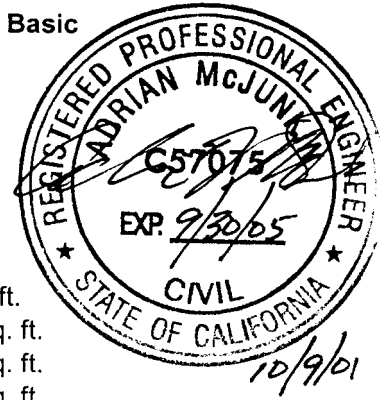


**FORMAL STRESS ANALYSIS DOCUMENT**  
**Self-Supporting Crank-Up Tower Structure**

**Tower Model: HDX-572**

Design Specifications Meeting:  
 1997 Uniform Building Code (UBC)

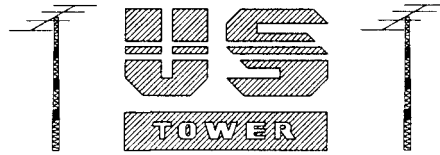
	<b>70 mph Basic</b>	<b>50 mph Basic</b>
<b>Design Wind Speed:</b>	70 mph Basic	50 mph Basic
<b>Ice Loading:</b>	None	None
<b>Exposure:</b>	B	B
<b>Importance Factor:</b>	1.00	1.00
<b>Antenna Loading:</b>		
<i>Max. Projected Area (at 1' above tower):</i>		
With round elements 2"Ø and less	18 sq. ft.	55 sq. ft.
With round elements > 2"Ø	22.5 sq. ft.	68.8 sq. ft.
With Flat elements	13.8 sq. ft.	42.3 sq. ft.
With 40% Flat & 60% Round elements	16.1 sq. ft.	49.1 sq. ft.
<b>Max. Antenna, Rotor, &amp; Mast Weight:</b>	350 lbs.	750 lbs.



**Notes:**

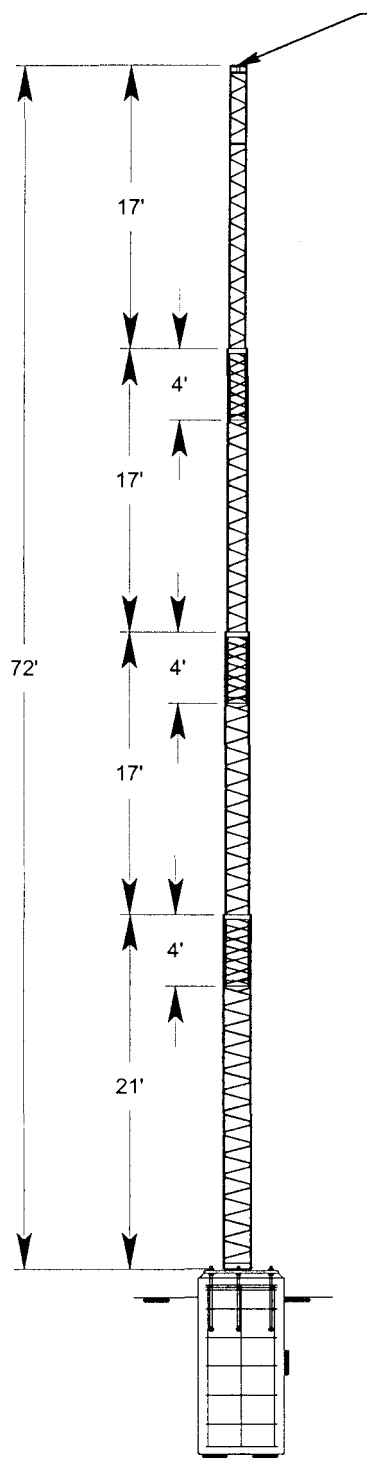
1. Antenna areas indicated at 50 mph Basic wind speeds are for information only. The loads indicated within this analysis have been generated using the antenna area associated with 70 mph Basic wind speed.
2. Analysis based on allowable stress design as defined by UBC-97 section 1602.
3. Analysis methodology uses fundamental concepts in statics equilibrium. The method of sections is used for analyzing tower members within the structural system. The results of our methodology has been verified and checked with traditional hand calculations.
4. Stress ratios are equal to the calculated stress divided by the AISC allowable stress.
5. This tower has been designed only for the antenna loads indicated within these calculations. Any additional loads or differences in design criteria shall be brought to the attention of US Tower Corp.
6. The engineering and design of the antennas are beyond the scope of these calculations.
7. All welds are performed by AWS certified welders utilizing ER70S-6 welding wire under a GMAW (spray Arc) welding process.
8. 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.
9. This document is provided only for the use of obtaining building permits and for tower design purposes. Please refer to the included footing installation drawing for all pertinent notes and details of foundation
10. This analysis assumes the tower has been installed to US Tower specifications and is vertically plumb.

