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Telecommunication Tower on Residential Apartment at Jabalpur City with Building Improvement Analysis

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Abstract: The building is analysis and study under the load of seismic behaviour, the six diverse cases are taken and the end outcome considerations are analysed, and it showed that building is well-organized as evaluate to other. Many analyses have been performed on various structures along diverse boundaries. The cases are supposed to be situated in earthquake zone III. Total 6 cases consider for this study and after that result of the worst case among all cases we have set another case with outrigger system then analysis the whole cases. G+19 building is considered for the research. The study obtained by using STAAD pro software. Graphs and different constraints are shown in tabular form. In this research work we have especially adaptation for the worst case for enhancing its property so structure will not be considered as worst.
Keywords: Telecommunication Towers, Seismic Activities, High-Rise, Tower Location, Seismic Analysis Method, Tower

I. INTRODUCTION

In this age of communication and networking telecommunication towers plays important role in human society. At times of occurrence of natural disasters, telecommunication towers have the crucial task of instant transmission of information from the affected areas to the rescue centres. In addition, performance of infrastructure such as dams, electric, gas, and fuel transmission stations, depends extensively on the information being transmitted via these telecommunication towers. Military and defence industries in addition to television, radio, and telecommunication industries are other areas of application for such towers and thus create the necessity for further research on telecommunication towers. 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 a 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 buildings. 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.

II. OBJECTIVES

To find the most efficient and Worst location of Tower, following objectives have been decided for Residential Apartment Building:-

1) To obtain the minimum values of Nodal Displacement and Base Shear in both X and Z direction
2) To determine Time period and Mass participation factor in both X and Z direction.
3) To find Maximum Axial Forces, Shear Force and Bending Moment in Column.
4) To compare Maximum Shear Forces, Bending Moments and Torsional Moments in beams parallel to X and Z direction.

To find the most efficient and Worst location of Tower, following objectives have been decided for Tower:-

a) To obtain the minimum values of Nodal Displacement and Base Shear in both X and Z direction
b) To determine Time period and Mass participation factor in both X and Z direction.
c) To find Maximum Axial Forces, Shear Force and Bending Moment in Column.

To obtain the most efficient parametric case and worst case by comparing all and then to erect the worst one, following objectives have been decided for both Residential Apartment Building and Tower:-

- To obtain the minimum values of Nodal Displacement and Base Shear in both X and Z direction
- To determine Time period and Mass participation factor in both X and Z direction.
- To find Maximum Axial Forces, Shear Force and Bending Moment in Column.
- To compare Maximum Shear Forces, Bending Moments and Torsional Moments in beams parallel to X and Z direction
- To obtain the minimum values of Nodal Displacement and Base Shear in both X and Z direction
- To determine Time period and Mass participation factor in both X and Z direction.
- To find Maximum Axial Forces, Shear Force and Bending Moment in Column.

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III. METHODOLOGY AND MODELING

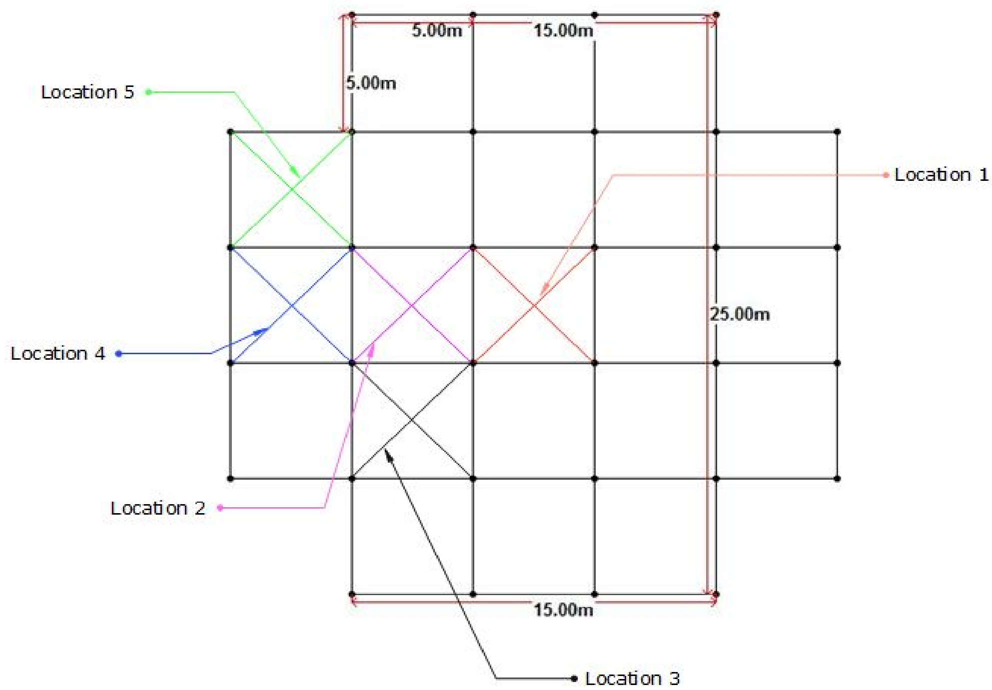

Fig. 1: Plan of all buildings

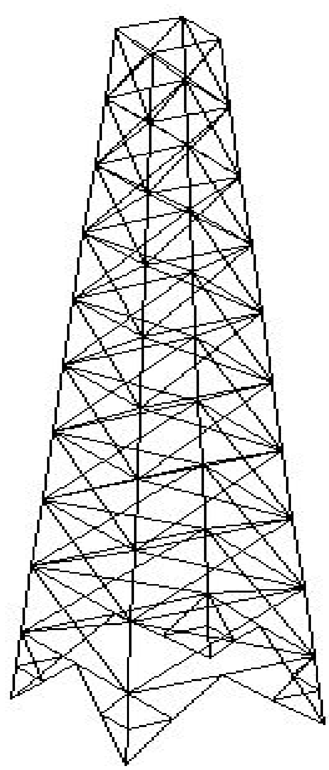

Fig. 2: 3D view of the Tower

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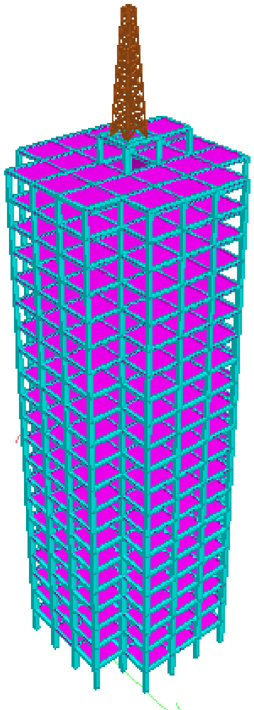

