NEXIUS

Accelerating Network and Business Transformation

April 4, 2017

Verizon Wireless
400 Friberg Parkway
Westborough, MA 01581

Ref.: Structural Analysis & Design
Verizon Wireless Site Ref. Portland 9
284 Danforth Street
Portland, ME 04102
Latitude: 43.646183° N
Longitude: 70.266519° W

To Whom It May Concern:

Nexius Solutions, Inc. has performed the structural analysis and design for the new elevated platform supporting the proposed Verizon Wireless (VZW) equipment. This analysis also includes the design of the new custom made non-penetrating roof ballast antenna mounts at the above referenced site. The purpose of this analysis is to determine the structural adequacy of the building roof structure (upper and lower roof).

The proposed upper roof antenna installation consists of two sectors with non-penetrating ballast mounts holding a total of eight (8) Commscope SBNHH-1D65 panel antennas (96.6" H x 11.9" W x 7.1" D, 49.6 lb.), two (2) Nokia 4x30-B13 – remote radio heads (21.6" H x 12" W x 9" D, 57.2 lb.), two (2) Nokia 4x30-B25 – remote radio heads (25.8" H x 12" W x 7.3" D, 57.0 lb.), two (2) Nokia 4x45-AWS – remote radio heads (25.6" H x 12" W x 7.3" D, 67 lb.) and related cables and hardware. The proposed lower roof antenna installation consists of four (4) Commscope SBNHH-1D65 panel antennas (96.6" H x 11.9" W x 7.1" D, 49.6 lb.), one (1) Nokia 4x30-B13 – remote radio head (21.6" H x 12" W x 9" D, 57.2 lb.), one (1) Nokia 4x30-B25 – remote radio head (25.8" H x 12" W x 7.3" D, 57.0 lb.), one (1) Nokia 4x45-AWS – remote radio head (25.6" H x 12" W x 7.3" D, 67 lb.) and related cables and hardware all mounted with side by side mounting frames to the proposed VZW equipment platform guardrails.

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The proposed Verizon Wireless platform equipment will consist of one (1) MTU 20KW natural gas generator; one (1) Charles universal broadband enclosure; one (1) Battery cabinet and related cables and hardware.

This analysis considered the effects of wind load, snow load and dead load in accordance with the 2009 International Building Code as amended by the Maine Uniform Building and Energy Code.

Based on the structural analysis performed for the aforementioned site (see attached document), it is our opinion that the existing roof structure can safely support the proposed Verizon Wireless equipment (Equipment platform and the non-penetrating ballast frames). It is assumed that the existing structure has been well maintained and is in good condition. In addition, it is assumed that all proposed equipment will be installed in accordance with manufacturers' specifications.

If you have any questions or need further assistance, please contact this office.

Sincerely,

STATE OF MAINE
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PROFESSIONAL ENGINEER

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Applicable Codes:

- 2009 International Building Code (IBC)
- ASCE 7-10 MinimumDesign Loads for Buildings and Other Structures
- AISC Steel Construction Manual (13th Ed.)
- TIA-222-G Structural Standards for Steel Antenna Towers and Antenna Supporting Structures

Scope of Calculation: VZW new steel equipment platform design and antenna ballast mount design. Existing building roof analysis.

Design Criteria:

Basic Wind Velocity, V = 100 mph
Ground Snow Loads, P_g = 50 psf
Radial ice thickness, t_i = 1.0 in
Density of ice, γ_i = 56 pcf
Exposure B
Occupancy Category Class IV (Communication, emergency response)
Topography Category: 1
Structure Type: Rooftop

Equipment Specifications: (Source: Email dated 3/30/17)

1. SBNHH-1D65C (LxWxD): 96.6"x11.9"x7.1" — Net Weight = 49.6 lbf
2. Nokia 4x30-B13 (700 MHz) (LxWxD): 21.6"x12"x9" — Net Weight = 57.2 lbf
3. Nokia 4x30-B25 (1900 MHz) (LxWxD): 25.8"x12"x7.3" — Net Weight = 57.0 lbf
4. Nokia 4x45-AWS (2100 MHz) (LxWxD): 25.6"x12"x7.3" — Net Weight = 67.0 lbf

Units:

$psf := \frac{lbf}{ft^2}$ $\quad$ $kips := 1000\ lbf$

- Gust Factor for Pole Structure, $G_h := 1.0$ (Appurtenances)
- Ground Snow Load $P_g := 50\ psf$
- Importance factor, $I_s := 1.2$
- Exposure factor, $C_e := 1.0$
- Thermal factor, $C_t := 1.2$
- Wind Speed, $V := 100$ mph
- Importance factor, $I_w := 1.15$
- Wind Direction Probability Factor, $K_d := 0.95$
- Exposure Category Coefficients (Table 2-4, TIA-222-G):

$Z_g := 1200\ ft$ (Exposure B) $\quad$ $\alpha := 7.0$ (Exposure B) $\quad$ $K_{zmin} := 0.70$ (Exposure B)

