STRUCTURAL ANALYSIS REPORT

For

ME 5023 (LTE-4C/5C)

BRADLEY'S CORNER

1050 Westbrook Street
Portland, ME 04102

Antennas Mounted on Non-Penetrating Ballast Frames on Roof; Equipment Area at Ground Level

Prepared for:

SAI at&t

STATE OF MAINE
DANIEL P. HAMM
No. 10344
LICENSED PROFESSIONAL ENGINEER

5-31-16

Dated: May 31, 2016

Prepared by:

Hudson Design Group LLC

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SCOPE OF WORK:

Hudson Design Group LLC (HDG) has been authorized by AT&T to conduct a structural evaluation of the structure that will support the existing AT&T equipment located in the areas depicted in the latest HDG's construction drawings.

This report represents this office's findings, conclusions and recommendations pertaining to the support of AT&T's proposed equipment.

CONCLUSION SUMMARY:

Building plans were not available and could not be obtained for our use. A limited visual survey of the structure was completed in or near the areas of the proposed work.

Based on our evaluation, we have determined that the existing structure **IS CAPABLE** of supporting the proposed equipment loading with the following modifications:

- Reconfigure ballast blocks as to meet the requirements shown below:

MINIMUM BALLAST REQUIREMENTS (ALPHA/BETA)		
SIDE	A (Back)	B (Front)
BALLAST REQUIRED	1057 lbs.	370 lbs.
TOTAL BALLAST WEIGHT	1427 lbs.	

MINIMUM BALLAST REQUIREMENTS (GAMMA)		
SIDE	A (Back)	B (Front)
BALLAST REQUIRED	966 lbs.	300 lbs.
TOTAL BALLAST WEIGHT	1266 lbs.	

APPURTENANCE/EQUIPMENT CONFIGURATION:

(6) HPA-65R-BUU-H8 Antennas (92.4"x14.8"x7.4" Wt. = 73 lbs. /each) (Two per sector)

(3) Powerwave 7770 Antennas (55"x11"x5" Wt. = 35 lbs. /each) (One per sector)

(2) P65-17-XLH-RR Antennas (96"x12"x6" Wt. = 70 lbs. /each) (Alpha & Beta sector)

(1) AM-X-CD-16-65-00T-RET Antenna (72"x11.8"x5.9" Wt. = 49 lbs.) (Gamma sector)

(12) RRH (RRUS-11) (19.69"x16.97"x7.17" – Wt. = 50.7 lbs. /each) (Four per sector)

(3) A2 Module (16.4"x15.2"x3.4" – Wt. = 22 lbs. /each) (One per sector)

(3) RRH (RRUS-32) (26.7"x12.1"x6.7" – Wt. = 60 lbs. /each) (One per sector)

(3) Surge Arrestors (24"x9.7"ø - Wt. = 32.8 lbs. /each) (One per sector)

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DESIGN CRITERIA:

1. International Building Code (IBC) 2009, and ASCE 7-05 (Minimum Design Loads for Buildings and Other Structures).

   Wind Analysis:

Reference Wind Speed:	100 mph	(FIG 6-1C; ASCE 7-05)
Category:	B	(Section 6.5.6.3; ASCE 7-05)

   Roof:

Ground Snow, P_g:	60 psf	(FIG 7-1; ASCE 7-05)
Importance Factor, I:	1.0	(Category II)
Exposure Factor, Ce:	1.0	(Exp. B- Partially Exposed)
Thermal Factor, Ct:	1.0	(Typical Structure)
Flat Roof Snow Load:	**42 psf**	**(P_f=0.7*Ce*Ct*I*P_g)**

2. EIA/TIA -222- G Structural Standards for Steel Antenna Towers and Antenna Supporting Structures

City/Town:	Portland
County:	Cumberland
Wind Load:	100 mph
Nominal Ice Thickness:	1 inch

3. Approximate height above grade to the center of the Antennas:

   74'-0"+/-

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ANTENNA/RRH SUPPORT RECOMMENDATIONS:

The new antennas and RRH's are proposed to be secured to the existing non-penetrating ballast frames located on the roof.

Limitations and assumptions:

1. Reference the latest HDG construction drawings for all the equipment locations details.

2. Mount all equipment per manufacturer's specifications.

3. All structural members and their connections are assumed to be in good condition and are free from defects with no deterioration to its member capacities.

