SELF- SUPPORTING TOWER 24.0M HIGH TO INSTALL AT AMERICAN CONSULATE PREMISIS , CHENNAI.

PROJECT :

To design a self supporting steel tower 24.0 m high to be install in American Consulate Premisis, Chennai.

Soil Report:

Given by Nagadi Consultants Pvt. ltd. , Chennai. Report No. G©8930

Dt : 17-11-2016.

S.B.C. Taken as 11 t / sq.m. at 1.5 m from E.G.L.

ANALYSIS & DESIGN :

a) I S Codes Reffered:

i) IS 800 - 2007 , General Construction in Steel – Code of Practice.

ii) IS 802 -1992, Code of Practice for use of Structural Steel in over head Transmission line Tower.

iii) IS 456 – 2000 Plain and Reinforced Concrete code of Practice

iv) IS 875 (Part 1) – 1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures - Dead Loads-Unit weights of Building Matrerials and Stored Materials

v) IS 875 (Part 3) – 1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures - Wind Loads

b) Materials used :

Tata Structura Circular Hollow Sections with YST 310 Grade

i) 65 Nominal bore X 4.5 thk. with 7.93 kg/ m

ii) 50 Nominal bore X 4.5 thk. with 6.19 kg/ m

iii) 40 Nominal bore X 4.0 thk. with 4.37 kg/ m

M S Plates for Base plate, Stiffener plate and cap plate with YST 250 Grade

High Strength Bolts

b) Loads Considered:

i) Dead Load (DL) - Self Weight of Structure

ii) Wind Load (WL) as per IS 875 (Part 3)

Basic Wind Speed in Chennai = Vb = 50 m /s upto 10M ht. (Appendix A)

Design Wind Speed = Vz = Vb * k1 * k2* k3

Structure is taken as of Class A Category 2 with Mean probable

Design Life of 25 Years.

where k1 - Risk Coefficient = 0.9 (Table 1)

k2 - Terrain Height and Structure Size Factor (Table 2)

k3 - Topography Factor - 1 (Table 3)

Design Wind Pressure (Pz) ;

The design wind speed at any height above mean ground level shall be obtained by the following relationship between wind pressure (Pz) and wind velocity (Vz)

Pz = 0.6 * Vz ^ 2*Cf*E

where Vz - Effective wind Velocity

Cf - Force Coefficient = 1.6 (Table 32 of IS 875 part 3 page 47)

E - Solid area / Gross area = 0.175

Design Wind Pressure calculation at different Heights :

DESIGN WIND SPEED (Pz)							
S.No	**Height in m**	**k1**	**k2**	**k3**	**Vz in m/s**	**Pz in N/ sq.m**	**Pz in kg/ sq m**
1	upto 10 m	0.9	1	1	45	238.14	24.05214
2	15 m	0.9	1.05	1	47.25	262.54935	26.51748435
3	20 m	0.9	1.07	1	48.15	272.646486	27.53729509
4	24 m	0.9	1.12	1	50.4	298.722816	30.17100442

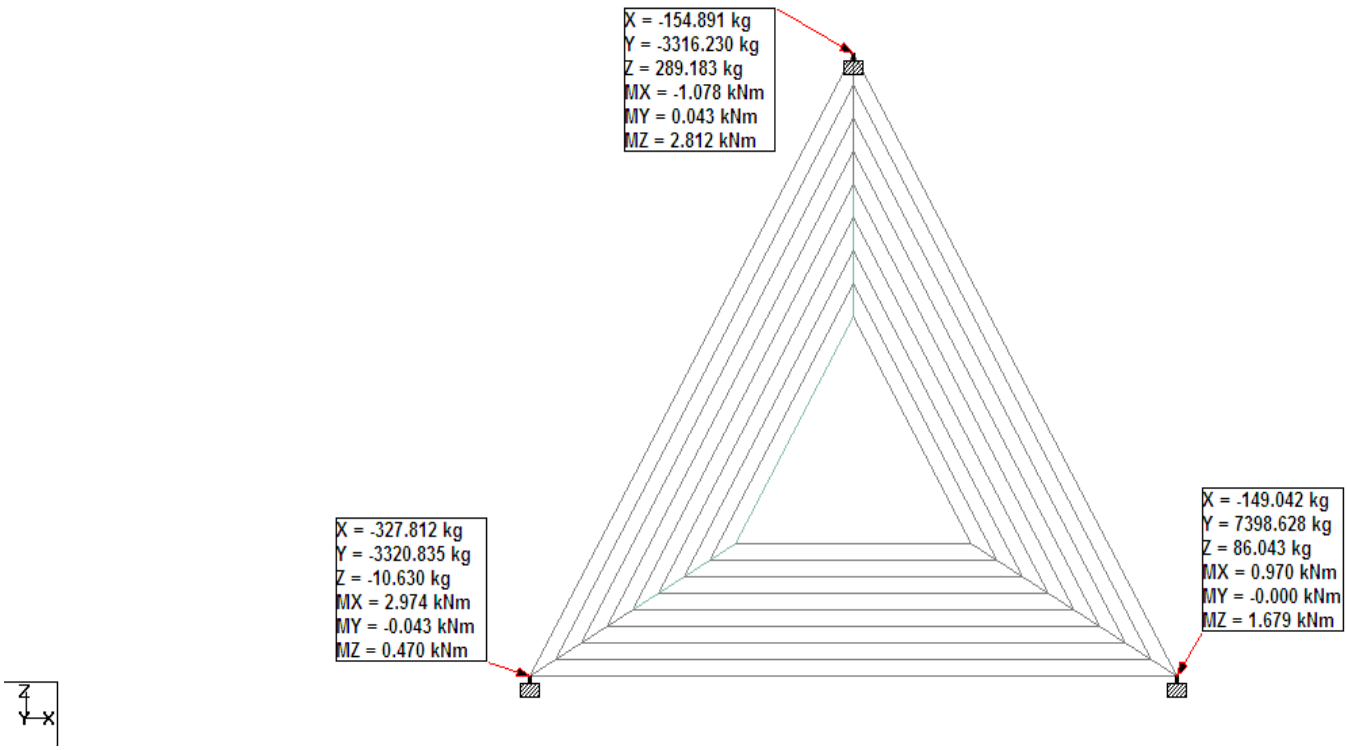
Average Wind Pressure = 27.11157 kg / sq.m
say 27 kg / sq.m

