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

Daniel F. Caruso
Chairman

December 11, 2007

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

RE: **EM-VER-020-071109** - Cellco Partnership d/b/a Verizon Wireless notice of intent to modify an existing telecommunications facility located at 12 Nepaug Road, Burlington, Connecticut.

Dear Attorney Baldwin:

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

The proposed modifications are to be implemented as specified here and in your notice dated November 9, 2007, including the placement of all necessary equipment and shelters within the tower compound. The modifications are in compliance with the exception criteria in Section 16-50j-72 (b) of the Regulations of Connecticut State Agencies as changes to an existing facility site that would not increase tower height, extend the boundaries of the tower site, increase noise levels at the tower site boundary by six decibels, and increase the total radio frequencies electromagnetic radiation power density measured at the tower site boundary to or above the standard adopted by the State Department of Environmental Protection pursuant to General Statutes § 22a-162. This facility has also been carefully modeled to ensure that radio frequency emissions are conservatively below State and federal standards applicable to the frequencies now used on this tower.

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

Thank you for your attention and cooperation.

Very truly yours,

Daniel F. Caruso
Chairman

DFC/MP/laf

c: The Honorable Kathleen K. Zabel, First Selectman, Town of Burlington
Robert J. Coates, Planning and Zoning Chairman, Town of Burlington
Christopher B. Fisher, Esq., Cuddy & Feder LLP
Michele G. Briggs, New Cingular Wireless PCS, LLC

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STATE OF CONNECTICUT
CONNECTICUT SITING COUNCIL
Ten Franklin Square, New Britain, CT 06051
Phone: (860) 827-2935 Fax: (860) 827-2950
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Daniel F. Caruso
Chairman

November 15, 2007

The Honorable Theodore C. Scheidel, Jr.
First Selectman
Town of Burlington
200 Spielman Highway
Burlington, CT 06013

RE: **EM-VER-020-071109** - Cellco Partnership d/b/a Verizon Wireless notice of intent to modify an existing telecommunications facility located at 12 Nepaug Road, Burlington, Connecticut.

Dear Mr. Scheidel:

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

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

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

Thank you for your cooperation and consideration.

Very truly yours,

S. Derek Phelps / M.P.

S. Derek Phelps
Executive Director

SDP/cm

Enclosure: Notice of Intent

c: Robert J. Coates, Planning and Zoning Chairman, Town of Burlington

EM-VER-020-071109

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

November 9, 2007

Via Hand Delivery

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

Re: **Notice of Exempt Modification – Antenna Swap**
12 Nepaug Road, Burlington, Connecticut

Dear Mr. Phelps:

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

The Council approved Cellco's shared use of this facility on January 25, 2006. Cellco currently has twelve (12) antennas at the 100-foot level on the tower. Cellco now intends to modify its installation by replacing two (2) PCS antennas with two (2) cellular antennas at the same level on the tower. Attached behind Tab 1 are the specifications for the proposed replacement antennas.

Please accept this letter as notification pursuant to R.C.S.A. § 16-50j-73, for construction that constitutes an exempt modification pursuant to R.C.S.A. § 16-50j-72(b)(2). In accordance with R.C.S.A. § 16-50j-73, a copy of this letter is being sent to Theodore Scheidel, First Selectman of the Town of Burlington. Pursuant to a Council directive, a copy of this letter is also being sent to Herbert F. and Audrey S. Weaver, the owners of the property on which the facility is located.

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

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

ROBINSON & COLE LLP

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

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

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

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

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

Sincerely,

Kenneth C. Baldwin

Enclosures
Copy to:
Theodore Scheidel, Burlington First Selectman
Herbert F. and Audrey S. Weaver
Sandy M. Carter

R&C

Vertically Polarized, Log Periodic 90° / 11.5 dBd

LPA-80090/4CF __

When ordering replace "__" with connector type.

Mechanical specifications

Length	1200 mm	47.2 in
Width	140 mm	5.5 in
Depth	240 mm	9.4 in
Depth with z-bracket	280 mm	11.0 in
4) Weight	5 kg	11.0 lbs
Wind Area		
Fore/Aft	0.17 m²	1.8 ft²
Side	0.29 m²	3.1 ft²
Rated Wind Velocity (Safety factor 2.0)	>444 km/hr	>276 mph
Wind Load @ 100 mph (161 km/hr)		
Fore/Aft	254 N	57.1 lbs
Side	415 N	93.3 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

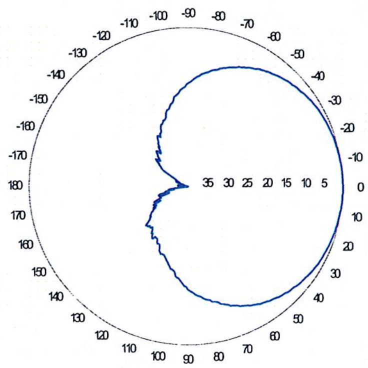
Electrical specifications

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	11.5 dBd
2) Power Rating	500 W
1) Half Power Angle	
H-Plane	90°
E-Plane	15°
1) Electrical Downtilt	0°
1) Null Fill	10-15%
Lightning Protection	Direct Ground

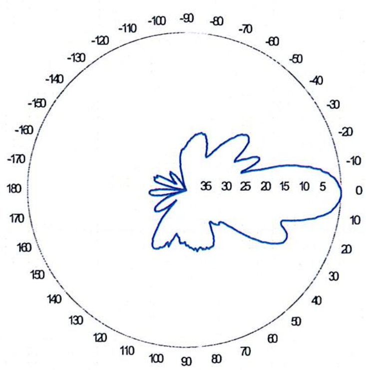
1) Typical values.
2) Power rating limited by connector only.
3) NE indicates an elongated N connector.
E-DIN indicates an elongated DIN connector.
4) The antenna weight listed above does not include the bracket weight.

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

Radiation pattern1)



Horizontal

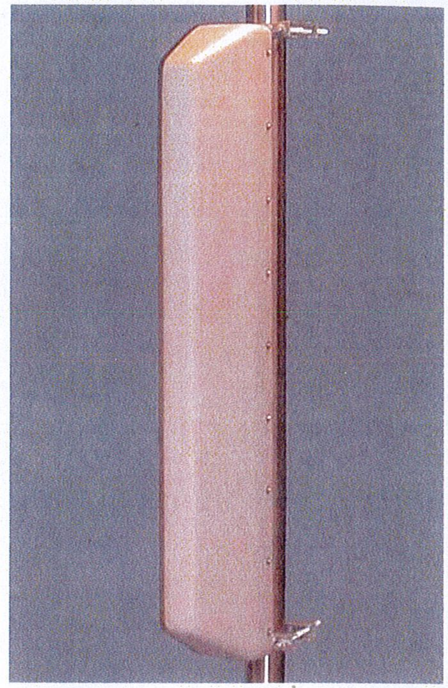


Vertical

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

Amphenol Antel, Inc.
The Antenna Technology Company

Revision Date: 7/5/07

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

	General	Power	Density					
Site Name: Burlington W								
Tower Height: Verizon @ 99Ft.								
CARRIER	**# OF CHAN.**	**WATTS ERP**	**HEIGHT**	**CALC. POWER DENS**	**FREQ.**	**MAX. PERMISS. EXP.**	**FRACTION MPE**	**Total**
*New Cingular	6	296	119	0.0451	880	0.5867	7.69%	
*New Cingular	3	427	119	0.0325	1930	1.0000	3.25%	
*Sprint	11	227	110	0.0742	1962.5	1.0000	7.42%	
Verizon	**9**	**200**	**99**	**0.0660**	**880**	**0.5830**	**11.33%**	
Verizon PCS	**3**	**285**	**99**	**0.0314**	**1970**	**1.0000**	**3.14%**	32.82%
* Source: Siting Council								

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

Site Name: Burlington West
12 Nepaug Road,
Burlington, CT 06013

prepared for

Verizon Wireless
99 East River Drive
East Hartford, Connecticut 06108

prepared by

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

36931098.00000
VZ4-022

November 1, 2007

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

This report summarizes the independent structural analysis of the existing 120' steel monopole structure, located at 12 Nepaug Road in Burlington, CT. The analysis was conducted in accordance with the 2005 Connecticut State Building Code and the TIA/EIA-222-F standard for a wind velocity of 80 mph (fastest mile) and 69 mph (fastest mile) concurrent with ½" ice. The antenna loading considered in the analysis consists of all existing and proposed antennas, transmission lines, and ancillary items as outlined in the Introduction Section of this report. The proposed Verizon Wireless installation is as follows:

Proposed Antenna and Mount	Carrier	Antenna Center Elevation
On the existing Verizon platform:		
Remove: **(Gamma sector only)** **(2) existing PCS antennas (outboard)**	**Verizon (existing)**	**@ 100'**
Install: **(Gamma Sector only)** **(2) Antel LPA 80090/4CF antennas (outboard)**	**Verizon (Proposed)**	

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

This analysis is based on:

1) The tower structure's theoretical capacity, not including any assessment of the condition of the tower.
2) Tower geometry and structural member sizes obtained from manufacturers design documents for a 120' monopole, prepared by Engineered Endeavors Incorporated, (EEI), EEI Job # 13749-E01, signed and sealed October 27, 2005.
3) Geotechnical Engineering Report prepared by Jaworksi Geotech, Inc., signed and sealed February 24, 2004.
4) Previous independent structural review prepared by URS Corporation on behalf of Cingular Wireless, signed and sealed October 28, 2005.
5) Site documentation conducted by URS during October 2007.
6) Antenna and mount configuration as specified within Section 2 of this report.

1. EXECUTIVE SUMMARY – *continued*

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

If you should have any questions, please call.

Sincerely,

URS Corporation

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

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

2. INTRODUCTION

The subject tower is located at 12 Nepaug Road in Burlington, CT. The structure is an existing 120' steel monopole, designed and manufactured by Engineered Endeavors Incorporated, (EEI).