- Topographic Category Coefficients (Table 2-5, TIA-222-G):

$K_t := 1.0$ $\quad$ $K_{zt} := 1.0$ & $f := 1.0$

- Wind Force on Appurtenances:

$Z_{\alpha\gamma} := 84\ ft$ (Antenna height above ground for Alpha & Gamma sectors)

$Z_{\beta} := 68.5\ ft$ (Antenna height above ground for Beta sector)

$Z_{RRH} := 80.5\ ft$ (RRH height above ground for Alpha & Gamma sectors)

- Velocity pressure coefficient:

$K_{z\alpha\gamma} := 2.01 \cdot \left(\frac{Z_{\alpha\gamma}}{Z_g}\right)^{\frac{2}{\alpha}}$ $K_{z\alpha\gamma} = 0.94$

$K_{z\beta} := 2.01 \cdot \left(\frac{Z_{\beta}}{Z_g}\right)^{\frac{2}{\alpha}}$ $K_{z\beta} = 0.89$

$K_{z\_RRH} := 2.01 \cdot \left(\frac{Z_{RRH}}{Z_g}\right)^{\frac{2}{\alpha}}$ $K_{z\_RRH} = 0.93$

- Velocity pressure, $q_{z\_\alpha\gamma} := .00256 \cdot K_{z\alpha\gamma} \cdot K_{zt} \cdot K_d \cdot V^2 \cdot I_w \cdot psf$ $q_{z\_\alpha\gamma} = 26.3\ psf$

$q_{z\_\beta} := .00256 \cdot K_{z\beta} \cdot K_{zt} \cdot K_d \cdot V^2 \cdot I_w \cdot psf$ $q_{z\_\beta} = 24.8\ psf$

$q_{z\_RRH} := .00256 \cdot K_{z\_RRH} \cdot K_{zt} \cdot K_d \cdot V^2 \cdot I_w \cdot psf$ $q_{z\_RRH} = 26\ psf$

(P) Antennas:

1. SBNHH-1D65C

$L_{Ant} := 96.6\ in$ $W_{Ant} := 11.9\ in$ $D_{Ant} := 7.1\ in$ $Wt_{Ant} := 49.6\ lbf$

$Area_{Ant} := L_{Ant} \cdot W_{Ant}$ $Area_{Ant} = 7.98\ ft^2$

Aspect Ratio, $AR_{Ant} := \frac{L_{Ant}}{W_{Ant}}$ $AR_{Ant} = 8.12$

$C_{a\_Ant} := 1.4 + \left(\left(\frac{(2.0 - 1.4)}{25 - 7}\right)\right) \cdot \left(\left(AR_{Ant} - 7\right)\right)$ $C_{a\_Ant} = 1.44$

$EPA_{Ant} := C_{a\_Ant} \cdot Area_{Ant}$ $EPA_{Ant} = 11.47\ ft^2$

$Weight\_of\_Antenna := Wt_{Ant} \cdot 1.15$ (15% hardware & misc.)

$D\_Ant := Weight\_of\_Antenna = 57\ lbf$ $D\_Ant = 57\ lbf$

- Wind Force on Panel Antenna for Alpha & Gamma sectors mounted to proposed ballast mounts,

$F_{Ant\_\alpha\gamma} := q_{z\_\alpha\gamma} \cdot G_h \cdot EPA_{Ant}$ $\quad F_{Ant\_\alpha\gamma} = 302\ lbf$

$F_{Ant\_\alpha\gamma} = 302\ lbf$ $\quad h_{Ant\_\alpha\gamma} := 6\ ft$ (Above Roof Base)

- Wind Force on Panel Antenna for Beta sector attached to proposed guardrails,

$F_{Ant\_\beta} := q_{z\_\beta} \cdot G_h \cdot EPA_{Ant}$ $\quad F_{Ant\_\beta} = 285\ lbf$

$F_{Ant\_\beta} = 285\ lbf$ $\quad h_{Ant\_\beta} := Z_\beta = 69\ ft$ (Above Ground)

2. 700 RRH (RRH_1)

$L_{RRH\_1} := 21.6\ in$ $\quad W_{RRH\_1} := 12\ in$ $\quad D_{RRH\_1} := 9\ in$ $\quad Wt_{RRH\_1} := 57.2\ lbf$

$Area_{RRH\_1} := L_{RRH\_1} \cdot W_{RRH\_1}$ $\quad Area_{RRH\_1} = 1.8\ ft^2$

Aspect Ratio, $AR_{RRH\_1} := \frac{L_{RRH\_1}}{W_{RRH\_1}}$ $\quad AR_{RRH\_1} = 1.8$

$C_{a\_RRH\_1} := 1.2$ (TIA-222-G, Table 2-8)

$EPA_{RRH\_1} := C_{a\_RRH\_1} \cdot Area_{RRH\_1}$ $\quad EPA_{RRH\_1} = 2.16\ ft^2$

$Total\_Weight\_of\_RRH\_1 := Wt_{RRH\_1} \cdot 1.15$ (15% hardware & misc.)

