Structural Analysis Report

Structural Analysis: Self-Supporting Tubular Crank-Up Tower

Mast Model: MA850

Design Code: IBC 2009 (TIA-222-G)

Basic Wind Velocity:	85	mph 3 second gust
Exposure		C
Ice Thkn's (in):		0
Topographic Category:		1
Structure Classification:		1

Max. Allowable Antenna Wind Load - Unfactored (lbs)	192
Max. Allowable Antenna Weight (lbs):	100
Max. Allowable Antenna Effective Wind Area (sq. ft.):	12.0

Note: The maximum antenna values shown above include the antenna, rotator, and any other items placed at the top of the tower. For purposes of these calculations the antenna was placed above the top of the tower a distance of (ft): 1

The tower Shall be retracted if winds over 50 mph are expected

Date Prepared: 6/5/2013

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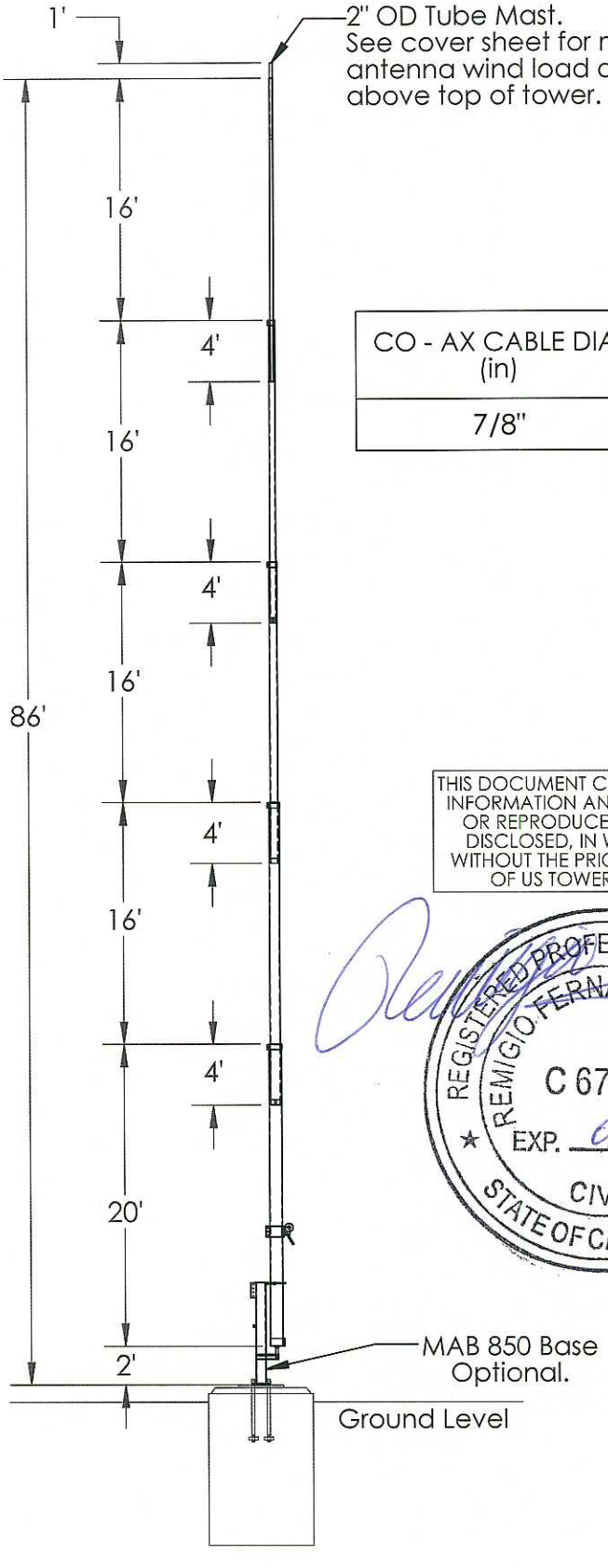
MA-850 TOWER ELEVATION

SECTION NO.	TUBE SIZE
MA 10	ROUND TUBE 10" OD X 0.135" WALL
MA 8	ROUND TUBE 8" OD X 0.135" WALL
MA 6	ROUND TUBE 6" OD X 0.135" WALL
MA 4.5	ROUND TUBE 4 1/2" OD X 0.120" WALL
MA 3	SQUARE TUBE 3" X 0.120" WALL



CO - AX CABLE DIA. (in)	MAX. QUANTITY
7/8"	1

REGISTERED PROFESSIONAL ENGINEER
REMIGIO FERNANDEZ-GARCIA
C 67794
EXP. 06/13
CIVIL
STATE OF CALIFORNIA

Elevation View
No Scale

General Notes

Tower Model: **MA850**

1. All work shall be in conformance with the requirements of the "International Building Code - 2009" and "Structural Standards for Steel Antenna Towers and Antenna Supporting Structures TIA/EIA-222-G", by the Telecommunications Industry Association.
2. The 2009 International Building Code requires the use TIA/EIA-222-G for tower design. TIA/EIA requires the use of the American Institute of Steel Construction, LRFD Specification for Structural Steel Buildings, December 27, 1999. (AISC 3rd Edition). Consequently, all steel design was performed using the AISC 3rd Ed.
3. All concrete shall have a minimum compressive strength of 2500 psi at 28 days unless noted otherwise. All concrete shall conform to the requirements of the International Building Code and referenced edition of ACI 318. Slump shall not exceed 4-1/2 inches.
4. Reinforcing steel shall be intermediate grade deformed bars conforming to ASTM A-615. No. 4 bars and smaller shall be Grade 40, No. 5 bars and larger shall be Grade 60. All reinforcing details, placement etc. shall conform to the requirements of the International Building Code and ACI 318. No welding allowed.
5. All reinforcing steel, anchor bolts, dowels and other inserts etc. shall be securely anchored in place, in the required positions, prior to pouring concrete.
6. Steel fabrication and erection shall conform to the requirements of the AISC Manual of Steel Construction and the Electronic Industries Association (as referenced in note 1 & 2 above).
7. All welding shall be performed by AWS certified welders for each type of weld used. (Using the GMAW welding process with ER70S-6 welding wire.
8. All tower section lift cables & guy cables shall be 7 x 19 Aircraft cable with the following minimum strengths:

Cable diameter (in)	Minimum Strength (lbs)
3/16	4200
1/4	7000
5/16	9800
3/8	14400
7/16	17600
1/2	22800

9. This tower analysis is based the antenna being installed at a height of one foot above the top of the tower. The wind load of the antenna(s) shall not exceed the load shown in these calculations. The Owner of the tower shall assume full liability for verification of the antenna loading.
10. This tower is designed to be used in its fully extended position.
11. The design of the hoist system is not with in the scope of these calculations and shall be designed by others.
12. This tower has not been designed to meet any twist or sway criteria.
13. The Owner shall verify that the quantity and size of waveguide / Coax cables match the values used in these calculations.
14. The engineering and design of the antennas are not with-in the scope of these calculations.
15. Installations on hills, escarpments and other special wind areas is not with-in the scope of these calcuations.
16. US Tower Corp. recommends that the installation of this tower and its foundation be performed by a Professional, licensed Contractor with experience installing these types of structures.
17. The Contractor is responsible for conducting all construction in accordance with all Federal, State, OSHA, and Local laws and ordinances. The Contractor is also responsible for checking the site for underground facilities prior to the start of work.

General Notes

Tower Model: **MA850**

18. US Tower Corp. and it's Engineers shall not be responsible for errors and omissions in the project not in conformance with these calculations and the Codes and Standards referenced here-in.
19. US Tower Corp. and it's Engineers accept no responsibility for field inspection during construction nor for the method of construction.
20. The Owner shall assume full responsibility & liability for the periodic inspection of all tower section lift cables & guy cables. Any cable with any sign of distress or excessive stretch shall be replaced immediately.
21. The information contained in these calculations is the property of US Tower Corp. and shall only be used to obtain an installation permit. Any other use shall be authorized by US Tower in writing prior to utilizing the information contained herein.

Code & Material Specifications

Mast Model: MA850

Governing Codes, Stresses, and Materials (Min.)

International Building Code	2009 Edition (Occ. Cat. II)
TIA-222-G	
AISC Specification for Steel Bldgs	AISC LRFD 3rd Edition
ACI 318	2008 Edition
Wind Loading	Basic Wind Speed
Governed by the TIA/EIA standard	50 mph, 3 second gust
	(Exposure B Terrain)
Structural Steel	ASTM A36
(All plates, bars, angles)	(F-y = 36 ksi)
	(Min. F-y for plates - 42 ksi)
Structural Pipe	ASTM A53 Gd. B, A500 Gd. B
	(F-y = 50 ksi for tower legs)
Structural Tubing (HSS)	ASTM A500 Gd. B
	(F-y = 46 ksi)
Welding	AWS D1.1-04
	GMAW w/ ER70S-6 wire
Hot-Dip Galvanizing	ASTM A123
Hardware	ASTM A153
Bolts: Tower & Accessories	ASTM A325
Reinforced Concrete	2500 psi strength @ 28 days
Reinforcing Steel	ASTM A615
	Gd. 40 for #4 & smaller dia.
	Gd. 60 for $5 & larger dia.
Anchor Rods	ASTM F1554 Gd. 36 or A-36
Foundation & Soils	1500 psf Bearing (TL = DL+LL)
Lateral Bearing Pressure	100 psf/ft of depth

Mast Section Properties

Mast Model: MA850

Design per EIA-222-G						
Structure Classification:	1	Importance Factor:	0.87	Ice Thickness (in):	0	
Wind velocity (mph):	85	Tower Height (ft):	25	Ice Weight (lb/in3):	56	
Exposure:	C	Topo Category:	1	Design Ice t (in):	0.00	
Z-g:	900	K-t:	1	Material Density:	0.284	(lb/in^3)
alpha:	9.5	f:	1			
K-z min:	0.85	H (ft):	0	Ht. of crest above surrounding terrain		
K-e:	1	K-h:	N.A.	Reduction factor		
K-d:	0.95	K-zt:	1.00	Topo wind speed up factor		
Gust Factor:	1.1	K-z:	0.945	Velocity pressure coefficient		

Section Name	MA3	MA45	MA6	MA8	MA10	NA	NA	NA
Section length (ft):	20	20	20	20	20	0	0	0
Top lap length (ft):	0	4	4	4	4	0	0	0
Bot lap length (ft):	4	4	4	4	0	0	0	0
Tube shape:								
1=round, 2=sq., 3=16 side	2	1	1	1	1	1	1	1
Tube O.D. :	3	4.5	6	8	10	0	0	0
(Note: OD = face width of square tubes, outside flat to flat of 16 sided polygons.								
Wall thk'ness:	0.12	0.135	0.135	0.135	0.135	0	0	0
Tube I.D.:	2.76	4.23	5.73	7.73	9.73	0.00	0.00	0.00
Tube F-y: (Steel only)	36000	36000	36000	36000	36000	36000	36000	36000
C: (For sq. tubes is aspect ratio)	64.0	28.8	38.2	50.8	60.9	0.0	0.0	0.0
C-f, force coefficient:	2.00	1.20	1.00	0.76	0.63	1.20	1.20	1.20

Linear Appurtenances:	Co-ax Cable dia. (in):	0.875	Lift Cable dia. (in):	0.25	
	Cable wt (lb/ft):	0.3	Cable wt. (lb/ft):	0.07	
	No. of Cables:	1	No. of Cables:	1	
		No ICE			

Projected Area:								
Tube (s.f. / ft.):	0.500	0.450	0.502	0.504	0.525	0.000	0.000	0.000
Co-ax cable (s.f./ft.):	0.088	0.088	0.088	0.088	0.088	0.000	0.000	0.000
Lift cable(sq. ft. /ft.):	0.025	0.025	0.025	0.025	0.025	0.000	0.000	0.000
Tot. Unif. EPA (sq.ft./ft.):	**0.613**	**0.563**	**0.615**	**0.617**	**0.638**	**0.000**	**0.000**	**0.000**