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



**TOWER MODEL: HDX-572**

Section No.	Leg Size	Diagonal Size
No. 5 Top	Pipe 1.05" OD x .154 wall	3/8" Solid Rod
No. 6	Pipe 1.315" OD x .179 wall	7/16" Solid Rod
No. 7	Pipe 1.66" OD x .191 wall	1/2" Solid Rod
No. 8 Base	Pipe 1.9" OD x .200 wall	5/8" Solid Rod



2" OD Tube Mast  
 See Cover for Max. Antenna  
 Wind Area @ 1 ft. above  
 Top of Tower

**Design Criteria:**

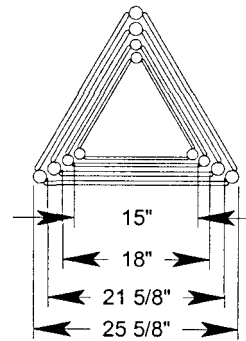
Wind: 70 mph Basic Wind Speed  
 Ice: None

**Design Codes:**

Structure: UBC-97 Div. III Sections 1615 Thru 1625  
 Exposure B  
 Importance = 1.00  
 Steel: AISC 9th Edition  
 Concrete: ACI 318-95

**Materials:**

Steel Tube: ASTM A53 Gr. B or A501  
 Solid Rod: ASTM A36  
 Shapes/Plates: ASTM A36  
 Erection Bolts: ASTM A325 & SAE Gr. 5  
 Anchor Bolts: ASTM A36