4. All antennas, coax cables and waveguide cables are assumed to be properly installed and supported as per the manufacturer requirements.

5. HDG is under the assumption that the ballast frames are located over structurally adequate roof supports (i.e. beams, columns, or bearing walls). HDG was not able to verify the roof structure and its components at the time of our visit.

6. HDG is not responsible for any modifications completed prior to and hereafter which HDG was not directly involved.

7. If field conditions differ from what is assumed in this report, then the engineer of record is to be notified as soon as possible.

FIELD PHOTOS:

Photo 1: Sample photo illustrating the existing antennas.

Photo 2: Sample photo illustrating the existing antennas.

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Calculations

Date: 05/31/2016
Project Number: ME5023
Project Name: Bradley's Corner
Designed By: GH **Checked By:** MSC

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2.6.5.2 Velocity Pressure Coeff:

$K_z = 2.01\ (z/z_g)^{2/\alpha}$

z=	74	(ft)
z_g=	1200	(ft)
α=	7	

K_z= 0.907

$Kzmin \leq Kz \leq 2.01$

Table 2-4

Exposure	Z_g	α	K_{zmin}	K_e
B	1200 ft	7.0	0.70	0.9
C	900 ft	9.5	0.85	1.0
D	700 ft	11.5	1.03	1.1

2.6.6.4 Topographic Factor:

Table 2-5

Topo. Category	K_t	f
2	0.43	1.25
3	0.53	2.0
4	0.72	1.5

$K_{zt} = [1+(K_e K_t/K_h)]^2$ $K_h = e^{(f*z/H)}$

K_{zt}= #DIV/0!

(If Category 1 then K_{zt} =1.0)

Category=	1

K_h=	#DIV/0!	
K_e=	0	(from Table 2-4)
K_t=	0	(from Table 2-5)
f=	0	(from Table 2-5)
z=	74	
H=	0	(Ht. of the crest above surrounding terrain)
K_{zt}=	1.00	

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2.6.7 Gust Effect Factor

2.6.7.1 Self Supporting Lattice Structures

Gh = 1.0 Latticed Structures > 600 ft

Gh = 0.85 Latticed Structures 450 ft or less

Gh = 0.85 + 0.15 [h/150 - 3.0] h= ht. of structure

h=	69	Gh=	0.85

2.6.7.2 Guyed Masts	Gh=	0.85
2.6.7.3 Pole Structures	Gh=	1.1
2.6.9 Appurtenances	Gh=	1.0

2.6.7.4 Structures Supported on Other Structures
(Cantilivered tubular or latticed spines, pole, structures on buildings (ht. : width ratio > 5)

Gh=	1.35	**Gh=**	**1.35**

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2.6.9.2 Design Wind Force on Appurtenances

$$F = q_z * G_h * (EPA)_A$$

$$q_z = 0.00256 * K_z * K_{zt} * K_d * V_{max}^2 * I$$

K_z=	0.907
K_{zt}=	1.0
K_d=	0.95
V_{max}=	100
I=	1.0

q_z= 22.05

Table 2-2

Structure Type	Wind Direction Probability Factor, Kd
Latticed structures with triangular, square or rectangular cross sections	0.85
Tubular pole structures, latticed structures with other cross sections, appurtenances	0.95

Determine Cf:

If lattice Structure See Manual

If Tubular Pole Structure, Use Corrected Value from Table 2.7 Below

C mph.ft	Round	18 Sided	16 Sided	12 Sided	8 Sided
< 32 (Subcritical)	1.2	1.2	1.2	1.2	1.2
32 to 64 (Transitional)	$38.4/C^{1.0}$	$25.8/C^{0.885}$	$12.6/C^{0.678}$	$2.99/C^{0.263}$	1.2
> 64 (Supercritical)	0.6	0.65	0.75	1	1.2

$$C = (I * K_{zt} * K_z)^{0.5} * V * D$$

D = Outside diameter for rounds: 0.25 feet

C= 23.81 **Cf= 1.2**

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Determine Ca:

Table 2-8

Force Coefficients (Ca) for Appurtenances				
Member Type		Aspect Ratio ≤ 2.5	Aspect Ratio = 7	Aspect Ratio ≥ 25
		Ca	Ca	Ca
Flat		1.2	1.4	2.0
Round	C < 32 (Subcritical)	0.7	0.8	1.2
	32 ≤ C ≤ 64 (Transitional)	$3.76/(C^{0.485})$	$3.37/(C^{0.415})$	$38.4/(C^{1.0})$
	C > 64 (Supercritical)	0.5	0.6	0.6

Aspect Ratio is the overall length/width ratio in the plane normal to the wind direction.
(Aspect ratio is independent of the spacing between support points of a linear appurtenance, and the section length considered to have uniform wind load).

