EARTHQUAKE ANALYSIS OF TALL STRUCTURE MOUNTED WITH TELECOMMUNICATION TOWER AT ROOFTOP

Digambar Patil[1], Nilesh Sargar[2], Abhisehk Nannikar[3], Akshay Mahajan[4]

[1,2,3]B.E Student, Department of Civil Engineering, SCT's V.T.C., Miraj, Maharastra, India
[4]Assistant Professor at V.T.C., Miraj, Maharastra, India

Abstract - *In today's world the telecommunication sector is growing dynamically and the trend of mobile communication is increasing rapidly day by day. A large proportion of world's population lives in regions of seismic hazards, at risk from earthquakes of varying severity and frequency of occurrence. Earthquake causes significant loss of life and damage of property every year. Generally for telecommunication purpose, the four legged supporting tower are used widely. Due scarcity of land, there is a need of vertical expansion and this results in installation of telecommunication tower at rooftop of tall structure. As tower plays a vital role for wireless communication network, the failure of such tall structure mounted with telecommunication tower at roof top. During earthquake causes failure of such structure is major concern therefore utmost important has been given. The present study investigates severity of earthquake for Mumbai region. In this study; we have considered G+10 building and 5 different positions on rooftop for installation of telecommunication tower. We have compared tall structure mounted with telecommunication tower for various parameters such as displacement, storey shear, and storey drift and twisting moments. Design load that are given in software where compared along with manual calculation using IS 1893:2002. We used ETABS software for analysis. In different 5 cases we compared which is the ideal position and critical position for installation telecommunication tower using response spectrum method.*

Key Words: **telecommunication tower, tall structure, rooftop, ETABS.**

1. INTRODUCTION

Communication plays a significant role in any generation. And this generation is widely using wireless communication which is supported by communication towers spread across the nations. As usage of cells is increasing very rapidly, few towers are installed at the higher elevation and few are installed at the tall structures or apartments for proper communication. As cities have scarcity of land and lack of open free spaces, there are many more towers which will be installed on the existing buildings for good service. Even though research says there is little effect of radiation around the tower, there is another effect which is not seen currently as a great threat and that is the effect of building response because of telecommunication tower installation on building rooftop.

Telecommunication towers are tall structure usually designed for supporting parabolic antennas which are normally used for microwave transmission for communication, also used for sending radio, television signals to remote places and they are installed at specific height. These towers are self-supporting structures and categorized as three-legged and four-legged space trussed structures. The self-supporting towers are normally square or triangular in plan and are supported on ground or on building. They act as cantilever trusses and are designed to carry wind and seismic loads. These towers even though demand more steel but cover less base area, due to which they are suitable in many situations. Most of the studies performed on low rise building mounted with telecommunication tower. The studies related to tall structure mounted with 4-legged self-supporting towers are rare.

The main objective of this study is to understand the change in behavior of existing structure after installation of telecommunication tower.

1.1 LITERATURE REVIEW

Nitin Bhosale (2012) has carried out the seismic response of 4 legged telecommunication towers under the effect of design spectrum from the Indian code of practice for zone – IV. The axial forces of the tower member were considered and comparison between roof top mounted tower and tower supported at ground had been performed to find out the difference.

Drisya S., (2016) has carried out the seismic analysis of low rise commercial building with roof top telecommunication tower with four different heights. Structure indicates that the position of tower on the host structure and its heights influence axial forces and stress in building members.

Faria Aseem (2016) has carried out Effect of rooftop mounted telecommunication tower on design of the building structure. They concluded that the design of the columns get effected tremendously hence the telecommunication tower should not be installed on the building which are not designed for such loads.

Arpit Chawda (2017) has carried out Seismic study of self-supporting telecommunication tower mounted on rooftop.

They studied the behavior of roof top telecommunication tower when subjected to lateral loads.

2. OBJECTIVES

1. To Analyses a G+10 Storey Structure by considering Roof mounted Tower.
2. To Compare the Behaviour of RCC Structure with and without Roof mounted Telecommunication Tower.
3. To locate ideal and critical position for construction of Roof mounted Telecommunication Tower.
4. To Enhance the Structural Stability of RCC Structure with Roof mounted Telecommunication Tower against Earthquake Forces.

