iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** XII **Month of publication:** December 2020

DOI: https://doi.org/10.22214/ijraset.2020.32514

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue XII Dec 2020- Available at www.ijraset.com

Determination of Worst Location of Telecommunication Tower over Residential Apartment with Introduction of Outrigger and Wall Belt Supported System at Bikaner City under Seismic 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***

I. INTRODUCTION

When we are talking about human civilization, the major disaster was earthquake. This can harm lives, structures and property. There has been experimental work going on around the world to resolve this problem and provide a harmless environment so that one can easily live his life hassle free. Now a day's massive and huge structure designed with special techniques to withstand earthquake forces. This includes special buildings which have much higher cost of manufacture than its performance. But when we are thinking from safety point of view, there is not much greater than one's life.

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 analysed 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.

Another stiffness increasing element used in construction practices is shear wall, since it is generally provided in the periphery of the lift area. This arrangement is known as core type shear wall system. Shear wall not only provide the stiffness, but also increases the stability to the structure from overturning. Also lateral effects can also be reduced. As per Taranath's approach, shear wall can be used as a outrigger system to minimize the deflection parameter and also reduces the worst effects of lateral forces. This system can be implemented at 0.466 of the structural height. The shear wall outrigger in connection with shear core make the outrigger system.

II. PROCEDURE AND 3D MODELING OF THE STRUCTURE

Earthquake analysis is carried out on a G+19 Storey Residential Apartment by using software approach. The total 6 models are created on the software. Firstly, tower is placed at different placing over the top of the apartment. Then the efficient case and the worst case have been pointed out then the worst case parameters have been optimized using Outrigger system implication.

The analysis part consist of the effect on building under the different loads such as dead load, live load and lateral loads (earthquake and wind) etc. into it based on software mechanism. The seismic data is taken as per the IS 1893(PART1):2016. The response spectrum analysis method is adopted for analysis of building.

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Table 1: Model Description

Models	Description
Case TLA	Building Without Outrigger System with Tower at Location 1
Case TLB	Building Without Outrigger System with Tower at Location 2
Case TLC	Building Without Outrigger System with Tower at Location 3
Case TLD	Building Without Outrigger System with Tower at Location 4
Case TLE	Building Without Outrigger System with Tower at Location 5
Case TLC-OT	Building With Outrigger System with Tower at Location 3

Table 2: 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
Build up area of building	625 sq. m.
Concrete and Steel Grade	M 30 & FE 415
Earthquake parameters	Zone III with RF 4 & 5% damping ratio
Period in X & Z direction	1.404 sec. & 1.404 sec. for both direction
Dead load for floor finish	2.5 KN/sq. m.
Live load for floor and roof	3KN/ sq. m. & 1.2 KN/ sq. m.

III.RESEARCH OBJECTIVES

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

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.
D. 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:-

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.

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:-

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

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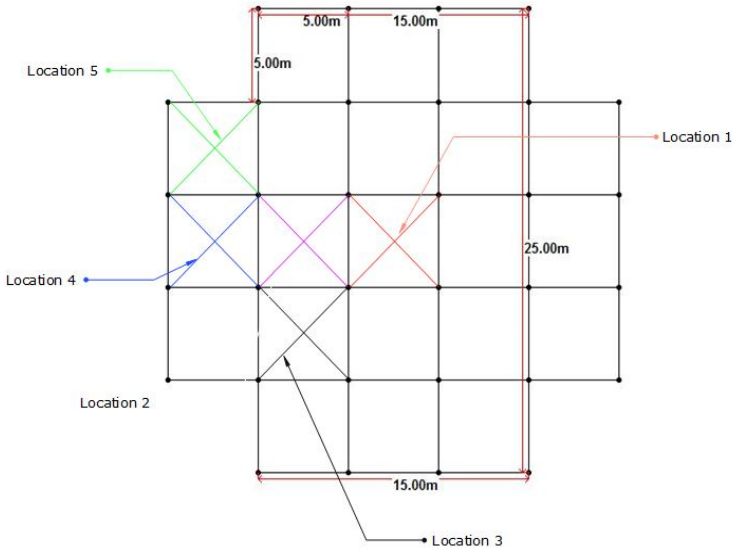

