



Structural Analysis Report

Structural Analysis: Self-Supporting Triangular Crank-Up Tower

Tower Model: HDX-689

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

Basic Wind Velocity:	90	mph	
Exposure	C	Ice:	None
		Topographic Category:	1
		Structure Classification:	1

Max. Allowable Antenna Wind Load (lbs) - Unfactored:	407
Max. Allowable Antenna Weight (lbs):	230
Max. Allowable Effective Antenna Wind Area (sq. ft.):	25.2

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: 3/10/2014

Sheet 1 of %

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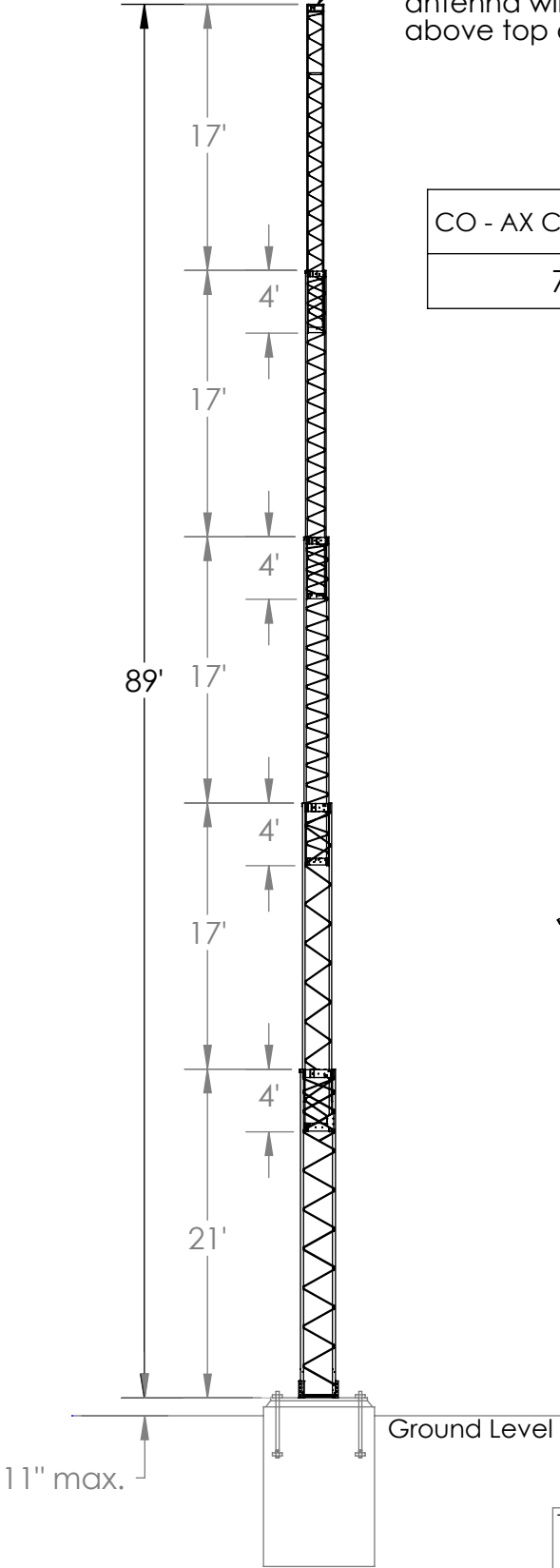


HDX-689 TOWER ELEVATION

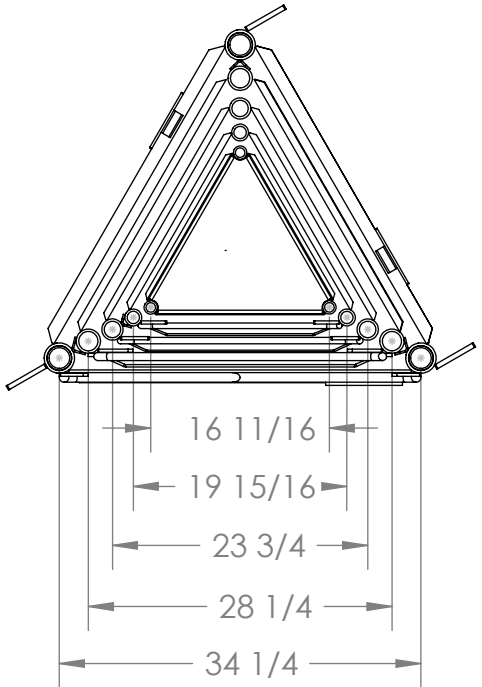
2" OD Tube Mast.
See cover sheet for max. allowable antenna wind load and area @ 1 FT. above top of tower.

