

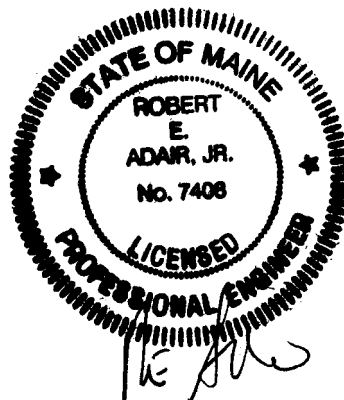
ALL-POINTS TECHNOLOGY CORPORATION, P.C.

**STRUCTURAL ANALYSIS REPORT
40' ROOF-TOP SELF-SUPPORTING TOWER
PORTLAND, MAINE**

Prepared for
Verizon Wireless

Verizon Site: One City Center

March 4, 2014



APT Project #ME1414651

**STRUCTURAL ANALYSIS REPORT
40' SELF-SUPPORTING TOWER
PORTLAND, MAINE
prepared for
Verizon Wireless**

EXECUTIVE SUMMARY:

All-Points Technology Corporation, P.C. (APT) performed a structural analysis of this 40-foot self-supporting tower. The analysis was performed for Verizon Wireless's proposed installation of six Andrew LNX-6514DS and six HBXX-6516DS panel antennas, three Alcatel-Lucent RRH2x60-AWS remote radio heads (RRHs), three Alcatel-Lucent 9442 RRHs, three Alcatel-Lucent PCS B25 RRH4x30 RRHs and two Raycap DB-B1-6C-12AB-0Z power/fiber distribution boxes (D-boxes), fed by twelve 1-5/8" waveguide cables and two hybrid fiber/power lines as detailed below.

Our analysis indicates the tower meets the requirements of the Maine Uniform Building and Energy Code with the proposed equipment.

INTRODUCTION:

A structural analysis was performed on the above-mentioned communications tower by APT for Verizon Wireless. The tower is located on the roof of the building at One City Center in Portland, Maine. APT previously climbed the structure in its entirety on November 7, 2013 to record information regarding physical and dimensional properties of the structure and its appurtenances.

The analysis was performed in accordance with the Maine Uniform Building and Energy Code and TIA-222 using the following antenna inventory (proposed equipment shown in **bold** text):

Antenna	Elev. ¹	Mount	Coax.
(3) 2' x 6" panel antennas	43'	8' x 2-3/8" pipe	(3) 1/4"
Beacon	40'	Top plate	3/4" conduit
(6) LNX-6514DS & (6) HBXX-6516DS panels, (3) 9442 RRHs, (3) RRH2x60 RRHs, (3) PCS B25 RRH4x30 RRHs, (2) D-boxes	35'	(3) 12' sector mounts	(12) 1-5/8", (2) hybrid
Vacant mounts	25'	(3) 10' sector mounts	None
(3) obstruction lights	20'	Conduit across legs	3/4" conduit
8' grid dish	7'	Leg	7/8"
1' square panel	7'	On horizontal brace	1/4"
(2) 2' yagis	1'	1' standoff	1/2"

¹ Elevations listed from base of tower.

The following equipment was assumed to be removed from the tower:

Antenna	Elev.	Mount	Coax.
Vacant mount	36'	10' x 4" tube steel horiz.	N.A.
(9) RV90-17-02DPL2 panel antennas	25'	Mounts left in place	(9) 1-5/8"
4' dish with radome	17'	Leg	3/4"
Vacant mount	11'	10' x 4" tube steel horiz.	N.A.

STRUCTURAL ANALYSIS:

Methodology:

The structural analysis was done in accordance with the Maine Uniform Building and Energy Code and TIA-222, Revision G (TIA), Structural Standard for Antenna Supporting Structures and Antennas.

