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Study of Seismic Effect on High Rise Building in Two Different Position of Shear Wall using Staad Pro

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Abstract: India at present is fast growing economy & Population growth will increase demands of land to construct high rise structure are more advantage to provide they demands in construction industry. The present study reports the effect of earthquake on high rise building to comparison of two different seismic zone with different position of shear wall using STAAD Pro. V8i SS5 to work out effective ideal location of shear walls. G+9 high rise building in zone III & zone V is considered for the present study. Analysis of the building is conferred with some preliminary investigations, analyzed by varied position of shear wall by considering three models as model 1 without shear wall, model 2 shear wall at corner with different position, model 3 shear wall in corner position. Maximum shear wall deflections are calculated and analyzed for all considered model. M30 grade of concrete is used with Fe415 steel is used for the present study. The seismic analysis performed is Equivalent Static Method as per IS 1893-2002 using the well-known analysis and design software STAAD PRO. V8i SS5 . Seismic performance of the building has been investigated based on parameters such as, Base Shear, Storey Displacements & Storey Drift along X direction & along Z direction of the structure.

Keywords: Shear Wall, STAAD PRO. V8i SS5, Base Shear, Storey Displacements, Storey Drift, Indian Standard Code
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I. INTRODUCTION

Vibrations which are caused under the earth's surface generate waves which disturb the earth surface, termed as earthquakes. It was said that earthquakes will not kill human but structures which are not constructed in considering the earthquake forces do. 60% of India lying in earthquake prone zone at which there is a need of increase of understanding the behaviour of earthquake, constructing and developing earthquake resistant structures. Shear walls to resist the lateral forces produced during earthquake. Shear walls behaviour depends upon the material used, wall thickness, wall length, wall positioning in building frame also. Shear wall is a structural member used to resist lateral forces that are designed to resist in-plane lateral forces, typically wind and seismic loads. It resists the loads due to Cantilever Action. In other words, Shear walls are vertical elements of the horizontal force resisting system. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants, create powerful twisting forces. These forces can shear a building apart. Reinforcing a frame by attaching or placing a rigid wall inside it maintains the shape of the frame and prevents rotation at the joints.

Shear walls are especially important in high-rise buildings subject to lateral wind and seismic forces. They also provide adequate strength and stiffness to control lateral displacements. The shape and plan position of the shear wall influences the behavior of the structure considerably. Shear walls resist the effect of mainly two things, they are in-plane shear and in-plane bending action due to moment from shear. Though in addition to these, the shear wall, as a structural element, tends also to resist plane shear in the vertical direction and the buckling effect of dead loads coming from the top. According a shear wall may fail either in one of these two modes. The modes are flexural shear failure, horizontal shear failure and vertical shear failure.

A. Functions of Shear Wall

1) Resist Lateral loads, Seismic loads, Vertical Forces
2) Reduces lateral sway of the building
3) Provide large strength and stiffness to buildings in the direction of their orientation
4) The rigid vertical diaphragm transfers the loads into foundations
5) Provide large strength and stiffness in the direction of orientation
6) Well-distributed reinforcement
7) Minimize damages to structural and nonstructural elements

B. Location & Design Classification of The Shear Wall

The location of the shear wall depends on the; structure plan,core location ,building symmetry. The lateral force of the structure. The most common and useful practice of the shear wall is in the centre (lift section) or the perimeter of the building. But in this case the location of shear wall at corner with different position and corner two case. The location is decided after the complete structural analysis.

II. PROBLEM STATEMENT AND METHODOLOGY

Analysis of any structure for resisting earthquake is the basic need of this study. In this project analysis of a seismic resistant structure is a need of concern, and thereby establishing a comparison between structures with normal shear wall. In high rise structures most adoptable type to resist earthquake is to provide shear wall. Basically, many analysis and design software can be adopted to analyze and design any earthquake resistant structure. There are many methods for analysis and design such as equivalent static method (seismic coefficient method) and response spectrum method. Among all these methods in this study only equivalent static method is adopted. In this study Staad Pro is used for analysis. The proposed work is planned to be carried out in the following manner.

