Reviewed for Code Compliance
Inspections Division
Approved with Conditions
Date: 12/16/16

STRUCTURAL ANALYSIS REPORT

For

4DN2284B

ME284 / 1 CITY CENTER

1 City Center
Portland, ME 04101

Antennas on Parapet and on Ballast Sleds; Equipment Curb on the Roof

Prepared for:

CENTERLINE COMMUNICATIONS

T-Mobile

Dated: October 11, 2016

Prepared by:

Hudson Design Group LLC

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

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SCOPE OF WORK:

Hudson Design Group LLC (HDG) has been authorized by T-Mobile to conduct a structural evaluation of the structure supporting the proposed T-Mobile 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 T-Mobile's proposed equipment.

This office conducted an on-site visual survey of the above areas on September 30, 2016. Attendees included Manuel Tejada (HDG – Field Technician).

CONCLUSION SUMMARY:

Building plans prepared by William Dorsky Associates dated were available and were obtained for our use. A limited visual survey of the structure was completed in or near the areas of the proposed work. The following documents were sued for our reference:

- Construction drawings prepared by Edwards and Kelcey Wireless dated March 11, 1998.

Based on our evaluation, we have determined that the existing structure **IS CAPABLE** of supporting the proposed equipment within or near the proposed locations with the following minor modifications:

- **Replace the existing 2" Std. pipe mast at Alpha with a new 2-1/2" X-Strong pipe mast (total of one).**
- **Rearrange the existing ballast blocks to meet to requirements shown in the table below:**

MINIMUM BALLAST REQUIREMENTS (BETA/GAMMA)		
SIDE	A (Back)	B (Front)
BALLAST REQUIRED	803 lbs.	484 lbs.
TOTAL BALLAST WEIGHT	1,287 lbs.	

APPURTENANCE/EQUIPMENT CONFIGURATION:

(3) APX16DWV-S-E-A20 Antennas (55.9"x13.3"x3.2" - Wt. = 41 lbs. /each)

(3) AIR21 B4A/B2P Antennas (56"x12.1"x7.9" – Wt. = 96 lbs/each)

(6) Twin TMA's

Referenced documents are attached.

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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:	50 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:	**35 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:

   168'-0"+/- (Alpha)
   157'-0"+/- (Beta & Gamma)

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EXISTING ROOF CONSTRUCTION:

The existing roof construction consists of a roofing membrane over rigid insulation over a reinforced concrete roof slab supported by a system of reinforced concrete beams, reinforced concrete columns, and CMU bearing walls.

ANTENNA SUPPORT RECOMMENDATIONS:

- The new Alpha sector antenna is proposed to be mounted on an existing pipe mast attached to existing angle wall mounts secured to the inside face of the existing concrete parapet with epoxy anchors.
- The new Beta and Gamma sector antennas are proposed to be mounted on existing pipe masts secured to existing non-penetrating ballast sleds 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 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.
7. A condition assessment of the existing roof was not part of the scope of work.

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FIELD PHOTOS:

Photo 1: Sample photo illustrating the existing Alpha sector antennas.

Photo 2: Sample photo illustrating the existing Beta sector antennas.

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FIELD PHOTOS (Cont.):

Photo 3: Sample photo illustrating the existing Gamma sector antennas.

Photo 4: Sample photo illustrating the existing T-Mobile equipment cabinets.

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Alpha Sector
Calculations

Date: 10-11-2016
Project Name: ME284 / 1 City Center
Project Number: 4DN2284B
Designed By: GH **Checked By:** MSC

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ALPHA SECTOR

2.6.5.2 Velocity Pressure Coeff:

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

z=	168	(ft)
z_g=	900	(ft)
α=	9.5	

K_z= 1.412

Kzmin ≤ Kz ≤ 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=	168	
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=	148	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

$$F = qz*Gh*(EPA)_A$$

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

K_z=	1.412
K_{zt}=	1.0
K_d=	0.95
V_{max}=	100
I=	1.0

q_z= 34.33

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= 29.70 **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) (normal)
APX16-DWV-S-E-A20	55.9	13.3	3.2	5.16	4.20	1.28	**305**
AIR21 B4A/B2P	56.0	12.1	7.9	4.71	4.63	1.29	**282**
TMA	9.9	6.7	5.4	0.46	1.48	1.20	**26**

