



Structural Analysis Report

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Structural Analysis: Self-Supporting Triangular Crank-Up Tower

Tower Model: TX-438

Design Code: IBC 2006 (TIA/EIA-222-F)

Basic Wind Velocity: 90 mph 3 second gust, 76 mph fastest mile

Ice: None

Max. Allowable Antenna Wind Load (lbs):	142	
Max. Allowable Antenna Weight (lbs):	200	
Max. Allowable Antenna Wind Area (sq. ft.):	9.3	(All Round Members)
Max. Allowable Antenna Wind Area (sq. ft.):	5.3	(All Flat Members)

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 1 ft. above the top of the tower.



Date Prepared: 8/20/2009
Prepared By: Remigio Fernandez P.E.

Sheet 1 of 17

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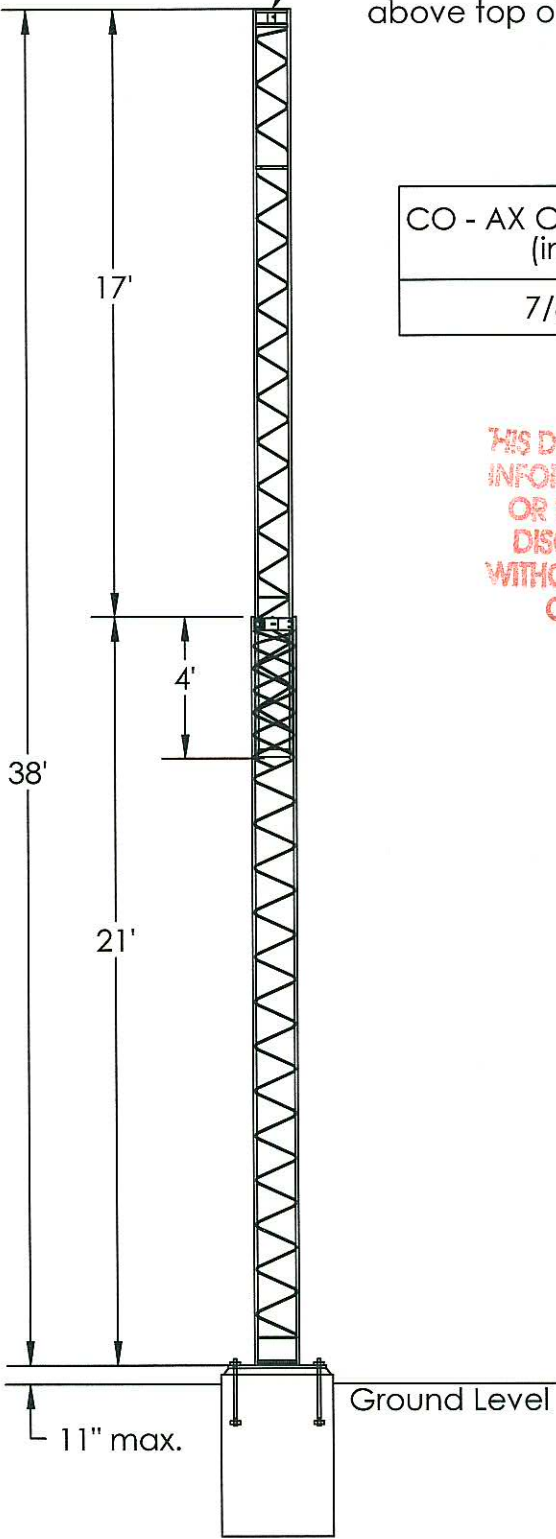
RF/MC 12/21/09



TX-438 TOWER ELEVATION

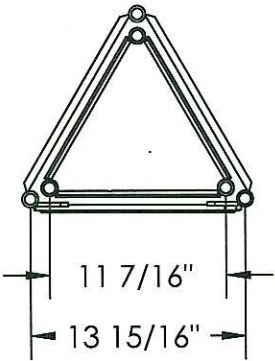
SECTION NO.	NO. 4 TOP	NO. 5 BASE
LEG SIZE	PIPE 1.05" OD X 0.154" WALL	PIPE 1.05" OD X 0.154" WALL
DIAGONAL SIZE	3/8" SOLID ROD	3/8" SOLID ROD

2" OD Tube Mast.
See cover sheet for max. allowable antenna wind load and area @ 1 FT. above top of tower.



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

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Plan View
No Scale

Elevation View
No Scale



General Notes:

Tower Model: TX-438

1. All work shall be in conformance with the requirements of the "International Building Code - 2006" and "Structural Standards for Steel Antenna Towers and Antenna Supporting Structures TIA/EIA-222-F", by the Telecommunications Industry Association.
2. The 2006 International Building Code requires the use TIA/EIA-222-F for tower design. TIA/EIA requires the use of the American Institute of Steel Construction, Specification for Structural Steel Buildings, June 1, 1989. (AISC 9th Edition). Consequently, all steel design was performed using the AISC 9th 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 (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:

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

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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 calculations.
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.