Wind Pressure equal to 27 kg / m2 is considered throughout as a conservative approach.

The above loads are applied to the Stadd Model and analysis is done.

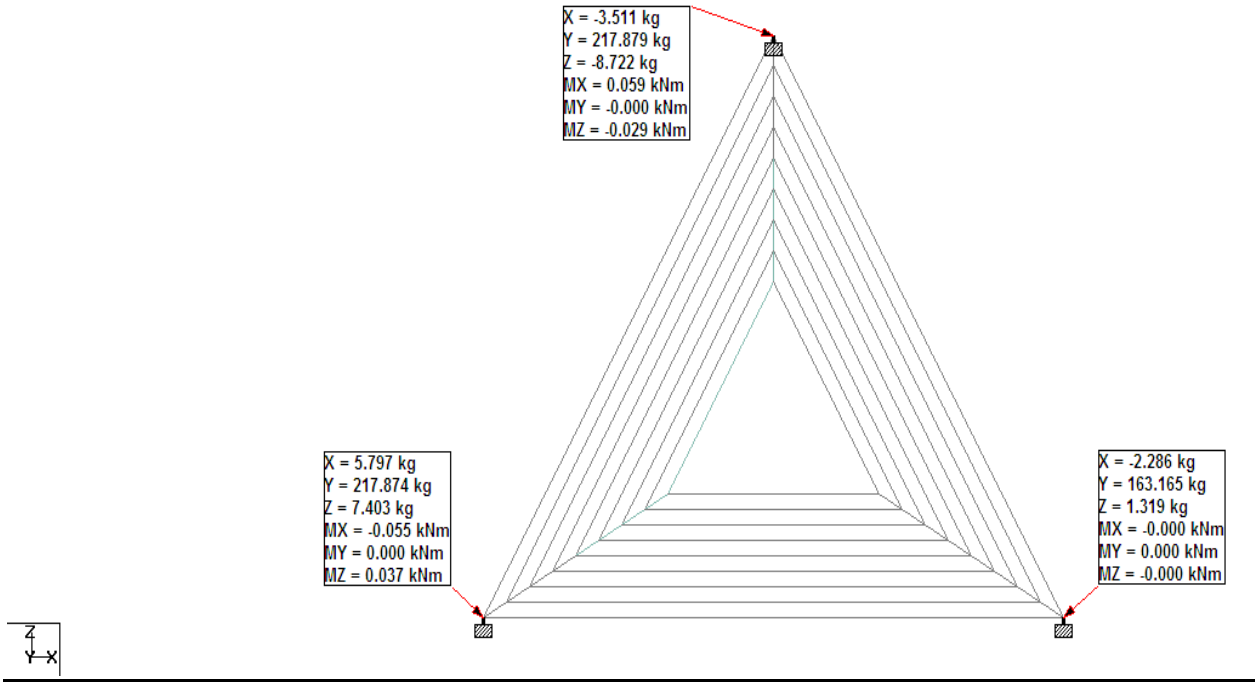
Stadd pro input and Out put are also enclosed.

