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Comparative seismic analysis study of G+ 20 story building with flat slab and conventional slab using ETABS

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***Abstract:** In the study, three dimensional analytical models of G+20 story buildings have been generated and analysed using CSI ETABS software version 2016. The earthquake zone III in India is considered for buildings during analysis. Here, the analysis and design is done of G+20 story building with flat slab(with drops) and conventional slab system. In earthquake zone the displacement and drift of the structures will be more so to have more stiffness to the structure shear wall is to be provided therefore a study is made by comparing between conventional slab & flat slab (with drops) building. Comparison of various parameters like story drift, story displacement, story stiffness and time period is done. The equivalent static method is used to design and analyze the structures, as categorized by Indian Standard Code for earthquake resistant structures. The study shows that story drift is 10% more in conventional slab as compared to flat slab; story displacements is observed linearly increasing with height of the building and is 11% more in conventional slab as compared to flat slab .*

***Keywords:** Equivalent Static Method, Flat Slab, ETABS 2016, story displacement, story stiffness, story drift, time period*

I. INTRODUCTION

About 65% of portion of India is susceptible to damaging the structure levels of seismic hazards. The structure which do not withstand the seismic pressure might endure extensive damages, break or even collapse. In this study, the structural analysis of G+20 storyed reinforced concrete frame building with flat slab(with drops) and conventional slab system is done with the help of ETABS software. To cope with the situation maximum utilization of space vertically calls for construction of multi-storey building (High rise building) in large number is taken place. In high rise buildings lateral loads like wind loads, earthquake loads and blast forces are attaining importance and every designer is facing with the problems of providing stability and adequate strength against lateral loads. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. A flat slab could be a reinforced concrete slab supported directly by concrete column without usage of beam.

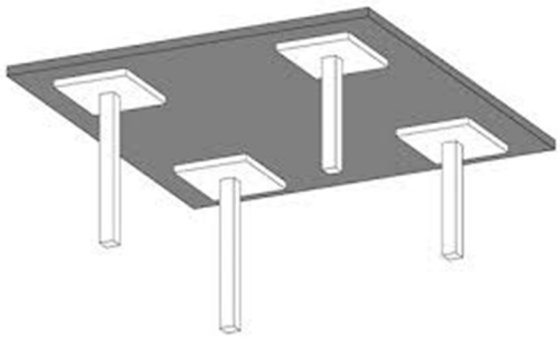

Fig -1: Typical shape of Reinforced Concrete Flat Slab with drop panel

In the present paper, an attempt is made to study and compare the effects of earthquake on a multi storied building comparing between conventional slab & flat slab (with drops) building for various parameters such as story drift, story displacement, story stiffness and time period. Analysis is been carried out as per the IS 1893:2002[6], IS 456:2000[9] and using ETABS v2016 software.

A Analysis And Design Of Flat Slab By Using Etabs Software by B.Anjaneyulu et.al.is done using ETABS software. In this paper it is found that Flat plate/slab construction is a developing technology in india flat slabs has manyadvantages over conventional slabs and hence it can be a very good option for modern constructions.[1]

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A Comparative Study of Seismic Analysis Between Conventional and Flat Slab with Drop and without Drop Framed Structures with Different Masonary Infills by M Vinod Kumar Reddy et.al.is done using ETABS software. In this paper it is found that Base shear of the conventional framed structures are having more than Flat slab with drop and without drop framed structures.[2]

Use of flat slabs in multi-storey commercial building by A.C.Thakur et.al.. In this paper it is concluded that The reduction in time period in Flat slab without drop, Flat Slab with Drop with opening and Flat Slab without Drop is 3%,6% and 7% as compared with Flat Slab with Drop.[3]

A Comparative Analysis of RCC and Steel-Concrete-Composite (B+G+ 11 Storey) Building is done by N.A.Mohite et.al. using ETABS software. The conclusion drawn out of this paper is that Still roof displacement and drift with earthquake in X and Y direction are less in Composite framed structure as to R.C.C. framed structure. This may be due to more ductility in case of Composite structure as compared to the R.C.C. which is best suited under the effect of lateral forces.[4]