Appurtenance @ top of Section: (Includes top caps & other items, coax arms not included since R-a < 0.1)								
Width (in):	4.00	5.50	7.00	9.00	11.00	0.00	0.00	0.00
Height (in):	2.00	2.00	2.00	2.00	2.00	0.00	0.00	0.00
C-f, force coefficient (Tbl. 2-8)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Conc. EPA @ top (sq. ft.):	**0.067**	**0.092**	**0.117**	**0.150**	**0.183**	**0.000**	**0.000**	**0.000**

Weight:								
Top cap:	3	5	6	8	10	0	0	0
Tube:	94	126	170	227	285	0	0	0
Bot. anchor:	3	5	6	8	10	0	0	0
Lift cable & standoff:	5	5	5	5	5	5	5	5
Misc.:	11	14	19	25	31	1	1	1
Total weight:	**116**	**155**	**205**	**273**	**341**	**0**	**0**	**0**

Top Mounted Equipment: (Antenna etc.)			
Antenna / Camera Area (sq.ft.):	10	Antenna Mast Diameter (in.):	2.0
Shape (1= round, 2 = flat):	1	Mast Length (ft):	2.0
C-f:	1.2	C-f:	1.2
Concentrated PA (sq. ft.)	12	**Concentrated PA (sq. ft.)**	0.400
Weight (lbs):	100	**Weight (lbs):**	5.0

Mast Loading

Mast Model: **MA850**

Tower Loading, Shear & Moments:

Design per EIA-222-G

Wind velocity (mph):	**85**	
Exposure:	**C**	
Topo Category:	**1**	
Tower Height (ft):	25	
Structure Class:	**1**	
H (ft):	0	Ht. of crest above surrounding terrain
K-h:	N.A.	Height reduction factor
K-zt:	1.00	Topo wind speed up factor
K-e:	1	Terrain constant
Kt:	1	Topographic constant
Are lift cables used? (Y/N)	Y	

G-h:	1.1	Gust factor
I:	0.87	Importance factor
Kd:	0.95	Wind direction probability factor
f:	1	Topographic coefficient
Zg:	900	Exposure category coefficient
alpha:	9.5	Exposure category coefficient
Kz-min:	0.85	Exposure category coefficient
Load Factor - Wind:	**1.6**	
Load Factor - Dead:	**1.2**	
Ant. Height Above Top of Mast (ft):	**1**	
Approx. Width of Payload Spread (ft):	**2.0**	(For determining min. torsion value to apply at top of mast.)

Base Top Bracket Height
Hbr = **6** ft
(Height at top of MARB/MAB or Eave)

Wind Velocicity Coeficient
Kz = 2.01*(z/Zg)^(2/a) z > 15'
q-z = 0.00256 * Kz * Kzt * Kd * I * G-h * V^2

Factored Loads - No ICE / Controlling Loading & Condition

Tower Section	Projected Area	Analysis height (ft)	z height (ft)	Kz	q-z (basic)	w (plf) or P (lb)	Shear (lbs)	Moment (ft-lbs)	P-Delta Mom. (ft-lbs)	Total Moment	Deflection (in)	Sway (deg)	Shear (lbs)	Moment (ft-lbs)	Load Condition
Antenna	12	26	26	0.953	14.57	307.7	308	0	0	0	2.5	0.9	308	0	No Ice
Mast	0.400	25	25.5	0.949	14.51	10.2	318	318	0	318	2.5	0.9	318	318	No Ice
Top of Section	0.067	25	25	0.945	14.45	1.7	320	318	0	318	2.5	0.9			
MA3	0.613	**24.25**	24.625	0.942	14.40	15.5	331	562	1	563	2.5	0.9	331	563	No Ice
Top of Section	0.092	24.25	24.25	0.939	14.36	2.3	334	562	1	563	2.5	0.9			
	0.563	24.25	24.25	0.939	14.36	14.2	334	562	1	563	-	-	334	563	No Ice
MA45	0.563	**23.5**	23.875	0.936	14.31	14.2	344	816	1	817	2.5	0.9	344	817	No Ice
Top of Section	0.117	23.5	23.5	0.933	14.26	2.9	347	816	1	817	2.5	0.9			
	0.615	23.5	23.5	0.933	14.26	15.4	347	816	1	817	-	-	347	817	No Ice
MA6	0.615	**22.75**	23.125	0.930	14.21	15.4	359	1081	1	1082	2.5	0.9	359	1082	No Ice
Top of Section	0.150	22.75	22.75	0.927	14.17	3.7	362	1081	1	1082	2.5	0.9			
	0.617	22.75	22.75	0.927	14.17	15.4	362	1081	1	1082	-	-	362	1082	No Ice
MA8	0.617	**22**	22.375	0.923	14.12	15.3	374	1357	1	1358	2.5	0.9	374	1358	No Ice
Top of Section	0.183	22	22	0.920	14.07	4.5	378	1357	1	1358	2.5	0.9			
Bracket	0.638	6	14	0.850	12.99	14.6	612	9279	1	9280	-	-	612	9280	No Ice
MA10	0.638	**0.1**	3.05	0.850	12.99	14.6	698	13143	225	13368	0.0	0.0	698	13368	No Ice
Top of Section	0.000	0	0	0.850	12.99	0.0	0	0	0	0	0.0	0.0			
	0.000	0	0	0.850	12.99	0.0	0	0	0	0	-	-	0	0	No Ice
NA	0.000	**0**	0	0.850	12.99	0.0	0	0	0	0	0.0	0.0	0	0	No Ice
Top of Section	0.000	0	0	0.850	12.99	0.0	0	0	0	0	0.0	0.0			
	0.000	0	0	0.850	12.99	0.0	0	0	0	0	-	-	0	0	No Ice
NA	0.000	**0**	0	0.850	12.99	0.0	0	0	0	0	0.0	0.0	0	0	No Ice
Top of Section	0.000	0	0	0.850	12.99	0.0	0	0	0	0	0.0	0.0			
	0.000	0	0	0.850	12.99	0.0	0	0	0	0	-	-	0	0	No Ice
NA	0.000	**0**	0	0.850	12.99	0.0	0	0	0	0	0.0	0.0	0	0	No Ice

Note: Top of ____ = concentrated load applied at the top of the tower section.