3. METHODOLOGY

RESPONSE SPECTRUM METHOD- Response spectrum is one of the useful tools of earthquake engineering for analysing the performance of structures especially in earthquakes, since many systems behave as single degree of freedom systems. Thus, if you can find out the natural frequency of the structure, then the peak response of the building can be estimated by reading the value from the ground response spectrum for the appropriate frequency. In most building codes in seismic regions, this value forms the basis for calculating the forces that a structure must be designed to resist (seismic analysis).

4. PLAN AND SPECIFICATIONS

A. Building specifications

Type of building	Commercial Building
Height of the building	35m
Number of stories	Eleven (G+10)
Floor-to-Floor height	3.2m
Materials	M25 for beams M25 for columns Fe-415 for steel
Column size	650mm × 650mm
Beam size	400mm × 400mm
Depth of Slab	125mm

B. Tower specifications

Height of tower	15m
Location	located on rooftop
Beams	I-section
Leg	ISA 100x100x10mm
Main bracing	ISA 65x65x5mm

C. Plan OF building

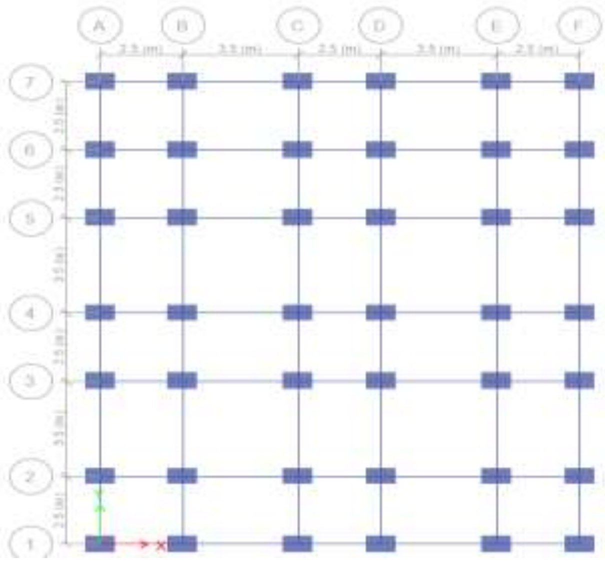
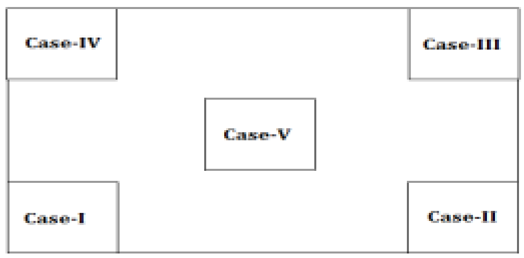


