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Comparative Study of R.C.C Frame Models for Seismic Effect of (Skyscraper) Tall R.C Building Frame of G+20 Storey with Outrigger System in Zone III by using ETABS

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Abstract: Present scenario in the world, particularly large cities facing the problem with the tall structures (skyscrapers) because of increasing the population and congested area, especially like Dubai, japan and Malaysia etc. Present work, the research is conducted to check the seismic performance of outrigger system at 10th and 20th storey and core walls at center position of building in zone III. For this research work G+20 storey of tall RC frame structure 20m x 15 m has been analyzed in zone III with FEM based software ETABS is chosen. Totally 3 models are analyzed for outrigger system with channel section at 10th & 20th Storey with core wall and seismic performance is checked by lateral deflection, storey drifts and storey shear and checked the comparative study of model 1(Bare frame) with model 2 (Bare frame with outrigger system at 10th storey) & model 3 (Bare frame with outrigger system at 10th storey). From the comparisons of 3 models, more deflection existing in model 1 as compared to other models because of providing the outrigger system to tall structures and controlling the storey drifts and storey shear in tall structures.

Keywords: ETABS software, G+20 storey building (Skyscraper), Lateral displacement, Outriggers, Storey drifts, Storey shea

I. INTRODUTON

The tall buildings having height is more than 30 meters. These using for different purposes like residential, educational institutes, commercial, healthcare and storage power generation etc. from the past few years the many structures are damaged and collapsed by earthquake, it shows that need of seismic adequacy for the existing building structures. The earthquake measures in terms of loss of life and country properties. Building should sustain and bearing loads from gravity and lateral loads. The characteristics of material used to construct decides the strength of the structure. The geometrical and cross sectional properties are depends on stiffness. In this project G+20 storey framed structure with 5 by 3 bays located at earthquake zone III is analysis in soft soil conditions using outrigger systems at 10^{th} and 20^{th} storey of tall RC frame building.

II. OBJECTIVES

A. The objective of present study the use of outriggers in a regular building under wind and earthquake forces in zone III.
B. The bare framed buildings with and without outrigger is compared by analyzed in zone III using software ETABS.
C. The outriggers are introduced at two levels in buildings.
D. The behavior of outriggers introduced as a steel bracing in a R.C tall framed structure.
E. The outrigger location in building is obtained for reducing lateral displacements.
F. The results of lateral displacements, storey drift and base shear are studied in zone III.
G. To study the comparison between the lateral displacements, storey drifts and storey shear of three models in seismic zones III.
H. To study failure conditions of three models at 10^{th} and 20^{th} storeys in zone III for three model buildings.
I. To promote safety without too much changing the constructional practice of reinforced concrete structures.

III. METHODOLOGY

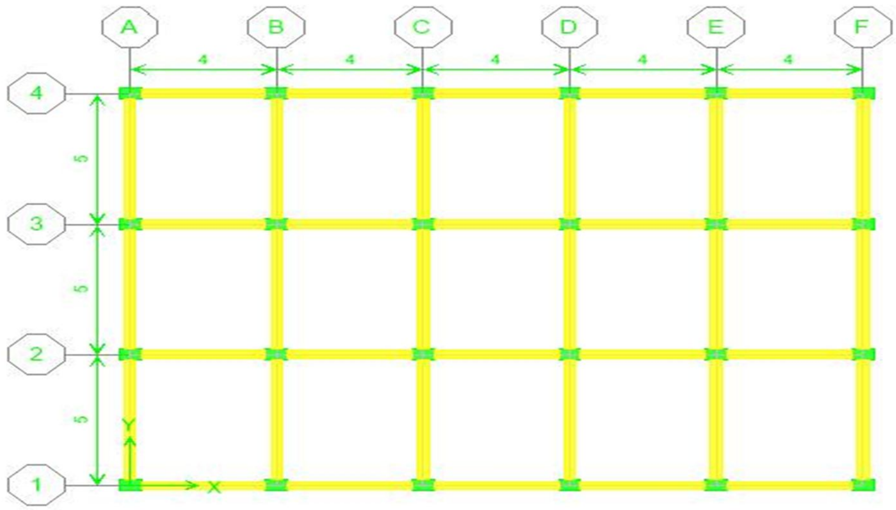
Most of the building structures were not designed to resist major and moderate types of seismic by using manually, in fact it usually by gravity loading and lateral load which make susceptible to attack the building during the event of earthquake. The three dimensional structure has modeled and Analyzed to gravity loading such as dead load, live load and Seismic loading. Then the outrigger to be placed for 10^{th} and 20^{th} storey of RC framed tall building and lateral deflection, Storey drift and Storey shear has been to be checked by using ETABS.