Table1 : Structural Modeling For The Project Models:

Grade of Concrete	M30
Grade of Steel	Fe415
Bays in X-direction and Width	4 bays of 4m each
Bays in Z-direction and Width	4 bays of 4m each
Floor to Floor Height	3m
Number of Storey	G+9
Column Size	600mmx600mm
Beam Size	400mmx600mm
Floor to Floor Height	3m
Thickness of Slab	150mm
Density of Concrete	25 KN/m^3
Live Load on Roof	1.5 KN/m^2
Live Load on Floors	3 KN/m^2
Thickness of External Wall	230mm
Thickness of Internal Wall	115mm
External Plaster	15mm
Internal Plaster	12mm
Density of Plaster	18 KN/m^3
Thickness of Shear Wall	230mm

Table2 : Seismic Parameters

Seismic Zone	III	V
Zone Factor (Z)	0.16	0.36
Response Reduction Factor Ordinary Shear Wall With SMRF (R)	4	
Type Of Soil	Medium soil	
Damping Percent	5%	
Natural Time Period (Ta)	0.675sec	0.675sec
Sa/g	2.014	2.014
Design Horizontal Seismic Coefficient (Ah)	0.0403	0.0907

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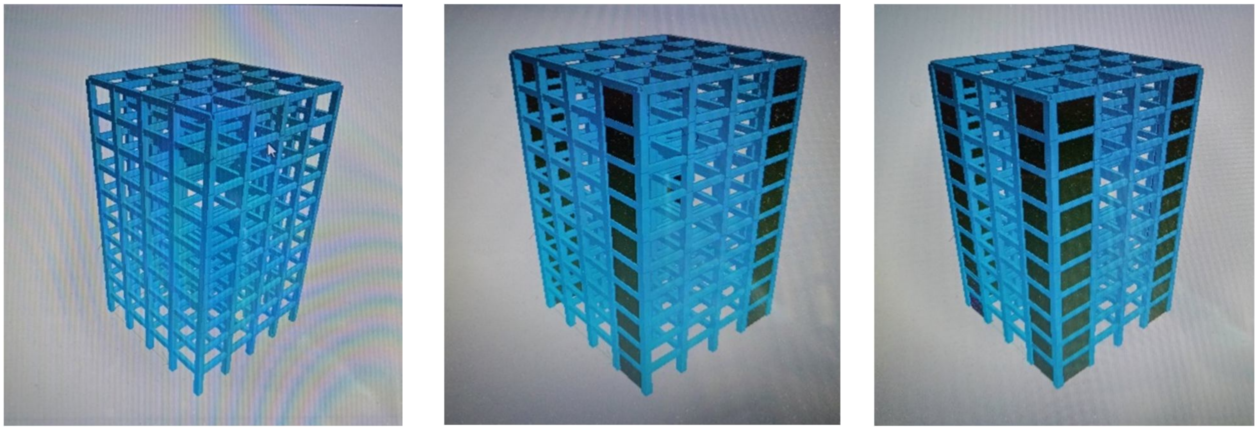
III. PLAN & MODEL GENERATED FOR STRUCTURAL MODELING

1) *Model 1:* Simple structure without any shear wall.
2) *Model 2:* Structure with symmetrical shear wall at corner in different position of building on outer walls of structure concentrically located.
3) *Model 3:* Structure with symmetrical shear wall at corner of building on outer walls of structure concentrically located.



