Structural Analysis Report

Self-Supporting Tubular Crank-Up Tower

Mast Model: MA-40

Prepared for Gary Loving

Design Code:	2012 IBC & 2009 ANSI/TIA-222-G (2)	
Basic Wind Velocity:	90	mph 3 second gust
Exposure	C	
Ice Thkn's (in):	0	
Topographic Category:	1	
Structure Classification:	1	
Tower Fully Retracted		
Max. Allowable Antenna Wind Load - Unfactored (lbs)		85
Max. Allowable Antenna Weight (lbs):		75
Max. Allowable Antenna Effective Wind Area (sq. ft.):		4.8

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

Per the Operation Instructions, the tower shall be fully retracted if winds over 50 mph are expected

Date Prepared: 6/9/2017 **Sheet 1 of 12**

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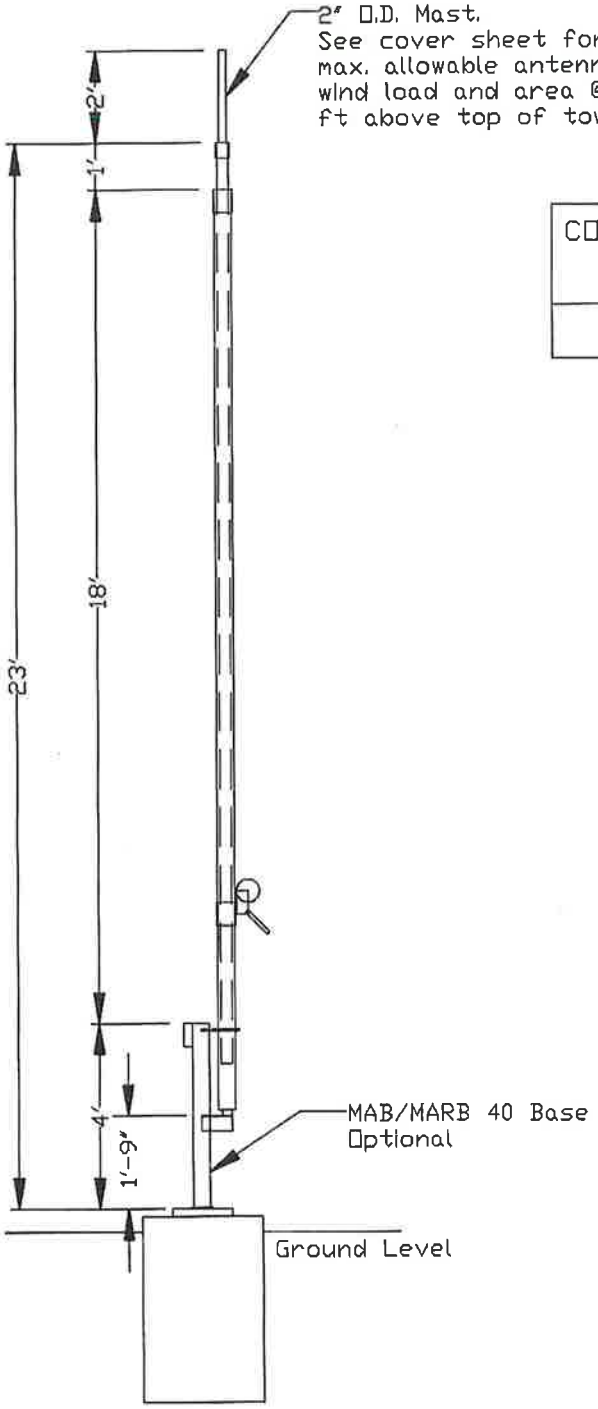
ELEVATION

MA-40

SECTION No.	TUBE SIZE
MA 4.5	ROUND TUBE 4 1/2" O.D. X 0.120" WALL
MA 3	SQUARE TUBE 3" X 0.120" WALL



Elevation View

Not to Scale

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

Registered Professional Engineer (Civil)
CERTIFICATE NO.
34986
ADRIAN
McJUNKIN
Date Signed 6/9/17
ARIZONA U.S.A.
Expires 06/30/18

General Notes

Tower Model: **MA-40**

1. All work shall be in conformance with the requirements of the 2012 IBC / 2013 CBC and "Structural Standards for Steel Antenna Towers and Antenna Supporting Structures ANSI/TIA-222-G", by the Telecommunications Industry Association.
2. The 2012 IBC / 2013 CBC requires the use ANSI/TIA-222-G for tower design.
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/California 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 (spray arc) 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

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.
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.
22. Per ASI/TIA-222-G, Ice and Seismic loads do not apply for Class I structures. (Table 2-3)

Code & Material Specifications

Mast Model: **MA-40**

Governing Codes, Stresses, and Materials (Min.)