Fig. 3: Case TTRA1: - Residential Apartment with tower at location 1

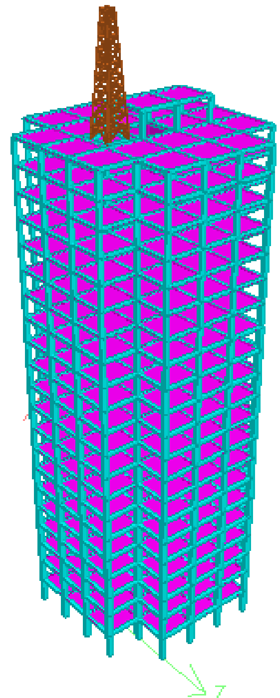

Fig. 4: Case TTRA2: - Residential Apartment with tower at location 2

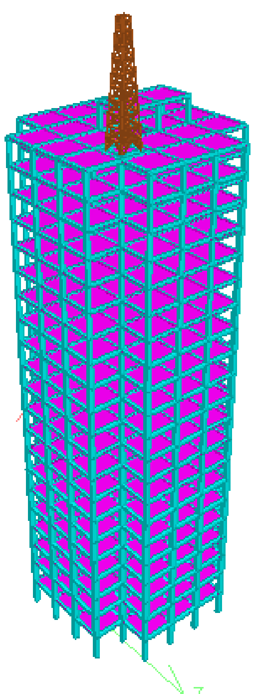

Fig. 5: Case TTRA1: - Residential Apartment with tower at location 3

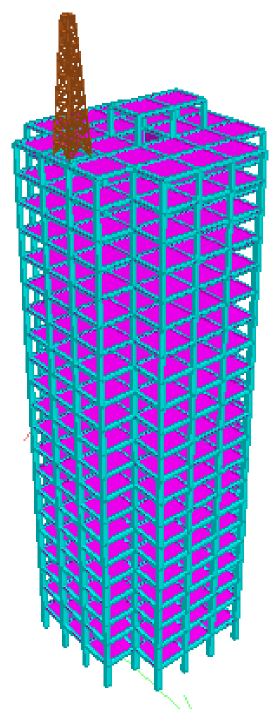

Fig. 6: Case TTRA1: - Residential Apartment with tower at location 4

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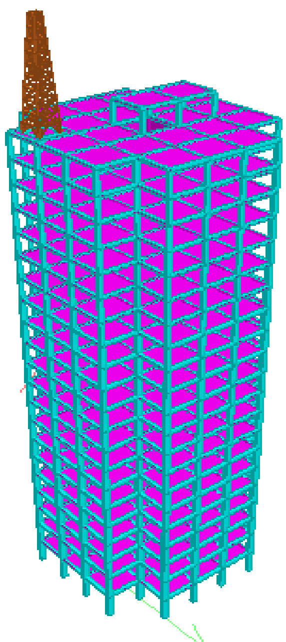

Fig. 7: Case TTRA5: - Residential Apartment with tower at location 5

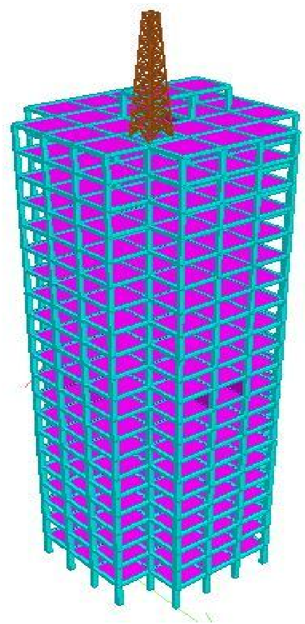

Fig. 8: Case TTRA3-OT: - Worst case optimized by implementing outrigger and belt supported system

Table 1: Data taken for analysis of structure

Constraint	Assumed data for all buildings
Soil type	Medium Soil
Seismic zone	III (Jabalpur City, M. P.)
Response reduction factor (ordinary shear wall with SMRF)	4
Importance factor (For all semi commercial building)	1.2
Damping ratio	5%
Plinth area of building	625 sq. m
Floors configuration	G + 19 (Residential Apartment)
Depth of foundation	4 m
Floor to floor height	GF-4 m, All floors-3.5 m each
Fundamental natural period of vibration (T_a)	$0.09*h/(d)^{0.5}$
Earthquake parameters	Zone III with RF 4 & 5% damping ratio
Period in X & Z direction	1.404 sec. & 1.404 sec. for both direction
Slab thickness	140 mm (0.140 m)
Shear wall and Outrigger thickness	135 mm (0.135 m)
Tower horizontal and Vertical elements	ISA 130x130x16
Tower bracing elements	ISA 100x100x15
Tower steel standing plate	25mm thick steel plate
Beam sizes	Up to 25.50m – 0.55m x0.40m Up to 50m – 0.50m x0.35m Up to 74.50m – 0.45m x0.30m
Column sizes	Up to 25.50m – 0.65m x0.60m Up to 50m – 0.55m x0.50m Up to 74.50m – 0.45m x0.40m
Material properties	M 30 Concrete Fe 500 grade steel

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IV. RESULTS ANALYSIS

The result parameters obtained by the application of loads and their combinations on various cases as per Indian Standard 1893: 2016 code of practice. Result of each parameter has discussed with its representation in graphical form below:-

