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ticut 06067

EM-CING-056-120918

John Lawrence
Real Estate Consultant
95 Ryan Drive, Suite #1
Raynham, MA 02767
Phone: (781) 715-5532
jlawrence@clinellc.com

April 23, 2012

William F. Smith, Jr., Town Manager
Granby Town Hall
15 North Granby Road
Granby CT 06035

Re: Notice of Exempt Modification – Existing Telecommunications Facility at 15 North Granby Road Granby CT.

Dear Mr. Smith,

New Cingular Wireless PCS, LLC ("AT&T") intends to replace telecommunications antennas and associated equipment at an existing telecommunications tower, owned and operated by AT&T.

A Notice of Exempt Modification has been filed with the Connecticut Siting Council as required by Regulations of Connecticut State Agencies ("R.C.S.A.") Section 16-50j-73. Please accept this letter as notification to the Town of Granby under Section 16-50j-73 of construction which constitutes an exempt modification pursuant to R.C.S.A. Section 16-50j-72(b)(2).

The attached letter fully sets forth the AT&T proposal. However, if you have any questions or require any further information on the plans for the site or the Siting Council's procedures, please contact John Lawrence at (781) 715-5532 or Linda Roberts, Executive Director of the Connecticut Siting Council, at (860) 827-2935.

Sincerely,

RECEIVED
SEP 18 2012
CONNECTICUT
SITING COUNCIL

John Lawrence
Real Estate Consultant

Enclosure
CC: Honorable Robert Stein, Chairmen of the Connecticut Siting Council

at&t
Your world. Delivered.

RECEIVED
SEP 18 2012
CONNECTICUT
SITING COUNCIL

New Cingular Wireless PCS, LLC
500 Enterprise Drive
Rocky Hill, Connecticut 06067

John Lawrence
Real Estate Consultant
95 Ryan Drive, Suite #1
Raynham, MA 02767
Phone: (781) 715-5532
jlawrence@clinellc.com

April 23, 2012

Honorable Robert Stein, Chairman,
and Members of the Connecticut Siting Council
Connecticut Siting Council
10 Franklin Square
New Britain, Connecticut 06051

Re: Notice of Exempt Modification – Existing Telecommunications Facility at 15 North Granby Road Granby CT.

Dear Chairman Stein and Members of the Council:

New Cingular Wireless PCS, LLC ("AT&T") intends to modify the existing telecommunications antennas and associated equipment at an existing multicarrier telecommunications tower at 15 North Granby Road, Granby . AT&T operates under licenses issued by the Federal Communications Commission ("FCC") to provide cellular and PCS mobile telephone service in Hartford County, which includes the area to be served by AT&T's proposed installation.

In order to accommodate technological changes, implement Long Term Evolution ("LTE") capabilities, and enhance system performance in the State of Connecticut, New Cingular Wireless PCS, LLC ("AT&T") plans to modify the equipment configurations at many of its existing cell sites. LTE is a new high-performance air interface for cellular mobile communications. It is designed to increase the capacity and speed of mobile telephone networks.

Please accept this letter as notification to the Council, pursuant to R.C.S.A. Section 16-50j-73, of construction which constitutes an exempt modification pursuant to R.C.S.A. Section 16-50j-72(b)(2). In compliance with R.C.S.A. Section 16-50j-73, a copy of this letter is being sent to the Town Manager William F. Smith, Jr.

Attached is a summary of the planned modifications, including power density calculations reflecting the change in AT&T's operations at the site. Also included is documentation of the structural sufficiency of the tower to accommodate the revised antenna configuration.

Existing Facility

The Granby facility is located at 15 North Granby Road, Granby, CT

The facility is owned by TowerCo.

The existing facility consists of a 150 foot monopole tower. AT&T currently operates wireless communications equipment at the facility and has six (6) antennas mounted at the tower centerline height of 140 feet.

Statutory Considerations

The changes to the Granby tower facility do not constitute a modification as defined in Connecticut General Statutes ("C.G.S.") Section 16-50i(d) because the general physical characteristics of the facility will not be significantly changed or altered. Rather, the planned changes to the facility fall squarely within those activities explicitly provided for in R.C.S.A. Section 16-50j-72(b)(2) because they will not result in any substantial adverse environmental effect.

1. The height of the overall structure will be unaffected.

2. The proposed changes will not affect the property boundaries. All new construction will take place inside the existing fenced compound.

3. The proposed additions will not increase the noise level at the existing facility by six decibels or more.

4. LTE will utilize additional radio frequencies newly licensed by the FCC for cellular mobile communications. However, the changes will not increase the calculated "worst case" power density for the combined operations at the site to a level at or above the applicable standard for uncontrolled environments as calculated for a mixed frequency site.

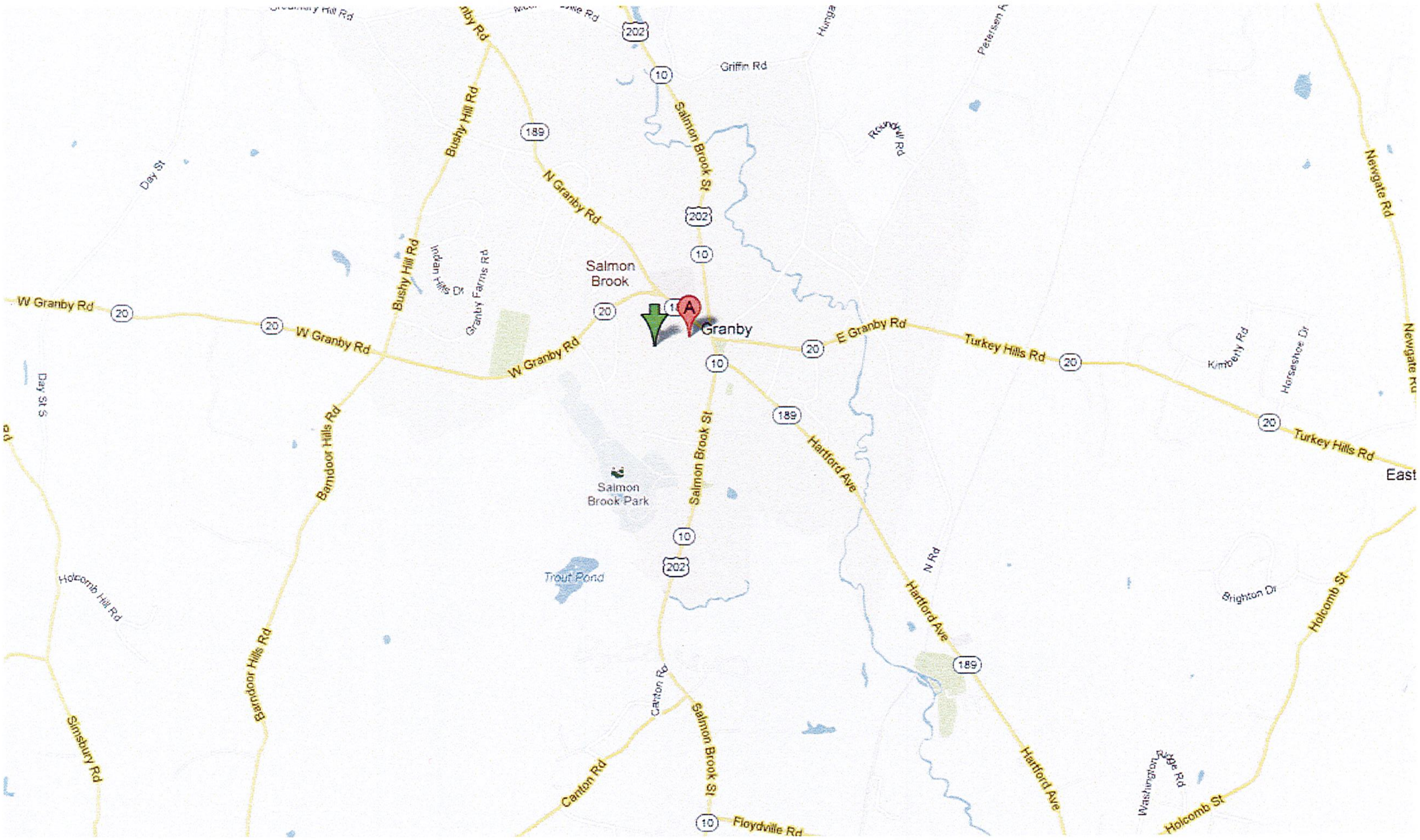
For the foregoing reasons, New Cingular Wireless respectfully submits that the proposed changes at the referenced site constitute exempt modifications under R.C.S.A Section §16-50j-72(b)(2).

Respectfully yours,

John Lawrence
Real Estate Consultant

Enclosures:
William F. Smith, Jr., Town Manager

Street Location Map



C Squared Systems, LLC
65 Dartmouth Drive, Unit A3
Auburn, NH 03032
(603) 644-2800
support@csquaredsystems.com

Calculated Radio Frequency Emissions

CT1219 (Granby PD)

15 North Granby Road, Granby, CT 06035

April 24, 2012

Table of Contents

List of Tables

List of Figures

1. Introduction

The purpose of this report is to investigate compliance with applicable FCC regulations for the proposed modifications to the existing AT&T antenna arrays mounted on the monopole located at 15 North Granby Road in Granby, CT. The coordinates of the tower are: 41° 57' 12.96"N, 72° 47' 37.32"W.

AT&T is proposing the following modifications:

1) Install three new panel antenna for LTE
2) Add 3 RRUs for LTE

2. FCC Guidelines for Evaluating RF Radiation Exposure Limits

In 1985, the FCC established rules to regulate radio frequency (RF) exposure from FCC licensed antenna facilities. In 1996, the FCC updated these rules, which were further amended in August 1997 by OET Bulletin 65 Edition 97-01. These new rules include Maximum Permissible Exposure (MPE) limits for transmitters operating between 300 kHz and 100 GHz. The FCC MPE limits are based upon those recommended by the National Council on Radiation Protection and Measurements (NCRP), developed by the Institute of Electrical and Electronics Engineers, Inc., (IEEE) and adopted by the American National Standards Institute (ANSI).

The FCC general population/uncontrolled limits set the maximum exposure to which most people may be subjected. General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

Public exposure to radio frequencies is regulated and enforced in units of milliwatts per square centimeter (mW/cm^2). The general population exposure limits for the various frequency ranges are defined in the attached "FCC Limits for Maximum Permissible Exposure (MPE)" in Attachment B of this report.

Higher exposure limits are permitted under the occupational/controlled exposure category, but only for persons who are exposed as a consequence of their employment and who have been made fully aware of the potential for exposure, and they must be able to exercise control over their exposure. General population/uncontrolled limits are five times more stringent than the levels that are acceptable for occupational, or radio frequency trained individuals. Attachment B contains excerpts from OET Bulletin 65 and defines the Maximum Exposure Limit.

Finally, it should be noted that the MPE limits adopted by the FCC for both general population/uncontrolled exposure and for occupational/controlled exposure incorporate a substantial margin of safety and have been established to be well below levels generally accepted as having the potential to cause adverse health effects.

3. RF Exposure Prediction Methods

The emission field calculation results displayed in the following figures were generated using the following formula as outlined in FCC bulletin OET 65:

$$\text{Power Density} = \left(\frac{1.6^2 \times EIRP}{4\pi \times R^2} \right) \text{x Off Beam Loss}$$

Where:

EIRP = Effective Isotropic Radiated Power

R = Radial Distance = $\sqrt{(H^2 + V^2)}$

H = Horizontal Distance from antenna in meters

V = Vertical Distance from radiation center of antenna in meters

Ground reflection factor of 1.6

Off Beam Loss is determined by the selected antenna pattern

These calculations assume that the antennas are operating at 100 percent capacity and power, and that all channels are transmitting simultaneously. Obstructions (trees, buildings, etc.) that would normally attenuate the signal are not taken into account. The calculations assume even terrain in the area of study and do not take into account actual terrain elevations which could attenuate the signal. As a result, the predicted signal levels reported below are much higher than the actual signal levels will be from the finished modifications.

C2 Systems

4. Calculation Results

Table 1 below outlines the power density information for the site. Because the proposed AT&T antennas are directional in nature, the majority of the RF power is focused out towards the horizon. As a result, there will be less RF power directed below the antennas relative to the horizon, and consequently lower power density levels around the base of the tower. Please refer to Attachment C for the vertical pattern of the proposed AT&T antennas. The calculated results for AT&T in Table 1 include a nominal 10 dB off-beam pattern loss to account for the lower relative gain below the antennas.

Carrier	Antenna Height (Feet)	Operating Frequency (MHz)	Number of Trans.	ERP Per Transmitter (Watts)	Power Density (mw/cm^2)	Limit	%MPE
AT&T UMTS	140	880	1	500	0.0092	0.5867	1.56%
AT&T GSM	140	880	4	296	0.0217	0.5867	3.70%
AT&T GSM	140	1900	2	427	0.0157	1.0000	1.57%
Pocket	100	2130	3	631	0.0681	1.0000	6.81%
Sprint	130	1962.5	11	420	0.0983	1.0000	9.83%
Nextel	150	851	9	100	0.0144	0.5673	2.54%
VoiceStream	120	1962.5	2	385	0.0192	1.0000	1.92%
Town 1	157.25	453	7	300	0.0305	0.3020	10.11%
Town 2	87.25	453	7	300	0.0992	0.3020	32.84%
AT&T UMTS	140	880	2	565	0.0021	0.5867	0.35%
AT&T UMTS	140	1900	2	875	0.0032	1.0000	0.32%
AT&T LTE	140	734	1	1615	0.0030	0.4893	0.61%
AT&T GSM	140	880	1	283	0.0005	0.5867	0.09%
AT&T GSM	140	1900	4	525	0.0039	1.0000	0.39%
						Total	**65.80%**

Table 1: Carrier Information[1 2]

[1] The existing CSC filing for Cingular should be removed and replaced with the updated AT&T technologies and values provided in Table 1. The power density information for carriers other than AT&T was taken directly from the CSC database dated 1/10/2012. Please note that %MPE values listed are rounded to two decimal points. The total %MPE listed is a summation of each unrounded contribution. Therefore, summing each rounded value may not identically match the total value reflected in the table.

[2] In the case where antenna models are not uniform across all 3 sectors for the same frequency band, the antenna model with the highest gain was used for the calculations to present a worse-case scenario.

5. Conclusion

The above analysis verifies that emissions from the existing site will be below the maximum power density levels as outlined by the FCC in the OET Bulletin 65 Ed. 97-01. Even when using conservative methods, the cumulative power density from the proposed transmit antennas at the existing facility is well below the limits for the general public. The highest expected percent of Maximum Permissible Exposure at ground level is **65.8% of the FCC limit**.

As noted previously, obstructions (trees, buildings, etc.) that would normally attenuate the signal are not taken into account. As a result, the predicted signal levels are more conservative (higher) than the actual signal levels will be from the finished modifications.

6. Statement of Certification

I certify to the best of my knowledge that the statements in this report are true and accurate. The calculations follow guidelines set forth in ANSI/IEEE Std. C95.3, ANSI/IEEE Std. C95.1 and FCC OET Bulletin 65 Edition 97-01.

Daniel L. Goulet
C Squared Systems, LLC

April 24, 2012
Date

Attachment A: References

OET Bulletin 65 - Edition 97-01 - August 1997 Federal Communications Commission Office of Engineering & Technology

ANSI C95.1-1982, American National Standard Safety Levels With Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 300 kHz to 100 GHz. IEEE-SA Standards Board

IEEE Std C95.3-1991 (Reaff 1997), IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave. IEEE-SA Standards Board

Attachment B: FCC Limits for Maximum Permissible Exposure (MPE)

(A) Limits for Occupational/Controlled Exposure[3]

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (E) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	$(900/f^2)$*	6
30-300	61.4	0.163	1.0	6
300-1500	-	-	f/300	6
1500-100,000	-	-	5	6

(B) Limits for General Population/Uncontrolled Exposure[4]

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (E) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	$(180/f^2)$*	30
30-300	27.5	0.073	0.2	30
300-1500	-	-	f/1500	30
1500-100,000	-	-	1.0	30

f = frequency in MHz * Plane-wave equivalent power density

Table 2: FCC Limits for Maximum Permissible Exposure (MPE)

[3] Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure

[4] General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure

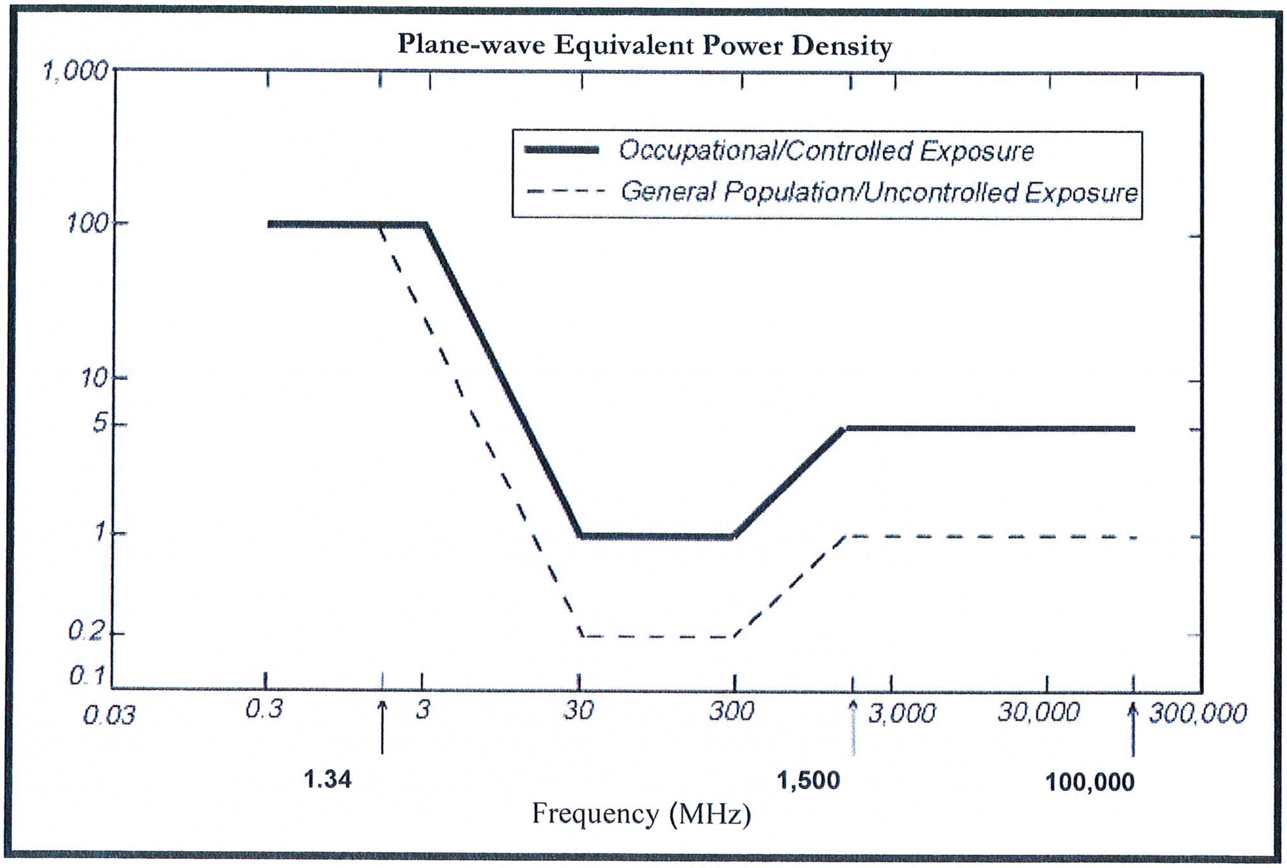
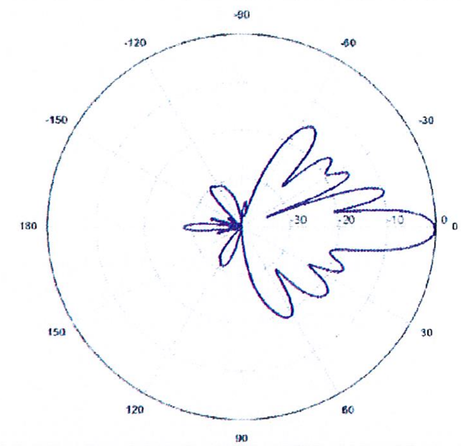


Figure 1: Graph of FCC Limits for Maximum Permissible Exposure (MPE)

