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# Analysis of Worst position of Telecommunication Tower over housing Apartment with Introduction of Outrigger System at Jabalpur City under Earthquake Loading

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**ABSTRACT**

When the structure has been analysed under the effect of seismic activities, the main thing has been observed that we have only considered the efficient case, we have not considered the worst case. If there will be a provision of telecommunication tower over multistoried building in future and we have the worst location of tower position, we have to do some measures to erect the parametric values and to stable it. In this research, what we did was we actually take total 5 residential apartment building cases of G+19 of different telecommunication tower location. After analysis, we found out the worst case, we have used the outrigger system and erected as discussed in graphical representations in discussion part. In conclusion, parametric result comparison noted down. Overall it is observed that the Case TLA is very efficient among all the cases. Also, we have enhanced the property of worst case TLC which is found by our result and discussion by implementing the outrigger system.

**Keywords**— Seismic activities, Multistoried Building, Response spectrum method, telecommunication tower

## INTRODUCTION

One of the key difficulties in this time of construction biosphere is the problematic of empty and steady land. This lack in city parts has showed to the plumb construction magnification of low-rise, medium-rise, tall buildings and even sky-scraper (over 50 meters tall). These structures usually used framed structures exposed to lateral loads along with vertical loads.

In these structures, the lateral loads from strong winds and earthquakes are the main concerns to keep in mind while designing rather than the vertical loads caused by the structure itself. These both factors may be inversely proportional to each other as the building which is planned to withstand perpendicular loads or resist the lateral loads. The loads mentioned here are lateral are the principal one as they are different against one another as the vertical loads are supposed to increase linearly with height; on the other hand crosswise loads are fairly changeable and rise quickly with elevation. When lateral loads of a uniform wind or an earthquake load arrives the overturning moment at base of the structure is humongous and varies proportionally to square of the building height. This causes the building to act as cantilever as these lateral loads are especially higher in the topmost storied comparatively different than the bottom storied. These lateral forces from the sideways have a tendency to influence the frame of the structure. The earthquake affected areas where the chances of earthquakes are comparatively higher the buildings collapsed which have not been designed in concern to these seismic loads. All these above stated reactions make it major to study the source and effects of lateral loads and lead us how to erect this.

For elevated buildings having fifth teen to twenty stories, clean rigid frame system is not passable because it does not provide the essential lateral stiffness and causes extreme deflection of the building. These requirements are satisfied by two ways. Firstly, by increasing the members size above the requirements of strength but this approach has its limitation and secondly, by adding one additional part of structure as tower over it in different parts considering with different cases. This increases the structure’s stability and rigidity and also restricts the deformation requirement.

Due to unsystematic ground motions, in all possible directions coming from epicenter creates earthquake. These seismic effects which have horizontal shaking effects causing a inertia effect above the surface of the earth crust. These inertial forces then applied to structures causes setback of stresses in the components of the structure. From that compression forces changes to tension forces and vice versa. It then creates yielding of structures and ultimately unserviceable. A large amount of drift will then be generated which will ultimately fails from the joint of the building frame.

In India, the most common practice to make a high rise structure is reinforced concrete frame. In this country, earthquake zones are divided under four zones viz. Zone II, Zone III, Zone IV and Zone V. The structure ought to be analyzed first and then designed with extra stiffness and ductility requirements to reduce damages against this force. Hence use of steel bracing arrangement into the frame structure used to reduce the lateral effects on the structures. Bracings can easy to handle when construction, provides strength and stiffness to the frame structure. It can also be used as architectural performances. These are used in structure to resist movement of the components of any structure.

## OBJECTIVE OF THE WORK

In ancient time many of the peoples are not considering the designing of building with tower as very important parameters to be considered while the construction of the houses. As I have researched, but much research had not been done on this topic.

1. One of the major objectives is to determine the role and the functioning of the multi-storey with tower in the rural or the urban areas. It is also taken into the consideration the seismic forces effect. This proves beneficial in the seismic prone areas so that it can withstand the seismic frequency. This objective is according to the zone where building with tower is to be constructed.
2. To examine and compare the building with tower at suitable location which has designed in a standard way. Compared different location of tower should be the standard one. It should fulfil the requirements of the peoples using it commercial purpose. It should not make any adverse effect on the environment surrounding it. So wooden members are generally preferred.
3. Various cases are observed in various directions and out of which best location of the direction is considered. It should have maximum pros and minimum cons. It should be

economically fulfilling the various requirements of the peoples using it. As for some special reasons there should be portability of the tower location as per the requirements So It should be examining according to the purpose.

4. Economic factor also plays an important role in the selection of the tower on building in weather direction it may be. Economic factor is always considered in the construction purpose. It should create any obstruction in the easily survival of the family members or any other obstruction of parking the vehicles or something else.

5. Study of purpose of the porch is also included in our objectives. As various factors for the selection of location of tower, its purpose is too responsible. On the selection purpose various engineering and architectural purposes are to be fulfil, study related to these factors also have a great significance in the construction field.

Now a day, one of the important considerations is of Energy efficient building. So that it can use maximum natural resources with minimum use of electricity hence saving the electricity and making the construction economic

**Table 1:** Input details for Residential Apartment Building for all cases

| | |
|---|---|
| Building configuration | G+19 (+ Shaped Structure) |
| Length of Apartment | 25m |
| Width of Apartment | 25m |
| Height of building | 78m |
| Height of Tower | 15m |
| Build up area of building | 625 sq. m. |
| Concrete and Steel Grade | M 30 & FE 415 |
| Weight of CDMA Antenna | 20 kg (0.2KN) |
| Weight of Microwave Antenna | 45 kg (0.45KN) |

**Table 2**: Data taken for analysis of structure

| Constraint | Assumed data for all buildings |
|---|---|
| Soil type | Medium Soil |
| Seismic zone | III (Jabalpur City) |
| 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 | 135 mm (0.135 m) |
| Shear wall and Outrigger thickness | 130 mm (0.130 m) |
| Tower horizontal and Vertical elements | ISA 130x130x10 |
| Tower bracing elements | ISA 100x100x10 |
| Tower steel standing plate | 25mm thick steel plate |
| Beam sizes | 0 to 25.50m – 0.55m x0.40m<br>25.50 to 50m – 0.50m x0.35m<br>50 to 75.50m – 0.45m x0.30m |
| Column sizes | 0 to 25.50m – 0.65m x0.60m<br>25.50 to 50m – 0.55m x0.50m<br>50 to 75.50m – 0.45m x0.40m |
| Material properties | M 30 Concrete<br>Fe 415 grade steel |

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**Result:-**

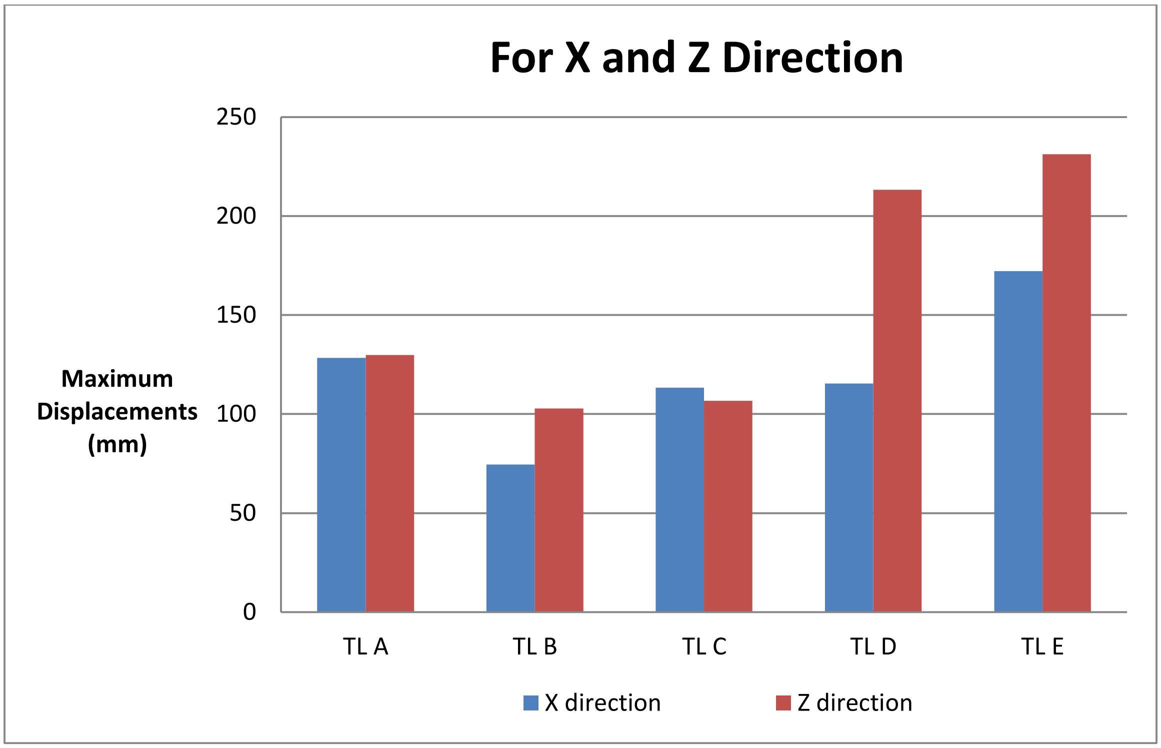


**Fig.1:**Comparative representation of Maximum Displacement in X and Z direction obtained in all Cases for Residential Apartment Building

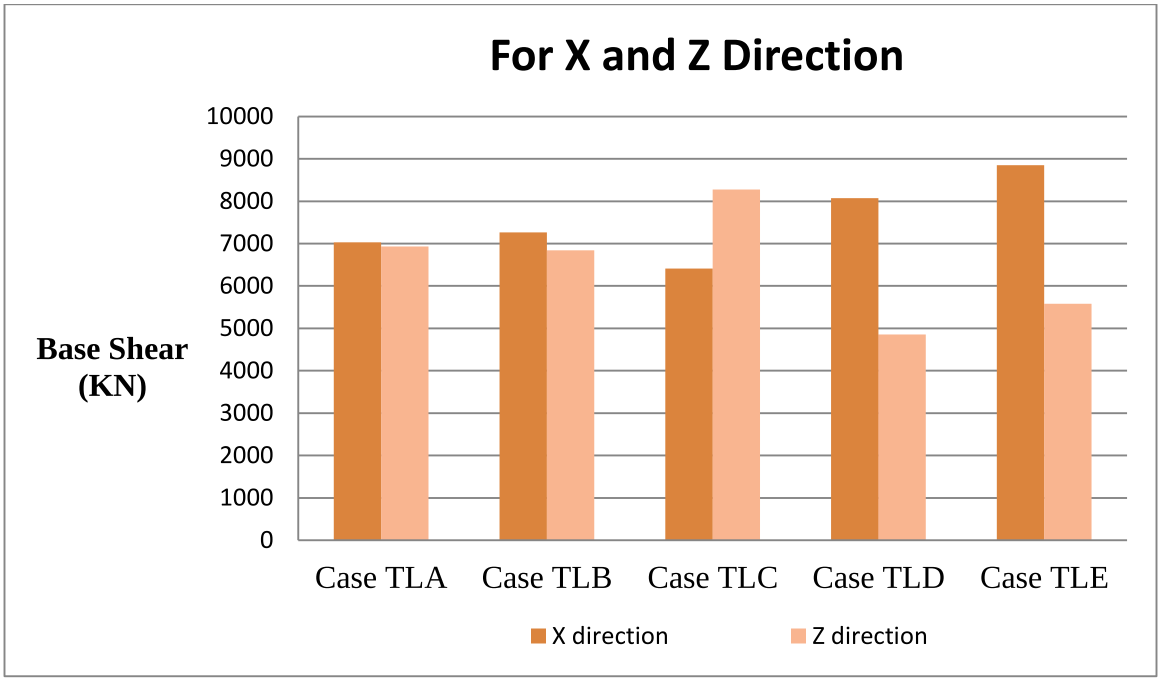


**Fig. 2:** Comparative representation of Base Shear in X and Z direction obtained in all Cases for Residential Apartment Building