The analysis was conducted using a 3-second gust wind speed of 100 miles per hour with no ice and 40-mph with 1" radial ice in accordance with the TIA-222-G standard for Cumberland County, Maine. The following additional design criteria were used:

Structure Class:	II
Topographic Category:	1
Exposure Category:	B

Analysis Results:

Analysis of the tower was conducted in accordance with the criteria outlined herein with antenna changes as previously described. The following table summarizes the results of the analysis based on stresses of individual leg and bracing members:

Elevation	Legs	Bracing
20'-40'	20%	29%
0'-20'	36%	36%

Bracing, Splice and Anchor Bolts:

Connection bolts were evaluated under the proposed loading. All bolts were found to be adequately sized to support the proposed loads.

Base Frame:

Evaluation of the existing base support frame was conducted based on field notes recorded by APT. The support members were found to be adequately sized for the proposed equipment.

Factored base reactions imposed with the proposed equipment were calculated as follows:

Compression:	44.8 kips
Uplift:	40.0 kips
Shear:	6.3 kips
Overturning Moment:	315 ft-kips

CONCLUSIONS AND RECOMMENDATIONS:

Our structural analysis indicates that the 40-foot self-supporting tower located at One City Center in Portland, Maine meets the requirements of the Maine Uniform Building and Energy Code with Verizon Wireless's proposed equipment.

LIMITATIONS:

This report is based on the following:

1. Tower is properly installed and maintained.
2. All members are in an undeteriorated condition.
3. All required members are in place.
4. All bolts are in place and are properly tightened.
5. Tower is in plumb condition.
6. All tower members were properly designed, detailed, fabricated, and installed and have been properly maintained since erection.

All-Points Technology Corporation, P.C. (APT) is not responsible for modifications completed prior to or hereafter which APT is not or was not directly involved. Modifications include but are not limited to:

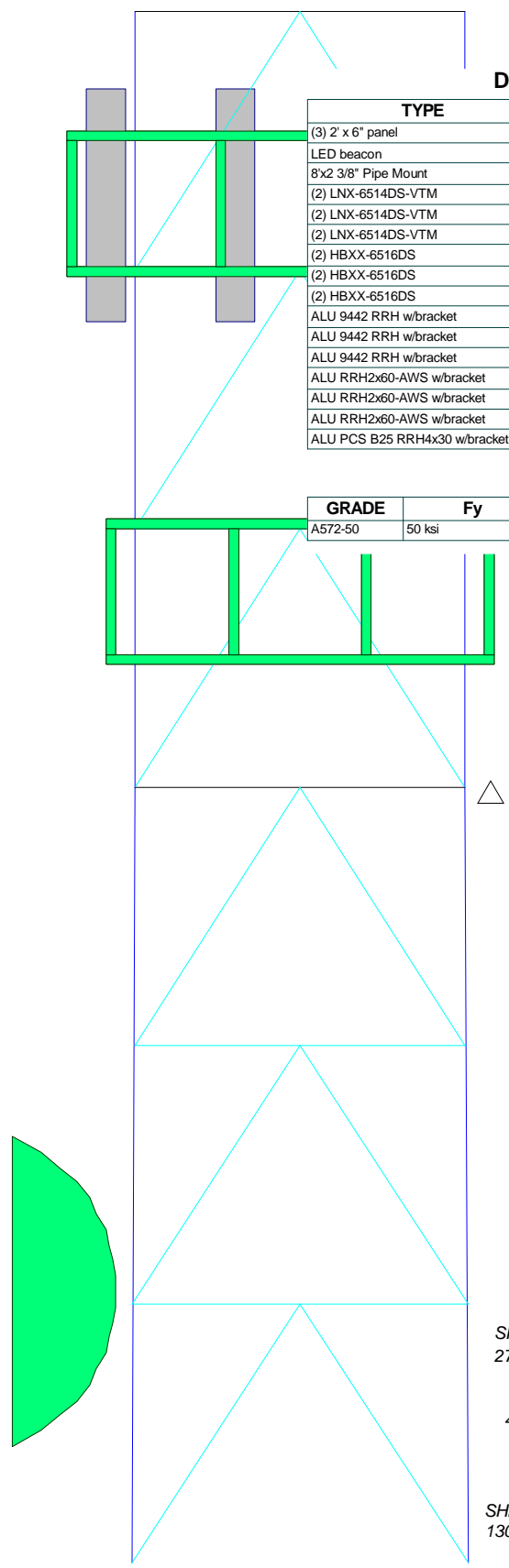
1. Replacing or strengthening bracing members.
2. Reinforcing vertical members in any manner.
3. Adding or relocating torque arms or guys.
4. Installing antenna mounting gates or side arms.