A. Discussions for Residential Apartment Building

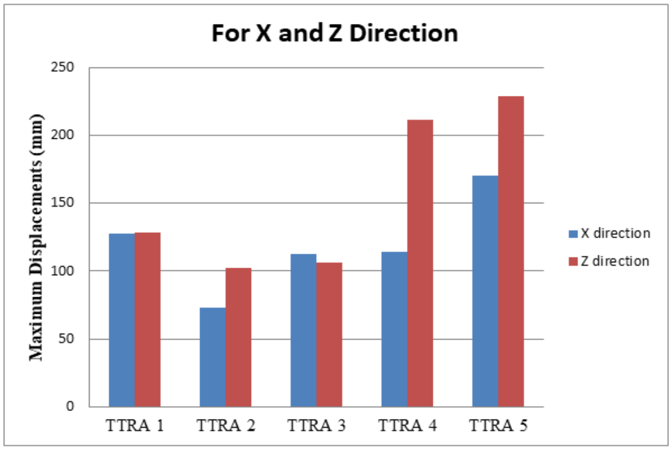

Fig. 9: Graphical Representation of Maximum Displacement in X and Z direction

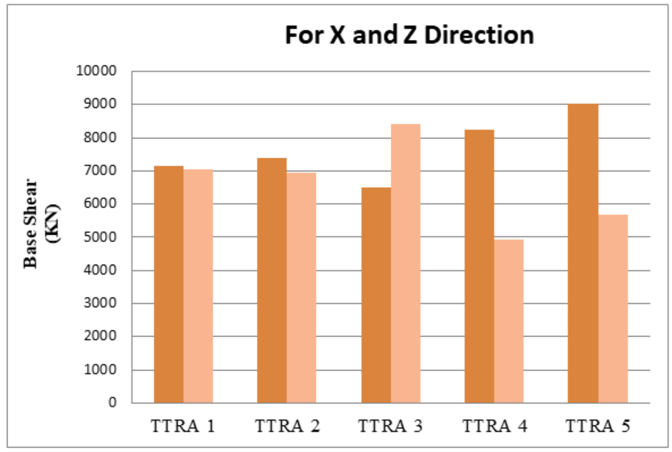

Fig. 10: Graphical Representation of Base Shear in X and Z direction

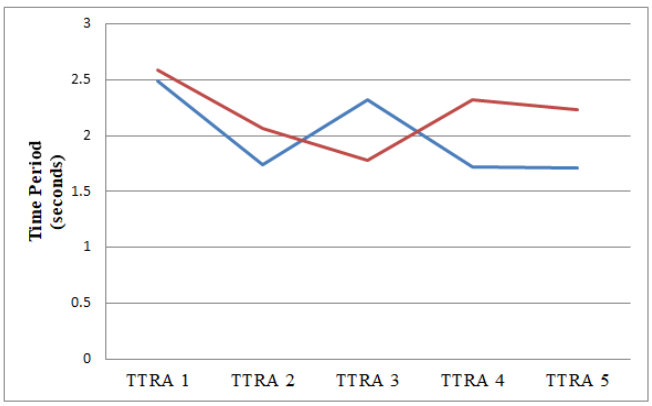

Fig. 11: Graphical Representation of Time Period parallel to X and Z directions for all Buildings in Zone III

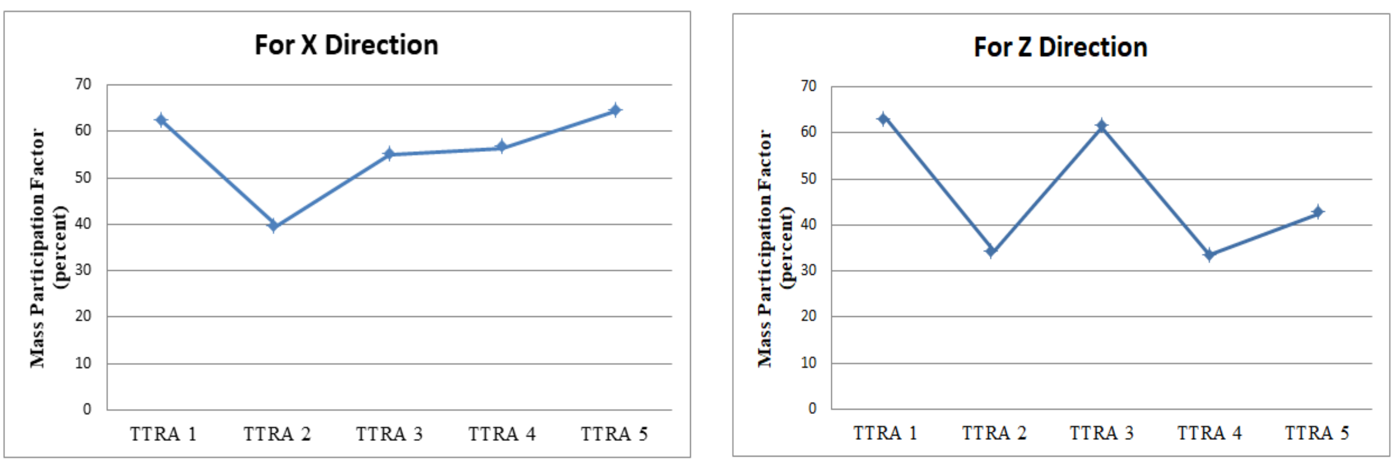

Fig. 12: Graphical Representation of Mass Participation Factor in X and Z directions for all Buildings in Zone III

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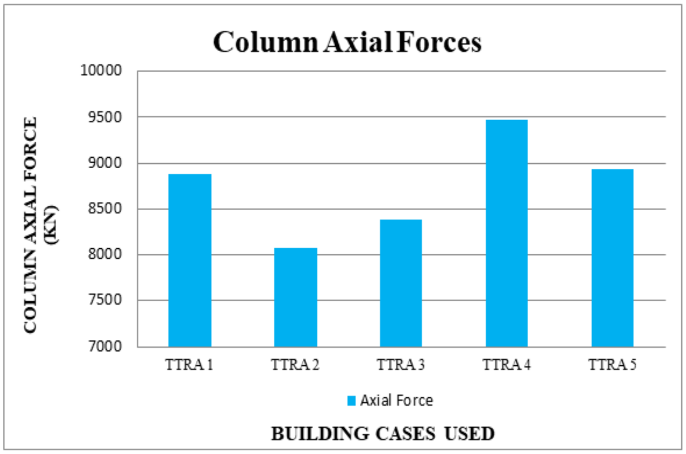