NO. 10 BASE	NO. 9	NO. 8	NO. 7	NO. 6 TOP
PIPE 2.875" OD X 0.276" WALL	PIPE 2.375" OD X 0.218" WALL	PIPE 1.9" OD X 0.2" WALL	PIPE 1.66" OD X 0.191" WALL	PIPE 1.315" OD X 0.179" WALL
7/8" SOLID ROD	3/4" SOLID ROD	5/8" SOLID ROD	1/2" SOLID ROD	7/16" SOLID ROD

SECTION NO.
LEG SIZE
DIAGONAL SIZE



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



Plan View
No Scale

Elevation View
No Scale

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND SHALL NOT BE USED OR REPRODUCED OR ITS CONTENTS DISCLOSED, IN WHOLE OR IN PART, WITHOUT THE PRIOR WRITTEN CONSENT OF US TOWER CORPORATION.



General Notes:

Tower Model: HDX-689

1. All work shall be in conformance with the requirements of the "International Building Code - 2009" and "Structural Standards for Antenna Supporting Structures and Antennas ANSI/TIA-222-G", by the Telecommunications Industry Association.
2. Steel design is per the requirements of ANSI/TIA-222-G and the American Institute of Steel Construction Specification for Structural Steel Buildings, ANSI/AISC 360-05.
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 Telecommunications Industry 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:

<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

9. 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. Unless otherwise noted.
11. The design of the hoist system is not within 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 within the scope of these calculations.
15. Installations on hills, escarpments and other special wind areas is not within the scope of these calculations.
16. Seismic analysis is not within the scope of these calculations. Unless noted otherwise.
17. 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.
18. 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.
19. US Tower Corp. and its 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.
20. US Tower Corp. and its Engineers accept no responsibility for field inspection during construction nor for the method of construction.
21. 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.
22. 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.
23. This tower has not been designed for snow or ice loading per TIA-G T. 2-3, Structure Class 1. The tower shall be fully retracted prior to any snow or ice event. Unless noted otherwise.
24. Foundation design covers F0, S0, P0, C0 & C1 exposure classes. If local conditions are known to differ, a qualified local professional engineer shall provide the foundation design.
25. Foundation Design does not include considerations for frost depth or high ground water level.



Code & Material Specifications

Tower Model: HDX-689

Governing Codes, Stresses, and Materials (Min.)

International Building Code TIA-222-G AISC Spec for Structural Steel Bldgs ACI 318	2009 Edition (Occ. Cat. II) ANSI/TIA-222-G ANSI/AISC 360-05 2008 Edition
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) ASTM A513 Type 1A (F-y = 42 ksi)
Welding	AWS D1.1-08 GMAW w/ ER70S-6 wire per AWS A5.18
Hot-Dip Galvanizing Hardware	ASTM A123 ASTM A153
Bolts: Tower & Accessories	ASTM A325
Reinforced Concrete	2500 psi strength @ 28 days Exposure Class F0, S0, P0, C0 & C1
Reinforcing Steel	ASTM A615 Gd. 40 for #4 & smaller dia. Gd. 60 for #5 & larger dia.
Anchor Rods	ASTM F1554 Gd. 36 or ASTM A-36
Foundation & Soils Lateral Bearing Pressure	1500 psf Bearing (TL = DL+LL) 100 psf/ft of depth



Tower Section Properties

Tower Model: HDX-689

Design per TIA-222-G

All units are in lbs. and inches U.O.N.

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

Tower Height (ft): **89**
 Ice t (in): **0**
 Density (pcf): **56**
 Design Ice t (in): **0**

Design Thickness Modifier: **1.00**

Tower section No.:	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
Lgth. of Section (ft):	0	0	0	21	21	21	21	21
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	0.154	0.154	0.154	0.179	0.191	0.200	0.218	0.276
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":	40	31	25	21	17	31	26	21.5
Web clear width:	7.90	10.42	12.89	15.37	18.28	21.83	25.88	31.38
Web L:	10.31	12.16	14.22	16.46	19.12	25.46	28.79	33.72
No. of diagonal webs:	0	0	0	41	46	24	24	21
Top Lap (ft):	0	0	0	0	4	4	4	4
Bottom Lap (ft):	0	0	0	4	4	4	4	0
No. of additional lap diagonal webs:	0	0	0	7	13	7	7	4
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

Appurtenance @ top of Section: (Coax arms need not be included since R-a <0.1)

Weight (lbs):	0	0	0	0	0	0	0	0
Area - No Ice (sq. ft.):	0	0	0	0	0	0	0	0
Area - w/ Ice (sq. ft.):	0	0	0	0	0	0	0	0
C-f, (TIA Tbl 2-8):	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Conc. EPA No Ice:	0	0	0	0	0	0	0	0
Conc. EPA w/ Ice:	0	0	0	0	0	0	0	0

Projected Areas Outside Lap Areas:

Section L (ft) Used:	0	0	0	17	13	13	13	17
Section PA (sqft/ft):	0.000	0.000	0.000	0.531	0.590	0.642	0.801	1.223
Section PA (sqft/ft):	0.000	0.000	0.000	0.531	0.590	0.642	0.801	1.223

Projected Areas at Laps:

Lap PA (sqft/ft):	Lap 3+4:	0.000	0.000	Lap 6+7:	1.966	1.966	Lap9+10:	3.785
	Lap 4+5:	0.000	0.000	Lap 7+8:	2.358	2.358		3.785
	Lap 5+6:	0.000	0.000	Lap 8+9:	2.792	2.792		

