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Stability Analysis of High Rise Buildings by altering the Beam Members

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Abstract: A structure can be build with different building elements. These building elements are basic part to resist the various loads and stress acting on it. The Beam is on the basic and essential elements under it to resist the bending behaviour on the structure. The project deals with four different types of 17 storied structures are modelled by altering beam members having rectangular shape i.e. G+16 storied building with 3.50 meters height for each story is modelled and analysed. The plan dimension of all four buildings is kept same i.e. 15.15 m x 46.35 m each. These buildings are designed in accordance with the Indian Code of Practice for the design of earthquake resistant buildings. Base of the building were fixed. The height of the buildings is considered constant throughout the structure. The buildings are modelled using ETABSvr.2018. The model has been studied in the earthquake zone IV and soil type II.
Keywords: ETABSvr.2018, Beam, zone IV, Soil Type II, altering beam members

I. INTRODUCTION

Beams are usually horizontal structural elements carrying loads that are perpendicular to their longitudinal direction. Think of a balancing beam in gymnastics. It is a rectangular object 15 feet long and supported at both ends. When a person walks on the beam near the centre of the span, their weight is a downward vertical force that acts perpendicular to the longitudinal direction of the beam. Beams are used to maintain the weight of the floors, ceilings and roofs of a building and to transfer the load to a vertical load-bearing element of the structure. Larger and heavier beams called transfer beams are sometimes used to maintain the cumulative weight of stacked walls or other beams and transfer the load to the supports.

The design or sizing of beams requires an understanding of basic physics principles and engineering statistics. A structural engineer is fully trained and equipped to check the loads acting on a beam, calculate the forces and stresses on it and select the material, size and shape accordingly. Part of the engineering consulting work I provide to my clients is the structural design of beams in new buildings and the restoration or strengthening of existing beams in a structure

In the case of a new building, there is more flexibility in choosing the size and type of materials for beams that work best for the structure. The most common types of materials I recommend for my clients are beams made of steel sections, reinforced concrete, grouted masonry, and beams made of wood. All materials have advantages and disadvantages, but they are usually chosen on the basis of their cost, size and fire rating. When working on the structural design of a new beam or restoring an existing one, there are a few factors I consider. These factors include the amount of load acting on the beam, the length or span of the beam, the clear height available under the beam or any restrictions on geometry, the deflection limits of the beam, the strength of the material, as well. with a fire rating and resistance. Similar factors are used when designing columns.

II. OBJECTIVE OF THE WORK

The following objectives are taken in this project

1) To study various elements in the building structure & classification of beam based on materials.
2) To Study the various past research based on use of various beam & columns.
3) To Model a G+16 multistory building under taking different materials types of beam in the structure.
4) To compare a different models case to find optimized structure.
5) To analysis G+16 multistory building under Seismic Analysis.
6) To assist the different parametric result such as Storey displacement, base shear, overturning moments, storey shears etc into it.

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III. METHODOLOGY AND MODELLING

Structure modeling is basically a framework for any buildings. It is frame representation of 3D model. It helps in understanding and analyzing of all members of complex buildings. It helps in the visualizing of each corner of complex buildings. The table 1 is shows the various model cases and its description are as follows:

Table 1: Model and Case Description

S. No.	Case Description	Model Description	Nomenclature
01	Case 1	Building having RCC Rectangular sections for Columns and Beams	Structure-I
02	Case 2	Building having Steel sections for Beams and RCC Rectangular sections for Columns	Structure-II
03	Case 3	Building having Concrete Precast I Sections for Beams and RCC Rectangular Section for Columns.	Structure-III
04	Case 4	Building having Concrete Tee Sections for Beams and RCC Rectangular Section for Columns.	Structure-IV

Figure 1, Figure 2, Figure 3 & Figure 4 represent the Plan and 3-D view of the Case 1 Model, Case 2 Model, Case 3 Model and Case 4 Model respectively.