A study on Assessment of Response Reduction Factor of Flat Slab Structures by Pushover Analysis by A.M. Balate et.al. is done using ETABS software for seismic zones II, III and IV. The conclusion drawn out of this paper is that the flat slab gives maximum bending moment at end corner as it behaves similarly to cantilever slab.[5]

II. MODELLING AND ANALYSIS OF MULTI-STOREY BUILDING

The three-dimensional reinforced concrete structure is modelled and analysed in Equivalent Static Method using CSI ETABS version 2016 software to indicate the likely maximum seismic response of the said structure.

For the present study work, G+ 20 stories with conventional slab and flat slab with drops have been modelled. Description of structure like Structure details, Material properties, section properties, and loads for conventional slab and flat slab with drops are shown in Table 1,2,3 and 4 respectively.

Table 1 Input data Structure details

Plan dimension	30m X 20 m
Number of arms in x-axis	6
Number of arms in y-axis	5
Arm length in x-axis	5m
Arm length in y-axis	4m
Bottom Height of the floor	4m
Floor to floor height	3m

Table 2 Material properties

	Conventional slab	Flat slab
Concrete grade	M30	M30
Concrete grade of drop	--	M30
Density of concrete	25kN/m^3	25kN/m^3
Grade of steel	Fe500	Fe500
Poisson's ratio	0.2	0.2
Modulus of elasticity	25kN/m^2	25kN/m^2

Table 3 Section properties

Structural element	Conventional slab building	Flat slab building
Beam	300x450	--
Column	750x750	750x750
Slab thickness	150	200
drop slab thickness	--	300
Panel size	--	5x4m

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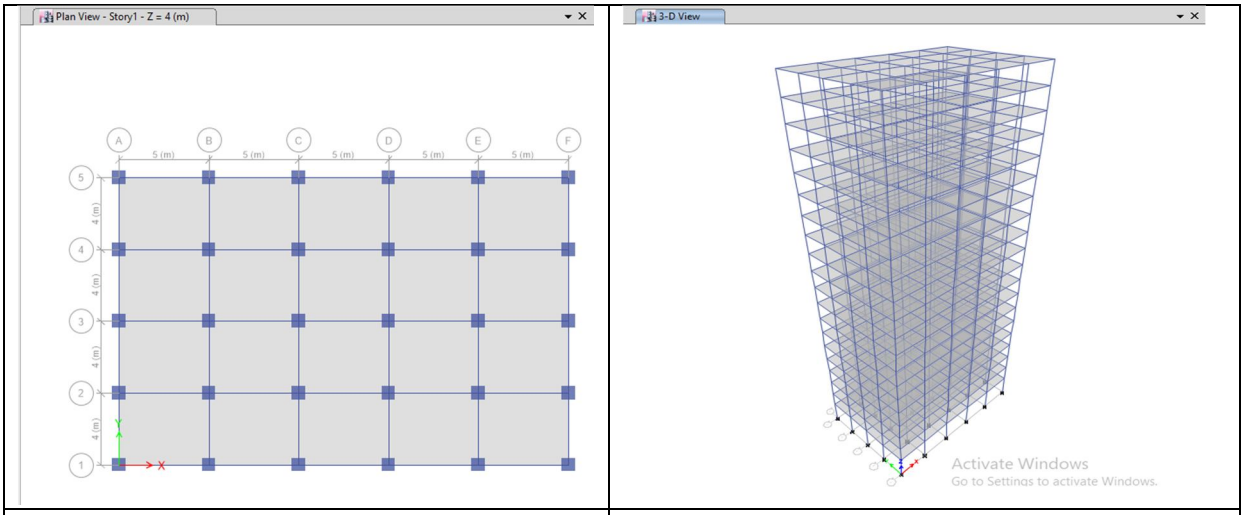
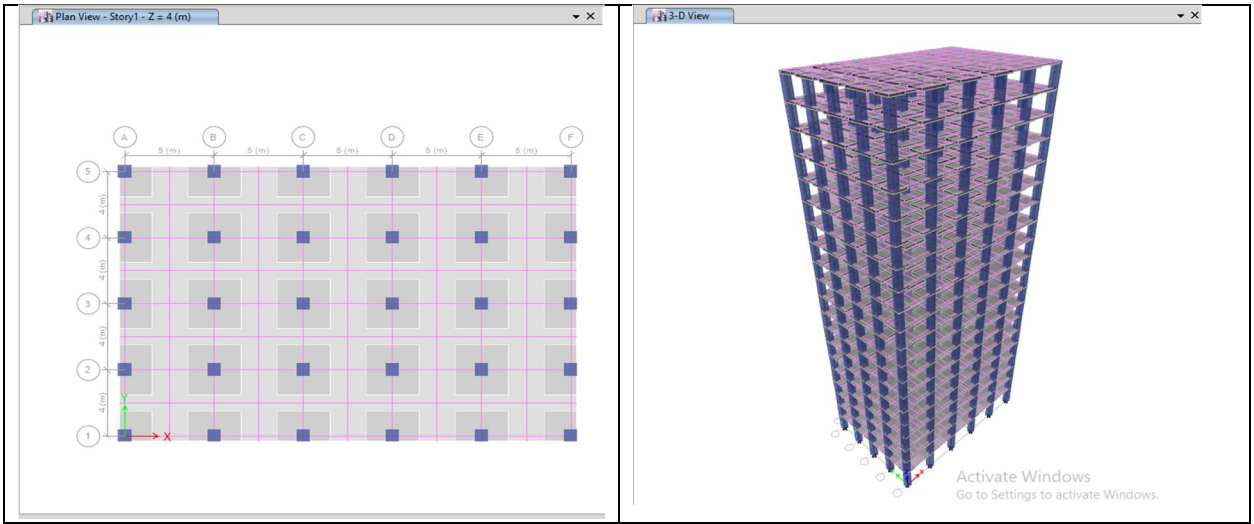
Table 4 Loads