$D_{RRH\_1} := Total\_Weight\_of\_RRH\_1 = 66\ lbf$

Wind Force on RRH_1, $\quad F_{RRH\_1} := q_{z\_RRH} \cdot G_h \cdot EPA_{RRH\_1}$

$F_{RRH\_1} = 56\ lbf$ $\quad h_{RRH\_1} := 30\ in$ (Above Roof Base)

3. 1900 RRH (RRH_2)

$L_{RRH\_2} := 25.8\ in$ $\quad W_{RRH\_2} := 12\ in$ $\quad D_{RRH\_2} := 7.3\ in$ $\quad Wt_{RRH\_2} := 57\ lbf$

$Area_{RRH\_2} := L_{RRH\_2} \cdot W_{RRH\_2}$ $\quad Area_{RRH\_2} = 2.15\ ft^2$

Aspect Ratio, $AR_{RRH\_2} := \frac{L_{RRH\_2}}{W_{RRH\_2}}$ $\quad AR_{RRH\_2} = 2.15$

$C_{a\_RRH\_2} := 1.2$ (TIA-222-G, Table 2-8)

$EPA_{RRH\_2} := C_{a\_RRH\_2} \cdot Area_{RRH\_2}$ $EPA_{RRH\_2} = 2.58\ ft^2$

$Total\_Weight\_of\_RRH\_2 := Wt_{RRH\_2} \cdot 1.15$ (15% hardware & misc.)

$D_{RRH\_2} := Total\_Weight\_of\_RRH\_2 = 66\ lbf$

Wind Force on RRH_2, $F_{RRH\_2} := q_{z\_RRH} \cdot G_h \cdot EPA_{RRH\_2}$

$F_{RRH\_2} = 67\ lbf$ $h_{RRH\_2} := 30\ in$ (Above Roof Base)

4. 2100 RRH, (RRH_3)

$L_{RRH\_3} := 25.6\ in$ $W_{RRH\_3} := 12\ in$ $D_{RRH\_3} := 7.3\ in$ $Wt_{RRH\_3} := 67\ lbf$

$Area_{RRH\_3} := L_{RRH\_3} \cdot W_{RRH\_3}$ $Area_{RRH\_3} = 2.13\ ft^2$

Aspect Ratio, $AR_{RRH\_3} := \frac{L_{RRH\_3}}{W_{RRH\_3}}$ $AR_{RRH\_3} = 2.13$

$C_{a\_RRH\_3} := 1.2$ (TIA-222-G, Table 2-8)

$EPA_{RRH\_3} := C_{a\_RRH\_3} \cdot Area_{RRH\_3}$ $EPA_{RRH\_3} = 2.56\ ft^2$

$Total\_Weight\_of\_RRH\_3 := Wt_{RRH\_3} \cdot 1.15$ (15% hardware & misc.)

$D_{RRH\_3} := Total\_Weight\_of\_RRH\_3 = 77\ lbf$

Wind Force on RRH_3, $F_{RRH\_3} := q_{z\_RRH} \cdot G_h \cdot EPA_{RRH\_3}$

$F_{RRH\_3} = 67\ lbf$ $h_{RRH\_3} := 30\ in$ (Above Roof Base)

5. DB-B1-6C-12AB-0Z (OVP)

$L_{OVP} := 21.5\ in$ $W_{OVP} := 15.73\ in$ $D_{OVP} := 10.31\ in$ $Wt_{OVP} := 32\ lbf$

$Area_{OVP} := L_{OVP} \cdot W_{OVP}$ $Area_{OVP} = 2.35\ ft^2$

Aspect Ratio, $AR_{OVP} := \frac{L_{OVP}}{W_{OVP}}$ $AR_{OVP} = 1.37$

$C_{a\_OVP} := 1.2$ (TIA-222-G, Table 2-8)

$EPA_{OVP} := C_{a\_OVP} \cdot Area_{OVP}$ $\qquad EPA_{OVP} = 2.82\ ft^2$

$Total\_Weight\_of\_OVP := Wt_{OVP} \cdot 1.15$ (15% hardware & misc.)