The inventory is summarized in the table below:

Antenna Type	***Carrier***	***Mount***	***Antenna Centerline Elevation***	***Cable***
(6) Powerwave 7770 antennas, (6) TMA's and (1) GPS antenna	AT&T (existing)	(1) 12' Low-Profile Platform	120'	(12) 1 5/8" coax cables and (1) 1/2" coax cable (within monopole)
(6) Panel antennas and (1) GPS antenna	Sprint/Nextel (existing)	(1) 12' Low-Profile Platform	110'	(12) 1 5/8" coax cables and (1) 1/2" coax cable (within monopole)
(4) Antel LPA 80090/4CF antennas, (6) Antel LPA 185090/8CF_2 antennas and (1) GPS antenna	Verizon (existing to remain)	(1) 12' Low-Profile Platform	100'	(12) 1 5/8" coax cables and (1) 1/2" coax cable (within monopole)
(2) Antel LPA 80090/4CF antennas	**Verizon (proposed)**	(1) 12' Low-Profile Platform (same as above)	100'	Existing coax to be re-used (same as above)

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

3. ANALYSIS METHODOLOGY AND LOADING CONDITIONS

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

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

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

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

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

4. FINDINGS AND EVALUATION

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

Tower Component Stress vs. Capacity Summary

Component/Member	Controlling Component / Elevation	Stress Ratio (% capacity)	Pass/Fail	Notes:
Pole Shaft	1'-48.75'	40.6%	Pass	
Anchor Bolts	Tension	22.0%	Pass	
Base Plate		36.0%	Pass	

Foundation	Vector	Overturning Factor (F.O.S)	Pass/Fail	Comments:
Reinf. Spread Footing with Pier	OTM	5.91	Pass	Min of 2.0 F.O.S reqd.

Note: Overturning Moment (OTM) controls foundation design

5. CONCLUSIONS

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

Limitations/Assumptions:

This report is based on the following:

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

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

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

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

Ongoing and Periodic Inspection and Maintenance:

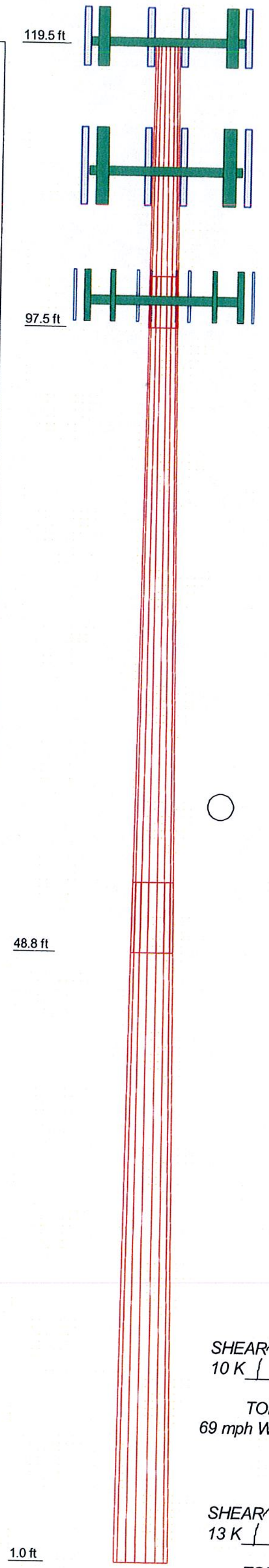
After the Contractor has successfully completed the installation and the work has been accepted, the owner will be responsible for the ongoing and periodic inspection and maintenance of the tower.

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

6. DRAWINGS AND DATA

RISA TOWER INPUT/OUTPUT SUMMARY

Section	1	2	3
Length (ft)	22.00	52.75	53.25
Number of Sides	18	18	18
Thickness (in)	0.1875	0.2500	0.3125
Lap Splice (ft)	4.00	5.50	
Top Dia (in)	22.0000	26.1986	37.6042
Bot Dia (in)	27.5900	39.4900	51.0000
Grade	A572-65	A572-65	A572-65
Weight (K) 13.6	1.1	4.6	7.9



DESIGNED APPURTENANCE LOADING

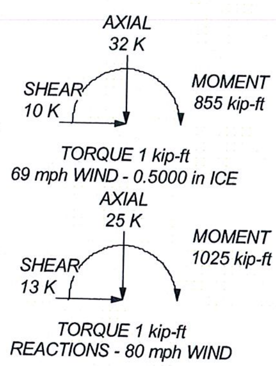
TYPE	ELEVATION	TYPE	ELEVATION
GPS (ATI)	122	GPS (Verizon)	102
(2) 7770.00 (ATI)	120	LPA-80090/4CF (Verizon)	100
(2) 7770.00 (ATI)	120	LPA-80090/4CF (Verizon)	100
(2) 7770.00 (ATI)	120	LPA-80090/4CF (Verizon)	100
(2) TMA (ATI)	120	LPA-80090/4CF (Verizon)	100
(2) TMA (ATI)	120	LPA-80090/4CF (Verizon - proposed)	100
(2) TMA (ATI)	120	LPA-80090/4CF (Verizon - proposed)	100
13' Low Profile Platform (ATI)	120	LPA-185090/8 (Verizon)	100
GPS Pipe Mount (ATI)	120	LPA-185090/8 (Verizon)	100
GPS (Sprint/Nextel)	112	LPA-185090/8 (Verizon)	100
(2) 4' Panel Antenna (Sprint/Nextel)	110	LPA-185090/8 (Verizon)	100
(2) 4' Panel Antenna (Sprint/Nextel)	110	LPA-185090/8 (Verizon)	100
(2) 4' Panel Antenna (Sprint/Nextel)	110	LPA-185090/8 (Verizon)	100
13' Low Profile Platform (Sprint/Nextel)	110	13' Low Profile Platform (Verizon)	100
GPS Pipe Mount (Sprint/Nextel)	110	GPS Pipe Mount (Verizon)	100

MATERIAL STRENGTH

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

TOWER DESIGN NOTES

1. Tower is located in Hartford County, Connecticut.
2. Tower designed for a 80 mph basic wind in accordance with the TIA/EIA-222-F Standard.
3. Tower is also designed for a 69 mph basic wind with 0.50 in ice.
4. Deflections are based upon a 50 mph wind.
5. TOWER RATING: 40.6%



URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job: **120' Existing EEI Monopole**				
	Project: **Burlington, CT**				
	Client: Verizon Wirless	Drawn by: Staff		App'd:	
	Code: TIA/EIA-222-F	Date: 11/01/07		Scale: NTS	
	Path: P:\08\ERI Files\120' Monopole - Burlington.eri			Dwg No. E-1	

RISA TOWER DETAILED OUTPUT

Tower Input Data

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

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

Options

Consider Moments - Legs
Consider Moments - Horizontals
Consider Moments - Diagonals
Use Moment Magnification
√ Use Code Stress Ratios
√ Use Code Safety Factors - Guys
Escalate Ice
Always Use Max Kz
Use Special Wind Profile
Include Bolts In Member Capacity
Leg Bolts Are At Top Of Section
Secondary Horizontal Braces Leg
Use Diamond Inner Bracing (4 Sided)
Add IBC .6D+W Combination

Distribute Leg Loads As Uniform
Assume Legs Pinned
√ Assume Rigid Index Plate
Use Clear Spans For Wind Area
Use Clear Spans For KL/r
Retension Guys To Initial Tension
Bypass Mast Stability Checks
Use Azimuth Dish Coefficients
√ Project Wind Area of Appurt.
Autocalc Torque Arm Areas
SR Members Have Cut Ends
√ Sort Capacity Reports By Component
Triangulate Diamond Inner Bracing

Treat Feedline Bundles As Cylinder
Use ASCE 10 X-Brace Ly Rules
Calculate Redundant Bracing Forces
Ignore Redundant Members in FEA
SR Leg Bolts Resist Compression
All Leg Panels Have Same Allowable
Offset Girt At Foundation
Consider Feedline Torque
Include Angle Block Shear Check

Poles

√ Include Shear-Torsion Interaction
Always Use Sub-Critical Flow
Use Top Mounted Sockets

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	119.50-97.50	22.00	4.00	18	22.0000	27.5900	0.1875	0.7500	A572-65 (65 ksi)
L2	97.50-48.75	52.75	5.50	18	26.1986	39.4900	0.2500	1.0000	A572-65 (65 ksi)
L3	48.75-1.00	53.25		18	37.6042	51.0000	0.3125	1.2500	A572-65 (65 ksi)

Tapered Pole Properties

Section	Tip Dia. in	Area in²	I in⁴	r in	C in	I/C in³	J in⁴	It/Q in²	w in	w/t
L1	22.3394	12.9812	780.3007	7.7434	11.1760	69.8193	1561.6281	6.4918	3.5420	18.891
	28.0156	16.3079	1547.0922	9.7279	14.0157	110.3826	3096.2202	8.1555	4.5258	24.138
L2	27.6262	20.5902	1751.5720	9.2118	13.3089	131.6090	3505.4487	10.2971	4.1710	16.684
	40.0992	31.1369	6057.1925	13.9302	20.0609	301.9399	12122.3553	15.5714	6.5102	26.041
L3	39.5892	36.9887	6498.7514	13.2385	19.1029	340.1968	13006.0541	18.4979	6.0683	19.419
	51.7868	50.2757	16319.1303	17.9941	25.9080	629.8877	32659.7336	25.1426	8.4260	26.963

Tower Elevation ft	Gusset Area (per face) ft²	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 119.50-97.50				1	1.02	1		
L2 97.50-48.75				1	1.02	1		
L3 48.75-1.00				1	1.02	1		

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number		C_AA_A ft²/ft	Weight plf
1 5/8 (AT&T)	C	No	Inside Pole	119.50 - 1.00	12	No Ice	0.00	1.04
						1/2" Ice	0.00	1.04
1/2 (AT&T - GPS)	C	No	Inside Pole	119.50 - 1.00	1	No Ice	0.00	0.25
						1/2" Ice	0.00	0.25
1 5/8 (Sprint/Nextel)	C	No	Inside Pole	110.00 - 1.00	12	No Ice	0.00	1.04
						1/2" Ice	0.00	1.04
1/2 (Sprint/Nextel - GPS)	C	No	Inside Pole	110.00 - 1.00	1	No Ice	0.00	0.25
						1/2" Ice	0.00	0.25
1 5/8 (Verizon)	C	No	Inside Pole	100.00 - 1.00	12	No Ice	0.00	1.04
						1/2" Ice	0.00	1.04
1/2 (Verizon - GPS)	C	No	Inside Pole	100.00 - 1.00	1	No Ice	0.00	0.25
						1/2" Ice	0.00	0.25

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft²	A_F ft²	C_AA_A In Face ft²	C_AA_A Out Face ft²	Weight K
L1	119.50-97.50	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	0.000	0.000	0.47
L2	97.50-48.75	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	0.000	0.000	1.86
L3	48.75-1.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	0.000	0.000	1.82

Feed Line/Linear Appurtenances Section Areas - With Ice

Tower Section	Tower Elevation ft	Face or Leg	Ice Thickness in	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
L1	119.50-97.50	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	0.47
L2	97.50-48.75	A	0.500	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	0.000	0.000	1.86
L3	48.75-1.00	A	0.500	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	0.000	0.000	1.82

