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Study and Analysis of Diagrid Structures with Conventional Frame Structure

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Abstract: ***The structure is the backbone of building Construction of the multi-storey building is quickly increasing throughout the globe. Advances in construction technology, materials, structural systems, analysis and design software package expedited the expansion of those buildings. Diagrid buildings square measure rising as structurally economical furthermore as architecturally important assemblies for tall buildings. The diagrid structural system may be outlined as a diagonal member shaped as a framework created by the intersection of various materials like metals, concrete or wood beams that are used in the construction of buildings and roofs. Diagrid structures of the steel members are efficient in providing a solution both in term of strength and stiffness. In this study the safety and minimum harm level of a structure may well be the prime demand of high-rise buildings. In this thesis Analysis and design of 16 storey diagrid building with plan of 18 m × 18 m size is considered.***
Keywords: Diagrid building, STAAD.Pro, Storey Drift, Storey Shear, Tall buildings, Seel members, High rise building.

I. INTRODUCTION

Construction of the multi-storey building is quickly increasing throughout the globe. Advances in construction technology, materials, structural systems, analysis and design software package expedited the expansion of those buildings. Diagrid buildings square measure rising as structurally economical furthermore as architecturally important assemblies for tall buildings. Recently the diagrid structural system has been wide used for tall buildings due to the structural efficiency and aesthetic potential provided by the distinctive geometric configuration of the system. Generally, for tall building diagrid structure steel is employed. In present work, concrete diagrid structure with completely different shapes is analysed and compared with a conventional concrete building. The structural design of high-rise buildings is ruled by lateral loads because of wind or earthquake. Lateral load resistance of the structure is provided by the inside structural system or exterior structural system. because of inclined columns, lateral loads are resisted by axial action of the diagonal in diagrid structure compared to bending of vertical columns within the typical building. The diagrid structural system may be outlined as a diagonal member shaped as a framework created by the intersection of various materials like metals, concrete or wood beams that are used in the construction of buildings and roofs. Diagrid structures of the steel members are efficient in providing a solution both in term of strength and stiffness. But these days a widespread application of diagrid is employed within the giant span and high-rise buildings, significantly after they area unit complicated geometries and arced shapes. Diagrid structure consists of inclined columns on the exterior surface of the building. Due to inclined columns, lateral loads are resisted by axial action of the diagonal compared to bending of vertical columns in framed tube structure. Diagrid structures typically, don't need core because of lateral shear may be carried by the diagonals on the outer boundary of a building.

II. OBJECTIVE OF STUDY

For comparison of this buildings under the same seismic zone, the parameter in both type of the buildings is taken same.

1) The work is to be carried out by conducting-
2) Modelling of both the building frames.
3) Analysis of building frames considering seismic parameters.
4) Study of results in terms of moments, stresses & Moment in Slab, forces, drift, deflection, and the economy

III.MODELLING

A. Modelling and Analysis

Different Model of building considered is given below:
Model-1 Conventional Building Denoted as CB
Model-2: Square Diagrid Building denoted as SDB
Model-3: Circular Diagrid Building denoted as CDB
Model-4: Triangular Diagrid Building denoted as TDB

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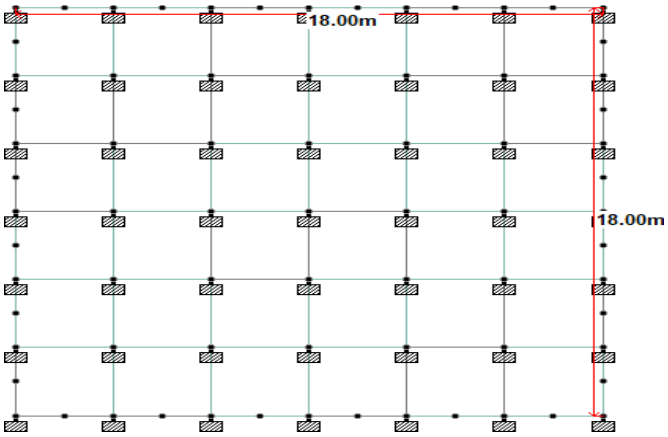
B. Preliminary Sections and materials considered:

The plan area for the proposed work is **18 x 18** m in which size of panels is **3x3** m for conventional and square diagrid building and similar area consider for circular and triangular buildings the preliminary sections of columns and beams were fixed based on deflection criteria [i.e. span to depth ratio]. The sections were found to be satisfactory for the given loads for a 16 storied model. These sections were maintained uniform throughout the height. Similarly, all other models of were analysed and meet the current Codes (IS 456:2000 and IS 1893:2002) andtheir structural member sizes chosen for the study are given in table below

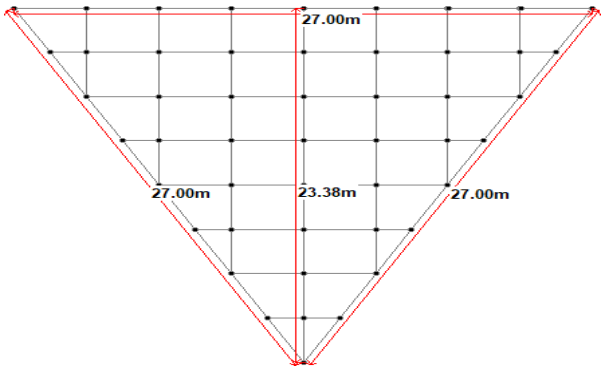
C. Design Parameters- Here the Analysis is being done for G+16 building by computer softwareusing STAAD-Pro.