Fig 1. Building plan

D. Different locations of installation of tower



5. Modelling

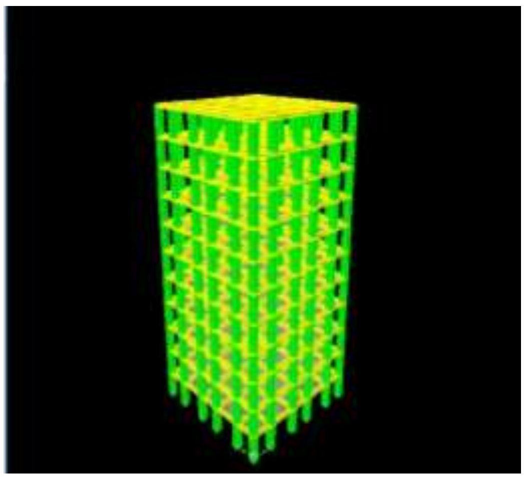


Fig 2. Assigning beam and column properties

5.1 Case I

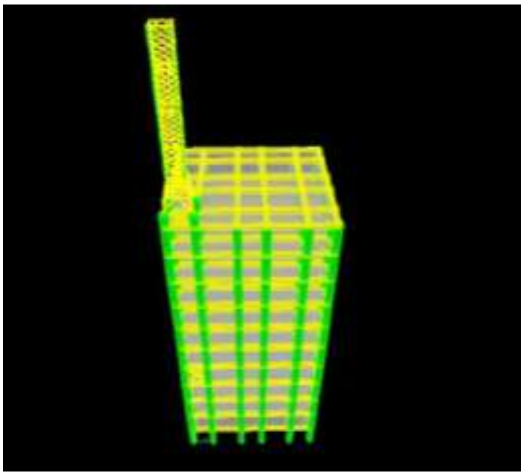


Fig 3. Location 1

5.2 Case II

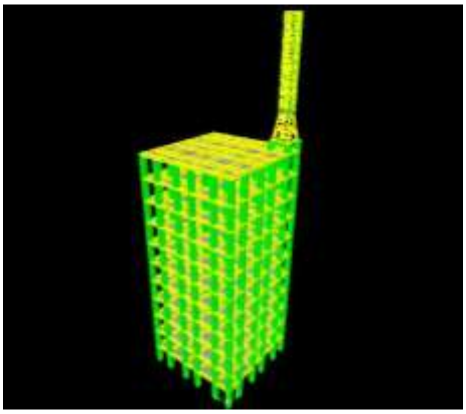


Fig 4. Location 2

5.3 Case III

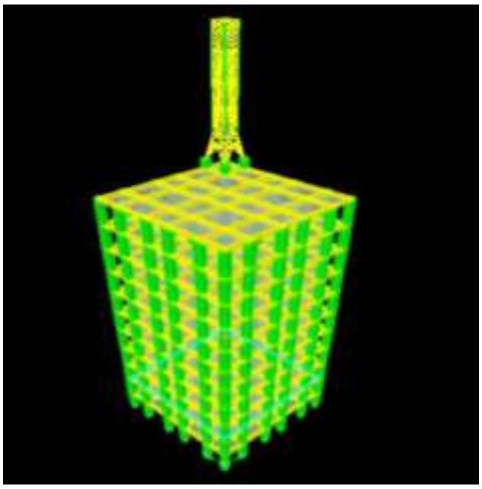


Fig 5. Location 3

5.4 Case IV

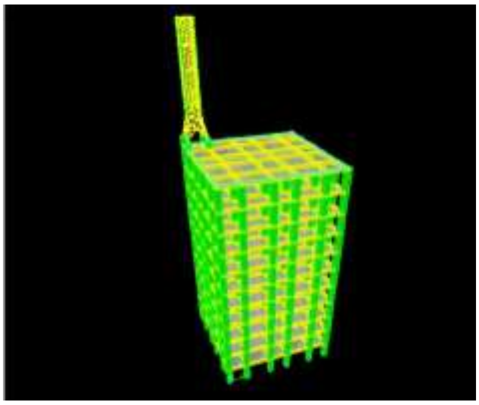


Fig 6. Location 4

5.5 Case V

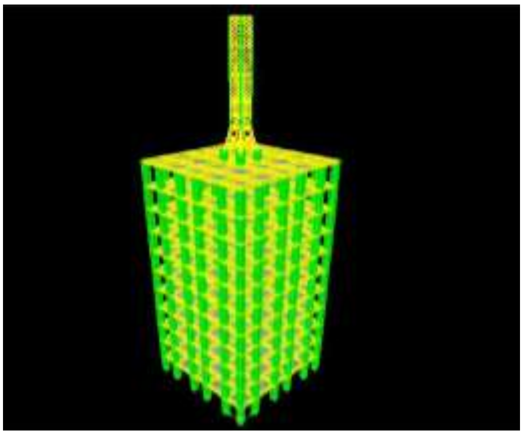


Fig 7. Location 5

6. RESULTS

Table -1: CASE-I

Storey Level	Displacements in (mm)	Storey shear (KN)	Storey Drift(mm)
11	137.5	79.5	18.92
10	107	178	14.2
8	85	221	11.3
6	70	469	9.56
4	42	735	6.47
2	18	936	4.23
0	0	0	0