Attachment C: AT&T Antenna Data Sheets and Electrical Patterns

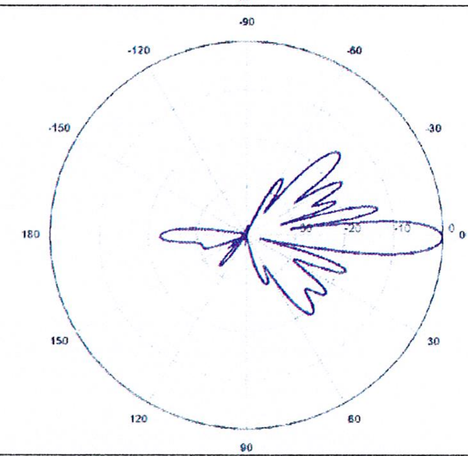
700 MHz

Manufacturer:	Powerwave
Model #:	P65-17-XLH-RR
Frequency Band:	698-806 MHz
Gain:	14.3 dBd
Vertical Beamwidth:	8.4°
Horizontal Beamwidth:	70°
Polarization:	Dual Linear ± 45°
Size L x W x D:	96.0" x 12.0" x 6.0"



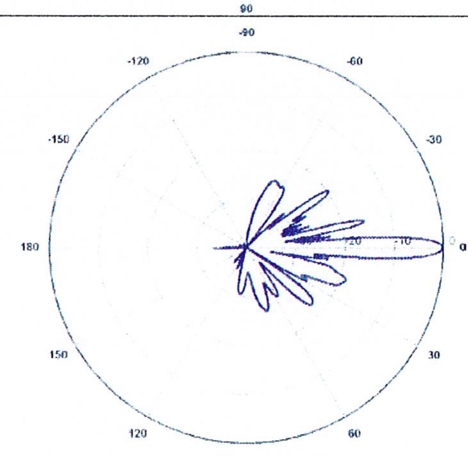
850 MHz GSM

Manufacturer:	Powerwave
Model #:	P65-17-XLH-RR
Frequency Band:	806-894 MHz
Gain:	15.1 dBd
Vertical Beamwidth:	8.4°
Horizontal Beamwidth:	63°
Polarization:	Dual Linear ±45°
Size L x W x D:	96.0" x 12.0" x 6.0"



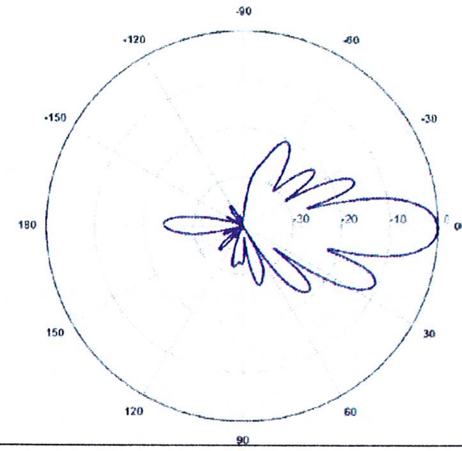
1900 MHz GSM

Manufacturer:	Commscope
Model #:	SBNH-1D6565C
Frequency Band:	1850-1990 MHz
Gain:	15.9 dBd
Vertical Beamwidth:	5.1°
Horizontal Beamwidth:	57°
Polarization:	± 45°
Size L x W x D:	96.4" x 11.9" x 7.1"



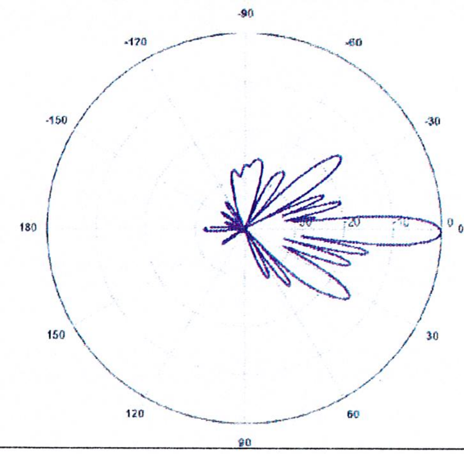
850 MHz UMTS

Manufacturer:	Kathrein-Scala
Model #:	80010121
Frequency Band:	824-896 MHz
Gain:	11.5 dBd
Vertical Beamwidth:	14.5°
Horizontal Beamwidth:	86°
Polarization:	±45°
Size L x W x D:	54.5" x 10.3" x 5.9"



1900 MHz UMTS

Manufacturer:	Kathrein-Scala
Model #:	80010121
Frequency Band:	1850-1990 MHz
Gain:	14.3 dBd
Vertical Beamwidth:	6.6°
Horizontal Beamwidth:	85°
Polarization:	±45°
Size L x W x D:	54.5" x 10.3" x 5.9"



TowerCo

PASS
(Shaft / Anchor Rods, **100%** capacity)

vertical solutions

September 7, 2012

Mr. Dwayne Lyerly
TowerCo, LLC
5000 Valleystone Drive
Cary, NC 27519
(919) 653-5713

Vertical Solutions, Inc.
PO Box 579
Holly Springs, NC 27540
(888) 321-6167
operations@verticalsolutions-inc.com

Subject	**Rigorous Structural Analysis**
Carrier Designation	**AT&T, Reconfiguration** **Site Number: CT1219** **Site Name: Granby PD**
TowerCo Designation	**Site Number: CT2010** **Site Name: Granby – N. Granby**
Engineering Firm Designation	**Vertical Solutions Project: 121657, Revision 0**
Site Data	**15 North Granby Rd., Granby, Hartford County, CT 06035** **Latitude: N41° 57' 12.90" ±; Longitude: W072° 47' 37.40" ±** **Elevation: 243 ft±, Topography Category: 1;** **Exposure Category: "C"; Structure Class II; Site Class "D"** **150-ft Self Supporting Pole Structure (Monopole)**

Dear Mr. Lyerly,

To your request, we present our structural analysis. Our work indicates that with the proposed appurtenance configuration, the tower and foundation **will** satisfy the structural strength requirements of TIA/EIA-222-F-1996, *Structural Standards for Steel Antenna Towers and Antenna Supporting Structures*(industry standard) and the *2005 Connecticut Building Code* (local building code) for:

- 80-mph fastest-mile basic wind speed
- 69-mph three-second gust with 1/2-in radial ice
- Earthquake design parameters and loading, per USGS Ground Motion Parameter Calculator and industry standard, respectively, including:
  - $S_s = 0.235$, $S_1 = 0.065$

All equipment and modifications proposed in this report shall be installed in accordance with the attached drawings for the determined available structural capacity to be effective.

We trust you find our work satisfactory. Please do not hesitate to call should you have any questions.

Sincerely,

Matthew E. Reeves, E.I.
Structural Engineer in Training

Reviewed by: JHW

STATE OF CONNECTICUT MICHAEL L. LASSITER No. 25064 LICENSED PROFESSIONAL ENGINEER
09/07/2012

Michael L. Lassiter, S.E., P.E., C.W.I.
Structural Engineer, Civil Engineer, Certified Weld Inspector & President
CT PE License No.: 25064

Table 1: Existing, Proposed and Reserved Appurtenance Configuration

Elevation (AGL, ft)	Carrier	Mount	Equipment	Coax	Location[3]
150.7	Sprint/Nextel	Low Profile Platform	(9) Andrew DB844H90E-XY (2) Beacon Lights	(9) 1 1/4	Inside
150	Town of Granby		(1) 10' Dipole with 8 elements (1) 3' Yagi with 6 elements (1) 18' Omni (1) 10' Omni	(3) 1/2 (1) 7/8	Inside
138	***AT&T***	Low Profile Platform	***(3) Powerwave P65-17-XLH-RR*** ***(6) RRUS 11*** (6) Powerwave 7770 (6) Powerwave LGP21401 (6) Powerwave LGP21903	***(3) Fiber Cables[2]*** (12) 1 1/4	***Inside***
126[1]	Sprint/Nextel (Design)	Low Profile Platform	(12) ALP 9011	(12) 1 5/8	Inside
126[1]	Sprint/Nextel (Existing)		(6) Andrew DB978H90EMS	(6) 1 5/8	Inside
115	T-Mobile	Flush Mounts	(3) EMS RR65-18-02DP (3) TMA	(6) 1 5/8	Inside
100	Pocket Communications	Flush Mounts	(3) Katherin 742 213	(6) 1 5/8	Inside
80	Unknown	Standoff Arm	--	--	--

1. Design loading was used in the analysis.
2. Inside (1) 3" Conduit.
3. See Sheet QP-P for coax layout.

Table 2: Tower Structure Results, Percent Capacity Utilized[1]

Elevation (ft)	Shaft	Result	Connections	Result
150 to 111.21	82	O. K.	-	-
111.21 to 76.85	**100**	**O. K.**	-	-
76.85 to 43.51	**100**	**O. K.**	-	-
43.51 to 0	**100**	**O. K.**	**100**	**O. K**

1. Percent capacity utilization of 100% or less considered acceptable.

Table 3: Foundation Results, Percent Capacity Utilized

Component	Design Capacity	Analysis Req.	Percent Utilized	Result
Bearing (psf)	6000	3114	52	O. K.
Overturning (kip-ft)	3198	2723	85	O. K.
Sliding (kip)	34	24	71	O. K.
Structure (kip-ft)	3825	3446	90	O. K.

Attachments:

- Project History
- Sheet QP-P, Coax configuration plan
- Program input and output – wind
- Tower improvement calculations
- Sheet BPL, Base plate layout
- Base plate and anchor rod calculations
- Foundation analysis
- Tower improvement drawings [For Construction]

Project History

VSi Project #: 121657, Revision 0
TowerCo Site Id: CT2010
TowerCo Site Name: Granby-n. Granby

Design Documents

TowerCo Document	Structure	Issued Date	Document ID	Issued By	Issued To	Description
242481	CT2010	6/18/1998	242481_CT2010 Granby-N. Granby Geotechnical Report - 06-18-1998.pdf	Tectonic Enigneering & Surveying Consultants	Nextel	Geotechnical Investigation
242484	CT2010	6/24/1998	242484_CT2010 Granby-N. Granby Tower and Foundation Design Calculations - 06-24-1998.pdf	Engineered Endeavors Inc.	Nextel	Tower and Foundation Design Calculations
197437	CT2010	4/21/1999	197437_CT2010 Granby-N. Granby Sprint SLA.pdf	Sprint Spectrum	Nextel	Site Lease Agreement
451136	CT2010	6/14/2000	451136_CT2010 Granby-N. Granby Snet Cellular Nextel Binder - AT&T SLA.pdf	SNET Cellular	Nextel	Site Lease Agreement
700173	CT2010	6/14/2000	700173_CT2010 Granby-n. Granby AT&T 1st Amendment -10-4-02-.pdf	Nextel	Springwich Cellular	Site Lease Agreement
242470	CT2010	5/21/2002	242470_CT2010 Granby-N. Granby AT&T SLA - TERMINATED.pdf	Nextel	AT&T	Site Lease Agreement
693090	CT2010	1/21/2006	693090_CT2010 Granby-n. Granby Pocket Mods Closeout Photos TCCI.pdf	TowerCo	Vertical Solutions	Photos
470868	CT2010	6/30/2006	470868_CT2010 Granby-N. Granby Cingular Notice of Non Renewal.pdf	Cingular Wireless	Nextel	Notice of Non Renewal
470869	CT2010	11/20/2006	470869_CT2010 Granby-N. Granby Cingular Notice of Termination.pdf	Sprint	New Cingular	Notice of Termination
197440	CT2010	8/1/2007	197440_CT2010 Granby-N. Granby Verizon Collocation Application.pdf	Sprint	Verizon	Co-location Tenant Application
242485	CT2010	8/9/2007	242485_CT2010 Granby-N. Granby Tower Mapping.pdf	HTS	Semaan Engineering Solutions	Tower Mapping
711885	CT2010	9/23/2008	711885_CT2010 Granby-n. Granby SLA.pdf	Tower Entity	Sprint Spectrum	Site Lease Agreement
504889	CT2010	10/29/2008	504889_CT2010 Granby-n. Granby _Semaan_Structural Analysis_Pocket Communications_colocation_20081029.pdf	Semaan Engineering Solutions	TowerCo	Structural Analysis Report

vertical solutions "execute & deliver"

Design Documents

TowerCo Document	Structure	Issued Date	Document ID	Issued By	Issued To	Description
714949	CT2010	10/30/2008	714949_CT2010 Granby-n. Granby Tower Profile.pdf	SiteMaster	TowerCo	Tower Profile Drawing
719730	CT2010	10/30/2008	719730_CT2010 Granby-n. Granby SiteMaster Inspection Report.pdf	SiteMaster	TowerCo	Tower Inspection Report
508381	CT2010	11/14/2008	508381_CT2010 Granby-n. Granby _Semaan_Structural_Pocket_Colocation_20081114.pdf	Semaan Engineering Solutions		Structural Analysis Report
527659	CT2010	2/6/2009	527659_CT2010 Granby-n. Granby Pocket Tower Modification Drawings and Calculations - 02-06-2009.pdf	Semaan Engineering Solutions		Baseplate Modification Package
693060	CT2010	3/2/2009	693060_CT2010 Granby-n. Granby Pocket PCS Rent Comm Letter.pdf	TowerCo	Youghioghney Communications	Commencement Notice
693101	CT2010	3/2/2009	693101_CT2010 Granby-n. Granby Pocket Mods As-Built Drawings TCCI 3-2-2009.pdf	Semaan Engineering Solutions		As-Built Drawings
693501	CT2010	3/3/2009	693501_CT2010 Granby-n. Granby Pocket Mods Stamped Closeout Letter from Semaan 3-3-2009.pdf	Semaan Engineering Solutions	TowerCo	Close-Out Letter
717156	CT2010	5/14/2009	717156_CT2010 Granby-n. Granby _Vertical_Structural Analysis_AT&T_Reconfiguration_20090514.pdf	Vertical Solutions	TowerCo	Structural Analysis Report
721739	CT2010	5/28/2009	721739_CT2010 Granby-n. Granby AT&T 2nd Amendment To SLA Fully Executed.pdf	TowerCo	New Cingular	Amendment SLA
727375	CT2010	6/24/2009	727375_CT2010 Granby-n. Granby AT&T Rent Comm Letter for 2nd Amd to SLA.pdf	TowerCo	New Cingular	Commencement Notice
804685	CT2010	8/27/2010	804685_CT2010 Granby-n. Granby Pocket PCS Clerical Error Amendment.pdf	TowerCo	Youghiogheny Communications	Amendment SLA
804685	CT2010	12/16/2011	804685_CT2010 Granby-n. Granby Pocket PCS Clerical Error Amendment.pdf	TowerCo	Sprint Spectrum	Site Lease Agreement
858068	CT2010	12/21/2011	858068_CT2010 Granby-n. Granby Sprint 1st Amd Rent Comm Notice.pdf	TowerCo	Sprint	Commencement Notice
859706	CT2010	1/10/2012	859706_CT2010 Granby-n. Granby Sprint 1st Amd Rent Commencement Notice to TowerCo.pdf	Sprint	TowerCo	Commencement Notice

Design Documents

TowerCo Document	Structure	Issued Date	Document ID	Issued By	Issued To	Description
862750	CT2010	2/21/2012	862750_CT2010 Granby-n. Granby Email from T-Mobile Confirming Rent Commencement Date.pdf	T-Mobile	TowerCo	Commencement Notice
708807	CT2010	3/20/2012	708807_CT2010 Granby-n. Granby Site Plan.pdf	TowerCo		Site Plan
--	CT2010	4/24/2012	CT1219 Co Lo App TowerCo 2010.doc	TowerCo	New Cingular	Reconfiguration Tenant Application
460349	CT2010	4/24/2012	TOWERDOCS_n460349_v1_CT2010_Granby-N__Granby_T-Mobile_SLA.pdf	Nextel	Omnipoint Communications	Site Lease Agreement
518237	CT2010	4/24/2012	TOWERDOCS_n518237_v1_CT2010_Granby-n__Granby__Pocket_Fully_Executed_SLA.pdf	TowerCo	Youghiogheny Communications	Site Lease Agreement
857814	CT2010	4/24/2012	TOWERDOCS_n857814_v1_CT2010_Granby-n__Granby_Sprint_1st_Amendment_to_SLA_Fully_Executed.pdf	TowerCo	Tower Entity	Site Lease Agreement
--	CT2010	4/25/2012	CT2010 SA Loading.xls	TowerCo	Vertical Solutions	SA Loading
197438	CT2010	4/27/2012	197438_CT2010 Granby-N. Granby Sprint Collocation Information.pdf	Sprint		Collocation Information
717156	CT2010	5/1/2012	717156_CT2010 Granby-n. Granby _Vertical_Structural Analysis_AT&T_Reconfiguration_20120501	Vertical Solutions	TowerCo	Structural Analysis Report

Table Note:

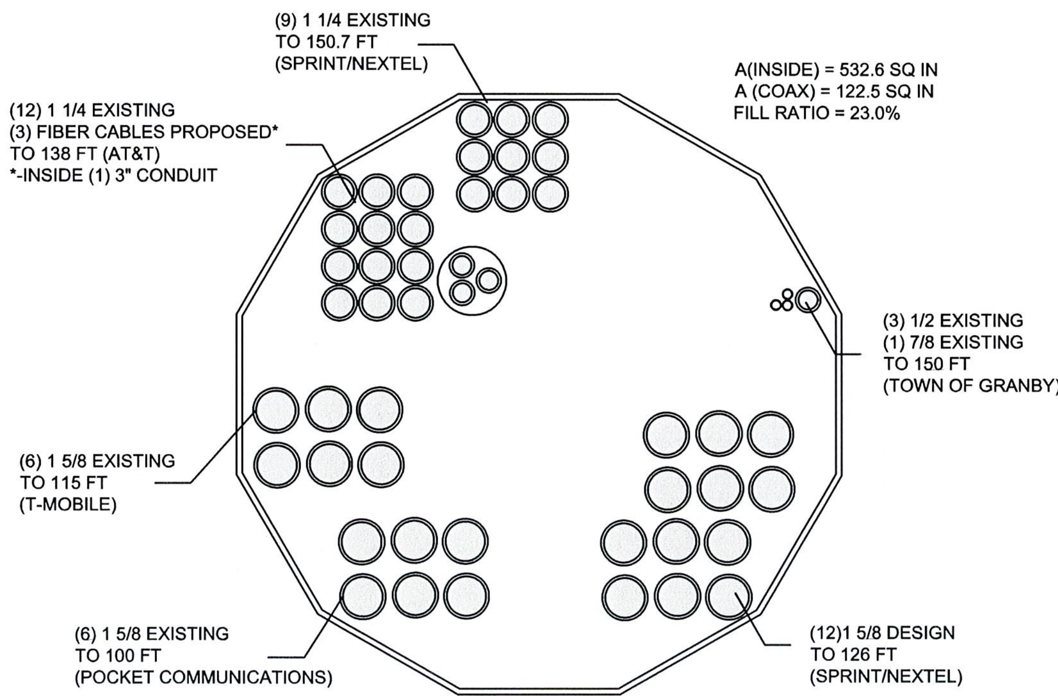
Files name format YYYYMMDD-XXX-ZZZZZZ.pdf

Where:

YYYYMMDD = Year, Month, Day published/issued

XXX=file describer

ZZZZZZ=TowerCo Site ID



COAX CONFIGURATION PLAN - 100 FT

SCALE: 1-1/2" = 1'-0"

PROJECT INFORMATION:

GRANBY-N. GRANBY
CT2010

15 NORTH GRANBY ROAD
GRANBY, CT 06035
(HARTFORD COUNTY)

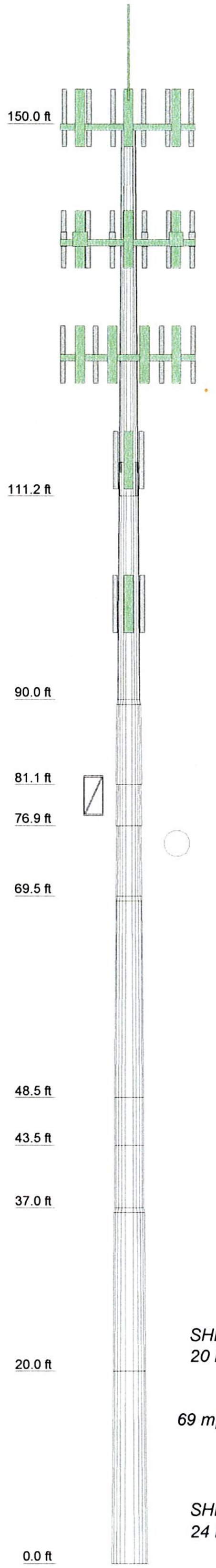
0	9-6-12	PSAR
REV	DATE:	Issued For:

DRAWN BY: MER CHECKED BY: JHW

SHEET NUMBER: **QP-P**
REVISION: 0
VSI #: 121657

PLANS PREPARED FOR:
TowerCo
5000 Valleystone Drive
Cary, NC 27519
Office (919) 469-5559
Fax (919) 469-5530

PLANS PREPARED BY:
vertical solutions
2002 Production Drive
Apex, NC 27539
Office: (888) 321-6167
Fax: (919) 321-1768



Section	Length (ft)	Number of Sides	Thickness (in)	Socket Length (ft)	Top Dia (in)	Bot Dia (in)	Grade	Weight (K)
1	38.79	12	0.1875	3.57	17.5000	24.5800	A572-65	1.7
2	24.78	12	0.2500		23.5533	27.9500		1.7
3	0.50	12	0.3465		27.9500	29.4470		0.1
4	8.35	12	0.3339		29.4470	31.0650	A572-50	0.9
5	4.29	12	0.3125		29.8500	31.0650		0.4
6	7.35	12	0.3125		29.8500	31.0700	A572-65	0.8
7	0.50	12	0.4343		31.0700	32.5700		0.1
8	20.51	12	0.4252		32.5700	36.4120	A572-50	3.3
9	4.98	12	0.3750		35.1900	36.4120		0.7
10	6.51	12	0.3750		35.1900	36.2550	A572-65	0.9
11	0.50	12	0.5258		36.2550	37.7550		0.1
12	16.50	12	0.4746		37.7550	40.8540	A572-50	3.3
13	20.00	12	0.4904		40.8540	44.5000		4.5
								18.5

DESIGNED APPURTENANCE LOADING

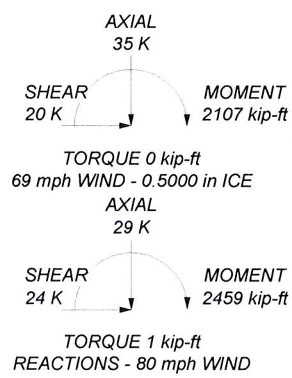
TYPE	ELEVATION	TYPE	ELEVATION
10' Omni (Town of Granby)	157.5	(2) Powerwave LGP21903 (Shielded) (ATT)	138
18' Omni (Town of Granby)	157.5	PiROD 13' Low Profile Platform (ATT)	138
3' Yagi with 6 elements (Town of Granby)	155	Powerwave P65-17-XLH-RR (ATT)	138
10' Dipole with 8 elements (Town of Granby)	155	Powerwave P65-17-XLH-RR (ATT)	138
		Powerwave P65-17-XLH-RR (ATT)	138
(3) DB844H90E-XY w/Mount Pipe (Sprint)	150.67	(2) RRU-11 (ATT)	138
		(2) RRU-11 (ATT)	138
(3) DB844H90E-XY w/Mount Pipe (Sprint)	150.67	(2) RRU-11 (ATT)	138
(3) DB844H90E-XY w/Mount Pipe (Sprint)	150.67	PiROD 13' Low Profile Platform (Sprint)	126
PiROD 13' Low Profile Platform (Sprint)	150	(4) ALP 9011 (Sprint)	126
		(4) ALP 9011 (Sprint)	126
(2) 7770.00 (ATT)	138	(4) ALP 9011 (Sprint)	126
(2) 7770.00 (ATT)	138	RR65-18-02DP w/Mount Pipe (T-Mobile)	115
(2) 7770.00 (ATT)	138	TMA (T-Mobile)	115
(2) Powerwave LGP21401 (Shielded) (ATT)	138	TMA (T-Mobile)	115
(2) Powerwave LGP21401 (Shielded) (ATT)	138	TMA (T-Mobile)	115
		RR65-18-02DP w/Mount Pipe (T-Mobile)	115
(2) Powerwave LGP21401 (Shielded) (ATT)	138	RR65-18-02DP w/Mount Pipe (T-Mobile)	115
(2) Powerwave LGP21903 (Shielded) (ATT)	138	Kathrein 742-213 w/MP (Pocket)	100
(2) Powerwave LGP21903 (Shielded) (ATT)	138	Kathrein 742-213 w/MP (Pocket)	100
		Kathrein 742-213 w/MP (Pocket)	100
		Standoff Arm	80

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-65	65 ksi	80 ksi	A572-50	50 ksi	65 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: 100.2%



TowerCo

TowerCo
5000 Valley Stone Drive
Cary, NC 27519
Phone: (919) 469-5559
FAX: (919) 469-5530

Job: ***CT2010-ERP***			
Project: ***ENG-xxxxx (100%)***			
Client: TowerCo	Drawn by: MER	App'd:	
Code: TIA/EIA-222-F	Date: 09/05/12	Scale: NTS	
Path: L:\2012\1657_Granby n.Granby_CT\Task 1\Models\tnxTower\CT2010-ERP.eri		Dwg No. E-1	

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	150.00-111.21	38.79	3.57	12	17.5000	24.5800	0.1875	0.7500	A572-65 (65 ksi)
L2	111.21-90.00	24.78	0.00	12	23.5533	27.9500	0.2500	1.0000	A572-65 (65 ksi)
L3	90.00-89.50	0.50	0.00	12	27.9500	29.4470	0.3465	1.3859	A572-50 (50 ksi)
L4	89.50-81.15	8.35	0.00	12	29.4470	31.0650	0.3339	1.3355	A572-50 (50 ksi)
L5	81.15-76.85	4.29	0.00	12	29.8500	31.0650	0.3125	1.2500	A572-65 (65 ksi)
L6	76.85-69.50	7.35	0.00	12	29.8500	31.0700	0.3125	1.2500	A572-65

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)
L7	69.50-69.00	0.50	0.00	12	31.0700	32.5700	0.4343	1.7373	A572-50 (50 ksi)
L8	69.00-48.49	20.51	0.00	12	32.5700	36.4120	0.4252	1.7007	A572-50 (50 ksi)
L9	48.49-43.51	4.98	0.00	12	35.1900	36.4120	0.3750	1.5000	A572-65 (65 ksi)
L10	43.51-37.00	6.51	0.00	12	35.1900	36.2550	0.3750	1.5000	A572-65 (65 ksi)
L11	37.00-36.50	0.50	0.00	12	36.2550	37.7550	0.5258	2.1034	A572-50 (50 ksi)
L12	36.50-20.00	16.50	0.00	12	37.7550	40.8540	0.4746	1.8982	A572-50 (50 ksi)
L13	20.00-0.00	20.00		12	40.8540	44.5000	0.4904	1.9616	A572-50 (50 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	18.1173	10.4524	399.8733	6.1979	9.0650	44.1118	810.2518	5.1444	4.1875	22.333
	25.4471	14.7270	1118.4383	8.7325	12.7324	87.8416	2266.2592	7.2482	6.0849	32.453
L2	25.0399	18.7591	1300.2687	8.3426	12.2006	106.5742	2634.6969	9.2327	5.6423	22.569
	28.9360	22.2985	2183.8416	9.9166	14.4781	150.8376	4425.0552	10.9746	6.8206	27.282
L3	28.9360	30.7959	2995.0727	9.8821	14.4781	206.8692	6068.8292	15.1568	6.5620	18.939
	30.4858	32.4660	3509.2653	10.4180	15.2535	230.0623	7110.7228	15.9788	6.9632	20.097
L4	30.4858	31.2993	3386.0899	10.4225	15.2535	221.9871	6861.1361	15.4046	6.9970	20.957
	32.1609	33.0388	3982.6064	11.0017	16.0917	247.4949	8069.8404	16.2607	7.4306	22.255
L5	30.9030	29.7221	3309.8861	10.5744	15.4623	214.0617	6706.7266	14.6283	7.1623	22.919
	32.1609	30.9447	3735.3657	11.0094	16.0917	232.1304	7568.8636	15.2300	7.4879	23.961
L6	30.9030	29.7221	3309.8861	10.5744	15.4623	214.0617	6706.7266	14.6283	7.1623	22.919
	32.1660	30.9497	3737.1880	11.0112	16.0943	232.2063	7572.5560	15.2325	7.4893	23.966
L7	32.1660	42.8450	5132.6414	10.9676	16.0943	318.9113	10400.1231	21.0870	7.1628	16.492
	33.7189	44.9428	5924.0791	11.5046	16.8713	351.1344	12003.7904	22.1195	7.5648	17.417
L8	33.7189	44.0095	5804.3623	11.5078	16.8713	344.0385	11761.2116	21.6602	7.5893	17.849
	37.6965	49.2696	8144.2662	12.8833	18.8614	431.7951	16502.4914	24.2490	8.6189	20.271
L9	36.4314	42.0391	6503.8765	12.4638	18.2284	356.7987	13178.6171	20.6904	8.4259	22.469
	37.6965	43.5147	7213.0506	12.9012	18.8614	382.4236	14615.5961	21.4166	8.7534	23.342
L10	36.4314	42.0391	6503.8765	12.4638	18.2284	356.7987	13178.6171	20.6904	8.4259	22.469
	37.5339	43.3251	7119.1869	12.8450	18.7801	379.0816	14425.4027	21.3233	8.7113	23.23
L11	37.5339	60.4978	9857.5948	12.7910	18.7801	524.8960	19974.1597	29.7752	8.3071	15.797
	39.0869	63.0377	11151.9874	13.3280	19.5571	570.2273	22596.9500	31.0252	8.7091	16.562
L12	39.0869	56.9675	10105.9038	13.3464	19.5571	516.7386	20477.3009	28.0377	8.8465	18.642
	42.2952	61.7030	12841.4168	14.4558	21.1624	606.8042	26020.1920	30.3683	9.6771	20.392
L13	42.2952	63.7365	13254.2233	14.4502	21.1624	626.3109	26856.6499	31.3692	9.6346	19.647
	46.0698	69.4938	17180.1457	15.7554	23.0510	745.3102	34811.6330	34.2027	10.6118	21.639

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 150.00-111.21				1	1	1		
L2				1	1	1		

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
111.21-90.00								
L3 90.00-89.50				1	1	1		
L4 89.50-81.15				1	1	1		
L5 81.15-76.85				1	1	1		
L6 76.85-69.50				1	1	1		
L7 69.50-69.00				1	1	1		
L8 69.00-48.49				1	1	1		
L9 48.49-43.51				1	1	1		
L10 43.51-37.00				1	1	1		
L11 37.00-36.50				1	1	1		
L12 36.50-20.00				1	1	1		
L13 20.00-0.00				1	1	1		

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number		C_AA_A ft^2/ft	Weight klf
LDF6-50A (1-1/4 FOAM) (Sprint)	C	No	Inside Pole	150.00 - 0.00	9	No Ice	0.00	0.00
						1/2" Ice	0.00	0.00
LDF4P-50A (1/2 FOAM) (Town of Granby)	C	No	Inside Pole	150.00 - 0.00	3	No Ice	0.00	0.00
						1/2" Ice	0.00	0.00
LDF5-50A (7/8 FOAM) (Town of Granby)	C	No	Inside Pole	150.00 - 0.00	1	No Ice	0.00	0.00
						1/2" Ice	0.00	0.00
***								
LDF6-50A (1-1/4 FOAM) (AT&T)	C	No	Inside Pole	138.00 - 0.00	12	No Ice	0.00	0.00
						1/2" Ice	0.00	0.00
***								
LDF7-50A (1-5/8 FOAM) (Sprint)	C	No	Inside Pole	126.00 - 0.00	12	No Ice	0.00	0.00
						1/2" Ice	0.00	0.00
***								
LDF7-50A (1-5/8 FOAM) (T-Mobile)	C	No	Inside Pole	115.00 - 0.00	6	No Ice	0.00	0.00
						1/2" Ice	0.00	0.00
***								
LDF7-50A (1-5/8 FOAM) (Pocket)	C	No	Inside Pole	100.00 - 0.00	6	No Ice	0.00	0.00
						1/2" Ice	0.00	0.00
*********								
Fiber Cables (AT&T)	C	No	Inside Pole	138.00 - 0.00	3	No Ice	0.00	0.00
						1/2" Ice	0.00	0.00
3" Conduit (AT&T)	C	No	Inside Pole	138.00 - 0.00	1	No Ice	0.00	0.00
						1/2" Ice	0.00	0.00

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
L1	150.00-111.21	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	0.67
L2	111.21-90.00	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	0.70
L3	90.00-89.50	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	0.02
L4	89.50-81.15	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	0.30
L5	81.15-76.85	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	0.15
L6	76.85-69.50	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	0.26
L7	69.50-69.00	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	0.02
L8	69.00-48.49	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	0.73
L9	48.49-43.51	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	0.18
L10	43.51-37.00	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	0.23
L11	37.00-36.50	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	0.02
L12	36.50-20.00	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	0.58
L13	20.00-0.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	0.000	0.000	0.71

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	150.00-111.21	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	0.67
L2	111.21-90.00	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	0.70
L3	90.00-89.50	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	0.02
L4	89.50-81.15	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	0.30
L5	81.15-76.85	A	0.500	0.000	0.000	0.000	0.000	0.00

Tower Section	Tower Elevation ft	Face or Leg	Ice Thickness in	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	0.000	0.000	0.15
L6	76.85-69.50	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	0.26
L7	69.50-69.00	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	0.02
L8	69.00-48.49	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	0.73
L9	48.49-43.51	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	0.18
L10	43.51-37.00	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	0.23
L11	37.00-36.50	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	0.02
L12	36.50-20.00	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	0.58
L13	20.00-0.00	A	0.500	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	0.000	0.000	0.71

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
(3) DB844H90E-XY w/Mount Pipe (Sprint)	A	From Face	4.00 0.00 0.00	0.0000	150.67	No Ice 1/2" Ice	3.58 4.20	5.40 6.49	0.04 0.08
(3) DB844H90E-XY w/Mount Pipe (Sprint)	B	From Face	4.00 0.00 0.00	0.0000	150.67	No Ice 1/2" Ice	3.58 4.20	5.40 6.49	0.04 0.08
(3) DB844H90E-XY w/Mount Pipe (Sprint)	C	From Face	4.00 0.00 0.00	0.0000	150.67	No Ice 1/2" Ice	3.58 4.20	5.40 6.49	0.04 0.08
PiROD 13' Low Profile Platform (Sprint) **	C	None		0.0000	150.00	No Ice 1/2" Ice	15.70 20.10	15.70 20.10	1.30 1.76
3' Yagi with 6 elements (Town of Granby)	A	None		0.0000	155.00	No Ice 1/2" Ice	2.08 3.79	2.08 3.79	0.03 0.05
10' Dipole with 8 elements (Town of Granby)	B	None		0.0000	155.00	No Ice 1/2" Ice	3.39 4.55	3.39 4.55	0.03 0.05
10' Omni (Town of Granby)	B	None		0.0000	157.50	No Ice 1/2" Ice	3.00 4.03	3.00 4.03	0.02 0.04
18' Omni (Town of Granby)	C	None		0.0000	157.50	No Ice 1/2" Ice	5.40 7.23	5.40 7.23	0.05 0.09

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
***									
(2) 7770.00 (AT&T)	A	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	5.88 6.31	2.93 3.27	0.04 0.07
(2) 7770.00 (AT&T)	B	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	5.88 6.31	2.93 3.27	0.04 0.07
(2) 7770.00 (AT&T)	C	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	5.88 6.31	2.93 3.27	0.04 0.07
(2) Powerwave LGP21401 (Shielded) (AT&T)	A	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	0.00 0.00	0.23 0.31	0.01 0.02
(2) Powerwave LGP21401 (Shielded) (AT&T)	B	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	0.00 0.00	0.23 0.31	0.01 0.02
(2) Powerwave LGP21401 (Shielded) (AT&T)	C	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	0.00 0.00	0.23 0.31	0.01 0.02
(2) Powerwave LGP21903 (Shielded) (AT&T)	A	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	0.00 0.00	0.27 0.34	0.01 0.01
(2) Powerwave LGP21903 (Shielded) (AT&T)	B	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	0.00 0.00	0.27 0.34	0.01 0.01
(2) Powerwave LGP21903 (Shielded) (AT&T)	C	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	0.00 0.00	0.27 0.34	0.01 0.01
PiROD 13' Low Profile Platform (AT&T)	C	None		0.0000	138.00	No Ice 1/2" Ice	15.70 20.10	15.70 20.10	1.30 1.76
***									
PiROD 13' Low Profile Platform (Sprint)	C	None		0.0000	126.00	No Ice 1/2" Ice	15.70 20.10	15.70 20.10	1.30 1.76
(4) ALP 9011 (Sprint)	A	From Face	4.00 0.00 0.00	0.0000	126.00	No Ice 1/2" Ice	4.60 5.20	4.60 5.20	0.02 0.04
(4) ALP 9011 (Sprint)	B	From Face	4.00 0.00 0.00	0.0000	126.00	No Ice 1/2" Ice	4.60 5.20	4.60 5.20	0.02 0.04
(4) ALP 9011 (Sprint)	C	From Face	4.00 0.00 0.00	0.0000	126.00	No Ice 1/2" Ice	4.60 5.20	4.60 5.20	0.02 0.04
***									
RR65-18-02DP w/Mount Pipe (T-Mobile)	A	From Face	0.50 0.00 0.00	0.0000	115.00	No Ice 1/2" Ice	4.91 5.57	3.64 4.70	0.04 0.08
RR65-18-02DP w/Mount Pipe (T-Mobile)	B	From Face	0.50 0.00 0.00	0.0000	115.00	No Ice 1/2" Ice	4.91 5.57	3.64 4.70	0.04 0.08
RR65-18-02DP w/Mount Pipe (T-Mobile)	C	From Face	0.50 0.00 0.00	0.0000	115.00	No Ice 1/2" Ice	4.91 5.57	3.64 4.70	0.04 0.08
TMA (T-Mobile)	A	From Face	0.50 0.00 0.00	0.0000	115.00	No Ice 1/2" Ice	0.93 1.07	0.47 0.57	0.02 0.03

Description	*Face or Leg*	*Offset Type*	*Offsets: Horz Lateral Vert ft ft ft*	*Azimuth Adjustment °*	*Placement ft*		*C_AA_A Front ft²*	*C_AA_A Side ft²*	*Weight K*
TMA (T-Mobile)	B	From Face	0.50 0.00 0.00	0.0000	115.00	No Ice 1/2" Ice	0.93 1.07	0.47 0.57	0.02 0.03
TMA (T-Mobile)	C	From Face	0.50 0.00 0.00	0.0000	115.00	No Ice 1/2" Ice	0.93 1.07	0.47 0.57	0.02 0.03
***									
Kathrein 742-213 w/MP (Pocket)	A	From Face	0.50 0.00 0.00	0.0000	100.00	No Ice 1/2" Ice	5.32 5.84	4.88 6.07	0.06 0.11
Kathrein 742-213 w/MP (Pocket)	B	From Face	0.50 0.00 0.00	0.0000	100.00	No Ice 1/2" Ice	5.32 5.84	4.88 6.07	0.06 0.11
Kathrein 742-213 w/MP (Pocket)	C	From Face	0.50 0.00 0.00	0.0000	100.00	No Ice 1/2" Ice	5.32 5.84	4.88 6.07	0.06 0.11
***********									
Powerwave P65-17-XLH-RR (AT&T)	A	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	11.47 12.08	6.80 7.38	0.07 0.13
Powerwave P65-17-XLH-RR (AT&T)	B	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	11.47 12.08	6.80 7.38	0.07 0.13
Powerwave P65-17-XLH-RR (AT&T)	C	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	11.47 12.08	6.80 7.38	0.07 0.13
(2) RRU-11 (AT&T)	A	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	2.99 3.23	1.25 1.41	0.05 0.07
(2) RRU-11 (AT&T)	B	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	2.99 3.23	1.25 1.41	0.05 0.07
(2) RRU-11 (AT&T)	C	From Face	4.00 0.00 0.00	0.0000	138.00	No Ice 1/2" Ice	2.99 3.23	1.25 1.41	0.05 0.07
************									
*********									
Standoff Arm	A	From Face	3.00 0.00 0.00	0.0000	80.00	No Ice 1/2" Ice	3.21 4.15	3.21 4.15	0.10 0.13