Model I Model II ModelIII

Fig.3.1: Models Generated in STAAD Pro V8i SS5 for the Problem Statement

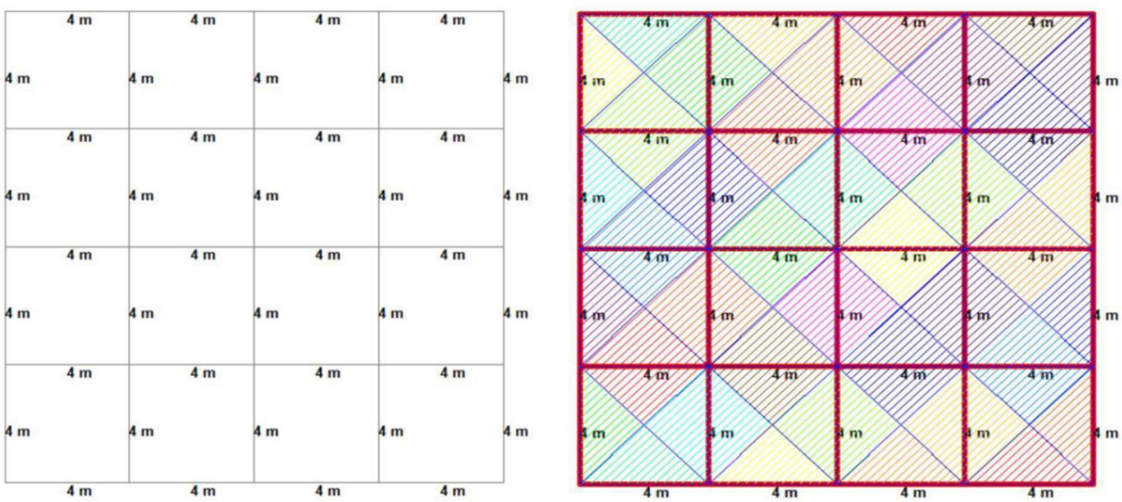


Fig.3.2: Plan of Building with and without Loading Distribution Generated in STAAD Pro

IV. CALCUALATION OF LOAD

A. *Calculation of Load & Earthquake Related Parameter*

Dead load of slab	= 0.15 x 1 x 25 = 3.75 KN/m^2
Dead load of outer brick wall	= 0.23 x (3-0.6) x 20 = 11.04 KN/m.
Dead load of inner brick wall	= 0.115 x (3-0.6) x 20 = 5.52 KN/m
Dead load of parapet wall	= 0.23 x 1 x 20 = 4.6 KN/m
Dead load of plaster for outer wall	= (0.015+0.012) x 3 x 18 = 1.458KN/m
Dead load of plaster for inner wall	= (0.012+0.012) x 3 x 18 = 1.296KN/m
Dead load of plaster for parapet wall	= (0.015+0.015) x 1 x 18 = 0.54KN/m
Total dead load for outer wall	= 11.04 + 1.458 = 12.498 KN/m
Total dead load for inner wall	= 5.52 + 1.296 = 6.816 KN/m
Total dead load for parapet wall	= 4.6 + 0.54 = 5.14 KN/m

B. Calculation of Seismic Weight

As per IS 1893 (Part 1):2002 table 3.1 in clause 7.3.1 of “Percentage of imposed load to be considered in seismic weight calculation” (As per the norms given in the IS 1893 (Part 1): 2002 for live load greater than 3, 50% of the live load is added for seismic weight. And for live load up to and less than 3, 25% live load is added for seismic weight).

Total seismic weight floors = 3.75 + (0.25 x3) = 4.5 kN/m^2

Total seismic weight roof floors = 3.75 kN/m^2

The fundamental natural period of vibration (Ta) is calculated by **Brick infill panel building type**

Ta= $\frac{0.09h}{\sqrt{d}}$

h= Height of building

d= Width of building at plinth height in a particular direction.