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ICE WEIGHT CALCULATIONS

Project: 4DN2284B

Thickness of ice:	1 in.
Density of ice:	56 pcf

APX16DWV-S-E-A20 Antenna

Weight of ice based on total radial SF area:

Depth (in):	3.2	
height (in):	55.9	
Width (in):	13.3	
Total weight of ice on object:		72 lbs
Weight of object:	41 lbs	
Combined weight of ice and object:		113 lbs

Twin TMA

Weight of ice based on total radial SF area:

Depth (in):	5.4	
height (in):	9.9	
Width (in):	6.7	
Total weight of ice on object:		13 lbs
Weight of object:	16 lbs	
Combined weight of ice and object:		29 lbs

AIR21 B4A/B2P Antenna

Weight of ice based on total radial SF area:

Depth (in):	7.9	
height (in):	56	
Width (in):	12.1	
Total weight of ice on object:		89 lbs
Weight of object:	57 lbs	
Combined weight of ice and object:		146 lbs

2-3/8" Pipe

Per foot weight of ice:

diameter (in):	2.38	
Per foot weight of ice on object:		3 plf

Project: 4DN2284B

Location: Existing Alpha Pipe
Multi-Loaded Multi-Span Beam
[2009 International Building Code(AISC 13th Ed ASD)]
Pipe 2 Std. x 8.5 FT (6.5 + 1.1 + 0.9) / ASTM A53-GR.B
Section Inadequate By: 125.7%
Controlling Factor: Deflection

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DEFLECTIONS	Left		Center		Right	
Live Load	1.37	IN 2L/114	-0.01	IN L/1579	0.02	IN 2L/1216
Dead Load	0.09	in	0.00	in	0.00	in
Total Load	1.47	IN 2L/106	-0.01	IN L/1480	0.02	IN 2L/1136

Live Load Deflection Criteria: L/180 Total Load Deflection Criteria: L/240

REACTIONS	A		B	
Live Load	1377	lb	0	lb
Dead Load	96	lb	-65	lb
Total Load	1472	lb	-65	lb
Uplift (1.5 F.S)	0	**lb**	**-1133**	**lb**
Bearing Length	0.45	in	0.00	in

BEAM DATA	Left		Center		Right	
Span Length	6.5	ft	1.08	ft	0.92	ft
Unbraced Length-Top	0	ft	0	ft	0	ft
Unbraced Length-Bottom	6.5	ft	1.08	ft	0.92	ft

STEEL PROPERTIES
Pipe 2 Std. - A53-GR.B

Properties:

Steel Yield Strength:	Fy =	35	ksi
Modulus of Elasticity:	E =	29000	ksi
Tube Steel Section (X Axis):	dx =	2.38	in
Tube Steel Section (Y Axis):	dy =	2.38	in
Tube Steel Wall Thickness:	t =	0.143	in
Area:	A =	1	in2
Moment of Inertia (X Axis):	Ix =	0.63	in4
Section Modulus (X Axis):	Sx =	0.53	in3
Plastic Section Modulus:	Z =	0.71	in3

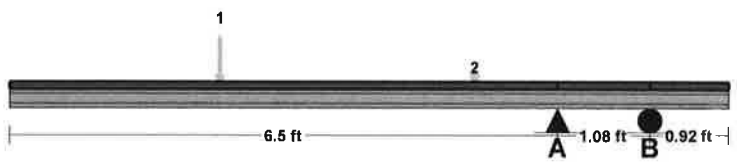
Design Properties per AISC 13th Edition Steel Manual:

Flange Buckling Ratio:	FBR =	16.61	
Allowable Flange Buckling Ratio:	AFBR =	58	
Allowable Flange Buckling Ratio non-compact:	AFBR_NC =	256.86	
Nominal Flexural Strength w/ Safety Factor:	Mn =	1245	ft-lb
Controlling Equation:	F8-1		
Shear Buckling Stress Coefficient Eqn. G6-2a:	Fcr =	21	ksi
Nominal Shear Strength w/ Safety Factor:	Vn =	6287	lb

Controlling Moment: -1231 ft-lb
Over right support of span 1 (Left Span)
Created by combining all dead loads and live loads on span(s) 1, 2, 3
Controlling Shear: 1141 lb
At left support of span 2 (Center Span)
Created by combining all dead loads and live loads on span(s