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

Comb. No.	Description
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
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 K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
L1	150 - 111.214	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-11.01	0.00	0.00
			Max. Mx	11	-6.29	286.14	0.01
			Max. My	2	-6.29	0.01	286.14
			Max. Vy	11	-13.33	286.14	0.01
			Max. Vx	2	-13.33	0.01	286.14
			Max. Torque	16			-0.00
L2	111.214 - 90	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-14.41	0.00	0.00
			Max. Mx	11	-9.32	648.51	0.01
			Max. My	2	-9.32	0.02	648.51
			Max. Vy	11	-16.03	648.51	0.01
			Max. Vx	2	-16.03	0.02	648.51
			Max. Torque	3			-0.00
L3	90 - 89.5	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-14.49	0.00	0.00
			Max. Mx	11	-9.41	656.53	0.01
			Max. My	2	-9.41	0.03	656.53
			Max. Vy	11	-16.07	656.53	0.01
			Max. Vx	2	-16.07	0.03	656.53
			Max. Torque	3			-0.00

TowerCo
5000 Valley Stone Drive
Cary, NC 27519
Phone: (919) 469-5559
FAX: (919) 469-5530

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Force K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
L4	89.5 - 81.1458	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-15.86	0.00	0.00
			Max. Mx	11	-10.68	794.11	0.02
			Max. My	2	-10.68	0.03	794.11
			Max. Vy	11	-16.87	794.11	0.02
			Max. Vx	2	-16.87	0.03	794.11
			Max. Torque	3			-0.00
L5	81.1458 - 76.8516	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-16.66	0.46	0.27
			Max. Mx	11	-11.42	868.12	0.21
			Max. My	2	-11.42	0.37	867.96
			Max. Vy	11	-17.38	868.12	0.21
			Max. Vx	2	-17.38	0.37	867.96
			Max. Torque	9			-0.50
L6	76.8516 - 69.5	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-17.83	0.46	0.27
			Max. Mx	11	-12.57	998.11	0.22
			Max. My	2	-12.57	0.37	997.94
			Max. Vy	11	-18.00	998.11	0.22
			Max. Vx	2	-18.00	0.37	997.94
			Max. Torque	9			-0.50
L7	69.5 - 69	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-17.93	0.46	0.27
			Max. Mx	11	-12.67	1007.11	0.22
			Max. My	2	-12.67	0.37	1006.95
			Max. Vy	11	-18.04	1007.11	0.22
			Max. Vx	2	-18.04	0.37	1006.95
			Max. Torque	9			-0.50
L8	69 - 48.487	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-22.36	0.46	0.27
			Max. Mx	11	-16.88	1396.56	0.22
			Max. My	2	-16.88	0.38	1396.40
			Max. Vy	11	-19.96	1396.56	0.22
			Max. Vx	2	-19.96	0.38	1396.40
			Max. Torque	9			-0.50
L9	48.487 - 43.5104	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-23.37	0.46	0.27
			Max. Mx	11	-17.87	1496.86	0.22
			Max. My	2	-17.87	0.38	1496.70
			Max. Vy	11	-20.37	1496.86	0.22
			Max. Vx	2	-20.37	0.38	1496.70
			Max. Torque	9			-0.50
L10	43.5104 - 37	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-24.70	0.46	0.27
			Max. Mx	11	-19.18	1630.99	0.22
			Max. My	2	-19.18	0.38	1630.83
			Max. Vy	11	-20.86	1630.99	0.22
			Max. Vx	2	-20.86	0.38	1630.83
			Max. Torque	9			-0.50
L11	37 - 36.5	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-24.83	0.46	0.27
			Max. Mx	11	-19.31	1641.42	0.22
			Max. My	2	-19.31	0.38	1641.26
			Max. Vy	11	-20.89	1641.42	0.22
			Max. Vx	2	-20.89	0.38	1641.26
			Max. Torque	9			-0.50
L12	36.5 - 20	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-29.16	0.46	0.27
			Max. Mx	11	-23.47	1997.09	0.22

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Force K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
			Max. My	2	-23.47	0.39	1996.92
			Max. Vy	11	-22.24	1997.09	0.22
			Max. Vx	2	-22.24	0.39	1996.92
			Max. Torque	9			-0.50
L13	20 - 0	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	14	-34.94	0.46	0.27
			Max. Mx	11	-29.04	2458.47	0.22
			Max. My	2	-29.04	0.39	2458.31
			Max. Vy	11	-23.93	2458.47	0.22
			Max. Vx	2	-23.93	0.39	2458.31
			Max. Torque	9			-0.50

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	150 - 111.214	48.982	36	3.0958	0.0008
L2	114.784 - 90	27.551	36	2.5378	0.0008
L3	90 - 89.5	16.007	37	1.8426	0.0008
L4	89.5 - 81.1458	15.815	37	1.8322	0.0008
L5	81.1458 - 76.8516	12.769	37	1.6485	0.0008
L6	76.8516 - 69.5	11.338	37	1.5352	0.0007
L7	69.5 - 69	9.142	37	1.3176	0.0005
L8	69 - 48.487	9.005	37	1.3082	0.0005
L9	48.487 - 43.5104	4.238	37	0.9121	0.0003
L10	43.5104 - 37	3.348	37	0.7949	0.0003
L11	37 - 36.5	2.378	37	0.6281	0.0002
L12	36.5 - 20	2.313	37	0.6199	0.0002
L13	20 - 0	0.680	37	0.3274	0.0001

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
157.50	10' Omni	36	48.982	3.0958	0.0008	36967
155.00	3' Yagi with 6 elements	36	48.982	3.0958	0.0008	36967
150.67	(3) DB844H90E-XY w/Mount Pipe	36	48.982	3.0958	0.0008	36967
150.00	PiROD 13' Low Profile Platform	36	48.982	3.0958	0.0008	36967
138.00	(2) 7770.00	36	41.322	2.9603	0.0008	6160
126.00	PiROD 13' Low Profile Platform	36	33.943	2.7817	0.0008	3079
115.00	RR65-18-02DP w/Mount Pipe	36	27.668	2.5434	0.0008	2121
100.00	Kathrein 742-213 w/MP	37	20.200	2.1025	0.0008	1893
80.00	Standoff Arm	37	12.378	1.6206	0.0007	2289

Maximum Tower Deflections - Design Wind

TowerCo
5000 Valley Stone Drive
Cary, NC 27519
Phone: (919) 469-5559
FAX: (919) 469-5530

Section No.	*Elevation* ft	*Horz. Deflection* in	*Gov. Load Comb.*	*Tilt* °	*Twist* °
L1	150 - 111.214	124.685	11	7.8864	0.0020
L2	114.784 - 90	70.212	11	6.4677	0.0019
L3	90 - 89.5	40.824	11	4.6986	0.0019
L4	89.5 - 81.1458	40.334	11	4.6722	0.0019
L5	81.1458 - 76.8516	32.575	11	4.2041	0.0019
L6	76.8516 - 69.5	28.927	11	3.9156	0.0017
L7	69.5 - 69	23.327	11	3.3615	0.0014
L8	69 - 48.487	22.977	11	3.3375	0.0014
L9	48.487 - 43.5104	10.817	11	2.3278	0.0008
L10	43.5104 - 37	8.548	11	2.0289	0.0007
L11	37 - 36.5	6.072	11	1.6035	0.0005
L12	36.5 - 20	5.905	11	1.5826	0.0005
L13	20 - 0	1.736	12	0.8360	0.0002

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	*Appurtenance*	*Gov. Load Comb.*	*Deflection* in	*Tilt* °	*Twist* °	*Radius of Curvature* ft
157.50	10' Omni	11	124.685	7.8864	0.0020	14975
155.00	3' Yagi with 6 elements	11	124.685	7.8864	0.0020	14975
150.67	(3) DB844H90E-XY w/Mount Pipe	11	124.685	7.8864	0.0020	14975
150.00	PiROD 13' Low Profile Platform	11	124.685	7.8864	0.0020	14975
138.00	(2) 7770.00	11	105.220	7.5421	0.0020	2493
126.00	PiROD 13' Low Profile Platform	11	86.468	7.0881	0.0020	1243
115.00	RR65-18-02DP w/Mount Pipe	11	70.510	6.4820	0.0019	853
100.00	Kathrein 742-213 w/MP	11	51.505	5.3602	0.0019	756
80.00	Standoff Arm	11	31.577	4.1332	0.0019	907

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	150 - 111.214 (1)	TP24.58x17.5x0.1875	38.79	0.00	0.0	38.011	14.3335	-6.29	544.83	0.012
L2	111.214 - 90 (2)	TP27.95x23.5533x0.25 H1-3 (1.33 CR) - 2	24.78	0.00	0.0	39.000	22.2985	-9.32	869.64	0.011
L3	90 - 89.5 (3)	TP29.447x27.95x0.3465	0.50	0.00	0.0	30.000	30.7959	-9.34	923.88	0.010
L4	89.5 - 81.1458 (4)	TP31.065x29.447x0.3339	8.35	0.00	0.0	30.000	33.0388	-10.68	991.16	0.011
L5	81.1458 - 76.8516 (5)	TP31.065x29.85x0.3125	4.29	0.00	0.0	39.000	30.9447	-11.42	1206.84	0.009
L6	76.8516 - 69.5 (6)	TP31.07x29.85x0.3125 H1-3 (1.33 CR) - 6	7.35	0.00	0.0	39.000	30.9497	-12.57	1207.04	0.010
L7	69.5 - 69 (7)	TP32.57x31.07x0.4343	0.50	0.00	0.0	30.000	42.8450	-12.58	1285.35	0.010
L8	69 - 48.487 (8)	TP36.412x32.57x0.4252	20.51	0.00	0.0	30.000	49.2696	-16.88	1478.09	0.011
L9	48.487 - 43.5104 (9)	TP36.412x35.19x0.375	4.98	0.00	0.0	39.000	43.1458	-17.64	1682.69	0.010
L10	43.5104 - 37 (10)	TP36.255x35.19x0.375 H1-3 (1.34 CR) - 10	6.51	0.00	0.0	39.000	43.3251	-19.18	1689.68	0.011
L11	37 - 36.5 (11)	TP37.755x36.255x0.5258	0.50	0.00	0.0	30.000	60.4978	-19.19	1814.93	0.011

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 $\frac{P}{P_a}$
L12	36.5 - 20 (12)	TP40.854x37.755x0.4746	16.50	0.00	0.0	30.000	61.7030	-23.47	1851.09	0.013
L13	20 - 0 (13)	TP44.5x40.854x0.4904	20.00	0.00	0.0	30.000	69.4938	-29.04	2084.81	0.014
		H1-3 (1.33 CR) - 13								

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	150 - 111.214 (1)	TP24.58x17.5x0.1875	286.14	-41.274	38.011	1.086	0.00	0.000	38.011	0.000
L2	111.214 - 90 (2)	TP27.95x23.5533x0.25	648.51	-51.593	39.000	1.323	0.00	0.000	39.000	0.000
L3	90 - 89.5 (3)	TP29.447x27.95x0.3465	648.51	-37.618	30.000	1.254	0.00	0.000	30.000	0.000
L4	89.5 - 81.1458 (4)	TP31.065x29.447x0.3339	794.11	-38.503	30.000	1.283	0.00	0.000	30.000	0.000
L5	81.1458 - 76.8516 (5)	TP31.065x29.85x0.3125	868.17	-44.880	39.000	1.151	0.00	0.000	39.000	0.000
L6	76.8516 - 69.5 (6)	TP31.07x29.85x0.3125	998.17	-51.583	39.000	1.323	0.00	0.000	39.000	0.000
L7	69.5 - 69 (7)	TP32.57x31.07x0.4343	998.17	-37.559	30.000	1.252	0.00	0.000	30.000	0.000
L8	69 - 48.487 (8)	TP36.412x32.57x0.4252	1396.62	-38.813	30.000	1.294	0.00	0.000	30.000	0.000
L9	48.487 - 43.5104 (9)	TP36.412x35.19x0.375	1471.66	-46.976	39.000	1.205	0.00	0.000	39.000	0.000
L10	43.5104 - 37 (10)	TP36.255x35.19x0.375	1631.05	-51.632	39.000	1.324	0.00	0.000	39.000	0.000
L11	37 - 36.5 (11)	TP37.755x36.255x0.5258	1631.05	-37.288	30.000	1.243	0.00	0.000	30.000	0.000
L12	36.5 - 20 (12)	TP40.854x37.755x0.4746	1997.15	-39.495	30.000	1.316	0.00	0.000	30.000	0.000
L13	20 - 0 (13)	TP44.5x40.854x0.4904	2458.53	-39.584	30.000	1.319	0.00	0.000	30.000	0.000

Pole Interaction Design Data

Section No.	Elevation ft	Size	Ratio $\frac{P}{P_a}$	Ratio $\frac{f_{bx}}{F_{bx}}$	Ratio $\frac{f_{by}}{F_{by}}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	150 - 111.214 (1)	TP24.58x17.5x0.1875	0.012	1.086	0.000	1.097 ✔	1.333	H1-3 ✔
L2	111.214 - 90 (2)	TP27.95x23.5533x0.25	0.011	1.323	0.000	1.334 ✔	1.333	H1-3 ✔
L3	90 - 89.5 (3)	TP29.447x27.95x0.3465	0.010	1.254	0.000	1.264 ✔	1.333	H1-3 ✔
L4	89.5 - 81.1458 (4)	TP31.065x29.447x0.3339	0.011	1.283	0.000	1.294 ✔	1.333	H1-3 ✔
L5	81.1458 - 76.8516 (5)	TP31.065x29.85x0.3125	0.009	1.151	0.000	1.160 ✔	1.333	H1-3 ✔
L6	76.8516 - 69.5 (6)	TP31.07x29.85x0.3125	0.010	1.323	0.000	1.333 ✔	1.333	H1-3 ✔
L7	69.5 - 69 (7)	TP32.57x31.07x0.4343	0.010	1.252	0.000	1.262 ✔	1.333	H1-3 ✔
L8	69 - 48.487 (8)	TP36.412x32.57x0.4252	0.011	1.294	0.000	1.305 ✔	1.333	H1-3 ✔
L9	48.487 - 43.5104 (9)	TP36.412x35.19x0.375	0.010	1.205	0.000	1.215 ✔	1.333	H1-3 ✔
L10	43.5104 - 37 (10)	TP36.255x35.19x0.375	0.011	1.324	0.000	1.335 ✔	1.333	H1-3 ✔
L11	37 - 36.5 (11)	TP37.755x36.255x0.5258	0.011	1.243	0.000	1.254 ✔	1.333	H1-3 ✔
L12	36.5 - 20 (12)	TP40.854x37.755x0.4746	0.013	1.316	0.000	1.329 ✔	1.333	H1-3 ✔
L13	20 - 0 (13)	TP44.5x40.854x0.4904	0.014	1.319	0.000	1.333 ✔	1.333	H1-3 ✔

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	SF*P_{allow} K	% Capacity	Pass Fail
L1	150 - 111.214	Pole	TP24.58x17.5x0.1875	1	-6.29	726.26	82.3	Pass
L2	111.214 - 90	Pole	TP27.95x23.5533x0.25	2	-9.32	1159.23	100.0	Pass
L3	90 - 89.5	Pole	TP29.447x27.95x0.3465	3	-9.34	1231.53	94.8	Pass
L4	89.5 - 81.1458	Pole	TP31.065x29.447x0.3339	4	-10.68	1321.22	97.1	Pass
L5	81.1458 - 76.8516	Pole	TP31.065x29.85x0.3125	5	-11.42	1608.72	87.0	Pass
L6	76.8516 - 69.5	Pole	TP31.07x29.85x0.3125	6	-12.57	1608.98	100.0	Pass
L7	69.5 - 69	Pole	TP32.57x31.07x0.4343	7	-12.58	1713.37	94.7	Pass
L8	69 - 48.487	Pole	TP36.412x32.57x0.4252	8	-16.88	1970.29	97.9	Pass
L9	48.487 - 43.5104	Pole	TP36.412x35.19x0.375	9	-17.64	2243.03	91.1	Pass
L10	43.5104 - 37	Pole	TP36.255x35.19x0.375	10	-19.18	2252.34	100.2	Pass
L11	37 - 36.5	Pole	TP37.755x36.255x0.5258	11	-19.19	2419.30	94.0	Pass
L12	36.5 - 20	Pole	TP40.854x37.755x0.4746	12	-23.47	2467.50	99.7	Pass
L13	20 - 0	Pole	TP44.5x40.854x0.4904	13	-29.04	2779.05	100.0	Pass
							Summary	
						Pole (L10)	100.2	Pass
						RATING =	**100.2**	**Pass**

Design	0

	Initials	Date
Produced By:	MER	9/6/2012
Checked By:	JHW	9/6/2012

SELF-SUPPORTING POLE STRUCTURE REINFORCEMENT DESIGN, TIA-222-F

VSi Job #	121657	
Client Site Name:	Granby-n. Granby	
Client Site Number:	CT2010	
Hole Size Allowance:	0.0625	inches
Allowable Stress Increase	133%	
Design Percentage	100%	
	133%	

vertical solutions

Pole Geometry									CT2010	121657
Section #	Sides # (12,16,18,0)	Elevation (ft) TOP	Elevation (ft) BOTTOM	Dia Across Flats (in) TOP	Dia Across Flats (in) BOTTOM	Splice (ft)	Thickness (in)	Material Specification	Taper (in/ft)	Length (ft)
1	12	150.00	111.21	17.50	24.58	3.57	0.1875	A572-65	0.183	38.79
2	12	114.78	76.85	23.42	30.35	4.29	0.2500	A572-65	0.183	37.93
3	12	81.15	43.51	28.94	35.82	4.98	0.3125	A572-65	0.183	37.64
4	12	48.49	0.00	34.16	43.00	0.00	0.3750	A572-65	0.182	48.49

Bar Reinforcement																						CT2010	121657
Section Letter	Elevation (ft)	Moment (kip-ft)	Section #	Bar # (3,4)	Bar Width (in)	Bar Thickness (in)	Bar Length (in)	OS Number	Bar Matertial Specification	r_{max}	r_b Pole	r_c	r_t Gross	rt Net	r_{BS}	r_p Bar	r_p Pole	r_v	t Model (in)	F_y Model (ksi)	r_l	D_o Model (in)	t_A Model (in)
K	90.00	664	2	3	4.75	1.5	24	7	A572-50	95%	47%	83%	65%	82%	32%	15%	73%	95%	0.45	50	100%	29.45	0.35
J	81.15	803	2	3	4.75	1.5	24	1000	A572-50	92%	53%	92%	72%	91%	0%	0%	1%	1%	0.44	50	100%	31.07	0.34
H	76.85	878	2	3	4.75	1.5	24	8	A572-50	97%	56%	97%	76%	96%	33%	15%	74%	97%	0.43	50	100%	31.85	0.34
G	69.50	1019	3	3	5.75	1.5	18	9	A572-50	95%	51%	81%	69%	82%	32%	15%	58%	95%	0.53	50	100%	32.57	0.45
F	48.49	1410	3	3	5.75	1.5	18	1000	A572-50	95%	59%	94%	80%	95%	0%	0%	1%	1%	0.51	50	100%	36.41	0.43
E	43.51	1511	3	3	5.75	1.5	18	11	A572-50	98%	61%	96%	82%	98%	32%	15%	57%	93%	0.50	50	100%	37.32	0.43
D	37.00	1653	4	3	5.75	1.5	18	11	A572-50	95%	59%	93%	80%	95%	31%	14%	46%	90%	0.56	50	100%	37.76	0.47
C	20.00	1997	4	3	5.75	1.5	18	11	A572-50	100%	62%	99%	84%	100%	33%	15%	48%	95%	0.54	50	100%	40.85	0.46
B	20.00	1997	4	3	6.50	1.5	15	1000	A572-50	92%	59%	91%	80%	92%	0%	0%	1%	1%	0.57	50	100%	40.85	0.50
A	0.00	2468	4	3	6.50	1.5	15	12	A572-50	100%	64%	97%	86%	99%	34%	16%	51%	100%	0.55	50	100%	44.50	0.49
B'	37.00	1653	4	3	6.50	1.5	15	11	A572-50	96%	56%	86%	76%	87%	32%	15%	49%	96%	0.59	50	100%	37.76	0.52
A'	0.00	2468	4	3	6.50	1.5	15	12	A572-50	100%	64%	97%	86%	99%	34%	16%	51%	100%	0.55	50	100%	44.50	0.49

vertical solutions	ALTERNATE SPLICE DESIGN @ 20-ft	**Job No.:** **Date:** **Calculated by:**	121657 09/05/2012 MER

SELF-SUPPORTING POLE STRUCTURE REINFORCEMENT BOLTED SPLICE DESIGN, TIA-222-G-F

Input - Reinforcing Bar Properties

CONSTANTS:

$E \equiv 29000 \cdot ksi$

$P_{max} := 290 \cdot kip$ = max axial force in reinforcing bar

$b_{bar} := 5.75 \cdot in$ = width of reinforcement

$t_{bar} := 1.5 \cdot in$ = thickness of reinforcement

$F_{yBar} := 50 \cdot ksi$ = specified minimum yield stress of reinforcement

$F_{uBar} := 65 \cdot ksi$ = specified minimum tensile stress of reinforcement

$ASI := 133\%$ = allowable stress increase

$A_{gBar} := b_{bar} \cdot t_{bar}$ $\quad A_{gBar} = 8.62 \cdot in^2$

Input - Splice & TB's Properties

$d := 20 \cdot mm$ = diameter of ONESIDE AJAX bolts

$d_{sleeve} := 29 \cdot mm$ = outside diameter of sleeve for ONESIDE AJAX bolts

$d_{hole} := 31 \cdot mm$ = diameter of hole for ONESIDE AJAX bolts

$n := 11$ = number of ONESIDE AJAX bolts at termination

$s := 3 \cdot in$ = spacing of termination bolts

$V_{all} := 20.9 \cdot kip$ = shear breaking strength of ONESIDE AJAX

$T_{all} := 74.4 \cdot kN$ = tensile breaking strength of ONESIDE AJAX PC8.8 $\quad T_{all} = 16.7 \cdot kip$

$b_{GPL} := 4.5 \cdot in$ = width of gusset plate

$t_{GPL} := 1.0 \cdot in$ = thickness of gusset plate

$F_{yGPL} := 50 \cdot ksi$ = specified minimum yield stress of gusset plate

$F_{uGPL} := 65 \cdot ksi$ = specified minimum tensile stress of gusset plate

$n_{sPLbolt} := 11$ = number of bar termination bolts for height of gusset plate (bolt providing M_{resist})

$n_{bGPL} := 12$ = number of gusset plate termination bolts

$d_{bGPL} := 0.75 \cdot in$ = diameter of gusset plate termination bolts

$F_{vbGPL} := 21.0 \cdot ksi$ = specified minimum tensile stength of gusset plate termiantion bolt

$s_{bGPL} := 3 \cdot in$ = spacing of gusset plate termination bolts

$end_{bGPL} := 1.5 \cdot in$ = end distance of gusset plate termination bolts

$K_{GPL} := 1.0$ = effective buckling length factor of gusset plate [Table C-C2.1, LRFD-99]

$b_{SPL} := 4.5 \cdot in$ = width of splice plate

$t_{SPL} := 1.0 \cdot in$ = thickness of splice plate

$F_{ySPL} := 50 \cdot ksi$ = specified minimum yield stress of splice plate

$F_{uSPL} := 65 \cdot ksi$ = specified minimum tensile stress of splice plate

$K_{SPL} := 1.0$ = effective buckling length factor of splice plate [Table C-C2.1, LRFD-99]

$L_{SPL} := 3.25 \cdot in$ = maximum spacing between gusset/splice plate bolts

$F_{EXX} := 70 \cdot ksi$ = ultimate stress of weld electrode

$H_{GPL} := (n_{sPLbolt} + 1) \cdot s$ = height of gusset plate $H_{GPL} = 36.00 \cdot in$

$$b'_{bar} := \begin{cases} b_{bar} & \text{if } b_{bar} \ge 4.5 \cdot in \\ 4.5 \cdot in & \text{if } b_{bar} < 4.5 \cdot in \end{cases}$$ $b'_{bar} = 5.75 \cdot in$

$H_{GPLcheck} := 2 \cdot end_{bGPL} + (n_{bGPL} - 1) \cdot s_{bGPL}$ $H_{GPLcheck} = 36.00 \cdot in$

$Length_{SPL} := L_{SPL} + 2 \cdot end_{bGPL} + 2 \cdot \left[(n_{bGPL} - 1) \cdot s_{bGPL} \right]$ $Length_{SPL} = 72.25 \cdot in$

SPLICE:

Output - Shear Strength of Bar Termination Bolts

$V_{max} := P_{max}$ $V_{max} = 290.0 \cdot kip$

$A_{bolt} := \frac{\pi}{4} \cdot d^2$ $A_{bolt} = 0.487 \cdot in^2$

$t_{sleeve} := \frac{d_{sleeve} - d}{2}$ $t_{sleeve} = 0.177 \cdot in$

$A_{sleeve} := \frac{\pi}{4} \cdot \left[d_{sleeve}^2 - (d_{sleeve} - 2 \cdot t_{sleeve})^2 \right]$ $A_{sleeve} = 0.537 \cdot in^2$

$A_{assembly} := A_{sleeve} + A_{bolt}$ $A_{assembly} = 1.024 \cdot in^2$

$F_v := \frac{V_{all}}{A_{assembly}}$ $F_v = 20.4 \cdot ksi$

$f_v := \frac{V_{max}}{n \cdot A_{assembly}}$ $f_v = 25.8 \cdot ksi$

$r_v := \frac{f_v}{F_v}$ $r_v = 126 \cdot \%$

Output - Combined Tension & Shear Strength Bar Termination Bolts

- Eccentricity Normal to the Plane of the Faying Surface: Case I-NA not at CG

$P_{bMax} := V_{max}$ $\quad P_{bMax} = 290 \cdot kip$

$edge_{bGPL} := \frac{b_{GPL}}{2}$ $\quad edge_{bGPL} = 2.25 \cdot in$

$e := t_{bar} + (b_{GPL} - edge_{bGPL})$ $\quad e = 3.75 \cdot in$

$$b_{eff} := \begin{cases} 8 \cdot t_{GPL} & \text{if } 8 \cdot t_{GPL} \le b'_{bar} \\ b'_{bar} & \text{otherwise} \end{cases}$$

$b_{eff} = 5.75 \cdot in$

$d_1 := 6.7565 \cdot in$ ***** adjust until d_1 is the same (Eq 1 = Eq 2)**

$$n' := \begin{cases} n_{sPLbolt} & \text{if } d_1 < s \\ (n_{sPLbolt} - 1) & \text{if } d_1 \ge s \wedge d_1 < 2 \cdot s \\ (n_{sPLbolt} - 2) & \text{if } d_1 \ge 2 \cdot s \wedge d_1 \le 3 \cdot s \\ \text{"ERROR"} & \text{otherwise} \end{cases}$$

$n' = 9$

$y := \left(\frac{n'}{2} + 0.5\right) \cdot s - \left[d_1 - (n_{sPLbolt} - n') \cdot s\right]$ $\quad y = 14.243 \cdot in$

$A_b := A_{assembly}$ $\quad A_b = 1.02 \cdot in^2$

$\Sigma A_b := n' \cdot A_b$ $\quad \Sigma A_b = 9.21 \cdot in^2$

$\Sigma A_b \cdot y = b_{eff} \cdot d_1 \cdot \frac{d_1}{2}$

$Find(d_1) = 6.756 \cdot in$ ***

$Eq1 := \Sigma A_b \cdot y$ $\quad Eq1 = 131.24 \cdot in^3$

$Eq2 := b_{eff} \cdot d_1 \cdot \frac{d_1}{2}$ $\quad Eq2 = 131.24 \cdot in^3$

$c := n_{sPLbolt} \cdot s - d_1$ $\quad c = 26.24 \cdot in$

$$y_i := \begin{bmatrix} c \\ (n_{sPLbolt} - 1)\cdot s - d_1 \\ (n_{sPLbolt} - 2)\cdot s - d_1 \\ (n_{sPLbolt} - 3)\cdot s - d_1 \\ (n_{sPLbolt} - 4)\cdot s - d_1 \\ (n_{sPLbolt} - 5)\cdot s - d_1 \\ (n_{sPLbolt} - 6)\cdot s - d_1 \\ (n_{sPLbolt} - 7)\cdot s - d_1 \\ (n_{sPLbolt} - 8)\cdot s - d_1 \end{bmatrix}$$

*** increase/decrease rows as needed**

$$y_i = \begin{pmatrix} 26.243 \\ 23.243 \\ 20.243 \\ 17.243 \\ 14.243 \\ 11.243 \\ 8.243 \\ 5.243 \\ 2.243 \end{pmatrix}\cdot in$$

$$I_x := n'\cdot\left(\frac{\pi\cdot d^4}{64}\right) + \sum\left(A_b\cdot y_i^2\right) + \frac{b_{eff}\cdot d_1^{\,3}}{12} + b_{eff}\cdot d_1\cdot\left(\frac{d_1}{2}\right)^2 \qquad I_x = 3013.56\cdot in^4$$

$$T_{bMax} := \frac{P_{bMax}\cdot e\cdot c}{I_x}\cdot A_b \qquad T_{bMax} = 9.7\cdot kip$$

$$F_t := \frac{T_{all}}{A_{bolt}} \qquad F_t = 34.3\cdot ksi$$

$$F'_t := \left[\sqrt{\left(\frac{ASI\cdot F_t}{ksi}\right)^2 - 2.15\cdot\left(\frac{f_v}{ksi}\right)^2}\right]\cdot ksi \qquad F'_t = 25.7\cdot ksi$$

$$f_t := \frac{T_{bMax}}{A_{bolt}} \qquad f_t = 19.9\cdot ksi$$

$$r_{combVT} := \frac{f_t}{F'_t} \qquad r_{combVT} = 77\cdot\%$$

Output - Bearing Strength: Reinforcing Bar

$$P_{max} := V_{max}$$

$$F_{pBar} := 1.2\cdot F_{uBar} \qquad F_{pBar} = 78.0\cdot ksi$$

$$f_{pBar} := \frac{P_{max}}{n\cdot t_{bar}\cdot d_{sleeve}} \qquad f_{pBar} = 15.4\cdot ksi$$

$$r_{pBar} := \frac{f_{pBar}}{F_{pBar}} \qquad r_{pBar} = 20\cdot\%$$

Output - Flexural Strength of Gusset Plate

$$P_{maxGPL} := \frac{P_{max}}{2} \qquad P_{maxGPL} = 145.0\cdot kip$$

$$S_{GPL} := \frac{t_{GPL}\cdot H_{GPL}^{\,2}}{6} \qquad S_{GPL} = 216.0\cdot in^3$$

$$f_{bGPL} := \frac{P_{maxGPL} \cdot e}{S_{GPL}}$$ $f_{bGPL} = 2.5 \cdot ksi$

$$F_{bGPL} := 0.75 \cdot F_{yGPL}$$ $F_{bGPL} = 37.5 \cdot ksi$

$$r_{mGPL} := \frac{f_{bGPL}}{F_{bGPL}}$$ $r_{mGPL} = 7 \cdot \%$

$$compact_{GPL} := \begin{cases} \text{"YES"} & \text{if } \frac{b_{GPL}}{t_{GPL}} < 0.38 \cdot \sqrt{\frac{E}{F_{yGPL}}} \\ \text{"NO"} & \text{otherwise} \end{cases}$$ $compact_{GPL} = \text{"YES"}$

Output - Compression Strength of Gusset Plate

$$r_{GPL} := \frac{t_{GPL}}{\sqrt{12}}$$ $r_{GPL} = 0.289 \cdot in$

$$A_{gGPL} := b_{GPL} \cdot t_{GPL}$$ $A_{gGPL} = 4.50 \cdot in^2$

$$KLr := K_{GPL} \cdot \frac{s_{bGPL}}{r_{GPL}}$$ $KLr = 10.4$

$$C_{cGPL} := \sqrt{\frac{2 \cdot \pi^2 \cdot E}{F_{yGPL}}}$$ $C_{cGPL} = 107.0$

$$F_{aGPL} := \begin{cases} \dfrac{\left(1 - \dfrac{KLr^2}{2 \cdot C_{cGPL}^2}\right) \cdot F_{yGPL}}{\dfrac{5}{3} + \dfrac{3}{8} \cdot \left(\dfrac{KLr}{C_{cGPL}}\right) - \dfrac{KLr^3}{8 \cdot C_{cGPL}^3}} & \text{if } KLr \le C_{cGPL} \\ \dfrac{12 \cdot \pi^2 \cdot E}{23 \cdot KLr^2} & \text{otherwise} \end{cases}$$ $F_{aGPL} = 29.2 \cdot ksi$

$$f_{aGPL} := \frac{P_{maxGPL}}{A_{gGPL}}$$ $f_{aGPL} = 32.2 \cdot ksi$

$$r_{cGPL} := \frac{f_{aGPL}}{F_{aGPL}}$$ $r_{cGPL} = 110 \cdot \%$

Output - Combined Fexure & Compression Strength of Gusset Plate

$$C_m := 0.85$$

$$F'_{eGPL} := \frac{12 \cdot \pi^2 \cdot E}{23 \cdot KLr^2}$$ $F'_{eGPL} = 1382.7 \cdot ksi$

$$Eq_{H11GPL} := \frac{f_{aGPL}}{F_{aGPL}} + \frac{C_m \cdot f_{bGPL}}{\left(1 - \frac{f_{aGPL}}{F'_{eGPL}}\right) \cdot F_{bGPL}}$$ $Eq_{H11GPL} = 1.161$

$$Eq_{H12GPL} := \frac{f_{aGPL}}{0.6 \cdot F_{yGPL}} + \frac{f_{bGPL}}{F_{bGPL}}$$ $Eq_{H12GPL} = 1.141$

$$Eq_{H13GPL} := \frac{f_{aGPL}}{F_{aGPL}} + \frac{f_{bGPL}}{F_{bGPL}}$$ $Eq_{H13GPL} = 1.17$

$$r_{CcombGPL} := \begin{cases} Eq_{H13GPL} & \text{if } \frac{f_{aGPL}}{F_{aGPL}} \le 0.15 \\ Eq_{H11GPL} & \text{if } \frac{f_{aGPL}}{F_{aGPL}} > 0.15 \wedge Eq_{H11GPL} \ge Eq_{H12GPL} \\ Eq_{H12GPL} & \text{if } \frac{f_{aGPL}}{F_{aGPL}} > 0.15 \wedge Eq_{H12GPL} > Eq_{H11GPL} \end{cases}$$ $r_{CcombGPL} = 116 \cdot \%$

Output - Shear Strengh of Gusset Plate Bolts

$V_{maxGPL} := P_{maxGPL}$ $V_{maxGPL} = 145.0 \cdot kip$

$$A_{bGPL} := \frac{\pi \cdot d_{bGPL}^{2}}{4}$$ $A_{bGPL} = 0.442 \cdot in^2$

$$f_{vbGPL} := \frac{V_{maxGPL}}{n_{bGPL} \cdot A_{bGPL}}$$ $f_{vbGPL} = 27.4 \cdot ksi$

$$r_{vbGPL} := \frac{f_{vbGPL}}{F_{vbGPL}}$$ $r_{vbGPL} = 130 \cdot \%$

Output - Bearing Strength: Gusset Plate

$F_{pGPL} := 1.2 \cdot F_{uGPL}$ $F_{pGPL} = 78.0 \cdot ksi$

$$f_{pGPL} := \frac{P_{maxGPL}}{n_{bGPL} \cdot t_{GPL} \cdot d_{bGPL}}$$ $f_{pGPL} = 16.1 \cdot ksi$

$$r_{bGPL} := \frac{f_{pGPL}}{F_{pGPL}}$$ $r_{bGPL} = 21 \cdot \%$

Output - Tension Strength of Gusset Plate

$T_{maxGPL} := P_{maxGPL}$ $T_{maxGPL} = 145.0 \cdot kip$

- Gross Area:

$F_{tGrossGPL} := 0.6 \cdot F_{yGPL}$ $F_{tGrossGPL} = 30.0 \cdot ksi$

$f_{tGrossGPL} := \frac{T_{maxGPL}}{A_{gGPL}}$ $f_{tGrossGPL} = 32.2 \cdot ksi$

$r_{tGrossGPL} := \frac{f_{tGrossGPL}}{F_{tGrossGPL}}$ $r_{tGrossGPL} = 107 \cdot \%$

- Net Area

$A_{enGPL} := \left[b_{GPL} - \left(d_{bGPL} + \frac{1}{8} \cdot in + \frac{1}{16} \cdot in\right)\right] \cdot t_{GPL}$ $A_{enGPL} = 3.56 \cdot in^2$

$f_{tNetGPL} := f_{tGrossGPL} \cdot \frac{A_{gGPL}}{A_{enGPL}}$ $f_{tNetGPL} = 40.7 \cdot ksi$

$F_{tNetGPL} := 0.5 \cdot F_{uGPL}$ $F_{tNetGPL} = 32.5 \cdot ksi$

$r_{tNetGPL} := \frac{f_{tNetGPL}}{F_{tNetGPL}}$ $r_{tNetGPL} = 125 \cdot \%$

Output - Combined Fexure & Tension Strength of Gusset Plate

$Eq_{H21GPLgross} := \frac{f_{tGrossGPL}}{F_{tGrossGPL}} + \frac{f_{bGPL}}{F_{bGPL}}$ $Eq_{H21GPLgross} = 1.141$

$Eq_{H21GPLnet} := \frac{f_{tNetGPL}}{F_{tNetGPL}} + \frac{f_{bGPL}}{F_{bGPL}}$ $Eq_{H21GPLnet} = 1.319$

$r_{TcombGPL} := \max(Eq_{H21GPLgross}, Eq_{H21GPLnet})$ $r_{TcombGPL} = 132 \cdot \%$

Output - Shear Strength Gusset Plate

- Gross Area:

$F_{vGrossGPL} := 0.4 \cdot F_{yGPL}$ $F_{vGrossGPL} = 20.0 \cdot ksi$

$A_{vGPL} := H_{GPL} \cdot t_{GPL}$ $A_{vGPL} = 36.00 \cdot in^2$

$f_{vGrossGPL} := \frac{V_{maxGPL}}{A_{vGPL}}$ $f_{vGrossGPL} = 4.0 \cdot ksi$

$r_{vGrossGPL} := \frac{f_{vGrossGPL}}{F_{vGrossGPL}}$ $r_{vGrossGPL} = 20 \cdot \%$

- Net Area

$A_{nvGPL} := \left[H_{GPL} - \left(d_{bGPL} + \frac{1}{8} \cdot in + \frac{1}{16} \cdot in\right) \cdot n_{bGPL}\right] \cdot t_{GPL}$ $A_{nvGPL} = 24.75 \cdot in^2$

$f_{vNetGPL} := f_{vGrossGPL} \cdot \frac{A_{vGPL}}{A_{nvGPL}}$ $f_{vNetGPL} = 5.9 \cdot ksi$

$F_{vNetGPL} := 0.3 \cdot F_{uGPL}$ $F_{vNetGPL} = 19.5 \cdot ksi$

$$r_{vNetGPL} := \frac{f_{vNetGPL}}{F_{vNetGPL}} \qquad r_{vNetGPL} = 30\cdot\%$$