Tower Section Factored Weights: (No Ice)

Section	Weight (lbs)	
Ant. + Mt.	126	
Co-ax Wt:	9	(at top of tower)
MA3	139	
MA45	186	
MA6	246	
MA8	328	
MA10	409	
NA	0	
NA	0	
NA	0	
Total:	1444	lbs

Section	Lift cable force (lbs)	Vert. Component of Guy Cables (lbs)
MA3	274	**0**
MA45	548	**0**
MA6	1194	**0**
MA8	2147	**0**
MA10	1653	**0**
NA	0	**0**
NA	0	**0**
NA	0	**0**

Note: Enter vert.comp. of guys only if a lift cable system is not utilized.

Vertical Load per Section

(Factored)	P (lbs)
MA3	274
MA45	548
MA6	1194
MA8	2147
MA10	1653
NA	0
NA	0
NA	0

Torsion at Base (Factored)
Tm (lb.ft) = 95
(Based on 15% eccentricity of payload)

Lift Cable Analysis
No Ice
Mast Model: MA850

Factored Loads Used

Note: All units are in pounds.

Tower Data:

No. of twr. sections:	5
Ant. + Mt. wght (lb):	126
Accessories wt. (lb):	0
Coax cable wt. (lb):	9
Weight at Top (lbs):	135

Tower Section:	Section Wt. (lb):	Vert. Component of Guy Cables (lb):
MA3	139	0
MA45	186	0
MA6	246	0
MA8	328	0
MA10	409	0
NA	0	0
NA	0	0
NA	0	0

Lift Cables factors:

End Efficiency F:	0.90	
Resistance Factor:	0.60	(phi)

Anchor Frame-Tower Section: MA3

Cable dia (in):	0.25		
Cable MBS:	7000	Cable force per face:	274
No. of faces w/cable:	1		
F-v = CFtot:	274	**Cable CSI:**	0.07

Pulley Frame-Tower Section: MA45
Sum F-vp: 548 (=Lift cable force for section analysis)

Anchor Frame-Tower Section: MA45

Cable dia (in):	0.25		
Cable MBS:	7000	Cable force per face:	734
No. of faces w/cable:	1		
F-v = CFtot:	734	**Cable CSI:**	0.19

Pulley Frame-Tower Section: MA6
Sum F-vp: 1194 (=Lift cable force for section analysis)

Anchor Frame-Tower Section: MA6

Cable dia (in):	0.25		
Cable MBS:	7000	Cable force per face:	1441
No. of faces w/cable:	1		
F-v = CFtot:	1441	**Cable CSI:**	0.38

Pulley Frame-Tower Section: MA8
Sum F-vp: 2147 (=Lift cable force for section analysis)

Anchor Frame-Tower Section: MA8

Cable dia (in):	0.25		
Cable MBS:	7000	Cable force per face:	825
No. of faces w/cable:	3		
F-v = CFtot:	2475	**Cable CSI:**	0.22

Pulley Frame-Tower Section: MA10
Sum F-vp: 1653 (=Lift cable force for section analysis)

Anchor Frame-Tower Section: MA10

Cable dia (in):	0.25		
Cable MBS:	7000	Cable force per face:	0
No. of faces w/cable:	2		
F-v = CFtot:	0	**Cable CSI:**	N/A

Pulley Frame-Tower Section: NA
Sum F-vp: 0 (=Lift cable force for section analysis)

Anchor Frame-Tower Section: NA

Cable dia (in):	0.25		
Cable MBS:	7000	Cable force per face:	0
No. of faces w/cable:	2		
F-v = CFtot:	0	**Cable CSI:**	N/A

Pulley Frame-Tower Section: NA
Sum F-vp: 0 (=Lift cable force for section analysis)

Anchor Frame-Tower Section: NA

Cable dia (in):	0.25		
Cable MBS:	7000	Cable force per face:	0
No. of faces w/cable:	4		
F-v = CFtot:	0	**Cable CSI:**	N/A

Pulley Frame - Tower Section: NA
Sum F-vp: 0 (=Lift cable force for section analysis)

Note:
1. At the bottom tower section input the No. of faces w/ cable = the no. of tower sections -1. (i.e. For a tower made up of 6 sections you would input 5 as the no. of faces w/ cable.)

Mast Section Analysis

Round & Square Sections (Steel)

Note: All units are in inches and lbs unless noted otherwise.

Modulus of Elasticity: **29000000** Design Thickness Modifier: **1**

				Section				
	MA3	MA45	MA6	MA8	MA10	NA	NA	NA
Tube Shape:	Square	Round	Round	Round	Round	Round	Round	Round
Tube OD:	3	4.5	6	8	10	0	0	0
Tube Design. Thkn's:	0.120	0.135	0.135	0.135	0.135	0.000	0.000	0.000
Tube Spec. Thkn's:	0.120	0.135	0.135	0.135	0.135	0.000	0.000	0.000
Tube ID:	2.760	4.230	5.730	7.730	9.730	0.000	0.000	0.000
Tube Area:	1.38	1.85	2.49	3.34	4.18	0.00	0.00	0.00
Tube I (in^4):	1.91	4.41	10.70	25.80	50.91	0.00	0.00	0.00
Tube S (in^3):	1.28	1.96	3.57	6.45	10.18	0.00	0.00	0.00
Tube r:	1.18	1.54	2.07	2.78	3.49	0.00	0.00	0.00
Tube Z (in^3):	1.49	2.57	4.64	8.35	13.14	0.00	0.00	0.00
Tube J (in^4):	2.87	8.83	21.40	51.60	101.81	0.00	0.00	0.00
Tube F-y (psi):	36000	36000	36000	36000	36000	36000	36000	36000
Design Length(ft):	16	16	16	16	16	0	0	0
Factored Forces: (Includes P-delta moments)								
Dead Ld. (P-u):	274	548	1194	2147	1653	0	0	0
Shear (V-u):	472	548	629	713	698	0	0	0
Torsion Mom (T-u) ft-lb:	95	95	95	95	95	95	95	95
Moment (M-u) ft-lb:	563	817	1082	1358	9280	0	0	0
Tube D/t:	22.0	33.3	44.4	59.3	74.1	0.0	0.0	0.0
	Note: D/t shall not exceed 400							
Axial Strength	phi:	**0.9**		K: **2.1**				
F-y' (round), F-e (sq):	2438	36000	36000	36000	36000	36000	36000	36000
Lamda-c (round), L-p (sq):	31.79	2.93	2.18	1.63	1.30	0.00	0.00	0.00
F-cr:	2138	3681	6642	11942	18786	0	0	0
phi*P-n (lbs):	2660	6133	14870	35852	70739	0	0	0
Flexural Strength	phi:	**0.9**						
phi*M-n (in-lbs):	48401	83365	150484	267784	404127	0	0	0
Shear Strength	phi:	**0.9**						
phi*V-n:	13686	29991	40297	54038	67779	0	0	0
phi*T-n: (in-lbs)	73706	127102	231142	417955	659732	0	0	0
Tube CSI:	**0.19**	**0.21**	**0.17**	**0.12**	**0.30**	**0.00**	**0.00**	**0.00**
	MA3	MA45	MA6	MA8	MA10	NA	NA	NA

