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Study of Wind Analysis on Multi-Storey Building for a Regular and Irregular Plans

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Abstract: The present study deals with the wind analysis of G+15 multi-storied structure. the principal wind speed considered is 50m/s. For the investigation the software tool is used, E-TABS 2013 (Extended three-dimensional analysis of building system) is that the tool to analyses the multi-storey structure. during this study the consequence of wind on multi story structure for plan of regular and irregular is examined. In addition, the effect of shape on wind investigation is also analysed. during this study the comparison of impact of wind for Rectangular, and U-shape, Stepped building structure is exhibited. The analysis consist typical characteristic comparison associated with storey displacement, storey drift, Storey stiffness, etc. The classification of structure as Class-B of wind zone thought for height is employed for modelling of structure. Modelling in category-2,3,4 is taken to check the result. This study of structure for plan of regular and irregular concludes that which shape and terrain category is more dominant for story displacement, story drift, storey stiffness etc. and also which shape is safer for wind effect. Over all analysis suggests rectangular structure for long wind or across wind direction is superior because of massive stiffness and fewer displacement against wind.

Keywords: E-TABS, multi-storied structure, storey displacement, storey drift, Storey stiffness, terrain conditions, wind analysis.

I. INTRODUCTION

For engineering structures wind load is one of the necessary design loads for high rise structures. For tall high-rise buildings and structural design depends on the wind load as its dynamic in nature. because the impact of wind load on tall structures is distributed over the broader surface and also the intensity of the load is additionally high. In general, for the proposition of tall structures, both wind as well as seismic loads should be considered. As per IS 875(Part 3):1987, wind associates with a structure, every positive and negative pressures happen at the same time, the structure ought to have adequate strength to resist the applied loads from these weights to prevent wind attracted building failure. Load applied on the structure is moved to the structural system then passing through the footing and finally moved to the ground. Lateral loads due to wind which that performing on multi story building will cause shake in the higher stories. This might be impact caused due to wind at higher stories because the wind intensity is increasing with graduating heights. Thus, the multi-story building conjointly act as a portal frame the instant concentrating at base due to lateral wind forces are bigger. Thus, it's necessary to nullify displacement in lateral direction by appropriate design.

A. Irregularities in Structure

There are numerous forms of inconsistencies in the structure's dependent upon their area and scope, but mainly, they're divided into two groups plan irregularities and vertical irregularities.

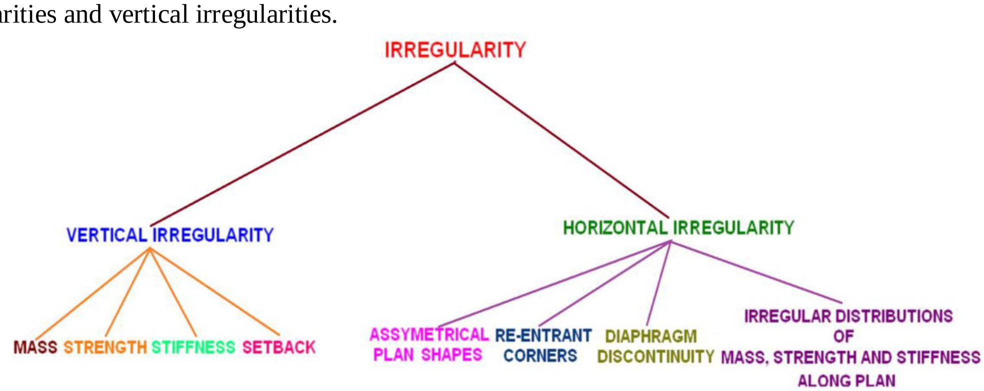

Fig.1 Classification of irregularities

B. Terrain Categorys

1) *Category I:* The Fig.2 showing Exposed open piece of land with few or no obstructions and during which the typical height of any object close the structure is smaller amount than 1.5m.

Fig.2 Showing different places of terrain category-I

2) *Category II:* The Fig.3 showing Open piece of land with well scattered obstructions having heights typically between 1.5 to 10 m.

Fig.3 Showing different places of terrain category-II

3) *Category III:* The Fig.4 showing piece of land with several closely spaced obstructions having the scale of building-structures up to 10 m tall with or while not many isolated tall structures.