Fig. 1: Plan of Structure

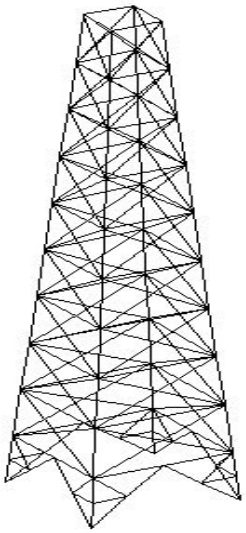

Fig. 2: 3D model of Tower

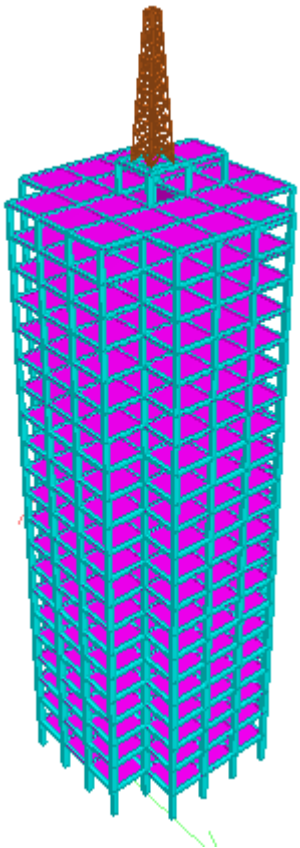

Fig. 3: Case TLA: - Building Without Outrigger System with Tower at Location 1

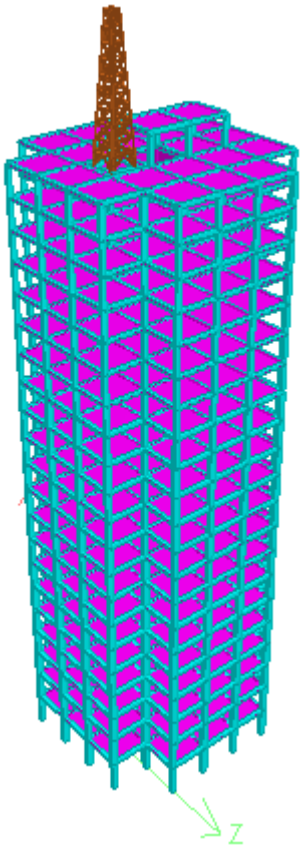

Fig. 4: Case TLB: - Building Without Outrigger System with Tower at Location 2

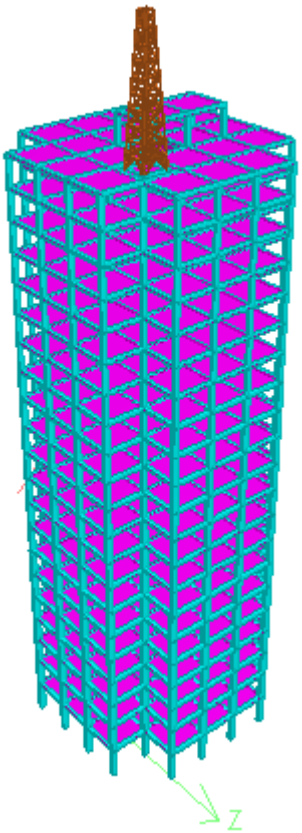

Fig. 5: Case TLC: - Building Without Outrigger System with Tower at Location 3

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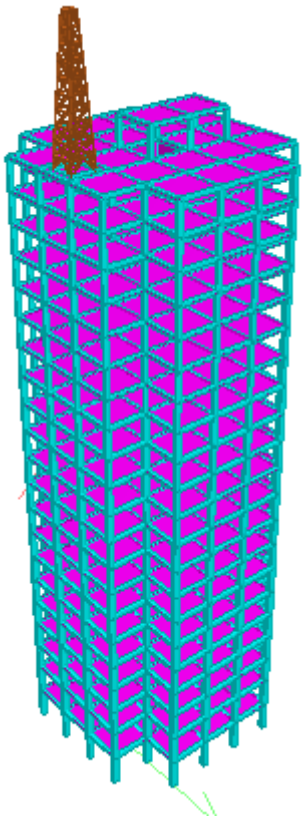