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
13' Low Profile Platform (AT&T)	C	None		0.0000	120.00	No Ice	15.00	15.00	2.10
						1/2" Ice	18.00	18.00	3.25
(2) 7770.00 (AT&T)	A	From Face	3.50 0.00 0.00	0.0000	120.00	No Ice	5.88	2.93	0.04
						1/2" Ice	6.31	3.27	0.07
(2) 7770.00 (AT&T)	B	From Face	3.50 0.00 0.00	0.0000	120.00	No Ice	5.88	2.93	0.04
						1/2" Ice	6.31	3.27	0.07
(2) 7770.00 (AT&T)	C	From Face	3.50 0.00 0.00	0.0000	120.00	No Ice	5.88	2.93	0.04
						1/2" Ice	6.31	3.27	0.07
(2) TMA (AT&T)	A	From Face	3.00 0.00 0.00	0.0000	120.00	No Ice	0.95	0.37	0.02
						1/2" Ice	1.09	0.48	0.02
(2) TMA (AT&T)	B	From Face	3.00 0.00 0.00	0.0000	120.00	No Ice	0.95	0.37	0.02
						1/2" Ice	1.09	0.48	0.02
(2) TMA (AT&T)	C	From Face	3.00 0.00 0.00	0.0000	120.00	No Ice	0.95	0.37	0.02
						1/2" Ice	1.09	0.48	0.02
GPS (AT&T)	C	From Face	3.00 0.00 0.00	0.0000	122.00	No Ice	1.00	1.00	0.01
						1/2" Ice	1.50	1.50	0.01
GPS Pipe Mount (AT&T)	C	From Face	3.00 0.00 0.00	0.0000	120.00	No Ice	1.36	1.36	0.03
						1/2" Ice	1.67	1.67	0.04
13' Low Profile Platform (Sprint/Nextel)	C	None		0.0000	110.00	No Ice	15.00	15.00	2.10
						1/2" Ice	18.00	18.00	3.25
(2) 4' Panel Antenna (Sprint/Nextel)	A	From Face	3.50 0.00 0.00	0.0000	110.00	No Ice	2.87	3.73	0.01
						1/2" Ice	3.18	4.10	0.04
(2) 4' Panel Antenna (Sprint/Nextel)	B	From Face	3.50 0.00 0.00	0.0000	110.00	No Ice	2.87	3.73	0.01
						1/2" Ice	3.18	4.10	0.04
(2) 4' Panel Antenna	C	From Face	3.50	0.0000	110.00	No Ice	2.87	3.73	0.01

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert	Azimuth Adjustment	Placement		C_AA_A Front	C_AA_A Side	Weight
			ft ft ft	°	ft		ft²	ft²	K
(Sprint/Nextel)			0.00 0.00			1/2" Ice	3.18	4.10	0.04
GPS (Sprint/Nextel)	C	From Face	3.00 0.00 0.00	0.0000	112.00	No Ice 1/2" Ice	1.00 1.50	1.00 1.50	0.01 0.01
GPS Pipe Mount (Sprint/Nextel)	C	From Face	3.00 0.00 0.00	0.0000	110.00	No Ice 1/2" Ice	1.36 1.67	1.36 1.67	0.03 0.04
13' Low Profile Platform (Verizon)	C	None		0.0000	100.00	No Ice 1/2" Ice	15.00 18.00	15.00 18.00	2.10 3.25
LPA-80090/4CF (Verizon)	A	From Face	3.50 6.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.62 2.92	4.31 4.68	0.01 0.04
LPA-80090/4CF (Verizon)	A	From Face	3.50 -6.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.62 2.92	4.31 4.68	0.01 0.04
LPA-80090/4CF (Verizon)	B	From Face	3.50 6.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.62 2.92	4.31 4.68	0.01 0.04
LPA-80090/4CF (Verizon)	B	From Face	3.50 -6.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.62 2.92	4.31 4.68	0.01 0.04
LPA-80090/4CF (Verizon - proposed)	C	From Face	3.50 6.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.62 2.92	4.31 4.68	0.01 0.04
LPA-80090/4CF (Verizon - proposed)	C	From Face	3.50 -6.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.62 2.92	4.31 4.68	0.01 0.04
LPA-185090/8 (Verizon)	A	From Face	3.50 4.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.09 2.39	2.33 2.62	0.01 0.02
LPA-185090/8 (Verizon)	A	From Face	3.50 -4.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.09 2.39	2.33 2.62	0.01 0.02
LPA-185090/8 (Verizon)	B	From Face	3.50 4.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.09 2.39	2.33 2.62	0.01 0.02
LPA-185090/8 (Verizon)	B	From Face	3.50 -4.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.09 2.39	2.33 2.62	0.01 0.02
LPA-185090/8 (Verizon)	C	From Face	3.50 4.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.09 2.39	2.33 2.62	0.01 0.02
LPA-185090/8 (Verizon)	C	From Face	3.50 -4.00 0.00	0.0000	100.00	No Ice 1/2" Ice	2.09 2.39	2.33 2.62	0.01 0.02
GPS (Verizon)	C	From Face	3.00 0.00 0.00	0.0000	102.00	No Ice 1/2" Ice	1.00 1.50	1.00 1.50	0.01 0.01
GPS Pipe Mount (Verizon)	C	From Face	3.00 0.00 0.00	0.0000	100.00	No Ice 1/2" Ice	1.36 1.67	1.36 1.67	0.03 0.04

Tower Pressures - No Ice

$G_H = 1.690$

Section Elevation ft	z ft	K_Z	q_z psf	A_G ft^2	Face	A_F ft^2	A_R ft^2	A_{leg} ft^2	Leg %	C_AA_A In Face ft^2	C_AA_A Out Face ft^2
L1 119.50-97.50	108.09	1.404	23	45.458	A	0.000	46.367	46.367	100.00	0.000	0.000
					B	0.000	46.367		100.00		
					C	0.000	46.367		100.00		
L2 97.50-48.75	72.21	1.251	20	135.477	A	0.000	138.187	138.187	100.00	0.000	0.000
					B	0.000	138.187		100.00		
					C	0.000	138.187		100.00		
L3 48.75-1.00	23.99	1	17	179.038	A	0.000	182.619	182.619	100.00	0.000	0.000
					B	0.000	182.619		100.00		
					C	0.000	182.619		100.00		

Tower Pressure - With Ice

$G_H = 1.690$

Section Elevation ft	z ft	K_Z	q_z psf	t_Z in	A_G ft^2	Face	A_F ft^2	A_R ft^2	A_{leg} ft^2	Leg %	C_AA_A In Face ft^2	C_AA_A Out Face ft^2
L1 119.50-97.50	108.09	1.404	17	0.5000	47.291	A	0.000	48.237	48.237	100.00	0.000	0.000
						B	0.000	48.237		100.00		
						C	0.000	48.237		100.00		
L2 97.50-48.75	72.21	1.251	15	0.5000	139.540	A	0.000	142.331	142.331	100.00	0.000	0.000
						B	0.000	142.331		100.00		
						C	0.000	142.331		100.00		
L3 48.75-1.00	23.99	1	12	0.5000	183.017	A	0.000	186.678	186.678	100.00	0.000	0.000
						B	0.000	186.678		100.00		
						C	0.000	186.678		100.00		

Tower Pressure - Service

$G_H = 1.690$

Section Elevation ft	z ft	K_Z	q_z psf	A_G ft^2	Face	A_F ft^2	A_R ft^2	A_{leg} ft^2	Leg %	C_AA_A In Face ft^2	C_AA_A Out Face ft^2
L1 119.50-97.50	108.09	1.404	9	45.458	A	0.000	46.367	46.367	100.00	0.000	0.000
					B	0.000	46.367		100.00		
					C	0.000	46.367		100.00		
L2 97.50-48.75	72.21	1.251	8	135.477	A	0.000	138.187	138.187	100.00	0.000	0.000
					B	0.000	138.187		100.00		
					C	0.000	138.187		100.00		
L3 48.75-1.00	23.99	1	6	179.038	A	0.000	182.619	182.619	100.00	0.000	0.000
					B	0.000	182.619		100.00		
					C	0.000	182.619		100.00		

Tower Forces - No Ice - Wind Normal To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.10	A	1	0.65	1	1	1	46.367	1.17	53.24	C
			B	1	0.65	1	1	1	46.367			
			C	1	0.65	1	1	1	46.367			
L2 97.50-48.75	1.86	4.64	A	1	0.65	1	1	1	138.187	3.09	63.48	C
			B	1	0.65	1	1	1	138.187			
			C	1	0.65	1	1	1	138.187			
L3 48.75-1.00	1.82	7.91	A	1	0.65	1	1	1	182.619	3.33	69.78	C
			B	1	0.65	1	1	1	182.619			
			C	1	0.65	1	1	1	182.619			
Sum Weight:	4.16	13.64						OTM	422.37 kip-ft	7.60		

Tower Forces - No Ice - Wind 45 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.10	A	1	0.65	1	1	1	46.367	1.17	53.24	C
			B	1	0.65	1	1	1	46.367			
			C	1	0.65	1	1	1	46.367			
L2 97.50-48.75	1.86	4.64	A	1	0.65	1	1	1	138.187	3.09	63.48	C
			B	1	0.65	1	1	1	138.187			
			C	1	0.65	1	1	1	138.187			
L3 48.75-1.00	1.82	7.91	A	1	0.65	1	1	1	182.619	3.33	69.78	C
			B	1	0.65	1	1	1	182.619			
			C	1	0.65	1	1	1	182.619			
Sum Weight:	4.16	13.64						OTM	422.37 kip-ft	7.60		

Tower Forces - No Ice - Wind 60 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.10	A	1	0.65	1	1	1	46.367	1.17	53.24	C
			B	1	0.65	1	1	1	46.367			
			C	1	0.65	1	1	1	46.367			
L2 97.50-48.75	1.86	4.64	A	1	0.65	1	1	1	138.187	3.09	63.48	C
			B	1	0.65	1	1	1	138.187			
			C	1	0.65	1	1	1	138.187			
L3 48.75-1.00	1.82	7.91	A	1	0.65	1	1	1	182.619	3.33	69.78	C
			B	1	0.65	1	1	1	182.619			
			C	1	0.65	1	1	1	182.619			
Sum Weight:	4.16	13.64						OTM	422.37	7.60		