Fig.4 Showing different places of terrain category-III

4) *Category IV:* The Fig.5 showing piece of land with varied giant high closely spaced obstructions

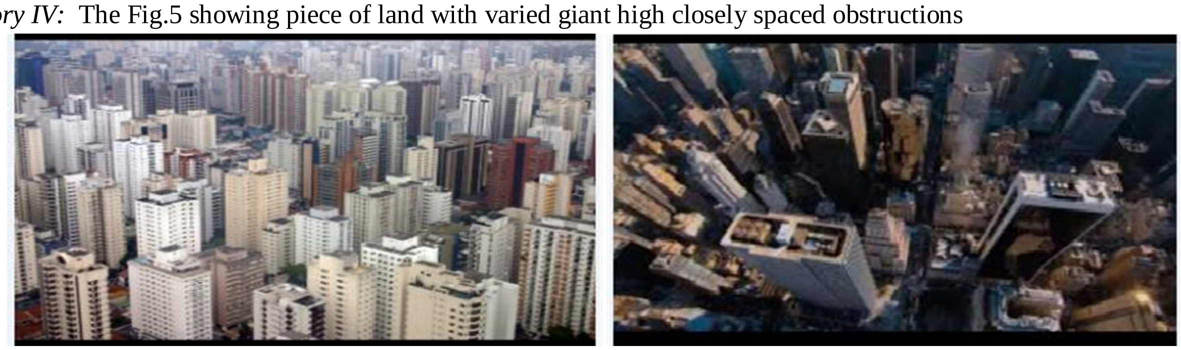

Fig.5 Showing different places of terrain category-IV

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II. OBJECTIVES OF THE PROJECT

A. To carry out modelling and analysis for 15 storey building using E-TABS Software.
B. To search out the parameters like storey displacements, storey shear, and relative storey drifts.
C. To study the wind impact on these models.
D. To study the regular and irregular structures for dynamic properties.
E. To check the behavior of the regular and irregular structures under strong wind effect for different terrain categories.
F. To analyse the structure for structure with shear wall.

III. ANALYSIS

A. Architectural And Structural Parameters Considered For Analysis

Sl no	Data	Description
1	Dimension of building	25 * 20 m
2	Number of storey	(G+15)
3	Storey height	Ground floor-3.5m & 1st -15th floor-3.0m
4	Grade of concrete and steel	M25 for Beams and Slabs M30 for columns and Fe500 steel
5	Thickness of slab	150mm
6	Column size	300mm X 800mm
7	Beam size	300mm X 600mm
8	Live load	3 kN/m^2
9	Floor finishes	1.5 kN/m^2
10	wall load	11.6 kN/m^2
11	Wind speed	50m/s
12	Structural class	B
13	Location of building	Delhi
14	Terrain category	II, III, IV
15	Building height (H)	48.5m

1) Model 1: Plan of regular RC frame structure.
2) Model 2: Plan of horizontal irregular RC frame structure.
3) Model 3: Plan of vertical irregular RC frame structure.