$D_{OVP} := Total\_Weight\_of\_OVP = 37\ lbf$

Wind Force on OVP, $\qquad F_{OVP} := q_{z\_RRH} \cdot G_h \cdot EPA_{OVP}$

$F_{OVP} = 73\ lbf$ $\qquad h_{OVP} := 30\ in$ (Above Roof Base)

Required number of ballasts for sector Alpha & Gamma Antenna (See attached calculations):

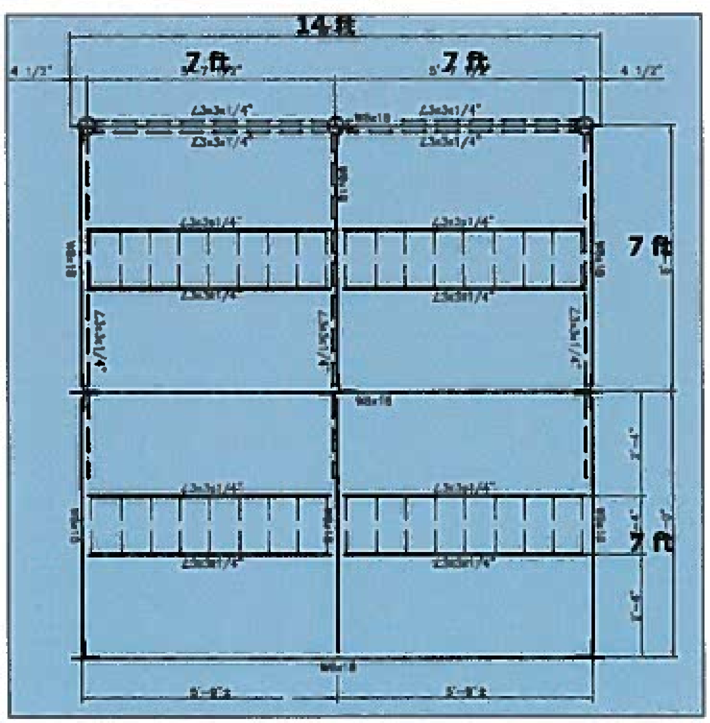
N: Number of antenna $\qquad N := 4$

N': Number of tray $\qquad N' := 4$

$Total\_WindLoad := N \cdot F_{Ant\_\alpha\gamma} = 1207\ lbf$

FS: Factor of Safety $\qquad SF := 1.5$

Assume 4"x8"x16" Solid Concrete Block weighs approx. 30 lbf.



Calculation of required ballast weghts for the proposed ballast frame

Total wind load	1207	lbf
Overturning arm lenght	8	ft
Factor of Safety (FS)	1.5	
Overturning moment	14482	lbf-ft

Overturning resistant weights

4.89	lbf/ft	L3x3x1/4 angle
18	lbf/ft	W8x18 beam

	length	sections	weight	moment arm length	Resistant moment
	ft	-	lbf	ft	lbf*ft
Part#1	7	3	378	3	1134
Part#2	12	1	216	6	1296
Part#3	7	3	378	9	3402
Part#4	12	1	216	12	2592
Part#7	7	2	68.46	2.25	154
Part#8	7	2	68.46	3.75	257
Part#9	7	2	68.46	8.25	565
Part#10	7	2	68.46	9.75	667
		Subtotal	1462	Subtotal	10067

Ballast weights			weight	arm length	Resistant moment
			lbf	ft	lbf*ft
Tray#1			W	3.5	3.5W
Tray#2			W	3.5	3.5W
Tray#3			W	10.5	10.5W
Tray#4			W	10.5	10.5W
				Subtotal	28W

Required resistant moment for 28W=	4415	lbf-ft
W	184	lbf
Weight per ballast weight	30	lbf
Ballast weights required	6	per tray
Provided	7	per tray
	O.K.	

- Snow Loads

$P_g = 50\ psf$ $\quad I_s := 1.2$ $\quad C_e := 1.0$ $\quad C_t := 1.2$

$$Pf := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot P_g = 50.4\ psf$$

(E) Roof Loads, $T.A_{avg} := 4\ ft + 8\ in = 4.67\ ft$

DL,

Roofing materials	2.0 psf
Decking	2.0 psf
Rigid Insulation	1.0 psf
Steel Joists	2.0 psf
Misc.	8.0 psf
Total DL	15.0 psf

SL,	Snow Load	50.0 psf

$Total\_Ant\_Dead\_Load := N \cdot D\_Ant = 228\ lbf$

$Total\_RRH\&OVP\_Dead\_Load := D_{RRH\_1} + D_{RRH\_2} + D_{RRH\_3} + D_{OVP}$

$Total\_DeadLoad := Total\_Ant\_Dead\_Load + Total\_RRH\&OVP\_Dead\_Load = 473\ lbf$

$Total\_Ballast\_Blocks := 7 \cdot N' \cdot 30\ lbf = 840\ lbf$

$Total\_DL\_BallastMount := 1315\ lbf \cdot 1.10 = 1447\ lbf$

$BallastMount\_Area := 196 \cdot ft^2$

$$Total\_Unit\_DeadLoad := \frac{(Total\_DeadLoad + Total\_Ballast\_Blocks + Total\_DL\_BallastMount)}{BallastMount\_Area}$$

$Total\_Unit\_DeadLoad = 14\ psf$ $\quad DL_{ballast\_mount} := Total\_Unit\_DeadLoad \cdot T.A_{avg} = 66\ plf$

$DL := 15\ psf \qquad SL := 50\ psf$

Load Combination:

LC_1 = DL
LC_2 = DL + SL

$(DL \cdot T.A_{avg} + DL_{ballast\_mount}) = 136\ plf$
$(DL + SL) \cdot T.A_{avg} + DL_{ballast\_mount} = 369\ plf$

$l := 27\ ft$ 16H6 steel joist

$w_{u\_1} := (DL + SL) \cdot T.A_{avg} = 303\ plf$

$w_{u\_2} := DL_{ballast\_mount} = 66\ plf$

$R_{max} := 4.71\ kip$
$M_{max} := 30.03\ ft \cdot kip$ @ 14 ft +/-

$$w_{equ} := \frac{8 \cdot M_{max}}{l^2} = 330\ plf$$

16H6 Steel Joist Allowable Capacity = 315 plf Engineering practice allows 5% overstress. Thus, the roof joists are adequate to support the custom made non penetrating ballast antenna mounts

Design of new VZW equipment steel platform on top of lower roof

VZW Equipment Platforrm Specifications: $A_{Platform} := 200\ ft^2$

1. Charles CUBE universal broadband enclosure — Weight = 1000 lbf
2. Battery Cabinet — Weight = 2500 lbf
3. Natural Gas Generator — Weight = 2200 lbf
4. Telco & Power Cabinets (Misc.) — Est. Weight = 250 lbf

$DL_{radio} := 1000\ lbf$ $DL_{batt} := 2500\ lbf$ $DL_{Gen} := 2200\ lbf$ $DL_{Misc} := 250\ lbf$

$DL_{eqpt} := (DL_{radio} + DL_{batt} + DL_{Gen} + DL_{Misc}) \cdot 1.15 = 6843\ lbf$ (15% cabling & misc.)

$Grating\_UnitWt := 10\ psf$ $DL_{Grat} := Grating\_UnitWt \cdot A_{Platform} = 2000\ lbf$

$UnitWt\_LL := 10\ psf$ (Technician & tools) $LL := UnitWt\_LL \cdot A_{Platform} = 2000\ lbf$

$SL := 50\ psf$ $SL_{Platform} := SL \cdot A_{Platform} = 10000\ lbf$

Load Combinations: (Allowable Stress Design)

LC1: DL
LC2: DL + LL
LC3: DL + SL
LC4: DL + 0.75LL + 0.75SL

$LC1 := DL_{eqpt} + DL_{Grat} = 8843\ lbf$
$LC2 := DL_{eqpt} + DL_{Grat} + LL = 10843\ lbf$
$LC3 := DL_{eqpt} + DL_{Grat} + SL_{Platform} = 18843\ lbf$ (Controlling)
$LC4 := DL_{eqpt} + DL_{Grat} + 0.75 \cdot LL + 0.75 \cdot SL_{Platform} = 17843\ lbf$

Design of Beam B1 $L_{B1} := 10\ ft$ $TA_{B1} := 3\ ft$ $Fy := 50\ ksi$

$$UL_{B1} := \frac{LC3}{A_{Platform}} \cdot TA_{B1} = 283\ plf$$

$$R_{max\_B1} := UL_{B1} \cdot \frac{L_{B1}}{2} = 1.41\ kip \qquad M_{max\_B1} := UL_{B1} \cdot \frac{L_{B1}^2}{8} = 3.53\ kip \cdot ft$$

Try W8x18:

$L_{b\_B1} := 3\ ft + 4\ in$ $Z_{x\_B1} := 17\ in^3$ $L_{p\_B1} := 4.34\ ft$ $L_{r\_B1} := 13.5\ ft$

$S_{x\_B1} := 15.2\ in^3$ $I_{x\_B1} := 61.9\ in^4$ $C_b := 1.0$ (Assumed) $\Omega := 1.67$

$M_{r\_B1} := 531.1\ kip \cdot in \qquad M_{p\_B1} := 849.7\ kip \cdot in$

$$M_{n\_B1} := C_b \cdot \left(M_{p\_B1} - \left(M_{p\_B1} - M_{r\_B1}\right) \cdot \left(\frac{L_{b\_B1} - L_{p\_B1}}{L_{r\_B1} - L_{p\_B1}}\right)\right) = 885\ kip \cdot in$$

$$\frac{M_{n\_B1}}{\Omega} = 44.1\ kip \cdot ft \ > \ M_{max\_B1} = 3.5\ kip \cdot ft$$

Design of Beam B2 $\qquad L_{B2} := 10\ ft \qquad a_{B2} := 4\ ft \qquad R_{max\_B1} = 1.41\ kip$

$R_{max\_B2} := 2 \cdot R_{max\_B1} = 2.83\ kip \qquad M_{max\_B2} := 2 \cdot R_{max\_B1} \cdot a_{B2} = 11.31\ kip \cdot ft$

Try W8x18:

$L_{b\_B2} := 4\ ft \qquad Z_{x\_B1} := 17\ in^3 \qquad L_{p\_B2} := 4.34\ ft \qquad L_{r\_B2} := 13.5\ ft$

