text{ in}$$

Radius of Gyration of Bolt:

$$r := \frac{D_n}{4} \quad r = 0.51 \text{ in}$$

Section Modulus of Bolt:

$$S_x := \frac{\pi \cdot D_n^3}{32} \quad S_x = 0.826 \text{ in}^3$$

Anchor Bolt Bending Stress:

Maximum Applied Bending:

$$M_x := \left(\frac{\text{Shear}}{N} \right) \cdot l \quad M_x = 0.917 \text{ ft-kips}$$

$$f_{bx} := \frac{M_x}{S_x} \quad f_{bx} = 13.3 \text{ ksi}$$

Allowable Bending

$$F_{bx} := 1.33 \cdot 0.60 \cdot F_y \quad F_{bx} = 59.9 \text{ ksi}$$

Note: 1.33 increase allowed per TIA/EIA

Check Tensile Forces:

Allowable Tensile Force:

$$\text{AllowableTension} := 1.33 \cdot (0.33 \cdot A_g \cdot F_u) \quad \text{AllowableTension} = 174.5 \text{ kips}$$

Note: 1.33 increase allowed per TIA/EIA

Maximum Tensile Force (Net Area):

$$F_{\text{net.area}} := 1.33 \cdot (0.60 \cdot A_n \cdot F_y) \quad F_{\text{net.area}} = 194.4 \text{ kips}$$

Note: 1.33 increase allowed per TIA/EIA

Applied Tension:

$$\text{MaxTension} := \frac{OM \cdot R_{bc}}{I_p} - \frac{\text{Axial}}{N} \quad \text{MaxTension} = 231.7 \text{ kips}$$

Check Stresses:

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

$$\frac{\text{MaxTension}}{F_{\text{net.area}}} = 1.19$$

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

Condition = "Overstressed"

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:

$$l_w := \begin{cases} 1 & \text{if } l > 2 \cdot D_n \\ 0.00 \text{ in} & \text{otherwise} \end{cases} \quad l = 0.00 \text{ in} \quad f_{bx} := \begin{cases} f_{bx} & \text{if } l > 2 \cdot D_n \\ 0.0 \text{ ksi} & \text{otherwise} \end{cases} \quad f_{bx} = 0.0 \text{ ksi}$$

Allowable Compressive Force:

$$K := 0.65$$

$$C_c := \sqrt{\frac{2 \cdot \pi^2 \cdot E}{F_y}} \quad C_c = 87.36$$

$$F_a := \begin{cases} \frac{\left[1 - \frac{\left(\frac{K \cdot l}{r} \right)^2}{2 \cdot C_c^2} \right] \cdot F_y}{\frac{5}{3} + \frac{3 \cdot \left(\frac{K \cdot l}{r} \right)}{8 \cdot C_c} - \frac{\left(\frac{K \cdot l}{r} \right)^3}{8 \cdot C_c^3}} & \text{if } \frac{K \cdot l}{r} \leq C_c \\ \frac{12 \cdot \pi^2 \cdot E}{23 \cdot \left(\frac{K \cdot l}{r} \right)^2} & \text{if } \frac{K \cdot l}{r} > C_c \end{cases} \quad F_a = 45.0 \text{ ksi}$$

$$F_a := 1.33 \cdot F_a \quad \text{Note: 1.33 increase allowed per TIA/EIA} \quad F_a = 59.9 \text{ ksi}$$

Applied Compressive Force:

$$\text{MaxCompression} := \frac{OM \cdot R_{bc}}{I_p} + \frac{\text{Axial}}{N} \quad \text{MaxCompression} = 236.0 \text{ kips}$$

$$f_a := \frac{\text{MaxCompression}}{A_n} \quad f_a = 72.7 \text{ ksi}$$

Check Combined Stresses:

$$\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} = 1.21$$

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

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Base Plate Analysis:

Force from Bolt(s):

$$C_i := \frac{OM \cdot d_i}{I_p} + \frac{Axial}{N}$$

$$C_1 = 62.7 \text{ kips}$$

$$C_7 = 228.0 \text{ kips}$$

$$C_2 = 119.1 \text{ kips}$$

$$C_8 = 204.7 \text{ kips}$$

$$C_3 = 167.5 \text{ kips}$$

$$C_9 = 167.5 \text{ kips}$$

$$C_4 = 204.7 \text{ kips}$$

$$C_{10} = 119.1 \text{ kips}$$

$$C_5 = 228.0 \text{ kips}$$

$$C_{11} = 62.7 \text{ kips}$$

$$C_6 = 236.0 \text{ kips}$$

etc.