Base Connection: MA850

Loads at Top of Support	
Shear (lbs):	698
Mast Weight (lbs):	1653
Moment (lbs.ft) (@ top of base support)	9280

Tower Tube dia. (in):	10
Ecc. c.l. tower tube to c.l. base pipe (in):	12.31
Distance between top & bot. brackets (ft):	4.81

Reaction @ top bracket (lbs):	2627
Reaction @ bot. bracket (lbs):	-1929
Shear @ + 0 ft (lbs):	698
Mom. @ +0 ft (lbs.ft):	15729

Distance to top bracket (ft):	6.81
Pipe F-y (psi):	42000
Plate F-y (psi):	42000
Plate F-u (psi):	60000

Base Support Pipe: Round = 1, Square = 2 — 2

Description:	HSS 8x8x1/4"	Kl/r:	51.6	Weld to base plate:	
O.D. (in):	8	Lamda-c:	0.6	Z-x (in^2):	12.38
t (in):	0.25	Pn (psi):	234891	L-w (in):	32.00
Area (in^2):	7.75	P-u (psi):	1653	Weld t(in):	0.250
I (in^4):	77.66			Vu (lb/in):	698
S (in^3):	19.42	Mn (lb.ft):	70973	Mu (lb-in):	188744
r (in):	3.17	Mu (lb.ft):	15729	Vnw (Lb):	152734
Z (in3):	22.53	**CSI:**	**0.23**	Mnw (lb-in)	668461
				CSI:	**0.28**

Top Bracket:

Bolts A307	4	Distance between tubes (in):	3.31	
Diameter (in)	0.50	Plate thk (in):	0.50	
fv (lb/in2) =	3345	Plate width (in):	15	
Fv (lb/in2) =	18000	Weld t (in):	0.3125	Plate to Base Pipe
CSI:	**0.19**	Aplate (in2):	7.50	

Plate Compression:

L (in):	3.31	Pn (lbs):	168169	Weld to pipe:	
r (in):	0.144	Pu (psi):	2627	f-v (lb/in):	328
Kl/r:	45.9	**CSI:**	**0.02**	F-w (lb/in):	5966
Lambda-c:	0.56			**CSI:**	**0.06**

Retainer Ring:

Ring width (in):	1.5	Pu (lbs):	2627	Vu (lbs):	2627
Ring thk. (in):	1	Ptg (lbs):	113400	Vng (lbs):	34020
Ag (in2):	1.50	Ptn (lbs):	90000	Vnn (lbs):	22680
An (in2):	1.00	**CSIg:**	**0.02**	**CSIg:**	**0.08**
		CSIn:	**0.03**	**CSIn:**	**0.12**

Base Connection: MA850

Loads at Top of Support

Shear (lbs):	698
Mast Weight (lbs):	1653
Moment (lbs.ft) (@ top of base support)	9280

Tower Tube dia. (in):	10.00
Ecc. c.l. tower tube to c.l. base pipe (in):	12.31
Distance between top & bot. brackets (ft):	4.81

Reaction @ top bracket (lbs):	2627
Reaction @ bot. bracket (lbs):	-1929
Shear @ + 0 ft (lbs):	698
Mom. @ +0 ft (lbs.ft):	15729

Distance to top bracket (ft):	6.81
L F-y (psi):	42000
Plate F-y (psi):	42000
Plate F-u (psi):	60000

Bottom Bracket:

Description:	2 L4"x4"x1/2"
B = H (in) =	4
t (in):	0.5
Area (in^2):	7.50
Ix (in^4):	11.10
Sx (in^3):	3.95
rx (in):	1.22
Zx (in3):	4.50
Zy (in3):	46.33

D/t:	8.0
C-c:	117
Kl/r:	20
Lamda-c:	0.24
Mu (lb-ft):	1386
Mn (Lb-ft):	14175
f-au (psi):	257
F-au (psi):	29094
CSI:	**0.10**

Weld to Support Channel

Z-x (in3):	1.22
L-w (in):	9.50
Weld t(in):	0.188
Vu (lb/in):	1929
Mu (lb-in):	20350
Vnw (Lb):	34007
Mnw (lb-in)	66129
CSI:	**0.31**

Description:	C4"x2"x1/2"
B (in) =	2.75
H (in) =	4
t (in) =	0.5
Area (in2):	4.75
Ix (in4):	13.72
Sx (in3):	6.86
rx (in):	1.70

Zx (in3) =	4.81
Zy (in3) =	2.14
Mu (lb-ft):	1696
Mn (lb-ft):	15159
Vu (lbs):	1929
Vn (lbs):	107730
CSI:	**0.13**

Weld to Support Pipe

Z-x (in3):	2.71
L-w (in)	7.07
Weld t (in):	0.1875
Vu (lb):	273
Mu (lb-ft):	7501
Vnw (Lb):	25303
Mnw (lb-in)	12208
CSI:	**0.61**

Base Plate:

Plate square (in):	**14.0**
Plate thk. (in):	**1.25**
Bolt edge dist. (in):	**1.5**
Critical section (in):	5.20
Concrete f-c' (psi):	**2500**
F-p (psi):	2125

f-p max (psi)	1081
f-p min (psi)	-845
f-pcr (psi)	256
Mu (in-lb):	10898
Z-x (in^3):	0.391
Mn (in-lb)	14766
CSI:	**0.74**

Foundation Design MA850

Tower Reactions:

Moment (ft-lbs):	**15729**
Shear (lbs):	**698**
Mast Weight (lbs):	**1653**
Base Plate (in):	**14**
Distance from ground to top of concrete (ft):	**0.667**
Square ft'g width (ft):	**5**
Footing depth (ft):	**6.5**
H (ft):	23.20
S-1:	433
A:	0.533
Depth req'd (ft):	**3.9**

(Increased S1 by 2x per IBC 1804.3.1 for isolated footing not adversely affected by 1/2" motion at ground surface.)