A. Modeling Description

According to this three dimensional analysis is necessary for typical tall structural model for the study. Here, the method is based on simplifying assumption which determined optimum locations of outriggers and core wall. A lateral load is linearly increased with height of building. The model is as 20 storey reinforced concrete consisting of frames, Core wall & outriggers. The modeling of G+20 storey building with outrigger system at 10th & 20th storey and shear wall at core of the building is prepared. Plan area of the building is 20m x 15m. The model prepared with 6 bays by 4 bays in both x and y directions respectively.

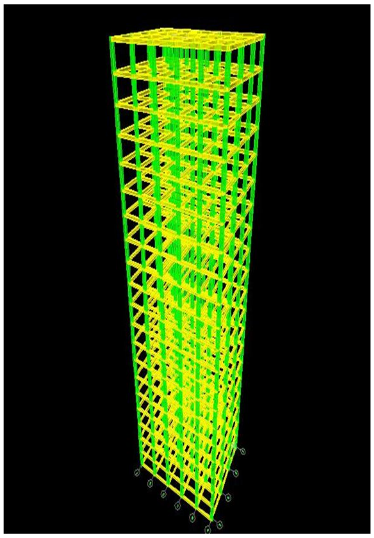
1) *Model 1:* RC bare frame
2) *Model 2:* RC bare frame with outrigger system at 10th storey and core wall
3) *Model 3:* RC bare frame with outrigger system at 10th and 20th storey and core wall

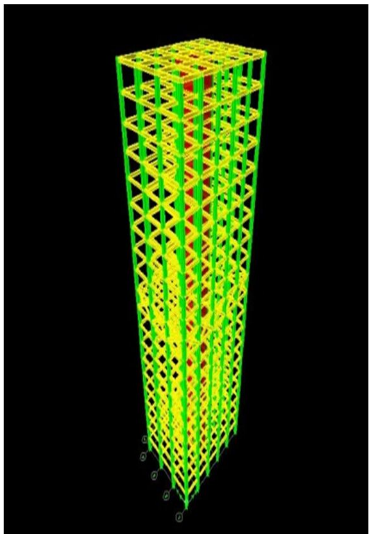
Plan area of the building is 20m x 15m. The model prepared with 6 bays by 4 bays in both x and y directions respectively.

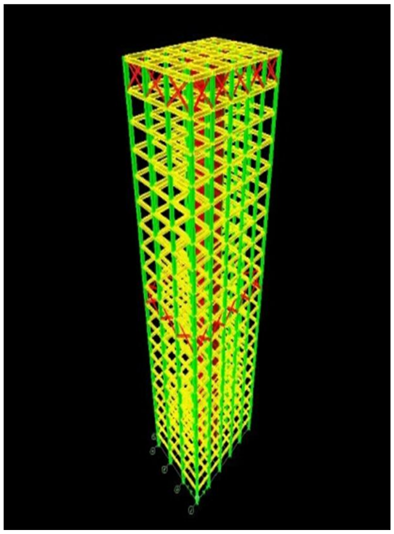


Structural modelling

The ETABS software is one in which we are able to are expecting the static analysis of the hundreds which act on the structural participants. It can be expecting the geometric nonlinear behaviour of area frames beneath static or dynamic loadings, taking into consideration both geometric nonlinearity and material inelasticity. Buildings of 20 storied are taken and their structural conduct is as compared beneath seismic zone III using static analysis.