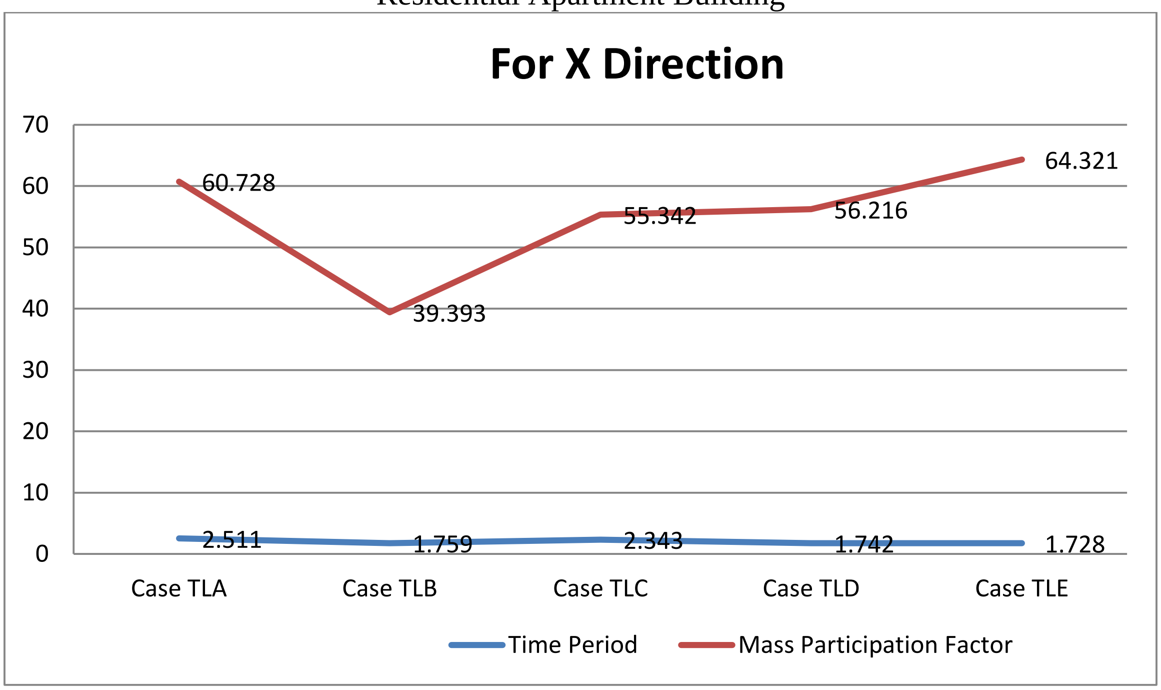


**Fig. 3:** Comparative representation of Time Period and Mass Participation Factor in X direction obtained in all Cases for Residential Apartment Building

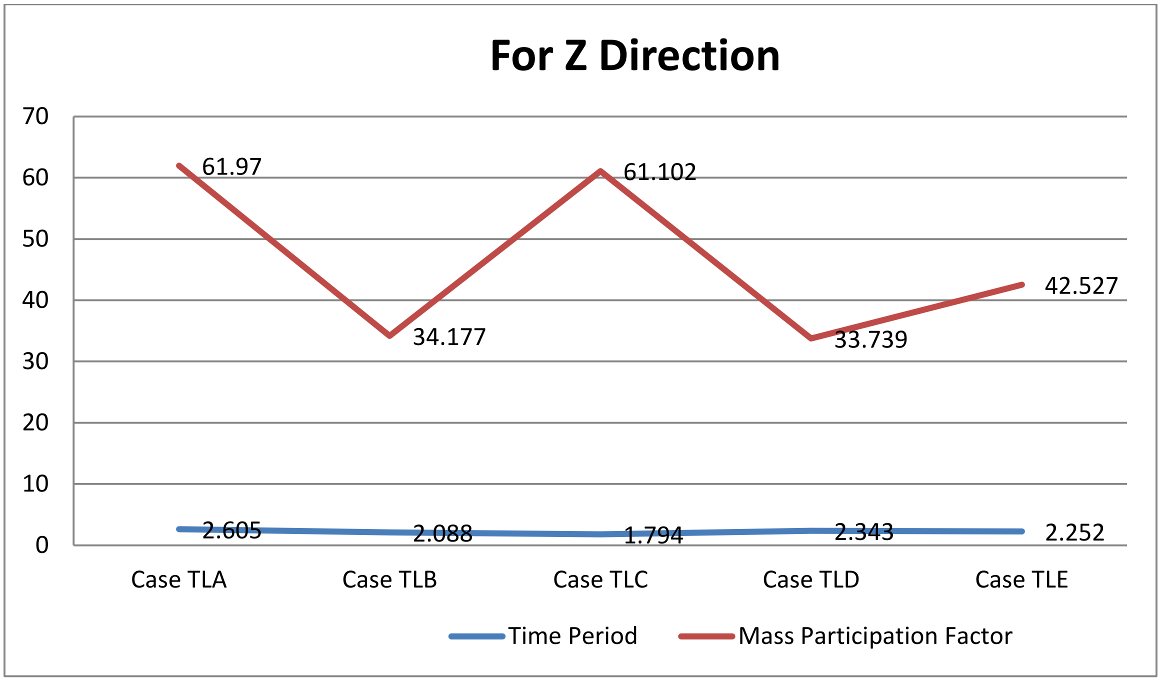


**Fig. 4:** Comparative representation of Time Period and Mass Participation Factor in Z direction obtained in all Cases for Residential Apartment Building

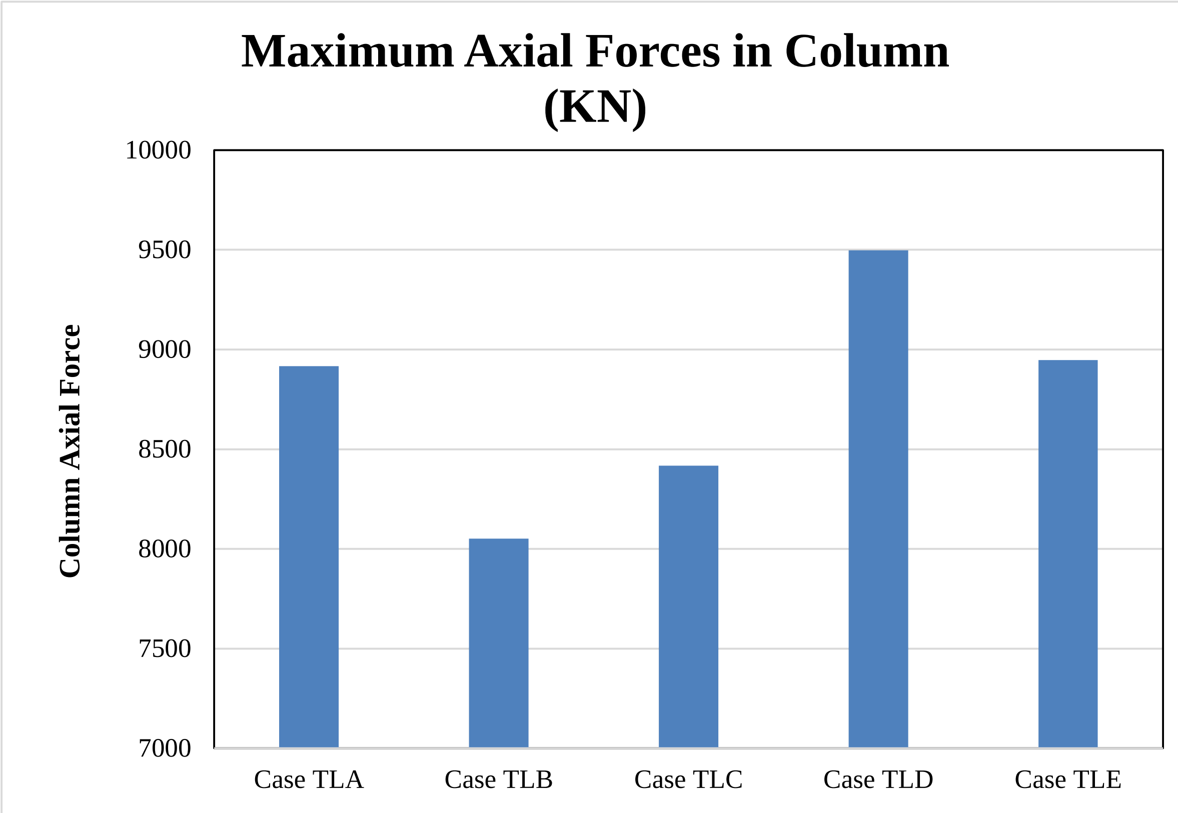


**Fig. 5:** Comparative representation of Maximum Axial Forces in Column obtained in all Cases for Residential Apartment Building

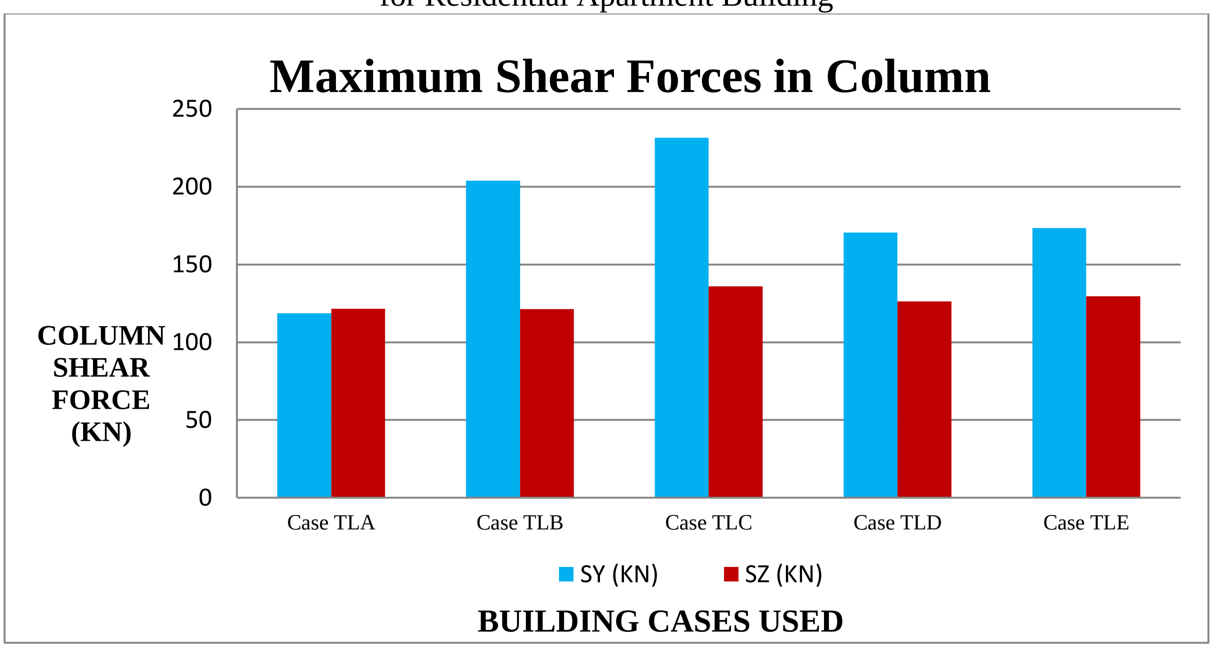


**Fig. 6:**Comparative representation of Maximum Shear Forces in Columns obtained in all Cases for Residential Apartment Building