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

Appendix A

Tower Schematic

Section		T1	ROHN 2.5 STD	ROHN 2 STD				8.5	250.0 ft
Legs									
Leg Grade			A572-50						
Diagonals									
Diagonal Grade			A36						
Top Girts			ROHN 1.5 STD						
Horizontals			ROHN 1.5 STD						
Inner Bracing			L2x2x1/8						
Face Width (ft)			8.54167						
# Panels @ (ft)			6 @ 6.66667						
Weight (lb)			1606.9						
									230.0 ft
									210.0 ft



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
(3) 2' x 6" panel	250	ALU PCS B25 RRH4x30 w/bracket	245
LED beacon	250	ALU PCS B25 RRH4x30 w/bracket	245
8'x2 3/8" Pipe Mount	249	RFS DB-B1-6C-12AB-0Z D-box	245
(2) LNX-6514DS-VTM	245	RFS DB-B1-6C-12AB-0Z D-box	245
(2) LNX-6514DS-VTM	245	12' T-frame sector mnt	245
(2) LNX-6514DS-VTM	245	12' T-frame sector mnt	245
(2) HBXX-6516DS	245	12' T-frame sector mnt	245
(2) HBXX-6516DS	245	10' sector mount	235
(2) HBXX-6516DS	245	10' sector mount	235
ALU 9442 RRH w/bracket	245	10' sector mount	235
ALU 9442 RRH w/bracket	245	Obstruction light	230
ALU 9442 RRH w/bracket	245	Obstruction light	230
ALU RRH2x60-AWS w/bracket	245	Obstruction light	230
ALU RRH2x60-AWS w/bracket	245	1' square panel	217
ALU RRH2x60-AWS w/bracket	245	8' grid dish	217
ALU PCS B25 RRH4x30 w/bracket	245	(2) 2' yagi	211

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-50	50 ksi	65 ksi	A36	36 ksi	58 ksi

ALL REACTIONS ARE FACTORED

MAX. CORNER REACTIONS AT BASE:

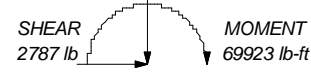
DOWN: 44833 lb

SHEAR: 6306 lb

UPLIFT: -39955 lb

SHEAR: 6233 lb

AXIAL
31267 lb



TORQUE 886 lb-ft

40 mph WIND - 1.0000 in ICE

AXIAL
8824 lb



TORQUE 6030 lb-ft

REACTIONS - 100 mph WIND

All-Points Technology Corporation			Job: 40' ROHN SSMW Tower		
P.O. Box 504 Conway, NH 03818 Phone: (603) 496-5853 FAX: (603) 447-2124			Project: ME1414651 One City Center		
Client: Verizon Wireless	Drawn by: Rob Adair	App'd:	Code: TIA-222-G	Date: 03/04/14	Scale: NTS
Path: C:\Users\Rob Adair\Documents\Job02\Verizon\TENA\ME1414651 One City Center\Portland\ME1414651 One City Center.dwg			Dwg No. E-1		

Appendix B

Calculations

tnxTower All-Points Technology Corporation P.O. Box 504 Conway, NH 03818 Phone: (603) 496-5853 FAX: (603) 447-2124	Job	40' ROHN SSMW Tower	Page	1 of 5
	Project	ME1414651 One City Center	Date	10:41:09 03/04/14
	Client	Verizon Wireless	Designed by	Rob Adair

Tower Input Data

The main tower is a 3x free standing tower with an overall height of 250.00 ft above the ground line.