Comparisons with required sections:	Req'd	Provided
Moment of Inertia (deflection):	1.41 in4	0.63 in4
Moment:	-1231 ft-lb	1245 ft-lb
Shear:	1141 lb	6287 lb

LOADING DIAGRAM



UNIFORM LOADS	Left		Center		Right	
Uniform Live Load	0	plf	0	plf	0	plf
Uniform Dead Load	0	plf	0	plf	0	plf
Beam Self Weight	4	plf	4	plf	4	plf
Total Uniform Load	4	plf	4	plf	4	plf

POINT LOADS - LEFT SPAN		
Load Number	One	Two
Live Load	282 lb	26 lb
Dead Load	0 lb	0 lb
Location	2.5 ft	5.5 ft

NOTES

Project: 4DN2284B

Location: Proposed Alpha Pipe
Multi-Loaded Multi-Span Beam
[2009 International Building Code(AISC 13th Ed ASD)]
Pipe 2-1/2 x-Strong x 8.5 FT (6.5 + 1.1 + 0.9) / ASTM A53-GR.B
Section Adequate By: 20.7%
Controlling Factor: Deflection

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DEFLECTIONS	Left		Center		Right	
Live Load	0.47	IN 2L/332	0.00	IN L/4610	0.01	IN 2L/3548
Dead Load	0.07	in	0.00	in	0.00	in
Total Load	0.54	IN 2L/290	0.00	IN L/4035	0.01	IN 2L/3090

Live Load Deflection Criteria: L/180 Total Load Deflection Criteria: L/240

REACTIONS	A		B	
Live Load	1377	lb	0	lb
Dead Load	202	lb	-137	lb
Total Load	1579	lb	-137	lb
Uplift (1.5 F.S)	**0**	**lb**	**-1205**	**lb**
Bearing Length	0.51	in	0.00	in

BEAM DATA	Left		Center		Right	
Span Length	6.5	ft	1.08	ft	0.92	ft
Unbraced Length-Top	0	ft	0	ft	0	ft
Unbraced Length-Bottom	6.5	ft	1.08	ft	0.92	ft

STEEL PROPERTIES
Pipe 2-1/2 x-Strong - A53-GR.B

Properties:

Steel Yield Strength:	Fy =	35	ksi
Modulus of Elasticity:	E =	29000	ksi
Tube Steel Section (X Axis):	dx =	2.88	in
Tube Steel Section (Y Axis):	dy =	2.88	in
Tube Steel Wall Thickness:	t =	0.257	in
Area:	A =	2.11	in2
Moment of Inertia (X Axis):	Ix =	1.83	in4
Section Modulus (X Axis):	Sx =	1.27	in3
Plastic Section Modulus:	Z =	1.77	in3

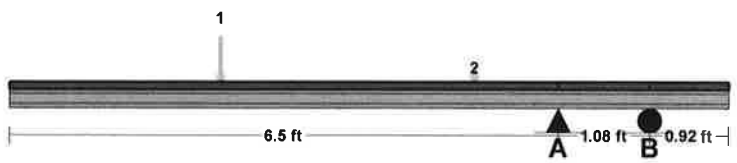
Design Properties per AISC 13th Edition Steel Manual:

Flange Buckling Ratio:	FBR =	11.19	
Allowable Flange Buckling Ratio:	AFBR =	58	
Allowable Flange Buckling Ratio non-compact:	AFBR_NC =	256.86	
Nominal Flexural Strength w/ Safety Factor:	Mn =	3091	ft-lb
Controlling Equation:	F8-1		
Shear Buckling Stress Coefficient Eqn. G6-2a:	Fcr =	21	ksi
Nominal Shear Strength w/ Safety Factor:	Vn =	13266	lb

Controlling Moment: -1317 ft-lb
Over right support of span 1 (Left Span)
Created by combining all dead loads and live loads on span(s) 1, 2, 3
Controlling Shear: 1221 lb
At left support of span 2 (Center Span)
Created by combining all dead loads and live loads on span(s

Comparisons with required sections:	Req'd	Provided
Moment of Inertia (deflection):	1.52 in4	1.83 in4
Moment:	-1317 ft-lb	3091 ft-lb
Shear:	1221 lb	13266 lb