Output - Block Shear Strength of Gusset Plate

$$A_{gv} := \left[\left(n_{bGPL} - 1\right)\cdot s_{bGPL} + edge_{bGPL}\right]\cdot t_{GPL} \qquad A_{gv} = 35.25\cdot in^2$$

$$A_{nv} := A_{gv} - \left[\left[d_{bGPL} + \left(\frac{1}{8}\cdot in\right) + \left(\frac{1}{16}\cdot in\right)\right]\cdot\left(n_{bGPL} - 0.5\right)\cdot\left(t_{GPL}\right)\right] \qquad A_{nv} = 24.47\cdot in^2$$

$$A_{nt} := \left[edge_{bGPL} - \frac{\left[d_{bGPL} + \left(\frac{1}{8}\cdot in\right)\right]}{2}\right]\cdot\left(t_{GPL}\right) \qquad A_{nt} = 1.81\cdot in^2$$

$$F_{vbsGPL} := 0.30\cdot F_{uGPL} \qquad F_{vbsGPL} = 19.5\cdot ksi$$

$$F_{tbsGPL} := 0.50\cdot F_{uGPL} \qquad F_{tbsGPL} = 32.5\cdot ksi$$

$$T_{bsGPLall} := A_{nv}\cdot F_{vbsGPL} + A_{nt}\cdot F_{tbsGPL} \qquad T_{bsGPLall} = 536.0\cdot kip$$

$$r_{bsGPL} := \frac{T_{maxGPL}}{T_{bsGPLall}} \qquad r_{bsGPL} = 27\cdot\%$$

Output - Strength of Gusset Plate Welds

$$V_{maxW} := \frac{P_{max}}{2} \qquad V_{maxW} = 145\cdot kip$$

- Shear:

$$t_{VW} := \begin{cases} \left[t_{GPL} - \left(\frac{3}{16} + \frac{1}{4}\right)\cdot in\right] & \text{if } t_{GPL} > 1.0\cdot in \\ \left[t_{GPL} - \left(\frac{1}{8} + \frac{1}{8}\right)\cdot in\right] & \text{if } t_{GPL} \le 1.0\cdot in \end{cases} \qquad t_{VW} = 0.750\cdot in$$

$$V_{allW} := \left(0.30\cdot F_{EXX}\right)\cdot t_{VW}\cdot H_{GPL} \qquad V_{allW} = 567.0\cdot kip$$

$$r_{vW} := \frac{V_{maxW}}{V_{allW}} \qquad r_{vW} = 26\cdot\%$$

- Tension/Flexure:

$$S_W := \frac{t_{VW}\cdot H_{GPL}^{\ 2}}{6} \qquad S_W = 162.0\cdot in^3$$

$$M_{allW} := \left(0.30\cdot F_{EXX}\right)\cdot S_W \qquad M_{allW} = 283.5\cdot kip\cdot ft$$

$$r_{fW} := \frac{V_{maxW}\cdot e}{M_{allW}} \qquad r_{fW} = 16\cdot\%$$

- Combined

$$r_{vfW} := \sqrt{r_{vW}^{\ 2} + r_{fW}^{\ 2}} \qquad r_{vfW} = 30\cdot\%$$

Output - Compression Strength of Splice Plate

$$P_{maxSPL} := \frac{P_{max}}{2}$$ $P_{maxSPL} = 145.0 \cdot kip$

$$r_{SPL} := \frac{t_{SPL}}{\sqrt{12}}$$ $r_{SPL} = 0.289 \cdot in$

$$A_{gSPL} := b_{SPL} \cdot t_{SPL}$$ $A_{gSPL} = 4.50 \cdot in^2$

$$KLr := K_{SPL} \cdot \frac{L_{SPL}}{r_{SPL}}$$ $KLr = 11.3$

$$C_{cSPL} := \sqrt{\frac{2 \cdot \pi^2 \cdot E}{F_{ySPL}}}$$ $C_{cSPL} = 107.0$

$$F_{aSPL} := \begin{cases} \dfrac{\left(1 - \dfrac{KLr^2}{2 \cdot C_{cSPL}^2}\right) \cdot F_{ySPL}}{\dfrac{5}{3} + \dfrac{3}{8} \cdot \left(\dfrac{KLr}{C_{cSPL}}\right) - \dfrac{KLr^3}{8 \cdot C_{cSPL}^3}} & \text{if } KLr \le C_{cSPL} \\ \dfrac{12 \cdot \pi^2 \cdot E}{23 \cdot KLr^2} & \text{otherwise} \end{cases}$$ $F_{aSPL} = 29.1 \cdot ksi$

$$f_{aSPL} := \frac{P_{maxSPL}}{A_{gSPL}}$$ $f_{aSPL} = 32.2 \cdot ksi$

$$r_{cSPL} := \frac{f_{aSPL}}{F_{aSPL}}$$ $r_{cSPL} = 111 \cdot \%$

Output - Tension Strength of Splice Plate

$$T_{maxSPL} := P_{maxGPL}$$ $T_{maxSPL} = 145.0 \cdot kip$

- Gross Area:

$$F_{tGrossSPL} := 0.6 \cdot F_{ySPL}$$ $F_{tGrossSPL} = 30.0 \cdot ksi$

$$f_{tGrossSPL} := \frac{T_{maxSPL}}{A_{gSPL}}$$ $f_{tGrossSPL} = 32.2 \cdot ksi$

$$r_{tGrossSPL} := \frac{f_{tGrossSPL}}{F_{tGrossSPL}}$$ $r_{tGrossSPL} = 107 \cdot \%$

- Net Area

$$A_{enSPL} := \left[b_{SPL} - \left(d_{bGPL} + \frac{1}{8} \cdot in + \frac{1}{16} \cdot in\right)\right] \cdot t_{SPL}$$ $A_{enSPL} = 3.56 \cdot in^2$

$$f_{tNetSPL} := f_{tGrossSPL} \cdot \frac{A_{gSPL}}{A_{enSPL}}$$ $f_{tNetSPL} = 40.7 \cdot ksi$

$F_{tNetSPL} := 0.5 \cdot F_{uSPL}$ $F_{tNetSPL} = 32.5 \cdot ksi$

$r_{tNetSPL} := \frac{f_{tNetSPL}}{F_{tNetSPL}}$ $r_{tNetSPL} = 125 \cdot \%$

Output - Block Shear Strength of Splice Plate

$A_{gv} := \left[\left(n_{bGPL} - 1\right) \cdot s_{bGPL} + edge_{bGPL} \right] \cdot t_{SPL}$ $A_{gv} = 35.25 \cdot in^2$

$A_{nv} := A_{gv} - \left[\left[d_{bGPL} + \left(\frac{1}{8} \cdot in \right) + \left(\frac{1}{16} \cdot in \right) \right] \cdot \left(n_{bGPL} - 0.5 \right) \cdot \left(t_{SPL} \right) \right]$ $A_{nv} = 24.47 \cdot in^2$

$A_{nt} := \left[edge_{bGPL} - \frac{\left[d_{bGPL} + \left(\frac{1}{8} \cdot in \right) \right]}{2} \right] \cdot \left(t_{SPL} \right)$ $A_{nt} = 1.81 \cdot in^2$

$F_{vbsSPL} := 0.30 \cdot F_{uSPL}$ $F_{vbsSPL} = 19.5 \cdot ksi$

$F_{tbsSPL} := 0.50 \cdot F_{uSPL}$ $F_{tbsSPL} = 32.5 \cdot ksi$

$T_{bsSPLall} := A_{nv} \cdot F_{vbsSPL} + A_{nt} \cdot F_{tbsSPL}$ $T_{bsSPLall} = 536.0 \cdot kip$

$r_{bsSPL} := \frac{T_{maxSPL}}{T_{bsSPLall}}$ $r_{bsGPL} = 27 \cdot \%$

Output - Bearing Strength: Splice Plate

$F_{pSPL} := 1.2 \cdot F_{uSPL}$ $F_{pGPL} = 78.0 \cdot ksi$

$f_{pSPL} := \frac{P_{maxSPL}}{n_{bGPL} \cdot t_{SPL} \cdot d_{bGPL}}$ $f_{pSPL} = 16.1 \cdot ksi$

$r_{bSPL} := \frac{f_{pSPL}}{F_{pSPL}}$ $r_{bSPL} = 21 \cdot \%$

Output - Design Summary:

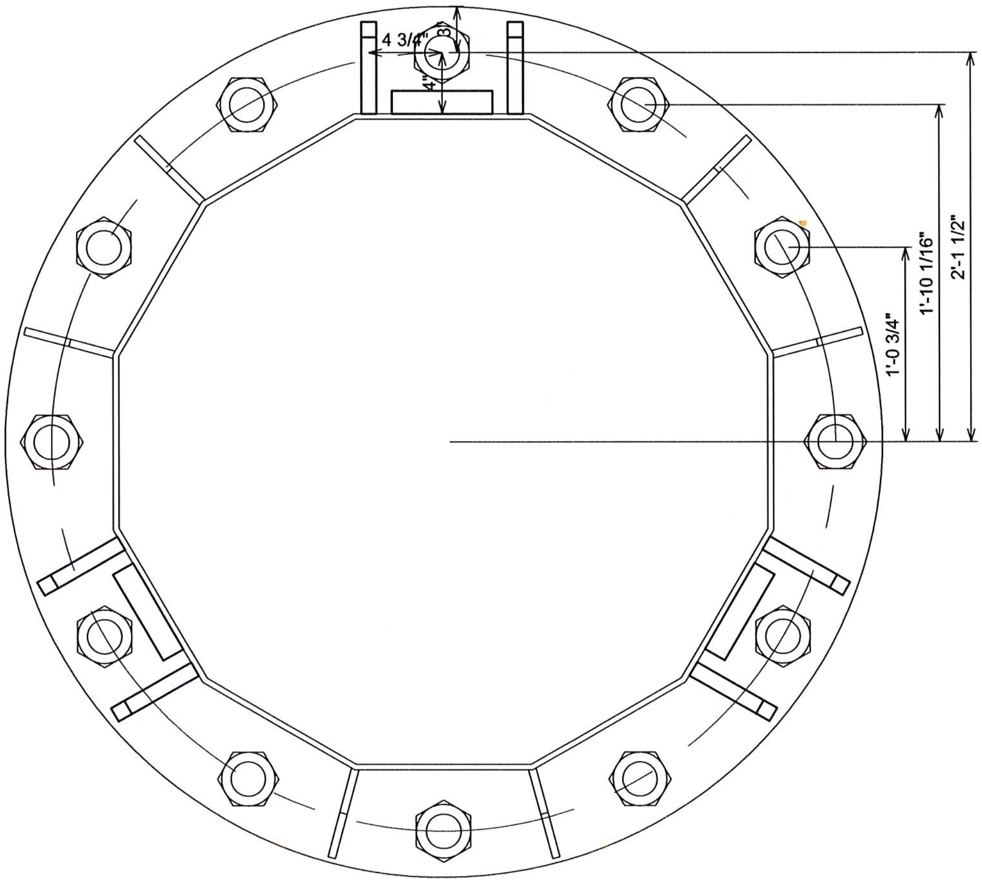
$results_{TB} := \begin{pmatrix} \frac{r_v}{ASI} \\ r_{combVT} \end{pmatrix}$ $results_{TB} = \begin{pmatrix} 95 \\ 77 \end{pmatrix} \cdot \%$ $results_{Bar} := \frac{r_{pBar}}{ASI}$ $results_{Bar} = 15 \cdot \%$

$$results_{GPL} := \begin{pmatrix} r_{mGPL} \\ r_{cGPL} \\ r_{CcombGPL} \\ r_{vbGPL} \\ r_{bsGPL} \\ r_{tGrossGPL} \\ r_{tNetGPL} \\ r_{TcombGPL} \\ r_{vGrossGPL} \\ r_{vNetGPL} \\ r_{bGPL} \\ r_{vW} \\ r_{fW} \\ r_{vfW} \end{pmatrix} \cdot \left(\frac{1}{ASI}\right) \quad results_{GPL} = \begin{pmatrix} 5 \\ 83 \\ 87 \\ 98 \\ 20 \\ 81 \\ 94 \\ 99 \\ 15 \\ 23 \\ 16 \\ 19 \\ 12 \\ 23 \end{pmatrix} \cdot \%$$

$$results_{SPL} := \begin{pmatrix} r_{cSPL} \\ r_{tGrossSPL} \\ r_{tNetSPL} \\ r_{bsSPL} \\ r_{bSPL} \end{pmatrix} \cdot \left(\frac{1}{ASI}\right) \quad results_{SPL} = \begin{pmatrix} 83 \\ 81 \\ 94 \\ 20 \\ 16 \end{pmatrix} \cdot \%$$

$$Max_{Utilization} := \max\left(results_{Bar}, results_{TB}, results_{GPL}, results_{SPL}\right)$$

$$Max_{Utilization} = 99 \cdot \%$$



BASE PLATE LAYOUT - CASE #1

SCALE: 1" = 1'

PROJECT INFORMATION:

GRANBY-N. GRANBY
CT2010

15 NORTH GRANBY ROAD
GRANBY, CT 06035
(HARTFORD COUNTY)

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VSI #: 121657

PLANS PREPARED FOR:
TowerCo
5000 Valleystone Drive
Cary, NC 27519
Office (919) 469-5559
Fax (919) 469-5530

PLANS PREPARED BY:
vertical solutions
2002 Production Drive
Apex, NC 27539
Office: (888) 321-6167
Fax: (919) 321-1768

Input -

CONSTANTS:
$ASI := 133 \cdot \%$

- Reactions & Forces:

$M := 2459 \cdot kip \cdot ft$ = max unfactored moment reaction at top of base plate

$P := 29 \cdot kip$ = max unfactored shear reaction at top of base plate

$P_{ADD1} := 28.7 \cdot kip$ = additional axial force to TSP on opposite side of TSP (left side)

$P_{ADD2} := 28.7 \cdot kip$ = additional axial force to TSP on opposite side of TSP (right side)

- Base Plate:

$t_{bpl} := 1.75 \cdot in$ = thickness of base plate

$F_y := 60 \cdot ksi$ = yield stress of base plate

$a := 4.75 \cdot in$ = distance from centerline of stiffener plate on left side to center of anchor rod

$b := 4.75 \cdot in$ = distance from centerline of stiffener plate on right side to center of anchor rod

$y := 4.0 \cdot in$ = distance from shaft wall to center of anchor rod

$k := 3.0 \cdot in$ = distance from center of anchor rod to edge of base plate

- TSP:

$b_{TSP} := 6.0 \cdot in$ = width of TSP

$t_{VW} := 0.3125 \cdot in$ = thickness of vertical weld

$F_{yTSP} := 50 \cdot ksi$ = specified minimum yield stress of TSP material

$F_{EXX} := 70 \cdot ksi$ = specified minimum ultimate stress of weld electrode

- Bar:

$P_{maxBar} := 335 \cdot kip$ = axial force from bar (see Pole Tool-F v1.6.xls)

$d_{1Bar} := 4.75 \cdot in$ = distance from center of bar to edge of TSP (left side)

$d_{2Bar} := 4.75 \cdot in$ = distance from center of bar to edge of TSP (right side)

$b_{bar} := 6.5 \cdot in$ = width of bar reinforcement

$t_{bar} := 1.5 \cdot in$ = width of bar reinforcement

$F_{yBar} := 50 \cdot ksi$ = yield strength of bar

$n := 12$ = number of termination bolts

$z := 6 \cdot in$ = height above base plate to bottom of bar

$h := 3 \cdot in$ = height above top termination bolt to top of TSP

- Anchor Rods:

$\eta := 0.5$ = coefficient per Figure 4.4

$F_{ub} := 100 \cdot ksi$ = specified minimum tensile stength of bolt

$$Q := \begin{pmatrix} 2 \\ 4 \\ 4 \\ 2 \\ 0 \\ 0 \\ 0 \end{pmatrix} \quad d := \begin{pmatrix} 2\cdot12 + 1 + \frac{1}{2} \\ 1\cdot12 + 10 + \frac{1}{16} \\ 1\cdot12 + \frac{3}{4} \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}\cdot in \quad A_{stiff} := \begin{pmatrix} 3.98 \\ 3.98 \\ 3.98 \\ 3.98 \\ 0 \\ 0 \\ 0 \end{pmatrix} in^2 \quad A_{stress} := \begin{pmatrix} 3.25 \\ 3.25 \\ 3.25 \\ 3.25 \\ 0 \\ 0 \\ 0 \end{pmatrix} in^2 \quad F_t := \begin{pmatrix} 0.6\cdot75 \\ 0.6\cdot75 \\ 0.6\cdot75 \\ 0.6\cdot75 \\ 0 \\ 0 \\ 0 \end{pmatrix}\cdot ksi$$

Output - Anchor Rod, Deformation Method:

$$\sum \overrightarrow{(Q)} = 12 \qquad sumQAd := \sum \overrightarrow{\left(Q\cdot d^2\cdot A_{stiff}\right)} \qquad sumQAd = 15513\cdot in^4$$

$$R := \frac{M\cdot\overrightarrow{\left(d\cdot A_{stiff}\right)}}{sumQAd} + \frac{P\cdot A_{stiff}}{\sum\overrightarrow{\left(A_{stiff}\cdot Q\right)}}$$

ϕRnt = nominal tension strength
d = distance from center
A = area of fastener
Q = quantity of fasteners

$$f_t := \overrightarrow{\left(\frac{R}{A_{stress}}\right)} \qquad r_{AR} := \overrightarrow{\left(\frac{f_t}{ASI\cdot F_t}\right)}$$

$$R = \begin{pmatrix} 195.5 \\ 169.4 \\ 98.9 \\ 2.4 \\ 0.0 \\ 0.0 \\ 0.0 \end{pmatrix}\cdot kip \qquad f_t = \begin{pmatrix} 60.1 \\ 52.1 \\ 30.4 \\ 0.7 \\ 0.0 \\ 0.0 \\ 0.0 \end{pmatrix}\cdot ksi \qquad r_{AR} = \begin{pmatrix} 100 \\ 87 \\ 51 \\ 1 \\ 0 \\ 0 \\ 0 \end{pmatrix}\cdot\%$$

Output - Base Plate:

$P_{maxAR} := \max(R)$ — $P_{maxAR} = 195\cdot kip$

$t := t_{bpl}$ — $t = 1.75\cdot in$

$I_x := \frac{(a + b)\cdot t^3}{12}$ — $I_x = 4.24\cdot in^4$

$k_x := \frac{3\cdot I_x}{y^3}$ — $k_x = 0.20\cdot in$

$S_x := \frac{I_x}{\left(\frac{t}{2}\right)}$ — $S_x = 4.85\cdot in^3$

$Z_x := 1.5\cdot S_x$ — $Z_x = 7.27\cdot in^3$

$$I_y := \frac{(y + k)\cdot t^3}{12}$$ $I_y = 3.13\cdot in^4$

$$k_y := \begin{cases} \dfrac{3\cdot I_y\cdot(3\cdot a + b)^2}{2\cdot a^3\cdot b^2} & \text{if } a \ge b \\ \dfrac{3\cdot I_y\cdot(3\cdot b + a)^2}{2\cdot b^3\cdot a^2} & \text{if } a < b \end{cases}$$ $k_y = 0.70\cdot in$

$$S_y := \frac{I_y}{\left(\frac{t}{2}\right)}$$ $S_y = 3.57\cdot in^3$

$$Z_y := 1.5\cdot S_y$$ $Z_y = 5.36\cdot in^3$

$$M_{xMax} := \frac{k_x}{k_x + k_y}\cdot P_{maxAR}\cdot y$$ $M_{xMax} = 14.4\cdot kip\cdot ft$

$$M'_{xAll} := ASI\cdot F_y\cdot S_x$$ $M'_{xAll} = 32.2\cdot kip\cdot ft$

$$r_x := \frac{M_{xMax}}{M'_{xAll}}$$ $r_x = 45\cdot\%$

$$M_{yMax} := \begin{cases} \dfrac{k_y}{k_x + k_y}\cdot\left[\dfrac{P_{maxAR}\cdot a\cdot b^2}{(a + b)^2}\right] & \text{if } a \le b \\ \dfrac{k_y}{k_x + k_y}\cdot\left[\dfrac{P_{maxAR}\cdot a^2\cdot b}{(a + b)^2}\right] & \text{if } a > b \end{cases}$$ $M_{yMax} = 15.1\cdot kip\cdot ft$

$$M'_{yAll} := ASI\cdot F_y\cdot S_y$$ $M'_{yAll} = 23.8\cdot kip\cdot ft$

$$r_y := \frac{M_{yMax}}{M'_{yAll}}$$ $r_y = 63\cdot\%$

$$r_{BPL} := \sqrt{{r_x}^2 + {r_y}^2}$$ $r_{BPL} = 78\cdot\%$

$$P_{maxShaft} := \frac{k_x}{k_x + k_y}\cdot P_{maxAR}$$ $P_{maxShaft} = 43.2\cdot kip$

$$P'_{maxTSP} := \frac{k_y}{k_x + k_y}\cdot P_{maxAR}$$ $P'_{maxTSP} = 152.2\cdot kip$

Output - TSP Required Thickness (based on area) and Length:

$A_{bar} := b_{bar} \cdot t_{bar}$ $\qquad A_{bar} = 9.75 \cdot in^2$

$A_{TSPreq} := \left(\frac{F_{yBar}}{F_{yTSP}}\right) \cdot \left(\frac{A_{bar}}{2}\right)$ $\qquad A_{TSPreq} = 4.88 \cdot in^2$

$t_{req} := \frac{A_{TSPreq}}{b_{TSP}}$ $\qquad t_{req} = 0.813 \cdot in$ $\qquad$ **USE:** $t_{TSP} := 1.25 \cdot in$

$L_{req} := n \cdot (3 \cdot in) + z + h$ $\qquad L_{req} = 45.00 \cdot in$

Output - Calculate Forces in TSP and Weld Properties:

$l := a + b$ $\qquad l = 9.5 \cdot in$

$P_{maxAR1} := \frac{P'_{maxTSP} \cdot b^2}{l^3} \cdot (b + 3 \cdot a)$ $\qquad P_{maxAR1} = 76.1 \cdot kip$

$P_{maxAR2} := \frac{P'_{maxTSP} \cdot a^2}{l^3} \cdot (a + 3 \cdot b)$ $\qquad P_{maxAR2} = 76.1 \cdot kip$

$P_{maxBar1} := \left(1 - \frac{d_{1Bar}}{d_{1Bar} + d_{2Bar}}\right) \cdot P_{maxBar}$ $\qquad P_{maxBar1} = 167.5 \cdot kip$