Bending Stress in Plate:

$$f_{bp} := \sum_i \frac{6 \cdot C_i \cdot MA_i}{\text{EffectiveWidth} \cdot \text{PlateThickness}^2}$$

$$f_{bp} = 39.8 \text{ ksi}$$

Check Stresses:

$$\frac{f_{bp}}{1.33 \cdot 0.75 F_{y_{bp}}} = 0.66$$

$$\text{Condition} := \text{if} \left(\frac{f_{bp}}{1.33 \cdot 0.75 F_{y_{bp}}} < 1.00, \text{"OK"}, \text{"Overstressed"} \right)$$

Condition = "OK"

FOUNDATION ANALYSIS

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MONOPOLE FOUNDATION ANALYSIS

TOWER FORCES:

Moment Caused by Tower $M_t := 8507 \cdot \text{ft} \cdot \text{kips}$
Shear at Base of Tower $S_t := 88.0 \cdot \text{kip}$
Max Compressive Force $C_t := 51.5 \cdot \text{kip}$
Height of Tower $H_t := 160 \cdot \text{ft}$
Base Plate Bolt Circle $MP := 6.06 \cdot \text{ft}$

FOOTING DIMENSIONS:

Overall Depth of Footing $D_f := 14.0 \cdot \text{ft}$
Length of Pier $L_p := 10 \cdot \text{ft}$
Extension of Pier Above Grade $L_{pag} := .5 \cdot \text{ft}$
Diameter of Pier $d_p := 8 \cdot \text{ft}$
Thickness of Footing $T_f := 4.0 \cdot \text{ft}$
Width of Footing: $W_f := 22 \cdot \text{ft}$
Length of Anchor Bolts: $L_{st} := 132 \cdot \text{in}$
Projection of anchor bolts above pier $A_{BP} := 10 \cdot \text{in}$
Anchor bolts area $A_{anchor} := 3.97 \cdot \text{in}^2$

PIER REINFORCEMENT:

Bar Size $BS_{pier} := 11$ Bar Diameter $d_{bpier} := 1.41 \cdot \text{in}$
Number of Bars $NB_{pier} := 31$ Bar Area $A_{bpier} := 1.56 \cdot \text{in}^2$

PAD REINFORCEMENT:

TOP: Bar Size $BS_{top} := 9$ Bar Diameter $d_{btop} := 1.128 \cdot \text{in}$
Number of Bars $NB_{top} := 35$ Bar Area $A_{btop} := 1.00 \cdot \text{in}^2$

BOTTOM: Bar Size $BS_{bot} := 10$ Bar Diameter $d_{bbot} := 1.27 \cdot \text{in}$
Number of Bars $NB_{bot} := 35$ Bar Area $A_{bot} := 1.27 \cdot \text{in}^2$

Coefficient of Lateral Soil Pressure: $K_p := \frac{1 + \sin(\phi_s)}{1 - \sin(\phi_s)}$ $K_p = 3.8518$

Load Factor (EIA 3.1.1): $LF := \text{if } H_t \leq 700 \cdot \text{ft}, 1.3, \text{if } H_t \geq 1200, 1.7, 1.3 + \left(\frac{H_t - 700}{1200 - 700} \right) \cdot 0.4 \Bigg] \quad LF = 1.3$

PROPERTIES:

Compressive Strength of Concrete $f_c := 4000 \cdot \text{psi}$
Yield Strength of Steel Reinforcement $f_y := 60000 \cdot \text{psi}$
Yield Strength of Anchor Bolt $f_{ya} := 75000 \cdot \text{psi}$
Internal Friction Angle of Soil $\phi_s := 36 \cdot \text{deg}$
Allowable Bearing Capacity $q_s := 10000 \cdot \text{psf}$
Unit Weight of Soil $\gamma_s := 125 \cdot \text{pcf}$
Unit Weight of Concrete $\gamma_c := 150 \cdot \text{pcf}$
Depth to Neglect $n := 0 \cdot \text{ft}$
Cohesion of Clay Type Soil $c := 0 \cdot \text{ksf}$
Note: Use 0 for Sandy Soil
Seismic Zone Factor: $Z := 2$
UBC Fig 23-2
Coefficient of Friction between soil and Concrete: $\mu := 0.45$
Clear Cover of Reinforcement Pier: $C_{vr_pier} := 3 \cdot \text{in}$
Clear Cover of Reinforcement Pad: $C_{vr_pad} := 3 \cdot \text{in}$
Anchor Bolt Diameter $d_{anchor} := 2.25 \cdot \text{in}$

CHECK ANCHOR STEEL EMBEDMENT

Depth: $D_{ab} := L_{st} - A_{BP}$ $D_{ab} = 10.1667 \text{ ft}$ $L_{anchor} := \frac{(0.11 \cdot f_y) \cdot \text{in}}{\sqrt{f_c \cdot \text{psi}}}$ $L_{anchor} = 8.6963 \text{ ft}$

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

DepthCheck = "Okay" **Note: anchor plate is provided**

STABILITY OF FOOTING

Passive Pressure: $P_{pn} := K_p \cdot \gamma_s \cdot n + c \cdot 2 \cdot \sqrt{K_p}$ $P_{pn} = 0 \text{ ksf}$

$P_{pt} := K_p \cdot \gamma_s \cdot (D_f - T_f) + c \cdot 2 \cdot \sqrt{K_p}$ $P_{pt} = 4.8148 \text{ ksf}$

$P_{top} := \text{if}[n < (D_f - T_f), P_{pt}, P_{pn}]$ $P_{top} = 4.8148 \text{ ksf}$

$P_{bot} := K_p \cdot \gamma_s \cdot D_f + c \cdot 2 \cdot \sqrt{K_p}$ $P_{bot} = 6.7407 \text{ ksf}$

$P_{ave} := \frac{P_{top} + P_{bot}}{2}$ $P_{ave} = 5.7778 \text{ ksf}$

$T_p := \text{if}[n < (D_f - T_f), T_f, (D_f - n)]$ $T_p = 4 \text{ ft}$

$A_p := W_f \cdot T_p$ $A_p = 88 \text{ ft}^2$

Ultimate Shear: $S_u := P_{ave} \cdot A_p$ $S_u = 508.4429 \text{ kip}$

Weight of Concrete Pad: $WT_c := \left[(W_f^2 \cdot T_f) + d_p^2 \cdot L_p \right] \cdot \gamma_c$ $WT_c = 386.4 \text{ kip}$

Weight of Soil above Footing: $WT_{s1} := \left[W_f^2 \cdot (|L_p - L_{pag}|) - \frac{d_p^2 \cdot \pi}{4} \cdot (|L_p - L_{pag}|) \right] \cdot \gamma_s$ $WT_{s1} = 515.0597 \text{ kip}$

Weight of Soil Wedge at back face: $WT_{s2} := \left(\frac{D_f^2 \cdot \tan(\phi_s)}{2} \cdot W_f \right) \cdot \gamma_s$ $WT_{s2} = 195.8032 \text{ kip}$

Total Weight: $WT_{tot} := WT_c + WT_{s1} + C_t$ $WT_{tot} = 952.9597 \text{ kip}$

Resisting Moment: $M_r := (WT_{tot}) \cdot \frac{W_f}{2} + S_u \cdot \frac{T_f}{3} + WT_{s2} \cdot \left(W_f + \frac{D_f \tan(\phi_s)}{3} \right)$ $M_r = 16132.0286 \text{ kip} \cdot \text{ft}$

Overturning Moment: $M_{ot} := M_t + S_t \cdot (L_p + T_f)$ $M_{ot} = 9739 \text{ kip} \cdot \text{ft}$