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
									kip-ft			

Tower Forces - No Ice - Wind 90 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.10	A	1	0.65	1	1	1	46.367	1.17	53.24	C
			B	1	0.65	1	1	1	46.367			
			C	1	0.65	1	1	1	46.367			
L2 97.50-48.75	1.86	4.64	A	1	0.65	1	1	1	138.187	3.09	63.48	C
			B	1	0.65	1	1	1	138.187			
			C	1	0.65	1	1	1	138.187			
L3 48.75-1.00	1.82	7.91	A	1	0.65	1	1	1	182.619	3.33	69.78	C
			B	1	0.65	1	1	1	182.619			
			C	1	0.65	1	1	1	182.619			
Sum Weight:	4.16	13.64						OTM	422.37 kip-ft	7.60		

Tower Forces - With Ice - Wind Normal To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.44	A	1	0.65	1	1	1	48.237	0.91	41.54	C
			B	1	0.65	1	1	1	48.237			
			C	1	0.65	1	1	1	48.237			
L2 97.50-48.75	1.86	5.66	A	1	0.65	1	1	1	142.331	2.39	49.04	C
			B	1	0.65	1	1	1	142.331			
			C	1	0.65	1	1	1	142.331			
L3 48.75-1.00	1.82	9.25	A	1	0.65	1	1	1	186.678	2.55	53.50	C
			B	1	0.65	1	1	1	186.678			
			C	1	0.65	1	1	1	186.678			
Sum Weight:	4.16	16.35						OTM	326.80 kip-ft	5.86		

Tower Forces - With Ice - Wind 45 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.44	A	1	0.65	1	1	1	48.237	0.91	41.54	C
			B	1	0.65	1	1	1	48.237			
			C	1	0.65	1	1	1	48.237			

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w plf	Ctrl. Face
L2 97.50-48.75	1.86	5.66	A	1	0.65	1	1	1	142.331	2.39	49.04	C
			B	1	0.65	1	1	1	142.331			
			C	1	0.65	1	1	1	142.331			
L3 48.75-1.00	1.82	9.25	A	1	0.65	1	1	1	186.678	2.55	53.50	C
			B	1	0.65	1	1	1	186.678			
			C	1	0.65	1	1	1	186.678			
Sum Weight:	4.16	16.35						OTM	326.80 kip-ft	5.86		

Tower Forces - With Ice - Wind 60 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.44	A	1	0.65	1	1	1	48.237	0.91	41.54	C
			B	1	0.65	1	1	1	48.237			
			C	1	0.65	1	1	1	48.237			
L2 97.50-48.75	1.86	5.66	A	1	0.65	1	1	1	142.331	2.39	49.04	C
			B	1	0.65	1	1	1	142.331			
			C	1	0.65	1	1	1	142.331			
L3 48.75-1.00	1.82	9.25	A	1	0.65	1	1	1	186.678	2.55	53.50	C
			B	1	0.65	1	1	1	186.678			
			C	1	0.65	1	1	1	186.678			
Sum Weight:	4.16	16.35						OTM	326.80 kip-ft	5.86		

Tower Forces - With Ice - Wind 90 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.44	A	1	0.65	1	1	1	48.237	0.91	41.54	C
			B	1	0.65	1	1	1	48.237			
			C	1	0.65	1	1	1	48.237			
L2 97.50-48.75	1.86	5.66	A	1	0.65	1	1	1	142.331	2.39	49.04	C
			B	1	0.65	1	1	1	142.331			
			C	1	0.65	1	1	1	142.331			
L3 48.75-1.00	1.82	9.25	A	1	0.65	1	1	1	186.678	2.55	53.50	C
			B	1	0.65	1	1	1	186.678			
			C	1	0.65	1	1	1	186.678			
Sum Weight:	4.16	16.35						OTM	326.80 kip-ft	5.86		

Tower Forces - Service - Wind Normal To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.10	A	1	0.65	1	1	1	46.367	0.46	20.80	C
			B	1	0.65	1	1	1	46.367			
			C	1	0.65	1	1	1	46.367			
L2 97.50-48.75	1.86	4.64	A	1	0.65	1	1	1	138.187	1.21	24.80	C
			B	1	0.65	1	1	1	138.187			
			C	1	0.65	1	1	1	138.187			
L3 48.75-1.00	1.82	7.91	A	1	0.65	1	1	1	182.619	1.30	27.26	C
			B	1	0.65	1	1	1	182.619			
			C	1	0.65	1	1	1	182.619			
Sum Weight:	4.16	13.64						OTM	164.99 kip-ft	2.97		

Tower Forces - Service - Wind 45 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.10	A	1	0.65	1	1	1	46.367	0.46	20.80	C
			B	1	0.65	1	1	1	46.367			
			C	1	0.65	1	1	1	46.367			
L2 97.50-48.75	1.86	4.64	A	1	0.65	1	1	1	138.187	1.21	24.80	C
			B	1	0.65	1	1	1	138.187			
			C	1	0.65	1	1	1	138.187			
L3 48.75-1.00	1.82	7.91	A	1	0.65	1	1	1	182.619	1.30	27.26	C
			B	1	0.65	1	1	1	182.619			
			C	1	0.65	1	1	1	182.619			
Sum Weight:	4.16	13.64						OTM	164.99 kip-ft	2.97		

Tower Forces - Service - Wind 60 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.10	A	1	0.65	1	1	1	46.367	0.46	20.80	C
			B	1	0.65	1	1	1	46.367			
			C	1	0.65	1	1	1	46.367			
L2 97.50-48.75	1.86	4.64	A	1	0.65	1	1	1	138.187	1.21	24.80	C
			B	1	0.65	1	1	1	138.187			
			C	1	0.65	1	1	1	138.187			
L3 48.75-1.00	1.82	7.91	A	1	0.65	1	1	1	182.619	1.30	27.26	C
			B	1	0.65	1	1	1	182.619			
			C	1	0.65	1	1	1	182.619			
Sum Weight:	4.16	13.64						OTM	164.99 kip-ft	2.97		

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

Tower Forces - Service - Wind 90 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w plf	Ctrl. Face
L1 119.50-97.50	0.47	1.10	A	1	0.65	1	1	1	46.367	0.46	20.80	C
			B	1	0.65	1	1	1	46.367			
			C	1	0.65	1	1	1	46.367			
L2 97.50-48.75	1.86	4.64	A	1	0.65	1	1	1	138.187	1.21	24.80	C
			B	1	0.65	1	1	1	138.187			
			C	1	0.65	1	1	1	138.187			
L3 48.75-1.00	1.82	7.91	A	1	0.65	1	1	1	182.619	1.30	27.26	C
			B	1	0.65	1	1	1	182.619			
			C	1	0.65	1	1	1	182.619			
Sum Weight:	4.16	13.64						OTM	164.99 kip-ft	2.97		

Force Totals

Load Case	Vertical Forces K	Sum of Forces X K	Sum of Forces Z K	Sum of Overturning Moments, M_x kip-ft	Sum of Overturning Moments, M_z kip-ft	Sum of Torques kip-ft
Leg Weight	13.64					
Bracing Weight	0.00					
Total Member Self-Weight	13.64			0.48	0.00	
Total Weight	24.74			0.48	0.00	
Wind 0 deg - No Ice		0.00	-12.92	-1001.40	0.00	0.00
Wind 30 deg - No Ice		6.46	-11.19	-867.17	-500.94	0.56
Wind 45 deg - No Ice		9.13	-9.13	-707.95	-708.44	0.79
Wind 60 deg - No Ice		11.19	-6.46	-500.46	-867.65	0.96
Wind 90 deg - No Ice		12.92	0.00	0.48	-1001.88	1.11
Wind 120 deg - No Ice		11.19	6.46	501.42	-867.65	0.96
Wind 135 deg - No Ice		9.13	9.13	708.92	-708.44	0.79
Wind 150 deg - No Ice		6.46	11.19	868.14	-500.94	0.56
Wind 180 deg - No Ice		0.00	12.92	1002.36	0.00	0.00
Wind 210 deg - No Ice		-6.46	11.19	868.14	500.94	-0.56
Wind 225 deg - No Ice		-9.13	9.13	708.92	708.44	-0.79
Wind 240 deg - No Ice		-11.19	6.46	501.42	867.65	-0.96
Wind 270 deg - No Ice		-12.92	0.00	0.48	1001.88	-1.11
Wind 300 deg - No Ice		-11.19	-6.46	-500.46	867.65	-0.96
Wind 315 deg - No Ice		-9.13	-9.13	-707.95	708.44	-0.79
Wind 330 deg - No Ice		-6.46	-11.19	-867.17	500.94	-0.56
Member Ice	2.70					
Total Weight Ice	31.54			0.68	0.00	
Wind 0 deg - Ice		0.00	-10.44	-825.64	0.00	0.00
Wind 30 deg - Ice		5.22	-9.04	-714.94	-413.16	0.56
Wind 45 deg - Ice		7.38	-7.38	-583.62	-584.30	0.79
Wind 60 deg - Ice		9.04	-5.22	-412.48	-715.61	0.97
Wind 90 deg - Ice		10.44	0.00	0.68	-826.32	1.12
Wind 120 deg - Ice		9.04	5.22	413.84	-715.61	0.97
Wind 135 deg - Ice		7.38	7.38	584.97	-584.30	0.79
Wind 150 deg - Ice		5.22	9.04	716.29	-413.16	0.56
Wind 180 deg - Ice		0.00	10.44	826.99	0.00	0.00
Wind 210 deg - Ice		-5.22	9.04	716.29	413.16	-0.56
Wind 225 deg - Ice		-7.38	7.38	584.97	584.30	-0.79
Wind 240 deg - Ice		-9.04	5.22	413.84	715.61	-0.97
Wind 270 deg - Ice		-10.44	0.00	0.68	826.32	-1.12

Load Case	Vertical Forces K	Sum of Forces X K	Sum of Forces Z K	Sum of Overturning Moments, M_x kip-ft	Sum of Overturning Moments, M_z kip-ft	Sum of Torques kip-ft
Wind 300 deg - Ice		-9.04	-5.22	-412.48	715.61	-0.97
Wind 315 deg - Ice		-7.38	-7.38	-583.62	584.30	-0.79
Wind 330 deg - Ice		-5.22	-9.04	-714.94	413.16	-0.56
Total Weight	24.74			0.48	0.00	
Wind 0 deg - Service		0.00	-5.05	-390.88	0.00	0.00
Wind 30 deg - Service		2.52	-4.37	-338.45	-195.68	0.22
Wind 45 deg - Service		3.57	-3.57	-276.25	-276.73	0.31
Wind 60 deg - Service		4.37	-2.52	-195.20	-338.93	0.38
Wind 90 deg - Service		5.05	0.00	0.48	-391.36	0.43
Wind 120 deg - Service		4.37	2.52	196.16	-338.93	0.38
Wind 135 deg - Service		3.57	3.57	277.21	-276.73	0.31
Wind 150 deg - Service		2.52	4.37	339.41	-195.68	0.22
Wind 180 deg - Service		0.00	5.05	391.84	0.00	0.00
Wind 210 deg - Service		-2.52	4.37	339.41	195.68	-0.22
Wind 225 deg - Service		-3.57	3.57	277.21	276.73	-0.31
Wind 240 deg - Service		-4.37	2.52	196.16	338.93	-0.38
Wind 270 deg - Service		-5.05	0.00	0.48	391.36	-0.43
Wind 300 deg - Service		-4.37	-2.52	-195.20	338.93	-0.38
Wind 315 deg - Service		-3.57	-3.57	-276.25	276.73	-0.31
Wind 330 deg - Service		-2.52	-4.37	-338.45	195.68	-0.22