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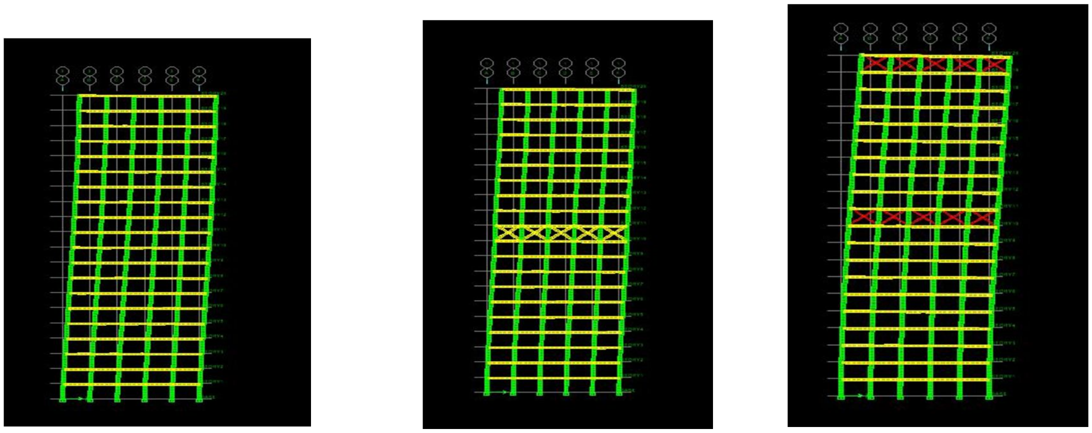

a) Deflection for Model 1   b) Deflection for Model 2   c) Deflection for Model 3

Fig 5: Prepared Models for analysis

B. Analyzing the Data

Linear dynamic analysis has been performed as per IS 1893 (Part 1): 2002 for each model using ETABS analysis package. Calculation of lateral loads and self-weights and its distribution along the elevation of the building is done. The seismic load is obtained using full dead load plus 25% of live load.

Table 2: Following data is used in the analysis of the tall RC frame building Models

Type of frame	(OMRF) Ordinary moment resisting RC frame fixed at the base of the tall building
Seismic zones	III
Number of storey	G+20 storey
Floor height	3 m
Size of beam	(300 × 400) mm
Size of column	(300 × 600) mm
Spacing between frames in x-direction	20 m
Spacing between frames in y-direction	15 m
Materials	M 25 concrete, Fe 415 steel
Type of section of outrigger system	channel section
Position of outrigger system	10th and 20th storey
Infill (shear wall)	Brick
Density of concrete	$24KN/m^3$
Density of infill	$20\ KN/m^3$
Type of soil	Medium soil
Seismic zone	As per IS (1893-2002)
Zone factore	For zone III: 0.16
Importance Factor, I	1
type of seismic analysis	Linear static analysis
Damping of structure	5 percent
Plinth height above ground level	3 m
Type of the building	OMRF (Ordinary moment resisting RC frame) along with outrigger system and core wall
Load on beams	3kN/m2
Live load	2 kN/m2
For Seismic zone loading only 50% of the imposed load is considered the structure is analyzed for all seismic zone by considering Medium for each seismic zone	

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IV. RESULTS AND DISCUSSIONS

Linear dynamic analysis is performed on all models. Loads are calculated and distributed as per code IS 1893 (Part I):2002 using ETABS. The results obtained from analysis are compared with respect to the following parameters. The analysis of three models includes the frame models and bare frame with outrigger system and shear wall at core of the tall building. The linear static analyses are done by using ETABS. The parameters which were studied are storey drifts, lateral displacement, and storey shear for all Models in zones III.