International Building Code	**2012 Edition**
TIA-222-G	
AISC Specification for Steel Bldgs	**360-05**
ACI 318	**2008 Edition**
Wind Loading **Governed by the TIA/EIA standard**	**Basic Wind Speed** **90 mph, 3 second gust** **(Exposure C Terrain)**
Structural Steel **(All plates, bars, angles)**	**ASTM A36** **(Fy = 36 ksi)** **(Min. Fy for plates - 42 ksi)**
Structural Pipe	**ASTM A53 Gr. B, A500 Gr. B** **(Fy = 50 ksi for tower legs)**
Structural Tubing (HSS)	**ASTM A500 Gr. B (Sq. Tube)** **(Fy = 46 ksi)** **ASTM A513 Type 1A (Rnd Tube)** **(Fy = 36 ksi)**
Welding	**AWS D1.1-04** **GMAW w/ ER70S-6 wire**
Hot-Dip Galvanizing **Hardware**	**ASTM A123** **ASTM A153**
Bolts: Tower & Accessories	**ASTM A325**
Reinforced Concrete	**2500 psi strength @ 28 days**
Reinforcing Steel	**ASTM A615** **Gr. 40 for #4 & smaller dia.** **Gr. 60 for $5 & larger dia.**
Anchor Rods	**ASTM F1554 Gr. 36** **or ASTM A36**
Foundation & Soils **Lateral Bearing Pressure**	**1500 psf Bearing (TL = DL+LL)** **100 psf/ft of depth**

Mast Section Properties

Mast Model: MA-40

Design per ANSI/TIA-222-G(2)

Structure Classification:	1	Importance Factor:	0.87	Ice Thickness (in):	0	
Wind velocity (mph):	90	Tower Height (ft):	23	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:	0.929	Velocity pressure coefficient		

Section Name	MA3	MA4.5	NA	NA	NA	NA	NA	NA
Section length (ft):	20	20	0	0	0	0	0	0
Top lap length (ft):	0	4	0	0	0	0	0	0
Bot lap length (ft):	4	0	0	0	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	6.625	8	10	12	14	16
(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	0.135	0.135	0.135
Tube I.D.:	2.76	4.23	6.36	7.73	9.73	11.73	13.73	15.73
Tube F-y: (Steel only)	36000	36000	36000	36000	36000	36000	36000	36000
C: (For sq. tubes is aspect ratio)	64.0	29.0	42.7	51.6	64.5	77.4	90.3	103.2
C-f, force coefficient:	2.00	1.20	0.90	0.74	0.60	0.60	0.60	0.60

Linear Appurtenances:	Co-ax Cable dia. (in):	0.875	Lift Cable dia. (in):	0.188	
	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	0.496	0.496	0.500	0.600	0.700	0.800
Co-ax cable (s.f./ft.):	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088
Lift cable(sq. ft. /ft.):	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
Tot. Unif. EPA (sq.ft./ft.):	**0.606**	**0.556**	**0.000**	**0.000**	**0.000**	**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):	6	7.5	9.625	11	13	15	17	19
Height (in):	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
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.):	**0.050**	**0.063**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Weight:								
Top cap:	5	6	10	12	15	20	25	30
Tube:	94	126	0	0	0	0	0	0
Bot. anchor:	5	5	8	10	12	15	20	25
Lift cable & standoff:	5	5	5	5	5	5	5	5
Misc.:	11	14	2	3	3	4	5	6
Total weight:	**120**	**156**	**0**	**0**	**0**	**0**	**0**	**0**