Code & Material Specifications

4

Tower Model: TX-438

Governing Codes, Stresses, and Materials (Min.)

International Building Code TIA/EIA-222-F AISC Specification for Steel Bldgs ACI 318	2006 Edition (Occ. Cat. II) AISC 9th Edition 2005 Edition
Wind Loading (Governed by the TIA/EIA standard so used fastest mile speed in the calculations.)	Basic Wind Speed 90 mph, 3 second gust 75 mph, fastest mile (Exposure C Terrain)
Structural Steel (All plates, bars, angles)	ASTM A36 (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 Hardware	ASTM A123 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. 55
Foundation & Soils Lateral Bearing Pressure	1500 psf Bearing (TL = DL+LL) 100 psf/ft of depth

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Tower Section Properties

Code: EIA-222-F
 All units are in lbs. and inches U.O.N.
 Ice: 0

Note: If a tower section is not in the tower being designed then input 0 for section length and top & bottom lap lengths.

Density: 55 (pcf)
 Tower Height: (ft) 38

Tower Model: TX-438

Tower section No.:	3	4	5	6	7	8	9	10
Lgth. of Section (ft):	0	21	21	0	0	0	0	0
Face width (C.L.):	8.95	11.47	13.94	16.68	19.94	23.725	28.25	34.25
Leg dia.:	1.05	1.05	1.05	1.315	1.66	1.9	2.375	2.875
Leg Thkn's: Spec.	0.154	0.154	0.154	0.179	0.191	0.2	0.218	0.276
Leg Thkn's: Design	0.143	0.143	0.143	0.166	0.178	0.186	0.203	0.257
Leg F-y:	50000	50000	50000	50000	50000	50000	50000	50000
Web dia:	0.375	0.375	0.375	0.4375	0.5	0.625	0.75	0.875
Web F-y:	36000	36000	36000	36000	36000	36000	36000	36000
Web spacing: (leg unsupported length)	15	15	15	15	15	30	30	30
Web "phi":	37.3	28.37	22.55	18.46	14.15	30.35	26.12	19.8
Web clear width:	7.90	10.42	12.89	15.37	18.28	21.83	25.88	31.38
Web L:	9.93	11.84	13.96	16.20	18.85	25.29	28.82	33.35
No. of diagonal webs:	0	40	40	0	0	0	0	0
Top Lap (ft):	0	0	4	0	0	0	0	0
Bottom Lap (ft):	0	4	0	0	0	0	0	0
No. of additional lap diagonal webs:	0	7	7	0	0	0	0	0
Top plate depth:	4	4	5	4	6	8	6	8
Bot plate depth:	2.5	2.5	3	6	5	8	8	8
Plate Thkn's:	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375

Yellow = No Ice Condition

Green = With Ice Condition

Projected Areas Outside Lap Areas:

Section L (ft) Used:	0	17	17	0	0	0	0	0
Section PA (sqft/ft):	0.000	0.404	0.426	0.000	0.000	0.000	0.000	0.000
Section PA (sqft/ft):	0.000	0.404	0.426	0.000	0.000	0.000	0.000	0.000

Projected Areas at Laps:

Lap PA (sqft/ft):	Lap 3+4:	0.000	0.000	Lap 6+7:	0.000	0.000	Lap 9+10:	0.000
	Lap 4+5:	1.129	1.129	Lap 7+8:	0.000	0.000		0.000
	Lap 5+6:	0.000	0.000	Lap 8+9:	0.000	0.000		

Weight:

Legs:	0	93	93	0	0	0	0	0
Webs:	0	54	63	0	0	0	0	0
Anchors:	0	24	36	0	0	0	0	0
Misc.:	0	17	19	0	0	0	0	0
Total weight:	0	188	211	0	0	0	0	0
Total weight:	0	188	211	0	0	0	0	0

Note:

1. Program assumes that all lap areas have x-braced webs in all tower sections.

This will result in slightly conservative design values if x-braces are not in the lap area.

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Tower Loading - Shear & Moments