Check concrete tensile stress: (neglect outer 2" of footing)

S-x (in^3):	29269
f-t (psi):	13
F-t (psi):	150
CSI:	**0.08**

Foundation Design Reactions:

Moment (ft-lbs):	25911
Shear (lbs):	1117
Mast Weight (lbs):	1984
Concrete f-c' (psi):	**2500**

Soil Design Parameters:

Allow. Lateral bearing (psf/ft):	**100**
Allow. Soil bearing (psf):	**1500**

Design is for non-constained condition per IBC reqmt's.

Allow. bearing (psf): **1500** Increased 20% for ea.
Act. bearing (psf): **1041** ft. of depth

Max. Moment in Footing (ft-lbs): 30845

CSI is < 1.0 therefore reinforcing is not req'd. Use minimal reinforcing.

rho:	**0.0018**
A-s req'd (sq. in.):	6.48
Rebar dia (in):	**0.75**
No. of bars provided:	**16**
A-s provided (sq. in.):	7.07 OK

Anchor Bolt Anchorage Design Load:

Anchorage Tension Design Force (lbs): **19587** (LRFD level force)

(See Anchor Bolt Anchorage page for anchorage design)

Summary:

Use foundation 5 ft. square by 6.5 ft. deep (below undisturbed soil).
Reinforce foundation with 16 #6 vertical bars (total) with #3 ties at 12" on center, and 3 ties in the top 5".
Use 2 vertical bar at each corner and 2 at the center of each face of the foundation.
Use 1 1/8" dia. ASTM A-36 or F1554 Gr.36 anchor bolts, 27" long.
Total of 4 anchor rods,one at each corner of the base plate with a minimum embedment of 21". Use hex nuts.

Anchor Bolt Anchorage

Tower Model: MA850

ACI 318-05 App. D Tension Anchorage Calculations - Cast in Place Straight Anchors

All units are pounds and inches unless noted otherwise. Date: 6/5/2013

Anchorage Description: 4 - 1 1/8" dia, A36 anchor rods

Concrete f-c' (psi):	2500	Is this in a moderate or High Seismic area	1.00	Factored Req'd Tens. Load (lb):	19587 (LRFD value)
Embedment:	21	AND do the loads include seismic loads? (Yes = 0.75, No = 1.0) ACI D.3.3 doesn't require this if loads don't include seismic.			

h-ef: 16.33 If embedment x 1.5 is > 3 of the edge distances then use h-ef = the largest of the 3 edge distances / 1.5 App. D Section D5.2.3.

Anchor Input:		Edge Distances:	
No. of Anchors n:	2	c-a1:	24.50
Anchor dia:	1.125	c-a2:	24.50
No. of threads / in:	7	c-a3:	24.50
Anchor f-y (psi):	36000	c-a4:	24.50
Anchor f-u (psi):	58000		
phi:	0.75		

phi = 0.65 if material used is not ductile

Steel Strength of Anchor in Tension (ACI D5.1)

A-se:	0.763	Effective anchor area (in^2)
N-sa:	88540	

Concrete Breakout Strength of Anchor in Tension (ACI D5.2)

N-b:	79212	ACI D5.2.2
N-cbg:	139430	

Anchor Pullout Strength (ACI D5.3)

N-p:	37020
N-pn:	103656

Concrete Side-Face Blowout, Tension

N-sbg: 133330 Note: If Ca1 is >0.4*h-ef then blowout does not occur.

Anchor Design Strength - LRFD

Steel:	66405
Breakout:	97601
Pullout:	72559
Blowout:	93331

(Note: If supplemental reinforcement is provided then the concrete strength limit does not apply, App. D D.4.2.1.)

Concrete Breakout Input: (Tension)

A-Nco:	2401.0	Projected breakout area of single anchor
A-Nc:	2940.0	Proj'd breakout area of anchor group (For a single anchor use A-Nco value) (If have more than two anchors need to hand input A-Nc)
ecc:	0	Eccentricity of tension load - anchor groups only
AdjF-ec,N:	1.000	(ACI D5.2.4) for anchor groups loaded eccentrically
AdjF-ed,N:	1.150	(ACI D5.2.5) for edge effects
AdfF-c,N:	1.25	(ACI D5.2.6) Assumed cracked at service load levels Can use 1.25 if is uncracked
phi:	0.7	Use 0.75 if supplemental reinforcement is provided Use 0.70 is supplemental reinforcement is not provided

Concrete Pullout Input:

A-head:	1.851	Area of anchor bolt head (Input 0 if plate washer is used)
Plate w:	0.00	Width of plate washer at embed end of anchor
Plate L:	0.00	Length of plate washer at embed end of anchor
A-pl:	1.851	Area of plate washer minus rod area (Plate thkn's must be >= 0.5 * bolt dia.)
AdfF-c,P:	1.4	Assumed cracked at service load levels Can used 1.4 if is uncracked
phi:	0.7	Use 0.75 if supplemental reinforcement is provided Use 0.70 is supplemental reinforcement is not provided

Side Face Blowout Input

Spacing:	11.00	Min. distance between multiple anchors (input 0 for one anchor)
c2:	24.50	Edge distance perp. to c-min.
c-min:	24.50	Min. edge distance considering all fasteners
AdjF1:	0.500	Factor for single anchor if c2 < 3(c-min)
AdjF2:	1.000	Factor for multiple anchors if c-min < .4(h-ef) and anchor spacing is < 6(c-min)
phi:	0.7	Use 0.75 if supplemental reinforcement is provided Use 0.70 is supplemental reinforcement is not provided

LRFD Design Strength:	**66405 Lbs**
ASD Design Strength:	**47432 Lbs**
Design Controlled By:	Steel Tension
Min. center to center of anchor spacing (in):	4.5
Min. edge distance is same as min. cover per ACI 7.7.	