Top Mounted Equipment: (Antenna etc.)			
Antenna / Camera Area (sq.ft.):	4	Antenna Mast Diameter (in.):	2.000
Shape (1= round, 2 = flat):	1	Mast Length (ft):	1.0
C-f:	1.2	C-f:	1.2
Concentrated PA (sq. ft.)	**4.8**	**Concentrated PA (sq. ft.)**	**0.200**
Weight (lbs):	**75**	**Weight (lbs):**	**10**

Mast Loading

Mast Model: MA-40

Tower Loading, Shear & Moments:

Design per EIA-222-G

Wind velocity (mph):	**90**		G-h:	1.1	Gust factor
Exposure:	**C**		I:	0.87	Importance factor
Topo Category:	**1**		Kd:	0.95	Wind direction probablility factor
Tower Height (ft):	23		f:	1	Topographic coefficient
Structure Class:	**1**		Zg:	900	Exposure category coefficient
H (ft):	0	Ht. of crest above surrounding terrain	alpha:	9.5	Exposure category coefficient
K-h:	N.A.	Height reduction factor	Kz-min:	0.85	Exposure category coefficient
K-zt:	1.00	Topo wind speed up factor	Load Factor - Wind:	**1.6**	
K-e:	1	Terrain constant	Load Factor - Dead:	**1.2**	
Kt:	1	Topographic constant			
Are lift cables used? (Y/N)	**Y**		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.)

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	4.8	24	24	0.937	16.06	135.7	136	0	0	0	8.8	3.4	136	0	No Ice
Mast	0.200	23	23.5	0.933	15.99	5.6	141	141	0	141	8.8	3.4	141	141	No Ice
Top of Section	0.050	23	23	0.929	15.92	1.4	143	141	0	141	8.8	3.4			
MA3	0.606	**22**	22.5	0.925	15.84	16.9	160	292	3	296	8.4	3.4	160	296	No Ice
Top of Section	0.063	22	22	0.920	15.77	1.7	161	292	3	296	8.4	3.4			
MA4.5	0.556	**4.5**	13.25	0.850	14.57	14.3	411	5300	200	5500	0.2	0.4	411	5500	No Ice
Top of Section	0.000	4.5	4.5	0.850	14.57	0.0	411	5300	200	5500	0.2	0.4			
NA	0.000	**0**	0	0.850	14.57	0.0	0	0	0	0	0.0	0.0	0	0	No Ice
Top of Section	0.000	0	0	0.850	14.57	0.0	0	0	0	0	0.0	0.0			
NA	0.000	**0**	0	0.850	14.57	0.0	0	0	0	0	0.0	0.0	0	0	No Ice
Top of Section	0.000	0	0	0.850	14.57	0.0	0	0	0	0	0.0	0.0			
NA	0.000	**0**	0	0.850	14.57	0.0	0	0	0	0	0.0	0.0	0	0	No Ice
Top of Section	0.000	0	0	0.850	14.57	0.0	0	0	0	0	0.0	0.0			
NA	0.000	**0**	0	0.850	14.57	0.0	0	0	0	0	0.0	0.0	0	0	No Ice
Top of Section	0.000	0	0	0.850	14.57	0.0	0	0	0	0	0.0	0.0			
NA	0.000	**0**	0	0.850	14.57	0.0	0	0	0	0	0.0	0.0	0	0	No Ice
Top of Section	0.000	0	0	0.850	14.57	0.0	0	0	0	0	0.0	0.0			
NA	0.000	**0**	0	0.850	14.57	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.	102	
Co-ax Wt:	8	(at top of tower)
MA3	144	
MA4.5	188	
NA	0	
NA	0	
NA	0	
NA	0	
NA	0	
NA	0	
Total:	442	lbs

Section	Lift cable force (lbs)	Vert. Component of Guy Cables (lbs)
MA3	254	**0**
MA4.5	509	**0**
NA	0	**0**
NA	0	**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	254
MA4.5	509
NA	0
NA	0
NA	0
NA	0
NA	0
NA	0

Torsion at Base (Factored)

Tm (lb.ft) = 42

(Based on 15% eccentricity of payload)

Lift Cable Analysis
No Ice
Mast Model: MA-40

Factored Loads Used

Note: All units are in pounds.

