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INFLUENCE OF STRUCTURE CHARACTERISTICS ON EARTHQUAKE RESPONSE UNDER DIFFERENT POSITION OF ROOFTOP TELECOMMUNICATION TOWERS

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ABSTRACT

In today's era the mobile sector is growing dynamically & the trend of mobile communication is increasing day by day. Generally for telecommunication purpose, the four legged supporting tower are used widely. In the last few years there has been tremendous increase in the communication industries which result in the installation of large number of tower for consistency of network and to increase the coverage area. The availability of land in urban areas is extremely limited for satisfying the ideal installation of tower thus giving no alternative but to adopt roof top towers. As tower plays a significant role for wireless communication network, the failure of such structure in a disaster is a major concern therefore utmost important has been given considering the seismic effect acting on the tower.

Firstly, the seismic effect is considered at the different types of soils and in the last, we considered the position of tower at roof top of structure, and it is observed that the displacement is different at various height of structure i.e. the displacement is maximum at the top height of tower and minimum at building. The results obtained from the above analysis are tabulated, compared and conclusions is drawn that as observed the displacement is minimum in soft soil, & displacement is minimum when the position of tower is at the centre of structure.

KEYWORDS: Rooftop Telecommunication Tower. Earthquake Effects. Towered building, types of soil, different size of column.

INTRODUCTION

For supporting parabolic antennas which are generally used for microwave transmission for communication and information are use for sending signals for radio, television signals to remote places, a tall structure named lattice tower is installed at specific height. These towers are categorized as three legged and four legged space trusses structure, which are self supporting. These self supporting structures are supported either on ground or on building and are generally square in plan or it may be triangular in plan. The major cause of failures of telecommunication tower throughout the world though still remains to be due to earthquake causes.

OBJECTIVE

The present study investigates that the lattice tower is placed on roof of a building at different positions, different soils under seismic effects for different zones.

SCOPE OF THE WORK

- In case of high rise buildings additional displacements would occur due to wind load therefore, a detailed sway analysis of high rise towered structure under different load combination and tower position is required.
- Evaluation of additional measures to strengthen an existing building to carry the loadings due to tower construction is required.
- As the communication sector is progressing specially in urban areas, so the antennas are established on roof top due to the land availability is limited which will be a major challenge to face.

These structures are generally designed to carry seismic load, which acts as cantilever trusses. As they cover less base area in towers, they are suitable in many situations but these structures demands more steel. The installation of these towers requires the availability of land depending and the location and availability of fund. The use of these towers is more in urban areas, but due to limited availability of land in urban areas, the concept of roof top tower is adopted in

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which tower is installed of the roof top of the building. Thus by this, the problem of land requirement can be removed and it serves efficiently.

METHODOLOGY

Methodology behind the research is as follows:

Seismically deficient buildings and their rehabilitation are major problems for earthquake regions of India. In this study, the method is proposed to build a structure which is seismically deficient. In order to achieve the above mentioned objective following methodology is adopted.

A tower is built manually and a model is prepared in staad pro software. The behavior of towered building is studies under earthquake effect, types of soils and at various positions of tower at the roof of building.

In the present studies of G+2 building with a lattice tower of 15 m height placed at different position and analysis of seismic force is done and resulting position is modeled of this building. The building is assumed to be situated in seismic zone like ZONE II, ZONE III , ZONE IV & ZONE V as defined in Indian Seismic Code IS 1893 (Part I) : 2002. The grade of concrete used is M20 and steel for main and transverse reinforcement is Fe 415 and soil beneath the structure is analyzed for different types of soil. Structure analysis and designs are carried out as IS Code.