Note: Linear interpolation may be used for aspect ratios other than those shown.

Appurtenances	Height	Width	Depth	Flat Area	Aspect Ratio	Ca	Force (lbs)
HPA-65R Antenna	92.4	14.8	7.4	9.50	6.24	1.37	386
7770 Antenna	55	11	5	4.20	5.00	1.31	164
P65-17-XLH Antenna	96	12	6	8.00	8.00	1.43	341
AM-X-CD Antenna	72	11.8	5.9	5.90	6.10	1.36	239
RRUS-11 (Shielded)	19.7	6.0	7.2	0.82	3.28	1.23	30
RRUS-32 (Shielded)	26.7	3.0	6.7	0.56	8.90	1.46	24
RRUS-11 (Side)	19.7	7.2	17.0	0.99	2.74	1.21	35

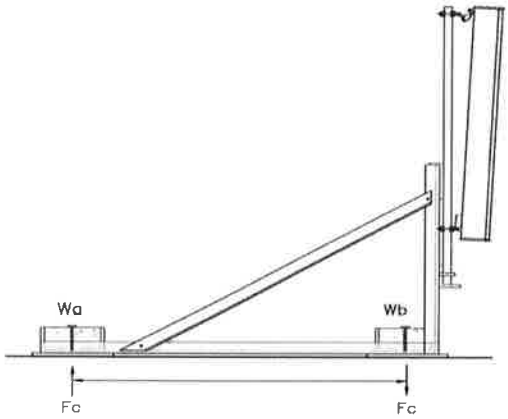
Date: 5/31/2016
Site Number: ME5023
Site Name: Bradley's Corner
Done by: GH **Checked by:** MSC

Calculate Total Ballast Required for Ballast Mount (ALPHA & BETA)

WIND FORCES

F antenna = 1277 lbs.

F rrh = 124 lbs.



Antenna Height = 5 ft

RRH & Surge Height = 3 ft

Length = 7 ft

Overturning at Ballast

Moment = 8446.25 lbs.-ft

S.F. 1.25

Hold Down Force = 1206.61 lbs. Per Side

Wa Ballast

Equipment

Frame = 150 lbs.

Total Ballast Required Wa= **1056.61 lbs.**

Wb Ballast

Equipment

Frame	300 lbs.
Antennas	251 lbs.
RRH's	286 lbs.
Total =	837 lbs.

Total Ballast Required Wb = **369.61 lbs.**

Total weight of Fully Loaded Ballast Frame = 2420 lbs

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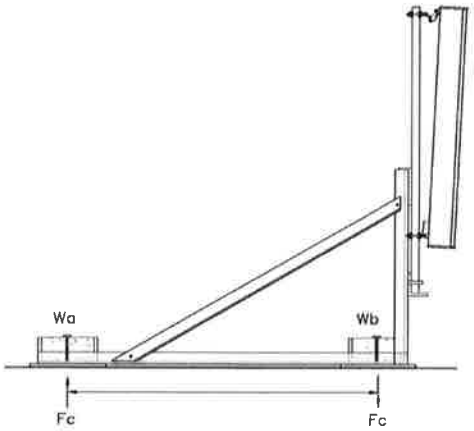
Calculate Total Ballast Required for Ballast Mount (GAMMA)

WIND FORCES

F antenna = 1175 lbs.

F rrh = 124 lbs.



Antenna Height = 5 ft

RRH & Surge Height = 3 ft

Length = 7 ft

Overturning at Ballast

Moment = 7808.75 lbs.-ft

S.F.
1.25

Hold Down Force = 1115.54 lbs. Per Side

Wa Ballast

Equipment

Frame = 150 lbs.

Total Ballast Required Wa= **965.54 lbs.**

Wb Ballast

Equipment

Frame	300 lbs.
Antennas	230 lbs.
RRH's	286 lbs.
Total =	816 lbs.

Total Ballast Required Wb = **299.54 lbs.**

Total weight of Fully Loaded Ballast Frame = 2232 lbs