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Design of cell transmission tower with different bracing patterns

MR: NAGA SURBRAMANIAN

ASSITANT PROFESSOR

PERI INSTITUTE OF TECHNOLOGY

MR: ARUN K FINAL YEAR CIVIL PERI IT

MR: SARAVANAN M FINAL YEAR CIVIL PERI IT

ABSTRACT

In this thesis Analysis and Design of Cell Transmission Tower using Different Bracing patterns. Steel lattice towers are usually fabricated using angles for the main legs and the bracing members Latticed Structures are ideally suited for situations requiring a high Load carrying capacity, a low self weight, an economic use of materials and fast fabrication and Construction. For these reasons self- supporting latticed towers are most used in the field of Telecommunication and Power line system. It is very important to find an economic and highly efficient design. The arrangement of the tower members should keep the tower simple Geometry by using as few members as possible and they should be fully stressed under more than one loading conditions . The goal is to Produce an economical structures that is well proportional and attractive . Tower is designed by providing high factor of safety for wind loads

OBJECTIVES OF THE PROJECT

The objectives of this project is to Design a cell transmission tower, along with Foundation details, and to analysis it, below mentioned basic parameters are considered

a. Base width

b. Height of the tower

c. Soil bearing capacity

d. configuration of tower

To meet these objectives the following works has to be done

a. Towers plans are drawn using AUTOCAD

b. Wind load is calculated on the longitudinal face of the towers.

c. loading format and safety pattern are to be evaluated

d. Now the towers are modelled and analysed as a three dimensional structure using STADD.pro

SCOPE

The Main scope of this project are:

1. To design tower with efficient Bracing pattern

2. To reduce the maximum member stress and frequency by suitable

Bracing pattern

2. To design the tower by providing high factor of safety for wind loads

SITE SELECTION

The selected area for our study is rich in red soil as well as peaty soul.

Red in the selected region possesses lower strength compared to other soils due to its porous and friable structure.

Madurai zone located in wind zone II. The basic wind speech in this region is considered as 39m/s

3.1 GENERAL

The following are the steps involved in the design of tower: a. Studying the site of the proposed cell communication steel lattice tower. b. Plotting the preliminary information. 1.Selection of configuration of tower 2.Computation of loads acting on tower 3.Preparation of plan c. Analysis of tower for appropriate loading conditions. d. Design of tower members according to codes of practices. e. Design of foundation according to codes of practices.

3.4 PRELIMINARY DESIGN

It involves the determination of the configuration of the tower, bracing pattern, loading considerations and determination of wind pressure 3.4.1 CONFIGURATION OF THE TOWER: Communication Tower, like any other exposed structure, has a super structure shaped, dimensioned and designed to suit the external loads and self- weight Selection of configuration of a tower involves fixing of top width, bottom width, number of panels and their heights, type of bracing system and slope of tower.

The following are key parameters in configuration of tower. a. Width at bottom level = 4 m b. Width at top level = 1.20 m c. Overall height = 30 m d. Number of levels = 9 levels e. Slope of outline tower = 87 degree 3.4.2 ELEVATION OF LEVELS: Different bracing patterns are provided along with the different levels and height of the tower

3.4.3 LOAD CONSIDERATIONS: In case of communication towers self-weight of tower is most important component of tower design. The tele communication steel tower is a pin-jointed light structure, it is still assumed that their behaviour is like simple truss. The percentage of openings in Tower structure will be more than 30%, so wind loads acting on the tower will be of less magnitude compared to chimneys, but the major cause of failures of telecommunication tower throughout the world though remains to be high intensity winds (HIW). The major problem faced is the difficulty in estimating wind loads as they are based on a probabilistic approach. There has been several studies in telecommunication towers taking into consideration the wind as well as dynamic effect. The loadings which are considered during this project are:

Dead loads or Vertical loads 1. Self-weight of tower members 2. Self-weight of antennas 3. Load due to labour and equipment during construction and maintenance

Transverse loads a. Wind load on exposed members of the tower and antenna. b. Wind load on tower: It can be calculated using the Indian standards IS: 875(Part 3) to 1987[3] and BS: 8100 (Part 1)-1996[4]. c. Wind load on antennae: Wind load on antennae shall be considered from Andrew’s catalogue. In the Andrew’s catalogue the wind loads on antennas are given for 200kmph wind speed. The designer must calculate the antenna loads corresponding to design wind speed

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CHAPTER 5

DETAILED DESIGN 5.1 DESIGN OF MEMBERS Suitable steel sections are initially assumed as members of the tower for analysing the structure. Once the analysis is done members are finalized based on the stresses developing in them, following the codal provisions provided by Indian Standards. 1. The maximum allowable stresses in the members are given in IS 802 (Part1). 2. Limiting slenderness ratios for members are given in IS 802(Part-1). 3. Effective Length of compression members should be assumed as per IS 806(1968).