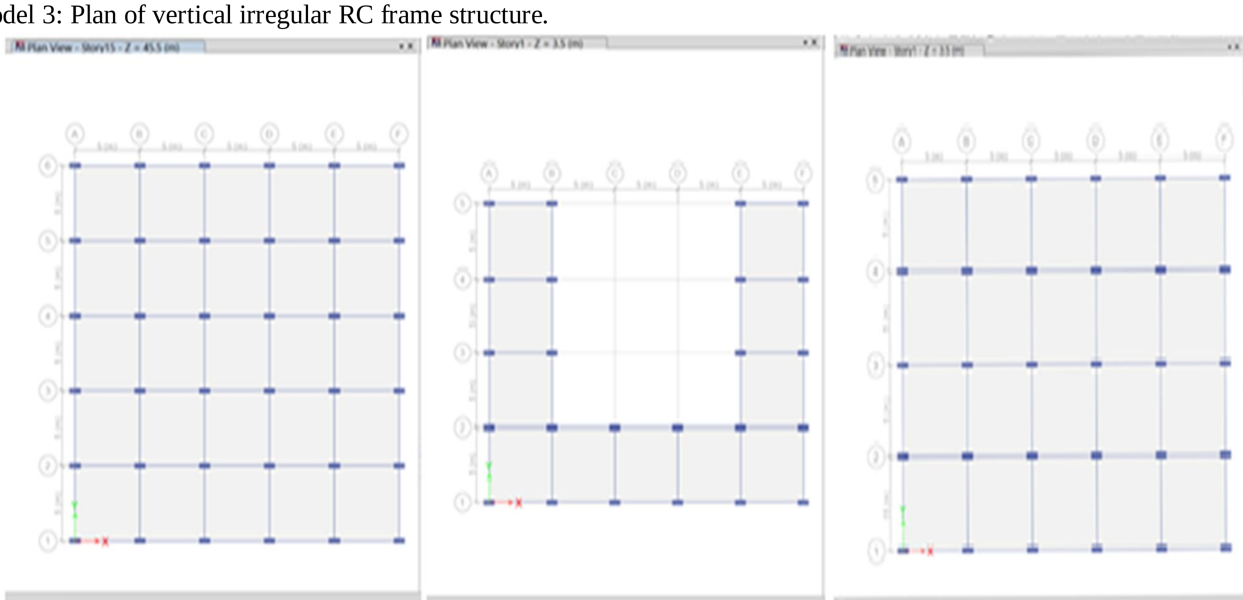

Fig.6 Plan of regular, horizontal irregular and vertical irregular structure

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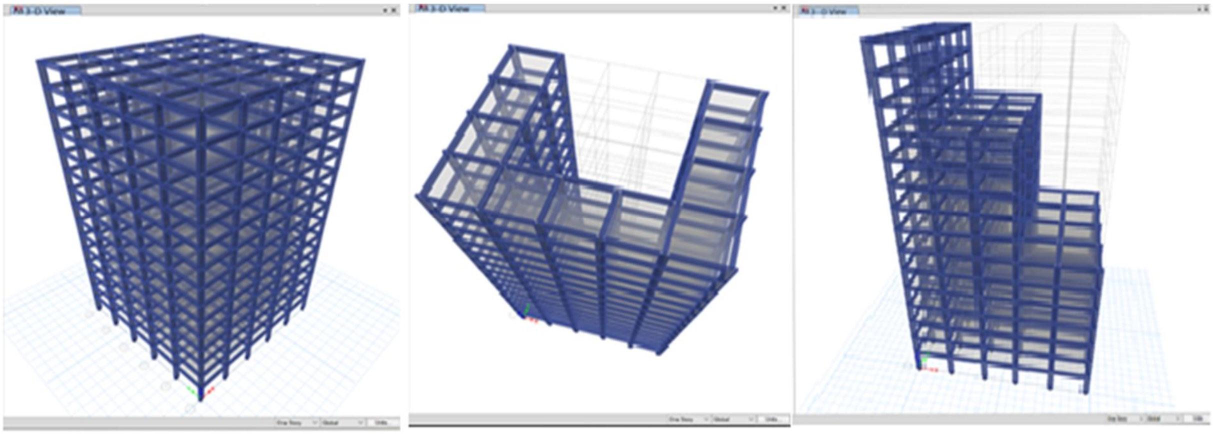

Fig.7 3D view of regular, horizontal irregular and vertical irregular structure

IV. RESULTS AND DISCUSSION

A. Storey Displacement

Table.1 Showing storey wise nodal displacement for all models

Story number	Model-1 (mm)	Model-2 (mm)	Model-3 (mm)
15	48.5	86.5	55.4
14	47.9	85.1	54.5
13	47	83.1	52.8
12	45.6	80.4	50.5
11	43.8	77.0	48.5
10	41.7	72.9	46.1
9	39.2	68.3	43.2
8	36.3	62.9	39.8
7	33.1	57.0	36.0
6	29.6	50.5	32.3
5	25.7	43.5	28.0
4	21.5	36.0	23.3
3	17.1	28.0	18.2
2	12.3	19.6	12.8
1	7.30	10.7	7.00