$S_{x\_B2} := 15.2\ in^3 \qquad I_{x\_B2} := 61.9\ in^4 \qquad C_b := 1.0$ (Assumed) $\qquad \Omega := 1.67$

$M_{r\_B2} := 531.1\ kip \cdot in \qquad M_{p\_B2} := 849.7\ kip \cdot in$

$$M_{n\_B2} := C_b \cdot \left(M_{p\_B2} - \left(M_{p\_B2} - M_{r\_B2}\right) \cdot \left(\frac{L_{b\_B2} - L_{p\_B2}}{L_{r\_B2} - L_{p\_B2}}\right)\right) = 862\ kip \cdot in$$

$$\frac{M_{n\_B2}}{\Omega} = 43\ kip \cdot ft \ > \ M_{max\_B2} = 11.3\ kip \cdot ft$$

Design of Beam B3 $\qquad L_{B3} := 27\ ft \qquad R_{max\_B1} = 1413\ lbf \qquad R_{max\_B2} = 2826\ lbf$

$TA_{B3} := 2\ ft \qquad UL_{B3} := \frac{LC3}{A_{Platform}} \cdot TA_{B3} = 188\ plf$

$R_{max\_B3} := 4513\ lbf \qquad M_{max\_B3} := 35.7\ kip \cdot ft$

Try W10x22:

$L_{b\_B3} := 7\ ft \qquad Z_{x\_B3} := 26\ in^3 \qquad L_{p\_B3} := 4.70\ ft \qquad L_{r\_B3} := 13.8\ ft$

$S_{x\_B3} := 23.2\ in^3 \qquad I_{x\_B3} := 118\ in^4 \qquad C_b := 1.0$ (Assumed)

$M_{r\_B3} := 811.6\ kip \cdot in \qquad M_{p\_B3} := 1300.6\ kip \cdot in$

$$M_{n\_B3} := C_b \cdot \left(M_{p\_B3} - \left(M_{p\_B3} - M_{r\_B3}\right) \cdot \left(\frac{L_{b\_B3} - L_{p\_B3}}{L_{r\_B3} - L_{p\_B3}}\right)\right) = 1177\ kip \cdot in$$

$$\frac{M_{n\_B3}}{\Omega} = 58.7\ kip \cdot ft \quad > \quad M_{max\_B3} = 35.7\ kip \cdot ft$$

Check Deflection for B3

$\Delta_{Tcalc} := 1.29\ in$ @ 13 ft +/- from support $\quad \Delta_{LLallow} := \frac{L_{B3}}{360} = 0.9\ in$

$\Delta_{LLcalc} := 0.69\ in$ @ 13 ft +/- from support $\quad \Delta_{Tallow} := \frac{L_{B3}}{240} = 1.35\ in$

Conclusion:
The proposed VZW designed platform is adequate to support all the equipment listed above along with the environmental loads(wind & snow) according to the applicable building code and standards.

Check capacity of existing roof beam 12WF27 $\quad TA := 24\ ft$

(E) Roof Loads,

DL,	Roofing materials	2.0 psf
	Decking	2.0 psf
	Rigid Insulation	1.0 psf
	Steel Joists	2.0 psf
	Misc.	8.0 psf
	Total DL	15.0 psf
SL,	Snow Load	50.0 psf

$DL := 15\ psf \quad SL := 50\ psf \quad R_{max\_B3\_DL} := 2115\ lbf \quad R_{max\_B3\_LL} := 2398\ lbf$

$UDL := DL \cdot TA = 360\ plf \quad USL := SL \cdot TA = 1200\ plf$

Load Combinations for (E) 12WF27: (Allowable Stress Design)

ELC1: DL + SL $\quad R_{max} := 15301\ lbf \quad M_{max} := 64365\ lbf \cdot ft$

Dimensions & Properties of (E) 12WF27 $\quad Fy' := 36\ ksi$

$A := 7.97\ in^2 \quad S_x := 34.1\ in^3 \quad Z_x := 37.5\ in^3 \quad I_x := 204.1\ in^4 \quad d := 11.96\ in$

$F_b := 0.66 \cdot Fy' = 24\ ksi \quad S_{req} := \frac{M_{max}}{F_b} = 33\ in^3 \quad < \quad S_x := 34.1\ in^3$ Provided!

Conclusion:

The existing roof beam is adequate to support the loads imposed by VZW platform accordingly to the applicable buidling code and standards.