Fig. 13: Graphical Representation of Maximum Axial Forces in Column

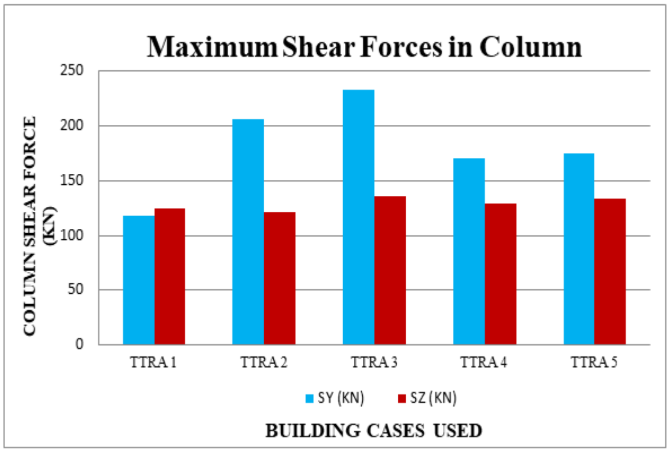

Fig. 14: Graphical Representation of Maximum Shear Force in Column

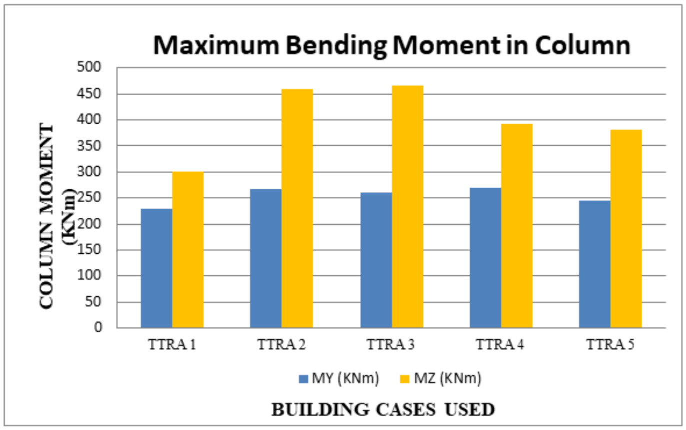

Fig. 15: Graphical Representation of Maximum Bending Moment in Column

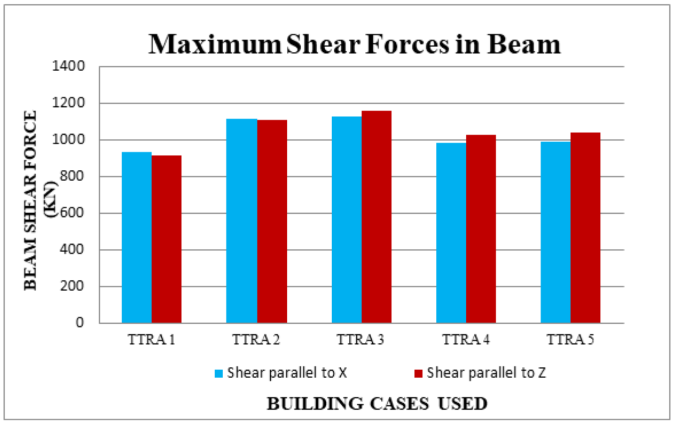

Fig. 16: Graphical Representation of Maximum Shear Force in Beam

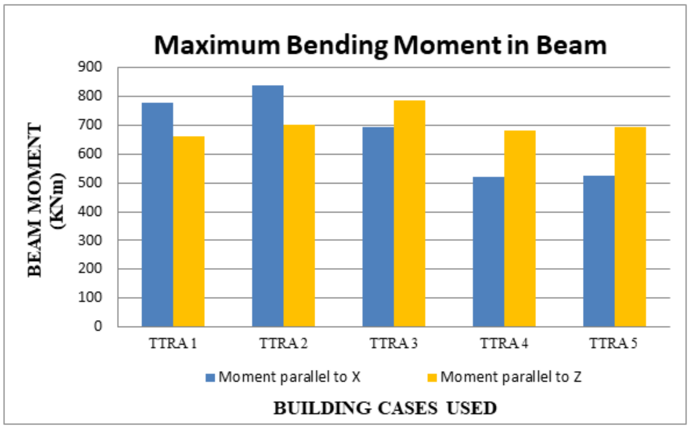

Fig. 17: Graphical Representation of Maximum Bending Moment in Beams parallel to X and Z directions

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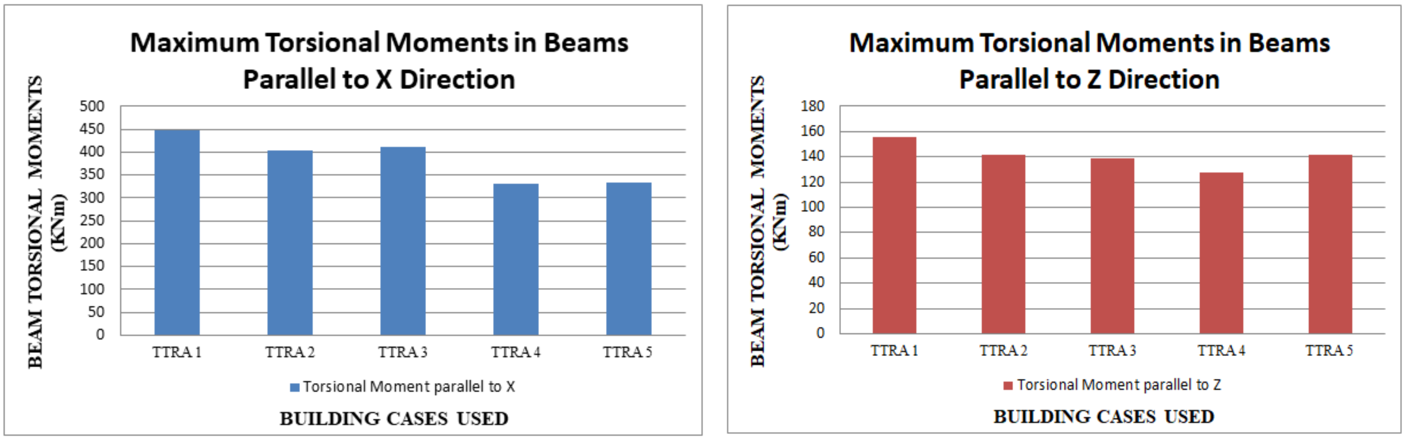

Fig. 18: Graphical Representation of Maximum Torsional Moment in Beams parallel to X and Z directions

B. *Discussions for Tower*

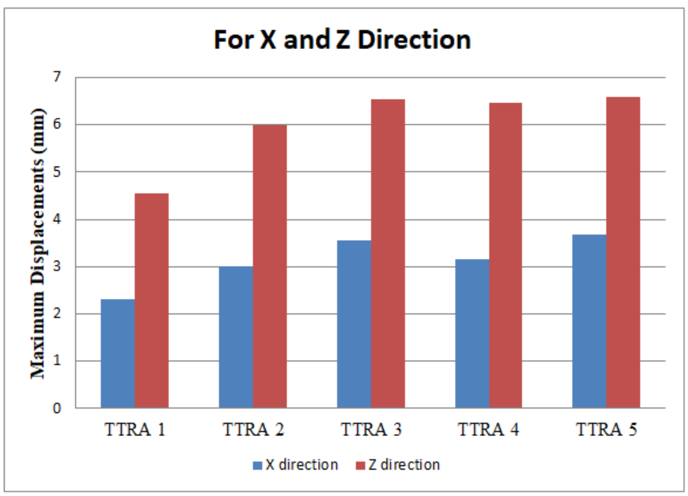

Fig. 19: Graphical Representation of Maximum Displacement in Tower X direction and Z direction