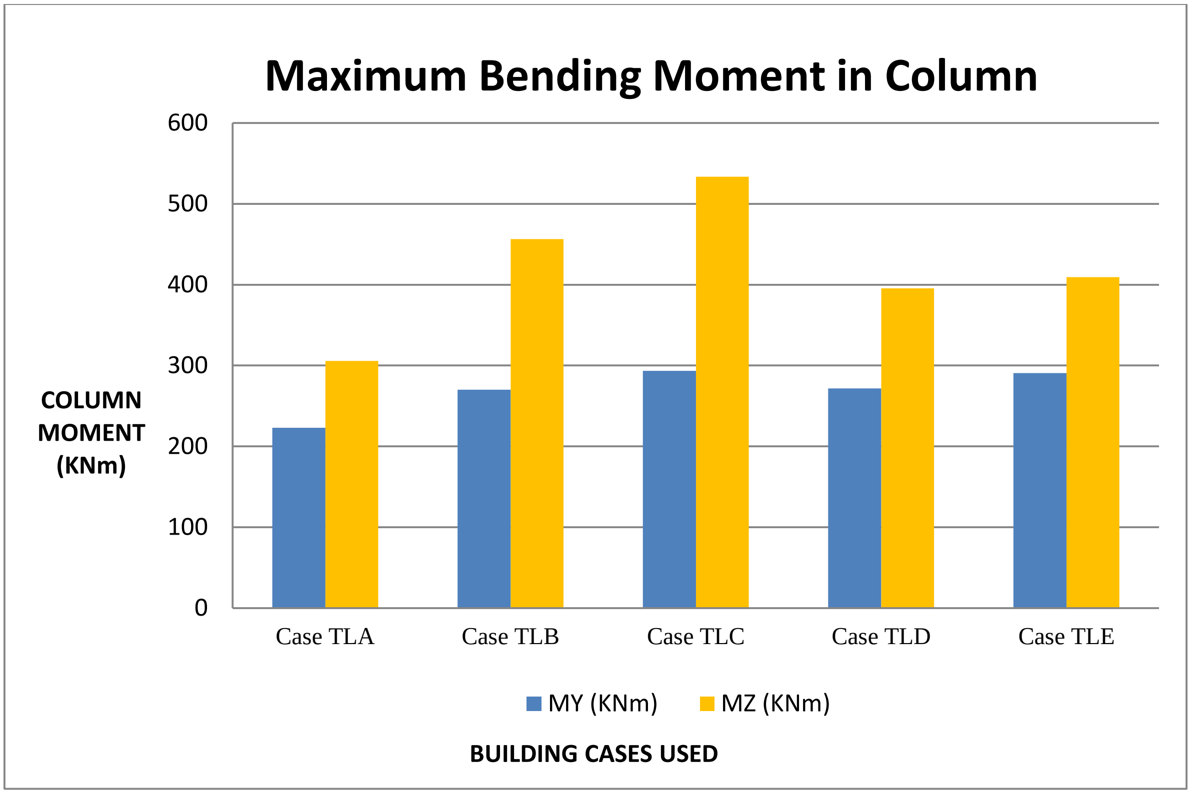


**Fig. 7:**Comparative representation of Maximum Bending Moment in Columns obtained in all Cases for Residential Apartment Building

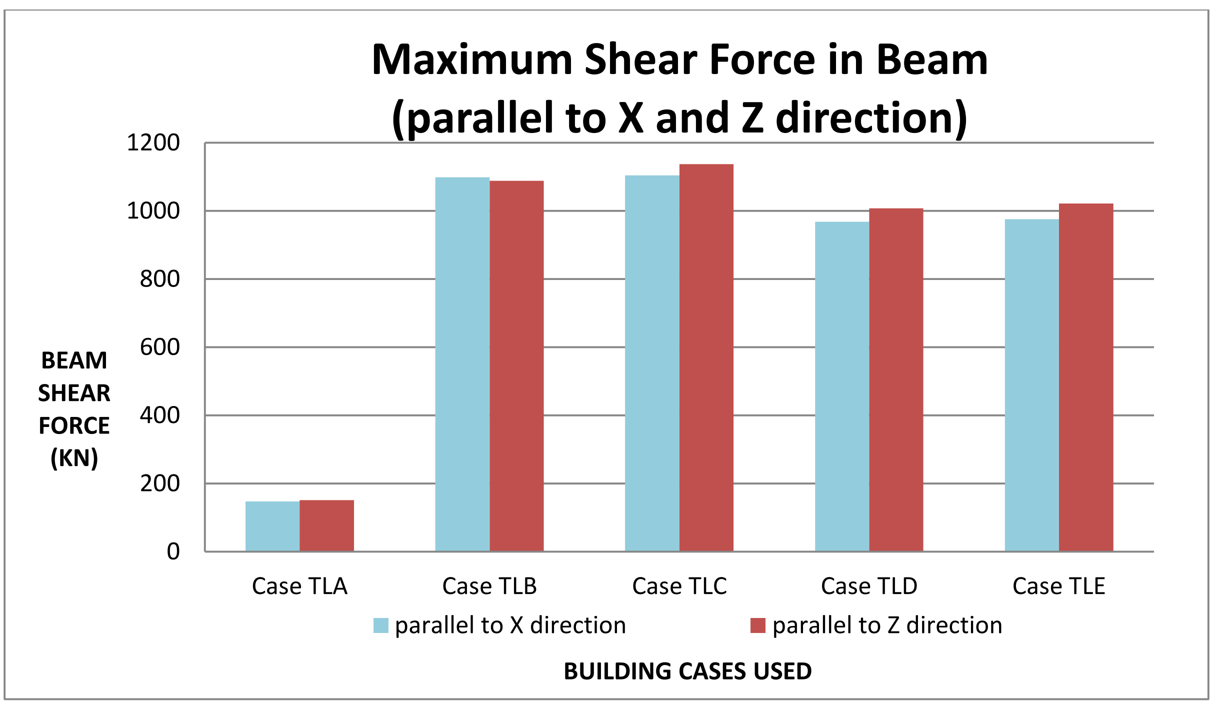

**Fig. 8:**Comparative representation of Maximum Shear Forces in Beams parallel to X and Z direction obtained in all Cases for Residential Apartment Building

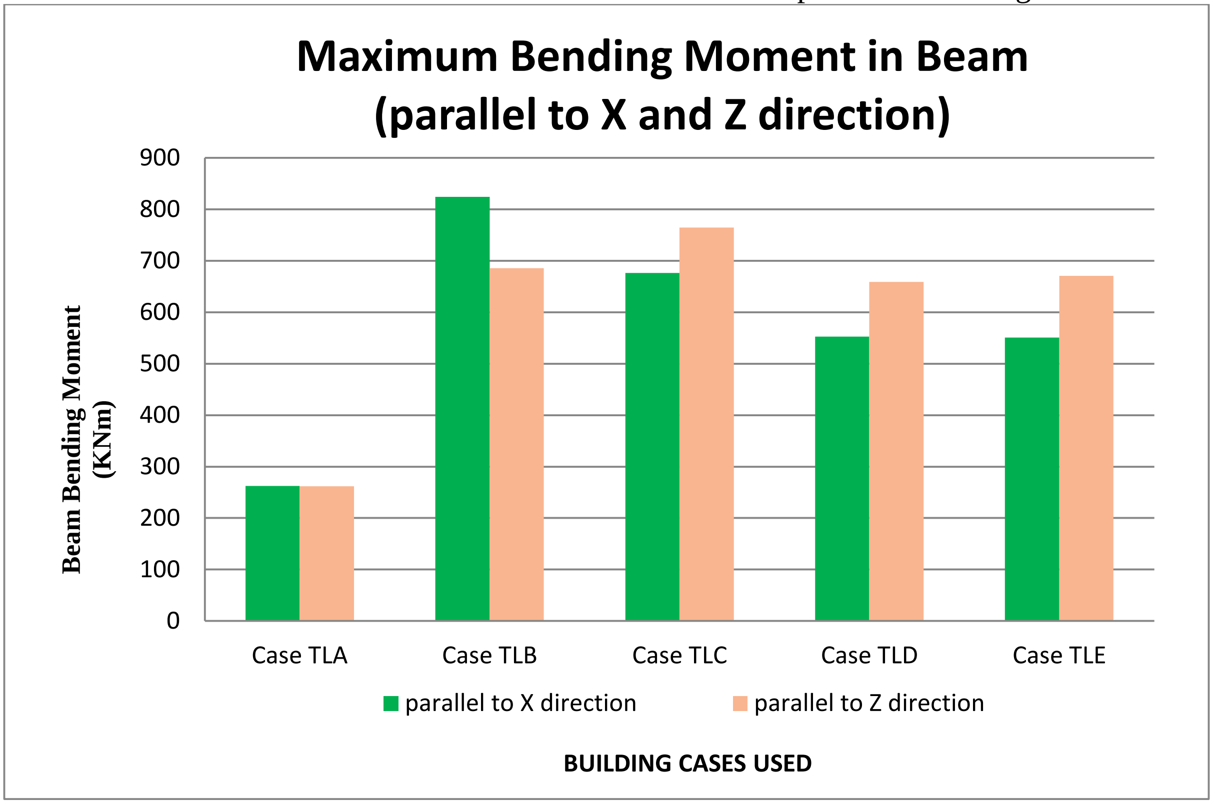


**Fig. 9:**Comparative representation of Maximum Bending Moment in beams parallel to X and Z direction obtained in all Cases for Residential Apartment Building

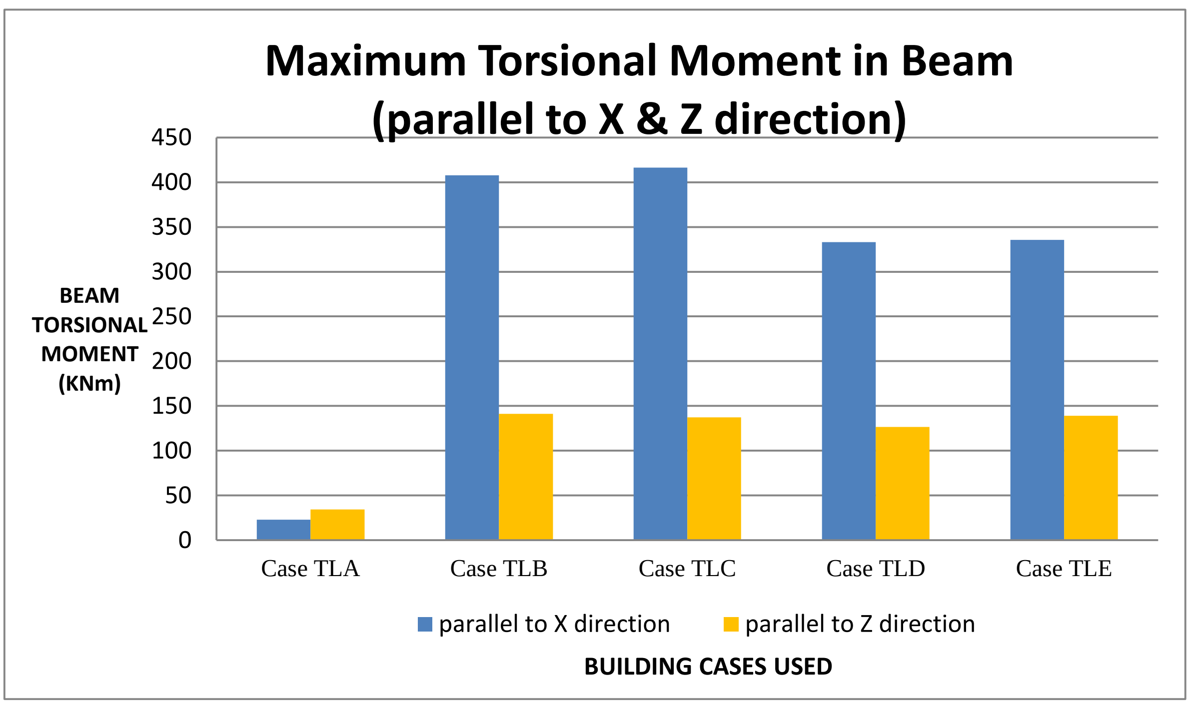

**Fig. 10:**Comparative representation of Maximum Torsional Moment in beams parallel to X &Z direction obtained in all Cases for Residential Apartment Building