Table -2: CASE-II

Storey Level	Displacements in (mm)	Storey shear (KN)	Storey Drift(mm)
11	111.9	105	16.35
10	91.23	196	11.1
8	69.23	286	9.41
6	51.43	535	7.36
4	29.56	735	4.96
2	13.9	1086	3.11
0	0	0	0

Table -3: CASE-III

Storey Level	Displacements in (mm)	Storey shear (KN)	Storey Drift(mm)
11	131.8	85.6	16.52
10	104.9	194	13.2
8	81.2	240	10.3
6	62.12	482	8.54
4	38.96	751	5.23
2	15.6	964	3.15
0	0	0	0

Table -4: CASE-IV

Storey Level	Displacements in (mm)	Storey shear (KN)	Storey Drift(mm)
11	105.9	101	15.34
10	86.52	186	10.3
8	59.63	256	8.63
6	48.82	502	6.42
4	24.16	696	3.92
2	9.86	951	2.51
0	0	0	0

Table -5: CASE-V

Storey Level	Displacements in (mm)	Storey shear (KN)	Storey Drift(mm)
11	91.36	136	12.36
10	72.36	296	8.96
8	42.3	386	6.21
6	32.6	625	5.23
4	16.98	896	2.05
2	5.62	1203	1.36
0	0	0	0