Design of Foundation:



Reactions from Stadd (DL + WL)

Sketch - 1



Reactions from Stadd For DL Only

Sketch - 2

Materials Required :

Grade of concrete = M25

Grade of Reinforcement = Fe 415

Calculations :

Area of Foundation provided (refer drawing) = A = 2.4 x 2.4=5.76 m2

Section Modulus of Footing (Z) = 2.4*2.4^ 2 /6 = 2.3 m3

C/C Distance between Tower Legs = L1 = 1.1 m

Lever arm (X1) = SQ. ROOT (1.1^2 - 0.55^2)

= 0.91m

From Stadd (Refer above figs.)

Total Reaction from the Tower = 2 *217.9 + 163.2
DL only (Refer Sketch – 2) = 600 kg = 6.0 kN (A)

Total Horizontal force in X-X Direction = 154.89+327.81+149
DL + WL (Refer Sketch – 2) = 631.7 kg = 6.2 k N

Total Horizontal force in Z-Z Direction = 289.18-10.63+86
DL + WL (Refer Sketch – 2) = 364.55 kg = 3.58 k N

Total Weight of the Foundation :

Weight of Footing Mat = 2.4*2.4*0.6*25 = 86.4 k N

Weight of Pedestal = 1.8*1.8*(1.5-0.6-0.1)*25 = 64.8 k N

= 1.8*1.8*0.3*25 = 24.3 k N

Total = 175.5 k N (B)

Total Downward Weight (P) = A + B = 185 k N

1) Check for Maximum Pressure :

$$qo\ (max.) = \frac{P}{A} + \frac{Pe}{Z} + \frac{Mxx}{Z} + \frac{Mzz}{Z}$$

$$= \frac{32}{5.76} + \frac{7.4*0.91}{2.3} + \frac{6.27*0.91}{2.3} + \frac{3.58*0.91}{2.3}$$

= 40.00 k N / m2 < 110 k N / m2 at 1.5 m from E.G.L.

(S B C of soil from soil report Attached)

2) Check for Minimum Pressure :

$$qo\ (min.) = \frac{P}{A} - \frac{Pe}{Z} - \frac{Mxx}{Z} - \frac{Mzz}{Z}$$

= 25.18 k N / m2

No Tension at the base of foundation.
Hence no uplift.
Hence Foundation is stable.

3) Design of Reinf. for Bending :

Actual Pressure at the base of foundation = 40.00 k N/ sq.m

Bending Moment = 40 * 0.3 ^2 / 2 = 1.8 k N –m

Area of Steel Required = $\frac{1.8 * 10^{\wedge} 6}{230 * 0.9 * 550}$ = 15.80 cm2

Provide 10Y @ 150 C/C . Hence Safe.

4) Check for Punching Shear :

Total downward force = 140.4 + 89.1 = 229.6 k N

Punching Sheer at distance d/2 from periphery of column

= qo (L X B – (a+d)(b+d))

= 40 (3*3 – 2* (1.8+.55))

= 172.50 K N

Shearing Area along Critical section = 2 * (a+d) (b+d) * d

= 2 * (1.8+0.55)(1.8+0.55)*0.55

= 6.07 m2

Nominal Shear Stress tv = 172.5 / 6.07

= 28.38 k N / m2

= 0.03 N / mm2

< 1.25 N / mm2

Hence Safe.

Permissible Shear Stress tc = ks * 0.25* sqrt fck

k s = 1 (As per Cl 10.24 0f IS 456- 2000)

tc = 1.25 N / mm2

Design of Pedestal :

Length of Pedestal = 1.8 m

Breadth of Pedestal = 1.8 m

Area of Pedestal = 3.24 m2

Total Reaction Load = 140.4 k N

Pressure = 140.4 / 3.24

= 43.34 k N/m2

= 0.0.44 N/ mm2

Permissible Bearing Stress = 0.8*25 = 20 N/ mm2

Hence Safe.

Min. Reinforcement required = 0.12 % *b*l

= 0.12 * 1.8 * 1.8/100

= 38.88 cm2

Provide 12Y @ 150 C/C alround.

Hence safe.

Design of Bolt :

Max. Factored Reaction = 74 .1 k N

Un Factored Reaction = 49.4 k N

(say) = 50.0 k N

No. of Bolts Provided = 4 nos.

Force on each bolt = 50 / 4 = 12.5 k N

Diameter of the bolt = 16 mm

Effective area of the bolt = 200.9 mm2

Stress in each bolt = 62.2 N/ mm2

Allowable tensile Stress = 100 N / mm2

(As per Table 2.10 of IS : 800-2000)

Hence Safe.

Length of Bolt provided = 900 mm

Permissible Bond Stress for M25 = 1.25*0.9 = 1.125 N/mm2

(Cl B-2.1 and Table 21 of IS 456 : 2000)

Total Force that each bolt can carry = 3.14*16*900*1.125

= 50.87 k N

> 12.5 k N (reqd.)

Hence Safe.