Factor of Safety: $FS := \frac{M_r}{M_{ot}}$ $FS_{req} := 2$ $FS = 1.66$

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

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SHEAR CAPACITY IN PIER

FS := 2

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

$$S_p = 468.6374 \text{ kips}$$

$$\text{ShearCheck} := \text{if}(S_p > S_t, \text{"Okay"}, \text{"No Good"})$$

$$\text{ShearCheck} = \text{"Okay"}$$

BEARING PRESSURE CAUSED BY FOOTING

$$A_{mat} := W_f^2$$

$$A_{mat} = 484 \text{ ft}^2$$

$$S := \frac{W_f^3}{6}$$

$$S = 1774.6667 \text{ ft}^3$$

$$P_{max} := \frac{W_{T_{tot}}}{A_{mat}} + \frac{M_{ot}}{S}$$

$$P_{max} = 7.4567 \text{ ksf}$$

$$P_{min} := \frac{W_{T_{tot}}}{A_{mat}} - \frac{M_{ot}}{S}$$

$$P_{min} = -3.5189 \text{ ksf}$$

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

$$\text{MaxPressure} = \text{"Okay"}$$

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

$$\text{MinPressure} = \text{"No Good"}$$

Distance to Resultant of Pressure Distribution:

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

$$X_p = 4.9822 \text{ ft}$$

Distance to Kern:

$$X_k := \frac{W_f}{6}$$

$$X_k = 3.6667 \text{ ft}$$

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

Eccentricity:

$$e := \frac{M_{ot}}{W_{T_{tot}}}$$

$$e = 10.2197$$

Adjusted Soil Pressure:

$$P_a := \frac{2 \cdot W_{T_{tot}}}{3 \cdot W_f \left(\frac{W_f}{2} - e \right)}$$

$$P_a = 37.0101 \text{ ksf}$$

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

$$q_{adj} = 37.0101 \text{ ksf}$$

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

$$\text{PressureCheck} = \text{"No Good"}$$

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CONCRETE BEARING CAPACITY (ACI 10.17)

$$\phi_c := 0.75 \quad (\text{ACI 9.3.2.2})$$

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

$$P_b = 18457.4852 \text{ kip}$$

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

$$\text{BearingCheck} = \text{"Okay"}$$

SHEAR STRENGTH OF CONCRETE

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

$$\phi_{sv} := .85 \quad (\text{ACI 9.3.2.3})$$

$$d := T_f - C_{vrpad} - d_{bbot}$$

$$d = 43.73 \text{ in}$$

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

$$d_1 = 7 \text{ ft}$$

$$d_2 := d_1 - d$$

$$d_2 = 3.3558 \text{ ft}$$

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

$$L = 2.3408 \text{ ft}$$

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

$$\text{Slope} = 15.811 \text{ kcf}$$

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

$$V_{\text{req}} = -3669.3472 \text{ kip}$$

ACI 11.3.1.1

$$V_{\text{Avail}} := \phi_c \cdot 2 \cdot \sqrt{f_c \cdot \text{psi}} \cdot W_f \cdot d$$

$$V_{\text{Avail}} = 1241.2587 \text{ kip}$$

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

$$\text{BeamShearCheck} = \text{"Okay"}$$

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

$$b_o := (d_p + d) \cdot \pi$$

$$b_o = 36.5812 \text{ ft}$$

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

$$A_{bo} = 106.4895 \text{ ft}^2$$

Area outside of bo: $A_{\text{out}} := A_{\text{mat}} - A_{bo}$

$$A_{\text{out}} = 377.5105 \text{ ft}^2$$

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Guess Value: $v_u := 1 \text{ ksf}$

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

$$\text{Given} \quad d^2 + d_p \cdot d = \frac{W_{T_{\text{tot}}}}{\pi \cdot v_u}$$

$$v_u := \text{Find}(v_u)$$

$$v_u = 7.1486 \text{ ksf}$$

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

$$V_u = 573.1132 \text{ kips}$$

$$V_{\text{req}} := L_F \cdot V_u$$

$$V_{\text{req}} = 745.0472 \text{ kips}$$

$$V_{\text{avail}} := \phi_c \cdot 4 \cdot \sqrt{f_c \cdot \text{psi}} \cdot b_o \cdot d$$

$$V_{\text{avail}} = 4127.8882 \text{ kips}$$

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

STEEL REINFORCEMENT IN THE PAD

$$\phi_m := .90 \text{ ACI 9.3.2.2}$$

Take Maximum Bending at face of Pier:

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

$$q_b = -73.667 \text{ ksf}$$

$$M_n := \frac{L_F}{\phi_m} \cdot \left[(q_{\text{adj}} - q_b) \cdot \frac{d_1^2}{3} + q_b \cdot \frac{d_1^2}{2} \right] \cdot W_f$$

$$M_n = 91.6964 \text{ kip} \cdot \text{ft}$$

ACI 10.2.7.3

$$\beta := \text{if} \left[f_c \leq 4000 \cdot \text{psi}, .85, \text{if} \left[f_c \geq 8000 \cdot \text{psi}, .65, .85 - \left(\frac{f_c - 4000}{1000} \right) \cdot .05 \right] \right] \beta = 0.85$$

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

$$R_u = 348.7 \text{ lbf}$$

$$\rho := \frac{0.85 \cdot f_c}{f_y} \left(1 - \sqrt{1 - \frac{2 \cdot R_u}{0.85 \cdot f_c}} \right)$$

$$\rho = 0$$

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

$$\rho_{\text{min}} = 0.00005$$

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

(ACI 7.12.2.1b)

FOR BOTTOM BARS: $A_s := \max(\rho, \rho_{min}, \rho_{sh}) \cdot W_f \cdot d$ $A_s = 20.7805 \text{ in}^2$

$A_{s_{prov}} := A_{bot} \cdot NB_{bot}$ $A_{s_{prov}} = 44.45 \text{ in}^2$

$PadReinforcement := \text{if}(A_{s_{prov}} > A_s, \text{"Okay"}, \text{"No Good"})$ $PadReinforcement = \text{"Okay"}$

FOR TOP BARS: $A_s := \rho_{sh} \cdot (W_f \cdot d)$ $A_s = 20.7805 \text{ in}^2$

$A_{s_{prov}} := A_{bot} \cdot NB_{bot}$ $A_{s_{prov}} = 35 \text{ in}^2$

$PadReinforcement := \text{if}(A_{s_{prov}} > A_s, \text{"Okay"}, \text{"No Good"})$ $PadReinforcement = \text{"Okay"}$

TENSION (ACI 12.2.3)

DEVELOPMENT LENGTH OF PAD REINFORCEMENT

Bar Spacing: $B_{sPad} := \frac{W_f - 2 \cdot C_{vr_{pad}} - NB_{bot} \cdot d_{bbot}}{NB_{bot} - 1}$ $B_{sPad} = 6.2809 \text{ in}$

Development Length Factors:

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

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

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

$L_{dbt} := \frac{3}{40} \cdot \frac{f_y}{\sqrt{f_c \cdot \text{psi}}} \cdot \frac{\alpha \cdot \beta \cdot \gamma \cdot \lambda}{c + k_{tr}} \cdot d_{bbot}$ $L_{dbt} = 38.2533 \text{ in}$

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

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

(ACI 12.2.1)

Available Length in Pad: $L_{Pad} := \frac{W_f}{2} - \frac{d_p}{2} - C_{vr_{pad}}$ $L_{Pad} = 81 \text{ in}$

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

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REINFORCEMENT IN PIER

Pier Area: $A_p := \frac{\pi \cdot d_p^2}{4}$ $A_p = 7238.2295 \text{ in}^2$
 (ACI 10.8.4 and 10.9.1) $A_{smin} := 0.01 \cdot 0.05 \cdot A_p$ $A_{smin} = 3.6191 \text{ in}^2$
 $A_{sprov} := NB_{pier} \cdot A_{bpier}$ $A_{sprov} = 48.36 \text{ in}^2$
 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: $B_{SPier} := \frac{d_p \cdot \pi}{NB_{pier}} - d_{bpier}$ $B_{SPier} = 8.3188 \text{ in}$
 Diameter of Reinforcement Cage: $Diam_{cage} := d_p - 2 \cdot C_{vr_{pier}}$ $Diam_{cage} = 90 \text{ in}$
 Maximum Moment in Pier: $M_p := \left[M_t + S_t \cdot \left(L_p + \frac{A_{BP}}{2} \right) \right] \cdot LF$ $M_p = 147009.2 \text{ in} \cdot \text{kips}$