Weight:

Legs:	0	0	0	137	189	229	317	484
Webs:	0	0	0	101	171	176	287	398
Anchors:	0	0	0	53	70	121	126	175
Misc.:	0	0	0	29	43	53	73	106
Total weight:	0	0	0	321	473	579	803	1163
Total weight:	0	0	0	321	473	579	803	1163



Tower Loading - Shear & Moments

Wind Loads

Tower Model: HDX-689

Design per TIA-222-G

Wind velocity (mph): **90**
 Exposure: **C**
 Topo Category: **1**
 Tower Height (ft): 89
 Structure Classif.: **1**
 Load Factor - Wind: **1.6**
 Load Factor - Dead: **1.2**
 Ant. Height Above Top of Tower (ft): **1**

Antenna & Mast / Mount Data:

Antenna Area (ft²): **21** Mast Dia. (in): **2**
 Force Coefficient C-f: **1.2** Mast Lgth (in): **48**
 EPA (ft²): 25.2 Force Coeff. C-f: **1.2**
 Ant. + Mt. wt. (lbs): **230** EPA (ft²/ft): 0.800

Co-ax Cable Data:

Cable dia. (in): **0.875**
 No. of cables: **1**
 C-a: **1.2** Table 3 - EIA
 Cable Proj. Area 0.088 (sq.ft. / ft.):

Wght. / Cable (lb/ft): **0.30**
 Total Wght (lb): 27

Wind Velocity Coefficient

$Kz = 2.01 * (z/Zg)^{2/3}$ $z > 15'$
 $q-z = 0.00256 * Kz * Kzt * Kd * I * G-h * V^2$

No ICE

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)	Lift Cable Force (lbs)	Load Condition
Antenna Mast	25.2	90	90	1.238	18.98	651	651	0	0	0	29.4	3.1	651	0		No Ice
Top of 3	0.800	89	89.5	1.236	18.96	21	671	661	0	661	29.4	3.1	671	661		No Ice
Top of 4	0.000	89	89	1.235	18.94	0	671	661	0	661	29.4	3.1	671	661		No Ice
3&4	0.000	89	89	1.235	18.94	0	671	661	0	661	29.4	3.1	671	661		No Ice
4	0.000	89	89	1.235	18.94	0	671	661	0	661	29.4	3.1	671	661		No Ice
4&5	0.000	89	89	1.235	18.94	0	671	661	0	661	29.4	3.1	671	661		No Ice
5	0.000	89	89	1.235	18.94	0	671	661	0	661	29.4	3.1	671	661		No Ice
5&6	0.000	89	89	1.235	18.94	0	671	661	0	661	29.4	3.1	671	661		No Ice
6	0.618	72	80.5	1.209	18.54	16	936	14323	291	14613	18.9	2.7	936	14613		No Ice
6&7	0.000	72	72	1.181	18.11	0	936	14323	291	14613	18.9	2.7	936	14613		No Ice
7	2.054	68	70	1.174	18.00	50	1137	18470	291	18760	-	-	1137	18760		No Ice
7&8	0.677	55	61.5	1.142	17.52	16	1347	34618	777	35395	10.4	2.0	1347	35395		No Ice
8	0.000	55	55	1.116	17.11	0	1347	34618	777	35395	10.4	2.0	1347	35395		No Ice
8&9	2.446	51	53	1.107	16.98	56	1573	40457	777	41235	-	-	1573	41235		No Ice
9	0.888	38	44.5	1.067	16.37	16	1784	62277	1353	63630	4.6	1.2	1784	63630		No Ice
9&10	0.000	34	36	1.021	15.65	61	2029	69903	1353	71256	-	-	2029	71256		No Ice
10	3.873	21	27.5	0.964	14.79	18	2261	97790	1841	99632	1.3	0.6	2261	99632		No Ice
Total	1.311	0.1	8.55	0.850	13.03	23	2942	153817	2123	155940	0.0	0.0	2942	155940		No Ice

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

Tower Section Weights: (No Ice)

Section	Weight (lbs)	Lift cable force (lbs)
Co-ax Wt:	27	693
3	0	1387
4	0	3216
5	0	5868
6	321	4628
7	473	0
8	579	0
9	803	0
10	1163	0
Total:	3366	0



Lift Cable Analysis

No Ice

Tower Model: HDX-689

Design per TIA-222-G

Note: All units are in pounds.