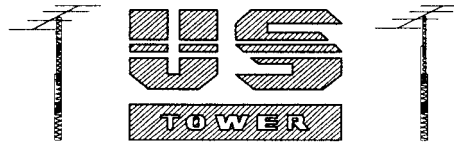


**Plan View**

No Scale

**Elevation View**  
 No Scale



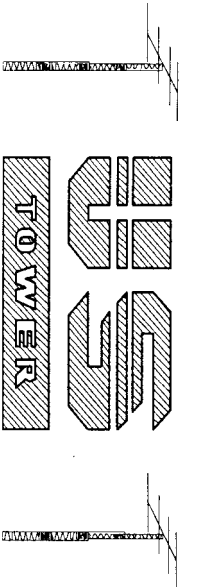


**Tower Section Characteristics:**

<b>Tower Section No.</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>
Section Length	21	21	21	21
Face Width (in)	13.96	16.68	19.94	23.72
Top Lap Length (ft.)	0	4	4	4
Bottom Lap Length (ft.)	4	4	4	0
Lift Cable size (in)	0.25	0.25	0.25	0.375
Top Plate depth (in)	4	4	5	6
Bottom Plate depth (in)	6	6	6	6
Plate Thickness (in)	0.25	0.25	0.25	0.375
<b>Leg properties:</b>				
Pipe/Tube size, OD (in)	1.05	1.315	1.66	1.9
Wall thickness (in)	0.154	0.179	0.191	0.200
Pipe/Tube F <sub>y</sub> (ksi)	36	36	36	36
A (in <sup>2</sup> )	0.433	0.639	0.881	1.068
r (in)	0.321	0.407	0.524	0.605
L <sub>L</sub> (in)	15	15	15	30
K <sub>L</sub>	0.9	0.9	0.9	0.9
K <sub>L</sub> L <sub>L</sub> /r	42.00	33.20	25.78	44.61
Cc <sub>L</sub>	126.10	126.10	126.10	126.10
FcA <sub>L</sub> (kips)	11.00	16.79	23.77	26.79
<b>Diagonal Properties:</b>				
Rod size (in)	0.375	0.4375	0.5	0.625
Rod F <sub>y</sub>	36	36	36	36
No. of Diag.s/section	44	44	37	10
Diag. Incline angle	21	16.5	35	30.35
A (in <sup>2</sup> )	0.110	0.150	0.196	0.307
r (in)	0.094	0.109	0.125	0.156
K <sub>r</sub>	0.8	0.8	0.8	0.8
L <sub>r</sub> (in)	13.83	16.02	22.32	25.29
K <sub>r</sub> L <sub>r</sub> /r	118.00	117.21	142.82	129.46
C <sub>cr</sub>	126.10	126.10	126.10	126.10
F <sub>c</sub> A <sub>r</sub> (kips)	1.56	2.14	1.92	3.64
<b>Projected Wind Area:</b>				
Leg EPA (sq. ft./ft.)	0.12	0.15	0.18	0.21
Diag.s EPA (sq. ft./ft.)	0.052	0.071	0.095	0.037
Anchor Plates (sq. ft./ft.)	0.044	0.053	0.070	0.091
Total Section w/o ice	0.214	0.270	0.349	0.339
<b>Section Weight:</b>				
Legs (lbs.)	92.7	136.7	188.6	228.5
Diag.s (lbs.)	57.1	90.0	137.6	65.9
Anchor Plates (lbs.)	37.0	44.3	58.2	113.3
Cables & Pulleys (lbs.)	28.0	40.6	57.7	61.1
Total Section Wt.	215	312	442	469

1220 N. Marcin St.  
 Visalia, CA, USA 93291

Phone: (559) 733-2438  
 Fax: (559) 733-7194



**Tower Loading Calculations:**

Code: UBC - 97

Design Wind Speed: 70 mph  
 Importance Factor: 1  
 Ice Loading: 0 in  
 Structure Height: 72 ft.

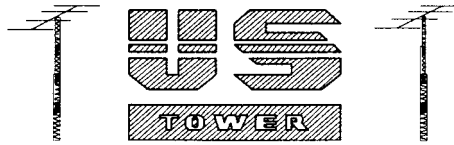
Antenna Area: 18 ft<sup>2</sup> (Factored Area)  
 Antenna Weight: 350 lbs. (max. w/ice)  
 Cable Size: 0.375 (in)  
 No. of Cables: 1

**100% Design Wind force without ice**

Tower Section	Section Length (ft.)	Projected Area (ft. <sup>2</sup> )	Mid-Height of Section	C <sub>q</sub>	C <sub>e</sub>	q <sub>s</sub> *1	Section Shear (lbs.)	Total Shear (lbs.)	Moment (ft. - lbs.)
Antenna	1	18	73	1	1	12.54	226	226	226
Mast & Rot.	1	0.670	72.5	1	1	12.54	8	234	230
5	17	3.630	63.5	3.2	0.96	12.54	151	385	5,491
Lap 5 & 6	4	1.933	53	3.2	0.9	12.54	73	458	7,176
6	13	3.508	44.5	3.2	0.86	12.54	128	586	13,963
Lap 6 & 7	4	2.476	36	3.2	0.81	12.54	84	671	16,477
7	13	4.539	27.5	3.2	0.74	12.54	144	814	26,128
Lap 7 & 8	4	2.751	19	3.2	0.66	12.54	77	892	29,539
8	17	5.756	8.5	3.2	0.62	12.54	156	1,047	46,019