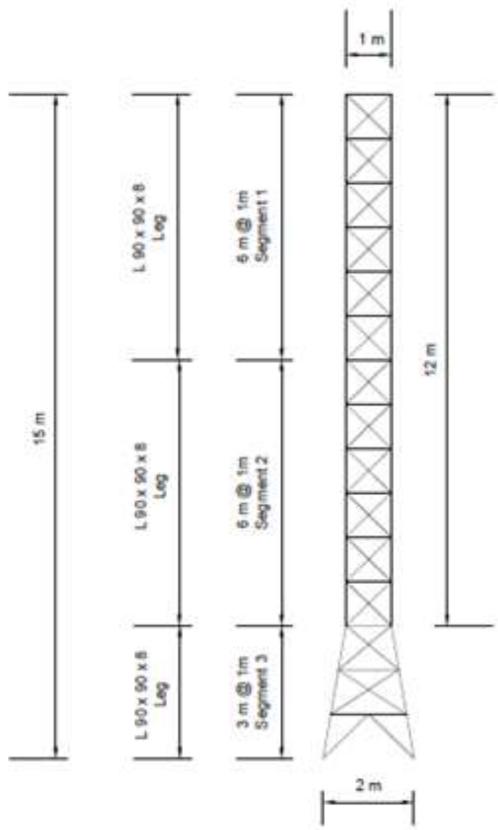

Figure 1 LATTICE TOWER

Various selected position of the rooftop (15m) tower mounted on 9m X 9m X 6m building

CASE I		
CASE III	**CASE II**	

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Procedure for static analysis

1. Designed the tower manually. Create the model, by selecting node, specifying the node distance, and no. of segments.
2. Assigned the section angle section and bracing in tower.
3. Using staad pro software designed beams & columns building & also assigned support conditions for column.
4. Defined the design code as IS 800-2007.
5. Define the design code as IS 456-2000.
6. Define material properties as Concrete M-20 Grade and Steel Fe-415.
7. Define the properties of frame sections as rectangular with reinforcement for beams & columns and assign them to the respective beams and columns of the frame.
8. Define wall load and slab load as per the details..
9. Assigned the live load, dead load, earthquake load & the combinations of load (according to IS 456-2000) to the building.
10. In building, slab is considered as a single rigid member during earthquake analysis. For that, all slabs are selected first and apply diaphragm action for rigid conditions.
11. Mass source is defined. As per IS: 1893(part 1) 2002.25% live load (of 2 KN/m^2) is considered on all floor of building except at roof level.
12. Define static load as per IS 1893(part 1) 2002.
13. Design is carried out using different combination. staad pro software have facility to generate combination as per IS 1893(part 1) 2002.
14. Several types of output can be obtained from the static analysis:
    a) Maximum story displacement and lateral force at each story.

    b) Displacement check is carried for different earthquake zones.
    c) Comparison for different types of soil.
    d) Comparison for the different positions of tower on building.

15. Output for the linear static analysis can be printed in a tabular form for the entire model or for selected elements of the model shown in figure 2-4

Figure 2 SWAY MODE OF G+2 TOWERED BUILDING (CASE I)

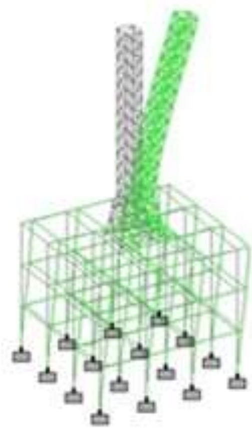

Figure 3 SWAY MODE OF G+2 TOWERED BUILDING (CASE II)

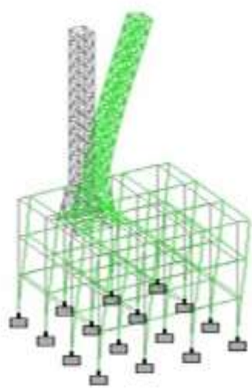

Figure 4 SWAY MODE OF G+2 TOWERED BUILDING (CASE-III)

RESULTS

The analysis was done for all seismic zones, but the result shown here is of ZONE IV. We carried the project in two sections i.e. Analysis for different soil condition & by changing the position of tower.