Fig. 6: Case TLD: - Building Without Outrigger System with Tower at Location 4

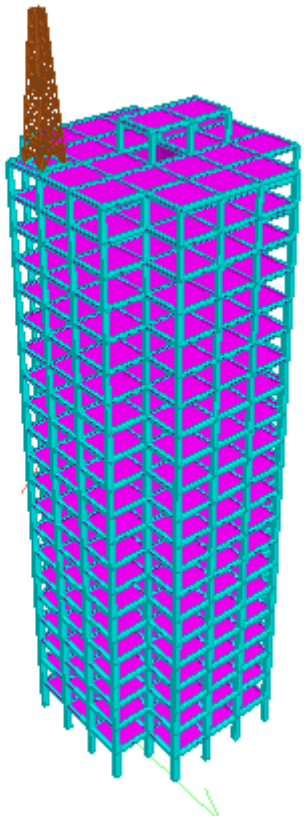

Fig. 7: Case TLE: - Building Without Outrigger System with Tower at Location 5

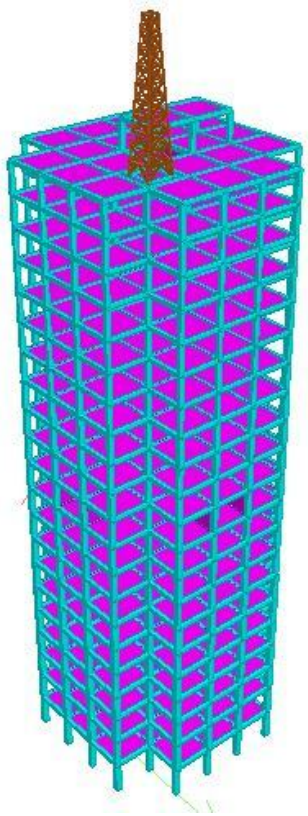

Fig. 8: Case TLC-OT: - Building with Outrigger System with Tower at Location 3

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:-

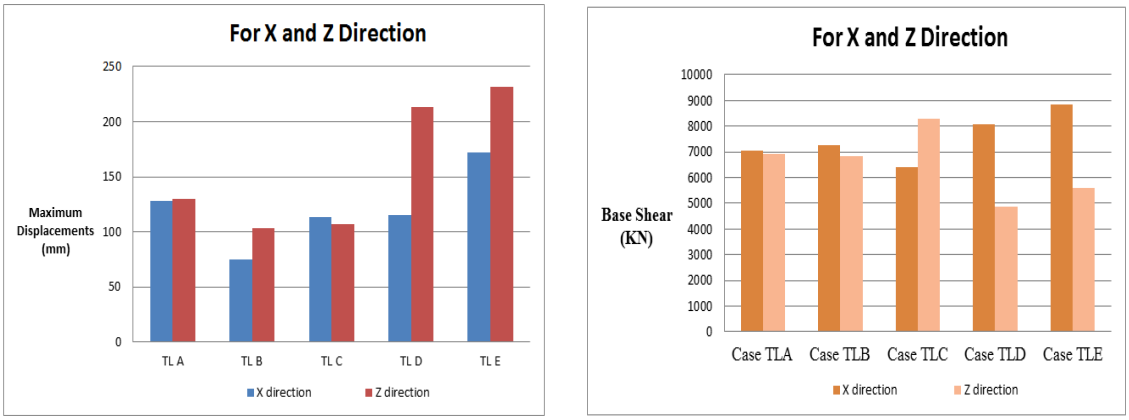

Fig. 9: Comparative representation of Maximum Displacement and Base Shear in X and Z direction obtained in all Cases for Residential Apartment Building

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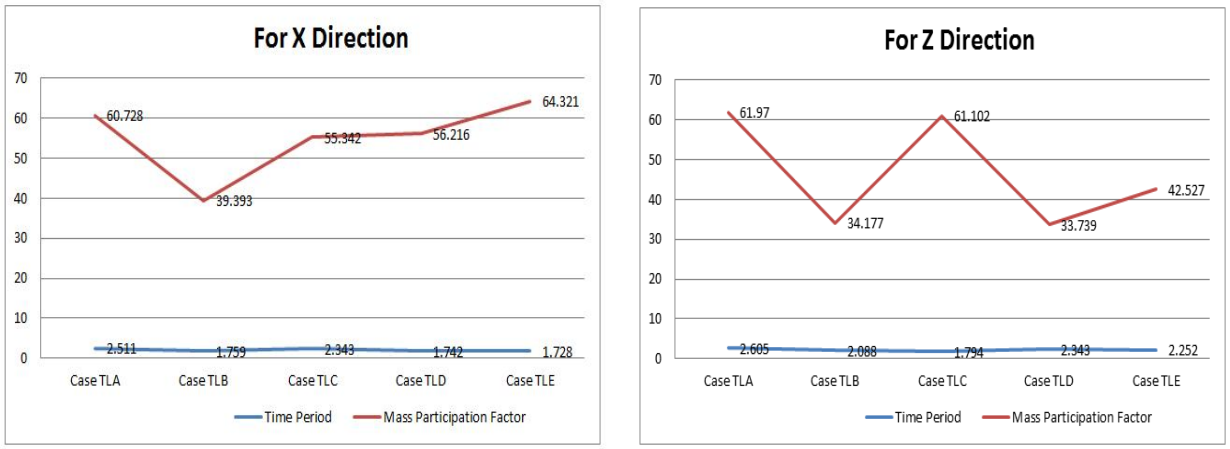

Fig. 10: Comparative representation of Time Period and Mass Participation Factor in X and Z direction obtained in all Cases for Residential Apartment Building

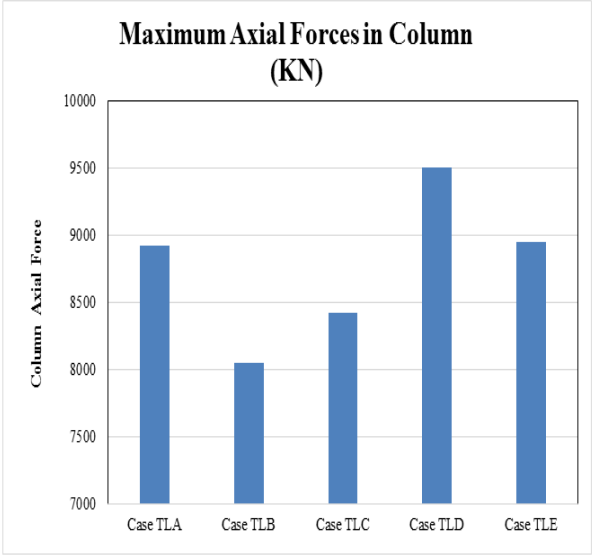

Fig. 11: Comparative representation of Maximum Axial Forces in Column obtained in all Cases for Residential Apartment Building