$P_{maxBar2} := \left(1 - \frac{d_{2Bar}}{d_{1Bar} + d_{2Bar}}\right) \cdot P_{maxBar}$ $\qquad P_{maxBar2} = 167.5 \cdot kip$

$P_{max1} := P_{maxAR1} + P_{maxBar1} + P_{ADD1}$ $\qquad P_{max1} = 272.3 \cdot kip$

$P_{max2} := P_{maxAR2} + P_{maxBar2} + P_{ADD2}$ $\qquad P_{max2} = 272.3 \cdot kip$

$P_{maxTSP} := \max(P_{max1}, P_{max2})$ $\qquad P_{maxTSP} = 272.3 \cdot kip$

$L_{TSP} := L_{req}$ $\qquad L_{TSP} = 45.00 \cdot in$

$clip := 0.75 \cdot in$

$L_{VW} := L_{TSP} - clip$ $\qquad L_{VW} = 44.25 \cdot in$

$L_{HW} := b_{TSP} - clip$ $\qquad L_{HW} = 5.25 \cdot in$

Output - Check TSP Welds:

- TSP Forces

$V_{maxTSP} := P_{maxTSP}$ $\qquad V_{maxTSP} = 272.3 \cdot kip$

$$M_{maxTSPx} := \begin{cases} P_{maxAR1} \cdot y + P_{maxBar1} \cdot \left(\frac{L_{HW}}{2} + clip\right) & \text{if } P_{maxTSP} = P_{max1} \\ P_{maxAR2} \cdot y + P_{maxBar2} \cdot \left(\frac{L_{HW}}{2} + clip\right) & \text{if } P_{maxTSP} = P_{max2} \end{cases}$$

$M_{maxTSPx} = 72.5 \cdot kip \cdot ft$

$T_{maxTSP} := P_{maxTSP}$ $T_{maxTSP} = 272.3 \cdot kip$

- Shear Strength of Vertical Weld

$V'_{yAll} := 2\left[\left(0.60 \cdot F_{EXX}\right) \cdot \left(0.707 \cdot t_{VW}\right) \cdot L_{VW}\right] \cdot ASI$ $V'_{yAll} = 1092 \cdot kip$

$r_v := \frac{V_{maxTSP}}{V'_{yAll}}$ $r_v = 25 \cdot \%$

- Flexural Strength of Vertical Weld

$S_{xTSP} := \frac{2 \cdot \left[\left(0.707 t_{VW}\right) \cdot L_{VW}^2\right]}{6}$

$M'_{xAllSP} := ASI \cdot \left[\left(0.3 F_{EXX}\right) \cdot S_{xTSP}\right]$ $M'_{xAllSP} = 335.6 \cdot kip \cdot ft$

$r_f := \frac{M_{maxTSPx}}{M'_{xAllSP}}$ $r_f = 22 \cdot \%$

- Combined Flexure & Shear Strength of Vertical Weld

$r_{vf} := \sqrt{r_v^2 + r_f^2}$ $r_{vf} = 33 \cdot \%$

- Tensile Strength of Horizontal Weld

$T'_{xAll} := \left[\left(0.60 \cdot F_y\right) t_{TSP} \cdot L_{HW}\right] \cdot ASI$ $T'_{xAll} = 314.2 \cdot kip$

$r_t := \frac{T_{maxTSP}}{T'_{xAll}}$ $r_t = 87 \cdot \%$

RESULTS:

$r_{maxAR} := \max\left(r_{AR}\right)$

$r := \begin{pmatrix} r_{maxAR} \\ r_{BPL} \\ r_v \\ r_f \\ r_{vf} \\ r_t \end{pmatrix}$ $r = \begin{pmatrix} 100 \\ 78 \\ 25 \\ 22 \\ 33 \\ 87 \end{pmatrix} \cdot \%$

$Max_{Utilization} := \max(r)$ $Max_{Utilization} = 100 \cdot \%$

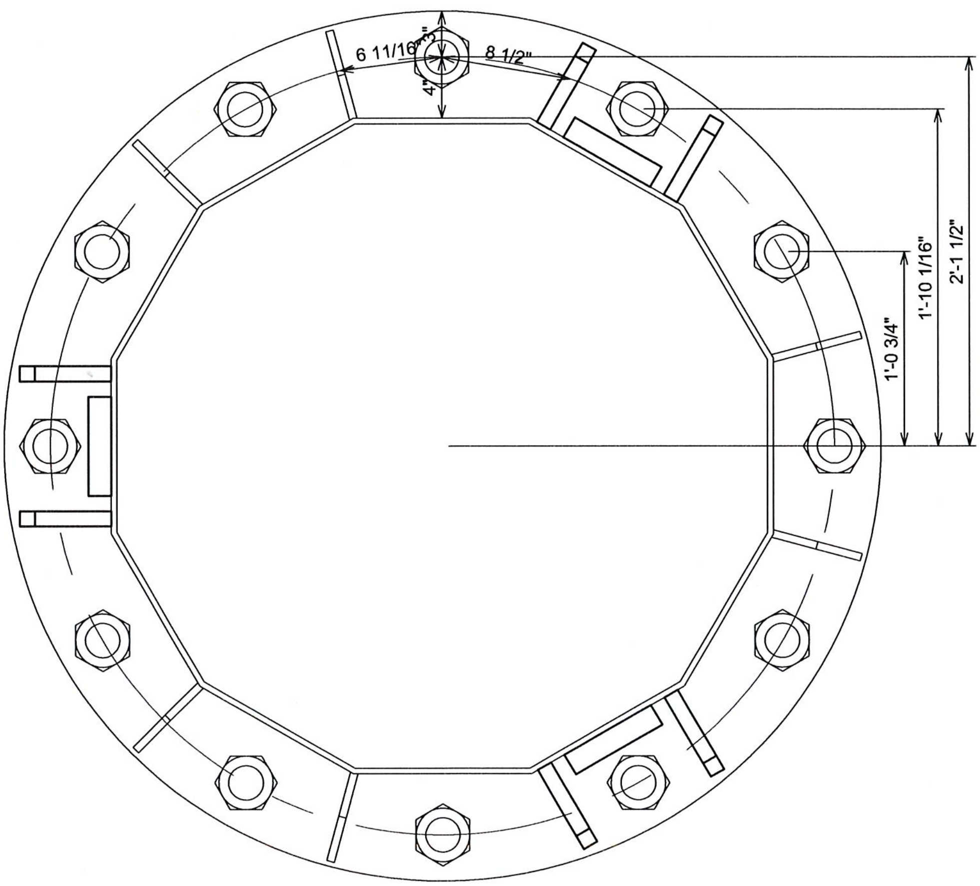
$t_{TSP} = 1.250 \cdot in$

$P_{ADD1} := P_{maxAR1} + P_{maxBar1}$ $P_{ADD1} = 243.6 \cdot kip$

$L_{TSP} = 45.00 \cdot in$

$P_{ADD2} := P_{maxAR2} + P_{maxBar2}$ $P_{ADD2} = 243.6 \cdot kip$

$b_{TSP} = 6.000 \cdot in$



BASE PLATE LAYOUT - CASE #2

SCALE: 1" = 1'

PROJECT INFORMATION:

GRANBY-N. GRANBY
CT2010

15 NORTH GRANBY ROAD
GRANBY, CT 06035
(HARTFORD COUNTY)

REV	DATE:	Issued For:
0	9-6-12	PSAR

DRAWN BY: MER | CHECKED BY: JHW

SHEET NUMBER: **BPL**

REVISION: 0

VSI #: 121657

PLANS PREPARED FOR:

TowerCo
5000 Valleystone Drive
Cary, NC 27519
Office (919) 469-5559
Fax (919) 469-5530

PLANS PREPARED BY:

vertical solutions
2002 Production Drive
Apex, NC 27539
Office: (888) 321-6167
Fax: (919) 321-1768

vertical solutions	**BASE PLATE w/ STIFFENERS, TIA-222-F** Case #2 - Existing SP	VSi Job No.: 121657 Date: 09/06/2012 Calculated by: MER

Input -

$M := 2459 \cdot kip \cdot ft$ = moment reaction at top of base plate

$P := 29 \cdot kip$ = shear reaction at top of base plate

$P_{add1} := 92.4 \cdot kip$ = additional axial force to SP on opposite side of SP (left side)

$P_{add2} := 243.6 \cdot kip$ = additional axial force to SP on opposite side of SP (right side)

$ASI := 133 \cdot \%$ = allowable stress increase

Base Plate:

$t_{bpl} := 1.75 \cdot in$ = thickness of base plate

$F_y := 60 \cdot ksi$ = yield stress of base plate

$a := 6.6875 \cdot in$ = distance from centerline of stiffener plate on left side to center of anchor rod

$b := 8.5 \cdot in$ = distance from centerline of stiffener plate on right side to center of anchor rod

$y := 4.0 \cdot in$ = distance from shaft wall to center of anchor rod

$k := 3.0 \cdot in$ = distance from center of anchor rod to edge of base plate

Stiffener Plates:

$t_{VW} := 0.3125 \cdot in$ = thickness of vertical weld

$L_{VW} := 17.25 \cdot in$ = length of vertical weld

$L_{HW} := 4.25 \cdot in$ = length of horizontal weld

$t_{HW} := 0.625 \cdot in$ = thickness of horizontal weld

$F_{ySP} := 50 \cdot ksi$ = yield stress of stiffener plate material

$F_{EXX} := 70 \cdot ksi$ = ultimate stress of weld electrode

$n_{SP} := 1$ = number of stiffener plates per anchor rod

ANCHOR ROD, DEFORMATION METHOD:

$$Q := \begin{pmatrix} 2 \\ 4 \\ 4 \\ 2 \\ 0 \\ 0 \\ 0 \end{pmatrix} \quad d := \begin{pmatrix} 2 \cdot 12 + 1 + \frac{1}{2} \\ 1 \cdot 12 + 10 + \frac{1}{16} \\ 1 \cdot 12 + \frac{3}{4} \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \cdot in \quad A_{stiff} := \begin{pmatrix} 3.98 \\ 3.98 \\ 3.98 \\ 3.98 \\ 0 \\ 0 \\ 0 \end{pmatrix} in^2 \quad A_{stress} := \begin{pmatrix} 3.25 \\ 3.25 \\ 3.25 \\ 3.25 \\ 0 \\ 0 \\ 0 \end{pmatrix} in^2 \quad F_t := \begin{pmatrix} 0.6 \cdot 75 \\ 0.6 \cdot 75 \\ 0.6 \cdot 75 \\ 0.6 \cdot 75 \\ 0 \\ 0 \\ 0 \end{pmatrix} \cdot ksi$$

$$\sum \overrightarrow{(Q)} = 12 \qquad sumQAd := \sum \overrightarrow{\left(Q \cdot d^2 \cdot A_{stiff}\right)} \qquad sumQAd = 15513 \cdot in^4$$

$$R_x := \frac{M\cdot\overrightarrow{(d\cdot A_{stiff})}}{sumQAd} + \frac{P\cdot A_{stiff}}{\sum\overrightarrow{(A_{stiff}\cdot Q)}}$$

$$f_t := \overrightarrow{\left(\frac{R}{A_{stress}}\right)} \qquad r_{AR} := \overrightarrow{\left(\frac{f_t}{ASI\cdot F_t}\right)}$$

$$R = \begin{pmatrix}195.5\\169.4\\98.9\\2.4\\0.0\\0.0\\0.0\end{pmatrix}\cdot kip \qquad f_t = \begin{pmatrix}60.1\\52.1\\30.4\\0.7\\0.0\\0.0\\0.0\end{pmatrix}\cdot ksi \qquad r_{AR} = \begin{pmatrix}100\\87\\51\\1\\0\\0\\0\end{pmatrix}\cdot\%$$

ϕRnt = nominal tension strength
d = distance from center
A = area of fastener
Q = quantity of fasteners

BASE PLATE:

$P_{maxAR} := \max(R)$ $\qquad P_{maxAR} = 195\cdot kip$

$t := t_{bpl}$ $\qquad t = 1.75\cdot in$

$$I_x := \frac{(a+b)\cdot t^3}{12} \qquad k_x := \frac{3\cdot I_x}{y^3} \qquad S_x := \frac{I_x}{\left(\frac{t}{2}\right)} \qquad S_x = 7.75\cdot in^3$$

$$I_y := \frac{(y+k)\cdot t^3}{12} \qquad k_y := \begin{cases}\frac{3\cdot I_y\cdot(3\cdot a+b)^2}{2\cdot a^3\cdot b^2} & \text{if } a \ge b\\ \frac{3\cdot I_y\cdot(3\cdot b+a)^2}{2\cdot b^3\cdot a^2} & \text{if } a < b\end{cases} \qquad S_y := \frac{I_y}{\left(\frac{t}{2}\right)} \qquad S_y = 3.57\cdot in^3$$

$$M_{xMax} := \frac{k_x}{k_x+k_y}\cdot P_{maxAR}\cdot y \qquad M'_{xAll} := ASI\cdot F_y\cdot S_x \qquad r_x := \frac{M_{xMax}}{M'_{xAll}} \qquad r_x = 81\cdot\%$$

$$M_{yMax} := \begin{cases}\frac{k_y}{k_x+k_y}\cdot\left[\frac{P_{maxAR}\cdot a\cdot b^2}{(a+b)^2}\right] & \text{if } a \le b\\ \frac{k_y}{k_x+k_y}\cdot\left[\frac{P_{maxAR}\cdot a^2\cdot b}{(a+b)^2}\right] & \text{if } a > b\end{cases} \qquad M'_{yAll} := ASI\cdot F_y\cdot S_y \qquad r_y := \frac{M_{yMax}}{M'_{yAll}} \qquad r_y = 51\cdot\%$$

$$r_{BPL} := \sqrt{r_x^2 + r_y^2} \qquad r_{BPL} = 96\cdot\%$$

$$P_{Shaft} := \frac{k_x}{k_x+k_y}\cdot P_{maxAR} \qquad P_{Shaft} = 125.6\cdot kip$$

$$P_{Stiff} := \frac{k_y}{k_x+k_y}\cdot P_{maxAR} \qquad P_{Stiff} = 69.9\cdot kip$$

FORCES IN SP:

$l := a + b$ $\quad l = 15.2\cdot in$

$$P_{SP1} := \frac{P_{Stiff}\cdot b^2}{l^3}\cdot(b + 3\cdot a) \qquad P_{SP1} = 41.2\cdot kip$$

$$P_{SP2} := \frac{P_{Stiff}\cdot a^2}{l^3}\cdot(a + 3\cdot b) \qquad P_{SP2} = 28.7\cdot kip$$

$P_{max1} := P_{SP1} + P_{add1}$ $\quad P_{max1} = 133.6\cdot kip$

$P_{max2} := P_{SP2} + P_{add2}$ $\quad P_{max2} = 272.3\cdot kip$

$P_{maxSP} := P_{max1}$ $\quad P_{maxSP} = 133.6\cdot kip$

$V_{maxSP} := P_{maxSP}$

$T_{maxSP} := P_{maxSP}$

$$M_{maxSPx} := \begin{cases} P_{SP1}\cdot y & \text{if } P_{maxSP} = P_{max1} \\ P_{SP2}\cdot y & \text{if } P_{maxSP} = P_{max2} \end{cases} \qquad M_{maxSPx} = 13.7\cdot kip\cdot ft$$

STIFFENER PLATE:

- Shear Strength of Vertical Weld

$V'_{yAll} := 2\left(0.60\cdot F_{EXX}\cdot 0.707\cdot t_{VW}\cdot L_{VW}\right)\cdot ASI$ $\quad V'_{yAll} = 426\cdot kip$

$$r_v := \frac{V_{maxSP}}{V'_{yAll}} \qquad r_v = 31\cdot\%$$

- Flexural Strength of Vertical Weld

$$S_{xSP} := \frac{2\cdot\left[\left(0.707t_{VW}\right)\cdot L_{VW}^2\right]}{6} \qquad M'_{xAllSP} := ASI\cdot\left[\left(0.3F_{EXX}\right)\cdot S_{xSP}\right] \qquad M'_{xAllSP} = 612.1\cdot kip\cdot in$$

$$r_f := \frac{M_{maxSPx}}{M'_{xAllSP}} \qquad r_f = 27\cdot\%$$

- Combined Flexure & Shear Strength of Vertical Weld

$$r_{vf} := \sqrt{r_v^2 + r_f^2} \qquad r_{vf} = 41\cdot\%$$

- Tensile Strength of Horizontal Weld

$T'_{all} := 2\left[\left(0.60\cdot F_{EXX}\right)\cdot\left(0.707\cdot t_{HW}\right)\cdot L_{HW}\right]\cdot ASI$ $\quad T'_{all} = 210\cdot kip$

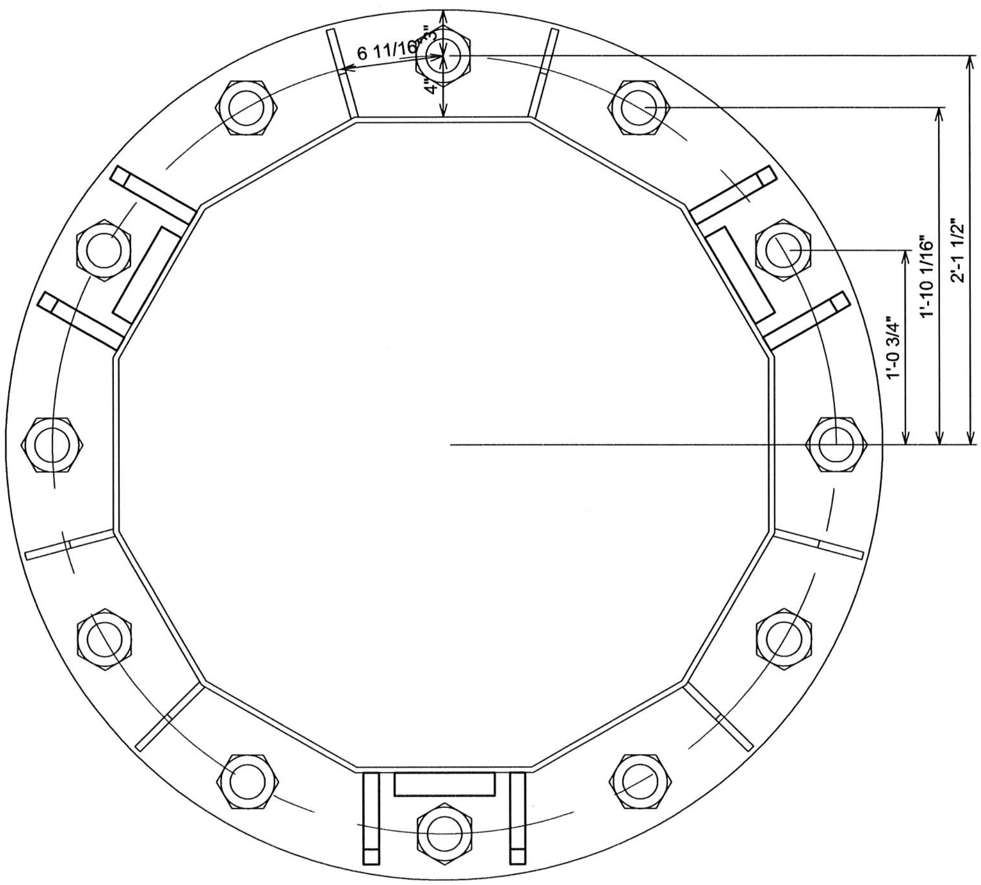
$$r_t := \frac{T_{maxSP}}{T'_{all}} \qquad r_t = 64\cdot\%$$

RESULTS:

$r_{maxAR} := \max(r_{AR})$

$$r := \begin{pmatrix} r_{maxAR} \\ r_{BPL} \\ r_{vf} \\ r_t \end{pmatrix} \qquad r = \begin{pmatrix} 100 \\ 96 \\ 41 \\ 64 \end{pmatrix} \cdot \%$$

$Max_{Utilization} := \max(r)$ $\qquad Max_{Utilization} = 100 \cdot \%$



BASE PLATE LAYOUT - CASE #3

SCALE: 1" = 1'

PROJECT INFORMATION:

GRANBY-N. GRANBY
CT2010

15 NORTH GRANBY ROAD
GRANBY, CT 06035
(HARTFORD COUNTY)

0	9-6-12	PSAR
REV	DATE:	Issued For:

DRAWN BY: MER | CHECKED BY: JHW

SHEET NUMBER: **BPL**

REVISION: 0

VSI #: 121657

PLANS PREPARED FOR:
TowerCo
5000 Valleystone Drive
Cary, NC 27519
Office (919) 469-5559
Fax (919) 469-5530