Dead load	Default values taken by E-Tabs		Zone factor (Z)	III, 0.16
Live load	4kN/m^2		Soil Type	Hard Soil-I
Floor finish	1.5kN/m^2		Response Reduction factor (R)	5.0
Wall load	14.66 kN/m^2		Importance factor(I)	1.0



Plan | Elevation

Fig.2 Geometric of G+20 storied reinforced concrete frame model with Conventional slab in CSI ETABS



Plan | Elevation

Fig.3 Geometric of G+20 storied reinforced concrete frame model with flat slab in CSI ETABS in CSI ETABS

Fig.4 Flow process adopted for analysis

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III. RESULTS AND DISCUSSIONS

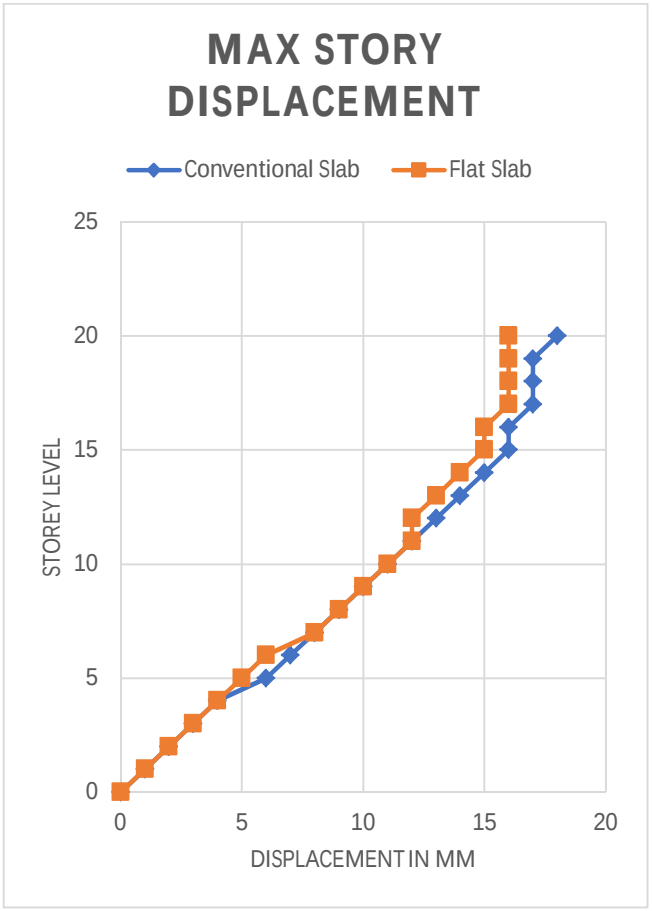
Following are the results of analysis. Comparison of parameters mentioned is tabulated in following tables.

