STRUCTURAL ANALYSIS REPORT

For

ME 5045 (LTE 3C)

PORTLAND USM

246 Deering Avenue
Portland, ME 03082

Antennas Mounted on Pipe Masts; Equipment on the Roof

Prepared for:

EMPIRE telecom

at&t

Dated: January 15, 2015

Prepared by:

STATE OF MAINE
DANIEL P. HAMM
No. 10044
LICENSED
PROFESSIONAL ENGINEER

Hudson Design Group LLC

1600 Osgood Street Building 20 North, Suite 3090
North Andover, MA 01845
Phone: (978) 557-5553
www.hudsondesigngroupllc.com

Hudson Design Group LLC

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.

An on-site visual survey of the above areas was performed by ProVertic on December 9, 2014. Attendees included Nick Bestor (ProVertic Field Technician).

CONCLUSION SUMMARY:

As-built plans prepared by Donald L. Dimick were available 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.

APPURTENACE/EQUIPMENT CONFIGURATION:

(6) CCI OPA-65R-LCUU-H8 Antennas (92.7"x14.4"x7"–Wt. = 95 lbs. /each) (Two per sector)

(3) HPA-65R-BUU-H8 Antennas (92.4"x14.8"x7.4" – Wt. = 68 lbs. each)(One per sector)

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

(3) RRH (RRUS-12) (20.4"x18.5"x7.5" – Wt. = 58 lbs. /each) (One per sector)

(3) RRH (RRUS-E2) (20"x20.4"x9.5" – Wt. = 58 lbs. /each) (One per sector)

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

(1) PURCELL FLX16WS CABINET (Wt. = 220 lbs.)

(1) Surge Suppressor (Wt. = 43.5 lbs.)

(1) PBC-02 MU (Wt. = 120 lbs.)

(3) Katherin 742-264 Antennas (51.8"x10.3"x5.5" – Wt. = 45 lbs./each)(One per sector)

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

Referenced documents are attached.

Hudson Design Group LLC

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:	C	(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:

   92'-5"+/- (Alpha)
   88'-3"+/- (Beta & Gamma)

Hudson Design Group LLC

ANTENNA SUPPORT RECOMMENDATIONS:

- The new Alpha sector antennas are proposed to be mounted on new pipe masts secured to the existing building façade with epoxy anchors.
- The new Beta and Gamma sector antennas are proposed to be mounted on existing pipe masts secured to the antenna support angles.

RRH SUPPORT RECOMMENDATIONS:

The new RRH's are proposed to be mounted on new unistruts and fastened to the existing building façade with epoxy anchors.

EQUIPMENT SUPPORT RECOMMENDATIONS:

The new Purcell cabinet, surge suppressor, and PBC-02 are proposed to installed on a new H-frame secured to a new curb platform anchored to the roof. The new curb platform is proposed to be installed near a building column as shown in the latest HDG construction drawings.

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

Photo 2: Sample photo illustrating the existing façade-mounted antennas.

Photo 3: Sample photo illustrating the existing RRHs.

Photo 4: Sample photo illustrating the existing antennas.

Photo 5: Sample photo illustrating the existing equipment.

Hudson Design Group LLC

Alpha Sector
Antenna Calculations

Date: 1/13/2015
Project Name: Portland USM
Project Number: ME5045
Designed By: SAG Checked By: MSC

Hudson Design Group LLC

2.6.5.2 Velocity Pressure Coeff:

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

z=	92.5	(ft)	Proposed Antennas
z_g=	900	(ft)	
α=	9.5		

K_z= 1.245

$Kzmin \leq Kz \leq 2.01$

Table 2-4

Exposure	Z_g	α	K_{zmin}	K_e
B	1200 ft	7	0.70	0.90
C	900 ft	9.5	0.85	1
D	700 ft	11.5	1.03	1.10

2.6.6.4 Topographic Factor:

Table 2-5

Topo. Category	K_t	f
2	0.43	1.25
3	0.53	2
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=	92.5	
H=	0	(Ht. above surrounding terrain)
K_{zt}=	1.00	

Date: 1/13/2015
Project Name: Portland USM
Project Number: ME5045
Designed By: SAG **Checked By: MSC**

Hudson Design Group LLC

2.6.7 Gust Effect Factors

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=	92.5	Gh=	0.4925

2.6.7.2 Guyed Masts Gh= 0.85

2.6.7.3 Pole Structures Gh= 1.1

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**

Date: 1/13/2015
Project Name: Portland USM
Project Number: ME5045
Designed By: SAG Checked By: MSC