## Discussion for Tower

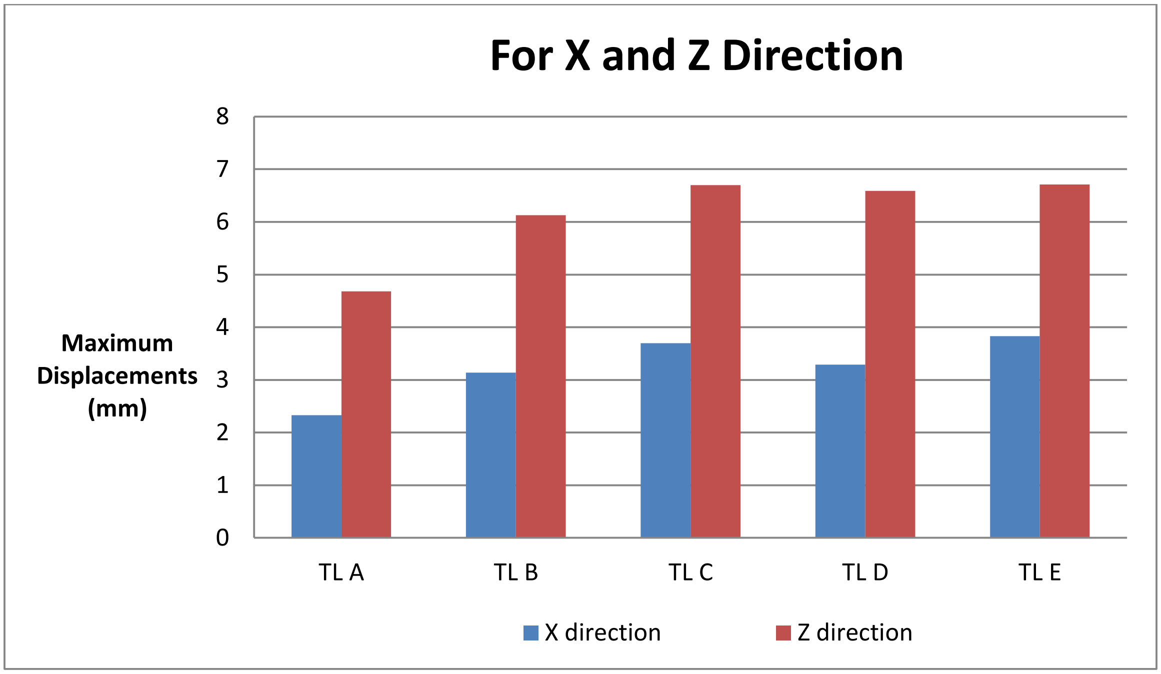


**Fig. 11** Comparative representation of Maximum Displacement in X and Z direction obtained in all Cases for Tower

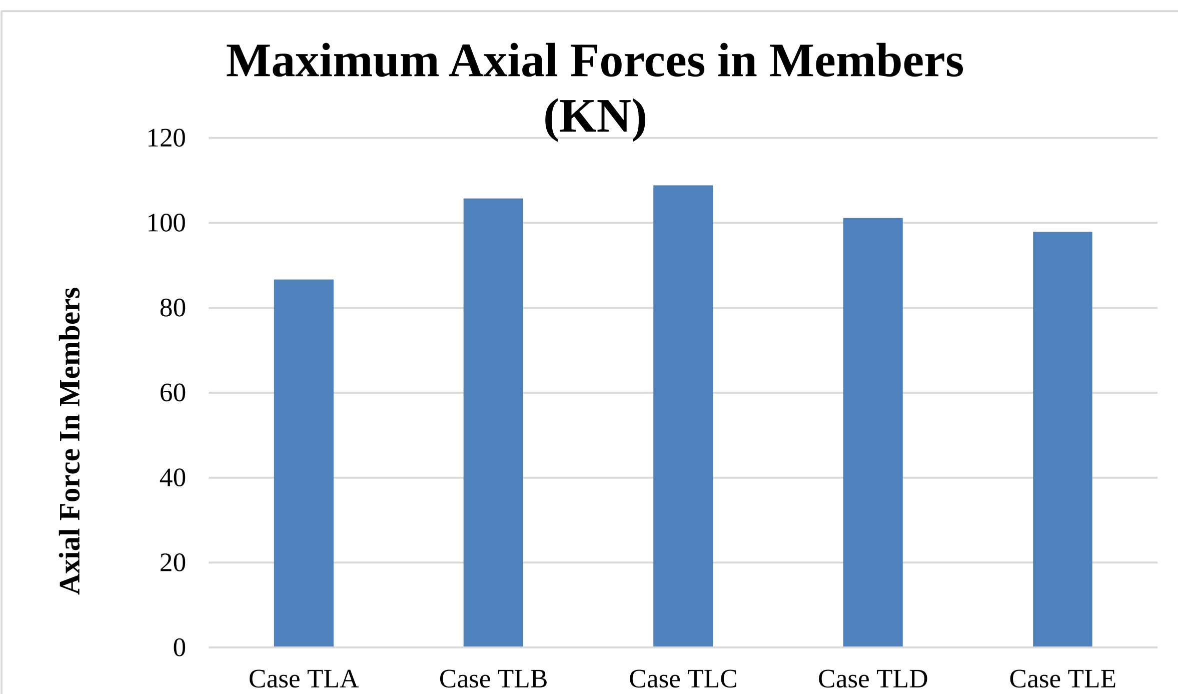

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**Fig. 12:** Comparative representation of Maximum Axial Forces in Members obtained in all Cases for Tower

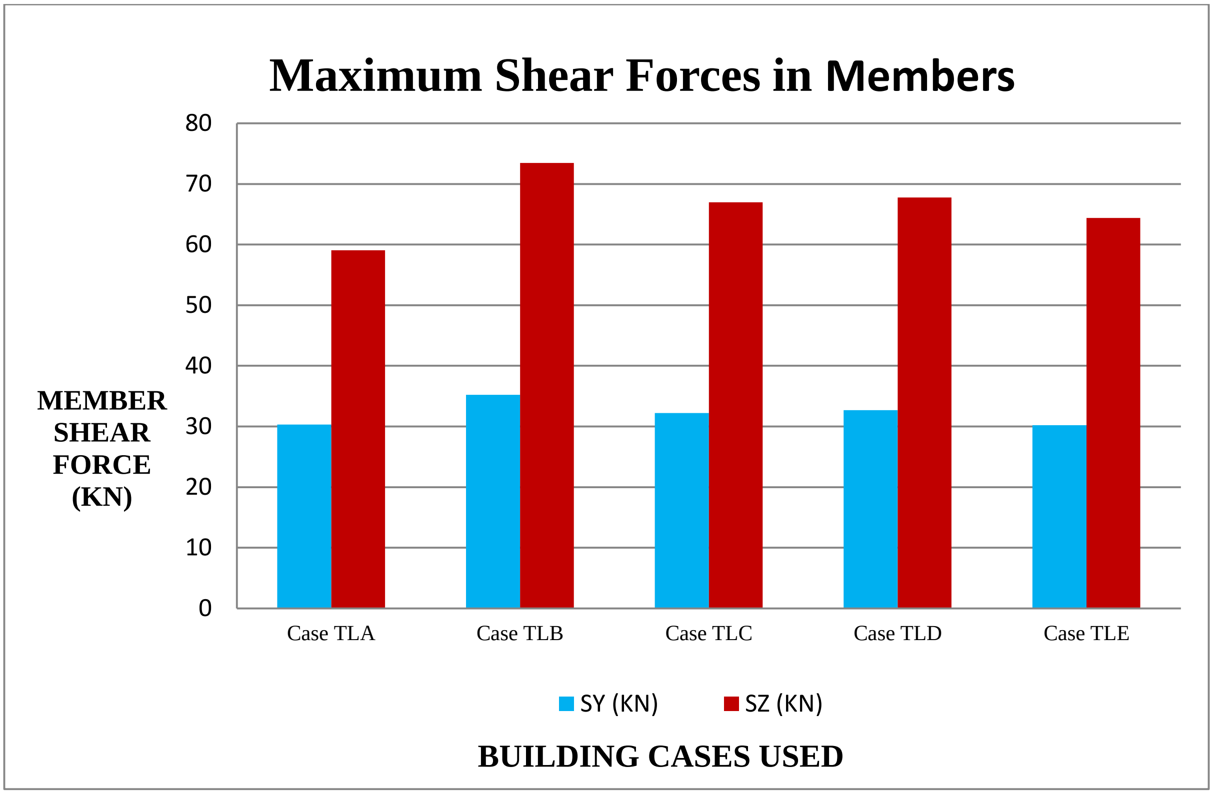


**Fig.13:** Comparative representation of Maximum Shear Forces in Members obtained in all Cases for Tower

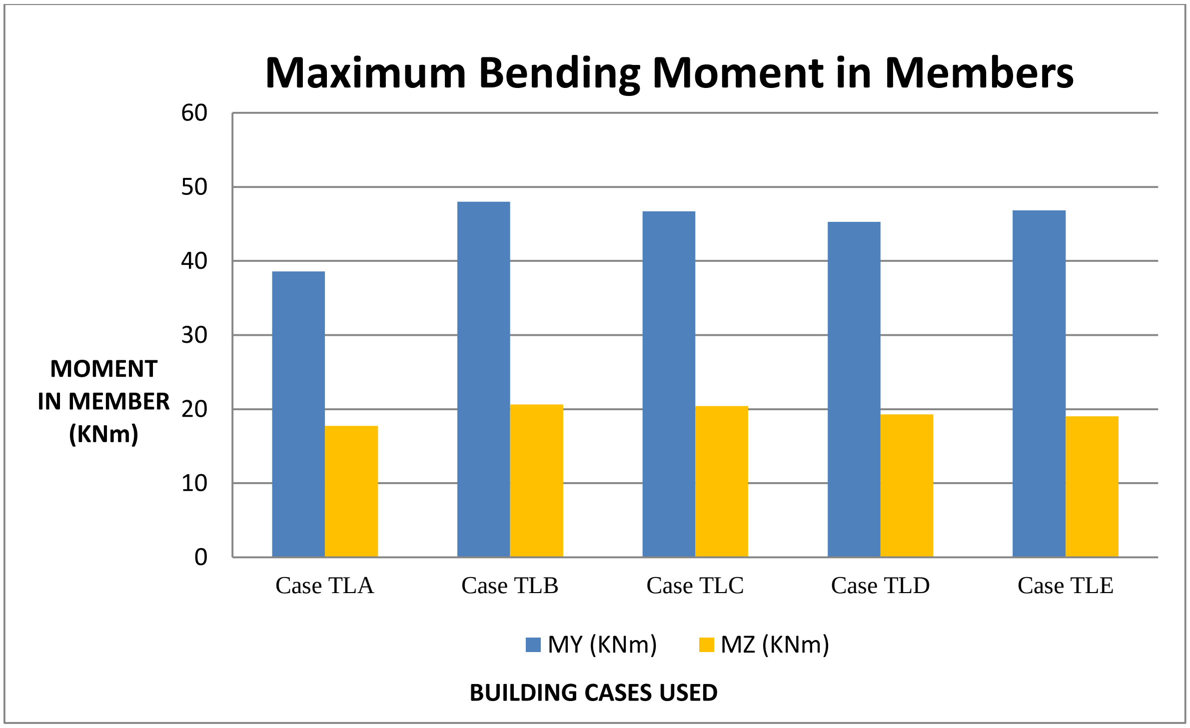

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**Fig. 14:** Comparative representation of Maximum Bending Moment in Member obtained in all Cases for Tower