PLANS PREPARED BY:
vertical solutions
2002 Production Drive
Apex, NC 27539
Office: (888) 321-6167
Fax: (919) 321-1768

Input -

$M := 2459 \cdot kip \cdot ft$ = moment reaction at top of base plate

$P := 29 \cdot kip$ = shear reaction at top of base plate

$ASI := 133 \cdot \%$ = allowable stress increase

Base Plate:

$t_{bpl} := 1.75 \cdot in$ = thickness of base plate

$F_y := 60 \cdot ksi$ = yield stress of base plate

$x := 6.6875 \cdot in$ = distance from centerline of stiffener plate to center of anchor rod

$y := 4.0 \cdot in$ = distance from shaft wall to center of anchor rod

$k := 3.0 \cdot in$ = distance from center of anchor rod to edge of base plate

Stiffener Plates:

$t_{VW} := 0.3125 \cdot in$ = thickness of vertical weld

$L_{VW} := 17.25 \cdot in$ = length of vertical weld

$L_{HW} := 4.25 \cdot in$ = length of horizontal weld

$t_{HW} := 0.625 \cdot in$ = thickness of horizontal weld

$F_{ySP} := 50 \cdot ksi$ = yield stress of stiffener plate material

$F_{EXX} := 70 \cdot ksi$ = ultimate stress of weld electrode

$n_{SP} := 1$ = number of stiffener plates per anchor rod

ANCHOR ROD, DEFORMATION METHOD:

$$Q := \begin{pmatrix} 2 \\ 4 \\ 4 \\ 2 \\ 0 \\ 0 \\ 0 \end{pmatrix} \quad d := \begin{pmatrix} 2 \cdot 12 + 1 + \frac{1}{2} \\ 1 \cdot 12 + 10 + \frac{1}{16} \\ 1 \cdot 12 + \frac{3}{4} \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \cdot in \quad A_{stiff} := \begin{pmatrix} 3.98 \\ 3.98 \\ 3.98 \\ 3.98 \\ 0 \\ 0 \\ 0 \end{pmatrix} in^2 \quad A_{stress} := \begin{pmatrix} 3.25 \\ 3.25 \\ 3.25 \\ 3.25 \\ 0 \\ 0 \\ 0 \end{pmatrix} in^2 \quad F_t := \begin{pmatrix} 0.6 \cdot 75 \\ 0.6 \cdot 75 \\ 0.6 \cdot 75 \\ 0.6 \cdot 75 \\ 0 \\ 0 \\ 0 \end{pmatrix} \cdot ksi$$

$$\sum \overrightarrow{(Q)} = 12 \qquad sumQAd := \sum \overrightarrow{\left(Q \cdot d^2 \cdot A_{stiff}\right)} \qquad sumQAd = 15513 \cdot in^4$$

$$R := \frac{M \cdot \overrightarrow{\left(d \cdot A_{stiff}\right)}}{sumQAd} + \frac{P \cdot A_{stiff}}{\sum \overrightarrow{\left(A_{stiff} \cdot Q\right)}}$$

ϕRnt = nominal tension strength
d = distance from center
A = area of fastener
Q = quantity of fasteners

$$f_t := \overrightarrow{\left(\frac{R}{A_{stress}}\right)} \qquad r_{AR} := \overrightarrow{\left(\frac{f_t}{ASI \cdot F_t}\right)}$$

$$R = \begin{pmatrix} 195.5 \\ 169.4 \\ 98.9 \\ 2.4 \\ 0.0 \\ 0.0 \\ 0.0 \end{pmatrix} \cdot kip \qquad f_t = \begin{pmatrix} 60.1 \\ 52.1 \\ 30.4 \\ 0.7 \\ 0.0 \\ 0.0 \\ 0.0 \end{pmatrix} \cdot ksi \qquad r_{AR} = \begin{pmatrix} 100 \\ 87 \\ 51 \\ 1 \\ 0 \\ 0 \\ 0 \end{pmatrix} \cdot \%$$

BASE PLATE:

$P_{maxAR} := \max(R)$ $\qquad P_{maxAR} = 195 \cdot kip$

$t := t_{bpl}$ $\qquad t = 1.75 \cdot in$

$$I_x := \frac{2 \cdot x \cdot t^3}{12} \qquad k_x := \frac{3 \cdot I_x}{y^3} \qquad S_x := \frac{I_x}{\left(\frac{t}{2}\right)} \qquad Z_x := 1.5 \cdot S_x \qquad Z_x = 10.24 \cdot in^3$$

$$I_y := \frac{(y + k) \cdot t^3}{12} \qquad k_y := \frac{192 \cdot I_y}{(2 \cdot x)^3} \qquad S_y := \frac{I_y}{\left(\frac{t}{2}\right)} \qquad Z_y := 1.5 \cdot S_y \qquad Z_y = 5.359 \cdot in^3$$

$$M_{xMax} := \frac{k_x}{k_x + k_y} \cdot P_{maxAR} \cdot y \qquad M'_{xAll} := ASI \cdot F_y \cdot S_x \qquad r_x := \frac{M_{xMax}}{M'_{xAll}} \qquad r_x = 76 \cdot \%$$

$$M_{yMax} := \frac{k_y}{k_x + k_y} \cdot \left[\frac{P_{maxAR} \cdot (2x)}{8}\right] \qquad M'_{yAll} := ASI \cdot F_y \cdot S_y \qquad r_y := \frac{M_{yMax}}{M'_{yAll}} \qquad r_y = 54 \cdot \%$$

$$r_{BPL} := \sqrt{r_x^2 + r_y^2} \qquad r_{BPL} = 93 \cdot \%$$

$$P_{Shaft} := \frac{k_x}{k_x + k_y} \cdot P_{maxAR} \qquad P_{Shaft} = 103.1 \cdot kip$$

$$P_{Stiff} := \frac{k_y}{k_x + k_y} \cdot P_{maxAR} \qquad P_{Stiff} = 92.4 \cdot kip$$

STIFFENER PLATE:

$$V_y := \frac{P_{Stiff}}{n_{SP}} \qquad V_y = 92 \cdot kip$$

$$M_{xMaxSP} := \frac{P_{Stiff}}{n_{SP}} \cdot y \qquad M_{xMaxSP} = 369 \cdot kip \cdot in$$

$$T_{xMax} := \frac{P_{Stiff}}{n_{SP}} \qquad T_{xMax} = 92 \cdot kip$$

$$V'_{yAll} := 2\left(0.60 \cdot F_{EXX} \cdot 0.707 \cdot t_{VW} \cdot L_{VW}\right) \cdot ASI \qquad V'_{yAll} = 426 \cdot kip$$

$$r_v := \frac{V_y}{V'_{yAll}}$$ $r_v = 22\cdot\%$

$$S_{ySP} := \frac{2\cdot 0.707 t_{VW}\cdot L_{VW}^{2}}{6}$$ $M'_{yAllSP} := ASI\cdot\left(0.3F_{EXX}\cdot S_{ySP}\right)$ $M'_{yAllSP} = 612\cdot kip\cdot in$

$$r_{fy} := \frac{M_{xMaxSP}}{M'_{yAllSP}}$$ $r_{fy} = 60\cdot\%$

$$r_{vf} := \sqrt{r_v^{2} + r_{fy}^{2}}$$ $r_{vf} = 64\cdot\%$

$$T'_{xAll} := 2\left(0.60\cdot F_{EXX}\cdot 0.707\cdot t_{HW}\cdot L_{HW}\right)\cdot ASI$$ $T'_{xAll} = 210\cdot kip$

$$r_t := \frac{T_{xMax}}{T'_{xAll}}$$ $r_t = 44\cdot\%$

RESULTS:

$$r_{maxAR} := \max\left(r_{AR}\right)$$

$$r := \begin{pmatrix} r_{maxAR} \\ r_{BPL} \\ r_{vf} \\ r_t \end{pmatrix} \qquad r = \begin{pmatrix} 100 \\ 93 \\ 64 \\ 44 \end{pmatrix}\cdot\%$$

PAD AND PIER FOUNDATION DESIGN FOR SELF-SUPPORTING POLE STRUCTURE: ANSI TIA-222-F

Inputs: Reactions

$M := 2459 \cdot k \cdot ft$ = Overturning moment at top of pier, unfactored

$P := 29 \cdot k$ = Axial load at top of pier unfactored

$V := 24 \cdot k$ = Shear load at top of pier unfactored

Inputs: Concrete

$B_{pad} := 19 \cdot ft$ = Pad width (and length)

$B_{pier} := 6 \cdot ft$ = Pier diameter

$H := 12 \cdot in$ = Distance from top of pier to top of grade

$z_{pad} := 10.0 \cdot ft$ = Pad depth

$t_{pad} := 3.0 \cdot ft$ = Pad thickness

$f'_c := 4000 \cdot psi$ = specified 28-day compressive strength

$\gamma_c := 150 \cdot pcf$ = Density of concrete

Inputs: Rebar and Anchorage

$d_{tie} := 0.5 \cdot in$ = diameter of tie in pier

$d_{vert} := 1.0 \cdot in$ = diameter of verticals in pier

$n_{vert} := 36$ = number of verticals in pier

$d_{hTop} := 1.0 \cdot in$ = diameter of horizontal bars in top of pad

$n_{hTop} := 18$ = number of horizontal bars in top of pad

$d_{hBot} := 1.0 \cdot in$ = diameter of horizontal bars in top of pad

$n_{hBot} := 26$ = number of horizontal bars in top of pad

$cover := 3 \cdot in$ = distanced from outside of concrete to edge of rebar

$BC := 51 \cdot in$ = bolt-circle diameter for anchor rods

$d_{template} := 6 \cdot in$ = anchor rod template width

$embed := 114 \cdot in$ = anchor rod embedment

$f_y := 60 \cdot ksi$ = specified minimum yield strength of rebar

Inputs: Strength

$\Phi M_{nPier} := 3825.1 \cdot k \cdot ft$ = nominal flexural resistance, positive moment [Pier.lpd (A-02)]

$\Phi M_{nBot} := 2838 \cdot k \cdot ft$ = nominal flexural resistance, positive moment [BM-FLEX_MnPadBot.xmcd (A-03)]

$\Phi M_{nTop} := 1980 \cdot k \cdot ft$ = nominal flexural resistance, negative moment [BM-FLEX_MnPadTop.xmcd (A-03)]

Inputs: Soil

$\gamma_s := 120 \cdot pcf$ = Density of soil

$q'_{all} := 6000 \cdot psf$ = Net allowable bearing pressure

$\psi := 0.3$ = coefficient of friction

CONSTANTS:

$kip \equiv 1000 \cdot lbf$

$ksi \equiv \frac{kip}{in^2}$

$G \equiv 11200 \cdot ksi$

$E \equiv 29000 \cdot ksi$

$pcf \equiv \frac{lb}{ft^3}$

$psf \equiv \frac{lb}{ft^2}$

$k \equiv 1000 \cdot lb$

$\Phi_s \equiv 0.75$

Ouput: Factored Reactions

$M_u := 1.3 \cdot M$ = Overturning moment at top of pier, factored — $M_u = 3197 \cdot k \cdot ft$

$P_u := 1.3P$ = Axial load at top of pier, factored — $P_u = 38 \cdot k$

$V_u := 1.3V$ = Shear load at top of pier, factored — $V_u = 31 \cdot k$

Output: Dead Loads

$$V_{pier} := \frac{\pi \cdot B_{pier}^{2}}{4}\left(z_{pad} - t_{pad} + H\right)$$

$D_{pier} := V_{pier} \cdot \gamma_c$ — $D_{pier} = 33.9 \cdot k$

$V_{pad} := B_{pad}^{2} \cdot t_{pad}$

$D_{pad} := V_{pad} \cdot \gamma_c$ — $D_{pad} = 162.4 \cdot k$

$$V_{soil} := B_{pad}^{2} \cdot \left(z_{pad} - t_{pad}\right) - V_{pier} + \frac{\pi \cdot B_{pier}^{2}}{4} \cdot H$$

$D_{soil} := V_{soil} \cdot \gamma_s$ — $D_{soil} = 279.5 \cdot k$

Output: Eccentricity:

$P_{total} := D_{pier} + D_{pad} + D_{soil} + P$ — $P_{total} = 504.9 \cdot k$

$M_{total} := M + V \cdot \left(H + z_{pad}\right)$ — $M_{total} = 2723 \cdot k \cdot ft$

$ecc := \frac{M_{total}}{P_{total}}$ — $ecc = 5.39\ ft$

$limit := \frac{B_{pad}}{6}$ — $limit = 3.17\ ft$

$X := 3 \cdot \left(\frac{B_{pad}}{2} - ecc\right)$ — $X = 12.32\ ft$

Output: Bearing pressures, unfactored (bottom)

$$q_{max1} := \frac{P_{total}}{B_{pad}^{2}} + \frac{M_{total}}{B_{pad}^{3}}$$ $q_{max1} = 3781 \cdot psf$

$$q_{max2} := \frac{2 \cdot P_{total}}{3 \cdot B_{pad}^{2} \cdot \left(0.5 - \frac{ecc}{B_{pad}}\right)}$$ $q_{max2} = 4314 \cdot psf$

$$q_{max} := if\left(ecc > \frac{B_{pad}}{6}, q_{max2}, q_{max1}\right)$$ $q_{max} = 4314 \cdot psf$

$$q_{min1} := \frac{P_{total}}{B_{pad}^{2}} + \frac{M_{total}}{B_{pad}^{3}}$$ $q_{min1} = 1796 \cdot psf$

$$B_{cant} := \frac{B_{pad} - B_{pier}}{2}$$ $B_{cant} = 6.50\ ft$

$$q_{pier1} := q_{min1} + (q_{max1} - q_{min1}) \cdot \frac{B_{pad} - B_{cant}}{B_{pad}}$$

$$q_{pier2} := q_{max} \cdot \left(\frac{X - B_{cant}}{X}\right)$$

$$q_{pier} := \text{if}\left(ecc < limit, q_{pier1}, \text{if}\left(q_{pier2} > 0, q_{pier2}, 0\right)\right)$$ $q_{pier} = 2038 \cdot psf$

$$q'_{max} := q_{max} - \gamma_s \cdot z_{pad}$$ $q'_{max} = 3114 \cdot psf$

Calculate qu, Bottom

$$q_{uMax} := 1.3 \cdot \left[q_{max} - \gamma_c \cdot t_{pad} - \gamma_s \cdot (z_{pad} - t_{pad})\right]$$ $q_{uMax} = 3931 \cdot psf$

$$q_{uPier} := 1.3 \cdot \left[q_{pier} - \gamma_c \, t_{pad} - \gamma_s \cdot (z_{pad} - t_{pad})\right]$$ $q_{uPier} = 972 \cdot psf$

Calculate qu, Top

$$q_{uTop} := 1.3\left[\gamma_c \, t_{pad} + \gamma_s \cdot (z_{pad} - t_{pad})\right]$$ $q_{uTop} = 1677 \cdot psf$

Calculate shear nominal resistances

$$A_{pier} := \frac{\pi \cdot B_{pier}^{\ 2}}{4}$$ $A_{pier} = 4072 \cdot in^2$

$$\Phi V_{cPier} := 0.85 \cdot 2 \cdot \frac{\sqrt{\frac{f_c}{psi}}}{1000} \cdot \frac{A_{pier}}{in^2} \cdot 1k$$ $\Phi V_{cPier} = 438 \cdot k$

$$d_{Bot} := t_{pad} - cover - 1.5 \cdot d_{hBot}$$ $d_{Bot} = 31.50 \cdot in$

$$\Phi V_{cPad} := 0.85 \cdot 2 \cdot \frac{\sqrt{\frac{f_c}{psi}}}{1000} \left(\frac{B_{pad}}{1 \cdot in} \cdot \frac{d_{Bot}}{1 \cdot in}\right) \cdot 1k$$ $\Phi V_{cPad} = 772 \cdot k$

Calculate Factored Forces in Pier:

$$M_{uPier} := M_u + V_u \cdot (H + z_{pad} - t_{pad})$$ $M_{uPier} = 3446 \cdot k \cdot ft$

$$V_{uPier} := V_u$$ $V_{uPier} = 31 \cdot k$

Calculate Factored Forces in Pad, Postive:

$$R_r := \text{if}\left(q_{uPier} > 0 \cdot psf, q_{uPier} \cdot B_{pad} \cdot B_{cant}, 0\right)$$

$$R_t := \text{if}\left[X < B_{cant}, \frac{1}{2} \cdot q_{uMax} \cdot X \cdot B_{pad}, \frac{1}{2} \cdot (q_{uMax} - q_{uPier}) \cdot B_{cant} \cdot B_{pad}\right]$$

$$M_{uR} := R_r \cdot \frac{B_{cant}}{2}$$

$$M_{uT} := \text{if}\left[X > B_{cant}, R_t \cdot \frac{2}{3} \cdot B_{cant}, R_t \cdot \left(B_{cant} - \frac{X}{3}\right)\right]$$

$$M_{uBot} := M_{uR} + M_{uT}$$ $M_{uBot} = 1182 \cdot k \cdot ft$

$$V_{uBot} := R_r + R_t$$ $V_{uBot} = 303 \cdot k$

Calculate Factored Forces in Pad, Negative:

$$M_{uTop} := q_{uTop} \cdot B_{cant} \cdot B_{pad} \cdot \frac{B_{cant}}{2}$$ $M_{uTop} = 673 \cdot k \cdot ft$

$$V_{uTop} := q_{uTop} \cdot B_{cant} \cdot B_{pad}$$ $V_{uTop} = 207 \cdot k$

Calculate Overturning Stability:

$$OTM_{total} := M + V \cdot (H + z_{pad})$$ $OTM_{total} = 2723 \cdot k \cdot ft$

$$OTM_r := P_{total} \cdot \frac{B_{pad}}{2}$$ $OTM_r = 4796 \cdot k \cdot ft$

Calculate Sliding Stability:

$$H_{total} := V$$ $H_{total} = 24 \cdot k$

$$H_r := (D_{pier} + D_{pad} + P) \cdot \psi$$ $H_r = 68 \cdot k$

Design Checks, Soil:

$$r_{q'} := \frac{q'_{max}}{q'_{all}}$$ Net Bearing Pressure $r_{q'} = 52 \cdot \%$

$$r_{OTM} := \frac{OTM_{total}}{\frac{OTM_r}{1.5}}$$ Overturning Stability $r_{OTM} = 85 \cdot \%$

$$r_H := \frac{H_{total}}{\frac{H_r}{2.0}}$$ Sliding Stability $r_H = 71 \cdot \%$

Design Checks, Pier Structure:

$$r_{mPier} := \frac{M_{uPier}}{\Phi M_{nPier}}$$ $r_{mPier} = 90 \cdot \%$

$$r_{vPier} := \frac{V_{uPier}}{\Phi V_{cPier}}$$ $r_{vPier} = 7 \cdot \%$

$$r_{dlPier} := \frac{0.04 \cdot \frac{\pi \cdot d_{vert}^{2}}{4 \cdot in} \cdot \frac{\frac{f_y}{psi}}{\sqrt{\frac{f'_c}{psi}}}}{embed - cover - \left(\frac{B_{pier}}{2} - cover - d_{tie} - \frac{d_{vert}}{2} - \frac{BC}{2}\right)}$$

$r_{dlPier} = 29 \cdot \%$

Design Checks, Pier Serviceability:

$$r_{sPier} := \frac{0.5 \cdot \% \cdot A_{pier}}{n_{vert} \cdot \frac{\pi \cdot d_{vert}^{2}}{4}}$$

$r_{sPier} = 72 \cdot \%$

Design Checks, Pad Structure:

$$r_{mBot} := \frac{M_{uBot}}{\Phi M_{nBot}}$$

$r_{mBot} = 42 \cdot \%$

$$r_{vBot} := \frac{V_{uBot}}{\Phi V_{cPad}}$$

$r_{vBot} = 39 \cdot \%$

$$r_{mTop} := \frac{M_{uTop}}{\Phi M_{nTop}}$$

$r_{mTop} = 34 \cdot \%$

$$r_{vTop} := \frac{V_{uTop}}{\Phi V_{cPad}}$$

$r_{vTop} = 27 \cdot \%$

Design Checks, Pad Serviceability:

$$r_{sPad} := \frac{0.0018 \cdot B_{pad} \cdot t_{pad}}{n_{hTop} \cdot \frac{\pi \cdot d_{hTop}^{2}}{4} + n_{hBot} \cdot \frac{\pi \cdot d_{hBot}^{2}}{4}}$$

$r_{sPad} = 43 \cdot \%$