Hudson Design Group LLC

2.6.8 Design Ice Thickness:

$t_{iz} = 2.0*t_i*I*K_{iz}*(K_{zt})^{0.35}$

t_i=	1
I=	1
K_{iz}=	1.11
K_{zt}=	1

t_{iz}= 2.22

$K_{iz} = [z/33]^{0.10} \leq 1.4$

K_{iz}= 1.11

Calculating the weight of ice, the cross-sectional area of ice shall be determined by:

$A_{iz} = \pi*t_{iz}*(D_c + t_{iz})$

Dc= 92.7 (in) Largest Dim of Member

A_{iz} = 661.13

2.6.9 Design Wind Load:

F= qz*Gh*(EPA's)

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

K_z=	1.245
K_{zt}=	1
K_d=	0.95
V_{max}=	100

q_z= 30.28

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**

Date: 1/13/2015
Project Name: Portland USM
Project Number: ME5045
Designed By: SAG **Checked By: MSC**

Hudson Design Group LLC

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

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

Dp = Outside Diameter or Out to Out: 0.2 feet

C= 22.32 **Cf=** 1.2

Appurtenances		Height	Width	Depth	Flat Area	Force Per Appurtenance
Item No.1	(P) Ant	92.7	14.4	7	9.27	**454.71** (lbs)
Item No.2	(P) Ant	92.4	14.8	7.4	9.50	**465.83** (lbs)

Date: 1/13/2015
Project Name: Portland USM
Project Number:ME5045
Designed By: SAG **Checked By:** MSC

Hudson Design Group LLC

ICE WEIGHT CALCULATIONS-Proposed Antenna

Thickness of ice:	1	
*Density of ice used=56 PCF		

Weight of ice based on total radial SF area:		**(P)Antenna** (OPA-65R-LCUU-H8)	
Depth (in):	7		
height (in):	92.7		
Width (in):	14.4		
Total weight of ice on object:		129	pounds ice
Weight of object:	95	pounds	
Combined weight of ice and object:		224	pounds

Per foot weight of ice:		**Pipe**	
pipe weight per foot:	3.65		
pipe length (ft):	9		
diameter (in):	2.375		
Per foot weight of ice on object:		3	pounds ice /ft
Total weight of ice on object:		26	pounds
Total weight of pipe:		32.85	pounds
Combined weight of pipe and ice:		59	pounds

Site Name: Portland USM
Site No. ME5045
Done by: SAG **Checked by:** MSC
Date: 1/13/2015

CHECK CONNECTION CAPACITY-Proposed Antenna (OPA-65R-LCUU-H8)

Reference: Hilti Volume 2: Anchor Fastening Technical Guide

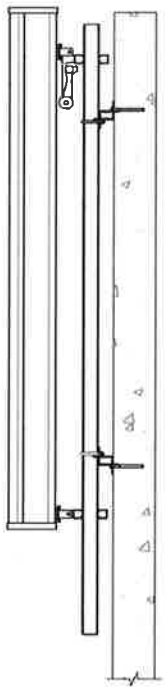
Epoxy Type =	HIT-HY200	
Anchor Diameter =	3/8	in.
Min. Embedment Depth =	2-3/8	in.

Allowable Tensile Load =

F_{Tall} = 2855 lbs.

Allowable Shear Load =

F_{Vall}= 3075 lbs. F= 455 lbs →



WIND FORCES

Reaction F = 455 lbs.

GRAVITY LOADS

Ice and Equipment 283 lbs.

No. of Supports = 2
No. of Anchors / Support = 2

Tension Design Load / Anchor =

f_t= 113.75 lbs. < 2855 lbs. **Therefore, OK !**

Shear Design Load / Anchor=

f_v= 70.75 lbs. < 3075 lbs. **Therefore, OK !**

CHECK COMBINED TENSION AND SHEAR

f_t / F_T	+	f_v / F_V	≤	1.0			
0.040	+	0.023	=	0.063	<	1.0	**Therefore, OK !**

Date: 1/13/2015
Project Name: Portland USM
Project Number:ME5045
Designed By: SAG **Checked By:** MSC

Hudson Design Group LLC

ICE WEIGHT CALCULATIONS-Proposed Antenna

Thickness of ice:	1	
*Density of ice used=56 PCF		

(P)Antenna (HPA-65R-BUU-H8)