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

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

Maximum Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Force K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
L1	119.5 - 97.5	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-8.92	0.00	-0.51
			Max. Mx	6	-5.83	-58.48	-0.34
			Max. My	10	-5.83	0.00	-58.84
			Max. Vy	6	4.53	-58.48	-0.34
			Max. Vx	10	4.53	0.00	-58.84
			Max. Torque	23			-0.92
L2	97.5 - 48.75	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-19.56	0.00	-0.68
			Max. Mx	6	-14.07	-431.01	-0.49
			Max. My	10	-14.07	0.00	-431.50
			Max. Vy	6	9.44	-431.01	-0.49
			Max. Vx	10	9.44	0.00	-431.50
			Max. Torque	23			-1.12
L3	48.75 - 1	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-31.54	0.00	-0.68
			Max. Mx	6	-24.74	-1024.98	-0.50
			Max. My	10	-24.74	0.00	-1025.48
			Max. Vy	6	12.93	-1024.98	-0.50
			Max. Vx	10	12.93	0.00	-1025.48
			Max. Torque	23			-1.12

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
Pole	Max. Vert	27	31.54	0.00	-10.44
	Max. H_x	14	24.74	12.92	-0.00
	Max. H_z	2	24.74	0.00	12.92

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
	Max. M_x	2	1024.47	0.00	12.92
	Max. M_z	6	1024.98	-12.92	-0.00
	Max. Torsion	31	1.12	10.44	0.00
	Min. Vert	1	24.74	0.00	0.00
	Min. H_x	6	24.74	-12.92	-0.00
	Min. H_z	10	24.74	0.00	-12.92
	Min. M_x	10	-1025.48	0.00	-12.92
	Min. M_z	14	-1024.98	12.92	-0.00
	Min. Torsion	23	-1.12	-10.44	0.00

Tower Mast Reaction Summary

Load Combination	Vertical K	$Shear_x$ K	$Shear_z$ K	Overturning Moment, M_x kip-ft	Overturning Moment, M_z kip-ft	Torque kip-ft
Dead Only	24.74	0.00	0.00	0.48	0.00	0.00
Dead+Wind 0 deg - No Ice	24.74	0.00	-12.92	-1024.47	0.00	0.00
Dead+Wind 30 deg - No Ice	24.74	6.46	-11.19	-887.15	-512.49	0.56
Dead+Wind 45 deg - No Ice	24.74	9.13	-9.13	-724.27	-724.77	0.79
Dead+Wind 60 deg - No Ice	24.74	11.19	-6.46	-511.99	-887.66	0.96
Dead+Wind 90 deg - No Ice	24.74	12.92	0.00	0.50	-1024.98	1.11
Dead+Wind 120 deg - No Ice	24.74	11.19	6.46	512.99	-887.66	0.96
Dead+Wind 135 deg - No Ice	24.74	9.13	9.13	725.27	-724.77	0.79
Dead+Wind 150 deg - No Ice	24.74	6.46	11.19	888.16	-512.49	0.56
Dead+Wind 180 deg - No Ice	24.74	0.00	12.92	1025.48	0.00	0.00
Dead+Wind 210 deg - No Ice	24.74	-6.46	11.19	888.16	512.49	-0.56
Dead+Wind 225 deg - No Ice	24.74	-9.13	9.13	725.27	724.77	-0.79
Dead+Wind 240 deg - No Ice	24.74	-11.19	6.46	512.99	887.66	-0.96
Dead+Wind 270 deg - No Ice	24.74	-12.92	0.00	0.50	1024.98	-1.11
Dead+Wind 300 deg - No Ice	24.74	-11.19	-6.46	-511.99	887.66	-0.96
Dead+Wind 315 deg - No Ice	24.74	-9.13	-9.13	-724.27	724.77	-0.79
Dead+Wind 330 deg - No Ice	24.74	-6.46	-11.19	-887.15	512.49	-0.56
Dead+Ice+Temp	31.54	0.00	0.00	0.68	0.00	0.00
Dead+Wind 0 deg+Ice+Temp	31.54	0.00	-10.44	-853.10	0.00	0.00
Dead+Wind 30 deg+Ice+Temp	31.54	5.22	-9.04	-738.71	-426.91	0.56
Dead+Wind 45 deg+Ice+Temp	31.54	7.38	-7.38	-603.02	-603.74	0.79
Dead+Wind 60 deg+Ice+Temp	31.54	9.04	-5.22	-426.19	-739.43	0.97
Dead+Wind 90 deg+Ice+Temp	31.54	10.44	0.00	0.72	-853.82	1.12
Dead+Wind 120 deg+Ice+Temp	31.54	9.04	5.22	427.63	-739.43	0.97
Dead+Wind 135 deg+Ice+Temp	31.54	7.38	7.38	604.47	-603.75	0.79
Dead+Wind 150 deg+Ice+Temp	31.54	5.22	9.04	740.15	-426.91	0.56
Dead+Wind 180 deg+Ice+Temp	31.54	0.00	10.44	854.55	0.00	0.00
Dead+Wind 210 deg+Ice+Temp	31.54	-5.22	9.04	740.15	426.91	-0.56
Dead+Wind 225 deg+Ice+Temp	31.54	-7.38	7.38	604.47	603.75	-0.79
Dead+Wind 240 deg+Ice+Temp	31.54	-9.04	5.22	427.63	739.43	-0.97
Dead+Wind 270 deg+Ice+Temp	31.54	-10.44	0.00	0.72	853.82	-1.12
Dead+Wind 300 deg+Ice+Temp	31.54	-9.04	-5.22	-426.19	739.43	-0.97
Dead+Wind 315 deg+Ice+Temp	31.54	-7.38	-7.38	-603.02	603.74	-0.79
Dead+Wind 330 deg+Ice+Temp	31.54	-5.22	-9.04	-738.71	426.91	-0.56
Dead+Wind 0 deg - Service	24.74	0.00	-5.05	-399.94	0.00	0.00
Dead+Wind 30 deg - Service	24.74	2.52	-4.37	-346.29	-200.22	0.22
Dead+Wind 45 deg - Service	24.74	3.57	-3.57	-282.65	-283.15	0.31
Dead+Wind 60 deg - Service	24.74	4.37	-2.52	-199.72	-346.79	0.38
Dead+Wind 90 deg - Service	24.74	5.05	0.00	0.50	-400.44	0.43
Dead+Wind 120 deg - Service	24.74	4.37	2.52	200.72	-346.79	0.38
Dead+Wind 135 deg - Service	24.74	3.57	3.57	283.66	-283.15	0.31
Dead+Wind 150 deg - Service	24.74	2.52	4.37	347.30	-200.22	0.22

Load Combination	Vertical K	$Shear_x$ K	$Shear_z$ K	Overturning Moment, M_x kip-ft	Overturning Moment, M_z kip-ft	Torque kip-ft
Dead+Wind 180 deg - Service	24.74	0.00	5.05	400.95	0.00	0.00
Dead+Wind 210 deg - Service	24.74	-2.52	4.37	347.30	200.22	-0.22
Dead+Wind 225 deg - Service	24.74	-3.57	3.57	283.66	283.15	-0.31
Dead+Wind 240 deg - Service	24.74	-4.37	2.52	200.72	346.79	-0.38
Dead+Wind 270 deg - Service	24.74	-5.05	0.00	0.50	400.44	-0.43
Dead+Wind 300 deg - Service	24.74	-4.37	-2.52	-199.72	346.79	-0.38
Dead+Wind 315 deg - Service	24.74	-3.57	-3.57	-282.65	283.15	-0.31
Dead+Wind 330 deg - Service	24.74	-2.52	-4.37	-346.29	200.22	-0.22

Solution Summary

Load Comb.	Sum of Applied Forces PX K	PY K	PZ K	Sum of Reactions PX K	PY K	PZ K	% Error
1	0.00	-24.74	0.00	0.00	24.74	0.00	0.000%
2	0.00	-24.74	-12.92	0.00	24.74	12.92	0.000%
3	6.46	-24.74	-11.19	-6.46	24.74	11.19	0.000%
4	9.13	-24.74	-9.13	-9.13	24.74	9.13	0.000%
5	11.19	-24.74	-6.46	-11.19	24.74	6.46	0.000%
6	12.92	-24.74	0.00	-12.92	24.74	-0.00	0.000%
7	11.19	-24.74	6.46	-11.19	24.74	-6.46	0.000%
8	9.13	-24.74	9.13	-9.13	24.74	-9.13	0.000%
9	6.46	-24.74	11.19	-6.46	24.74	-11.19	0.000%
10	0.00	-24.74	12.92	0.00	24.74	-12.92	0.000%
11	-6.46	-24.74	11.19	6.46	24.74	-11.19	0.000%
12	-9.13	-24.74	9.13	9.13	24.74	-9.13	0.000%
13	-11.19	-24.74	6.46	11.19	24.74	-6.46	0.000%
14	-12.92	-24.74	0.00	12.92	24.74	-0.00	0.000%
15	-11.19	-24.74	-6.46	11.19	24.74	6.46	0.000%
16	-9.13	-24.74	-9.13	9.13	24.74	9.13	0.000%
17	-6.46	-24.74	-11.19	6.46	24.74	11.19	0.000%
18	0.00	-31.54	0.00	0.00	31.54	0.00	0.000%
19	0.00	-31.54	-10.44	0.00	31.54	10.44	0.000%
20	5.22	-31.54	-9.04	-5.22	31.54	9.04	0.000%
21	7.38	-31.54	-7.38	-7.38	31.54	7.38	0.000%
22	9.04	-31.54	-5.22	-9.04	31.54	5.22	0.000%
23	10.44	-31.54	0.00	-10.44	31.54	0.00	0.000%
24	9.04	-31.54	5.22	-9.04	31.54	-5.22	0.000%
25	7.38	-31.54	7.38	-7.38	31.54	-7.38	0.000%
26	5.22	-31.54	9.04	-5.22	31.54	-9.04	0.000%
27	0.00	-31.54	10.44	0.00	31.54	-10.44	0.000%
28	-5.22	-31.54	9.04	5.22	31.54	-9.04	0.000%
29	-7.38	-31.54	7.38	7.38	31.54	-7.38	0.000%
30	-9.04	-31.54	5.22	9.04	31.54	-5.22	0.000%
31	-10.44	-31.54	0.00	10.44	31.54	0.00	0.000%
32	-9.04	-31.54	-5.22	9.04	31.54	5.22	0.000%
33	-7.38	-31.54	-7.38	7.38	31.54	7.38	0.000%
34	-5.22	-31.54	-9.04	5.22	31.54	9.04	0.000%
35	0.00	-24.74	-5.05	0.00	24.74	5.05	0.000%
36	2.52	-24.74	-4.37	-2.52	24.74	4.37	0.000%
37	3.57	-24.74	-3.57	-3.57	24.74	3.57	0.000%
38	4.37	-24.74	-2.52	-4.37	24.74	2.52	0.000%
39	5.05	-24.74	0.00	-5.05	24.74	0.00	0.000%
40	4.37	-24.74	2.52	-4.37	24.74	-2.52	0.000%
41	3.57	-24.74	3.57	-3.57	24.74	-3.57	0.000%
42	2.52	-24.74	4.37	-2.52	24.74	-4.37	0.000%
43	0.00	-24.74	5.05	0.00	24.74	-5.05	0.000%
44	-2.52	-24.74	4.37	2.52	24.74	-4.37	0.000%