Tower Model: TX-438

Design per EIA-222-F

Wind velocity (mph): **76**

Tower Section	Projected Area	Analysis height (ft)	z height (ft)	K-z	G-h	q-z (basic)	No ICE Condition		
							w (plf)	Shear (lbs)	Moment (ft-lbs)
Mast	0.670	39	39	1.049	1.238	14.79	12.9	13	13
3	0.000	38	38.5	1.045	1.238	14.79	0.0	13	26
3&4	0.000	38	38	1.041	1.238	14.79	0.0	13	26
4	0.491	21	29.5	1.000	1.238	14.79	9.0	166	1544
4&5	1.217	17	19	1.000	1.238	14.79	22.3	255	2385
5	0.513	0.1	8.55	1.000	1.238	14.79	9.4	414	8033
5&6	0.088	0	0.05	1.000	1.238	14.79	1.6	414	8074
6	0.000	0	0	1.000	1.238	14.79	0.0	414	8074
6&7	0.000	0	0	1.000	1.238	14.79	0.0	414	8074
7	0.000	0	0	1.000	1.238	14.79	0.0	414	8074
7&8	0.000	0	0	1.000	1.238	14.79	0.0	414	8074
8	0.000	0	0	1.000	1.238	14.79	0.0	414	8074
8&9	0.000	0	0	1.000	1.238	14.79	0.0	414	8074
9	0.000	0	0	1.000	1.238	14.79	0.0	414	8074
9&10	0.000	0	0	1.000	1.238	14.79	0.0	414	8074
10	0.000	0	0	1.000	1.238	14.79	0.0	414	8074

Tower Section Weights: (No Ice)

Section	Weight (lbs)	Lift cable force (lbs)
Antenna	200	
Co-ax Wt:	12	(at top of tower)
3	0	0
4	188	450
5	211	899
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0

Note:

- 1 ≤ G-h ≤ 1.25
- 1 ≤ K-z ≤ 2.58

Co-ax Cable Data:

Cable dia. (in):	0.875	
No. of cables:	1	
C-a:	1.2	Table 3 - EIA
<u>Cable Proj. Area</u>	0.088	<u>(sq.ft. / ft.):</u>
Wght. / Cable (lb/ft):	0.30	
Total Wght (lb):	12	

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Lift Cable Analysis

Note: All units are in pounds.

Tower Data:

No. of twr. sections: 2
 Antenna weight (lb): 200
 Ant. mount wt. (lb): 50
 Accessories wt. (lb): 0
 Coax cable wt. (lb): 12

Tower Section:	Section Wt. (lb):	Vert. Component of Guy Cables (lb):
4	188	0
5	211	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0

Pulley Frame - Tower Section: 4

F-v: 262 (Force on Section)

Pulley Frame - Tower Section: 5

Cable dia (in): 0.25
 Cable MBS: 7000
 No. of faces w/cable: 1
 Sum F-v: 899 (Force on Section)
 CF-tot: 450 (At Anchor in above section)
 CF-face: 450 (At Anchor in above section)

Cable Safety Factor: 15.57

Pulley Frame - Tower Section: 6

Cable dia (in): 0.25
 Cable MBS: 7000
 No. of faces w/cable: 1
 Bottom locked out? 1=y, 2=n: 2
 Sum F-v: NA (Force on Section)
 CF-tot: NA (At Anchor in above section)
 CF-face: NA (At Anchor in above section)

Cable Safety Factor: NA

Pulley Frame - Tower Section: 7

Cable dia (in): 0.25
 Cable MBS: 7000
 No. of faces w/cable: 3

Sum F-v: NA (Force on Section)
 CF-tot: NA (At Anchor in above section)
 CF-face: NA (At Anchor in above section)

Cable Safety Factor: NA

Pulley Frame - Tower Section: 8

Cable dia (in): 0.25
 Cable MBS: 7000
 No. of faces w/cable: 4
 Bottom locked out? 1=y, 2=no: 2
 Sum F-v: NA (Force on Section)
 CF-tot: NA (At Anchor in above section)
 CF-face: NA (At Anchor in above section)

Cable Safety Factor: NA

Pulley Frame - Tower Section: 9

Cable dia (in): 0.25
 Cable MBS: 7000
 No. of faces w/cable: 4
 Sum F-v: NA (Force on Section)
 CF-tot: NA (At Anchor in above section)
 CF-face: NA (At Anchor in above section)

Cable Safety Factor: NA

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Max. Allowable Antenna Area
Based on Leg Compressive Strength

Tower Model: TX-438

Reference "Tower Section Property" sheets for section data.

Tower Section	Analysis Height (ft)	KL/r	F-a (psi)	Allow. 'P' (lbs)	Actual 'P' (lbs)	Allow. Mom. ft-lb	Actual Mom. ft-lb	P-antenna (lbs)
3	38	41.6	34136	13927	40	8995	26	4485
4	21	41.6	34136	13927	2015	11404	1544	519
5	0.1	41.6	34136	13927	8285	13709	8033	142
6	0	32.9	35709	21449	6708	25819	8074	10000
7	0	25.6	36903	30527	5611	43929	8074	10000
8	0	44.3	33614	33666	4716	57641	8074	10000
9	0	35.0	35344	48901	3960	99694	8074	10000
10	0	29.0	36356	76761	3267	189732	8074	10000

Allow. Antenna Wind Load (lb): 142
 Allow. Antenna Area (sq. ft.): 5.7

NOTE:

1. Allow. Moment = 0.866 * (face width / 12)(allow. axial load - lift cable force / 3)
2. Allow. Antenna Wind Load = (allow. mom. - actual mom.) / (antenna hgt - analysis hgt.)
3. Allow. Antenna Area = allow. ant. wind load / (1.3 *K-z*G-h* q-z)
4. P-antenna column - the value of 10000 means that this tower section was not used on this tower.
5. The tower height is shown in analysis height until you get down to the actual first tower section used in this tower.