DESIGN OF FOUNDATION

The raft foundation is selected for this tower. Since the soil is under consolidated to about 5-8 m depth, it was decided to improve the ground and bearing capacity of the soil. Therefore, raft foundation is selected for this structure

DESIGN OF BASE SLAB

As per IS 800:2007, Bearing strength of concrete = 0.6fck But for practical consideration bearing strength = 0.45fck

Area of plate required = $(Pu)/0.45fck$ Where Pu = Factored load Load on each leg is = 400KN Factored load on each leg = 600KN Area of plate required = (600) / (0.45×25) = 53333.33 mm2 ∴ Side of each base plate = 300 × 300 mm2 Minimum thickness required [ts] = (2.5$w(a2-0.3b2)\gamma mo\ fy$)0.5 Where W = Pu ×area of base plate = 600×1000 300×300 = 6.66 N/mm2

A= 95 mm and b = 95 mm ts = (2.5×6.66 × (952−0.3×952) m × 1.1250). ∴ ts =25 mm (As ts > tf (truss angle thickness ts = 12mm), hence safe.) Connect base plate to foundation concrete using 4 Numbers of 20mm diameter and 300mm long anchor bolts. If weld is to be used for connecting column to base plate check the weld length of filler weeds.

DESIGN OF RAFT FOUNDATION

Initially assume footing size = 5m × 5m Uniform load on footing (W) = axial load area = 800 * 25 = 32 KN/m2 Consider per meter width then load is = 32 KN/m Maximum bending moment at centre of footing = 100 KNm Bending moment required Mu = 0.138fckbd2 100×106 = 0.138 × 25 × 1000 × d2 = 170.25 mm ∴ d = 200 mm. 5.2.3 Area of steel required Mu = 0.87 fy Ast d (1- $Ast\times fy\ bd\times fck$) 100×106 = 0.87×415×Ast×200× (1- Ast×415 1000×200×25) Assume concrete grade = M20 Steel grade = Fe415 Ast required = 1596.36 mm2 Assume diameter of bars = 12 mm No. of bars required = 1596.36 (π4)×122 = 15 bars Spacing of bars = 5000 /20 =250 mm ∴ Provide 20 bars of 12 mm dia 250 mm cc on both sides. 35 5.2.4 Design of concrete column for slab base Axial load on the column = 600KN. According to code axial load on column = 0.4fckAc + 0.67fyAst (As per IS 456:2000) 600×103 = 0.4fckAc + 0.67fyAst 600×103 = 0.4×25×Ac + 0.67fyAst Assume 1% of steel of concrete area. 600×103 = 0.4×25×Ac + 0.67×

415 × 1 100 Ac ∴ Ac = 46946.6 mm2 = 216.67 × 216.68 mm2 . ∴ Ac = 220 × 220 mm2 . Hence provide 300 × 300 mm2 square column at 350mm from

RESULT

A Telecommunication tower of 30m high is analysed and designed. a. The configuration of the tower is as follows: 1. Height of tower = 30m 2. Base width = 4m 3. Top width = 1.2m 4. Type of tower = Four-legged lattice tower with two slopes. 5. Number of members = 184 6. Number of joints = 61 b. Design has been done according to IS: 802 using STADD.Pro and following results are obtained, 1.Total weight of steel required in superstructure = 327.593 kg. c.

Raft foundation of 5m x 5m has been designed along with slab base column base to transfer the loads to raft. The details of foundation are: 1. Allowable Bearing Pressure = 250 KPa 2. Thickness of slab base = 25 mm c/c 3. Thickness of column base = 450 mm

CONCLUSION The response spectrum analysis reveal that the XX-bracing tower joint displacement at the top and maximum member stresses were lowest when compared with other tower models in the order of K-bracing and the V-bracing. More so, the modal analysis revealed the V bracing tower has the lowest frequency follow by K-bracing, then and lastly XX-bracing. This is an indication that lesser frequency is the function of weight of the tower. In both it was revealed that average displacement, compressive stress and base shear of the XX-bracing tower model is less than that of K-bracing tower model but higher at average tensile stress. For the XX-bracing model to have gotten three of its four effects lesser than that of the K-bracing, this is an indication that it will perform better than the K-bracing model. More so, the high frequency in the XX bracing model can be reduced by increasing the size of the members since lower frequency is a function of both weight and stiffness. The wind load acting on the telecommunication towers will be comparatively less in magnitude as it is open structure with more openings, but failure of the towers is mainly due to High Intensity Winds. So high factor of safety should be given to wind loads.