Comparative study of lateral displacement, Storey drifts and Storey shear from model 1, model 2 and model 3

A. Comparison Of Lateral Displacements In Model 1, Model 2 And Model 3

Table 10: Results for lateral displacements in model 1, model 2 and model 3

S.No	Storey	Lateral displacement (m) in Model 1	Lateral displacement (m) in Model 2	Lateral displacement (m) in Model 3
1	Storey 20	0.0147	0.0275	0.0166
2	Storey 19	0.0144	0.0265	0.0156
3	Storey 18	0.014	0.0253	0.0146
4	Storey 17	0.0136	0.024	0.0135
5	Storey 16	0.0131	0.0226	0.0125
6	Storey 15	0.0125	0.0212	0.0114
7	Storey 14	0.0118	0.0196	0.0103
8	Storey 13	0.011	0.0181	0.0093
9	Storey 12	0.0102	0.0165	0.0082
10	Storey 11	0.0094	0.0151	0.0072
11	Storey 10	0.0086	0.0146	0.0062
12	Storey 9	0.0077	0.0132	0.0052
13	Storey 8	0.0068	0.0114	0.0043
14	Storey 7	0.0059	0.0097	0.0034
15	Storey 6	0.0049	0.0079	0.0026
16	Storey 5	0.004	0.0062	0.0019
17	Storey 4	0.0031	0.0045	0.0013
18	Storey 3	0.0022	0.003	0.0008
19	Storey 2	0.0013	0.0017	0.0004
20	Storey 1	0.0005	0.0006	0.0001
21	Base storey	0	0	0

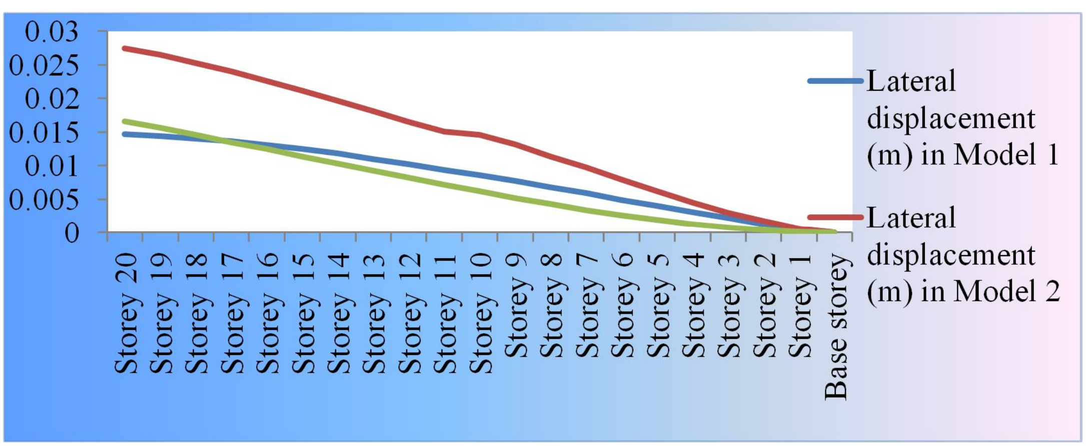

Fig 6: Comparison of lateral displacements in model 1, model 2 and model 3

From above graph, the lateral displacement has been studied from model 1, model 2 and model 3 in seismic zone III and the displacement was more in model 2 as compared to model 1 and model 3 because of outrigger system at 10th storey of the building. And also in model 3 the lateral displacement has been decreased due to outrigger at both 10th and 20th storey of skyscraper. So from above comparison the model 3 (outrigger at both 10th & 20th storey) was much strengthened (stabilized) building as compared to model 1 & model 2. The use of outrigger structural system in tall buildings increases the stiffness with decreasing lateral displacement. Outrigger structural system makes the efficient structure under seismic and wind loads.