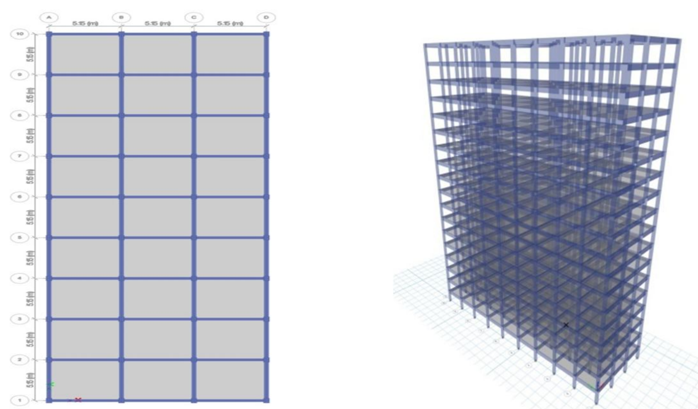

Fig. 1: Case 1 Structure a) Plan b) 3D model

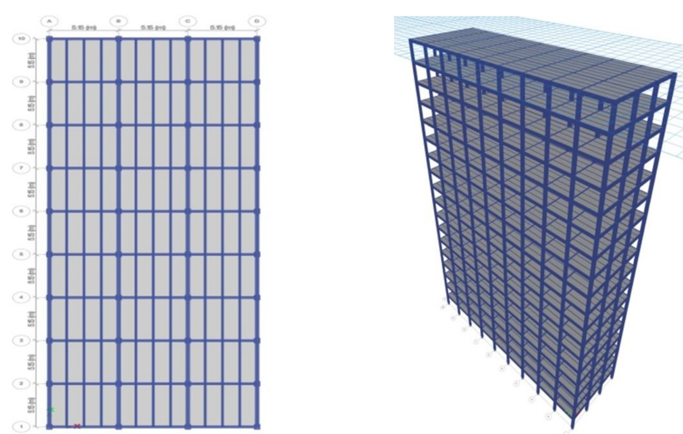

Fig. 2: Case 2 Structure a) Plan b) 3D mode

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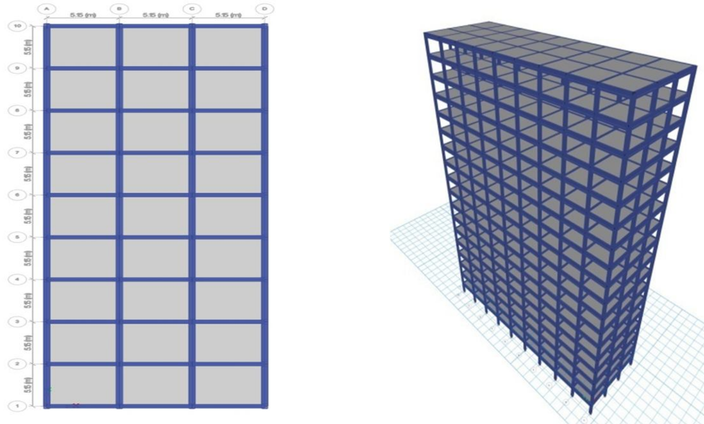

Fig. 3: Case 3 Structure a) Plan b) 3D model

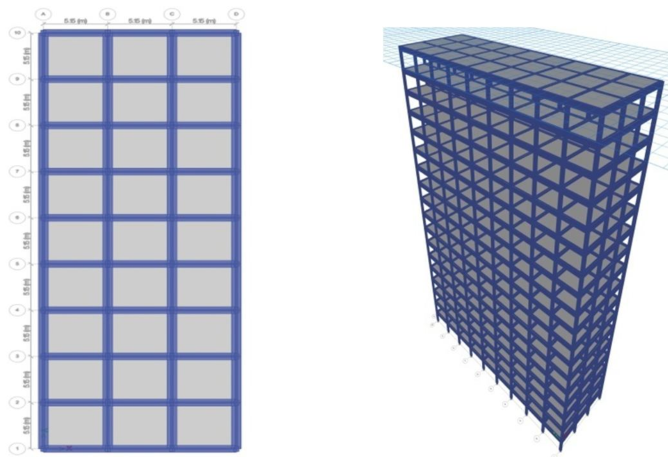

Fig. 4: Case 4 Structure a) Plan b) 3D model

A. Material and Structural Properties

Table 1 and 2 enlist the structural and material properties respectively.