Tower Data:

No. of twr. sections:	2
Ant. + Mt. wght (lb):	102
Accessories wt. (lb):	0
Coax cable wt. (lb):	8
Weight at Top (lbs):	110

Tower Section:	Section Wt. (lb):	Vert. Component of Guy Cables (lb):
MA3	144	0
MA4.5	188	0
NA	0	0
NA	0	0
NA	0	0
NA	0	0
NA	0	0
NA	0	0

Lift Cables factors:

End Efficiency F:	1.00	
Resistance Factor:	0.60	(phi)

Anchor Frame-Tower Section: MA3

Cable dia (in):	0.25		
Cable MBS:	7000	Cable force per face:	254
No. of faces w/cable:	1		
F-v = CFtot:	254	**Cable CSI:**	0.06

Pulley Frame-Tower Section: MA4.5

Sum F-vp: 509 (=Lift cable force for section analysis)

Anchor Frame-Tower Section: MA4.5

Cable dia (in):	0.25		
Cable MBS:	7000	Cable force per face:	0
No. of faces w/cable:	1		
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:**	NA

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:**	NA

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:	1		
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:	1		
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:	1		
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: **0.93**

				Section				
	MA3	MA4.5	NA	NA	NA	NA	NA	NA
Tube Shape:	Square	Round	Round	Round	Round	Round	Round	Round
Tube OD:	3	4.5	6.625	8	10	12	14	16
Tube Design. Thkn's:	0.112	0.126	0.126	0.126	0.126	0.126	0.126	0.126
Tube Spec. Thkn's:	0.120	0.135	0.135	0.135	0.135	0.135	0.135	0.135
Tube ID:	2.777	4.249	6.374	7.749	9.749	11.749	13.749	15.749
Tube Area:	1.29	1.73	2.56	3.11	3.89	4.68	5.47	6.26
Tube I (in^4):	1.80	4.13	13.54	24.08	47.48	82.56	131.69	197.24
Tube S (in^3):	1.20	1.84	4.09	6.02	9.50	13.76	18.81	24.66
Tube r:	1.18	1.55	2.30	2.78	3.49	4.20	4.91	5.61
Tube Z (in^3):	1.40	2.40	5.30	7.79	12.24	17.70	24.17	31.64
Tube J (in^4):	2.69	8.26	27.08	48.16	94.95	165.12	263.38	394.48
Tube F-y (psi):	36000	36000	36000	36000	36000	36000	36000	36000
Design Length(ft):	16	20	0	0	0	0	0	0
Factored Forces: (Includes P-delta moments)								
Dead Ld. (P-u):	254	509	0	0	0	0	0	0
Shear (V-u):	234	411	0	0	0	0	0	0
Torsion Mom (T-u) ft-lb:	42	42	42	42	42	42	42	42
Moment (M-u) ft-lb:	296	5500	0	0	0	0	0	0
Tube D/t:	23.9	35.8	52.8	63.7	79.6	95.6	111.5	127.4
	Note: D/t shall not exceed 400							
Axial Strength	phi:	**0.9**		K: **2.1**				
F-y' (round), F-e (sq):	2452	36000	36000	36000	36000	35499	33857	32625
Lamda-c (round), L-p (sq):	31.79	3.65	0.00	0.00	0.00	0.00	0.00	0.00
F-cr:	2150	2366	0	0	0	0	0	0
phi*P-n (lbs):	2495	3673	0	0	0	0	0	0
Flexural Strength	phi:	0.9						
phi*M-n (in-lbs):	45272	77862	171858	246086	372062	523600	700699	903357
Shear Strength	phi:	0.9						
phi*V-n:	12849	27952	41530	50316	63095	74819	83376	91923
phi*T-n: (in-lbs)	64714	118958	264901	390085	615300	879232	1146499	1447847
Tube CSI:	**0.13**	**0.99**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	MA3	MA4.5	NA	NA	NA	NA	NA	NA

Anchor Bolt Anchorage

Tower Model: **MA-40**

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

All units are pounds and inches unless noted otherwise. Date: 6/9/2017

Anchorage Description: **4 - 3/4" 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): 12625 (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: 10.17 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:

No. of Anchors n:	1
Anchor dia:	0.750
No. of threads / in:	10
Anchor f-y (psi):	36000
Anchor f-u (psi):	58000
phi:	0.75

phi = 0.65 if material used is not ductile

Edge Distances:

c-a1:	**15.25**
c-a2:	**15.25**
c-a3:	**15.25**
c-a4:	**15.25**

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

A-se:	0.334	Effective anchor area (in^2)
N-sa:	19399	

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

N-b:	38173	ACI D5.2.2
N-cb:	54873	

Anchor Pullout Strength (ACI D5.3)

N-p:	18220
N-pn:	25508

Concrete Side-Face Blowout, Tension

N-sb: 58222 Note: If Ca1 is >0.4*h-ef then blowout does not occur.