**As per comparison of the numerous cases againstvarious parameters among each other, it has been pointed out that the optimum case evolved will be Case TLAin total 8 parameters and the worst case will be Case TLC 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:-**

## 4.6 Discussion on Worst Case and Erected Case

## For Residential Apartment Building

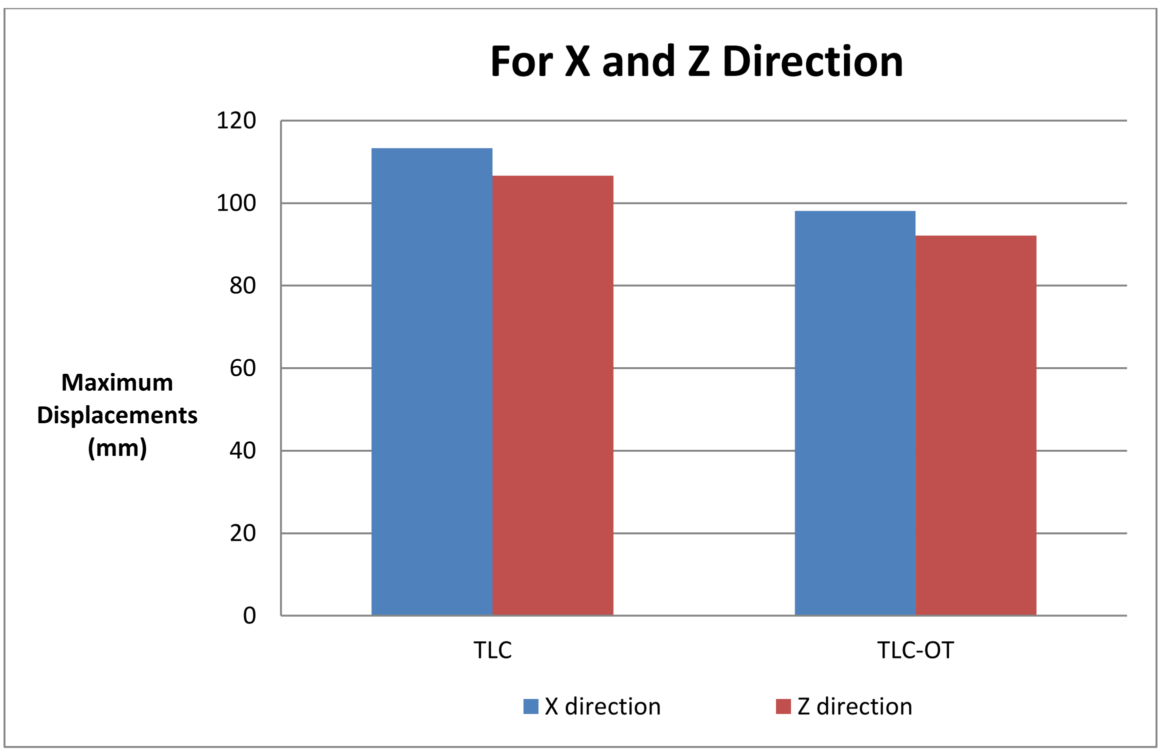


**Fig. 15:** Comparative representation of Maximum Displacement in X and Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

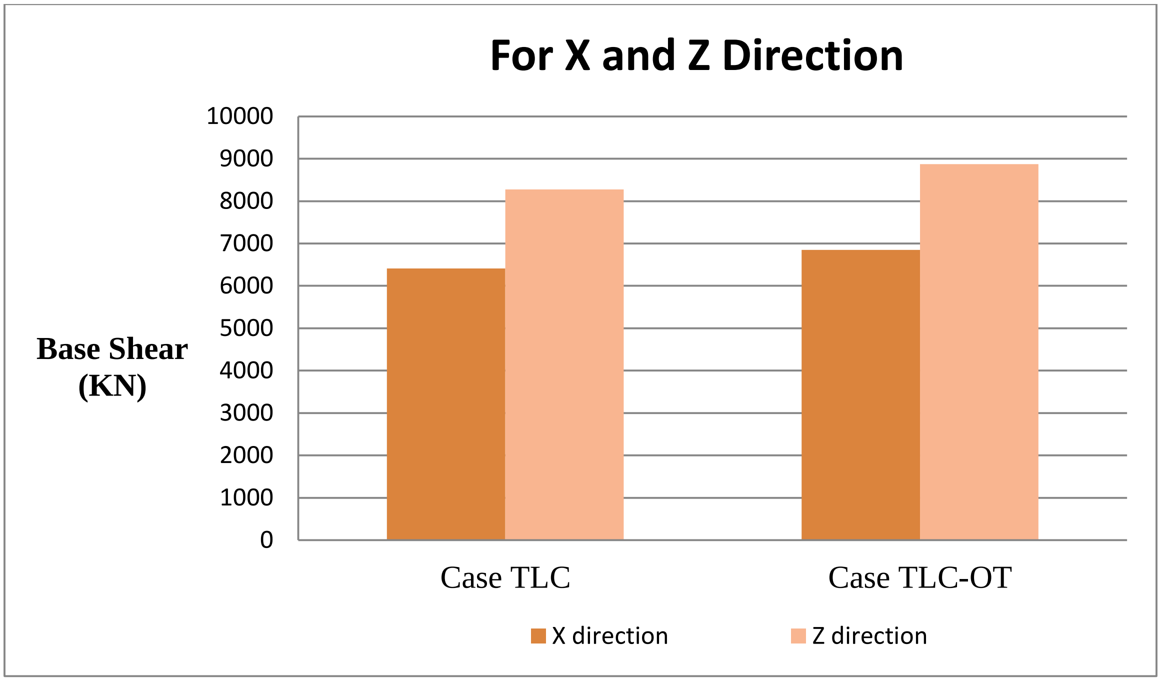


**Fig. 16:** Comparative representation of Base Shear in X and Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

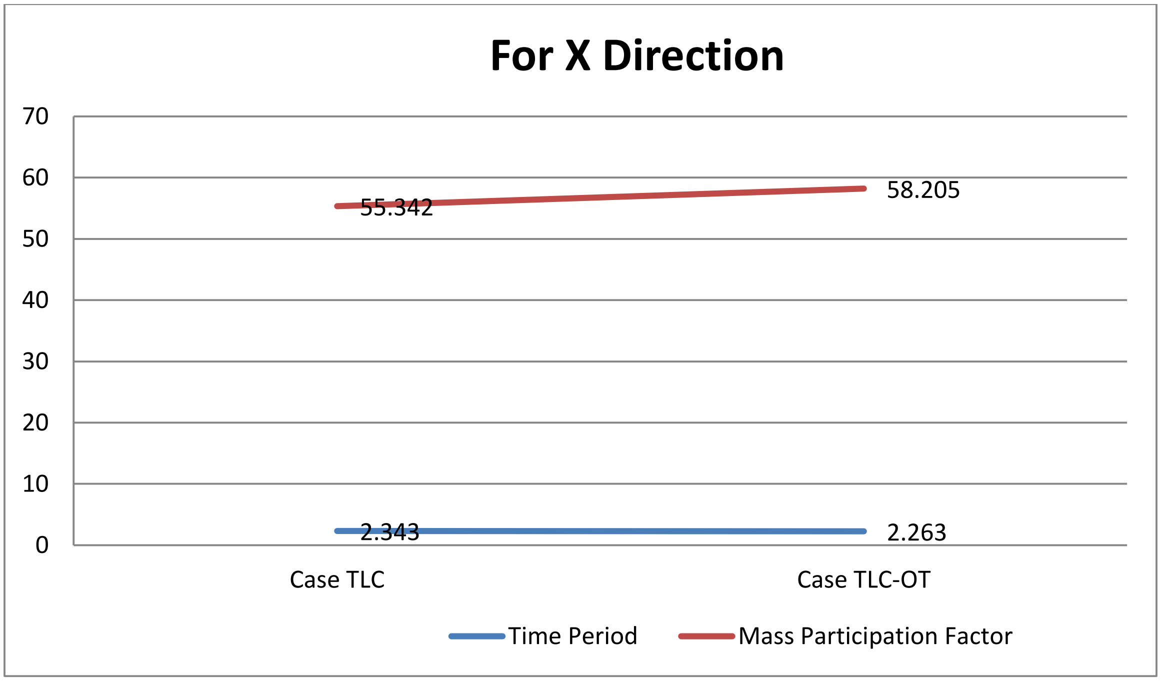


**Fig. 17:** Comparative representation of Time Period and Mass Participation Factor in X direction obtained in Worst Case and Erected Case for Residential Apartment Building

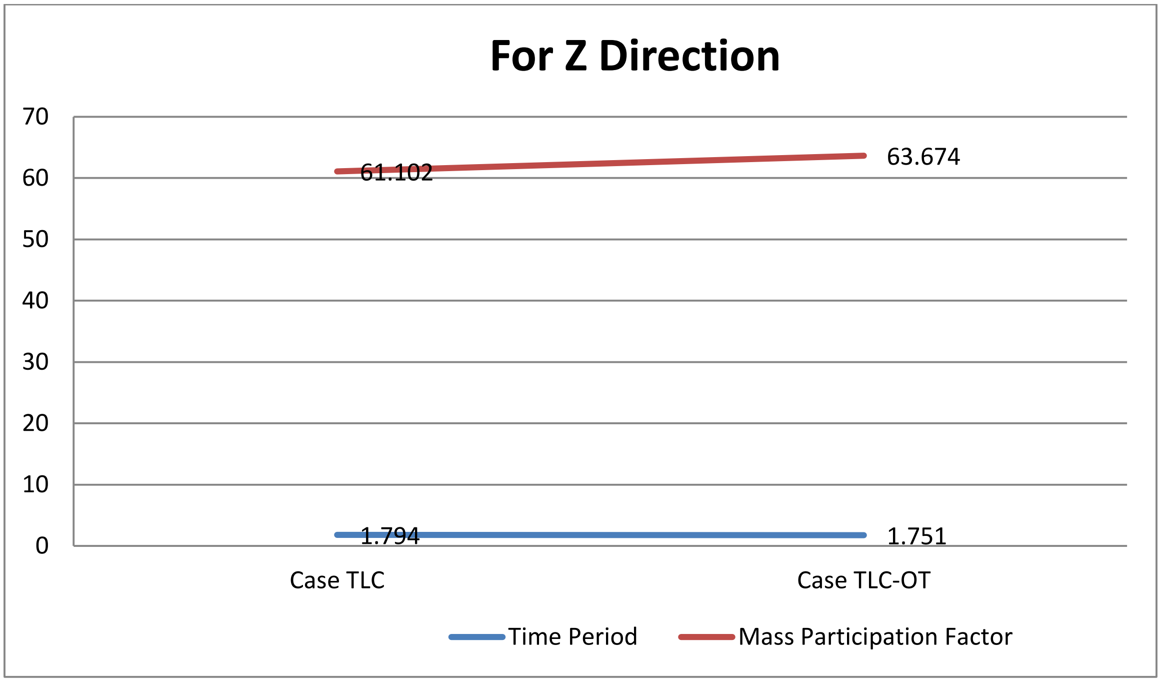


**Fig. 18:** Comparative representation of Time Period and Mass Participation Factor in Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