Table 1: Material Properties

Material Properties		
S. No.	Types of material	Dimensions / comments
1	Concrete (beam & column)	M-30
2	Concrete (Slab)	M-25
3	Grade of rebar (R/F)	HYSD-500
4	Grade of Steel for Built up Section	Fe-345

Table 2: Structural Properties

Structural Properties		
S. No.	Descriptions Of Parameters	Dimensions / Comments
A)	Common Parameters	
1	Structure type	Rigid frame structure
2	No of storey /total height	G+16 / 59.50 m.
3	Plan area	15.45 m x 46.35 m
4	Spacing in grid in x –direction	5.15 m. c/c
5	Spacing in grid in y –direction	5.15 m. c/c
6	Individual storey height	3.50 m.
B)	Case 1: Building having RCC sections for Columns and Beams (RCC Structure	
1	Column size	400 mm x 600 mm
2	Beam Size	300mm x 750 mm
3	Secondary Beam Size	Nil
4	Slab Thickness	125 mm
C)	Case 2: Building having Composite RCC and Steel sections for Beams and RCC Rectangular sections for Columns	
1	Column size	400 mm x 600 mm
2	Beam Size	ISHB 450
	Total Depth	450 mm
	Flange Width	250 mm
	Flange Thickness	13.70 mm
	Web Thickness	11.30 mm
3	Secondary Beam Size	ISMB 250
4	Slab Thickness	125 mm
	Total Depth	250 mm
	Flange Width	125 mm
	Flange Thickness	12.50 mm
	Web Thickness	6.90 mm
D)	Case 3: Building having Concrete Precast I Sections for Beams and RCC Rectangular Section for Columns	
1	Column size	400 mm x 600 mm
2	Beam Size	
	Total Depth	750 mm
	Top Flange Width	450 mm
	Top Flange Thickness	200 mm
	Bottom Flange Width	350 mm
	Bottom Flange Thickness	200 mm
	Filet Depth	50 mm

	Web Thickness	150 mm
3	Secondary Beam Size	Nil
4	Slab Thickness	125 mm
E)	Case 4: Building having Concrete Tee Sections for Beams and RCC Rectangular Section for Columns.	
1	Column size	400 mm x 600 mm
2	Beam Size	
	Total Depth	750 mm
	Flange Width	750 mm
	Flange Thickness	200 mm
	Web Thickness	200 mm
3	Secondary Beam Size	Nil
4	Slab Thickness	125 mm

IV. RESULTS AND DISCUSSION

Based on the modelling the lists out results are taken from the software analysis of all four models with the concept of altering the beam approach. The results are as follows:

A. *Maximum Storey Displacements*

Deflection of the stories from the initial position is termed as storey displacements and its maximum value is obtained at the top storey. The values of storey displacements in X and Y directions obtained from the analysis has been shown in table 3.