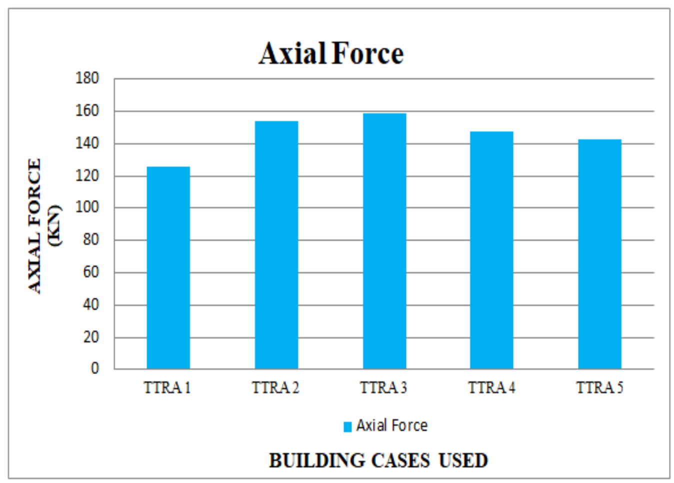

Fig. 20: Graphical Representation of Maximum Axial Forces in Tower

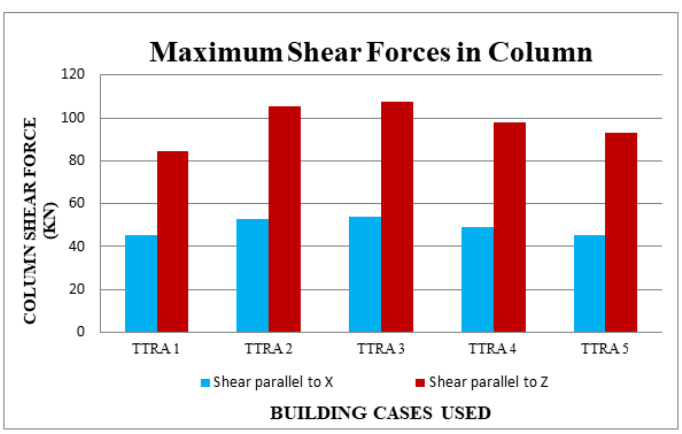

Fig. 21: Graphical Representation of Maximum Shear Force in Tower Column

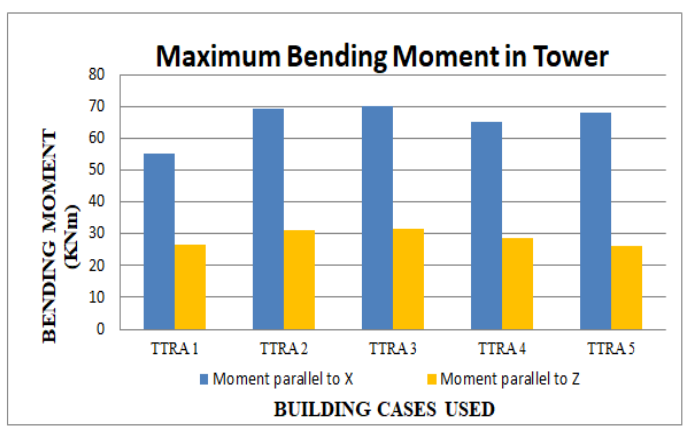

Fig. 22: Graphical Representation of Maximum Bending Moment in Tower

As per comparison of the numerous cases against various parameters among each other, it has been pointed out that the optimum case evolved will be Case TTRA1 in total 8 parameters and the worst case will be Case TTRA3 with total 8 cases.
If there is no provision of placing of tower to the optimum case, again the provision at planning stage that the tower will be located at the worst case as per this research, it has to be erected first by providing the outrigger system into it to make it more stable than before. Comparative analysis of worst case with its erected case has shown below:-

C. Discussion on Worst Case and Erected Case for Residential Apartment Building

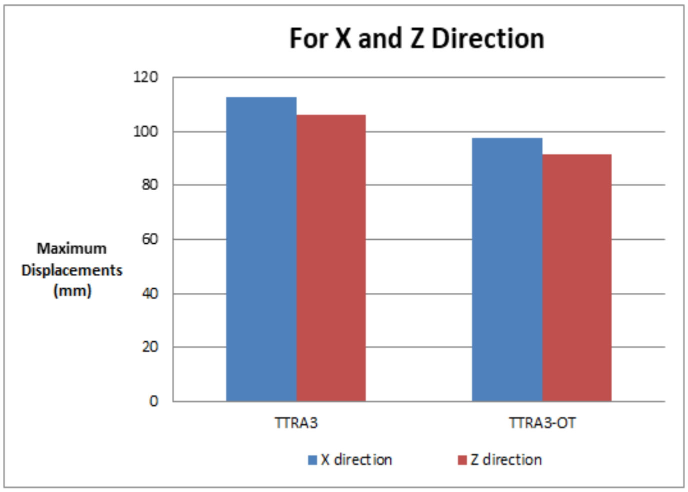

Fig. 23: Comparative representation of Maximum Displacement in X and Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

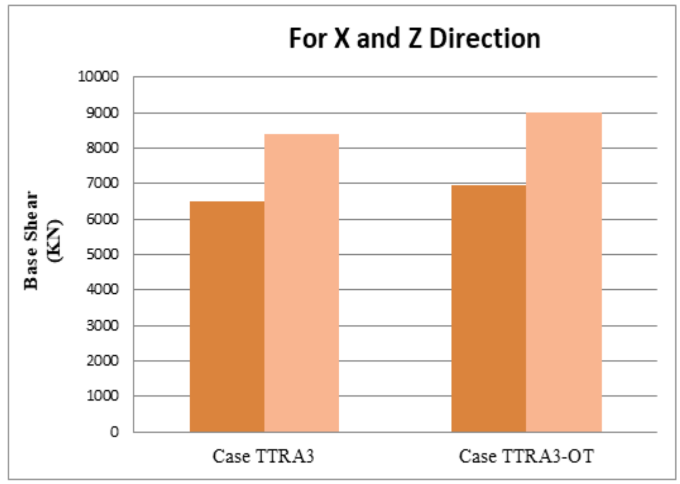

Fig. 24: Graphical Representation of Base Shear in X direction and Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