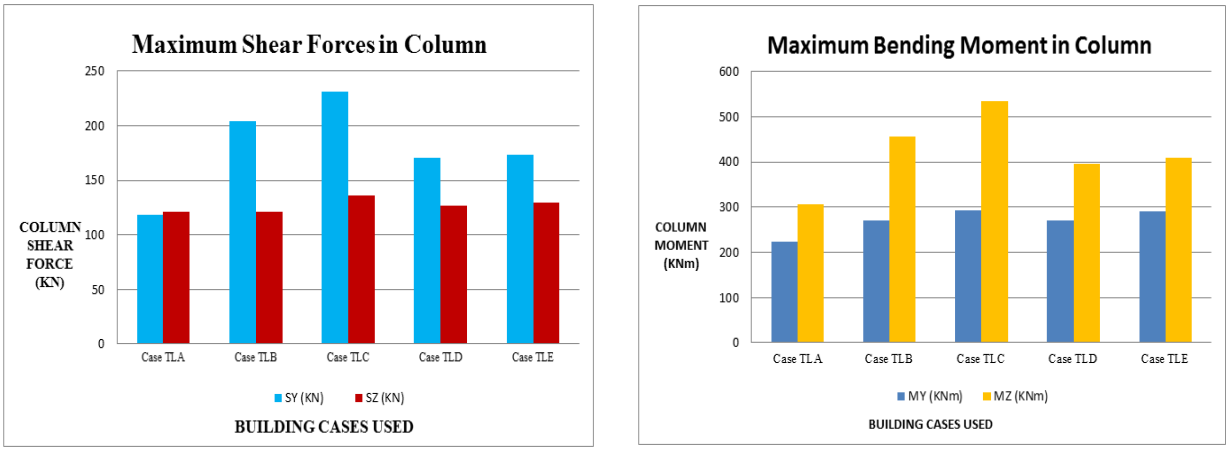

Fig. 12: Comparative representation of Maximum Shear Forces and Bending Moments in Columns obtained in all Cases for Residential Apartment Building

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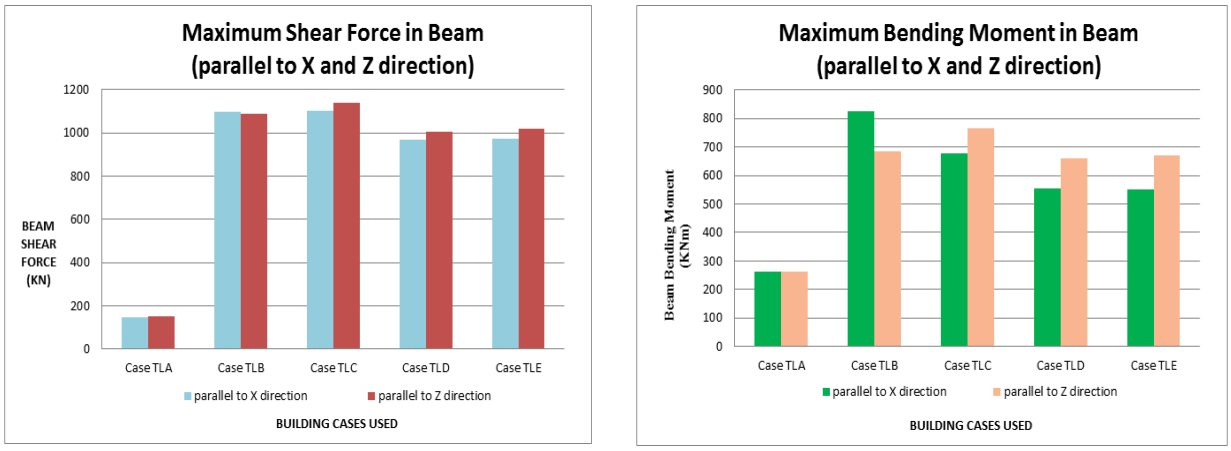

Fig. 13: Comparative representation of Maximum Shear Forces and Bending Moments in Beams parallel to X and Z direction obtained in all Cases for Residential Apartment Building

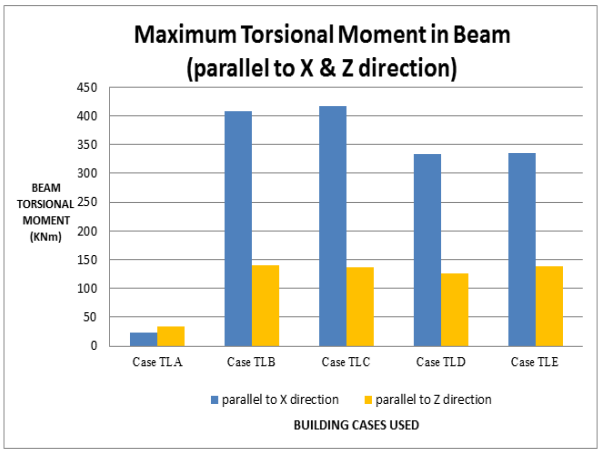

Fig. 14: Comparative representation of Maximum Torsional Moment in beams parallel to X & Z direction obtained in all Cases for Residential Apartment Building