Anchor Design Strength - LRFD

Steel:	14549
Breakout:	38411
Pullout:	17856
Blowout:	40756

(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:	930.3	Projected breakout area of single anchor
A-Nc:	930.3	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:	**0.911**	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:	0.911	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:	**5.50**	Min. distance between multiple anchors (input 0 for one anchor)
c2:	**15.25**	Edge distance perp. to c-min.
c-min:	15.25	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:	**14549 Lbs**
ASD Design Strength:	**10392 Lbs**
Design Controlled By:	Steel Tension
Min. center to center of anchor spacing (in):	3
Min. edge distance is same as min. cover per ACI 7.7.	

ACI D.8.1

Loads at Bolts

Vu =	103	lbs
Pu =	12625	lbs
Stress check	Phi = 0.75	
Pn =	14549	lbs
n =	0.55	Det.C F4.4

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

CSI = 0.88

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. If the design is controlled by concrete failure (i.e. non-ductile failure) then the Design Strengths controlled by concrete must be at least 2.5 times the factored forces transmitted by the attachment. (2006 IBC 1908.1.16) Alternatively, the steel anchor "or the attachment that the anchor is connecting to the structure shall be designed so that the attachment will undergo ductile yielding at a load level corresponding to anchor forces no greater than the design strength of the anchors" determined above. If "Steel Tension" controlled above then the connection is considered ductile and no further adjustments etc. are required. (Also see note 6.)
5. Any supplemental reinforcing shall have f-y = 60,000 psi min.
6. 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.

Foundation Design MA-40

Tower Reactions:

Moment (ft-lbs):	5194
Shear (lbs):	257
Mast Weight (lbs):	424
Base Plate (in):	8
Distance from ground to top of concrete (ft):	0.67
Square ft'g width (ft):	3
Footing depth (ft):	4.5
H (ft):	20.89
S-1:	300

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

A:	0.472
Depth req'd (ft):	**3.5**

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

S-x (in^3):	5461
f-t (psi):	22
F-t (psi):	138
CSI:	**0.16**

Foundation Design Reactions:

Moment (ft-lbs):	8586
Shear (lbs):	411
Mast Weight (lbs):	509
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): **722** ft. of depth

Max. Moment in Footing (ft-lbs): 9839

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

rho:	0.0018
A-s req'd (sq. in.):	2.33
Rebar dia (in):	0.625
No. of bars provided:	8
A-s provided (sq. in.):	2.45 OK

Anchor Bolt Anchorage Design Load:

Anchorage Tension Design Force (lbs): **12625** (LRFD level force)
(See Anchor Bolt Anchorage page for anchorage design)

Summary:

Use foundation 3 ft. square by 5 ft. deep (below undisturbed soil).
Reinforce foundation with 8 #5 vertical bars (total) with #3 ties at 12" on center, and 3 ties in the top 5".
Use 2 vertical bar at each corner of the foundation.
Use 3/4" 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.

MA 40 FOUNDATION

Foundation has been designed to accommodate the following loads:

Overturning Moment = 7.2 ft - kips
Base Shear = 0.54 kips
Structure Weight = 0.50 kips

Soil and Concrete Design Parameters.