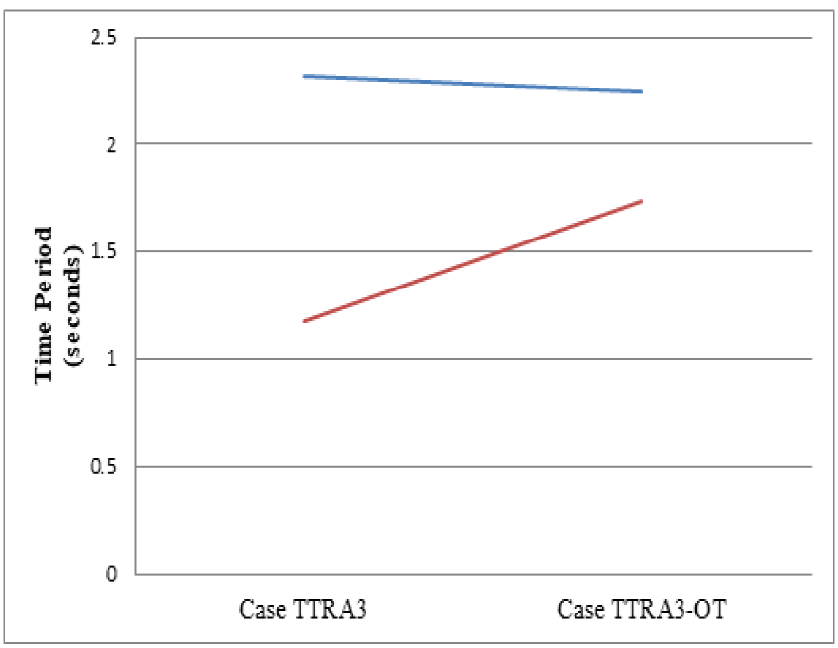

Fig. 25: Graphical Representation of Time Period obtained in Worst Case and Erected Case for Residential Apartment Building

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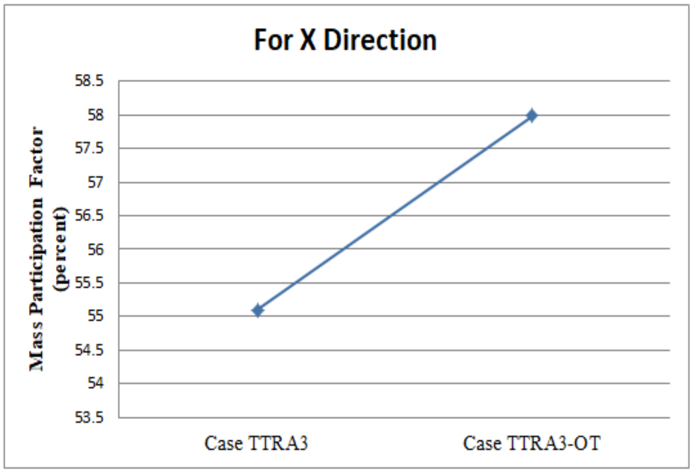


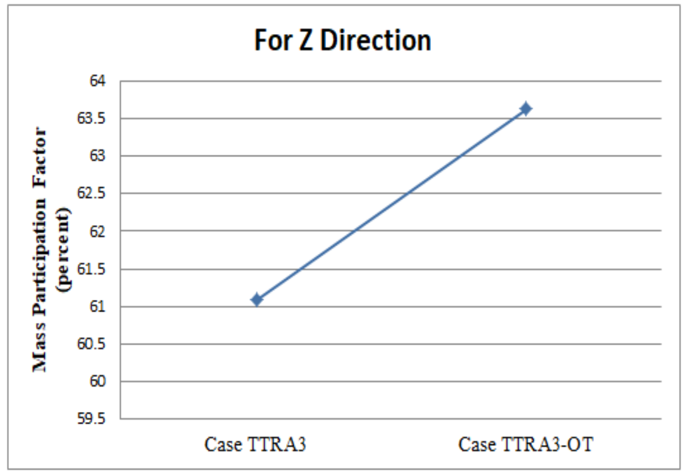


Fig. 26: Graphical Representation of Mass Participation Factor in X and Z direction for obtained in Worst Case and Erected Case for Residential Apartment Building

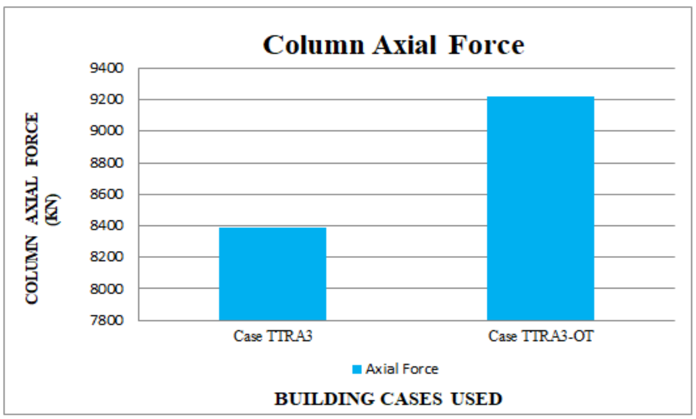


Fig. 27: Graphical Representation of Maximum Axial Forces in Column obtained in Worst Case and Erected Case for Residential Apartment Building

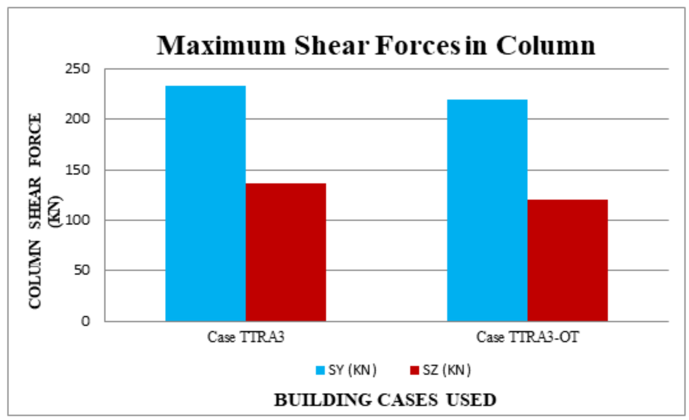


Fig. 28: Graphical Representation of Maximum Shear Force in Column obtained in Worst Case and Erected Case for Residential Apartment Building