The base of the tower is set at an elevation of 210.00 ft above the ground line.

The face width of the tower is 8.50 ft at the top and 8.63 ft at the base.

This tower is designed using the TIA-222-G standard.

The following design criteria apply:

Tower is located in Cumberland County, Maine.

Basic wind speed of 100 mph.

Structure Class II.

Exposure Category B.

Topographic Category 1.

Nominal ice thickness of 1.0000 in.

Ice thickness is considered to increase with height.

Ice density of 56 pcf.

A wind speed of 40 mph is used in combination with ice.

Deflections calculated using a wind speed of 60 mph.

Pressures are calculated at each section.

Stress ratio used in tower member design is 1.

Local bending stresses due to climbing loads, feed line supports, and appurtenance mounts are not considered.

Feed Line/Linear Appurtenances

Description	Face or Shield Leg	Allow	Component Type	Placement ft	Face Offset in	Lateral Offset (Frac FW)	#	# Per Row	Clear Spacing in	Width or Diameter in	Perimeter in	Weight plf
3/8" safety cable	A	No	Ar (CaAa)	250.00 - 210.00	-36.0000	0.5	1	1	0.3750	0.3750		0.22
Climbing Ladder	A	No	Af (CaAa)	250.00 - 210.00	-40.0000	0.5	1	1	3.0000	3.0000		7.90
3/4" conduit	A	No	Ar (CaAa)	250.00 - 210.00	0.0000	0.45	1	1	0.7500	0.7500		0.40
1 5/8	C	No	Ar (CaAa)	245.00 - 210.00	0.0000	0.4	12	6	0.5000	1.9800		1.04
1.57" Hybrid fiber-power cable	C	No	Ar (CaAa)	245.00 - 210.00	0.0000	0.4	2	2	0.5000	1.5700		0.66
7/8	C	No	Ar (CaAa)	217.00 - 210.00	0.0000	0.5	1	1	1.1100	1.1100		0.54
1/4	B	No	Ar (CaAa)	217.00 - 210.00	0.0000	0.5	1	1	0.2500	0.2500		0.05
1/2	C	No	Ar (CaAa)	211.00 - 210.00	0.0000	0.5	1	1	0.5800	0.5800		0.25

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft	Azimuth Adjustment °	Placement ft	C _{AA} Front ft ²	C _{AA} Side ft ²	Weight lb
(3) 2' x 6" panel	C	From Leg	0.00	0.0000	250.00	No Ice	0.72	15.00
			0.00			1/2" Ice	0.88	23.69
			3.00			1" Ice	1.07	34.70
LED beacon	A	None		0.0000	250.00	No Ice	0.53	30.00
						1/2" Ice	0.65	39.39
						1" Ice	0.78	50.57
8'x2 3/8" Pipe Mount	C	None		0.0000	249.00	No Ice	1.90	29.20
						1/2" Ice	2.73	43.54
						1" Ice	3.40	63.16

<i>tnxTower</i> All-Points Technology Corporation P.O. Box 504 Conway, NH 03818 Phone: (603) 496-5853 FAX: (603) 447-2124	Job		40' ROHN SSMW Tower					Page		2 of 5
	Project		ME1414651 One City Center					Date		10:41:09 03/04/14
	Client		Verizon Wireless					Designed by		Rob Adair