A. Story Displacement

Table 5 demonstrates the maximum displacement for conventional slab building and flat slab building. The results of conventional slab building model shows that at top floor as compared with the flat slab building model produces 18mm and 16mm displacement with 11% difference.

Table 5 Story displacement

Story	Conventional Slab	Flat Slab
20	18	16
19	17	16
18	17	16
17	17	16
16	16	15
15	16	15
14	15	14
13	14	13
12	13	12
11	12	12
10	11	11
9	10	10
8	9	9
7	8	8
6	7	6
5	6	5
4	4	4
3	3	3
2	2	2
1	1	1
0	0	0



Graph 1. Story displacement

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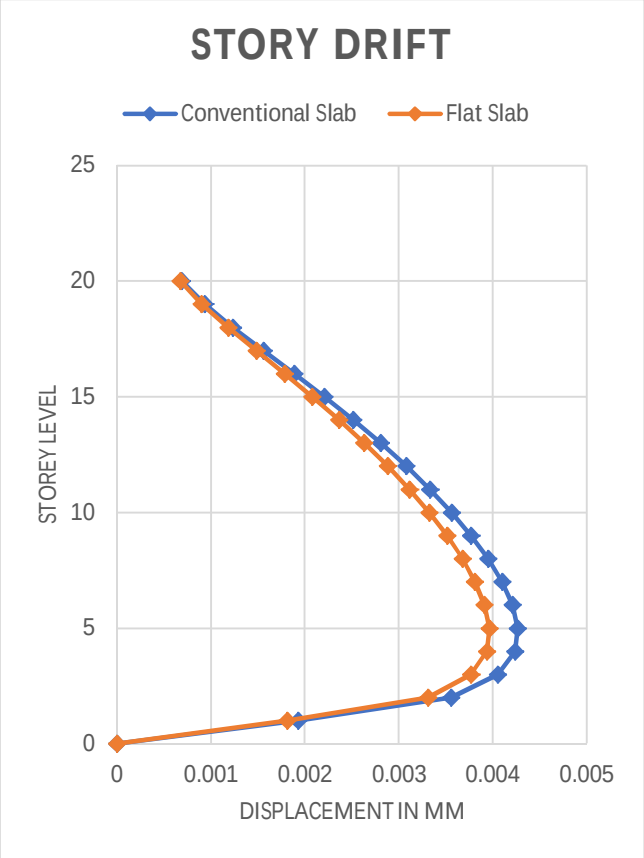
B. Story Drift

Table 6 demonstrates the maximum story drift occurs at story 1 in conventional slab building with a difference of 10.63% as compared to flat slab building.