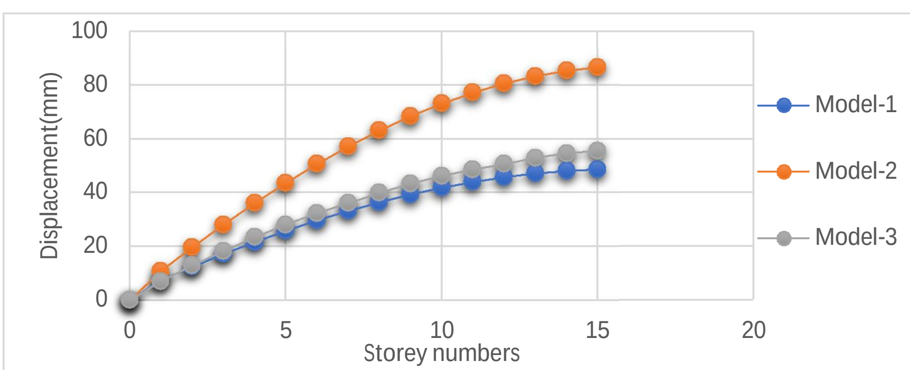

Fig.8. Graph showing displacement v/s storey numbers

From the above Fig.8 showing the variation of displacement v/s storey number and it shows the displacement in TG-4 is smaller amount as compared to other terrain categories.

B. Storey Drift

Table.2 Showing storey wise drift for all models

Story number	Model-1	Model-2	Model-3
15	0.000139	0.000453	0.00039
14	0.000198	0.000673	0.00066
13	0.000265	0.000902	0.00087
12	0.000333	0.001127	0.00065
11	0.000401	0.001348	0.00082
10	0.000466	0.001564	0.00097
9	0.00053	0.001772	0.00113
8	0.000591	0.001971	0.00126
7	0.000649	0.002161	0.00125
6	0.000704	0.002340	0.00142
5	0.000755	0.002508	0.00156
4	0.000802	0.002662	0.00169
3	0.000842	0.002805	0.00181
2	0.000842	0.002964	0.00194
1	0.000621	0.00306	0.00200

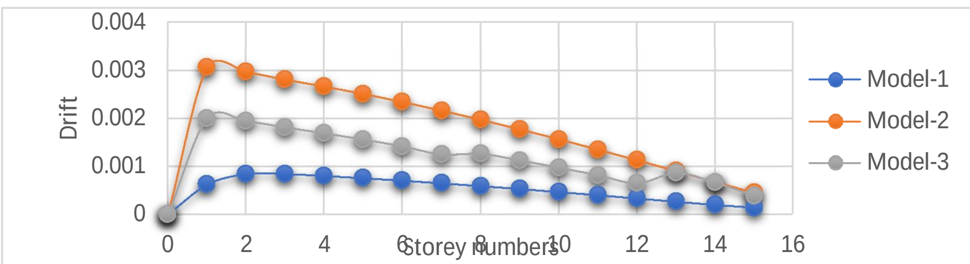

Fig.9. Graph showing drift v/s storey numbers

From the above Fig.9 showing the variation of drift v/s storey number and it shows the drift is more in horizontal irregular structure (model-2) as compared to alternative models.

C. Storey Stiffness

Table.3 Showing storey stiffness for all models

Storey numbers	Model-1 (kN/m)		Model-2 (kN/m)		Model-3 (kN/m)	
	Without shear wall($x10^5$)	With shear wall($x10^5$)	Without shear wall($x10^5$)	With shear wall($x10^5$)	Without shear wall($x10^5$)	With shear wall($x10^5$)
15	2.896	2.296	0.825	0.870	0.576	0.790
14	4.621	4.786	1.577	1.903	1.173	2.057
13	5.406	6.937	2.083	2.880	1.806	3.316
12	5.855	8.772	2.448	3.798	3.230	4.739
11	6.155	10.364	2.730	4.677	3.614	5.966
10	6.377	11.798	2.961	5.543	3.850	7.265
9	6.552	13.153	3.159	6.427	4.121	8.662
8	6.696	14.524	3.336	7.377	4.825	10.438
7	6.824	16.026	3.502	8.463	6.593	13.966
6	6.944	17.807	3.666	9.791	6.886	16.304
5	7.061	20.094	3.836	11.544	7.044	19.204
4	7.191	23.304	4.027	14.078	7.185	23.186
3	7.396	28.307	4.291	18.252	7.393	29.421
2	7.967	37.995	4.854	26.704	7.966	41.283
1	10.642	58.532	7.090	51.639	10.646	53.723