Discussion for Tower

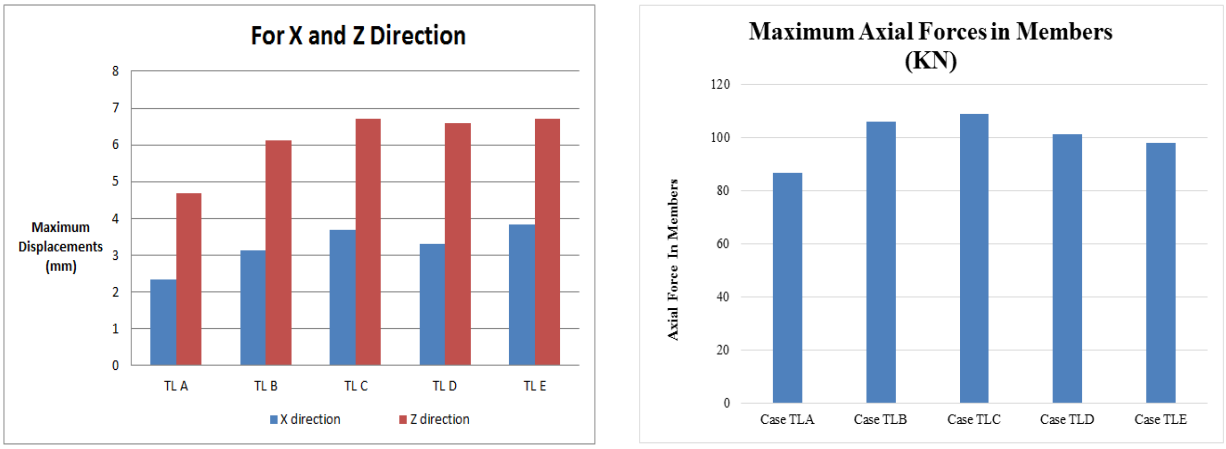

Fig. 15: Comparative representation of Maximum Displacement and Axial Forces in X and Z direction obtained in all Cases for Tower

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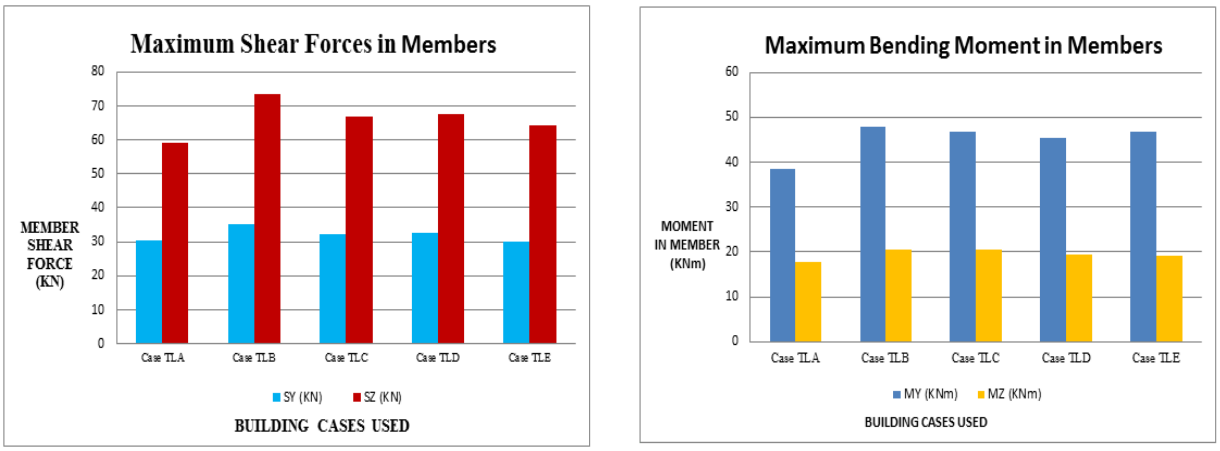

Fig. 16: Comparative representation of Maximum Shear Forces and Bending Moments in Members obtained in all Cases for Tower

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 TLA in 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:-

A. Discussion on Worst Case and Erected Case

1) For Residential Apartment Building

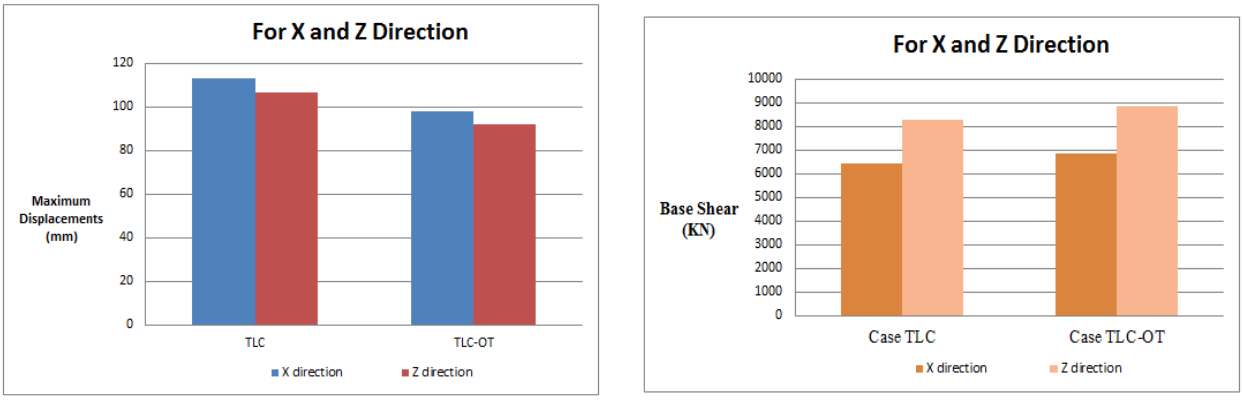

Fig. 17: Comparative representation of Maximum Displacement and Base Shear in X and Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