LOADING DIAGRAM



UNIFORM LOADS	Left		Center		Right	
Uniform Live Load	0	plf	0	plf	0	plf
Uniform Dead Load	0	plf	0	plf	0	plf
Beam Self Weight	8	plf	8	plf	8	plf
Total Uniform Load	8	plf	8	plf	8	plf

POINT LOADS - LEFT SPAN		
Load Number	One	Two
Live Load	282 lb	26 lb
Dead Load	0 lb	0 lb
Location	2.5 ft	5.5 ft

NOTES

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Site Name: ME248 / 1 City Center
Site No. 4DN2284B
Done by: GH **Checked by:** MSC
Date: 10/11/2016

Hudson Design Group LLC

CHECK CONNECTION CAPACITY

Reference: Hilti North American Product Technical Guide 2008

Epoxy Type =	HIT-HY20	(Assumed)
Anchor Diameter =	3/8	in.
Embedment Depth =	2	in. (Assumed)

Allowable Tensile Load =

F_{Tall} = 525 lbs.

Allowable Shear Load =

F_{Vall}= 790 lbs.

WIND FORCES

Reaction **F =** 1377 lbs.
(See StruCalc Results)

GRAVITY LOADS

Ice and Equipment 240 lbs.

No. of Supports = 2
No. of Anchors / Support = 4

Tension Design Load / Anchor =

f_t= 344.25 lbs. < 525 lbs. **Therefore, OK !**

Shear Design Load / Anchor=

f_v= 30.00 lbs. < 790 lbs. **Therefore, OK !**

CHECK COMBINED TENSION AND SHEAR

f_t / F_T	+	f_v / F_V	≤	1.0			
0.656	+	0.038	=	0.694	<	1.0	**Therefore, OK !**

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Beta & Gamma Sector Calculations

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BETA & GAMMA SECTORS

2.6.5.2 Velocity Pressure Coeff:

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

z=	157	(ft)
z_g=	900	(ft)
α=	9.5	

K_z= 1.392

Kzmin ≤ Kz ≤ 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=	157	
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=	148	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

$$F = qz*Gh*(EPA)_A$$

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

q_z=	33.85

K_z=	1.392
K_{zt}=	1.0
K_d=	0.95
V_{max}=	100
I=	1.0

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= 29.49 **Cf=** 1.2

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Hudson Design Group LLC

CITY OF PORTLAND, MAINE
Reviewed for Code Compliance
Inspections Division
Approved with Conditions
Date: 12/16/16

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) (normal)
APX16-DWV-S-E-A20	55.9	13.3	3.2	5.16	4.20	1.28	**301**
AIR21 B4A/B2P	56.0	12.1	7.9	4.71	4.63	1.29	**278**
TMA	9.9	6.7	5.4	0.46	1.48	1.20	**25**

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Date: 10/11/2016
Site Number: 4DN2284B
Site Name: ME284 / 1 City Center
Done by: GH **Checked by:** MSC

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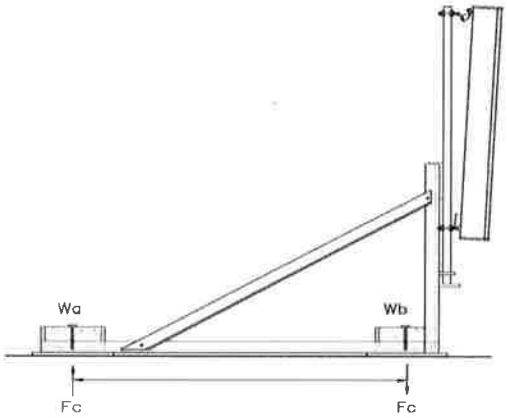
Calculate Total Ballast Required for Ballast Mount (BETA & GAMMA)

WIND FORCES

F antenna = 579 lbs.

F tma = 25 lbs.



Antenna Height = 9 ft

TMA Height = 5 ft

Length = 7 ft

Overturning at Ballast

Moment = 6670 lbs.-ft

S.F.
1.25

Hold Down Force = 952.86 lbs. Per Side

Wa Ballast

Equipment

Frame = 150 lbs.

Total Ballast Required Wa= **802.86 lbs.**

Wb Ballast

Equipment

Frame	300 lbs.
Antennas	137 lbs.
TMA's	32 lbs.
Total =	469 lbs.