Tower Data:

No. of twr. sections: **5**
 Ant & Mt weight (lb): 276
 Misc. wt. (lb): **0**
 Accessories wt. (lb): **0**
 Coax cable wt. (lb): 32
 Weight at Top (lbs): 308

Tower Section Wt. (lb): of Guy Cables (lb):

6 385 **0**
7 568 **0**
8 695 **0**
9 964 **0**
10 1395 **0**
1 0 **0**
1 0 **0**
1 0 **0**

Cable Phi Factor: 0.60
 Load Factor - Dead: 1.2
 Load Factor - Wind: 1.6
 (Included in calc)
 (Included w/ guy cable forces)

Anchor Frame-Tower Section: 6

Cable dia (in): **0.25**
 Cable MBS: **7000**
 No. of faces w/cable: **3**
 F-v = CFtot: 693
 Cable Force Section: 7
 Cable force per face: 231
 Cable CSI: 0.06

Anchor Frame-Tower Section: 10

Cable dia (in): **0.25**
 Cable MBS: **7000**
 No. of faces w/cable: **5**
 F-v = CFtot: 0
 Cable Force Section: 1
 Cable force per face: 0
 Cable CSI: N/A

Pulley Frame-Tower Section: 7

Sum F-vp: 1387 (=Lift cable force for section analysis)

Pulley Frame-Tower Section: NA

Sum F-vp: 0 (=Lift cable force for section analysis)

Anchor Frame-Tower Section: 7

Cable dia (in): **0.25**
 Cable MBS: **7000**
 No. of faces w/cable: **3**
 F-v = CFtot: 1955
 Cable Force Section: 8
 Cable force per face: 652
 Cable CSI: 0.16

Anchor Frame-Tower Section: NA

Cable dia (in): **0.25**
 Cable MBS: **7000**
 No. of faces w/cable: **1**
 F-v = CFtot: 0
 Cable Force Section: 1
 Cable force per face: 0
 Cable CSI: N/A

Pulley Frame-Tower Section: 8

Sum F-vp: 3216 (=Lift cable force for section analysis)

Pulley Frame-Tower Section: NA

Sum F-vp: 0 (=Lift cable force for section analysis)

Anchor Frame-Tower Section: 8

Cable dia (in): **0.3125**
 Cable MBS: **9800**
 No. of faces w/cable: **3**
 F-v = CFtot: 3912
 Cable Force Section: 9
 Cable force per face: 1304
 Cable CSI: 0.22

Anchor Frame-Tower Section: NA

Cable dia (in): **0.25**
 Cable MBS: **7000**
 No. of faces w/cable: **1**
 F-v = CFtot: 0
 Cable Force Section: 1
 Cable force per face: 0
 Cable CSI: N/A

Pulley Frame-Tower Section: 9

Sum F-vp: 5868 (=Lift cable force for section analysis)

Pulley Frame - Tower Section: NA

Sum F-vp: 0 (=Lift cable force for section analysis)

Anchor Frame-Tower Section: 9

Cable dia (in): **0.25**
 Cable MBS: **7000**
 No. of faces w/cable: **4**
 F-v = CFtot: 6832
 Cable Force Section: 10
 Cable force per face: 1708
 Cable CSI: 0.41

Anchor Frame-Tower Section: NA

Cable dia (in): **0.25**
 Cable MBS: **7000**
 No. of faces w/cable: **1**
 F-v = CFtot: 0
 Cable Force Section: 1
 Cable force per face: 0
 Cable CSI: N/A

Pulley Frame-Tower Section: 10

Sum F-vp: 4628 (=Lift cable force for section analysis)

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.)



Tower Sections - Analysis	
Tower Model:	HDX-689

Design per TIA-222-G

	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
Shear (lb):	0	0	0	936	1347	1784	2261	2942
Lift Cable Force (lb):	0	0	0	693	1387	3216	5868	4628
Moment (ft-lb):	0	0	0	14613	35395	63630	99632	155940
Face Width (in):	8.95	11.47	13.94	16.68	19.94	23.725	28.25	34.25
Panel Height (in):	15	15	15	15	15	30	30	30
Lap length (ft):	0	0	0	4	4	4	4	4
Lap X Braced? Y=1, N=2	2	1	1	1	1	1	1	1

Web Analysis:	Web Phi:	0.9		Weld Phi:	0.75		Weld F-exx:	70,000	psi
Dia. (in):	0.375	0.375	0.375	0.4375	0.5	0.625	0.75	0.875	
F-y (psi):	36000	36000	36000	36000	36000	36000	36000	36000	
Area(in^2):	0.110	0.110	0.110	0.150	0.196	0.307	0.442	0.601	
L (in):	10.89	12.84	14.91	17.10	19.76	26.48	29.91	34.78	
r (in):	0.094	0.094	0.094	0.109	0.125	0.156	0.188	0.219	
L/r:	116.2	136.9	159.1	156.3	158.1	169.5	159.5	159.0	
K:	0.74	0.70	0.70	0.70	0.70	0.70	0.70	0.70	
KL/r:	85.8	95.9	111.4	109.4	110.6	118.6	111.7	111.3	
λ-c:	0.96	1.08	1.25	1.23	1.24	1.33	1.25	1.25	
Web Force (lbs):	0	0	0	579	813	1202	1453	1826	
Ø*P-n (lbs):	2430	2206	1863	2593	3339	4738	7425	10151	
Web CSI:	0.00	0.00	0.00	0.22	0.24	0.25	0.20	0.18	
Effective Weld size (in):	0.141	0.141	0.141	0.164	0.188	0.234	0.281	0.328	
50% of Tot. Weld L (in):	0.5	0.5	0.5	0.625	0.625	0.625	0.75	0.75	
Ø*F-w (lbs):	2215	2215	2215	3230	3691	4614	6645	7752	
Weld CSI:	0.00	0.00	0.00	0.18	0.22	0.26	0.22	0.24	