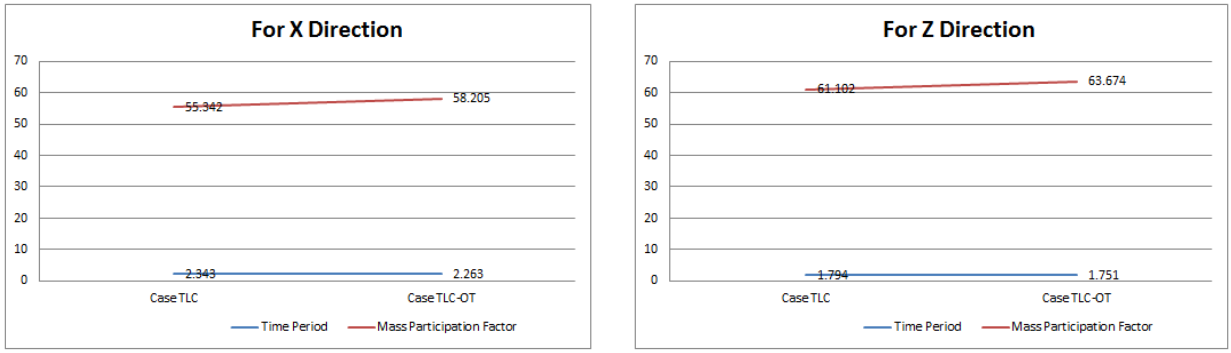

Fig. 18: Comparative representation of Time Period and Mass Participation Factor in X and Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

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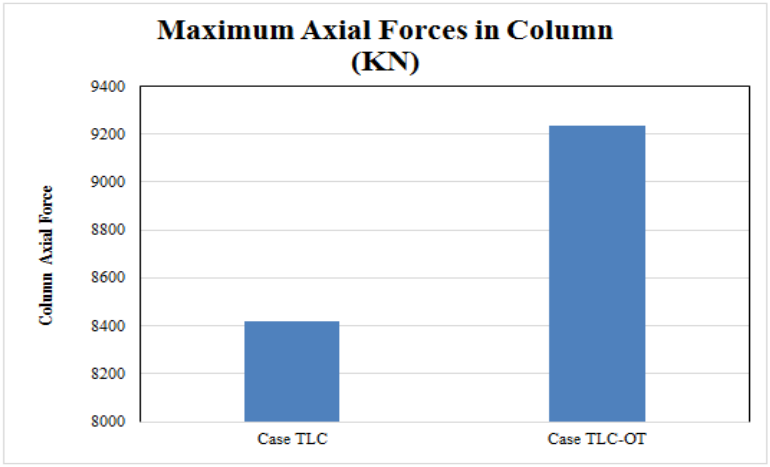
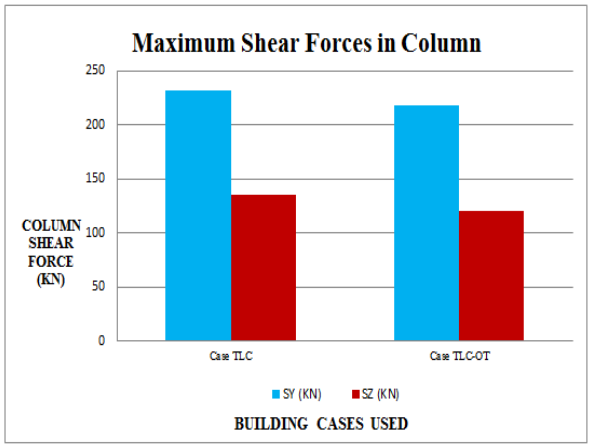


Fig. 19: Comparative representation of Maximum Axial Forces in Column obtained in Worst Case and Erected Case for Residential Apartment Building



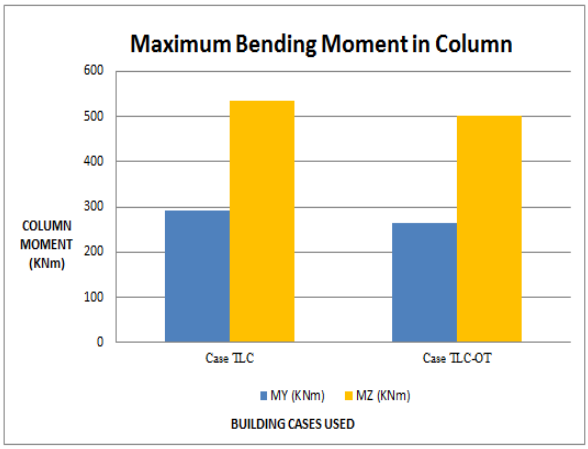
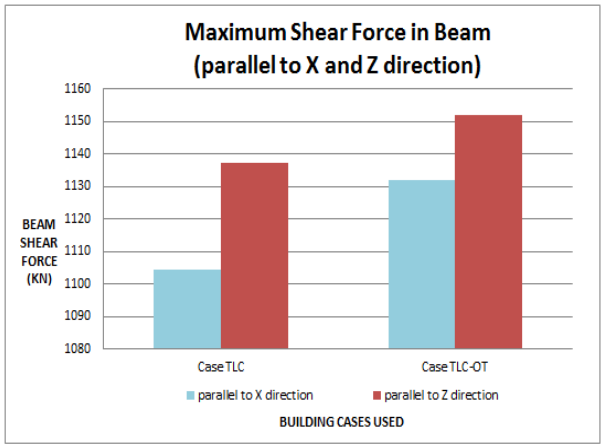