Table 6 Story drift

Story	Conventional Slab	Flat Slab
20	0.000692	0.0006735
19	0.0009327	0.0009017
18	0.001235	0.001184
17	0.001559	0.001484
16	0.001886	0.001785
15	0.002206	0.002079
14	0.002513	0.002362
13	0.002806	0.00263
12	0.003079	0.002881
11	0.003333	0.003113
10	0.003564	0.003324
9	0.00377	0.003512
8	0.00395	0.003675
7	0.004098	0.003809
6	0.004208	0.003909
5	0.004266	0.003961
4	0.004238	0.003936
3	0.004053	0.00377
2	0.003553	0.003311
1	0.00193	0.001814
0	0	0



Graph 2. Story drift

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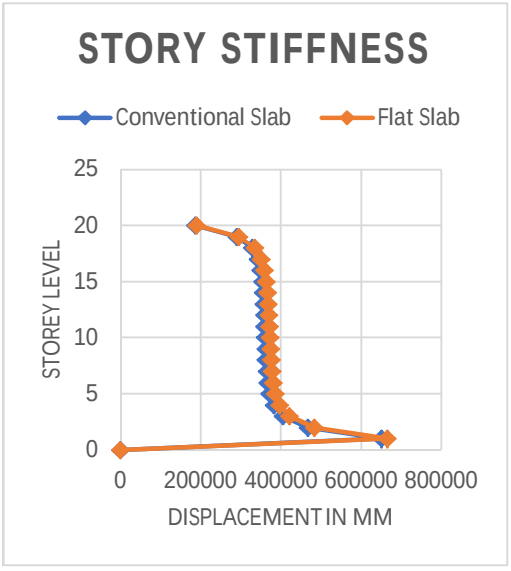
C. Story Stiffness

Table 7 demonstrates the story stiffness . Story stiffness is more for Flat Slab Building as compared to Conventional Slab building.

Table 7 Story stiffness

Story	Conventional Slab	Flat Slab
20	186517.036	190727.93
19	291536.912	295949.71
18	329081.324	335302.34
17	343784.792	351559.32
16	350422.253	359409.29
15	353939.573	363855.75
14	356113.699	366758.78
13	357655.577	368892.85
12	358883.537	370621.88
11	359962.423	372143.07
10	360998.994	373585.95
9	362091.837	375064.31
8	363378.014	376723.29
7	365110.627	378816.83
6	367830.197	381876.49
5	372771.201	387120.31
4	382918.717	397524.64
3	406215.499	421094.97
2	468323.496	483994.95
1	650675.638	666318.33
0	0	0



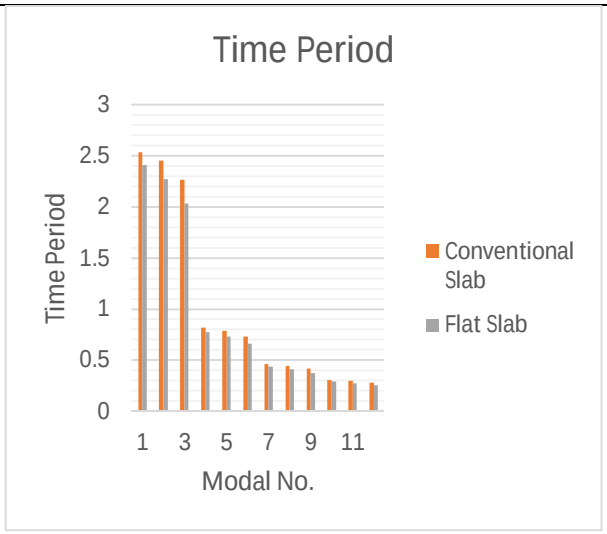
Graph 4. Story stiffness

D. Time Period

Time period for conventional slab model is 2.535sec.and 2.406 sec. for flat slab model which is 5.36 % more than flat slab model.

Table 8. Time period

Mode	Conventional Slab	Flat Slab
1	2.535	2.406
2	2.452	2.274
3	2.265	2.032
4	0.818	0.776
5	0.789	0.733
6	0.732	0.66
7	0.461	0.438
8	0.441	0.411
9	0.415	0.377
10	0.308	0.292
11	0.296	0.276
12	0.277	0.254



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IV. CONCLUSION

A. The maximum story drift is 10% more in conventional slab model as compared to flat slab.

B. The story displacement increases linearly and the results of conventional slab building model shows that at top floor as compared with the flat slab building model produces 18mm and 16mm displacement with 11% difference. .