Table 3: Maximum Storey Displacement (mm)

S.N.	Case	X-Dir	Y-Dir
1	Case 1	170.81	70.20
2	Case 2	203.24	105.21
3	Case 3	1491.54	1079.75
4	Case 4	175.10	70.65

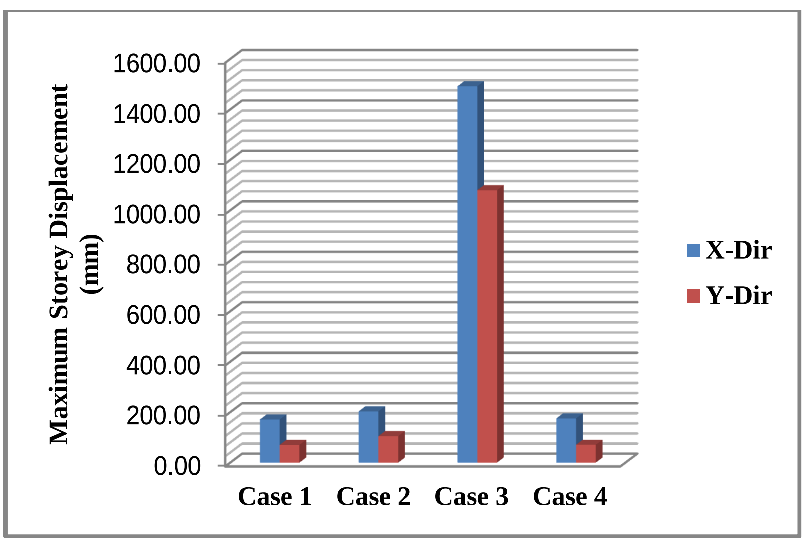

Fig 5: Maximum Storey Displacement

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B. *Storey Acceleration*

Table 4: Storey Acceleration (mm/sec^2)

S.N.	Case	Storey Acceleration		
		U_X	U_Y	U_Z
1	Case 1	636.01	706.58	78.42
2	Case 2	634.02	772.63	48.68
3	Case 3	896.77	1343.23	8.87
4	Case 4	638.37	708.00	81.84

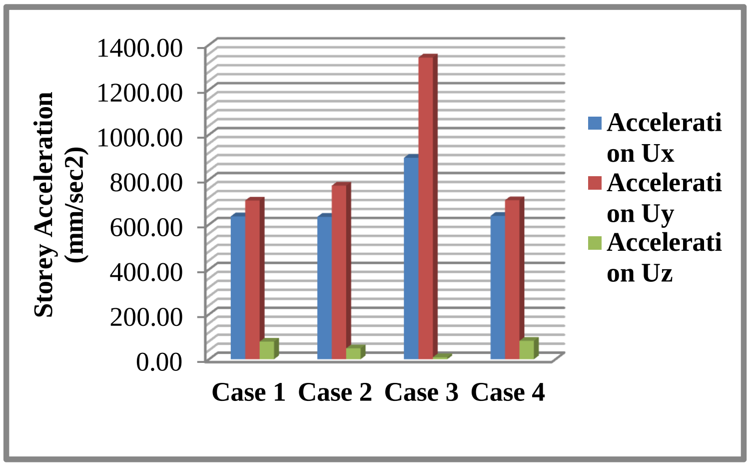

Fig 6: Storey Acceleration

C. *Base Shear*

Table 4.3: Base Shear (kN)

S.N.	Case	X-Direction	Y-Direction
1	Case 1	5702.50	4632.25
2	Case 2	4159.03	3378.46
3	Case 3	3758.84	3053.38
4	Case 4	6022.63	4892.30

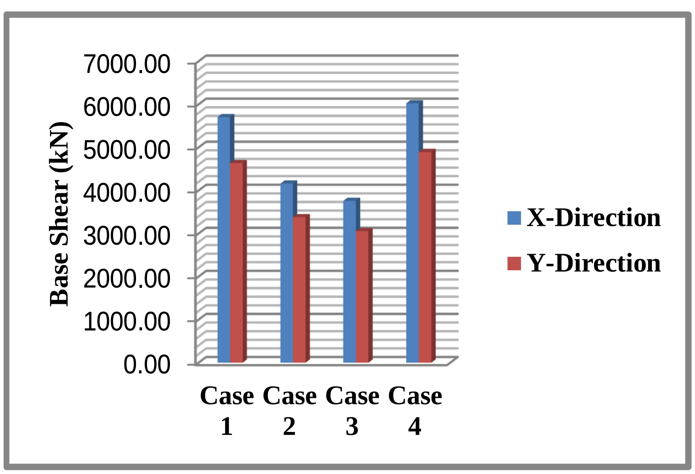

Fig 7: Base shear

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D. Modal Acceleration

Table 4.4: Modal Acceleration (mm/sec2)