SNOW LOADS BY LOCATION

Applied Technology Council

Search Result

Elevation Limitation: ASCE 7* Ground Snow Load
Query Date: April 03, 2017
Latitude: 43.646183
Longitude: -70.266519
Elevation: 109 Feet

Elevation ≤ 500 feet: Ground Snow Load is 50 psf

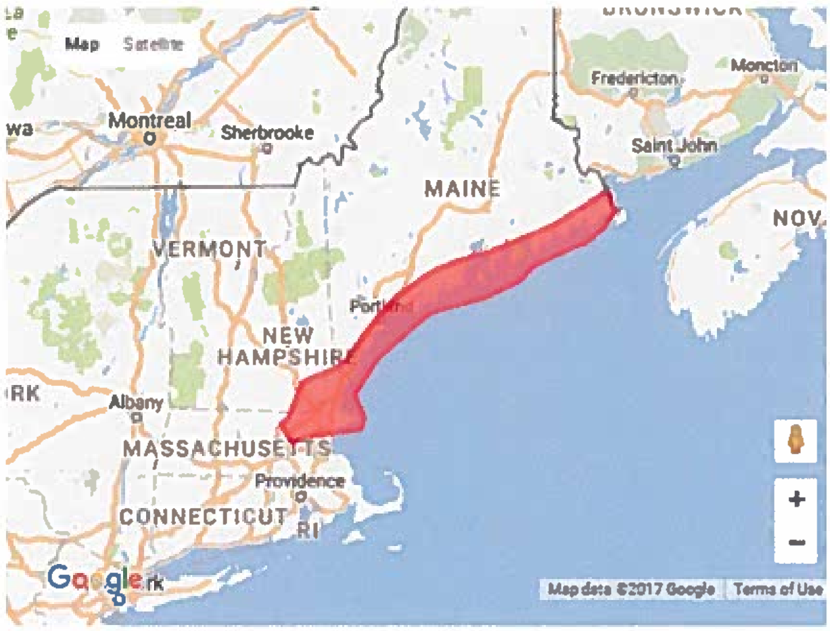
All loading data is in pounds per square foot.

For a site-specific case study area, a case study is required to establish ground snow loads.

*Based on Figure 7-1 Ground Snow Loads printed in ASCE 7-95 through ASCE 7-10.

Users should consult with local building officials to determine if there are community-specific snow load requirements that govern.

Red shaded area is the load specific boundaries. Any darker red area is the overlapping load specific boundary.



GROUND SNOW LOAD WEBSITE DISCLAIMER

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WINDSPEED BY LOCATION

ASCE 7 Windspeed | ASCE 7 Ground Snow Load | Related Resources | Sponsors | About ATC | Contact

Search Results

Query Date: Mon Apr 03 2017
Latitude: 43.6462
Longitude: -70.2665

ASCE 7-10 Windspeeds
(3-sec peak gust in mph*):

Risk Category I: 107
Risk Category II: 118
Risk Category III-IV: 127
MRI 10-Year:** 76
MRI 25-Year:** 86
MRI 50-Year:** 91
MRI 100-Year:** 97

ASCE 7-05 Windspeed:
99 (3-sec peak gust in mph)
ASCE 7-93 Windspeed:
83 (fastest mile in mph)

*Miles per hour
**Mean Recurrence Interval

Users should consult with local building officials to determine if there are community-specific wind speed requirements that govern.

Print your results

WINDSPEED WEBSITE DISCLAIMER

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Total wind load	1207	lbf
Overturning arm lenght	8	ft
Factor of Safety (FS)	1.5	
Overturning moment	14482	lbf-ft

Overturning resistant weights

4.89	lbf/ft	L3x3x1/4 angle
18	lbf/ft	W8x18 beam

	length	sections	weight	moment arm length	Resistant moment
	ft	-	lbf	ft	lbf*ft
Part#1	7	3	378	3	1134
Part#2	12	1	216	6	1296
Part#3	7	3	378	9	3402
Part#4	12	1	216	12	2592
Part#7	7	2	68.46	2.25	154
Part#8	7	2	68.46	3.75	257
Part#9	7	2	68.46	8.25	565
Part#10	7	2	68.46	9.75	667
		Subtotal	1462	Subtotal	10067

Ballast weights			weight	arm length	Resistant moment
			lbf	ft	lbf*ft
Tray#1			W	3.5	3.5W
Tray#2			W	3.5	3.5W
Tray#3			W	10.5	10.5W
Tray#4			W	10.5	10.5W
				Subtotal	28W

Required resistant moment for 28W=	4415	lbf-ft
W	184	lbf
Weight per ballast weight	30	lbf
Ballast weights required	6	per tray
Provided	7	per tray
	O.K.	