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Max. Allowable Antenna Area
Based on Webs - Outside Lap Areas

Tower Model: TX-438

Reference "Tower Section Property" sheets for section data.

Tower Section	Analysis Height (ft)	Web 'L' (in)	KL/r	F-a (psi)	Allow. 'P' (lbs)	Actual 'P' (lbs)	Allow. F-h (lbs)	Actual Shr (lbs)	P-antenna (lbs)
3	38	11.25	96.0	13606	1503	9	1195	12	2058
4	38	13.04	111.2	11677	1290	8	1135	12	1953
5	17	15.09	128.8	12002	1326	254	1224	406	1715
6	0	17.58	128.6	12036	1809	263	1716	431	10000
7	0	20.56	131.6	11495	2257	257	2189	431	10000
8	0	27.49	140.8	10049	3083	289	2660	431	10000
9	0	31.46	134.2	11049	4881	277	4383	431	10000
10	0	36.40	133.1	11235	6756	265	6356	431	10000

Allow. Antenna Wind Load (lb): 1715
 Allow. Antenna Area (sq. ft.): 72.6

NOTE:

1. Allow. F-h = allow. P * cos(phi). = Allow. shear in one face of tower.
2. Allow. Antenna Wind Load = 2 * cos(30) * allow. F-h - actual shear.
3. Allow. Antenna Area = allow. ant. wind load / (1.3 * K-z * G-h * q-z)
4. P-antenna column - the value of 10000 means that this tower section was not used on this tower.
5. The tower height is shown in analysis height until you get down to the actual first tower section used in this tower.

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Max. Allowable Antenna Area
Based on Webs in Lap Areas

Tower Model: TX-438

Reference "Tower Section Property" sheets for section data.

Tower Section	Analysis Height (ft)	Web 'L' (in)	KL/r	F-a (psi)	Allow. 'P' (lbs)	Actual 'P' (lbs)	Allow. Mom ft-lb	Actual Mom ft-lb	P-antenna (lbs)
3	38	11.25	96.0	17966	3968	0	21819	26	10897
4	21	13.04	111.2	15337	1694	253	9663	1544	427
5	0.1	15.09	96.6	17868	3947	628	23599	8033	10000
6	0	17.58	96.5	17891	5379	614	33693	8074	10000
7	0	20.56	98.7	17518	6879	601	44559	8074	10000
8	0	27.49	105.6	16344	10029	675	58301	8074	10000
9	0	31.46	100.7	17185	15184	649	92799	8074	10000
10	0	36.40	99.8	17327	20838	619	134174	8074	10000

Allow. Antenna Wind Load (lb): 427
 Allow. Antenna Area (sq. ft.): 17.1

NOTE:

1. Allow. Moment = allow. P * cos(phi) * 8 * cos(30).
2. Allow. Antenna Wind Load = (allow. mom. - act. mom.) / (antenna hgt. - analysis hgt.).
3. Allow. Antenna Area = allow. ant. wind load / (1.3 * K-z * G-h * q-z)
4. P-antenna column - the value of 10000 means that this tower section was not used on this tower or the tower section is the base section.)
5. The tower height is shown in analysis height until you get down to the actual first tower section used in this tower.

Maximum Antenna Wind Load and Wind Area:

(Ref. this sheet and the previous 2 sheets.)

Allow. antenna Wind Load (lb): 142
Allow. antenna Area (sq. ft.): 5.7 (w/ appurtenance force coefficient = 1.3)
Allow. antenna Area (sq. ft.): 5.3 (w/ appurtenance force coefficient = 1.4, i.e. all flat members)
Allow. antenna Area (sq. ft.): 9.3 (w/ appurtenance force coefficient = 0.8, i.e. all round members)

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Tower Section No. 4 - Analysis

11

Tower Model: TX-438

Shear (lb): 308
 Lift Cable Force (lb): 450
 Face Width (in): 11.47

Moment (ft-lb): 4247
 Panel Height (in): 15
 Lap length (ft): 4
 Lap X Braced? Y=1, N=2 **2**

Web Analysis:

Dia. (in): 0.375
 F-y (psi): 36000
 Area(in²): 0.110
 L (in): 13.04
 r (in): 0.094
 K: **0.8**
 KL/r: 111.2

C-c: 126.1
 Actual f-a (psi): 1830
 Allow. F-a (psi): 15337

Web CSI: 0.12

Weld size (in): **0.188**
 Weld L (in): **0.5**
 Act. weld 'f' (lb/in): 404
 Allow. weld 'F' (lb/in): 3722

Weld CSI: 0.11

Web Analysis - Lap Area

Dia. (in): 0.375
 F-y (psi): 36000
 Area (in²): 0.110
 L (in): 13.04
 r (in): 0.094
 K: **0.8**
 KL/r: 111.2