Fig. 20: Comparative representation of Maximum Shear Forces and Bending Moments in Columns obtained in Worst Case and Erected Case for Residential Apartment Building



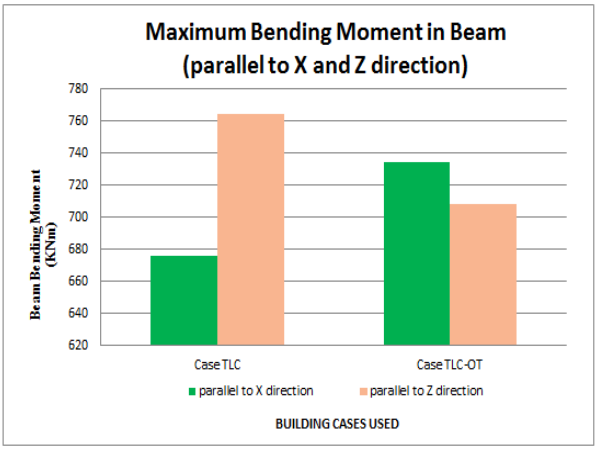


Fig. 21: Comparative representation of Maximum Shear Forces and Bending Moments in Beams parallel to X and Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

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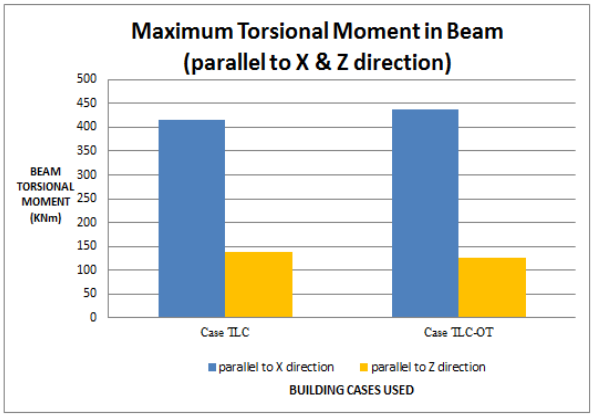

Fig. 22: Comparative representation of Maximum Torsional Moment in beams parallel to X & Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

2) For Tower

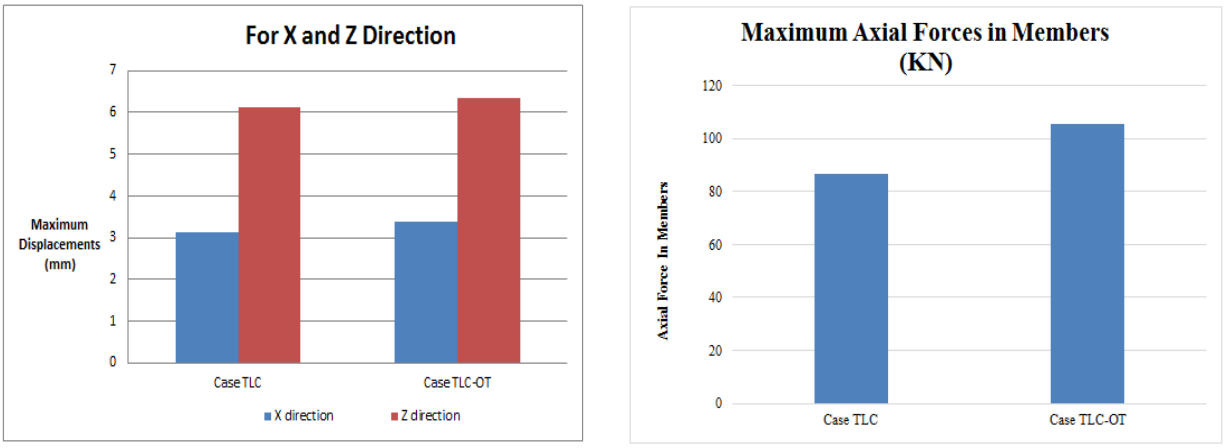

Fig. 23: Comparative representation of Maximum Displacement in X and Z direction obtained in Worst Case and Erected Case for Residential Apartment Building