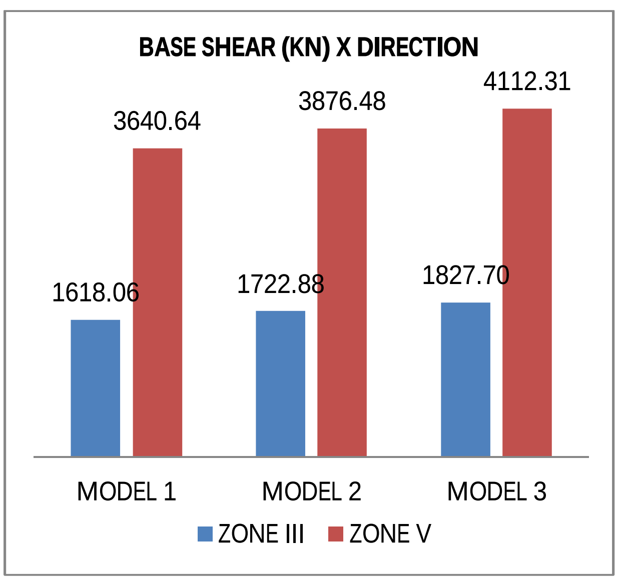
V. RESULT

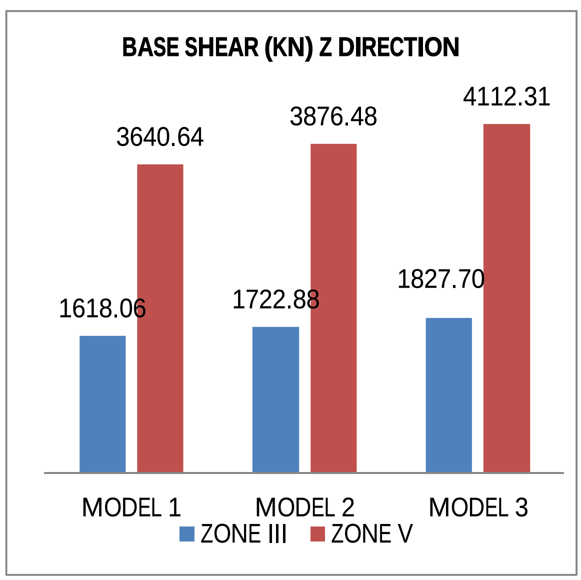
A. Base Shear

Base shear values at different floor level along X direction and along Z direction, Base shear is cumulative of lateral force from top storey to bottom storey. Therefore, the value of the shear of the lower floor is the maximum and the value of the shear of the upper floor is the minimum. This briefly states that the building is stiff with shear walls.

BASE SHEAR ZONE III			
Along X Direction		Along Z Direction	
MODEL	VB (KN)	MODEL	VB (KN)
MODEL 1	1618.06	MODEL 1	1618.06
MODEL 2	1722.88	MODEL 2	1722.88
MODEL 3	1827.70	MODEL 3	1827.70

BASE SHEAR ZONE V			
Along X Direction		Along Z Direction	
MODEL	VB (KN)	MODEL	VB (KN)
MODEL 1	3640.64	MODEL 1	3640.64
MODEL 2	3876.48	MODEL 2	3876.48
MODEL 3	4112.31	MODEL 3	4112.31



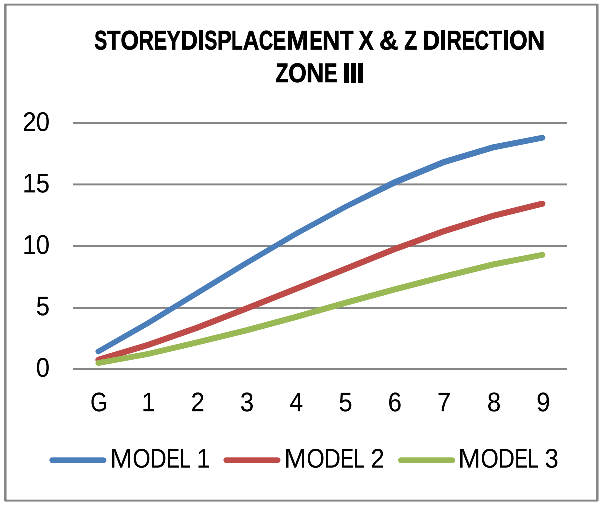


1) Increase in the zones the base shear values is also found to be increasing and is found to be highest in zones V.
2) Base Shear is maximum for Zone III is 1827.70KN and Zone V is 4112.31KN as model 3 along X direction & along Z direction..
3) Base shear is found to be minimum model 1 for zone III & V along X direction & along Z direction.
4) When compared zone III and zone V then base shear is increase for model 1 125%, model 2 125% & model 3 125%.
5) Base shear increase for model-2 &model-3 when compared with model-1 for both the zone III & V along X direction and along Z direction.