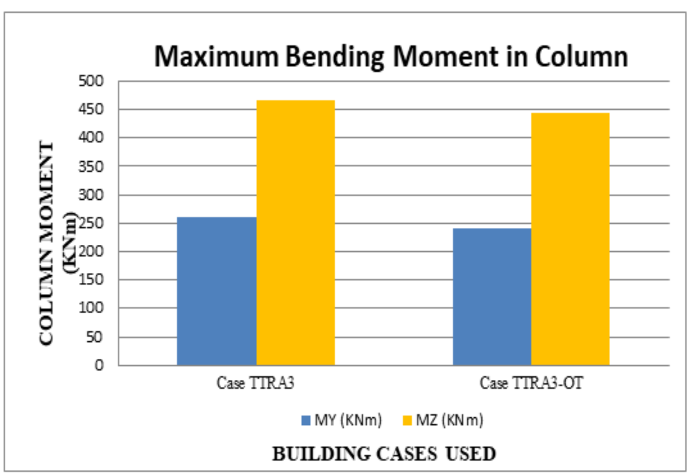


Fig. 29: Graphical Representation of Maximum Bending Moment in Column obtained in Worst Case and Erected Case for Residential Apartment Building

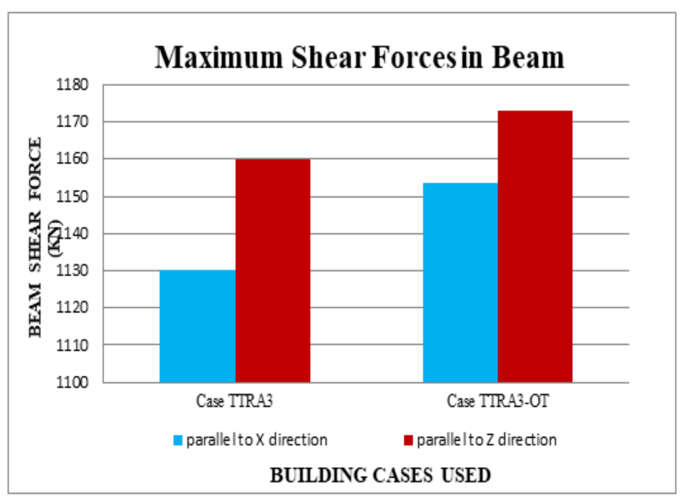


Fig. 30: Graphical Representation of Maximum Shear Force in Beam obtained in Worst Case and Erected Case for Residential Apartment Building

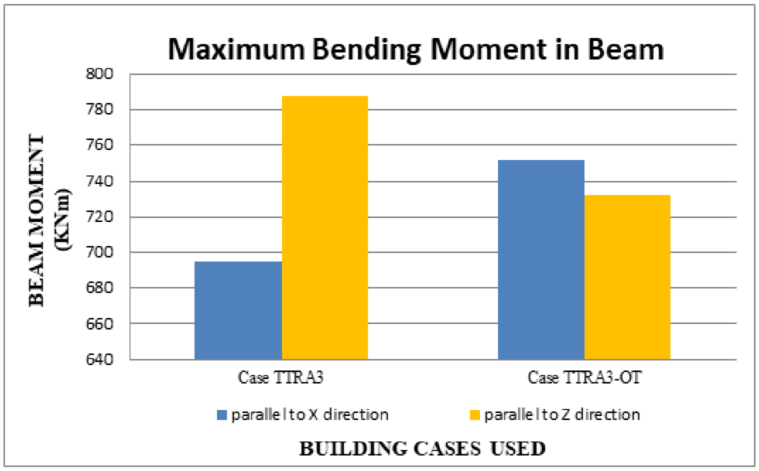
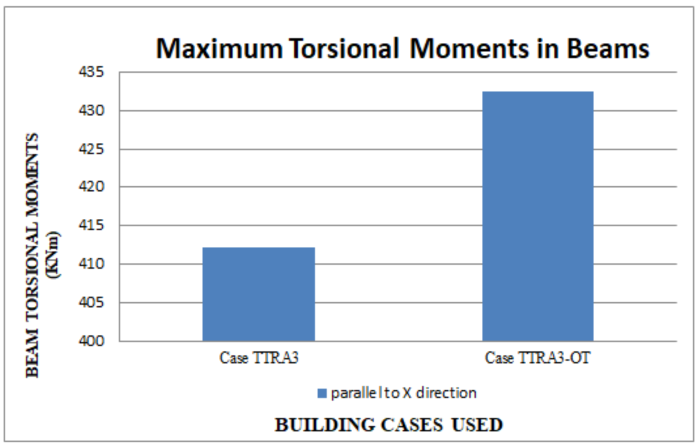


Fig. 31: Graphical Representation of Maximum Bending Moment in Beam obtained in Worst Case and Erected Case for Residential Apartment Building



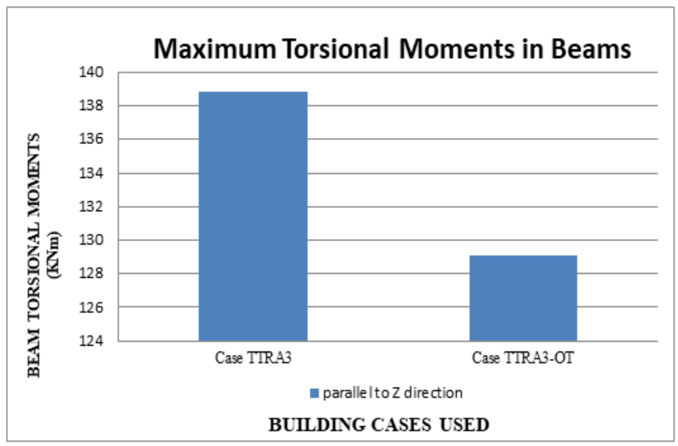


Fig. 32: Graphical Representation of Maximum Torsional Moments in beams parallel to Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

D. Discussion on Worst Case and Erected Case for Tower

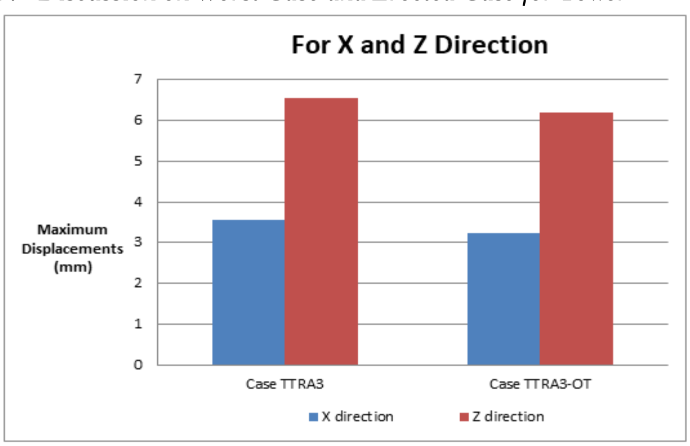


Fig. 33: Comparative representation of Maximum Displacement in X and Z direction obtained in Worst Case and Erected Case for Tower