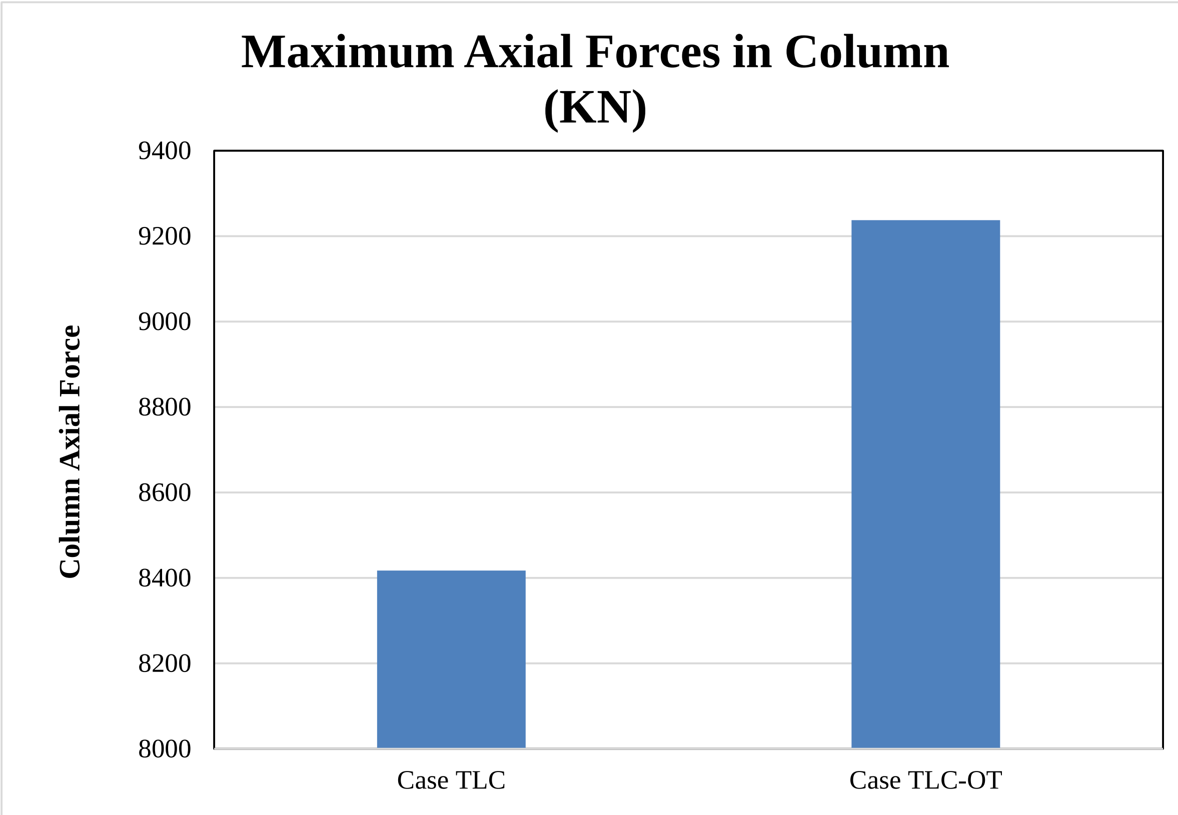


**Fig. 19:** Comparative representation of Maximum Axial Forces in Column obtained in Worst Case and Erected Case for Residential Apartment Building

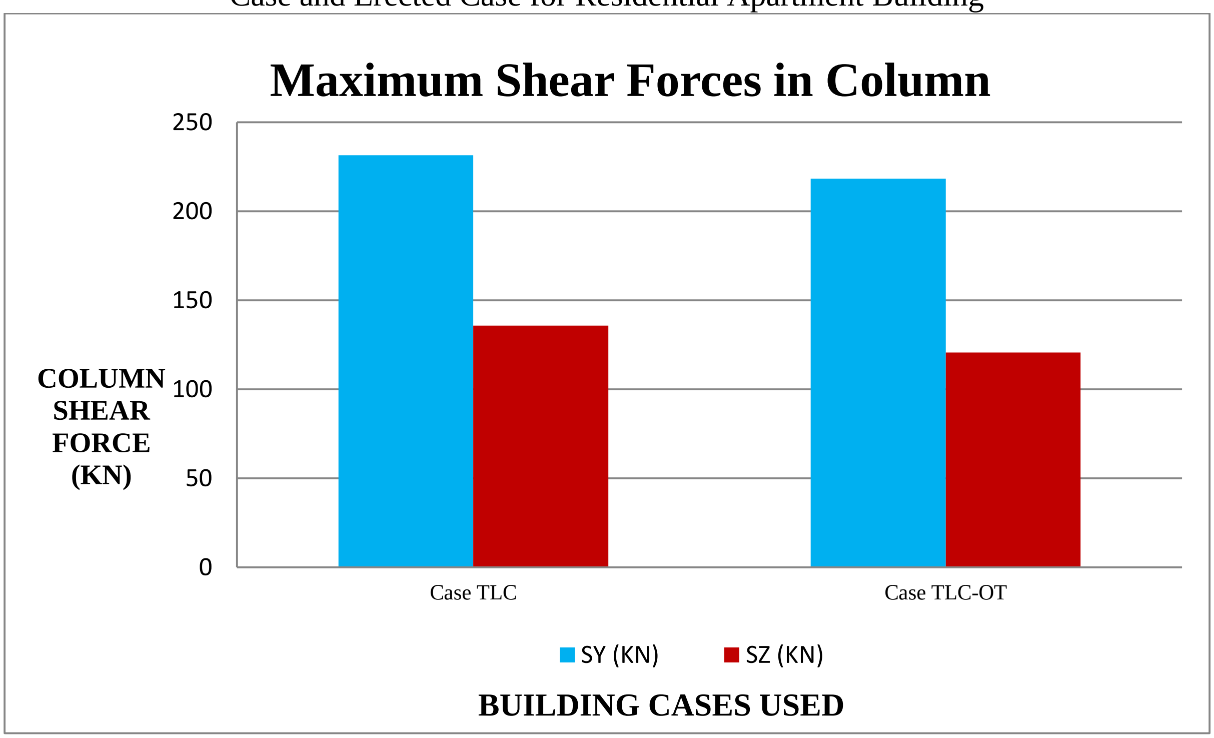

**Fig. 20:** Comparative representation of Maximum Shear Forces in Columns obtained in Worst Case and Erected Case for Residential Apartment Building

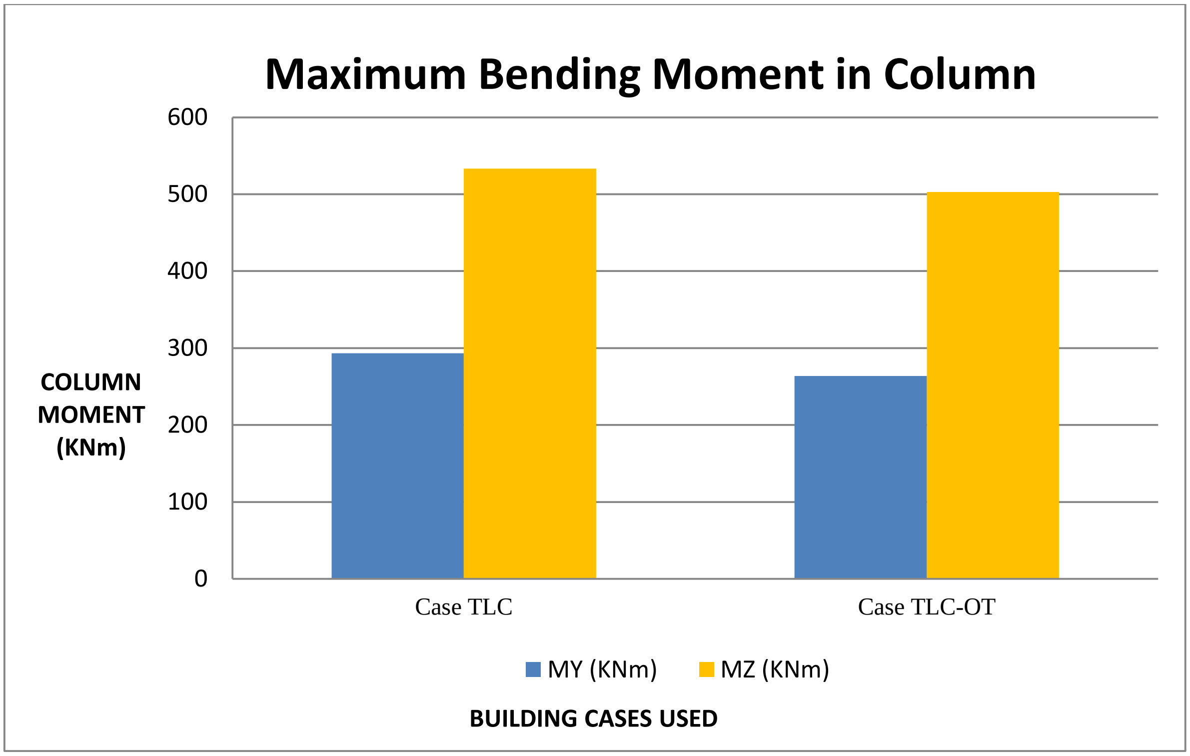


**Fig. 21:** Comparative representation of Maximum Bending Moment in Columns obtained in Worst Case and Erected Case for Residential Apartment Building

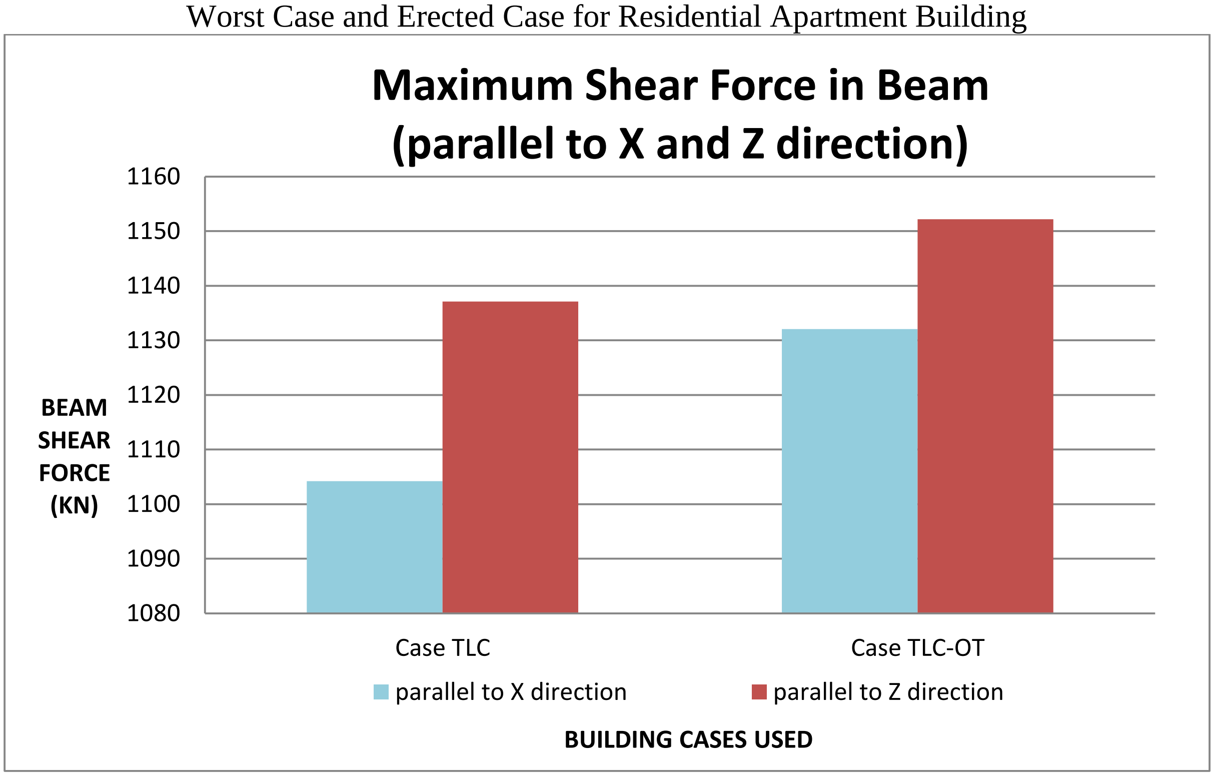

**Fig. 22:** Comparative representation of Maximum Shear Forces in Beams parallel to X and Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