C. The story stiffness is less in conventional slab building model as compared to flat slab building model.

D. The time period in conventional slab building model structure is 1.05times more than the flat slab building model.

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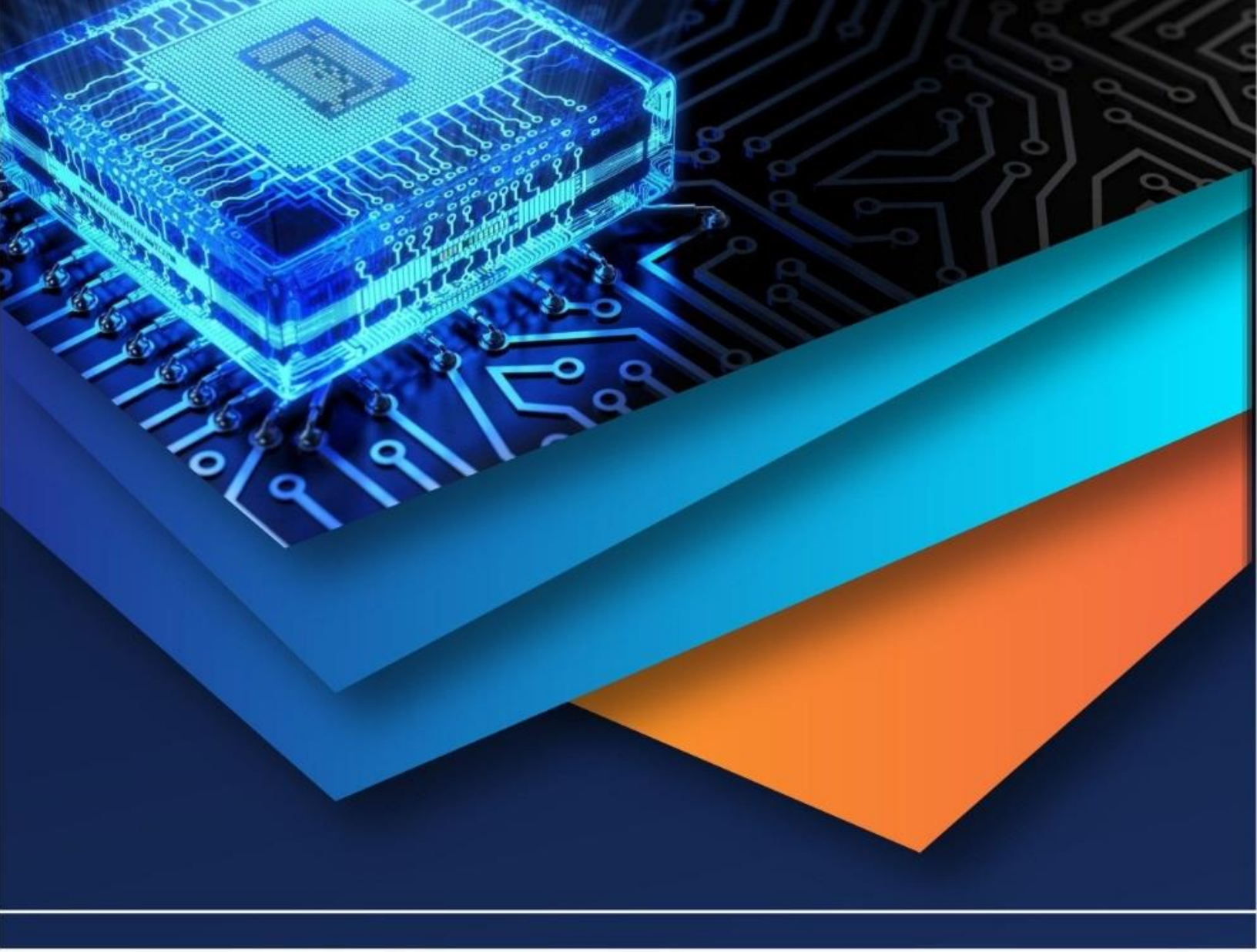

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