Loads at Bolts

	Vu =	186	lbs
	Pu =	9794	lbs
ACI D.8.1	Stress check	Phi = 0.75	
	Pn =	33202	lbs
	n =	0.55	Det.C F4.4

(Pu+Vu/n)/(Phi.Pn) <= 1.0

CSI = 0.31

Notes:

1. For normal weight concrete only.
2. Anchors shall be either a headed bolt or have nuts and a bearing plate at the embed end as indicated above.
3. ACI Section D.5.2.3 is not included in this spreadsheet. (i.e. End of wall applications are not covered.)
4. Any supplemental reinforcing shall have f-y = 60,000 psi min.
5. Per ACI D.3.3 if anchor design does not include seismic loads then the design does not have to be controlled by steel ductility.

MA-850 FOUNDATION

Foundation has been designed to accommodate the following loads:

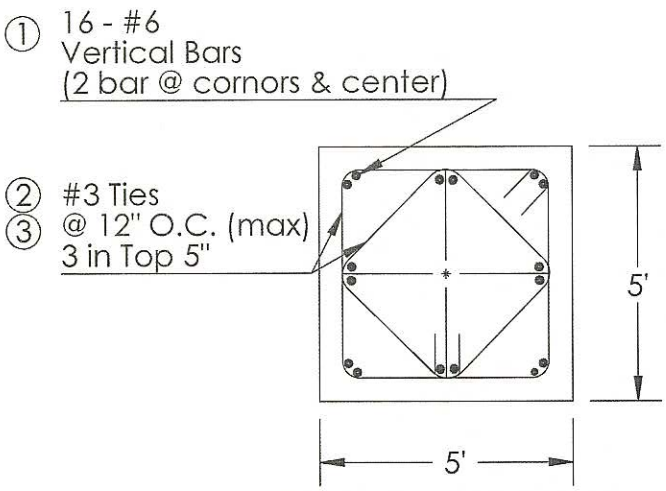
Overturning Moment = 49.91 ft - kips
Base Shear = .88 kips
Structure Weight = 2.04 kips

Soil and Concrete Design Parameters.

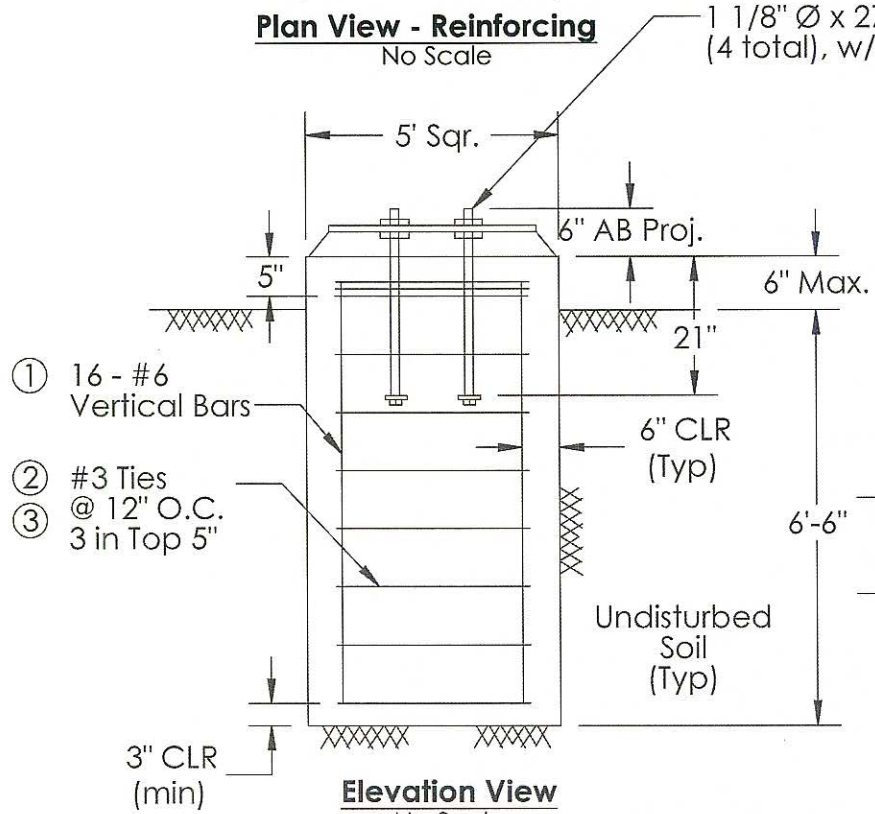
Allowable Foundation Pressure 1500 psf
(Increases based on depth)

Lateral Bearing Pressure 100 psf/ft
(Increases based on depth)

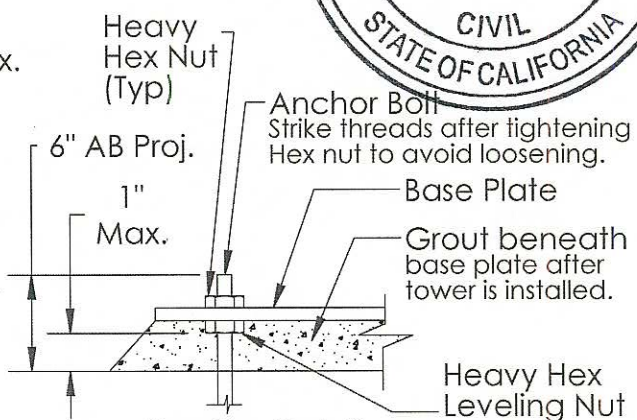
Concrete fc'= 2500 psi min. @ 28 days.



Plan View - Reinforcing
No Scale



Elevation View
No Scale



Grouting Detail
Extreme care should be taken to assure that all leveling nuts are level with respect to each other prior to installation of tower.