Description	Face or Leg	Offset Type	Offsets:		Azimuth Adjustment	Placement	C _{AA}		Weight
			Horz	Lateral			Front	Side	
			ft	ft	°	ft	ft ²	ft ²	lb
(2) LNX-6514DS-VTM	A	From Leg	3.00	0.0000	245.00	No Ice	8.41	4.17	30.00
			0.00			1/2" Ice	8.96	4.61	74.68
			0.00			1" Ice	9.52	5.07	125.36
(2) LNX-6514DS-VTM	B	From Leg	3.00	0.0000	245.00	No Ice	8.41	4.17	30.00
			0.00			1/2" Ice	8.96	4.61	74.68
			0.00			1" Ice	9.52	5.07	125.36
(2) LNX-6514DS-VTM	C	From Leg	3.00	0.0000	245.00	No Ice	8.41	4.17	30.00
			0.00			1/2" Ice	8.96	4.61	74.68
			0.00			1" Ice	9.52	5.07	125.36
(2) HBXX-6516DS	A	From Leg	3.00	0.0000	245.00	No Ice	5.94	3.30	15.00
			0.00			1/2" Ice	6.36	3.63	50.44
			0.00			1" Ice	6.78	4.00	90.58
(2) HBXX-6516DS	B	From Leg	3.00	0.0000	245.00	No Ice	5.94	3.30	15.00
			0.00			1/2" Ice	6.36	3.63	50.44
			0.00			1" Ice	6.78	4.00	90.58
(2) HBXX-6516DS	C	From Leg	3.00	0.0000	245.00	No Ice	5.94	3.30	15.00
			0.00			1/2" Ice	6.36	3.63	50.44
			0.00			1" Ice	6.78	4.00	90.58
ALU 9442 RRH w/bracket	A	From Leg	2.00	0.0000	245.00	No Ice	3.89	1.94	137.00
			0.00			1/2" Ice	4.15	2.14	164.58
			0.00			1" Ice	4.42	2.35	195.59
ALU 9442 RRH w/bracket	B	From Leg	2.00	0.0000	245.00	No Ice	3.89	1.94	137.00
			0.00			1/2" Ice	4.15	2.14	164.58
			0.00			1" Ice	4.42	2.35	195.59
ALU 9442 RRH w/bracket	C	From Leg	2.00	0.0000	245.00	No Ice	3.89	1.94	137.00
			0.00			1/2" Ice	4.15	2.14	164.58
			0.00			1" Ice	4.42	2.35	195.59
ALU RRH2x60-AWS w/bracket	A	From Leg	2.00	0.0000	245.00	No Ice	3.96	2.16	60.00
			0.00			1/2" Ice	4.27	2.44	84.31
			0.00			1" Ice	4.60	2.73	112.31
ALU RRH2x60-AWS w/bracket	B	From Leg	2.00	0.0000	245.00	No Ice	3.96	2.16	60.00
			0.00			1/2" Ice	4.27	2.44	84.31
			0.00			1" Ice	4.60	2.73	112.31
ALU RRH2x60-AWS w/bracket	C	From Leg	2.00	0.0000	245.00	No Ice	3.96	2.16	60.00
			0.00			1/2" Ice	4.27	2.44	84.31
			0.00			1" Ice	4.60	2.73	112.31
ALU PCS B25 RRH4x30 w/bracket	A	From Leg	2.00	0.0000	245.00	No Ice	2.57	2.25	60.00
			0.00			1/2" Ice	2.79	2.46	81.60
			0.00			1" Ice	3.02	2.68	106.28
ALU PCS B25 RRH4x30 w/bracket	B	From Leg	2.00	0.0000	245.00	No Ice	2.57	2.25	60.00
			0.00			1/2" Ice	2.79	2.46	81.60
			0.00			1" Ice	3.02	2.68	106.28
ALU PCS B25 RRH4x30 w/bracket	C	From Leg	2.00	0.0000	245.00	No Ice	2.57	2.25	60.00
			0.00			1/2" Ice	2.79	2.46	81.60
			0.00			1" Ice	3.02	2.68	106.28
RFS DB-B1-6C-12AB-0Z D-box	A	From Leg	0.50	0.0000	245.00	No Ice	2.94	1.91	27.00
			0.00			1/2" Ice	3.17	2.11	49.89
			0.00			1" Ice	3.41	2.31	75.90
RFS DB-B1-6C-12AB-0Z D-box	C	From Leg	0.50	0.0000	245.00	No Ice	2.94	1.91	27.00
			0.00			1/2" Ice	3.17	2.11	49.89
			0.00			1" Ice	3.41	2.31	75.90
12' T-frame sector mnt	A	None		0.0000	245.00	No Ice	13.60	6.80	465.00
						1/2" Ice	18.40	9.20	600.00
						1" Ice	23.20	11.60	735.00
12' T-frame sector mnt	B	None		0.0000	245.00	No Ice	13.60	6.80	465.00
						1/2" Ice	18.40	9.20	600.00
						1" Ice	23.20	11.60	735.00
12' T-frame sector mnt	C	None		0.0000	245.00	No Ice	13.60	6.80	465.00
						1/2" Ice	18.40	9.20	600.00