Sentenia Systems	Project: VZW_Portland 9_ME	Engineer: SA Date: 04-Apr-17	Project #
GoBeam Version 2015.1	Subject: Roof Structural Members Analysis	Checker: Date:	Page: 1

LOAD CASE: DL+SL

ANALYSIS RESULTS				
X, ft	Shear, lb	Moment, lb-ft	Deflections, in	Rotations, rad
0	4266.5	0.00	0.00	-0.04569
1E-06	4266.5	0.00	0.00	-0.04569
1.08	3939.3	4431.11	-0.59	-0.04528
2.16	3612.0	8508.80	-1.17	-0.04408
3.24	3284.8	12233.07	-1.73	-0.04216
4.32	2957.5	15603.93	-2.26	-0.03959
5.4	2630.3	18621.36	-2.75	-0.03643
6.48	2303.1	21285.37	-3.20	-0.03275
7.56	1975.8	23595.97	-3.60	-0.02861
8.64	1648.6	25553.15	-3.94	-0.02408
9.72	1321.3	27156.90	-4.22	-0.01921
10.8	994.1	28407.24	-4.44	-0.01409
11.88	666.9	29304.16	-4.59	-0.00877
12.96	339.6	29847.66	-4.67	-0.00331
14.04	12.4	30037.74	-4.67	0.00221
15	-278.5	29910.00	-4.62	0.00713
15.12	-322.8	29873.92	-4.61	0.00774
16.2	-721.3	29310.12	-4.47	0.01320
17.28	-1119.8	28315.92	-4.27	0.01852
18.36	-1518.3	26891.31	-3.99	0.02361
19.44	-1916.9	25036.30	-3.66	0.02840
20.52	-2315.4	22750.89	-3.26	0.03281
21.6	-2713.9	20035.08	-2.81	0.03676
22.68	-3112.4	16888.87	-2.31	0.04017
23.76	-3510.9	13312.25	-1.77	0.04296
24.84	-3909.5	9305.24	-1.20	0.04505
25.92	-4308.0	4867.82	-0.60	0.04636
27	-4706.5	0.00	0.00	0.04682
27	-4706.5	0.00	0.00	0.04682

Horizontal sway displacements = 0 in

	Max	Min	Area	Area(+)	Area(-)
Shear	4266.5	-4706.5	0.0	30038.0	-30038.0
Moment	30037.74	0.00	541277.76	541277.76	0.00
Deflections	0.00	-4.67	-80.77	0.00	-80.77
Rotations	0.04682	-0.04569	0.00000	0.38939	-0.38939
Reactions	4706.5	4266.5			

Coordinate	Reaction	Displ.
X, ft	R, lb	Δ, in
0	4266.5	0.00
27	4706.5	0.00

ΣR = 8973 lb

Sentenia Systems	Project: VZW_Portland 9_ME	Engineer: SA Date: 04-Apr-17	Project #
GoBeam Version 2015.1	Subject: 12WF27 Beam Analysis	Checker: Date:	Page: 1

LOAD CASE: DL+SL

ANALYSIS RESULTS				
X, ft	Shear, lb	Moment, lb-ft	Deflections, in	Rotations, rad
0	14172.4	0.00	0.00	-0.01381
1E-06	14172.4	0.00	0.00	-0.01381
0.64	13174.0	8750.83	-0.11	-0.01370
1.28	12175.6	16862.69	-0.21	-0.01335
1.92	11177.2	24335.57	-0.31	-0.01279
2.56	10178.8	31169.47	-0.41	-0.01204
3.2	9180.4	37364.40	-0.49	-0.01112
3.84	8182.0	42920.35	-0.58	-0.01004
4.48	7183.6	47837.33	-0.65	-0.00881
5.12	6185.2	52115.33	-0.71	-0.00747
5.76	5186.8	55754.35	-0.76	-0.00601
6.4	4188.4	58754.40	-0.80	-0.00447
7.04	3190.0	61115.47	-0.83	-0.00285
7.68	2191.6	62837.57	-0.85	-0.00118
8.32	1193.2	63920.69	-0.85	0.00053
8.96	194.8	64364.83	-0.84	0.00225
9.6	-803.6	64170.00	-0.81	0.00399
10	-1427.6	63723.75	-0.79	0.00506
10	-5940.6	63723.74	-0.79	0.00506
10.24	-6315.0	62253.07	-0.78	0.00570
10.88	-7313.4	57891.97	-0.73	0.00732
11.52	-8311.8	52891.89	-0.67	0.00881
12.16	-9310.2	47252.83	-0.59	0.01016
12.8	-10308.6	40974.80	-0.51	0.01135
13.44	-11307.0	34057.79	-0.42	0.01236
14.08	-12305.4	26501.81	-0.32	0.01318
14.72	-13303.8	18306.85	-0.22	0.01379
15.36	-14302.2	9472.91	-0.11	0.01416
16	-15300.6	0.02	0.00	0.01429
16	-15300.6	0.00	0.00	0.01429

Horizontal sway displacements = 0 in

	Max	Min	Area	Area(+)	Area(-)
Shear	14172.4	-15300.6	0.0	64377.0	-64377.0
Moment	64364.83	0.00	667041.93	667041.93	0.00
Deflections	0.00	-0.85	-8.67	0.00	-8.67
Rotations	0.01429	-0.01381	0.00000	0.07076	-0.07076
Reactions	15300.6	14172.4			

Coordinate	Reaction	Displ.
X, ft	R, lb	Δ, in
0	14172.4	0.00
16	15300.6	0.00

ΣR = 29473 lb

NEXIUS

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