C-c: 126.1
 Actual f-a (psi): 8137
 Allow. F-a (psi): 15337

Web CSI: 0.53

Weld size (in): **0.188**
 Weld L (in): **0.5**
 Act. weld 'f' (lb/in): 1797
 Allow weld 'F' (lb/in): 3722

Weld CSI: 0.48

Lap shear (lbs): 1062

Leg Analysis:

Dia. (in): 1.05
 Thk. (in): 0.14322
 F-y (psi): 50000
 Area(in²): 0.408
 L (in): 15
 r (in): 0.325
 K: **0.9**
 KL/r: 41.6

C-c: 107.0
 Leg Comp. load (lb): 5280
 Actual f-a (psi): 12942
 Allow F-a (psi): 34136

Leg CSI: 0.38

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Tower Section No. 5 - Analysis

Tower Model: TX-438

Shear (lb): 556
 Lift Cable Force (lb): 899
 Face Width (in): 13.94

Moment (ft-lb): 13709
 Panel Height (in): 15
 Lap length (ft): 4
 Lap X Braced? Y=1, N=2 **1**

Web Analysis:

Dia. (in): 0.375
 F-y (psi): 36000
 Area(in²): 0.110
 L (in): 15.09
 r (in): 0.094
 K: **0.8**
 KL/r: 128.8

Web Analysis - Lap Area

Dia. (in): 0.375
 F-y (psi): 36000
 Area (in²): 0.110
 L (in): 15.09
 r (in): 0.094
 K: **0.6**
 KL/r: 96.6

Lap shear (lbs): 1062

C-c: 126.1
 Actual f-a (psi): 3147
 Allow. F-a (psi): 12002

Web CSI: 0.26

Weld size (in): **0.188**
 Weld L (in): **0.5**
 Act. weld 'f' (lb/in): 695
 Allow. weld 'F' (lb/in): 3722

Weld CSI: 0.19

C-c: 126.1
 Actual f-a (psi): 4578
 Allow. F-a (psi): 17868

Web CSI: 0.26

Weld size (in): **0.188**
 Weld L (in): **0.5**
 Act. weld 'f' (lb/in): 1011
 Allow weld 'F' (lb/in): 3722

Weld CSI: 0.27

Leg Analysis:

Dia. (in): 1.05
 Thk. (in): 0.14322
 F-y (psi): 50000
 Area(in²): 0.408
 L (in): 15
 r (in): 0.325
 K: **0.9**
 KL/r: 41.6

C-c: 107.0
 Leg Comp. load (lb): 13927
 Actual f-a (psi): 34136
 Allow F-a (psi): 34136

Leg CSI: 1.00

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Tower Base Connection
#5 Base

TX-438

Shear (lbs): **556**
 Moment (ft-lbs): **13709**
 Lift Cable force (lbs): **899**
 Face width (in): **13.94**

Leg Comp. (lbs): 13927
 Leg Tension (lbs): 13328
 Leg O.D. (in): **1.05**

Tab Plate to Leg:
 Plate width (in): **2**
 Plate height (in): **5.25**
 Plate Thkn. (in): **0.375**

C.L. bolt to leg (in): **1.25**
 Bolt dia. (in): **0.75 (A325N)**
 No. of bolts: **2**
 Dist. between bolts: **2**

Bolt force (lbs): 9310
 Allow. bolt shr. (lbs): 12370
 Br'g check OK
 Bolt CSI: 0.75

Weld tab to leg: Weld size (in): **0.1875**
 Moment (in-lbs): 24720
 Weld S-x (in²): 9.188
 Weld stress (lbs/in): 3016
 Allow Stress (lbs/in): 3712
 Weld CSI: 0.81

Tab Plate to Base:
 Plate F-y (psi): **42000**
 Plate width (in): **3.5**
 Plate height (in): **5.25**
 Plate Thkn. (in): **0.375**
 Bolt ecc. (in): **0.5**
 Shear ecc. (in): **3.125**
 Distance from first bolt to base plate: **2.125**

KL/r: 24
 F-a (psi): 31499
 P-allow (lb): 41343
 Moment (in-lbs): 7543
 h/t: 9.333333
 F-b(psi): 36960
 Plate CSI: 0.69
 f-a (psi): 10611
 F-e (psi): 269124
 Sx (in³): 0.766

Weld tab to base: Weld size (in): **0.3125**
 Weld S-x (in²): 4.083
 Weld stress (lbs/in): 2602
 Allow Stress (lbs/in): 6187

Moment (in-lbs): 7243
 Weld CSI: 0.42

Base Plate Assembly:

Top Plate:	Bot. Plate:
W (in): 3.500	W (in): 3.500
L (in): 5.500	L (in): 5.500
Thkn. (in): 0.375	Thkn. (in): 0.375