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

(defined variables)

$$(f_c \ f_y \ c1 \ Spiral) = (4 \ 60 \ 3 \ 0)$$

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:

$$(D \ N \ n \ P_u \ M_{xu}) := (96 \ 31 \ 11 \ 55 \ 147009)$$

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:

$$(\phi P_n \ \phi M_{xn} \ f_{sp} \ \rho) = (40.2813 \ 107667.5794 \ -60 \ 0.0067)$$

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

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

AxialLoadCheck = "No Good"

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

BendingCheck = "No Good"

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	$\gamma := 1.0$

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

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

$$L_{dbt} := \frac{3}{40} \cdot \frac{f_y}{\sqrt{f_c \cdot \text{psi}}} \cdot \frac{\alpha \cdot \beta \cdot \gamma \cdot \lambda}{c + k_{tr}} \cdot d_{bpier} \quad L_{dbt} = 47.1519 \text{ in}$$

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

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

$$L_{dh} := \frac{1200 \cdot d_{bpier}}{\sqrt{\frac{f_c}{\text{psi}}}} \cdot .7 \quad L_{dh} = 18.727 \text{ in}$$

$$L_{db} := \max(L_{dbt}, L_{dbmin}) \quad L_{db} = 47.1519 \text{ in}$$

COMPRESSION: (ACI 12.3.2)

$$L_{dbc1} := \frac{.02 \cdot d_{bpier} \cdot f_y}{\sqrt{f_c \cdot \text{psi}}} \quad L_{dbc1} = 26.7529 \text{ in}$$

$$L_{dbmin} := 0.0003 \cdot \frac{\text{in}^2}{\text{lb}} \cdot (d_{bpier} \cdot f_y) \quad L_{dbmin} = 25.38 \text{ in}$$

$$L_{dbc} := \text{if}(L_{dbc1} \geq L_{dbmin}, L_{dbc1}, L_{dbmin}) \quad L_{dbc} = 26.7529 \text{ in}$$

Available Length in Pier: $L_{pier} := L_p - 3 \cdot \text{in}$ $L_{pier} = 117 \text{ in}$

$$L_{piertension} := \text{if}(L_{pier} > L_{dbt}, \text{"Okay"}, \text{"No Good"}) \quad L_{piertension} = \text{"Okay"}$$

$$L_{piercompression} := \text{if}(L_{pier} > L_{dbc}, \text{"Okay"}, \text{"No Good"})$$

NOTE: Anchor bolts and plate provided, OK

Available Length in Pad: $L_{pad} := T_f - 3 \cdot \text{in}$ $L_{pad} = 45 \text{ in}$

$$L_{padtension} := \text{if}(L_{pad} > L_{dh}, \text{"Okay"}, \text{"No Good"}) \quad L_{padtension} = \text{"Okay"}$$

$$L_{padcompression} := \text{if}(L_{pad} > L_{dbc}, \text{"Okay"}, \text{"No Good"})$$

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TIE SIZE AND SPACING IN COLUMN

Minimum Tie Size:

$$Tie_{min} := \text{if}(BS_{pier} \leq 10, 3, 4)$$

$$Tie_{min} = 4$$

Used #5 Ties

$$d_{Tie} := 5$$

Seismic factor:
 (ACI 21.10.5)

$$z := \text{if}(Z \leq 2, 1, 0.5)$$

$$z = 1$$

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

$$s_{lim1} = 22.56 \text{ in}$$

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

$$s_{lim2} = 30 \text{ in}$$

$$s_{lim3} := D_f \cdot z$$

$$s_{lim3} = 168 \text{ in}$$

$$s_{lim4} := 18 \text{ in}$$

$$s_{lim4} = 18 \text{ in}$$

Maximum Spacing:

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

$$s_{tie} = 18 \text{ in}$$

Number of Ties Required:

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

$$n_{tie} = 7.3333$$

Used 21 Ties