Weight of ice based on total radial SF area:		
Depth (in):	7.4	
height (in):	92.4	
Width (in):	14.8	
Total weight of ice on object:		133 pounds ice
Weight of object:	68	pounds
Combined weight of ice and object:		201 pounds

Pipe

Per foot weight of ice:		
pipe weight per foot:	3.65	
pipe length (ft):	9	
diameter (in):	2.375	
Per foot weight of ice on object:		3 pounds ice /ft
Total weight of ice on object:		26 pounds
Total weight of pipe:		32.85 pounds
Combined weight of pipe and ice:		59 pounds

Site Name: Portland USM
Site No. ME5045
Done by: SAG **Checked by:** MSC
Date: 1/13/2015

CHECK CONNECTION CAPACITY-Proposed Antenna (HPA-65R-BUU-H8)

Reference: Hilti Volume 2: Anchor Fastening Technical Guide

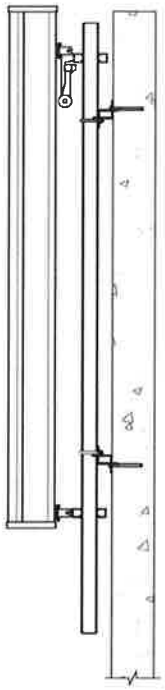
Epoxy Type =	HIT-HY200	
Anchor Diameter =	3/8	in.
Min. Embedment Depth =	2-3/8	in.

Allowable Tensile Load =

F_{Tall} = 2855 lbs.

Allowable Shear Load =

F_{Vall}= 3075 lbs. F= 466 lbs →



WIND FORCES

Reaction F = 466 lbs.

GRAVITY LOADS

Ice and Equipment 260 lbs.

No. of Supports = 2
No. of Anchors / Support = 2

Tension Design Load / Anchor =

f_t= 116.50 lbs. < 2855 lbs. **Therefore, OK !**

Shear Design Load / Anchor=

f_v= 65.00 lbs. < 3075 lbs. **Therefore, OK !**

CHECK COMBINED TENSION AND SHEAR

f_t / F_T	+	f_v / F_V	≤	1.0			
0.041	+	0.021	=	0.062	<	1.0	**Therefore, OK !**

Hudson Design Group LLC

Beta & Gamma Sector
Antenna Calculations

Date: 1/13/2015
Project Name: Portland USM
Project Number: ME5045
Designed By: SAG Checked By: MSC

Hudson Design Group LLC

2.6.5.2 Velocity Pressure Coeff:

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

z=	88.25	(ft)	Proposed Beta & Gamma
z_g=	900	(ft)	Sector Antenna & RRHs
α=	9.5		

K_z= 1.233

Kzmin ≤ Kz ≤ 2.01

Table 2-4

Exposure	Z_g	α	K_{zmin}	K_e
B	1200 ft	7	0.70	0.90
C	900 ft	9.5	0.85	1
D	700 ft	11.5	1.03	1.10

2.6.6.4 Topographic Factor:

Table 2-5

Topo. Category	K_t	f
2	0.43	1.25
3	0.53	2
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!

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=	88.25	
H=	0	(Ht. above surrounding terrain)
K_{zt}=	1.00	

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

Category= 1

Date: 1/13/2015
Project Name: Portland USM
Project Number: ME5045
Designed By: SAG **Checked By: MSC**

Hudson Design Group LLC

2.6.7 Gust Effect Factors

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=	88.25	Gh=	0.48825

2.6.7.2 Guyed Masts Gh= 0.85

2.6.7.3 Pole Structures Gh= 1.1

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

Date: 1/13/2015
Project Name: Portland USM
Project Number: ME5045
Designed By: SAG Checked By: MSC

Hudson Design Group LLC

2.6.8 Design Ice Thickness:

$t_{iz} = 2.0*t_i*I*K_{iz}*(K_{zt})^{0.35}$

t_i=	1
I=	1
K_{iz}=	1.10
K_{zt}=	1

t_{iz}= 2.21

$K_{iz} = [z/33]^{0.10} \leq 1.4$

K_{iz}= 1.10

Calculating the weight of ice, the cross-sectional area of ice shall be determined by:

$A_{iz} = \pi*t_{iz}*(D_c + t_{iz})$

Dc= 92.7 (in) Largest Dim of Member

A_{iz} = 657.96

2.6.9 Design Wind Load:

F= qz*Gh*(EPA's)

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

K_z=	1.233
K_{zt}=	1
K_d=	0.95
V_{max}=	100

q_z= 29.98

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**

Date: 1/13/2015
Project Name: Portland USM
Project Number: ME5045
Designed By: SAG Checked By: MSC