Web Analysis - Lap Area	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
Add'l Lap shear (lbs):	0	0	0	3653	8849	15908	24908	24908
F-y (psi):	36000	36000	36000	36000	36000	36000	36000	36000
L (in):	10.89	6.42	7.46	8.55	9.88	13.24	14.95	17.39
L/r:	116.2	68.5	79.5	78.2	79.0	84.7	79.8	79.5
K:	0.77	1.00	1.00	1.00	1.00	0.97	1.00	1.00
KL/r:	89.9	68.5	79.5	78.2	79.0	82.2	79.8	79.5
λ-c:	1.01	0.77	0.89	0.88	0.89	0.92	0.89	0.89
Web Force (lbs):	0	0	0	1419	3078	5958	8726	8641
Ø*P-n (lbs):	2338	2796	2565	3531	4579	6963	10241	13970
Web CSI:	0.00	0.00	0.00	0.40	0.67	0.86	0.85	0.62
Effective Weld size (in):	0.141	0.141	0.141	0.164	0.188	0.234	0.281	0.328
50% of Tot. Weld L (in):	0.5	0.5	0.5	0.625	0.625	0.9375	1.125	1.125
Ø*F-w (lbs):	2215	2215	2215	3230	3691	6921	9967	11628
Weld CSI:	0.00	0.00	0.00	0.44	0.83	0.86	0.88	0.74

Leg Analysis:	Leg phi:	0.9							
Leg Eccentricity (in):	0	0.6	1.09	1.66	2.45	0.46	1.32	1.82	
Dia. (in):	1.05	1.05	1.05	1.315	1.66	1.9	2.375	2.875	
Thk. (in):	0.154	0.154	0.154	0.179	0.191	0.200	0.218	0.276	
F-y (psi):	50000	50000	50000	50000	50000	50000	50000	50000	
Area(in^2):	0.433	0.433	0.433	0.639	0.881	1.068	1.477	2.254	
r (in):	0.321	0.321	0.321	0.407	0.524	0.605	0.766	0.924	
D/t:	6.82	6.82	6.82	7.35	8.69	9.50	10.89	10.42	
F-y' for compression (psi):	50000	50000	50000	50000	50000	50000	50000	50000	
K:	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
KL/r:	46.7	46.7	46.7	36.9	28.6	49.6	39.1	32.5	
λ-c:	0.62	0.62	0.62	0.49	0.38	0.66	0.52	0.43	
Leg Comp. load (lb):	0	0	0	12371	25059	38236	50826	64633	
ØP-n (lbs):	16636	16636	16636	26024	37357	40162	59433	93888	
M-u = M-ecc (in-lb):	0	0	0	1688	4409	2823	10099	11527	
ØM-n (in-lbs):	5618	5618	5618	10481	18652	26130	45798	84210	
Leg CSI:	0.00	0.00	0.00	0.59	0.87	0.95	0.99	0.77	
	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10	



Tower Base Connection
Base Section #10
Tower Model: HDX-689

Base Connection:

Shear (lbs): 2942
 Moment (ft-lbs): 155940
 Lift Cable force (lbs): 4628
 Face width (in): 34.25

Leg Comp. (lbs): 64633
 Leg Tension (lbs): 61547
 Leg O.D. (in): 2.875

Tab Plate to Leg:

Plate width (in): 4
 Plate height (in): 19
 Plate Thkn. (in): 0.5

C.L. bolt to leg (in): 2
 Bolt dia. (in): 1 (A325N)
 No. of bolts: 6
 Dist. between bolts: 3

Bolt force (lbs): 15099
 Allow. bolt shr. (lbs): 21991
Br'g check OK
Bolt CSI: 0.69

Weld tab to leg: Weld size (in): 0.1875
 Moment (in-lbs): 222176
 Weld Zx (in3): 11.965
 Weld stress (lbs/in2): 22729
 Allow Stress (lbs/in2): 31500
Weld CSI: 0.72

4x4x1/2 Angle to Base:

F-y (psi): 42000
 S-x (in3): 7.30
 Area (in2): 7.75
 Zx (in3): 11.56
 Bolt ecc. (in): 0.82
 Shear ecc. (in): 10.5
 Distance from first bolt to base plate: 3

Including gusset

KL/r: 3
 Lambda-c: 0.04
 Fcr (psi): 41978
 Pn (lbs): 276527
 Mn (lb-in): 436968
 Vn (lb): 175770

Pu (lbs): 64633
 Mu (lbs-in): 222176
 Vu (lbs): 981
Angle CSI: 0.56

Weld tab to base:

Weld Zx (in3): 4.311
 Moment (in-lbs): 60767
 Weld stress (lbs/in2): 14096
 Allow Stress (lbs/in2): 31500

Weld size (in): 0.1875
Weld CSI: 0.45

Base Plate Assembly:

Top Plate: Bot. Plate:
 W (in): 8.000 W (in): 8.000
 L (in): 8.000 L (in): 8.000
 Thkn. (in): 0.375 Thkn. (in): 1.000

Concrete bearing: f-c (psi): 2500
 f-p (psi): 631
 F-p (psi): 1700
CSI: 0.37

Combined Plate Properties:

Top Plate: Bot. Plate: Combined Section
 Area: 3.0000 Area: 8.0000 Zx (in3): 7.56

Moment - from comp (in-lbs): 64633
 Mn (lb-in): 381150
CSI: 0.17



Foundation Design	
Tower Model:	HDX-689

Tower Reactions: (ASD)

Ft'g size per ASD

Moment (ft-lbs): **97463**
 Shear (lbs): **1839**
 Lift Cable Force (lbs): **3857**

Foundation Design Reactions: (LRFD)

Concrete design per LRFD

Moment (ft-lbs): 157903
 Shear (lbs): 2942
 Lift Cable Force (lbs): 4628

Tower Face Width(in): **34.25**
 Distance from ground to top of concrete (ft): **0.667**
 Square ft'g width (ft): **6.5**
 Footing depth (ft): **10**

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

Soil Design Parameters:

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

H (ft): 53.67
 S-1: 667

Allow. bearing (psf): 1500
Act. bearing (psf): 1591

(Increased S1 by 2x per IBC 1806.3.4 for isolated footing not adversely affected by 1/2" motion at ground surface.)

A: 0.702
Depth req'd (ft): 6.8

Max. Moment in Footing (ft-lbs): 177789

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

S-x (in³): 67537
 f-t (psi): 32
 F-t (psi): 150
CSI: 0.21

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

rho: **0.0018**
 A-s req'd (sq. in.): 10.95
 Rebar dia (in): **1**
 No. of bars provided: **16**
 A-s provided (sq. in.): 12.57 OK

Anchor Bolt Anchorage Design Load:

Anchorage Tension Design Force (lbs): **60005** (LRFD level force)
 (See Anchor Bolt Anchorage page for anchorage design)

Summary:

Use foundation : **6.5** ft square by : **10** ft. deep (below undisturbed soil).
 Reinforce foundation with: **16** # **8** (total) with #3 ties at 12" on center, and 3 ties in the top 5".

Use bundles of 2 vertical bars at each corner of the foundation and two at the middle of each face of the fdn.
 Use 4 - 1 1/8" dia. ASTM F1554 Gd. 36 or ASTM A-36 headed anchor bolts, 27" long.
 Total of 12 anchor rods, one near each tower leg with a minimum embedment of 21". Use hex nuts.



Anchor Bolt Anchorage

Tower Model: **HDX-689**

ACI 318-08 App. D Tension Anchorage Calculations - Cast in Place Straight Anchors

All units are pounds and inches unless noted otherwise.

Anchorage Description: **4 - 1 1/8" dia, F1554 Grd. 36 or A-36 anchor rods**

Concrete f-c' (psi): **2500** Is this in a moderate or High Seismic area **1.00** Factored Req'd Tens. Load (lb): **60005** (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: 21.00 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: **2** Concrete Breakout Input: (Tension)
 Anchor dia: **1.125** A-Nco: 3969.0 Projected breakout area of single anchor
 No. of threads / in: **7** A-Nc: 3427.6 Proj'd breakout area of anchor group (For a single anchor use A-Nco value)
 Anchor f-y (psi): **36000** ecc: **0.29** (If have more than two anchors need to hand input A-Nc)
 Anchor f-u (psi): **58000** AdjF-ec,N: 0.991 Eccentricity of tension load - anchor groups only
 phi: **0.75** AdjF-ed,N: 0.880 (ACI D5.2.4) for anchor groups loaded eccentrically
 phi = 0.65 if material used is not ductile Adff-c,N: **1.25** (ACI D5.2.5) for edge effects
 (ACI D5.2.6) Assumed cracked at service load levels
 Can use 1.25 if is uncracked

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

A-se: 0.763 Effective anchor area (in²)
 N-sa: 88540

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

N-b: 115481 ACI D5.2.2
 N-cbg: 108690

Anchor Pullout Strength (ACI D5.3)

N-p: 37020
 N-pn: 103656

Concrete Side-Face Blowout, Tension

N-sbg: 156760 Note: If Ca1 is >0.4*h-ef then blowout does not occur.

Anchor Design Strength - LRFD

Steel: 66405
 Breakout: 76083
 Pullout: 72559
 Blowout: 109732

(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. 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.

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.)