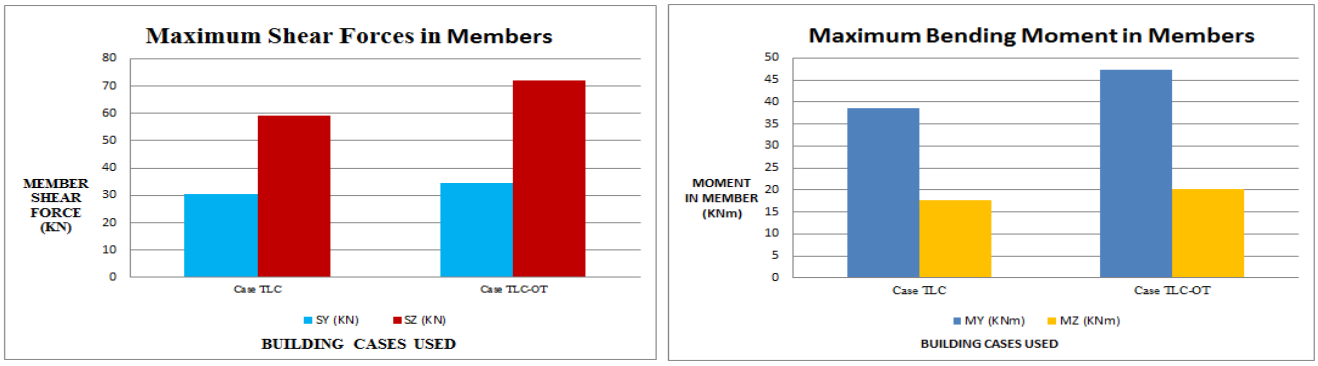

Fig. 24: Comparative representation of Maximum Shear Forces and Bending Moments in Members obtained in Worst Case and Erected Case for Residential Apartment Building

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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V. CONCLUSIONS

The conclusion can be pointed out are as follows:-

A. 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.

B. 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.

C. 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.

D. In Column Axial Forces, Case TLB suited best and Case TLD suited worst among all when compared amongst each other.

E. 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.

F. Again in Beam Shear Force, Beam Bending Moment and Torsion in Beam, the trend follows the same as Column Shear Force and Bending Moment.

G. Minimum values have been observed in Case TLA for Tower Displacement parameter.

H. 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.

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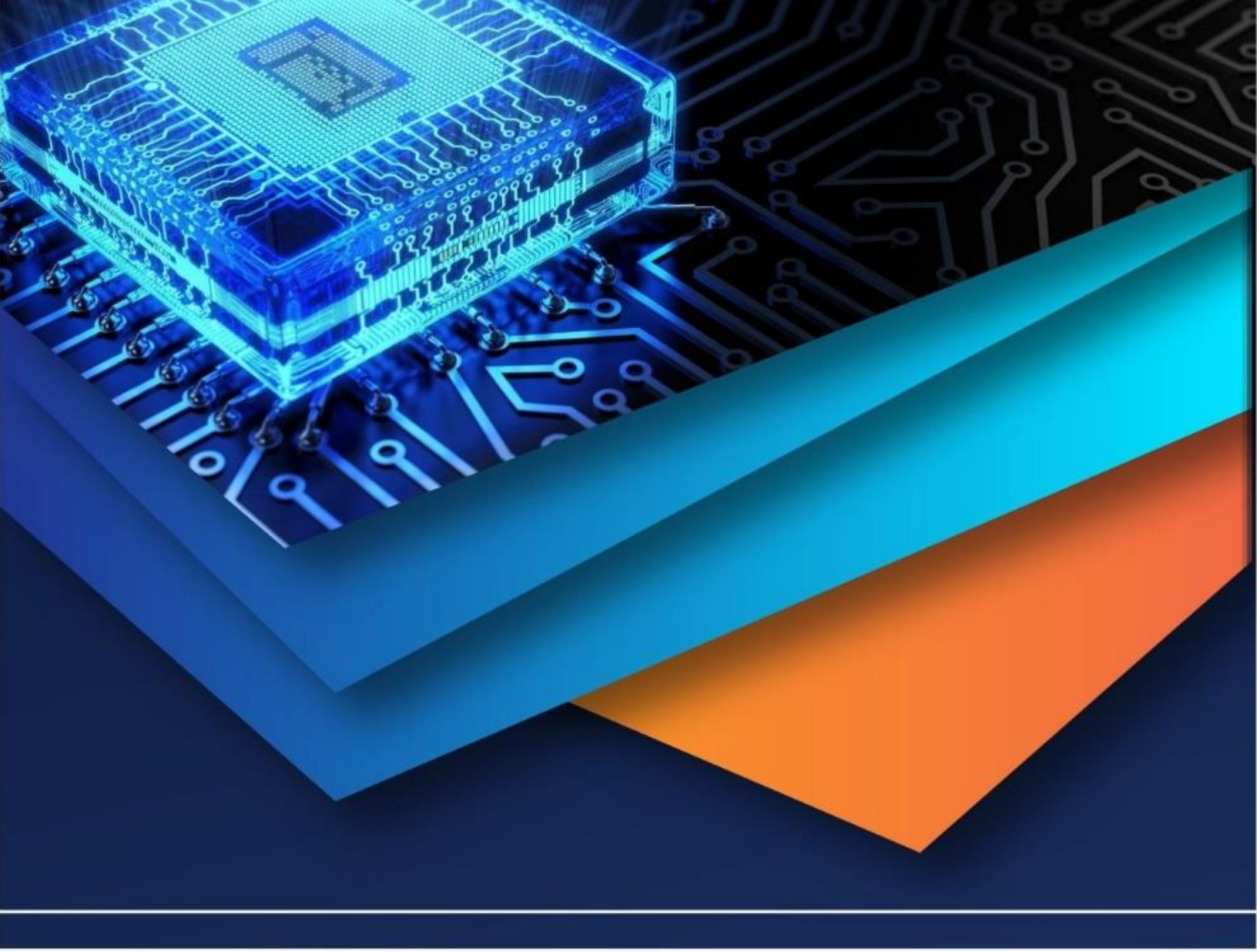

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