HEIGHT	CASE-I			CASE-II			CASE-III		
	SOFT SOIL	MEDIUM SOIL	HARD SOIL	SOFT SOIL	MEDIUM SOIL	HARD SOIL	SOFT SOIL	MEDIUM SOIL	HARD SOIL
3	11.765	16	19.674	11.08	15.067	18.502	11.089	15.081	18.518
6	24.266	33.002	40.425	22.63	30.337	37.793	22.66	30.818	37.842
9	31.624	43.008	52.812	28.85	39.235	48.178	28.889	39.28	48.245
24	47.805	65.015	79.834	46.12	61.359	75.345	46.82	63.675	78.189

TABLE NO.1 COMPARISION OF DISPLACEMENT FOR DIFFERENT SOIL TYPES & DIFFERENT POSITION OF TOWER IN ZONE IV

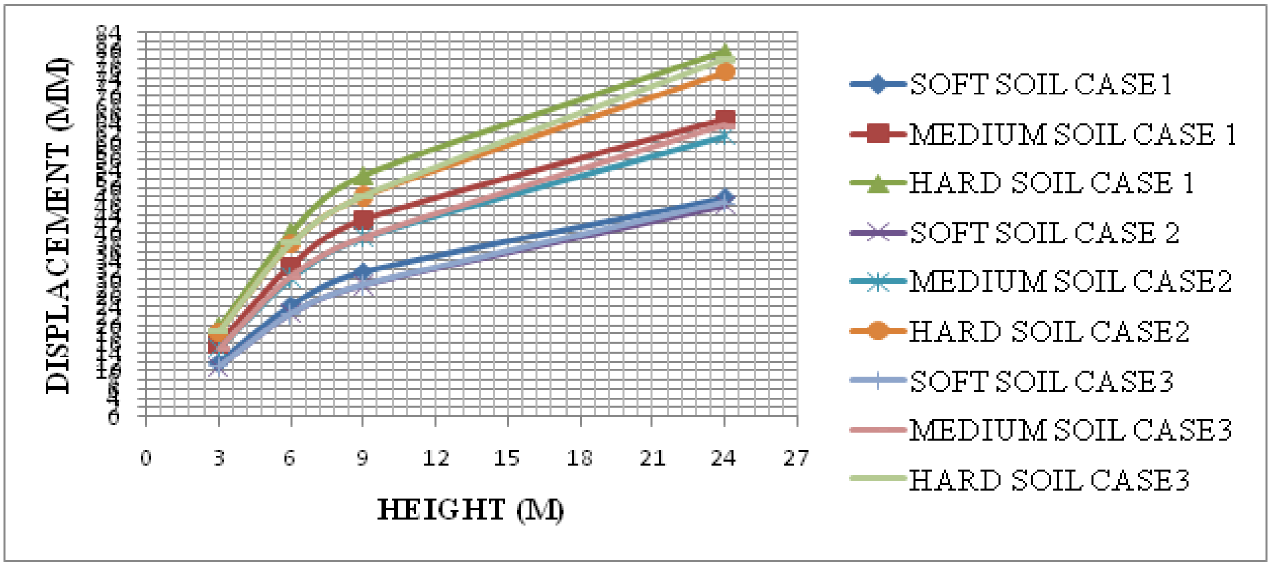

FIGURE 6: PLOT OF COMPARISION OF DISPLACEMENT FOR DIFFERENT SOIL TYPES & DIFFERENT POSITION OF TOWER IN ZONE IV

CONCLUSION

Tower was placed at three different locations on the rooftop. The analysis was carried out for four earthquake zones and three soil types. For all the combination displacement at different heights of towered building were compared. The following conclusions are drawn from the above analysis.

1. For all the earthquake zones and all soil condition, the displacement in the towered structure was found to increase with the height of structure.
2. For all the earthquake zones, considered, the displacement was maximum in hard soil which was followed by medium and soft soil.
3. For all the earthquake zones minimum displacement was observed when the tower was placed at the center of the roof i.e. CASE II. Therefore, the optimal position of the tower is at the center of the roof.
4. Increasing the size of column by jacketing could be provided for the existing building, which is not designed to withstand additional load due to tower construction and/or earthquake.

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