**Notes:**

1. Antenna weight includes the weight of the antenna, rotor, and antenna mounting pipe.
2. The projected area includes the tower members, lifting cable, and feedline cable(s) for each section



### Analysis of Tower Sections

<b>Tower Section:</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>
Shear (lb):	385	586	814	1,047
Moment (ft-lb):	5,491	13,963	26,128	46,019
Panel Height (in):	15	15	15	30
Lap length (ft):	4	4	4	0

#### **Lift Cable Analysis:**

No. of Lift Cables	1	1	2	2
Pulley Frm Force (lbs)	--	1,130	2,318	2,698
Lift Cable Force (lbs)	565	1,441	1,380	

#### **Leg Analysis:**

Dia. (in):	1.05	1.315	1.66	1.9
Wall Thk. (in):	0.154	0.179	0.191	0.2
Compr. load (kips):	5,639	12,080	18,617	26,883
Allow $F_a A_L$ (kips):	10,996	16,786	23,773	26,788
<b>Leg F.S.:</b>	<b>0.51</b>	<b>0.72</b>	<b>0.78</b>	<b>1.00</b>

#### **Diagonal Analysis:**

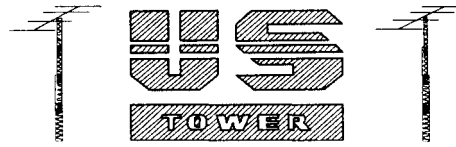
Rod Size (in):	0.375	0.4375	0.5	0.625
Calc'd Load (lbs):	238	353	574	701
Allow. Load (lbs):	1,556	2,140	1,917	3,645
<b>Diagonal F.S.:</b>	<b>0.15</b>	<b>0.16</b>	<b>0.30</b>	<b>0.19</b>

Calc'd Load (lbs):	0.125	0.1875	0.1875	0.25
Weld L (in):	0.75	1	1.25	1.5
Calc'd weld load (#/in):	317	353	459	467
Allow. weld 'F' (lb/in):	2,475	3,712	3,712	4,950
<b>Diagonal Weld F.S.:</b>	<b>0.13</b>	<b>0.10</b>	<b>0.12</b>	<b>0.09</b>

#### **Diagonal Analysis - Lap Area** (Note: Allowable loads based on reduction in unbraced member length)

Lap Tower Sections	5 & 6	6 & 7	7 & 8
Lap shear (lbs):	1,757	4,077	7,346
Rod Size (in):	0.375	0.4375	0.5
Calc'd Load (lbs):	657	1,508	3,203
Allow. Load (lbs):	2,580	3,520	4,262
<b>Diagonal F.S.:</b>	<b>0.25</b>	<b>0.43</b>	<b>0.75</b>

Weld size (in):	0.125	0.1875	0.1875
Weld L (in):	0.75	1	1.25
Calc'd weld load (#/in):	725	1,227	2,071
Allow. weld 'F' (lb/in):	2,475	3,712	3,712
<b>Diagonal Weld F.S.:</b>	<b>0.29</b>	<b>0.33</b>	<b>0.56</b>



## Tower-to-Anchor Bolt Interface

### Base Reactions:

Overturning Moment (ft-lbs)	46,019 ft.-lbs.	Base Leg OD	1.9	in
Base Shear (lbs)	1,047 lbs.			
Base Weight (lbs)	1,787 lbs.			
Max. Compr. Force (lbs)	27,479 lbs.			
Max. Tensile Force (lbs)	26,288 lbs.			