Hudson Design Group LLC

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

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

Dp = Outside Diameter or Out to Out: 0.2 feet

C= 22.21 **Cf=** 1.2

Appurtenances		Height	Width	Depth	Flat Area	Force Per Appurtenance
Item No.1	(P) Ant	92.7	14.4	7	9.27	**450.23** (lbs)
Item No.2	(P) Ant	92.4	14.8	7.4	9.50	**461.24** (lbs)
Item No.3	(E) ANT	72	11.8	7.14	5.90	**286.55** (lbs)
Item No.3	(P) RRH(11)	19.7	17	7.17	2.33	**112.96** (lbs)
Item No.4	(P) RRH(12)	20.4	18.5	7.5	2.62	**127.29** (lbs)
Item No.5	(P)RRH(E2)	20	20.4	9.5	2.83	**137.61** (lbs)
Item No.6	(P) RRH(32)	26.7	12.1	6.7	2.24	**108.97** (lbs)
Item No.7	(P) A2 Mod	16.4	15.2	3.4	1.73	**84.08** (lbs)

Date: 1/13/2015
Project Name: Portland USM
Project Number:ME5045
Designed By: SAG **Checked By**: MSC

Hudson Design Group LLC

ICE WEIGHT CALCULATIONS-Proposed Antenna

Thickness of ice: 1
*Density of ice used=56 PCF

(P)Antenna x2

Weight of ice based on total radial SF area:		
Depth (in):	7	
height (in):	92.7	
Width (in):	14.4	
Total weight of ice on object:	129	pounds ice
Weight of object:	95	pounds
Combined weight of ice and object:	447	pounds

Pipe x2

Per foot weight of ice:		
pipe weight per foot:	3.65	
pipe length (ft):	9	
diameter (in):	2.375	
Per foot weight of ice on object:	3	pounds ice /ft
Total weight of ice on object:	26	pounds
Total weight of pipe:	32.85	pounds
Combined weight of pipe and ice:	118	pounds

4"x4"x1/2" angle

Weight of ice based on total radial SF area:		
Depth (in):	4	
height (in):	4	
Width (in):	84	
Total weight of ice on object:	23	pounds ice
Weight of object:	90	pounds
Combined weight of ice and object:	226	pounds

(P)RRH(32)

Weight of ice based on total radial SF area:		
Depth (in):	6.7	
height (in):	26.7	
Width (in):	12.1	
Total weight of ice on object:	33	pounds ice
Weight of object:	60	pounds
Combined weight of ice and object:	93	pounds

(P)RRH(E2)

Weight of ice based on total radial SF area:		
Depth (in):	9.5	
height (in):	20	
Width (in):	20.4	
Total weight of ice on object:	39	pounds ice
Weight of object:	58	pounds
Combined weight of ice and object:	97	pounds

Site Name: Portland USM
Site No. ME5045
Done by: SAG **Checked by:** MSC
Date: 1/13/2015

CHECK CONNECTION CAPACITY-Proposed Antenna

Reference: Hilti Volume 2: Anchor Fastening Technical Guide

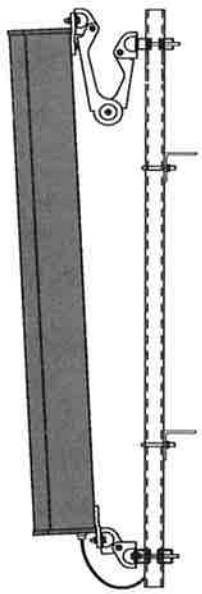
Epoxy Type =	HIT-HY20	assumed	
Anchor Diameter =	1/2	in.	
Min. Embedment Depth =	2	in.	assumed

Allowable Tensile Load =

F_{Tall} = 525 lbs.

Allowable Shear Load =

F_{Vall}= 1230 lbs. F= 1158 lbs →



WIND FORCES

Reaction F = 1158 lbs.

GRAVITY LOADS

Ice and Equipment 981 lbs.

No. of Supports = 4
No. of Anchors / Support = 3

Tension Design Load / Anchor =

f_t= 96.50 lbs. < 525 lbs. **Therefore, OK !**

Shear Design Load / Anchor=

f_v= 81.75 lbs. < 1230 lbs. **Therefore, OK !**

CHECK COMBINED TENSION AND SHEAR

f_t / F_T	+	f_v / F_V	≤	1.0			
0.184	+	0.066	=	0.250	<	1.0	**Therefore, OK !**