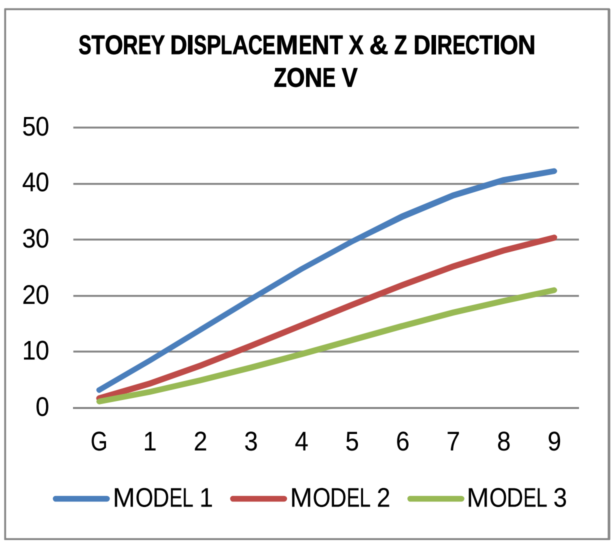
B. *Storey Displacement*

Equivalent static method of analysis, the storey displacements for all the stories, and for all the models is tabulated in the table along X direction and along Z direction and graphs are plotted for seismic zone III and V respectively.

STOREY DISPLACEMENT (mm) Zone III			
STOREY	**MODEL 1**	**MODEL 2**	**MODEL 3**
Ground	1.433	0.742	0.488
1	3.740	1.942	1.245
2	6.193	3.360	2.159
3	8.639	4.917	3.181
4	11.003	6.543	4.272
5	13.213	8.173	5.389
6	15.185	9.744	6.493
7	16.825	11.195	7.545
8	18.037	12.460	8.493
9	18.780	13.474	9.317



STOREY DISPLACEMENT (mm) Zone V			
STOREY	**MODEL 1**	**MODEL 2**	**MODEL 3**
Ground	3.224	1.670	1.098
1	8.414	4.369	2.800
2	13.934	7.561	4.857
3	19.438	11.062	7.158
4	24.757	14.722	9.611
5	29.730	18.390	12.125
6	34.167	21.925	14.609
7	37.856	25.190	16.969
8	40.582	28.035	19.108
9	42.200	30.317	20.964



- The maximum storey displacement obtained for zone III is 18.780mm and for zone V 42.200mm is for model 1 along X direction and along Z direction as shown in the table for zone III and zone V is within the permissible limits.
- The minimum storey displacement obtained for zone III is 0.488mm and for zone V 1.098mm is for model 3 along X direction and along Z direction as shown in the table for zone III and zone V is within the permissible limits.
- Stories Displacement is found to be highest in model 1 and is found to be minimum in model 3 for zone III and zone V respectively.