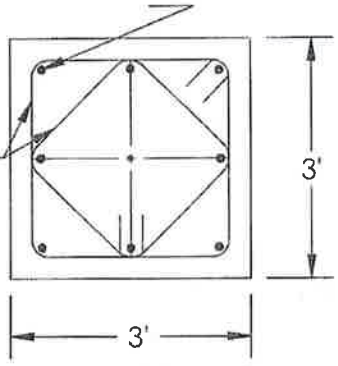
Allowable Foundation Pressure 1500 psf
(Increases based on depth)

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

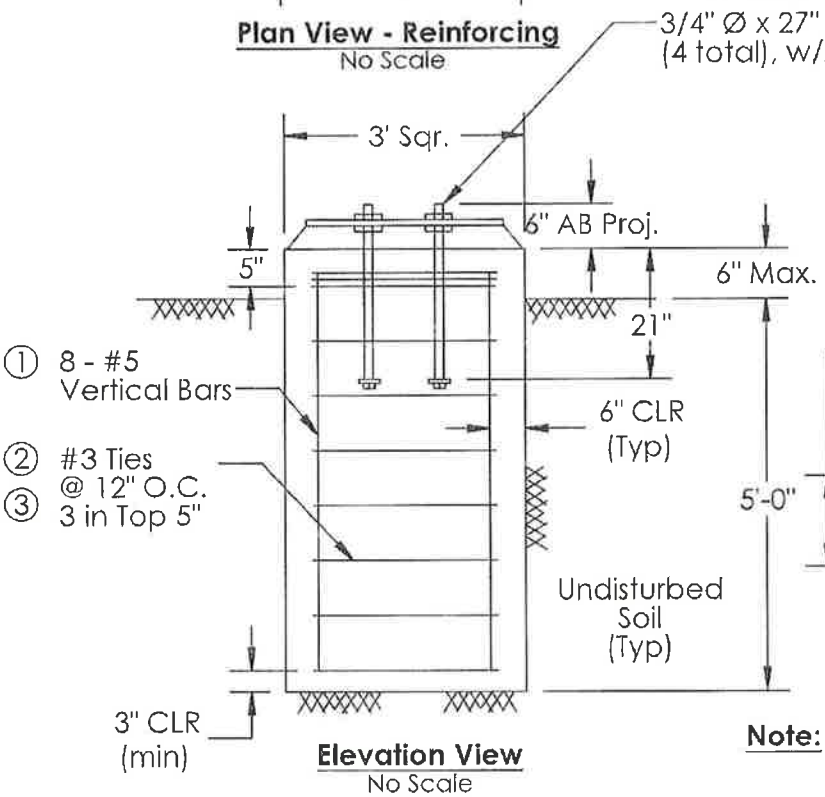
Concrete fc'= 2500 psi min. @ 28 days.

① 8 - #5 Vertical Bars (1 bar @ corners & center)

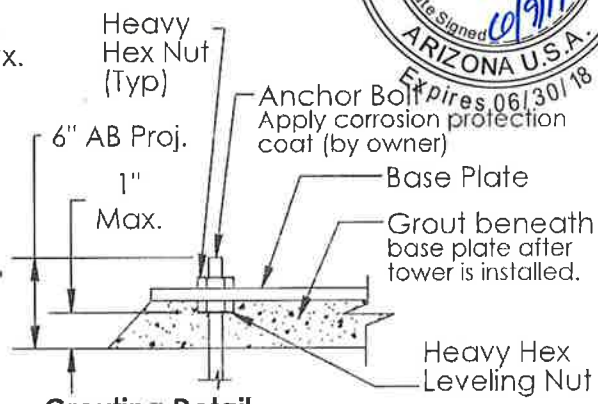
② #3 Ties @ 12" O.C. (max)
③ 3 in Top 5"



Plan View - Reinforcing
No Scale



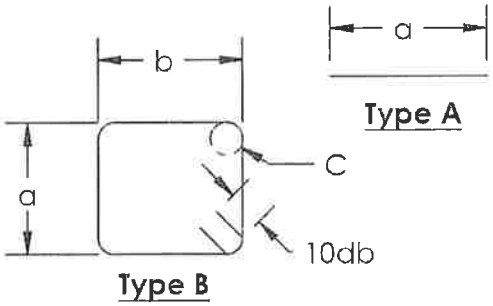
Elevation View
No Scale



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.

Note: If leveling nuts are not used, base plate shall bear directly on concrete, grout is not required, and reduce AB projection to 4".