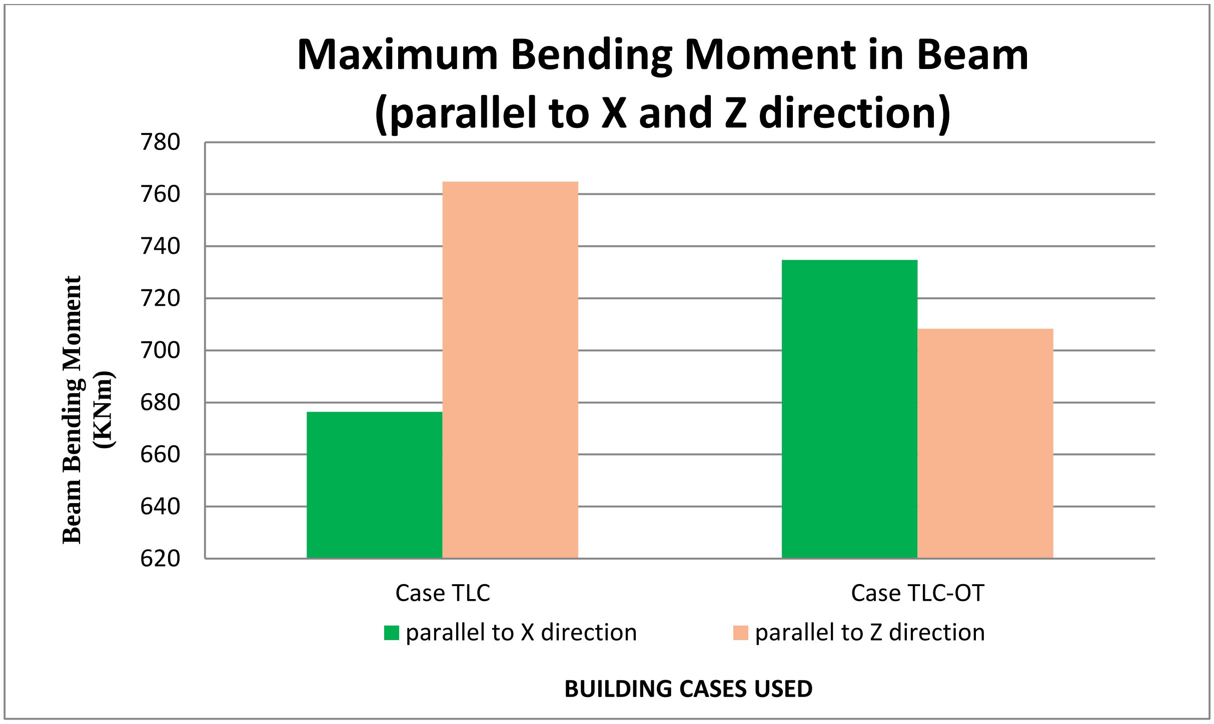


**Fig. 23:** Comparative representation of Maximum Bending Moment in beams parallel to X and Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

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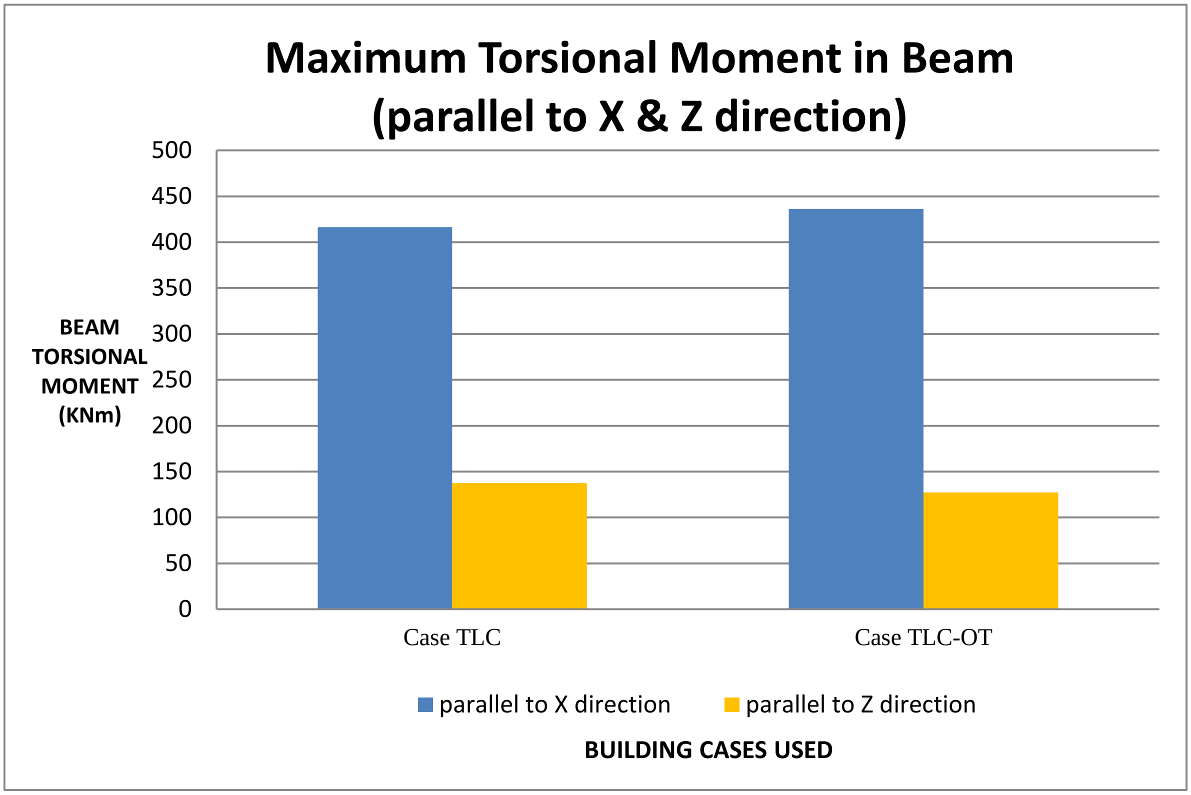


**Fig. 24:** Comparative representation of Maximum Torsional Moment in beams parallel to X & Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

### For Tower

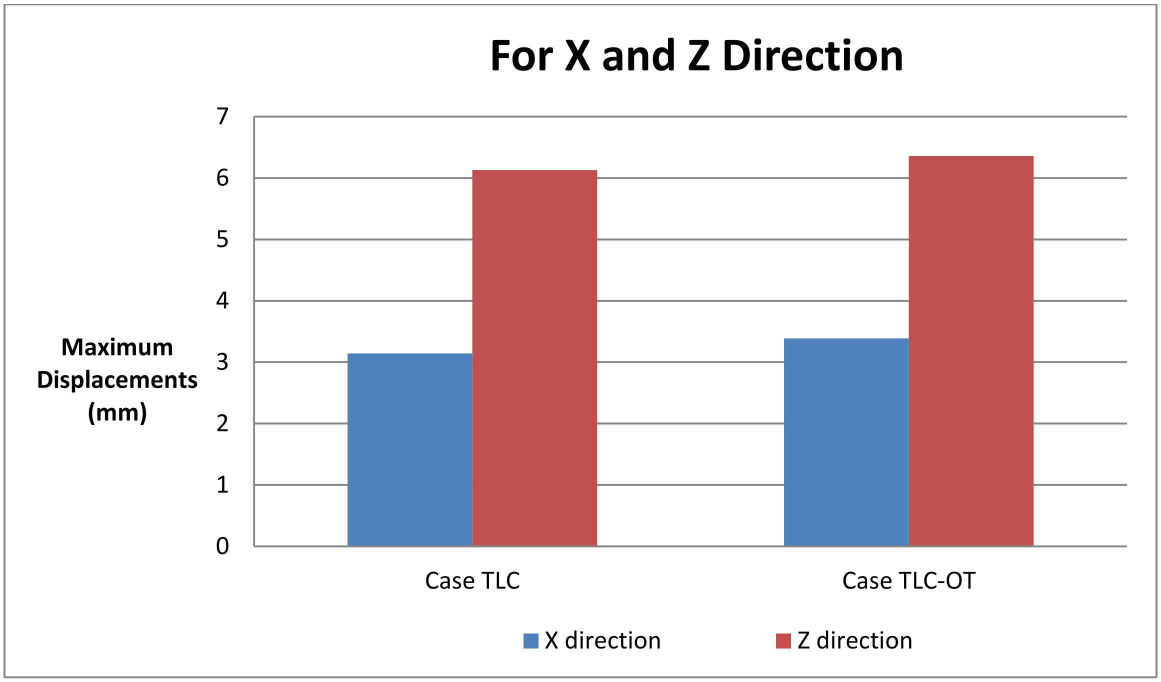


**Fig. 25:** Comparative representation of Maximum Displacement in X and Z direction obtained in Worst Case and Erected Case for Tower

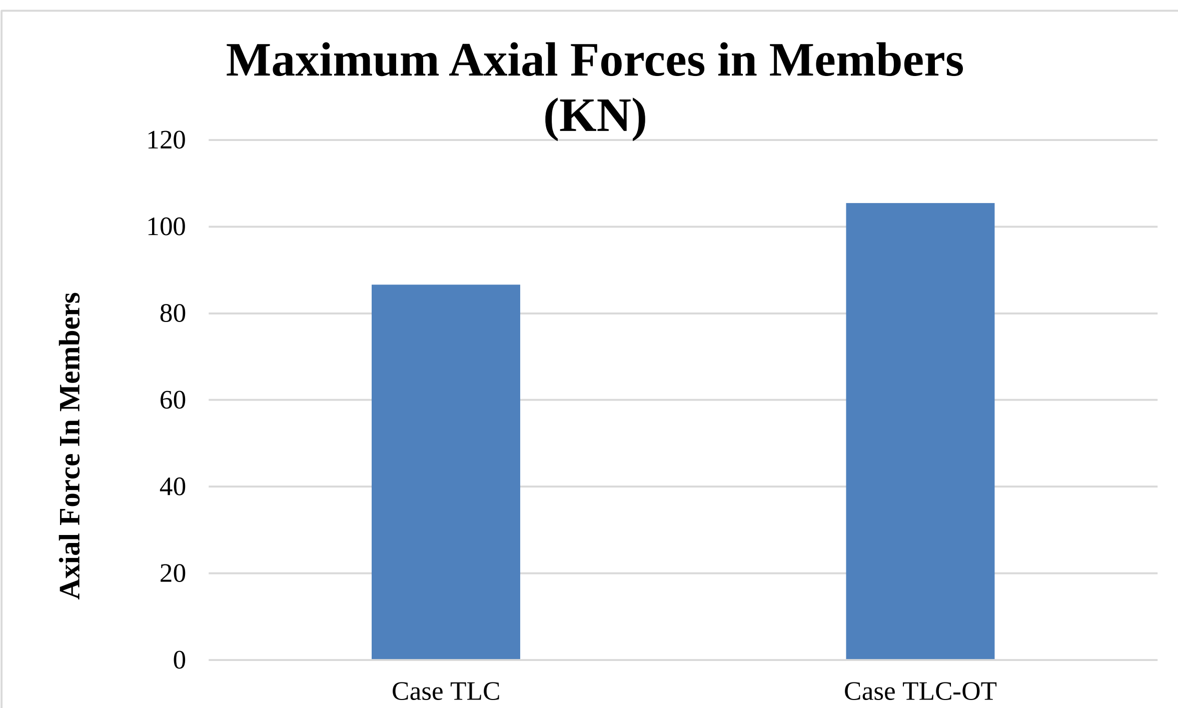

**Fig. 26:** Comparative representation of Maximum Axial Forces in Members obtained in Worst Case and Erected Case for Tower