tnxTower All-Points Technology Corporation P.O. Box 504 Conway, NH 03818 Phone: (603) 496-5853 FAX: (603) 447-2124	Job	40' ROHN SSMW Tower	Page	3 of 5
	Project	ME1414651 One City Center	Date	10:41:09 03/04/14
	Client	Verizon Wireless	Designed by	Rob Adair

Description	Face or Leg	Offset Type	Offsets:		Azimuth Adjustment	Placement	CAA		Weight	
			Horz Lateral	Vert			Front	Side		
			ft	ft	°	ft	ft ²	ft ²	lb	
10' sector mount	A	None			0.0000	235.00	1" Ice	23.20	11.60	735.00
							No Ice	10.10	5.05	300.00
							1/2" Ice	14.30	7.15	350.00
10' sector mount	B	None			0.0000	235.00	1" Ice	18.50	9.25	425.00
							No Ice	10.10	5.05	300.00
							1/2" Ice	14.30	7.15	350.00
10' sector mount	C	None			0.0000	235.00	1" Ice	18.50	9.25	425.00
							No Ice	10.10	5.05	300.00
							1/2" Ice	14.30	7.15	350.00
Obstruction light	A	None			0.0000	230.00	1" Ice	18.50	9.25	425.00
							No Ice	0.18	0.18	8.00
							1/2" Ice	0.25	0.25	10.47
Obstruction light	B	None			0.0000	230.00	1" Ice	0.33	0.33	13.91
							No Ice	0.18	0.18	8.00
							1/2" Ice	0.25	0.25	10.47
Obstruction light	C	None			0.0000	230.00	1" Ice	0.33	0.33	13.91
							No Ice	0.18	0.18	8.00
							1/2" Ice	0.25	0.25	10.47
1' square panel	B	None			0.0000	217.00	1" Ice	0.33	0.33	13.91
							No Ice	1.40	0.35	15.00
							1/2" Ice	1.56	0.45	22.91
(2) 2' yagi	C	From Leg	1.00	0.0000	211.00	1" Ice	1.73	0.56	32.76	
			0.00			No Ice	0.20	0.20	10.00	
			0.00			1/2" Ice	0.32	0.32	11.93	
							1" Ice	0.45	0.45	15.35

Dishes

Description	Face or Leg	Dish Type	Offset Type	Offsets:		Azimuth Adjustment	3 dB Beam Width	Elevation	Outside Diameter	Aperture Area	Weight	
				Horz Lateral	Vert							
				ft	ft	°	°	ft	ft	ft ²	lb	
8' grid dish	C	Grid	From Leg	0.50	0.0000	0.0000		217.00	8.00	No Ice	50.27	225.00
				0.00						1/2" Ice	51.32	488.43
				0.00						1" Ice	52.37	731.43

tnxTower All-Points Technology Corporation P.O. Box 504 Conway, NH 03818 Phone: (603) 496-5853 FAX: (603) 447-2124	Job 40' ROHN SSMW Tower	Page 4 of 5
	Project ME1414651 One City Center	Date 10:41:09 03/04/14
	Client Verizon Wireless	Designed by Rob Adair