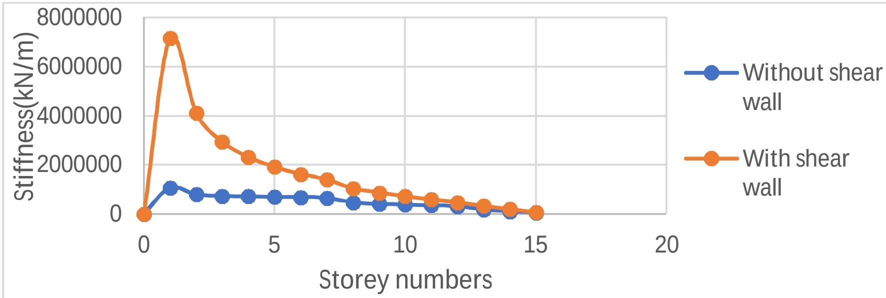

Fig.10. Graph showing stiffness v/s storey numbers.

From the above Fig.10 showing the variation of Stiffness v/s story number and it the stiffness is more in bottom stories and with shear wall structure, while not shear wall structure showing very terribly low stiffness.

D. Maximum Displacement

Table.4 Showing maximum displacement for all models

Type of structure	Displacement at WY (mm)	Displacement at WX (mm)
Regular	48.5	24.7
Horizontal irregular	86.5	59.3
Vertical irregular	55.4	31.9

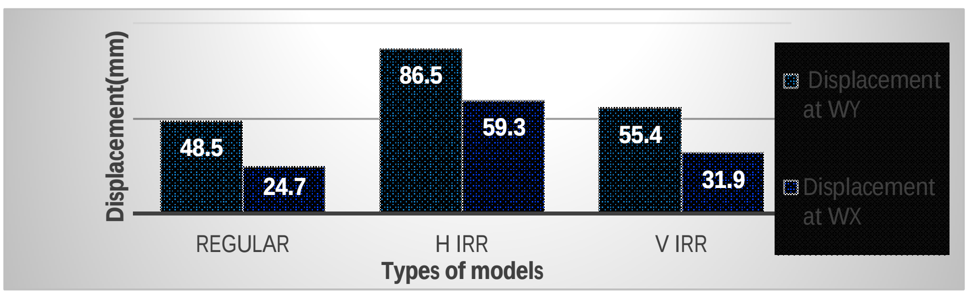

Fig 11. Graph showing maximum displacement in x & y direction

E. Maximum Storey Drift

Table.5 Showing storey drift for all models

Type of structure	Drift at WY	Drift at WX
Regular	0.000116	0.000621
Horizontal irregular	0.00306	0.00171
Vertical irregular	0.001997	0.000785

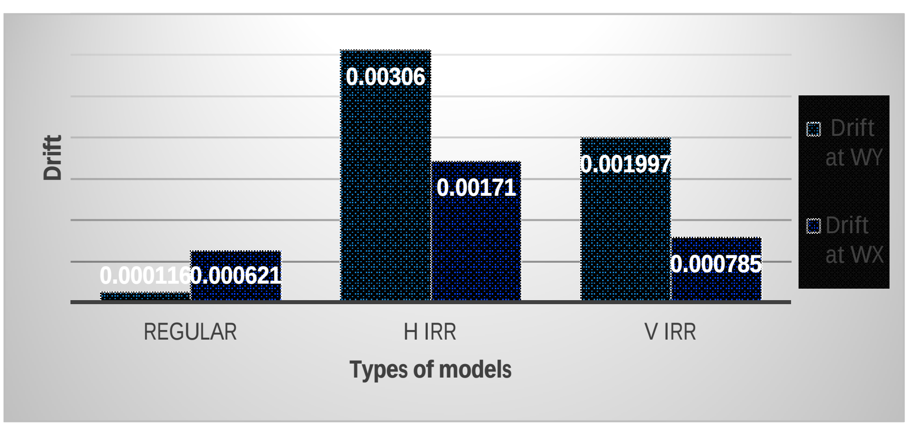

Fig 12. Graph showing maximum storey drift in x & y direction

F. Maximum Storey Shear

Table.6 Showing storey shear for all models

Type of structure	Shear at WY (KN)	Shear at WX (KN)
Regular	2458.5	1966.83
Horizontal irregular	2119.89	1695.9097
Vertical irregular	1844.77	1936.5499