Load Comb.	Sum of Applied Forces PX K	PY K	PZ K	Sum of Reactions PX K	PY K	PZ K	% Error
45	-3.57	-24.74	3.57	3.57	24.74	-3.57	0.000%
46	-4.37	-24.74	2.52	4.37	24.74	-2.52	0.000%
47	-5.05	-24.74	0.00	5.05	24.74	0.00	0.000%
48	-4.37	-24.74	-2.52	4.37	24.74	2.52	0.000%
49	-3.57	-24.74	-3.57	3.57	24.74	3.57	0.000%
50	-2.52	-24.74	-4.37	2.52	24.74	4.37	0.000%

Non-Linear Convergence Results

Load Combination	Converged?	Number of Cycles	Displacement Tolerance	Force Tolerance
1	Yes	4	0.00000001	0.00000001
2	Yes	4	0.00000001	0.00003002
3	Yes	5	0.00000001	0.00004837
4	Yes	5	0.00000001	0.00005156
5	Yes	5	0.00000001	0.00003889
6	Yes	4	0.00000001	0.00051459
7	Yes	5	0.00000001	0.00005251
8	Yes	5	0.00000001	0.00005186
9	Yes	5	0.00000001	0.00004074
10	Yes	4	0.00000001	0.00003008
11	Yes	5	0.00000001	0.00004074
12	Yes	5	0.00000001	0.00005186
13	Yes	5	0.00000001	0.00005251
14	Yes	4	0.00000001	0.00051459
15	Yes	5	0.00000001	0.00003889
16	Yes	5	0.00000001	0.00005156
17	Yes	5	0.00000001	0.00004837
18	Yes	4	0.00000001	0.00000001
19	Yes	5	0.00000001	0.00007136
20	Yes	5	0.00000001	0.00013399
21	Yes	5	0.00000001	0.00014490
22	Yes	5	0.00000001	0.00012509
23	Yes	5	0.00000001	0.00007880
24	Yes	5	0.00000001	0.00013967
25	Yes	5	0.00000001	0.00014585
26	Yes	5	0.00000001	0.00012679
27	Yes	5	0.00000001	0.00007163
28	Yes	5	0.00000001	0.00012679
29	Yes	5	0.00000001	0.00014585
30	Yes	5	0.00000001	0.00013967
31	Yes	5	0.00000001	0.00007880
32	Yes	5	0.00000001	0.00012509
33	Yes	5	0.00000001	0.00014490
34	Yes	5	0.00000001	0.00013399
35	Yes	4	0.00000001	0.00001353
36	Yes	4	0.00000001	0.00013326
37	Yes	4	0.00000001	0.00013851
38	Yes	4	0.00000001	0.00009990
39	Yes	4	0.00000001	0.00009144
40	Yes	4	0.00000001	0.00015955
41	Yes	4	0.00000001	0.00014033
42	Yes	4	0.00000001	0.00009720
43	Yes	4	0.00000001	0.00001361
44	Yes	4	0.00000001	0.00009720
45	Yes	4	0.00000001	0.00014033

46	Yes	4	0.00000001	0.00015955
47	Yes	4	0.00000001	0.00009144
48	Yes	4	0.00000001	0.00009990
49	Yes	4	0.00000001	0.00013851
50	Yes	4	0.00000001	0.00013326

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	119.5 - 97.5	10.461	43	0.7510	0.0044
L2	101.5 - 48.75	7.687	43	0.7069	0.0031
L3	54.25 - 1	2.137	43	0.3705	0.0008

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
122.00	GPS	43	10.461	0.7510	0.0044	46550
120.00	13' Low Profile Platform	43	10.461	0.7510	0.0044	46550
112.00	GPS	43	9.288	0.7386	0.0039	31033
110.00	13' Low Profile Platform	43	8.978	0.7343	0.0037	24500
102.00	GPS	43	7.761	0.7090	0.0031	13546
100.00	13' Low Profile Platform	43	7.465	0.7000	0.0030	12536

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	119.5 - 97.5	26.722	10	1.9161	0.0114
L2	101.5 - 48.75	19.643	10	1.8049	0.0080
L3	54.25 - 1	5.464	10	0.9472	0.0020

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
122.00	GPS	10	26.722	1.9161	0.0114	18414
120.00	13' Low Profile Platform	10	26.722	1.9161	0.0114	18414
112.00	GPS	10	23.728	1.8825	0.0099	12276
110.00	13' Low Profile Platform	10	22.937	1.8715	0.0096	9691
102.00	GPS	10	19.833	1.8099	0.0080	5356
100.00	13' Low Profile Platform	10	19.077	1.7886	0.0077	4954

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 K	Allow. P_a K	Ratio $\frac{P}{P_a}$
L1	119.5 - 97.5 (1)	TP27.59x22x0.1875	22.00	118.50	151.8	6.480	15.7030	-8.82	101.75	0.087
L2	97.5 - 48.75 (2)	TP39.49x26.1986x0.25	52.75	118.50	105.8	13.336	30.0373	-14.07	400.59	0.035
L3	48.75 - 1 (3)	TP51x37.6042x0.3125	53.25	118.50	79.0	21.990	50.2757	-24.74	1105.58	0.022

Pole Bending Design Data

Section No.	Elevation ft	Size	Actual M_x kip-ft	Actual f_{bx} ksi	Allow. F_{bx} ksi	Ratio $\frac{f_{bx}}{F_{bx}}$	Actual M_y kip-ft	Actual f_{by} ksi	Allow. F_{by} ksi	Ratio $\frac{f_{by}}{F_{by}}$
L1	119.5 - 97.5 (1)	TP27.59x22x0.1875	51.28	6.014	39.000	0.154	0.00	0.000	39.000	0.000
L2	97.5 - 48.75 (2)	TP39.49x26.1986x0.25	431.50	18.432	38.850	0.474	0.00	0.000	38.850	0.000
L3	48.75 - 1 (3)	TP51x37.6042x0.3125	1025.48	19.537	37.642	0.519	0.00	0.000	37.642	0.000

Pole Shear Design Data

Section No.	Elevation ft	Size	Actual V K	Actual f_v ksi	Allow. F_v ksi	Ratio $\frac{f_v}{F_v}$	Actual T kip-ft	Actual f_{vt} ksi	Allow. F_{vt} ksi	Ratio $\frac{f_{vt}}{F_{vt}}$
L1	119.5 - 97.5 (1)	TP27.59x22x0.1875	3.92	0.249	26.000	0.019	0.00	0.000	26.000	0.000
L2	97.5 - 48.75 (2)	TP39.49x26.1986x0.25	9.44	0.314	26.000	0.024	0.00	0.000	26.000	0.000
L3	48.75 - 1 (3)	TP51x37.6042x0.3125	12.93	0.257	26.000	0.020	0.00	0.000	26.000	0.000

Pole Interaction Design Data

Section No.	Elevation ft	Ratio $\frac{P}{P_a}$	Ratio $\frac{f_{bx}}{F_{bx}}$	Ratio $\frac{f_{by}}{F_{by}}$	Ratio $\frac{f_v}{F_v}$	Ratio $\frac{f_{vt}}{F_{vt}}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	119.5 - 97.5 (1)	0.087	0.154	0.000	0.019	0.000	0.241 ✓	1.333	H1-3+VT ✓
L2	97.5 - 48.75 (2)	0.035	0.474	0.000	0.024	0.000	0.510 ✓	1.333	H1-3+VT ✓
L3	48.75 - 1 (3)	0.022	0.519	0.000	0.020	0.000	0.541 ✓	1.333	H1-3+VT ✓

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	$SF*P_{allow}$ K	% Capacity	Pass Fail
L1	119.5 - 97.5	Pole	TP27.59x22x0.1875	1	-8.82	135.64	18.1	Pass
L2	97.5 - 48.75	Pole	TP39.49x26.1986x0.25	2	-14.07	533.98	38.2	Pass
L3	48.75 - 1	Pole	TP51x37.6042x0.3125	3	-24.74	1473.74	40.6	Pass
							Summary	
						Pole (L3)	40.6	Pass
						RATING =	**40.6**	**Pass**

ANCHOR BOLT AND BASE PLATE ANALYSIS

ANCHOR BOLT AND BASE PLATE ANALYSIS

Input Data

Tower Reactions:

Overturning Moment:	$OM := 1025 \cdot ft \cdot kips$	*user input*
Shear Force:	$Shear := 13.0 \cdot kips$	*user input*
Axial Force:	$Axial := 25.0 \cdot kips$	*user input*

Anchor Bolt Data:

Use ASTM A615 Grade 75 *user input*

Number of Anchor Bolts = N	$N := 12$	*user input*
Diameter of Bolt Circle:	$D_{bc} := 60in$	*user input*
Bolt "Column" Distance:	$l := 3.0in$	*user input*
Bolt Ultimate Strength:	$F_u := 100 \cdot ksi$	*user input*
Bolt Yield Strength:	$Fy := 75 \cdot ksi$	*user input*
Bolt Modulus:	$E := 29000 \cdot ksi$	*user input*
Anchor Bolt Diameter	$D := 2.25in$	*user input*
Threads per Inch:	$n := 4.5$	*user input*

Base Plate Data:

Use ASTM A633 GR. E (60ksi)		*user input*
Plate Yield Strength:	$Fy_{bp} := 60 \cdot ksi$	*user input*
Base Plate Thickness:	$PlateThickness := 2.25 \cdot in$	*user input*
Base Plate Diameter:	$D_{bp} := 66 \cdot in$	*user input*
Outer Pole Diameter:	$D_{pole} := 51.0in$	*user input*

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: $i := 1..N$

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

$d_1 = 15.00\cdot in$	$d_7 = -15.00\cdot in$
$d_2 = 25.98\cdot in$	$d_8 = -25.98\cdot in$
$d_3 = 30.00\cdot in$	$d_9 = -30.00\cdot in$
$d_4 = 25.98\cdot in$	$d_{10} = -25.98\cdot in$
$d_5 = 15.00\cdot in$	$d_{11} = -15.00\cdot in$
$d_6 = 0.00\cdot in$	etc.