Concrete bearing: f-c (psi): 2000
 f-p (psi): 723
 F-p (psi): 1867
 CSI: 0.39

Combined Plate Properties:

Top Plate:	Bot. Plate:	Centroid:
Area: 1.3125	Area: 1.3125	0.375
Y-bar (in): 0.5625	Y-bar (in): 0.1875	I (in ⁴): 0.123
		C (in): 0.375

Moment - from comp (in-lbs): 9575
 f-b (psi): 29180
 F-b (psi): 36000
 CSI: 0.81

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Anchor Bolt Anchorage

Tower Model: TX-438

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

All units are pounds and inches unless noted otherwise. Date: 8/14/2009

Anchorage Description: 1-3/4" dia, F1554 Grd. 55 anchor rods

Concrete f_c' (psi): 2500 Is this in a moderate or High Seismic area: 1.00 Factored Req'd Tens. Load (lb): 17446 (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: 15.00 If embedment $\times 1.5$ 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: Concrete Breakout Input: (Tension)
 No. of Anchors n: 1 Edge Distances: A-Ncc: 2025.0 Projected breakout area of single anchor
 Anchor dia: 0.75 c-a1: 22.50 Proj'd breakout area of anchor group (For a single anchor use A-Ncc value)
 No. of threads / in: 10 c-a2: 19.20 (If have more than two anchors need to hand input A-Nc)
 Anchor f_y (psi): 55000 c-a3: 8.50 Eccentricity of tension load - anchor groups only
 Anchor f_u (psi): 75000 c-a4: 33.50 (ACI D5.2.4) for anchor groups loaded eccentrically
 phi: 0.75 AdjF-ec,N: 1.000 (ACI D5.2.5) for edge effects
 phi = 0.65 if material used is not ductile AdjF-ec,N: 0.870 (ACI D5.2.6) Assumed cracked at service load levels
 Can use 1.25 if is uncracked
 Use 0.75 if supplemental reinforcement is provided
 Use 0.70 if supplemental reinforcement is not provided

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

A-se: 0.334 Effective anchor area (in²)
 N-sa: 25084

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

N-b: 69714 ACI D5.2.2
 N-cb: 48397

Anchor Pullout Strength (ACI D5.3)

N-p: 71164
 N-pn: 99630

Concrete Side-Face Blowout, Tension

N-sb: 128270 Note: If c_{a1} is $> 0.4 \times h_{ef}$ then blowout does not occur.

Anchor Design Strength - LRFD

Steel: 18813
 Breakout: 33878
 Pullout: 69741
 Blowout: 89789
 (Note: If supplemental reinforcement is provided then the concrete strength limit does not apply, App. D.D.4.2.1.)

Notes:

- For normal weight concrete only.
- Anchors shall be either a headed bolt or have nuts and a bearing plate at the embed end as indicated above.
- ACI Section D.5.2.3 is not included in this spreadsheet. (i.e. End of wall applications are not covered.)
- 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.)
- Any supplemental reinforcing shall have $f_y = 60,000$ psi min.
- 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.

LRFD Design Strength:	18813 Lbs
ASD Design Strength:	13438 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

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Foundation Design

Tower Model: TX-438

Tower Reactions:

Moment (ft-lbs): **13709**
 Shear (lbs): **556**
 Lift Cable Force (lbs): **899**
 Modification Factor: **1.3**
 (Req'd by EIA-F 3.1.16.1)
 Tower Face Width(in): **13.94**
 Distance from ground to top of concrete (ft): **0.667**
 Square ft'g width (ft): **3.5**
 Footing depth (ft): **6**

H (ft): 25.32
 S-1: 400
 (Increased S1 by 2x per IBC 1804.3.1 for isolated footing not adversely affected by 1/2" motion at ground surface.)
 A: 0.854
Depth req'd (ft): 5.3

Foundation Design Reactions:

Moment (ft-lbs): 18304
 Shear (lbs): 723
 Lift Cable Force (lbs): 1169

Concrete f-c' (psi): **2500**

Soil Design Parameters:

Allow. Lateral bearing (psf/ft): **100**
 Allow. Soil bearing (psf): **1500**
 Design is for non-contained condition per IBC reqmt's.

Allow. bearing (psf): 3000 Increased 20% for ea.
Act. bearing (psf): 973 ft. of depth

Max. Moment in Footing (ft-lbs): 21244

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

S-x (in³): 9145
 f-t (psi): 45
 F-t (psi): 138
CSI: 0.32

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

rho: **0.0018**
 A-s req'd (sq. in.): 3.18
 Rebar dia (in): **0.875**
 No. of bars provided: **8**
 A-s provided (sq. in.): 4.81 OK

Anchor Bolt Anchorage Design Load:

Anchorage Tension Design Force (lbs): 17446 (LRFD level force)
 (See Anchor Bolt Anchorage page for anchorage design)

Summary:

Use foundation 3.5 ft. square by 6.0 ft. deep (below undisturbed soil).
 Reinforce foundation with 8 #7 vertical bars (total) with #3 ties at 12" on center, and 3 ties in the top 5".
 Use 1 vertical bar at each corner of the foundation and one bar at the middle of each face of the fdn.
 Use 3/4" dia. ASTM F1554 Gd. 55 galvanized anchor bolts w/ welding supplement S1 requirements, 27" long.
 Total of 3 anchor rods, one near each tower leg with a minimum embedment of 21". Use heavy hex nuts.
 A minimum of a 2" sq. x 5/8" thick plate washer is req'd at the bottom of each anchor bolt. If headed anchor rods are provided then place the plate washer on top of the anchor head at the bottom of the anchor and tack weld the washers to the anchor rod. If a headed bolt is not provided then use double hex nuts at the bottom of anchor with the plate washer located between the nuts. Tack weld the nuts to the anchor bolt.

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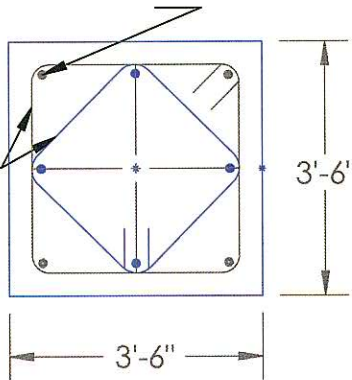
TX-438 FOUNDATION

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16

- ① 8 - #7 Vertical Bars (1 bar @ corners & center)

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



Plan View - Reinforcing
No Scale

Foundation has been designed to accommodate the following loads:

Overturing Moment = 18.51ft - kips
 Base Shear = 1.03 kips
 Structure Weight = 1.17 kips

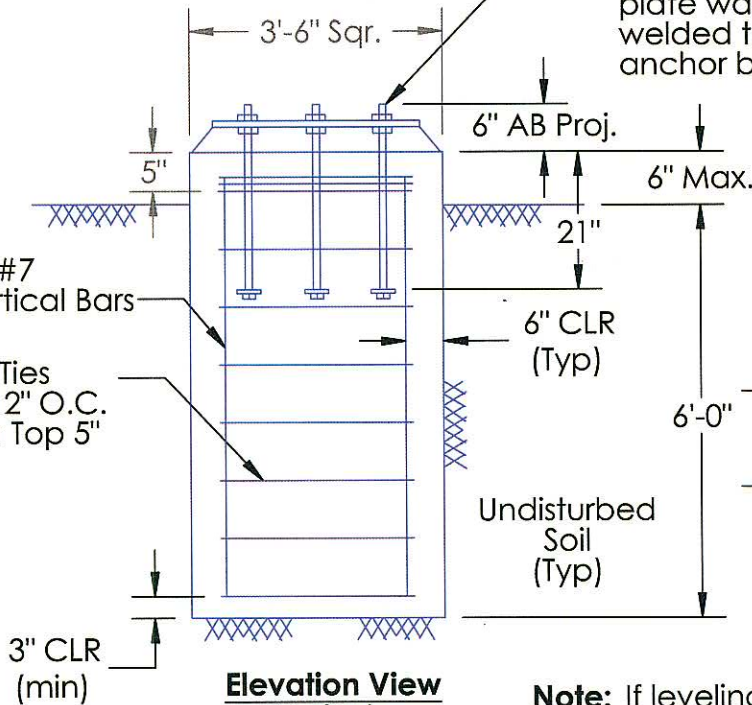
Soil and Concrete Design Parameters.

Allowable Foundation Pressure 1500 psf
 (Increases based on depth)

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

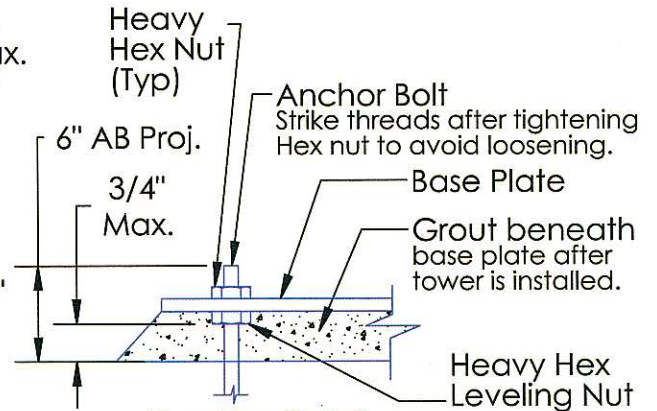
Concrete f_c' = 2500 psi min. @ 28 days.

- ① 8 - #7 Vertical Bars
- ② #3 Ties @ 12" O.C.
- ③ 3 in Top 5"



Elevation View
No Scale

3/4" \varnothing x 27" ASTM F1554 GD. 55 headed anchor bolt w/SI welding supplement, (3 total), w/21" min. embedment. Use min. of 2" SQ x 5/8" thk ASTM A36 plate washer on top of bottom bolt head, tack welded to bolt. See calcs. for alternate to a headed anchor bolt.