Assumed cracked at service load levels

Can use 1.4 if is uncracked

Use 0.75 if supplemental reinforcement is provided

Use 0.70 is supplemental reinforcement is not provided

Side Face Blowout Input

Spacing: 5.00 Min. distance between multiple anchors (input 0 for one anchor)

c2: 38.71 Edge distance perp. To c-min.

c-min: 18.905 Min. edge distance considering all fasteners

AdjF1: 0.762 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)

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:	41503 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 = 490 lbs
 Pu = 30002 lbs
 Stress check Phi = 0.75
 Pn = 33202 lbs
 n = 0.55 Det.C F4.4
 (Pu+Vu/n)/(Phi.Pn) <= 1.0
CSI = 0.93



ELEVATION

HDX-689

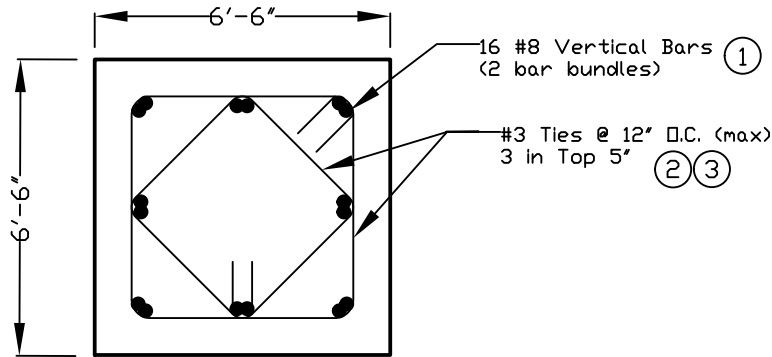
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FOUNDATION DESIGN LOADS

OVERTURNING MOMENT: 157.90 ft.kips
 BASE SHEAR: 2.94 Kips
 STRUCTURE WEIGHT: 4.63 Kips

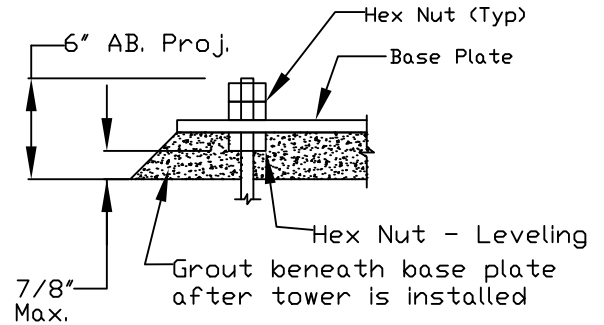
SOIL & CONCRETE DESIGN PARAMETERS

ALLOWABLE VERTICAL BEARING PRESSURE: 1500 PSF
 ALLOWABLE LATERAL PRESSURE: 100 PSF
 CONCRETE F'c = 2500 psi @ 28 DAIS



Plan View - Reinforcing

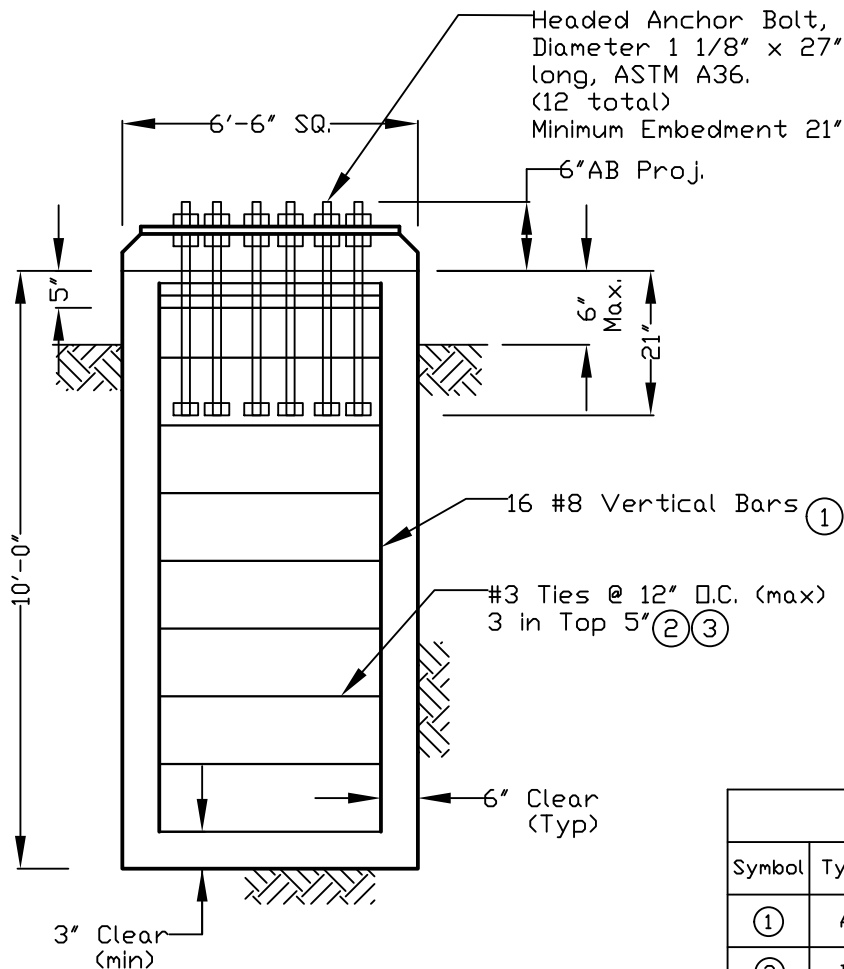
Not to Scale



Grouting Detail

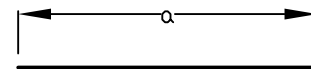
Extreme care should be taken to assure that all leveling nuts are level with respect to each other prior to installation of tower.