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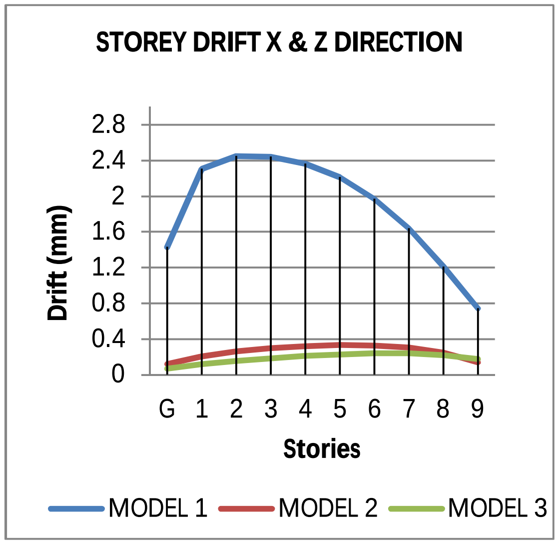
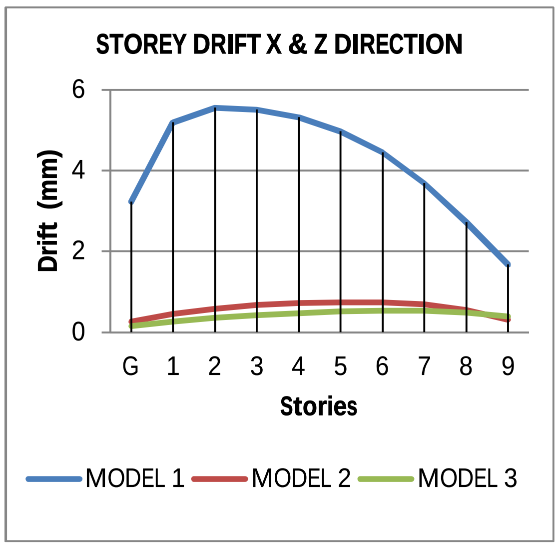
C. *Storey Drift*

The storey drift ratio for equivalent static method of analysis all the stories and for all the models are tabulated in the table along X direction and along Z direction and graphs are plotted for seismic zone III and V respectively.

STOREY DRIFT (mm) Zone III			
STOREY	MODEL 1	MODEL 2	MODEL 3
Ground	1.433	0.116	0.069
1	2.307	0.205	0.119
2	2.453	0.261	0.156
3	2.446	0.297	0.186
4	2.364	0.32	0.210
5	2.210	0.331	0.229
6	1.972	0.329	0.240
7	1.640	0.305	0.239
8	1.212	0.245	0.219
9	0.744	0.139	0.177



STOREY DRIFT (mm) Zone V			
STOREY	MODEL 1	MODEL 2	MODEL 3
Ground	3.224	0.262	0.156
1	5.190	0.461	0.268
2	5.552	0.587	0.352
3	5.504	0.669	0.419
4	5.320	0.72	0.473
5	4.972	0.746	0.515
6	4.437	0.741	0.540
7	3.690	0.687	0.537
8	2.726	0.552	0.493
9	1.673	0.312	0.399



- The maximum storey drift obtained for zone III is 2.453mm and for zone V 5.552mm is for model 1 along X direction and along Z direction as shown in the table for zone III and zone V respectively.
- The minimum storey drift obtained for zone III is 0.069mm and for zone V is 0.156mm for model 3 along X direction and along Z direction as shown in the table for zone III and zone V is within the permissible limits.
- The maximum storey drift obtained at second storey is found to be 5.552mm for zone V along X direction and along Z direction in model 1 as shown in the table.
- Storey drift is found to be highest in model 1 along X direction and along Z directions respectively for zone III and V respectively.
- Similarly storey drift is found to be least is model 3 along X direction and Z directions respectively for zones III and V respectively.

VI. CONCLUSION

From the results and discussions following conclusions are made with respect to equivalent static method of analysis of RCC Framed structure with and without shear wall-

1) The base shear values are incrementing in zone V & shows highest base shear value for zone V
2) The maximum time period obtained is 0.675sec for model 1, model 2 and model 3. Hence, from this analysis stiffer zones III and V.
3) The storey displacement at the top storey is more in zone III and zone V.
4) Models with shear wall shows reduction in displacement, there by models-2 and model-3.
5) The storey displacement in the shear wall model 3 is less than model-1 and model-2..
6) The storey displacement is increased gradually from bottom to top storey for all model.
7) The storey drift is gradually reduced in model 2.