Type A

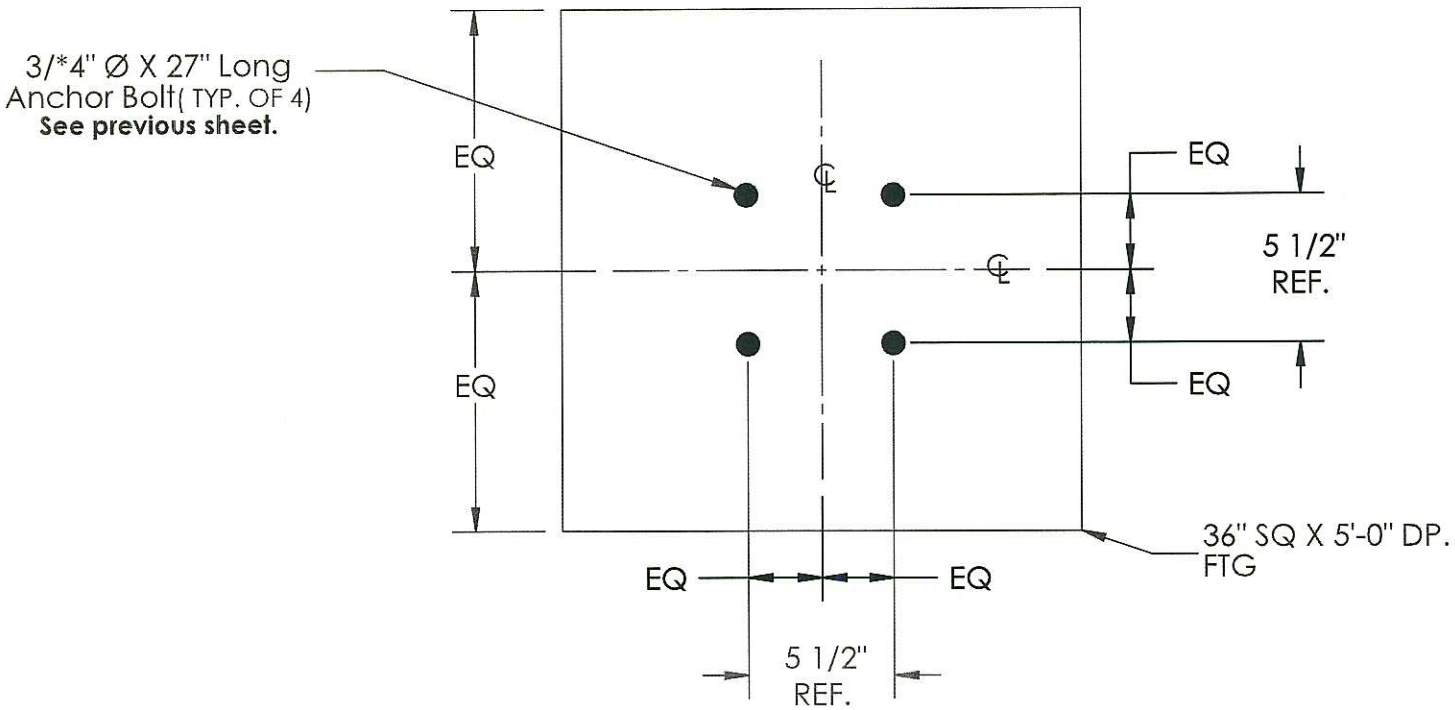
Type B

Reinforcement Material List

Sym	Type	Bar Size	Dimensions a	b	c	10db	Qty
①	A	#5	5' - 0" *	---	---	---	8
②	B	#3	2' - 0" *	2' - 0" *	2"	3.75"	9
③	B	#3	1'-5" *	1'-5" *	2"	3.75"	9

* = Nominal dimension

MA 40 FOUNDATION



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 owner is responsible for verifying the soil at the site provides a minimum safety factor of 2.0 for the soil parameters used for this design.
5. The allowable lateral soil bearing value was doubled as allowed per 2012 IBC section 1806.3.4 for isolated foundations not adversely affected by a 0.5" motion at the ground surface due to short term lateral loads.
6. The foundation design does not consider the effects of ground water.
7. The contractor is responsible for safe excavations in accordance with all Federal & Local laws and ordinances and OSHA requirements.
8. 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.)
9. 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.
10. 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.
11. See General Notes sheet (earlier in calcs) for additional information & requirements.