Note:
 If leveling nuts are not used, make sure that base plate is in full contact with concrete, grout is not required, and reduce AB projection to 4".

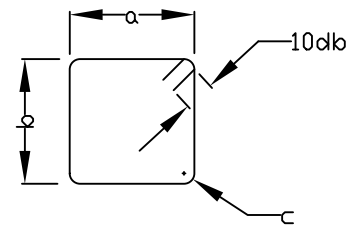


Elevation View

Not to Scale



Type A



Type B

Reinforcement Material List

Symbol	Type	Bar Size	Dimensions				Qty
			a	b	c	10db	
①	A	#8	10'-0"	—	—	—	16
②	B	#3	5'-6" *	5'-6" *	2"	3.75"	13
③	B	#3	3'-10" *	3'-10" *	2"	3.75"	13

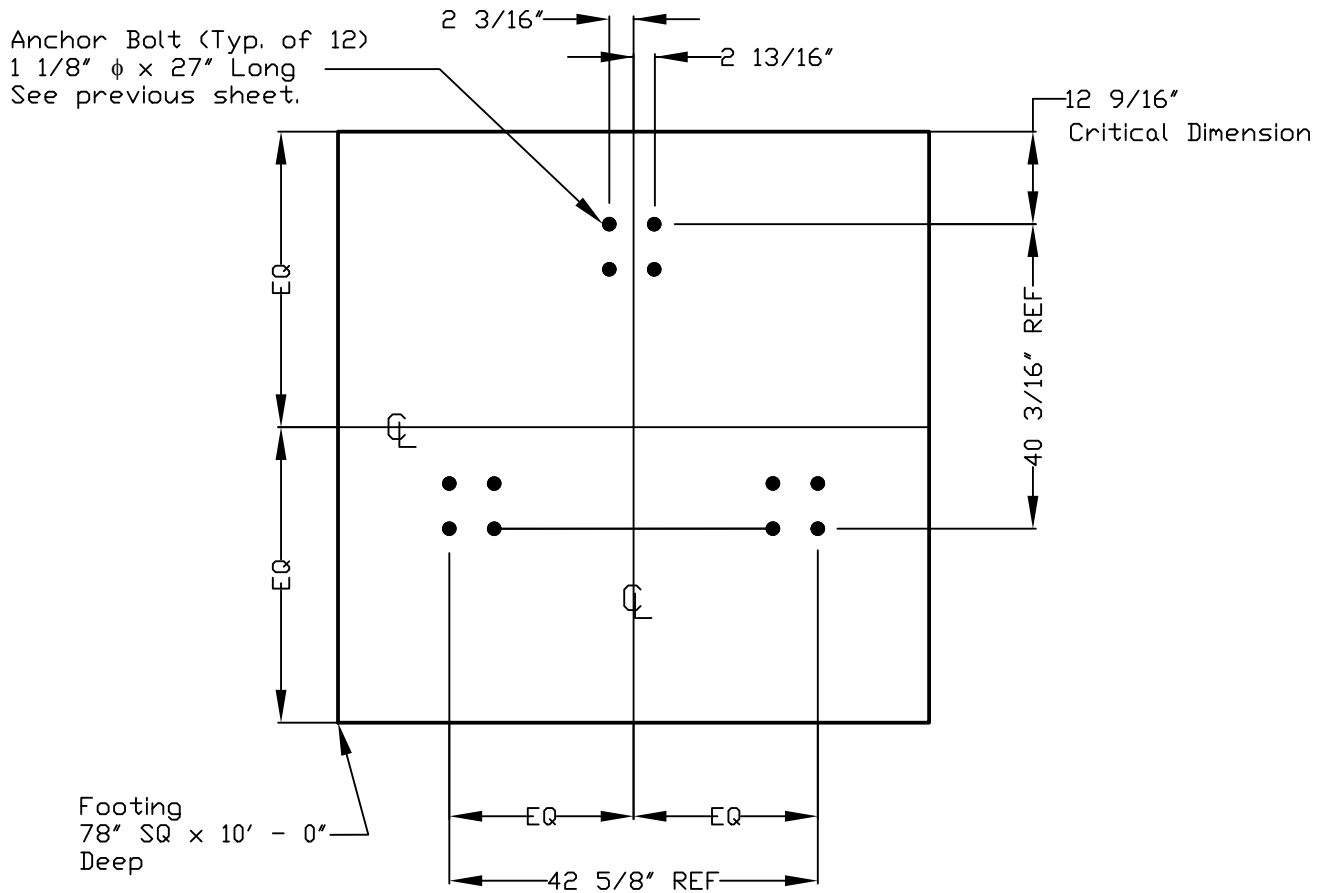
* = Nominal dimension



ELEVATION

HDX-689

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Plan View - Anchor Bolt Layout

Not to 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 1806.3.4 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