Solution Summary

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
T1	250 - 230	0.126	14	0.0166	0.0037
T2	230 - 210	0.047	14	0.0136	0.0027

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
250.00	(3) 2' x 6" panel	14	0.126	0.0166	0.0037	390199
249.00	8'x2 3/8" Pipe Mount	14	0.122	0.0166	0.0037	390199
245.00	(2) LNX-6514DS-VTM	14	0.105	0.0165	0.0036	390199
235.00	10' sector mount	14	0.064	0.0152	0.0031	130066
230.00	Obstruction light	14	0.047	0.0136	0.0027	106418
217.00	8' grid dish	14	0.014	0.0056	0.0011	278714
211.00	(2) 2' yagi	14	0.002	0.0008	0.0002	390202

Bolt Design Data

Section No.	Elevation ft	Component Type	Bolt Grade	Bolt Size in	Number Of Bolts	Maximum Load per Bolt lb	Allowable Load lb	Ratio Load Allowable	Allowable Ratio	Criteria
T1	250	Leg	A325N	0.7500	4	1520.15	29820.60	0.051	✓	1 Bolt Tension
		Diagonal	A325N	0.6250	3	1646.64	12425.20	0.133	✓	1 Bolt Shear
		Horizontal	A325N	0.6250	2	1334.90	12425.20	0.107	✓	1 Bolt Shear
		Top Girt	A325N	0.6250	2	232.91	12425.20	0.019	✓	1 Bolt Shear
T2	230	Leg	A325N	0.8750	4	7399.75	40589.10	0.182	✓	1 Bolt Tension
		Diagonal	A325N	0.6250	3	2654.78	12425.20	0.214	✓	1 Bolt Shear
		Horizontal	A325N	0.6250	2	2171.38	12425.20	0.175	✓	1 Bolt Shear
		Top Girt	A325N	0.6250	2	1568.30	12425.20	0.126	✓	1 Bolt Shear

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P lb	ϕP_{allow} lb	% Capacity	Pass Fail
T1	250 - 230	Leg	ROHN 2.5 STD	3	-9019.83	45528.30	19.8	Pass
		Diagonal	ROHN 2 STD	9	-4939.92	16869.10	29.3	Pass
		Horizontal	ROHN 1.5 STD	7	-2669.79	18513.10	14.4	Pass
		Top Girt	ROHN 1.5 STD	6	-465.83	18554.70	2.5	Pass
		Inner Bracing	L2x2x1/8	17	-2.93	6529.03	0.8	Pass
T2	230 - 210	Leg	ROHN 3 EH	42	-34124.30	94459.10	36.1	Pass
		Diagonal	ROHN 2 X-STR	48	-7964.33	22398.60	35.6	Pass

<i>tnxTower</i> All-Points Technology Corporation P.O. Box 504 Conway, NH 03818 Phone: (603) 496-5853 FAX: (603) 447-2124	Job	40' ROHN SSMW Tower	Page	5 of 5
	Project	ME1414651 One City Center	Date	10:41:09 03/04/14
	Client	Verizon Wireless	Designed by	Rob Adair

Section No.	Elevation ft	Component Type	Size	Critical Element	P lb	ϕP_{allow} lb	% Capacity	Pass Fail
		Horizontal	ROHN 1.5 STD	46	-4332.09	18487.00	23.4	Pass
		Top Girt	ROHN 1.5 STD	43	-3104.92	18492.20	16.8	Pass
		Inner Bracing	L2x2x1/8	78	-54.06	6511.12	0.8	Pass
							Summary	
							Leg (T2)	36.1 Pass
							Diagonal (T2)	35.6 Pass
							Horizontal (T2)	23.4 Pass
							Top Girt (T2)	16.8 Pass
							Inner Bracing (T2)	0.8 Pass
							Bracing (T2)	
							Bolt Checks	21.4 Pass
							RATING =	36.1 Pass