S.N.	Case	Acceleration	
		Ux	Uy
1	Case 1	1083.96	1054.20
2	Case 2	1218.52	1289.20
3	Case 3	2098.48	2563.32
4	Case 4	1096.32	1056.12

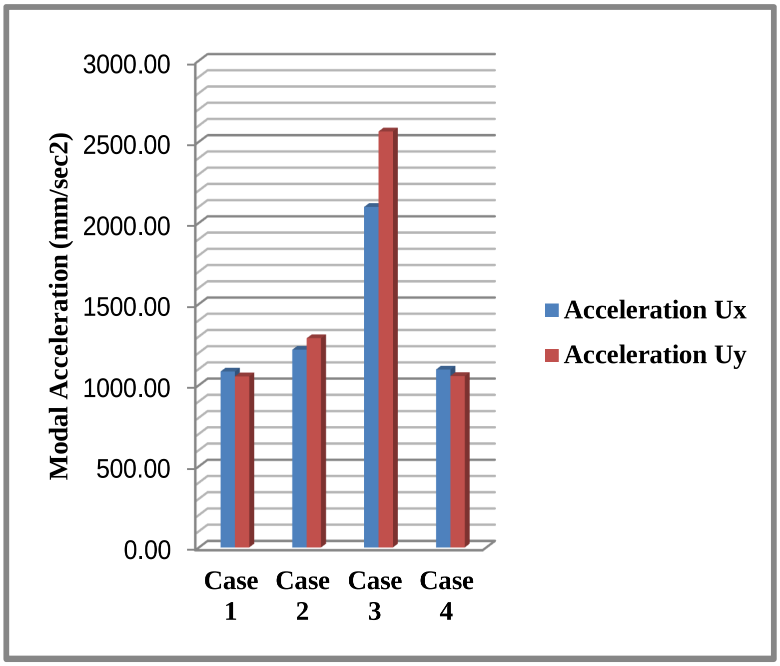

Fig 8: Modal Acceleration

V. CONCLUSIONS

A. Maximum storey displacement is highest in Case 3 Model (Building having Concrete Precast I Sections for Beams and RCC Rectangular Section for Columns.) which is almost nine times to the Case 1 Model (Building having RCC Rectangular sections for Columns and Beams).

B. Case 2 Model (Building having Steel sections for Beams and RCC Rectangular sections for Columns) and Case 4 Model (Building having Concrete Tee Sections for Beams and RCC Rectangular Section for Columns) shows much lower value than Case 3 Model.

C. Storey Acceleration in X and Y direction of Case 3 Model is nearly 1.5 to 2 times of other models.

D. Storey Acceleration in Z direction of Case 3 Model is lowest than that of other models.

E. Base shear of Case 1, 2 and 4 models ranges between 1.10 to 1.60 times of base shear of Case 3 Model.

F. Modal Acceleration of Case 3 Model is 1.75 to 2.00 times of other Modals.

G. For this study, Case 1 Model i.e. Model (Building having RCC Rectangular sections for Columns and Beams) and Case 4 Model (Building having Concrete Tee Sections for Beams and RCC Rectangular Section for Columns) outperformed other two models.

H. For this study, in Case 3 Model (Building having Concrete Precast I Sections for Beams and RCC Rectangular Section for Columns.) is most vulnerable to seismic forces. That's why section sizes and other parameters of Pre-Cast Beams has to be re-assessed for this study.