### Base Leg Tab Plate Analysis:

Plate Width (in)	2.5	Plate Moment (in-lbs)	60,454	(Bending about strong axis)
Plate Height (in)	13	Plate Shear (lbs)	27,479	
Plate Thickness (in)	3/8	Plate Stress (psi)	11,360	<b>Plate Stress Ratio: 0.45</b>
Bolt diameter (in)	3/4	Force per Bolt (lbs)	6,295	
No. of Bolts	6	Allow. Bolt Shear (lb)	12,017	<b>Shear Stress Ratio: 0.52</b>
Ctr of Bolts to leg (in)	1.25	Allow. Bolt Brg. (lb)	16,200	<b>Brg. Stress Ratio: 0.39</b>
Bolt Spacing (in)	3			
Weld Size (in)	3/16	Weld Moment (in-lbs)	60,454	
Weld S <sub>x</sub> (in <sup>3</sup> )	7.47	Weld Shear (in)	27,479	
Weld Area (in <sup>2</sup> )	3.45	Weld Stress (psi)	11,362	<b>Weld Stress Ratio: 0.41</b>

### Interface Tab Angle Analysis:

Plate Width (in)	5	K <sub>x</sub>	1.2	Shear (lbs)	524
Plate Height (in)	14 2/4	r <sub>x-x</sub> (in)	0.14	Axial Compression (lbs)	27,479
Plate Thickness (in)	1/2	L (in)	3.00	Moment (in-lbs)	23,081
Bolt eccentricity (in)	0.6875	K <sub>x</sub> L/r <sub>x-x</sub>	24.94	f <sub>a</sub> (psi)	10,992
Shear eccentricity (in)	8	A (in <sup>2</sup> )	2.50	f <sub>b</sub> (psi)	11,079
Dist. of first bolt to B.P. (in)	3	b/t	10.00	F <sub>a</sub> (psi)	20,286
		F <sub>e</sub> ' (psi)	240,052	F <sub>b</sub> (psi)	31,680

**Combined Stress Ratio Per AISC eq. (H1-1): 0.85 <==== Governs**  
**Combined Stress Ratio Per AISC eq. (H1-2): 0.73**

Weld Size (in)	0.375			
Weld S <sub>x</sub> (in <sup>3</sup> )	2.21			
Weld Area (in <sup>2</sup> )	2.65	<b>Combined Stress Ratio:</b>	<b>0.73</b>	<b>&lt; 1.00 (OK)</b>

### Interface Base Plate Analysis:

	<i>Top Plate:</i>	<i>Bottom Plate:</i>		
Plate Width (in):	6	6	Moment Arm (in):	2.00
Plate Length (in):	8 1/2	8 1/2	Moment (in-lbs):	12,595
Plate Thickness (in):	3/8	1/2	S <sub>x</sub> (in <sup>3</sup> ):	0.563
			<b>Stress Ratio:</b>	<b>0.62 &lt; 1.00 (OK)</b>

# FOUNDATION NOTES - GENERAL

1. US Tower Corporation highly recommends the customer obtain a Professional, licensed, and insured Contractor for installing this tower foundation
2. The contractor is responsible for checking the area for underground facilities prior to excavating any soil material.
3. U.S. Tower Corporation or their Engineers accept no responsibility for field inspection during construction nor for the method of construction. This foundation may be inadequate if the ground water table rises into, and influences the strength of the surrounding soil.
4. Contractor shall use and provide deformed reinforcing bars conforming to ASTM A615 Gr. 60 (60,000 psi min. yield). Contractor shall use steel wire to tie reinforcing bars together. No welding shall be permitted on A615 reinforcing bars. If welding is preferred to hold the reinforcement cage together, ASTM A706 Gr. 60 deformed reinforcing bars shall be used.
5. Contractor is responsible for correct placement of anchor bolts. Anchor bolts must be plumb and shall be held with the projection as indicated (proj. tol.  $\pm 1/2"$  max.).
6. Contractor shall use and provide concrete with a minimum compressive strength of 3,000 psi @ 28 days. Maximum concrete slump shall not exceed 6". Contractor to reference ACI "Building Code Requirements for Reinforced Concrete", ACI 318 latest edition for detailed concrete requirements.
7. Contractor shall place concrete against unconditioned soil to the depth indicated, and shall form above grade portion of foundation. Footing shall be a continuous pour such that cold joints will not develop. The contractor is responsible for verifying adequate concrete coverage around reinforcement cage to avoid the potential for rebar corrosion.
8. The top of the footing shall be troweled level and smooth. Broom brushed surface texture permitted where preferred.
9. Actual footing dimensions may be slightly larger due to excavation methods and soil conditions.