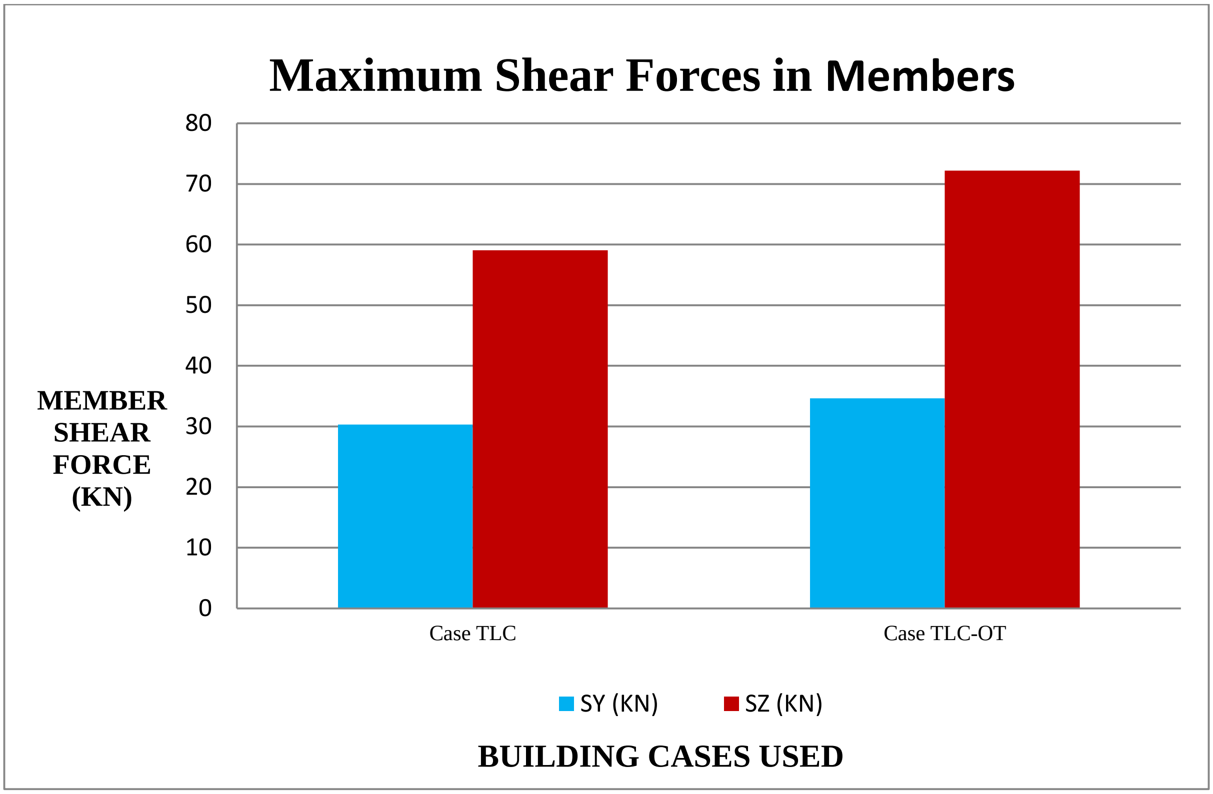


**Fig. 27:** Comparative representation of Maximum Shear Forces in Members obtained in Worst Case and Erected Case for Tower

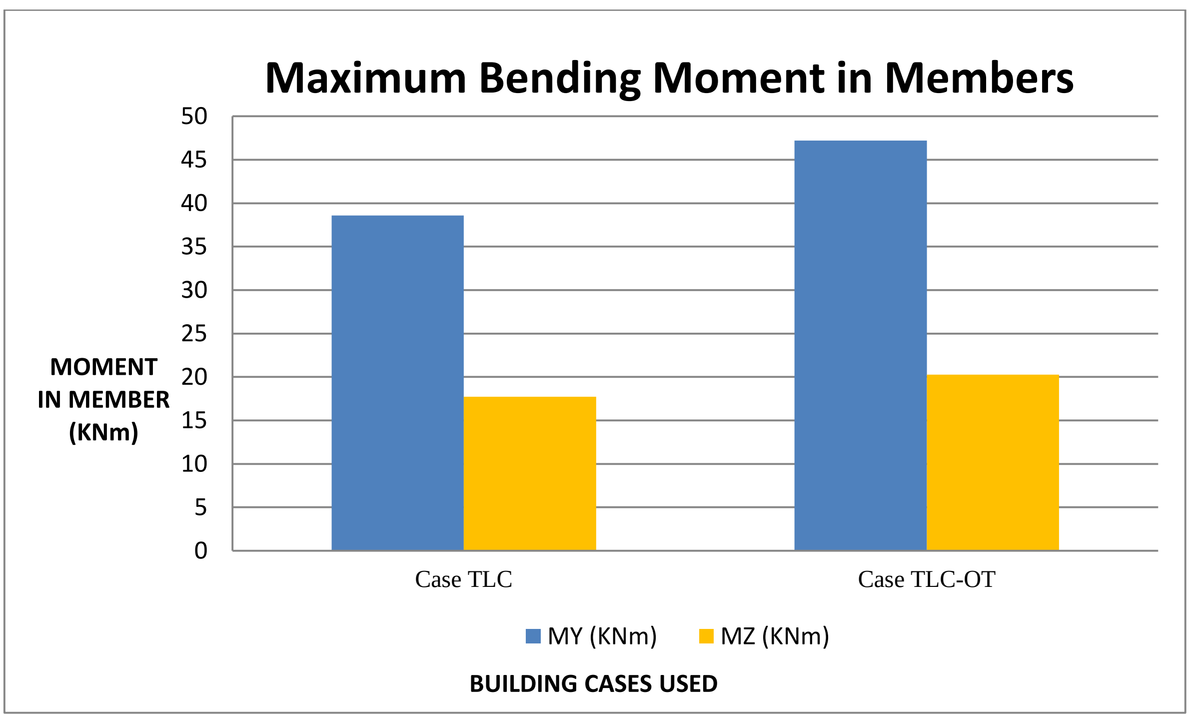

**Fig. 28:** Comparative representation of Maximum Bending Moment in Member obtained in Worst Case and Erected Case for Tower

**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.**

## Conclusion

The conclusion can be pointed out are as follows:-

1. Nodal displacement for Residential Apartment Building seems to be least in Model Case TLB for X and Z direction and for story drift, again Model P4 shows least values among all tower placing.
2. It is found that when determining the Base Shear for both X and Z direction, Base Shear values Decreases up to Case TLD and increases to TLC and TLE, average value should be taken into account and then compared.
3. On comparing the mass participation factor in both X and Z direction, the maximum mass with respect of time has taken into consideration. The optimum case obtained was Case TLB and the worst was TLE in X direction, TLB and TLD in obtained optimum and TLA and TLC were the worst respectively.
4. In Column Axial Forces, Case TLB suited best and Case TLD suited worst among all when compared amongst each other.
5. It is found similar trend observed in Case TLA obtained as efficient case and Case TLC obtained as worst in both Column Shear Force and Bending Moment parameter.
6. Again in Beam Shear Force, Beam Bending Moment and Torsion in Beam, the trend follows the same as Column Shear Force and Bending Moment.
7. Minimum values have been observed in Case TLA for Tower Displacement parameter.
8. The same case again obtained efficient for maximum axial force, for maximum shear force and maximum bending moment parameter and proves to be economical.

**Overall it is observed that the Case TLA is very efficient among all the cases. Also, we have enhanced the property of worst case TLC which is found by our result and discussion by implementing the outrigger system.**

**Hence best suitable location of tower by considering different result parameters seems to be tower at center of the building roof i.e. Case TLA in Residential Apartment building. Also we have tried to minimize the worst effects in some parameters by implementing the Outrigger walls at 0.446 H as per Taranath's approach.**

## REFERENCES

1. Tak, N., Pal, A. and Choudhary, M. (2020). Analysis of Building with Tower on Sloping Ground International Journal of Current Engineering and Technology, DOI: https://doi.org/10.14741/ijcet/v.10.2.10 E-ISSN 2277-4106, P-ISSN 2347-5161 pp 247-254.
2. Tak, N., Pal, A. and Choudhary, M. (2020). A Review on Analysis of Tower on Building with Sloping Ground. International Journal of Advanced Engineering Research and Science, 7(2), pp.84-87.
3. **Suyash Malviya, Sagar Jamle, (2019), "Response of Multistorey Building with Rooftop Telecommunication Tower in Different Positions: An Approach to Efficient Case", International Research Journal of Engineering and Technology, (ISSN: 2395-0072(P), 2395-0056(O)), vol. 6, no. 4, pp. 3783-3790**
4. Mohd. Arif Lahori, Sagar Jamle, (2018), "Investigation of Seismic Parameters of R.C. Building on Sloping Ground", International Journal of Advanced Engineering Research and Science, (ISSN: 2349-6495(P), 2456-1908(O)), vol. 5, no. 8, pp.285-290 AI Publications, https://dx.doi.org/10.22161/ijaers.5.8.35
5. Mohd. Arif Lahori, Sagar Jamle, (2018), "Investigation of Seismic Parameters of R.C. Building on Sloping Ground", International Journal of Advanced Engineering Research and Science, (ISSN: 2349-6495(P), 2456-1908(O)), vol. 5, no. 8, pp.285-290 AI Publications, doi: 10.22161/ijaers 5.8.35.
6. Shailesh S. Goral, Prof. S. M. Barelikar (2015), "Influence of Structure Characteristics on Earthquake Response Under Different Position of Rooftop Telecommunication Towers", International Journal of Engineering Sciences & Research Technology, ISSN 2277-9655, Vol. 4, Issue 10, pp. 73-78.
7. Hemal J shah Dr. Atul K Desai 2014 "Seismic analysis of tall tv tower cosidering different bracing systems" International Journal of Engineering, Business and Enterprise Application ISSN (Print): 2279-0020 ISSN (Online): 2279-0039s pp113-119.

8. GholamrezaSoltanzadeh, Hossein Shad, MohammadrezaVafaei, Azlan Adnan (2014), "Seismic Performance of 4-Legged Self-supporting Telecommunication Towers", International Journal of Applied Sciences and Engineering Research, ISSN 2277-9442, Vol. 3, Issue 2, pp. 319-332.
9. C. Preeti and K. Jagan Mohan (2013), "Analysis of Transmission Towers with Different Configurations", Jordan Journal of Civil Engineering, Vol. 7, Issue 4, pp. 450-460.
10. NitinBhosale, Prabhat Kumar, Pandey A. D. (2012), "Influence of Host Structure Characteristics on Response of Rooftop Telecommunication Towers", International Journal of Civil and Structural Engineering, ISSN 0976-4399, Vol. 2, Issue 3, pp. 737-748.
11. G. GhodratiAmiri, M A. Barkhordari, S.R. Massah and M.R. Vafaei (2007), "Earthquake Amplification Factors for Self-supporting 4-legged Telecommunication Towers", World Applied Sciences Journal, ISSN 1818-4952, Vol. 2, Issue 6, pp. 635-643.
12. Massah, S.R., Barkhordari, M.A. and GhodratiAmiri, G. (2007), Base Shear Amplification Factors for Self-Supporting 4-Legged Telecommunication Towers under Seismic Excitations, Proceedings of the 5th International Conference on Seismology and Earthquake Engineering, International Institute of Earthquake Engineering and Seismology, Tehran, Iran, May 14-16.
13. GhyslaineMcclure, Laura Georgi, RolaAssi (2004), "Seismic Considerations for Telecommunication Towers Mounted on Building Rooftops", 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada, Paper no. 1988, pp. 1-14.