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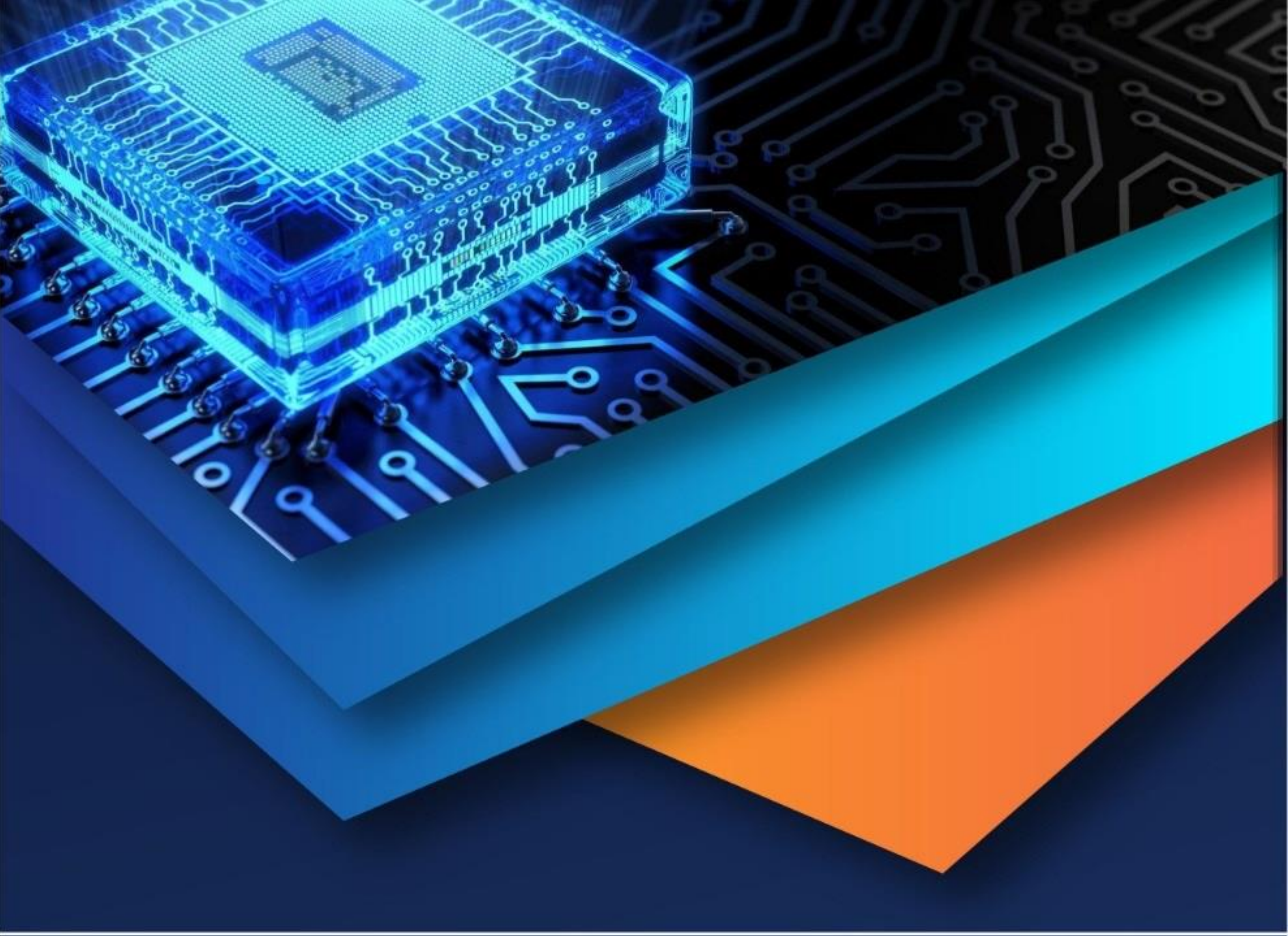

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