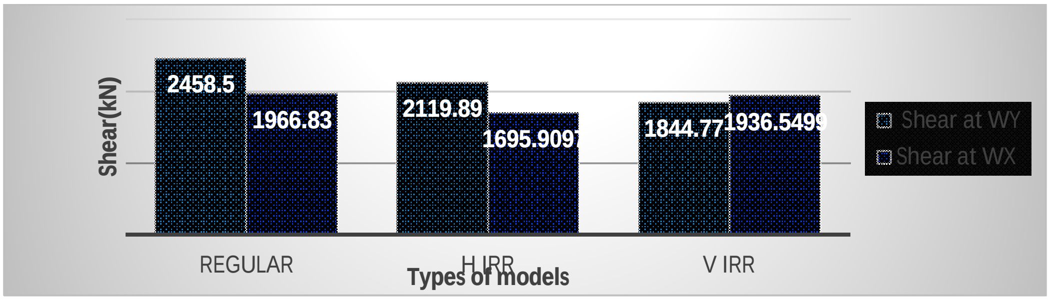

Fig.13 Graph showing maximum storey Shear in both x & y direction

From the above Fig.11 and Fig.12 shows the displacement is more in wind force y direction at horizontal irregular structure. and the maximum drift is more in wind force y direction at horizontal irregular structure and very less drift in regular structure and Fig.13 shows storey shear is more regular structure in wind force y direction.

G. Results for Models at Different Terrain Categorys

Table.7 Nodal displacement comparison (mm)

compare to m1	increase (%)	decrease (%)	compare to m2	increase (%)	decrease (%)	compare to m3	increase (%)	decrease (%)
M2	42.35	-	M1	-	42.35	M1	9.44	-
M3	-	9.44	M3	-	36.34	M2	36.34	-

The Table.7 gives following results

1) There is a nominal decrease in displacement in model-3 when subjected to any or all sort of loading in compared with model-1, there is an increase of displacement in model-2 as compared to model-1.
2) There is a decrease in the displacement in model-1(42.35%) and model-3(36.34%) as compared to model-2.
3) When model-3 compared with all models a rise in displacement in model-1(9.44%) and model-2(36.34%).

Table.8 Storey Drift Comparison

Compare to M1	Increase (%)	Decrease (%)	Compare to M2	Increase (%)	Decrease (%)	Compare to M3	Increase (%)	Decrease (%)
M2	71.25	-	M1	-	71.25	M1	51.81	-
M3	-	51.81	M3	-	34.93	M2	34.93	-

The Table.8 gives following results:

1) There is a nominal decrease in drift in model-3 when subjected to all type of loading in comparison with model-1, there is an increase of drift in model-2 as compared to model-1.
2) There is a decrease in the drift in model-1(71.25%) and model-3(34.93%) as compared to model-2.
3) When model-3 compared with all models there’s a rise in drift in model-1(51.81%) and model-2(34.93%).

V. CONCLUSIONS

In this work an effort has been created to examine the performance of various RC frame building like regular, horizontal irregular and vertical irregular structures for various terrain category's far wind topography.

Totally G+15 storey are considered for the analysis. The conclusion based on analysis presented here

A. The displacement in horizontal irregular structure (U-Shape) is 42.35% more as compared to model-1, the displacement will increases abruptly as increase in height of storey, thus U-Shape structure isn't preferred in wind zone.
B. The displacement is 30.88% less in terrain catagory-3 and 12.36% less in terrain category-4 as compared to terrain category-2.
C. The drift is 12.36% a lot of in terrain category-2 and 19.42% a lot of in terrain category-3 as compared to terrain category-4.
D. During this study the drift is more in horizontal irregular structure as compared to other structures.
E. The horizontal structure (U-Shape) is a lot of sensitive to the wind as compared to different structures
F. Over all analysis suggests rectangular structure for long wind or across wind direction is preferred because of giant stiffness and fewer displacement against wind.