Total Ballast Required Wb = **483.86 lbs.**

Total weight of Fully Loaded Ballast Frame =	1906 lbs
Footprint Area under Ballast Frame =	62.5 ft^2
Area Load under Ballast Frame =	30 psf

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Referenced Documents

CITY OF PORTLAND, MAINE
RESURGAM
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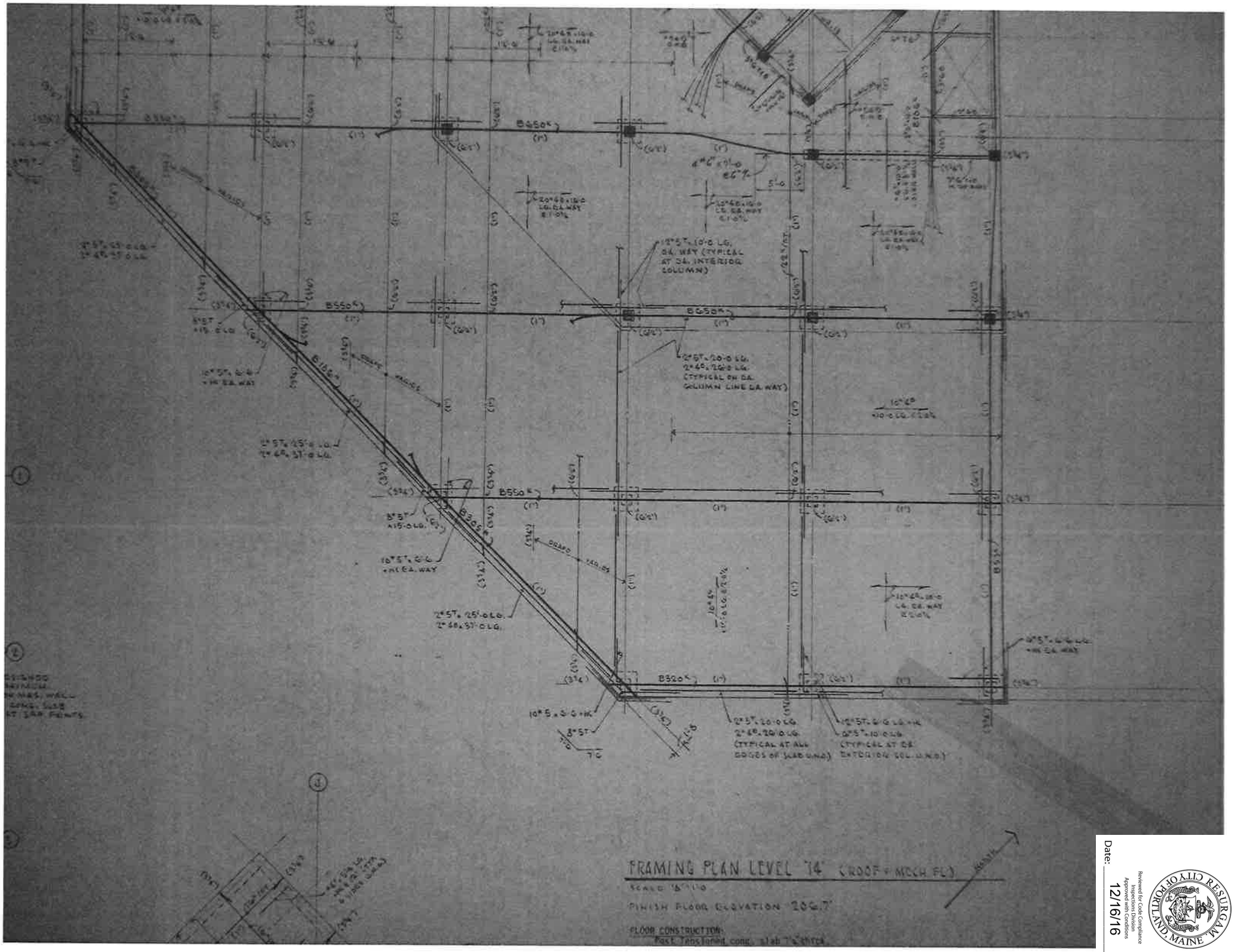