B. Comparison Of Storey Drifts In Model 1, Model 2 And Model 3

Table 11: Results for Storey drifts in model 1, model 2 and model 3

S.No	Storey	Storey drifts (m) in Model 1	Storey drifts (m) in Model 2	Storey drifts (m) in Model 3
1	Storey 20	0.00009	0.00035	0.00033
2	Storey 19	0.00012	0.00039	0.00035
3	Storey 18	0.00015	0.00043	0.00035
4	Storey 17	0.00018	0.00046	0.00035
5	Storey 16	0.00020	0.00049	0.00036
6	Storey 15	0.00023	0.00051	0.00036
7	Storey 14	0.00025	0.00053	0.00036
8	Storey 13	0.00026	0.00053	0.00035
9	Storey 12	0.00028	0.00045	0.00034
10	Storey 11	0.00029	0.00017	0.00033
11	Storey 10	0.00030	0.00048	0.00032
12	Storey 9	0.00030	0.00058	0.00031
13	Storey 8	0.00031	0.00059	0.00029
14	Storey 7	0.00031	0.00059	0.00027
15	Storey 6	0.00031	0.00058	0.00024
16	Storey 5	0.00031	0.00055	0.00021
17	STOREY 4	0.00030	0.00050	0.00017
18	STOREY 3	0.00029	0.00044	0.00013
19	STOREY 2	0.00026	0.00036	0.00009
20	STOREY 1	0.00018	0.00020	0.00004

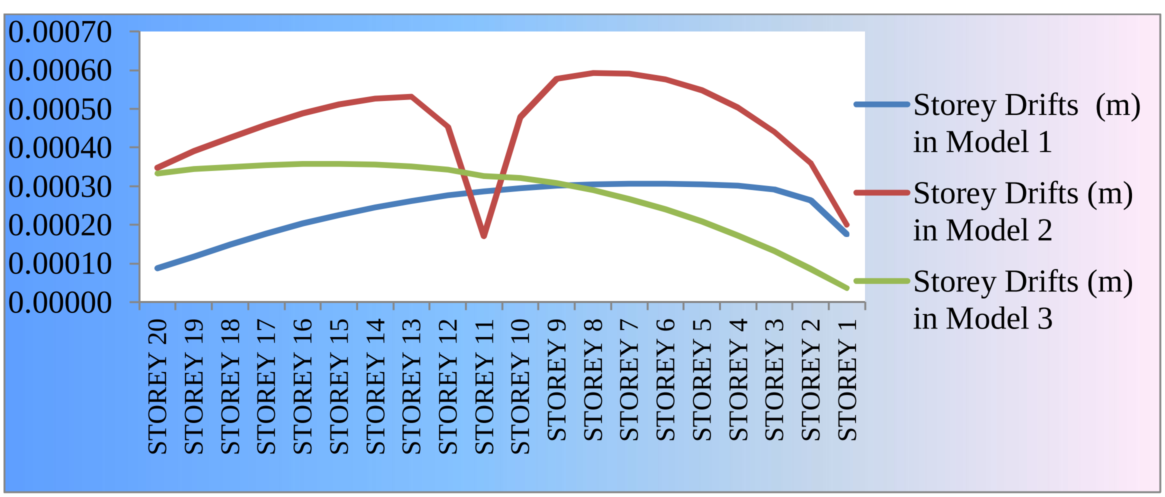

Fig 7: Comparison of Storey drifts in model 1, model 2 and model 3

From above graph, the storey drifts has been studied from model 1, model 2 and model 3 in seismic zone III and the maximum storey drifts were obtained for model 2 because of the outrigger system is established at only one place i.e at 10th storey and the minimum storey drifts were obtained n model 3 because of the outrigger system is established at two place i.e at 10th storey and 20th storey. So the model 3 has more stability nature as compared to other two models. Here the outrigger system and core wall were controls the lateral storey drifts. The load resisting capacity of tall structures increases by providing outrigger due to its characteristic of strength