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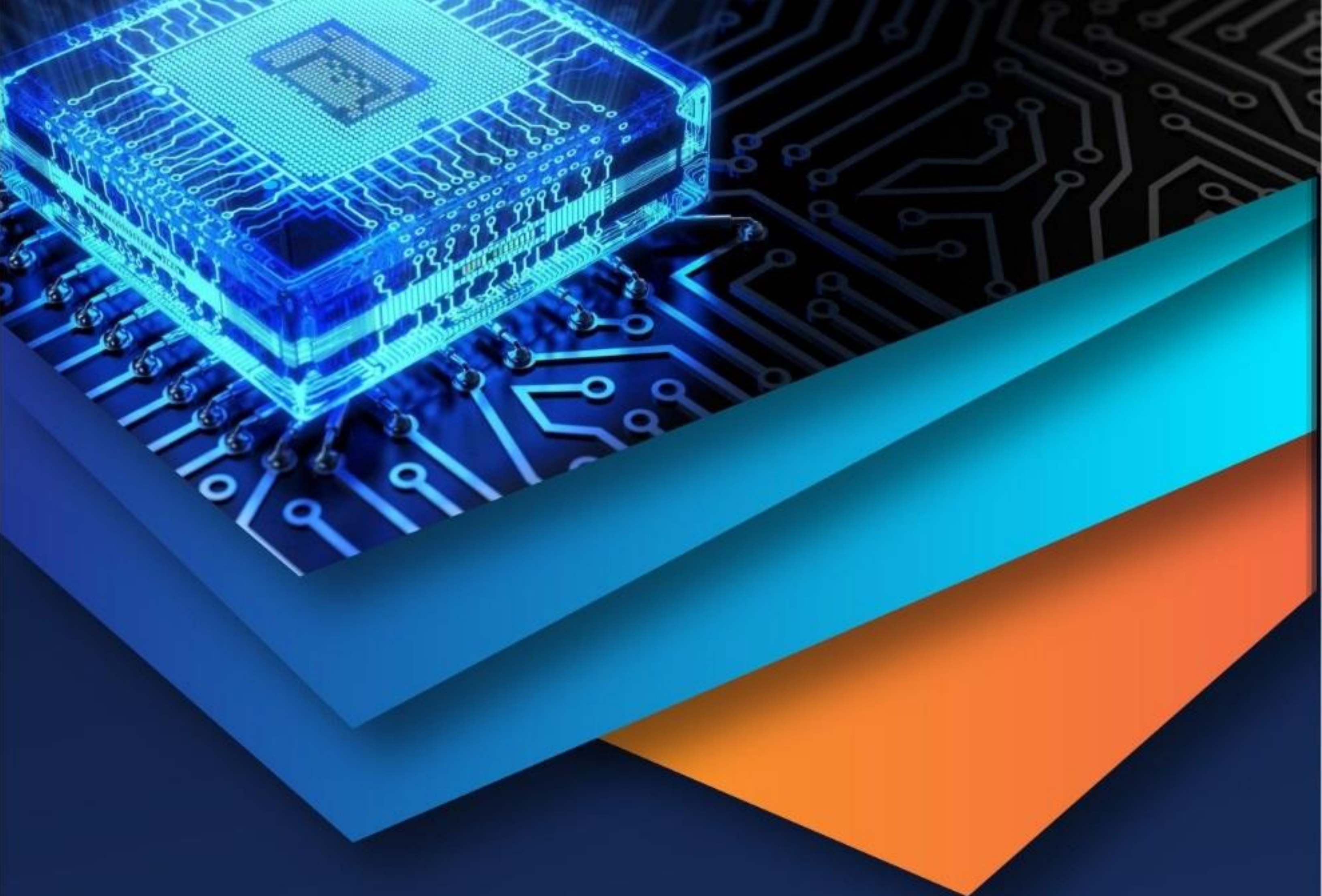

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