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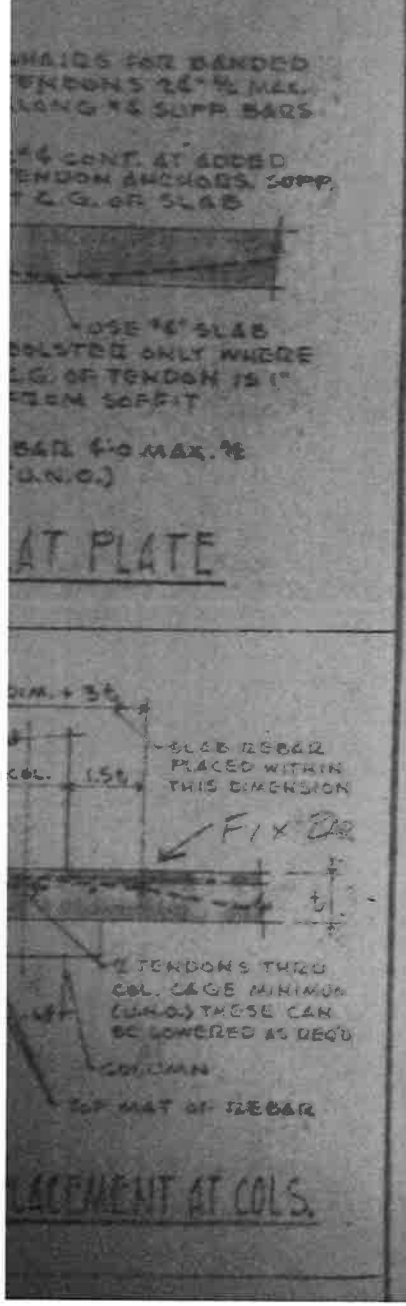

GENERAL NOTES

See Specifications for Detailed Requirements

LIVE LOAD:

Roof	35 psf	Office & Retail	75 psf
Snow Accumulation per ANSI A-58.1		Lobbies	100 psf
Stairs	100 psf		

EARTHQUAKE LOAD: By BOCA 1981, Zone 2, box system (Z = 0.50, K = 1.33)

FOUNDATIONS: Per soils report by Morrison Geotechnical Engineering.

1. Design bearing pressure is 16,000 psf on bedrock.
2. Provide sheeting, shoring and bracing as required to protect adjacent buildings, streets and utilities.
3. Notify structural engineer and soils consultant of any unusual soil conditions before proceeding with work.
4. Place footings at elevations shown or to bedrock of design capacity: whichever is lower.
5. Footing steps may be one (1) vertical to two (2) horizontal with maximum step of two feet.
6. Remove accumulated water from side-sumps adjacent to footing excavations.
7. Do not backfill against basement walls until the first level slab and second level are in place.
8. Compact backfill over footings and beneath slab-on-grade to 95% standard density per ASTM D698 at +2% optimum moisture content. See specifications for other backfill requirements.

CONCRETE: Per ACI 318-83 and ACI 301-72 (Rev. 81)

1. Concrete Types	Min. Strength:	Min. Cement:	Max. W/C*
Footings, piers and grade beams	3000 psi:	470#/cy:	.60
All others	4000 psi:	564#/cy:	.50

*W/C = Water to Cement Ratio

2. Use superplasticizer in concrete to be pumped.
3. Use 6% ±1½% entrained air, ASTM C260, for all concrete exposed to weather.
4. Do not use calcium chloride or admixtures containing chlorides in prestressed concrete or concrete on permanent metal form deck.
5. Use non-staining curing compound on all flat or formed surfaces, compatible with flooring or sealer, or moist cure per ASTM C171.
6. Reinforcing Steel:
   a. Deformed bars per ASTM A615, Grade 60 except Grade 40 for #3 bars.
   b. Welded wire fabric per ASTM A185.
   c. Post-tension tendons to be 7 wire strand, 270 ksi per ASTM A416, greased, plastic coated.
   d. Lap reinforcement 36 diameters unless noted otherwise.
7. Expansion anchors into concrete to be wedge type.
8. Construction joints:
   a. Basement walls: 60' max spacing, vertical joints only.
   b. Beams & slabs: at midspan, use keyed joint and top dowels.
   c. Use waterstops in all horizontal and vertical construction joints in well

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