Rebar Bending & Lap Splice Requirements					
ACI 318-89					
Applicable only to ASTM A615 Gr. 60 Rebar & 3000 psi Concrete strength					
Rebar Size	Wt./ft. (lbs/ft)	Std. Bend Diam.	Stirrup Bend Diam.	Vert. & Bottom Horiz. Lap Splice	Top Horiz. Lap Splice
#4	0.67	3"	2"	1' - 10"	2' - 5"
#5	1.04	3 3/4"	2 1/2"	2' - 3"	3' - 0"
#6	1.50	4 1/2"	4 1/2"	2' - 8"	3' - 6"
#7	2.04	5 1/4"	5 1/4"	3' - 2"	4' - 2"
#8	2.67	6"	6"	3' - 7"	4' - 8"
#9	3.40	9 1/2"	---	4' - 1"	5' - 4"
#10	4.30	10 3/4"	---	6' - 1"	7' - 10"
#11	5.31	12"	---	7' - 5"	9' - 8"

For 2,500 psi concrete - increase lap lengths by 10%  
 For 2,000 psi concrete - increase lap lengths by 25%

**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.**

B	Added note 9.	AM		11 Nov 00
A	Added weldable rebar spec.	AM		25 Sep 00
REV. NO.	DESCRIPTION OF REVISION	BY	CHKD BY	DATE

**UNLESS OTHERWISE SPECIFIED:**

ALL DIMENSIONS IN INCHES.

TOLERANCES:  
 +/- 1/16" ON ALL FRACTIONAL DIMENSIONS  
 +/- 1/2 DEG. ON ALL ANGLE DIMENSIONS



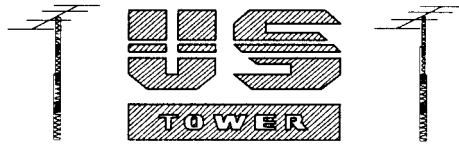
US TOWER CORPORATION  
 1220 MARCIN STREET  
 VISALIA, CALIFORNIA 93291  
 PHONE 559-733-2438  
 FAX 559-733-7194

DRAWING TITLE

General Notes for  
 Crank-Up Towers

SCALE	None	REV. NO.	B
APPROVED		DATE	
CHKD. BY	US	DATE	5 Oct 99
DRAWN. BY	AM	DATE	2 Oct 99

DRAWING NO.  
**A-991009**



**Anchor Bolt Design:**

Material: A36 Steel

Anchor Dia. (in): 1 (2 each leg)  
Rod Area (in<sup>2</sup>): 0.785  
Fy (psi): 36000  
Allow. Tension (lbs): 45,239  
  
Calc'd Tension (lbs): 26,288 (OK)

**Anchor Bolt Embedment:**

Anchor Embedment (in): 22  
Conc. f<sub>c</sub>(psi): 2500  
Pullout Capacity (lbs): 258,490 (OK)

**USE: 1 in x 27 in long  
A36 Anchor Bolts (or equivalent)**

**Foundation Design:**

Ref. UBC-97 Section 1806 - Nonconstrained condition (1806.8.2.1)

Moment: 46,019 ft. - lbs.  
Shear: 1,047 lbs.  
Ftg. Width: 5 ft. (square)  
Ftg. Depth: 7.0 ft.  
Ftg. Proj.: 6 in. above grade

Allowable Lateral Soil Brg. (psf/ft): 266.67  
S1 (ft): 622.23  
h (ft): 44.4  
A: 0.79

Minimum Depth Required by UBC:

L<sub>D</sub> = 6.6 ft. minimum

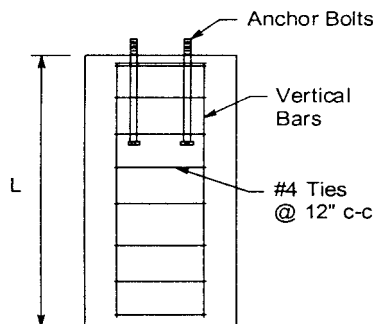
**USE: 5 ft. square x 7 ft. deep Footing**

**Reinforcement Design:**

Factored Moment: 79,122 ft. - lbs.  
Bar Size: 9  
A<sub>s</sub>/bar: 0.99 in<sup>2</sup>  
No. of Vert. Bars: 8  
d: 40.75  
Nominal Moment: 181,232 ft. - lbs. (OK)

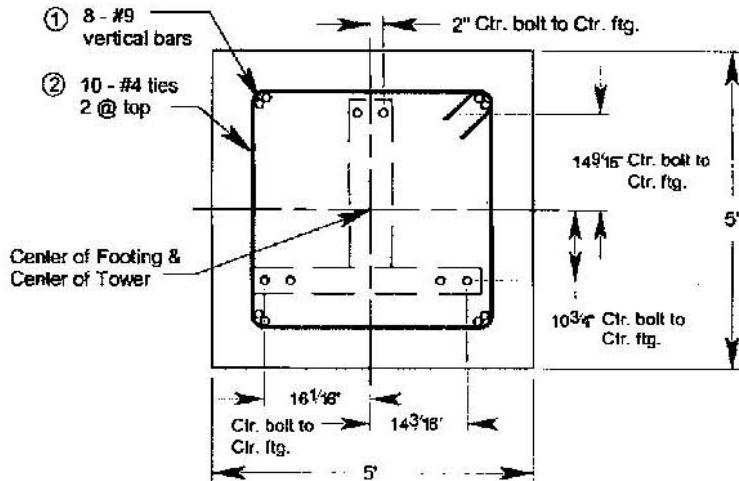
F<sub>y</sub> (reinforcement): 60,000 psi  
f<sub>c</sub> (concrete): 2,500 psi  
Min. Temp/Shrink. A<sub>s</sub> req'd: 6.48 in<sup>2</sup>  
A<sub>s</sub> provided: 7.95 in<sup>2</sup>

**USE: 8 - No. 9 A615 Gr. 60 vertical bars  
with 36" square ties at 12" c-c spacing**



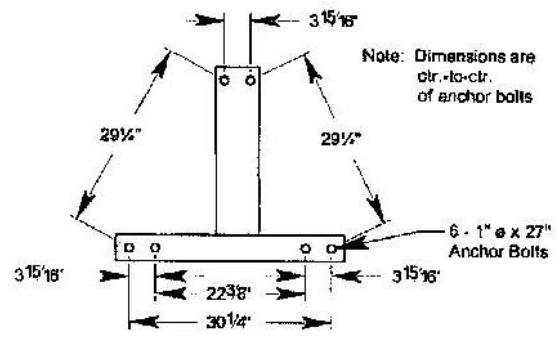
Note: Ref. Foundation drawing for complete details for installing footing.