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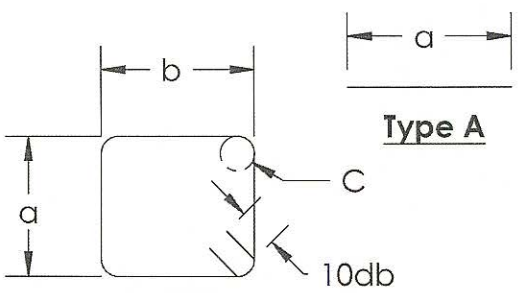
Note: If leveling nuts are not used, grout is not required, and reduce AB projection to 4".

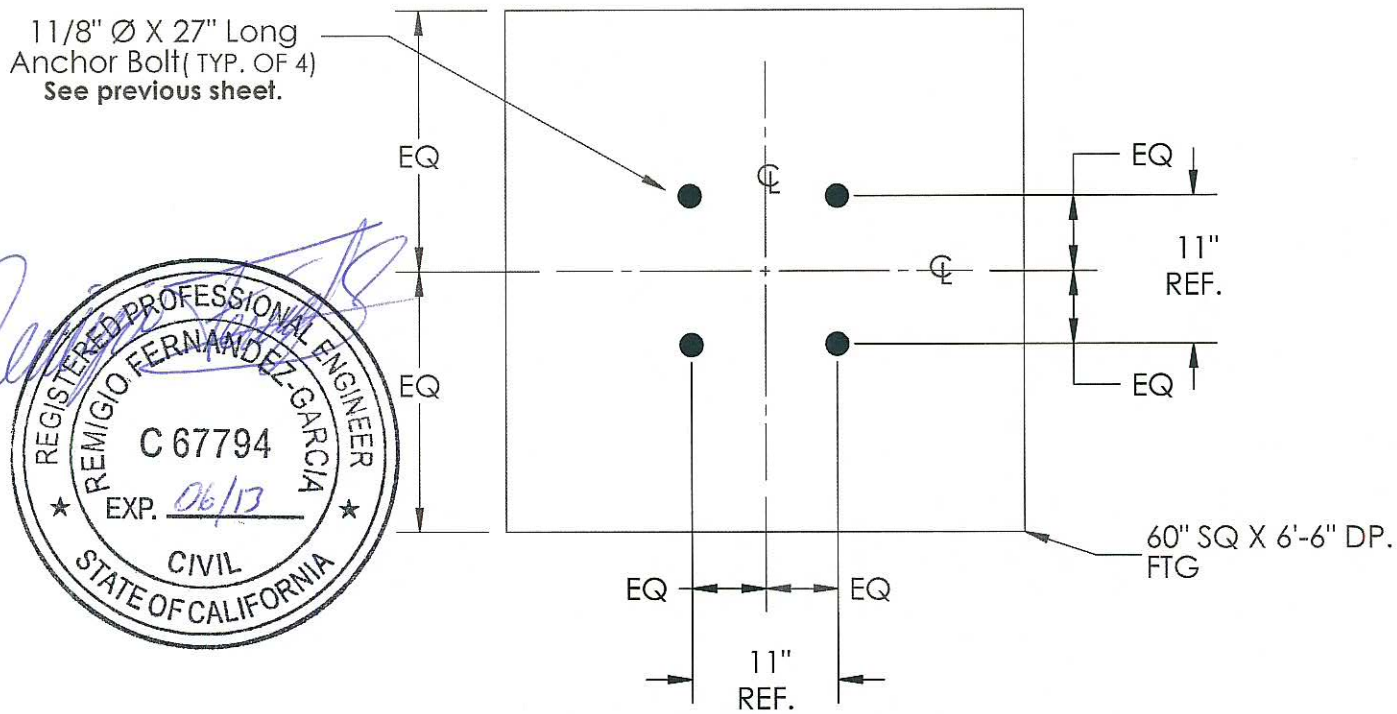


Reinforcement Material List

Sym	Type	Bar Size	Dimensions a	b	c	10db	Qty
①	A	#6	6' - 6" *	---	---	---	16
②	B	#3	4' - 0" *	4' - 0" *	2"	3.75"	9
③	B	#3	2' - 10" *	2' - 10 "*	2"	3.75"	9

* = Nominal dimension

MA-850 FOUNDATION



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Plan View - Anchor Bolt Layout
No Scale

"REF" dimensions are provided for reference only. Use the tower base plate assembly to locate anchor bolts.

Foundation Notes:

1. All concrete shall have a minimum compressive strength of 2500 psi at 28 days unless noted otherwise. All concrete shall conform to the requirements of the International Building Code and the referenced edition of ACI 318. Slump shall not exceed 4-1/2 inches.
2. Reinforcing steel shall be intermediate grade deformed bars conforming to ASTM A-615. No. 4 bars and smaller shall be Grade 40, No. 5 bars and larger shall be Grade 60. All reinforcing details, placement etc. shall conform to the requirements of the International Building Code and ACI 318. No welding allowed.
3. All reinforcing steel, anchor bolts, dowels and other inserts etc. shall be securely anchored in place, in the required positions, prior to pouring concrete.
4. The allowable lateral soil bearing value was doubled as allowed per 2009 IBC section 1805.1 for isolated foundations not adversely affected by a 0.5" motion at the ground surface due to short term lateral loads.
5. The foundation design does not consider the effects of ground water.
6. The contractor is responsible for safe excavations in accordance with all Federal & Local laws and ordinances and OSHA requirements.
7. The contractor is responsible for the correct placement of all anchor bolts. US Tower recommends that the anchor bolts be placed using the tower base plate assembly provided with the tower. (The base plate assembly can be provided before the tower if desired.)
8. The foundation shall be one continuous pour such that cold joints do not develop. The contractor is responsible for verifying adequate concrete coverage is provided for all reinforcement to avoid the potential for rebar corrosion. Concrete shall be consolidated using vibratory methods.
9. The top of the footing shall be troweled level and smooth (or have a broom finish if preferred) in the area of the tower. Water shall be directed away from the tower base and anchor bolts outside of the tower area.
10. See General Notes sheet (earlier in calcs) for additional information & requirements.