C. Comparison of Storey shear in Model 1, Model 2 and Model 3

Table 12: Results for Storey shear in model 1, model 2 and model 3

S.NO	Storey	Storey Shear (kN) in Model 1	Storey Shear (kN) in Model 2	Storey Shear (kN) in Model 3
1	Storey 20	99.32	82.41	20.68
2	Storey 19	234.67	167.37	44.22
3	Storey 18	354.91	243.61	65.35
4	Storey 17	462.17	311.62	84.2
5	Storey 16	557.17	371.86	100.89
6	Storey 15	640.67	424.81	115.56
7	Storey 14	713.41	470.93	128.34
8	Storey 13	776.13	510.7	139.36
9	Storey 12	829.57	544.59	148.76
10	Storey 11	874.94	577.09	156.65
11	Storey 10	912.43	603.95	163.17
12	Storey 9	942.49	623.01	168.45
13	Storey 8	966.24	638.07	172.62
14	Storey 7	984.43	649.6	175.82
15	Storey 6	997.79	658.07	178.17
16	Storey 5	1007.07	663.95	179.8
17	Storey 4	1013	667.72	180.84
18	Storey 3	1016.34	669.84	181.43
19	Storey 2	1017.83	670.78	181.69
20	Storey 1	1018.2	671.01	181.75

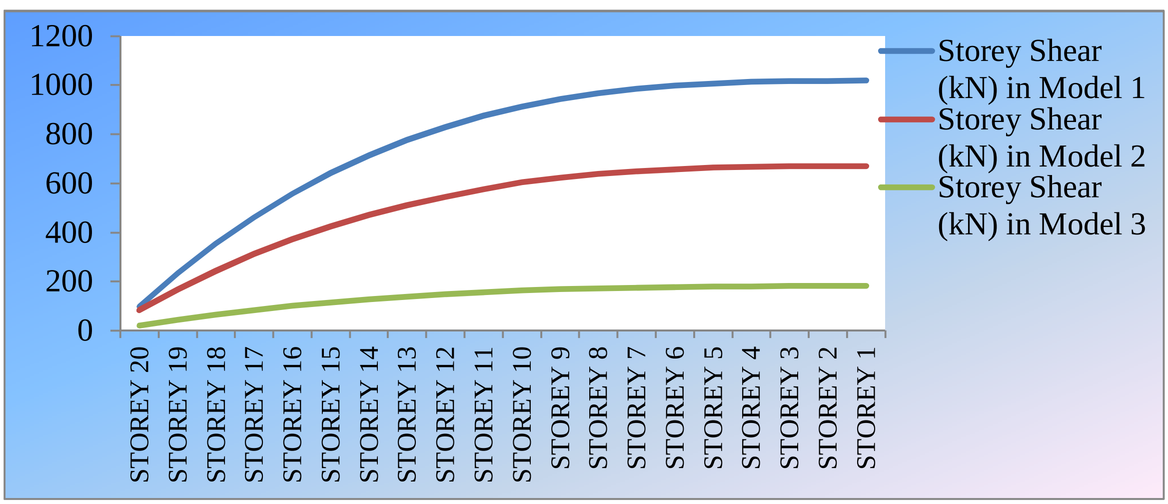

Fig 8: Comparison of Storey shear in model 1, model 2 and model 3

From above graph, the storey shear has been studied from model 1, model 2 and model 3 in seismic zone III and the maximum storey shear occurs in model 1 and minimum storey shear occurs in model 3. The load resisting capacity of tall structures increases by providing outrigger due to its characteristic of strength. And due to this minimum shear because of stipulated condition of shear wall at center of the structure when located an outrigger system to control less movement conditions. And from above results, the outrigger system controls the storey shear.

V. CONCLUSIONS

The complete results refers that outrigger system is great seismic replacer for more stability and to minimize the further damages. Analyzed and compared the lateral deflection and lateral drifts, it gives a maximum higher check to the protection of systems analyzed by way of technique specified by way of IS code and using ETABS.

A. When parameter considered such as lateral displacement in tall building, then the optimum position of outrigger is at middle height of the building for lateral loads.

B. Due to this minimum deflection because of stipulated condition of shear wall at center of the structure when located an outrigger system to control less movement conditions.

C. The outrigger structural system not only efficient for lateral displacement, it can also play the good role for storey drifts.

D. The use of outrigger structural system in tall buildings increases the stiffness with decreasing lateral displacement. Outrigger structural system makes the efficient structure under seismic and wind loads.