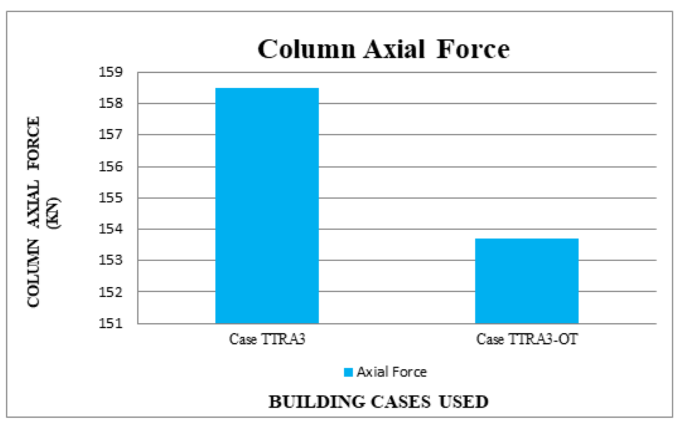


Fig. 34: Graphical Representation of Maximum Axial Forces in obtained in Worst Case and Erected Case for Tower

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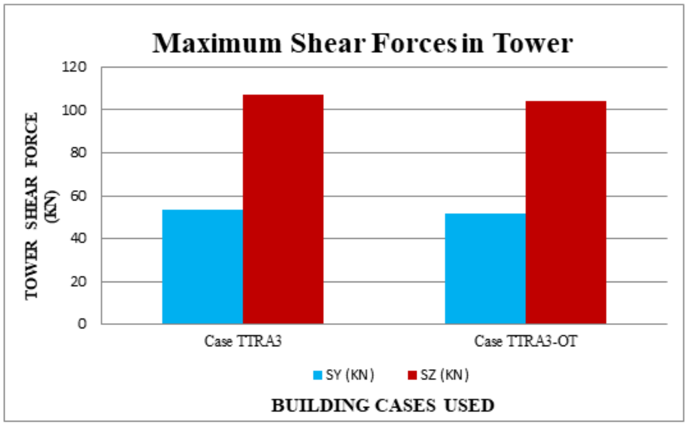

Fig. 35: Comparative representation of Maximum Shear Force obtained in Worst Case and Erected Case for Tower

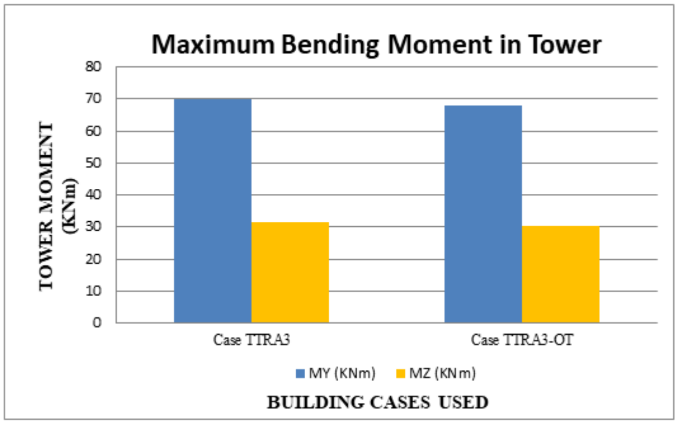

Fig. 36: Graphical Representation of Maximum Bending Moment obtained in Worst Case and Erected Case for Tower

V. CONCLUSIONS

As we have studied about Telecommunication Tower on Residential Apartment at Jabalpur City with Building Improvement Analysis in software and there are 5 cases in software model. In this research work we study Telecommunication Tower on Residential Apartment at Jabalpur City with Building Improvement Analysis in software. On the basis of above parameters following results are obtained from this comparative study.

A. Results for Residential Apartment Building

1) On comparing it has been concluded that the maximum displacement in X direction obtained for case TTRA 2 with a minimum value respectively again maximum displacement in Z direction obtained for case TTRA 2 with a minimum value.
2) As per comparative results, TTRA 1 and TTRA 4 for base shear forces in X direction and Z direction values are respectively efficient among all cases.
3) As per comparative results in axial force, TTRA 2 is very effective than other cases.
4) As per comparative results, TTRA 2 and TTRA 1 for Column shear forces in X direction and Z direction values are respectively efficient among all cases.
5) As per comparative results, TTRA 1 and TTRA 1 for Column beam bending in X direction and Z direction values are respectively efficient among all cases.
6) As per comparative results, TTRA 1 and TTRA 1 for Beam shear forces in X direction and Z direction values are respectively efficient among all cases.
7) As per comparative results, TTRA 1 and TTRA 5 for Beam Bending Moment in X direction and Z direction values are respectively efficient among all cases.
8) On analyzing the Torsional Moment in beams TTRA 4 is very efficient and Torsional Moment in column TTRA 2 is very efficient

B. Results For Tower

1) On comparing results of Tower it has been concluded that the maximum displacement in X direction obtained for case TTRA 2 with a minimum value respectively again maximum displacement in Z direction obtained for case TTRA 1 with a minimum value.
2) As per comparative results in axial force, TTRA 5 is very effective than other cases.
3) As per comparative results of Tower, TTRA 5 and TTRA 5 for Column shear forces in X direction and Z direction values are respectively efficient among all cases.
4) As per comparative results of Tower, TTRA 4 and TTRA 5 for Column beam bending in X direction and Z direction values are respectively efficient among all cases.

As per comparison of the numerous cases against various parameters among each other, it has been pointed out that the optimum case evolved will be Case TTRA1 in total 8 parameters and the worst case will be Case TTRA3 with total 8 cases.

If there is no provision of placing of tower to the optimum case, again the provision at planning stage that the tower will be located at the worst case as per this research, it has to be erected first by providing the outrigger system into it to make it more stable than before. As per comparison between the worst case and the erected case, it has been proved that if such kind of provision situation arises, provision of erection in the analysis phase should be performed before the construction to lessen the higher parametric values as discussed in this research.

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