Grouting Detail

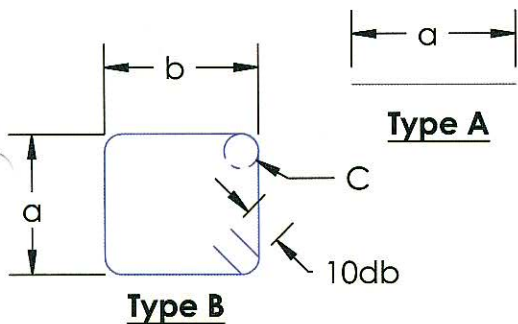
Extreme care should be taken to assure that all leveling nuts are level with respect to each other prior to installation of tower.

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

Reinforcement Material List

Sym	Type	Bar Size	Dimensions				Qty
			a	b	c	10db	
①	A	#7	6' - 0" *	---	---	---	8
②	B	#3	3' - 0" *	3' - 0" *	2"	3.75"	9
③	B	#3	2' - 1" *	2' - 1" *	2"	3.75"	9

* = Nominal dimension

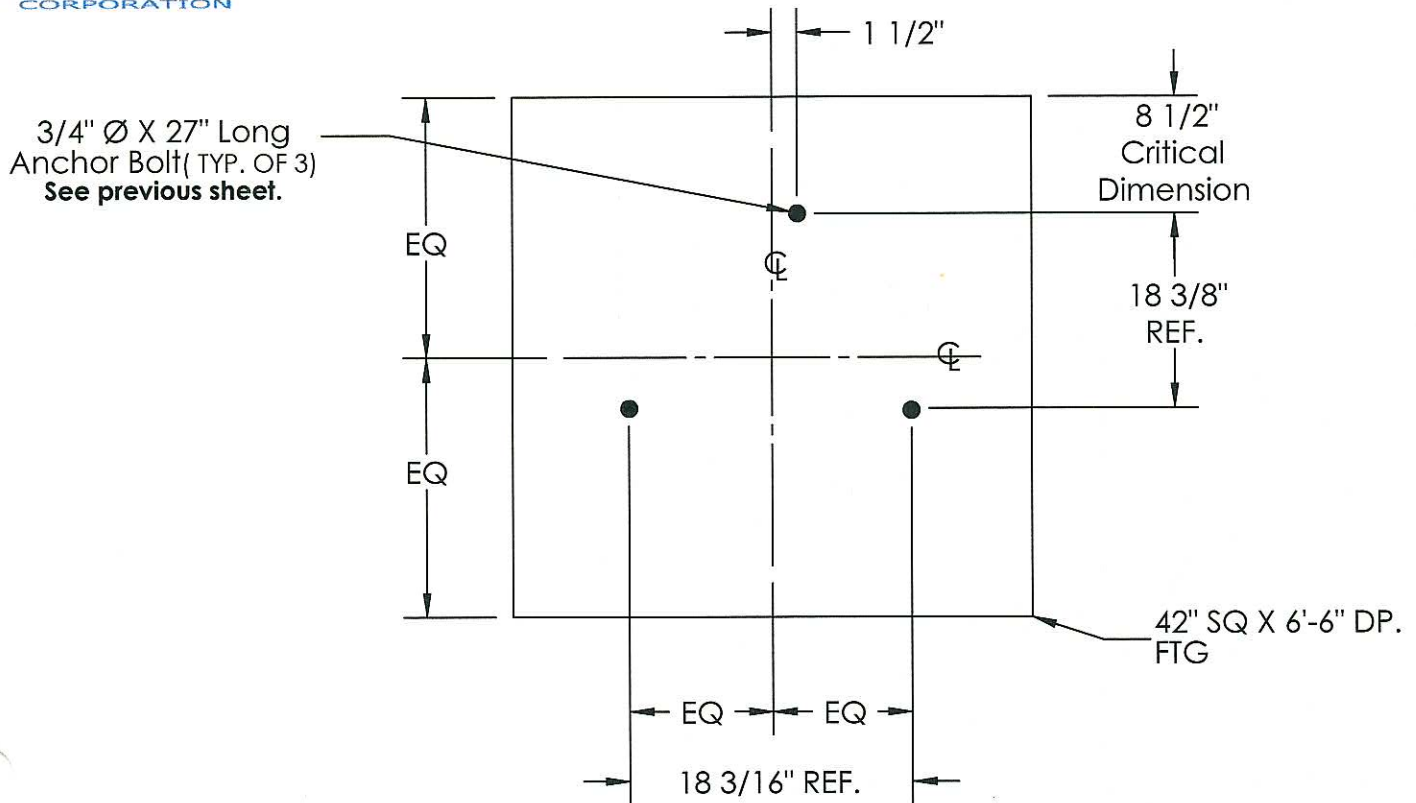




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17



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 2006 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.
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.