E. The load resisting capacity of tall structures increases by providing outrigger due to its characteristic of strength.

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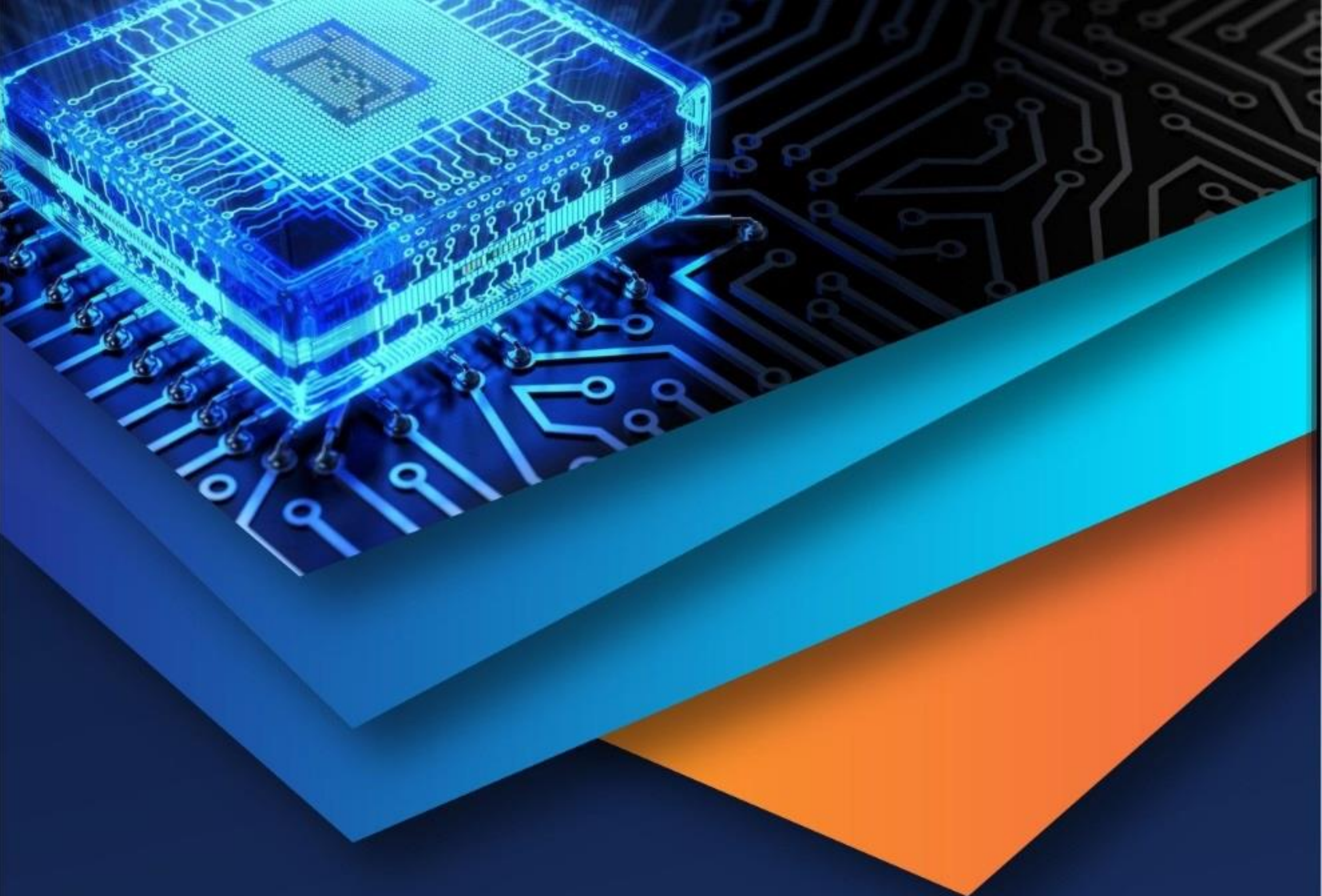

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