Considering the construction time factor with shear wall structure need more time to execution however proper workmanship needs to be followed for better structural behavior.

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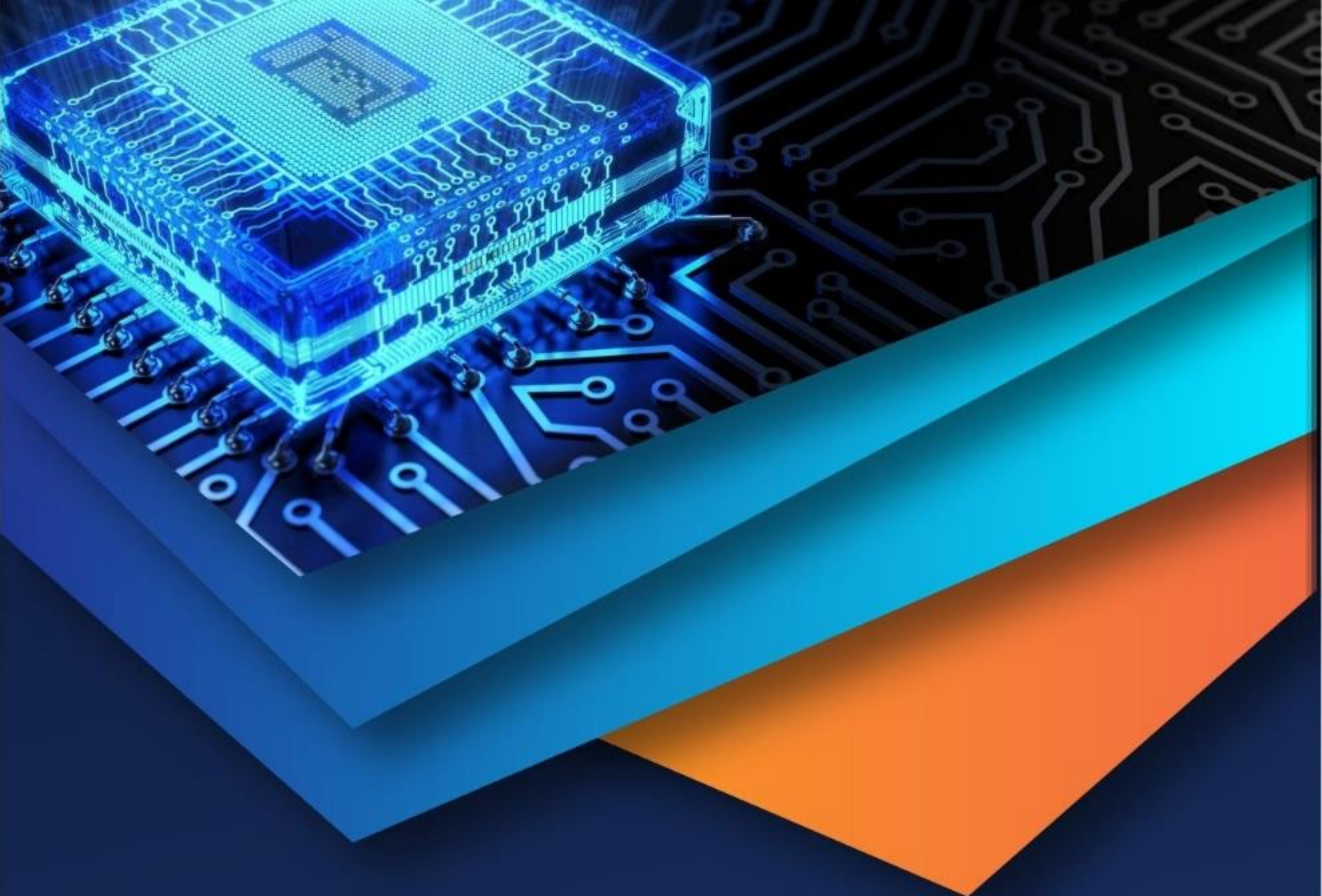

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