7. PLOT OF COMPARISON BETWEEN CASES

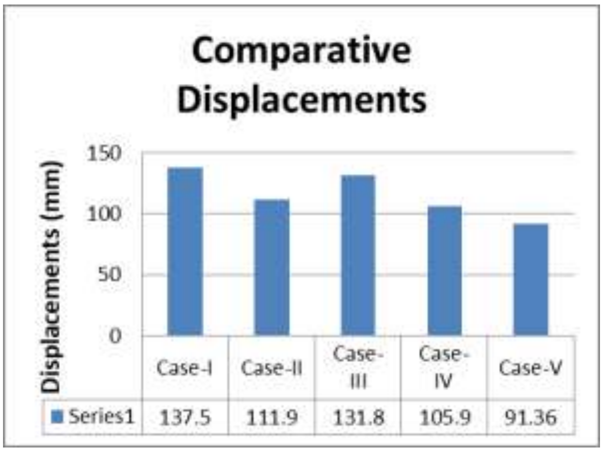


Chart -1: Comparative Displacements

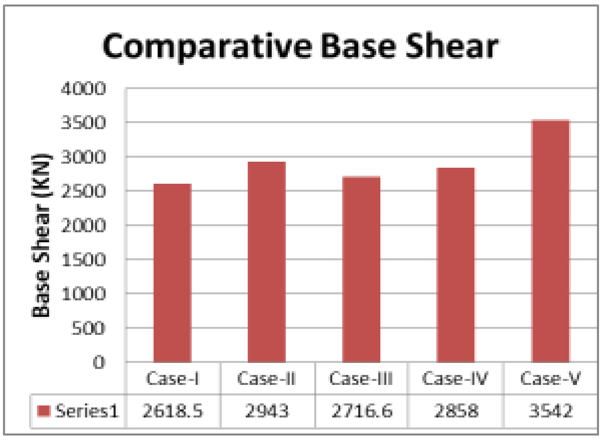


Chart -2: Comparative Base Shear

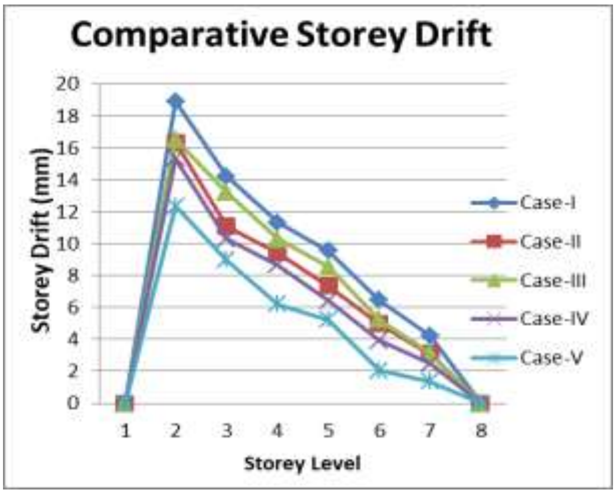


Chart -3: Comparative Storey Drift

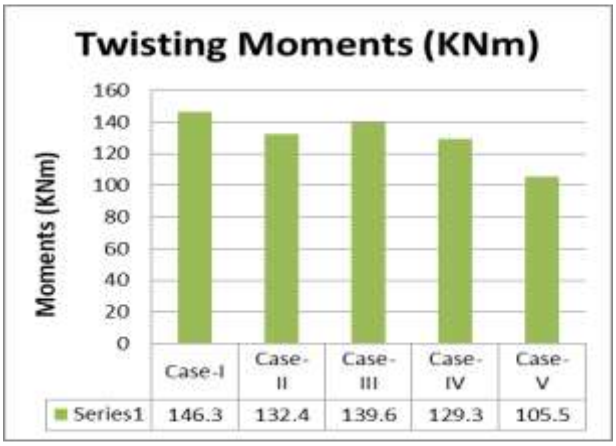


Chart -4: Comparative Twisting Moments

8. CONCLUSIONS

1. Tower location at corner towards seismic is most critical direction, as it shows 33.56% increase in displacement, 34.67% increase in drift, 27.88% increase in twisting moments and 35.29% decrease in base shear compare to other locations.

2. Tower locations at corner but opposite to seismic waves provide better results than case (I).

3. Tower location in Case (IV) is better than case (II), the change of position shows 4.63% less displacement, 4.98% less drifts, 1.92% less twisting moments and 8.53% more base shear.

4. The ideal location of tower is in case (V) i.e., at center of building, as it is resulted in average 24.07% decrease in displacements, average 25.91% decrease in drifts, average 22.75% decrease in twisting moments and 35.29% increase in base shear.

ACKNOWLEDGEMENT

Words are inadequate in offering thanks to Mr. Amit Kharade, M.Tech., Assistant professor, T.K.I.E.T Engineering college for their valuable guidance and timely suggestions and kind encouragement to carry out this project work.

REFERENCES

1) Nitin Bhosale, Prabhat Kumar and Pandey.A.D (2012): "*Influence of Host Structure Characteristics on Response of Rooftop Telecommunication Towers*", International Journal of Civil and Structural Engineering Volume 2, No 3, February 2012, ISSN 0976 – 4399

2) Drisya S. and Joshma M. (August 2016): "*Seismic analysis of Low-Rise commercial building with rooftop telecommunication tower*", volume – 3, ISSN: 2348-8

3) Faria Aseem and Abdul Quadir (Nov. 2017): "*Effect of rooftop mounted telecommunication tower on design of building structure*", Vol.4, pp.2395-0072 3523, February 2012, ISSN 0976 – 4399

4) Drisya S. and Joshma M. (August 2016): "*Seismic analysis of Low-Rise commercial building with rooftop telecommunication tower*", volume – 3, ISSN: 2348-8352

5) Archanna Dongre, et al., (April 2016): "*Effect in Seismic response of a structure due to installation of a communication tower on existing building*", International Conference On Earthquake Engineering And Post Disaster Reconstruction Planning

6) IS1893 (Part 1):2002, Indian Standard Code of Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi.

7) IS 456:2000, Indian Standard Code of Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi.

BIOGRAPHIES

Digambar Patil is presently studying B.E (Civil Engineering) in VTC, Miraj, Maharashtra.

Nilesh Sargar is presently studying B.E (Civil Engineering) in VTC, Miraj, Maharashtra.

Abhishek Nannikar is presently studying B.E (Civil Engineering) in VTC, Miraj, Maharashtra.

Akshay Mahajan is presently working as Assistant professor, Dept. of Civil Engineering at VTC, Maharashtra. He obtained his M.Tech degree in Structures from RIT.