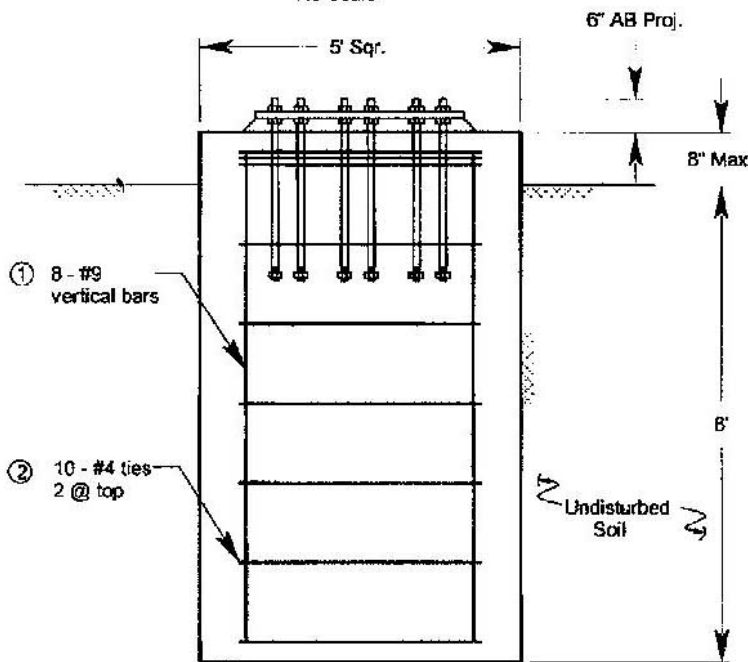


**Plan View**  
No Scale

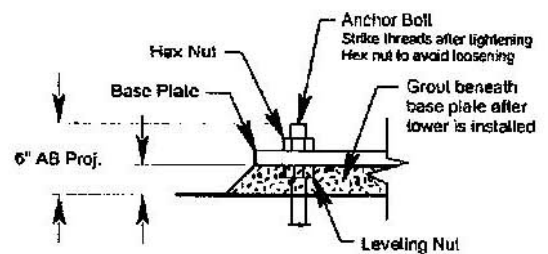
Foundation has been design to accommodate the following loads:  
 Overturning Moment = 59.4 ft.-kips  
 Base Shear = 1.50 kips  
 Structure Weight = 1.84 kips  
 Concrete volume is estimated at 7.0 cu. yds.



**Anchor Bolt Detail**  
No Scale



**Elevation View**  
No Scale

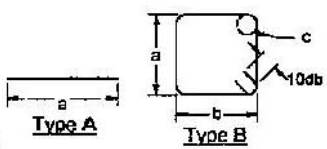
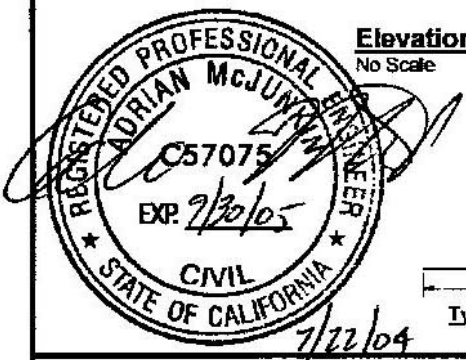


**Grouting Detail**  
Extreme care should be taken to assure that all leveling nuts are level with respect to each other prior to installation of tower

Note: If leveling nuts not used, grout is not required. Reduce AB projection to 4\".

**Reinforcement Material List**

Sym	Type	Bar Size	Bar Spacing	Dimensions				Qty	Weight (lbs.)
				a	b	c	10db		
①	A	#9	See Plan	8' - 0"	---	---	---	8	216 lbs.
②	B	#4	12"	3' - 0"	3' - 0"	2"	5"	8	69 lbs.
Total Steel Weight for Complete Foundation Installation									285 lbs.



REV. NO.	DESCRIPTION OF REVISION	BY	CHKD BY	DATE
C	Footing depth was 7'.	AM	US	21 Jan 02
B	Combined HDX-572 & TX-489	AM	US	24 Oct 01
A	General Revisions	AM	US	18 Mar 01

UNLESS OTHERWISE SPECIFIED:

ALL DIMENSIONS IN INCHES.  
 TOLERANCES:  
 +/- 1/16" ON ALL FRACTIONAL DIMENSIONS  
 +/- 1/2 DEG. ON ALL ANGLE DIMENSIONS



US TOWER CORPORATION  
 1220 MARGIN STREET  
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**DRAWING TITLE**

Installation of Pier Footing  
 HDX-572/TX-489 Crank-Up Tower

SCALE	REV. NO.
None	C
APPROVED	DATE
CHKD. BY	DATE
US	16 Oct 00
DRAWN. BY	DATE
AM	16 Oct 00
DRAWING NO.	

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