Critical Distances For Bending in Plate:

Outer Pole Radius: $R_{pole} := \frac{D_{pole}}{2}$ $R_{pole} = 25.50\cdot in$

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

$MA_1 = 0.00\cdot in$	$MA_7 = 0.00\cdot in$
$MA_2 = 0.48\cdot in$	$MA_8 = 0.00\cdot in$
$MA_3 = 4.50\cdot in$	$MA_9 = 0.00\cdot in$
$MA_4 = 0.48\cdot in$	$MA_{10} = 0.00\cdot in$
$MA_5 = 0.00\cdot in$	$MA_{11} = 0.00\cdot in$
$MA_6 = 0.00\cdot in$	etc.

Effective Width of Baseplate for Bending: $EffectiveWidth := .8\cdot 2\cdot\sqrt{\left(\frac{D_{bp}}{2}\right)^2 - \left(\frac{D_{pole}}{2}\right)^2}$ $EffectiveWidth = 33.51\cdot in$

Anchor Bolt Analysis:

Polar Moment of Inertia I_p:

$$I_p := \sum_i \left(d_i\right)^2 \qquad I_p = 5.400 \times 10^3 \cdot in^2$$

Gross Area of Bolt:

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

Net Area of Bolt:

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

Net Diameter:

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

Radius of Gyration of Bolt:

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

Section Modulus of Bolt:

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

Anchor Bolt Bending Stress:

Maximum Applied Bending:

$$M_x := \left(\frac{Shear}{N}\right) \cdot 1 \qquad M_x = 0.271 \cdot ft \cdot kips$$

$$f_{bx} := \frac{M_x}{S_x} \qquad f_{bx} = 3.9 \cdot ksi$$

Allowable Bending

$$F_{bx} := 1.333 \cdot 0.60 \cdot Fy \qquad F_{bx} = 60.0 \cdot ksi$$

Note: 1.333 increase allowed per TIA/EIA

Check Tensile Forces:

Maximum Tensile Force (Gross Area):

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

Note: 1.333 increase allowed per TIA/EIA

Maximum Tensile Force (Net Area):

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

Note: 1.333 increase allowed per TIA/EIA

Applied Tension:

$\text{MaxTension} := \frac{OM \cdot R_{bc}}{I_p} - \frac{\text{Axial}}{N}$ $\text{MaxTension} = 66.3 \cdot \text{kips}$

Check Stresses:

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

$$\frac{\text{MaxTension}}{F_{net.area}} = 0.34$$

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

Condition = "OK"

Check Compression & Combined Stresses (if required):

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

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

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

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

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

Allowable Compressive Force:

$$K := 0.65$$

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

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

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

Applied Compressive Force:

$$MaxCompression := \frac{OM \cdot R_{bc}}{I_p} + \frac{Axial}{N} \qquad MaxCompression = 70.4 \cdot kips$$

$$f_a := \frac{MaxCompression}{A_n} \qquad f_a = 21.7 \cdot ksi$$

Check Combined Stresses:

$$\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} = 0.36$$

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

Base Plate Analysis:

Force from Bolt(s):

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

$C_1 = 36.3 \cdot kips$ $\quad C_7 = -32.1 \cdot kips$

$C_2 = 61.3 \cdot kips$ $\quad C_8 = -57.1 \cdot kips$

$C_3 = 70.4 \cdot kips$ $\quad C_9 = -66.3 \cdot kips$

$C_4 = 61.3 \cdot kips$ $\quad C_{10} = -57.1 \cdot kips$

$C_5 = 36.3 \cdot kips$ $\quad C_{11} = -32.1 \cdot kips$

$C_6 = 2.1 \cdot kips$ $\quad$ etc.

Bending Stress in Plate:

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

$f_{bp} = 13.3 \cdot ksi$

Check Stresses:

$$\frac{f_{bp}}{1.333 \cdot 0.75Fy_{bp}} = 0.22$$

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

Condition = "OK"

FOUNDATION ANALYSIS

URS

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MONOPOLE FOUNDATION ANALYSIS

TOWER FORCES:

Moment Caused by Tower $M_t := 1025 \cdot ft \cdot kips$

Shear at Base of Tower $S_t := 13.0kip$

Max Compressive Force $C_t := 25.0 \cdot kip$

Height of Tower $H_t := 120.0 \cdot ft$

Base Plate Bolt Circle $MP := 60in$

FOOTING DIMENSIONS:

Overall Depth of Footing $D_f := 5.0ft$

Length of Pier $L_p := 3.0 \cdot ft$

Extension of Pier Above Grade $L_{pag} := 1.0 \cdot ft$

Diameter of Pier $d_p := 7.0 \cdot ft$

Thickness of Footing $T_f := 3.0 \cdot ft$

Width of Footing: $W_f := 25.0ft$

Length of Anchor Bolts: $L_{st} := 72in$

Projection of anchor bolts above pier $A_{BP} := 12 \cdot in$

PROPERTIES:

Compressive Strength of Concrete $f'c := 4000psi$

Yield Strength of Steel Reinforcement $fy := 60000 \cdot psi$

Yield Strength of Anchor Bolt $fya := 75000 \cdot psi$

Internal Friction Angle of Soil $\theta_s := 30 \cdot deg$

Allowable Bearing Capacity $q_s := 6000 \cdot psf$

Unit Weight of Soil $\pi_s := 120 \cdot pcf$

Unit Weight of Concrete $\pi_c := 150 \cdot pcf$

Depth to Neglect $n := 0ft$

Cohesion of Clay Type Soil
Note: Use 0 for Sandy Soil $c := 0 \cdot ksf$

Seismic Zone Factor:
UBC Fig 23-2 $Z := 2$

Coefficient of Friction
between Concrete: $\mu := 0.45$

Clear Cover of Reinforcement Pier: $Cvr_{pier} := 3 \cdot in$

Clear Cover of Reinforcement Pad: $Cvr_{pad} := 3 \cdot in$

Anchor Bolt Diameter $d_{anchor} := 2.25in$

Anchor bolt area $A_{anchor} := 3.97 \cdot in^2$

PIER REINFORCEMENT:

Bar Size $BSpier := 8$ Bar Diameter $d_{bpier} := 1.000 \cdot in$

Number of Bars $NBpier := 30$ Bar Area $A_{bpier} := 0.790 \cdot in^2$

PAD REINFORCEMENT:

TOP:

Bar Size $BS_{top} := 8$ Bar Diameter $d_{btop} := 1.000 \cdot in$

Number of Bars $NB_{top} := 22$ Bar Area $A_{btop} := 0.790 \cdot in^2$

BOTTOM:

Bar Size $BS_{bot} := 8$ Bar Diameter $d_{bbot} := 1.000 \cdot in$

Number of Bars $NB_{bot} := 29$ Bar Area $A_{bot} := 0.790 \cdot in^2$

Coefficient of Lateral Soil Pressure: $K_p := \frac{1 + \sin(\theta_s)}{1 - \sin(\theta_s)}$ $K_p = 3$

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

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CHECK ANCHOR STEEL EMBEDMENT

Depth:

$D_{ab} := L_{st} - A_{BP}$ $\quad D_{ab} = 5 \cdot ft$ $\quad L_{anchor} := \dfrac{(0.11 \cdot fy) \cdot in}{\sqrt{fc \cdot psi}}$ $\quad L_{anchor} = 8.6963 \cdot ft$

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

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

STABILITY OF FOOTING

Passive Pressure:

$P_{pn} := K_p \cdot \pi_s \cdot n + c \cdot 2 \cdot \sqrt{K_p}$ $\quad P_{pn} = 0 \cdot ksf$

$P_{pt} := K_p \cdot \pi_s \cdot (D_f - T_f) + c \cdot 2 \cdot \sqrt{K_p}$ $\quad P_{pt} = 0.72 \cdot ksf$

$P_{top} := if[n < (D_f - T_f), P_{pt}, P_{pn}]$ $\quad P_{top} = 0.72 \cdot ksf$

$P_{bot} := K_p \cdot \pi_s \cdot D_f + c \cdot 2 \cdot \sqrt{K_p}$ $\quad P_{bot} = 1.8 \cdot ksf$

$P_{ave} := \dfrac{P_{top} + P_{bot}}{2}$ $\quad P_{ave} = 1.26 \cdot ksf$

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

$A_p := W_f \cdot T_p$ $\quad A_p = 75 \cdot ft^2$

Ultimate Shear: $S_u := P_{ave} \cdot A_p$ $\quad S_u = 94.5 \cdot kip$

Weight of Concrete Pad: $WT_c := [(W_f^2 \cdot T_f) + d_p^2 L_p] \cdot \pi_c$ $\quad WT_c = 303.3 \cdot kip$

Weight of Soil: above Footing: $WT_{s1} := \left[W_f^2 \cdot (|L_p - L_{pag}|) - \dfrac{d_p^2 \cdot \pi}{4} \cdot (|L_p - L_{pag}|)\right] \cdot \pi_s$ $\quad WT_{s1} = 140.7637 \cdot kip$

Weight of Soil Wedge at back face: $WT_{s2} := \left(\dfrac{D_f^2 \cdot \tan(\theta_s)}{2} \cdot W_f\right) \cdot \pi_s$ $\quad WT_{s2} = 21.6506 \cdot kip$

Total Weight: $WT_{tot} := WT_c + WT_{s1} + C_t$ $\quad WT_{tot} = 469.0637 \cdot kip$

Resisting Moment: $M_r := (WT_{tot}) \cdot \dfrac{W_f}{2} + S_u \cdot \dfrac{T_f}{3} + WT_{s2} \cdot \left(W_f + \dfrac{D_f \cdot \tan(\theta_s)}{3}\right)$ $\quad M_r = 6519.8957 \cdot kip \cdot ft$

Overturning Moment: $M_{ot} := M_t + S_t \cdot (L_p + T_f)$ $\quad M_{ot} = 1103 \cdot kip \cdot ft$

Factor of Safety: $FS := \dfrac{M_r}{M_{ot}}$ $\quad FS_{req} := 2$ $\quad FS = 5.91$

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

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SHEAR CAPACITY IN PIER

$FS := 2$

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

$S_p = 152.7893 \cdot kips$

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

ShearCheck = "Okay"

BEARING PRESSURE CAUSED BY FOOTING

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

$A_{mat} = 625 \cdot ft^2$

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

$S = 2604.1667 \cdot ft^3$

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

$P_{max} = 1.1741 \cdot ksf$

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

$P_{min} = 0.3269 \cdot ksf$

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

MaxPressure = "Okay"

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

MinPressure = "Okay"

Distance to Resultant of Pressure Distribution:

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

$X_p = 11.5497 \cdot ft$

Distance to Kern: $X_k := \dfrac{W_f}{6}$

$X_k = 4.1667 \cdot ft$

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

Eccentricity: $e := \dfrac{M_{ot}}{WT_{tot}}$

$e = 2.3515$

Adjusted Soil Pressure:

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

$P_a = 1.2325 \cdot ksf$

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

$q_{adj} = 1.1741 \cdot ksf$

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

PressureCheck = "Okay"

CONCRETE BEARING CAPACITY (ACI 10.17)

$\theta_c := 0.75$ (ACI 9.3.2.2)

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

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

SHEAR STRENGTH OF CONCRETE

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

$\theta_c := .85$ (ACI 9.3.2.3)

$d := T_f - Cvr_{pad} - d_{bbot}$ $\qquad d = 32 \cdot in$

$d_1 := \frac{W_f}{2} - \frac{d_p}{2}$ $\qquad d_1 = 9 \cdot ft$

$d_2 := d_1 - d$ $\qquad d_2 = 6.3333 \cdot ft$

$L := \left(\frac{W_f}{2} - e\right) \cdot 3$ $\qquad L = 30.4455 \cdot ft$

$Slope := if\left(L > W_f, \frac{P_{max} - P_{min}}{W_f}, \frac{q_{adj}}{L}\right)$ $\qquad Slope = 0.0339 \cdot kcf$

$V_{req} := LF \cdot \left[\left(q_{adj} - Slope \cdot d_1\right) + \left(\frac{Slope \cdot d_1}{2}\right)\right] \cdot W_f \cdot d_1$ $\qquad V_{req} = 306.396 \cdot kip$

ACI 11.3.1.1 $\qquad V_{Avail} := \theta_c \cdot 2 \cdot \sqrt{fc \cdot psi} \cdot W_f \cdot d$ $\qquad V_{Avail} = 1032.1674 \cdot kip$

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

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

$b_o := (d_p + d) \cdot \pi$ $\qquad b_o = 30.3687 \cdot ft$

Area included inside bo: $\qquad A_{bo} := \frac{\pi \cdot (d_p + d)^2}{4}$ $\qquad A_{bo} = 73.3911 \cdot ft^2$

Area outside of bo: $\qquad A_{out} := A_{mat} - A_{bo}$ $\qquad A_{out} = 551.6089 \cdot ft^2$

Guess Value: $v_u := 1ksf$

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

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

$v_u := Find(v_u)$ $\quad v_u = 5.7921 \cdot ksf$

$V_u := v_u \cdot d \cdot W_f$ $\quad V_u = 386.1404 \cdot kips$

$V_{req} := LF \cdot V_u$ $\quad V_{req} = 514.7251 \cdot kips$

$V_{Avail} := \theta_c \cdot 4 \cdot \sqrt{fc \cdot psi} \cdot b_o \cdot d$ $\quad V_{Avail} = 2507.649 \cdot kips$

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

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

Take Maximum Bending at face of Pier:

$q_b := q_{adj} - d_1 \cdot Slope$ $\quad q_b = 0.8691 \cdot ksf$

$$M_n := \frac{1}{LF \cdot \theta_m} \cdot \left[(q_{adj} - q_b) \cdot \frac{d_1^2}{3} + q_b \cdot \frac{d_1^2}{2} \right] \cdot W_f \quad M_n = 905.065 \cdot kip \cdot ft$$

ACI 10.2.7.3

$$\beta := if\left[fc \le 4000 \cdot psi, .85, if\left[fc \ge 8000 \cdot psi, .65, .85 - \left(\frac{\frac{fc}{psi} - 4000}{1000}\right) \cdot .05\right]\right] \quad \beta = 0.85$$

$$R_u := \frac{M_n}{\theta_m \cdot W_f \cdot d^2} \quad R_u = 5656.7\ lbf$$

$$\rho := \frac{0.85 \cdot fc}{fy}\left(1 - \sqrt{1 - \frac{2 \cdot R_u}{0.85 \cdot fc}}\right) \quad \rho = 0.0007$$

$\rho_{min} := 1.333 \cdot \rho$ $\quad \rho_{min} = 0.00088$

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

(ACI 7.12.2.1b)

FOR BOTTOM BARS:

$As := \max(\rho_{,}\rho_{min}, \rho_{sh}) \cdot W_f \cdot d$ $\qquad As = 17.28 \cdot in^2$

$As_{prov} := A_{bot} \cdot NB_{bot}$ $\qquad As_{prov} = 22.91 \cdot in^2$

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

FOR TOP BARS:

$As := \rho_{sh} \cdot (W_f \cdot d)$ $\qquad As = 17.28 \cdot in^2$

$As_{prov} := A_{btop} \cdot NB_{top}$ $\qquad As_{prov} = 17.38 \cdot in^2$

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

TENSION (ACI 12.2.3)

DEVELOPMENT LENGTH OF PAD REINFORCEMENT

Bar Spacing: $B_{sPad} := \dfrac{W_f - 2 \cdot Cvr_{pad} - NB_{bot} \cdot d_{bbot}}{NB_{bot} - 1}$ $\qquad B_{sPad} = 9.4643 \cdot in$

Development Length Factors:

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

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

Transverse Reinforcement IndexAs allowed by ACI 12.2.4 $\qquad k_{tr} := 0$

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

$L_{dbt} = 23.7171 \cdot in$

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

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

Available Length in Pad: $L_{Pad} := \dfrac{W_f}{2} - \dfrac{d_p}{2} - Cvr_{pad}$ $\qquad L_{Pad} = 105 \cdot in$

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

REINFORCEMENT IN PIER

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

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

$A_{sprov} := NBpier \cdot A_{bpier}$ $A_{sprov} = 23.7 \cdot in^2$

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

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

Bar Spacing In Pier: $B_{sPier} := \frac{d_p \cdot \pi}{NBpier} - d_{bpier}$ $B_{sPier} = 7.7965 \cdot in$

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

Maximum Moment in Pier: $M_p := \left[M_t + S_t \cdot \left(L_p + \frac{A_{BP}}{2}\right)\right] \cdot LF$ $M_p = 17123.718 \cdot in \cdot kips$

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

(defined variables) $(f'_c \;\; f_y \;\; cl \;\; Spiral) = (3 \;\; 60 \;\; 3 \;\; 0)$

The required input is column diameter in inches, number of reinforcing bars, bar size number, factored axial load in kips and moment in kip inches: $(D \;\; N \;\; n \;\; P_u \;\; M_{xu}) := (84 \;\; 30 \;\; 8 \;\; 33.3 \;\; 17124)$

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

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

The Output is given as useable axial load in kips, moment capacity in kip inches, splicing stress in ksi, and reinforcement ratio: $(\theta P_n \;\; \theta M_{xn} \;\; f_{sp} \;\; \rho) = (94.5076 \;\; 48599.0284 \;\; -60 \;\; 0.0043)$

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

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

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

DEVELOPMENT LENGTH OF PIER REINFORCEMENT

TENSION (ACI 12.2.3)

Factors for development:

Reinforcement Location Factor $\alpha := 1.0$

Coating Factor $\beta := 1.0$

Concrete strength Factor $\lambda := 1.0$

Reinforcement Size Factor $\pi := 1.0$

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

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

$$L_{dbt} := \frac{3}{40} \cdot \frac{fy}{\sqrt{f'c \cdot psi}} \cdot \frac{\alpha \cdot \beta \cdot \pi \cdot \lambda}{\frac{c + k_{tr}}{d_{bpier}}} \cdot d_{bpier} \qquad L_{dbt} = 23.7171 \cdot in$$

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

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

$$L_{dh} := \frac{1200 \cdot d_{bpier}}{\sqrt{\frac{f'c}{psi}}} \cdot .7 \qquad L_{dh} = 13.2816 \cdot in$$

$$L_{db} := \max\left(L_{dbt}, L_{dbmin}\right) \qquad L_{db} = 23.7171 \cdot in$$

COMPRESSION: (ACI 12.3.2)

$$L_{dbc1} := \frac{.02 \cdot d_{bpier} \cdot fy}{\sqrt{f'c \cdot psi}} \qquad L_{dbc1} = 18.9737 \cdot in$$

$$L_{dbmin} := 0.0003 \cdot \frac{in^2}{lb} \cdot \left(d_{bpier} \cdot fy\right) \qquad L_{dbmin} = 18 \cdot in$$

$$L_{dbc} := \text{if}\left(L_{dbc1} \ge L_{dbmin}, L_{dbc1}, L_{dbmin}\right) \qquad L_{dbc} = 18.9737 \cdot in$$

Available Length in Foundation:

$$L_{pier} := L_p - Cvr_{pier} \qquad L_{pier} = 33 \cdot in$$

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

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

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

NOTE: Anchor bolts and plate provided, OK

TIE SIZE AND SPACING IN COLUMN

Minimum Tie Size:

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

Used #4 Ties $\quad d_{Tie} := 4$

Seismic factor:
(ACI 21.10.5)

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

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

$s_{lim2} := \frac{48 \cdot d_{Tie} \cdot in}{8} \cdot z$ $\quad s_{lim2} = 24 \cdot in$

$s_{lim3} := D_f \cdot z$ $\quad s_{lim3} = 60 \cdot in$

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

Maximum Spacing:

$$s_{tie} := min\left(\begin{pmatrix} s_{lim1} \\ s_{lim2} \\ s_{lim3} \\ s_{lim4} \end{pmatrix}\right) \qquad s_{tie} = 16 \cdot in$$

Number of Ties Required:

$$n_{tie} := \frac{L_{pier} - 3 \cdot in}{s_{tie}} + 1 \qquad n_{tie} = 2.875$$