Table 1 Design parameters

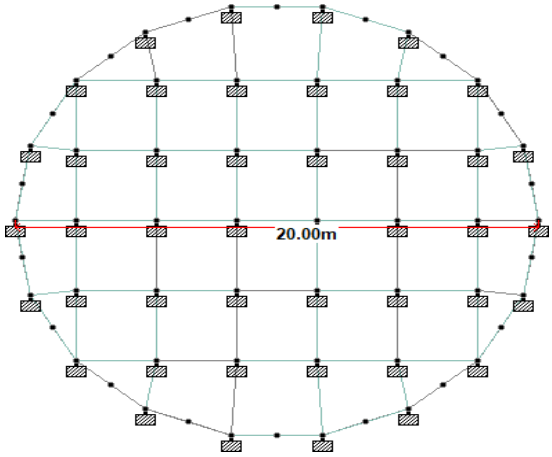
S.No	Particulars	Dimension/Size/Value
1	Model	G+16
2	Seismic Zones	IIIrd
3	Floor height	3.6
4	The configuration of both the models	Square, Circular and triangular
5	Angle of diagrid-	67.4°
6	Plan size	18X18
7	Size of columns	500mmX500mm
8	Size of beams	300mmX500mm
9	Thickness of slab	120mm
10	Size of Diagonals	300X500
11	Type of soil	Medium soil Type-II
12	Dead Load	10 & 12 KN/N2 (Roof & Floor)
13	Live load	3 &1.5KN/M^2 (Roof & Floor)
14	Material used	Grade of Concrete M25& Steel Fe415
15	Dynamic Analysis	Response Spectrum Analysis& Wind analysis
16	Fundamental natural period of building	Ta = 0.075 $h^{0.75}$
17	Zone factor Z	0.16
18	Response Reduction factor (RF)	5
19	Importance factor (I)	1
20	Rock and soil factor (SS)	2
21	Type of structures	1
22	Damping ratio (DM)	0.05



Plan area of Conventionaland Square diagrid Building= 18*18
= 324 sq. meter



Plan area of Triangularbuilding
= **316 sq. Meter** approx.



Plan area of CircularBuilding
= 315 sq. Meterapprox.

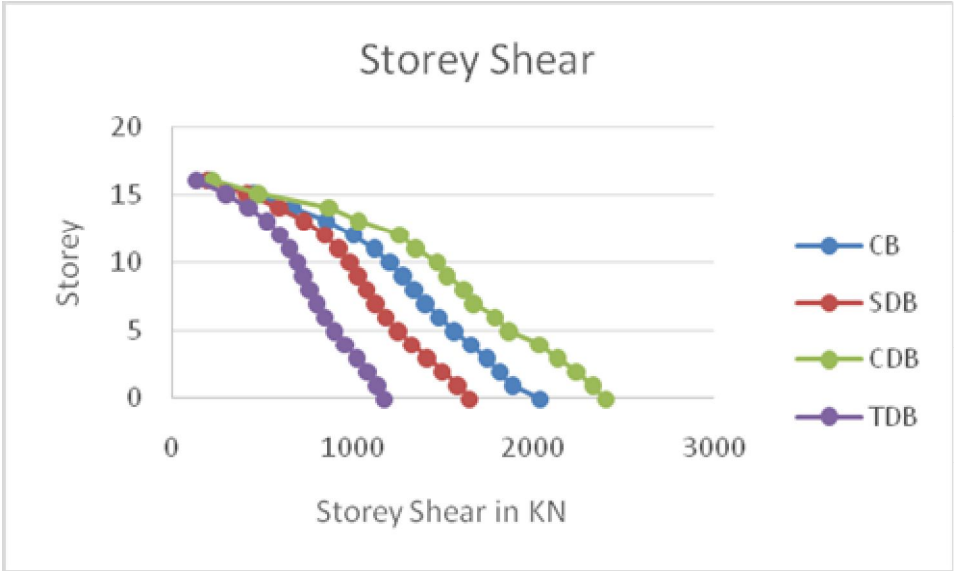
Figure 1 Plan area of Different Shapes of Diagrid buildings

IV. RESULT AND DISCUSSION

A. Peak Storey Shear

Table 2 Peak storey Shear for Seismic Analysis

	STORY	CB	SDB	CDB	TDB
PEAK STORYSHEAR IN KN	16	206	194	227	132
	15	450	410	478	295
	14	667	590	867	419
	13	852	731	1030	522
	12	1001	842	1258	595
	11	1117	919	1346	650
	10	1204	982	1467	690
	9	1273	1028	1520	725
	8	1334	1077	1613	758
	7	1399	1125	1666	798
	6	1474	1184	1785	842
	5	1559	1250	1862	897
	4	1651	1326	2030	955
	3	1738	1411	2132	1020
	2	1812	1498	2232	1080
	1	1883	1582	2325	1134
	0	2030	1647	2396	1172



Graph 1 Storey vs peak storey shear

Peak storey shear decreases 16 % average at each story in Square diagrid building when is compare to conventional building with similar plan area.
Peak storey shear increases 20% average at each story in Circular diagrid building when is compare to conventional building with similar plan area.
Peak storey shear decreases 40% average at each story in Triangular diagrid building when is compare to conventional building with similar plan area

B. Node Displacement for Seismic force

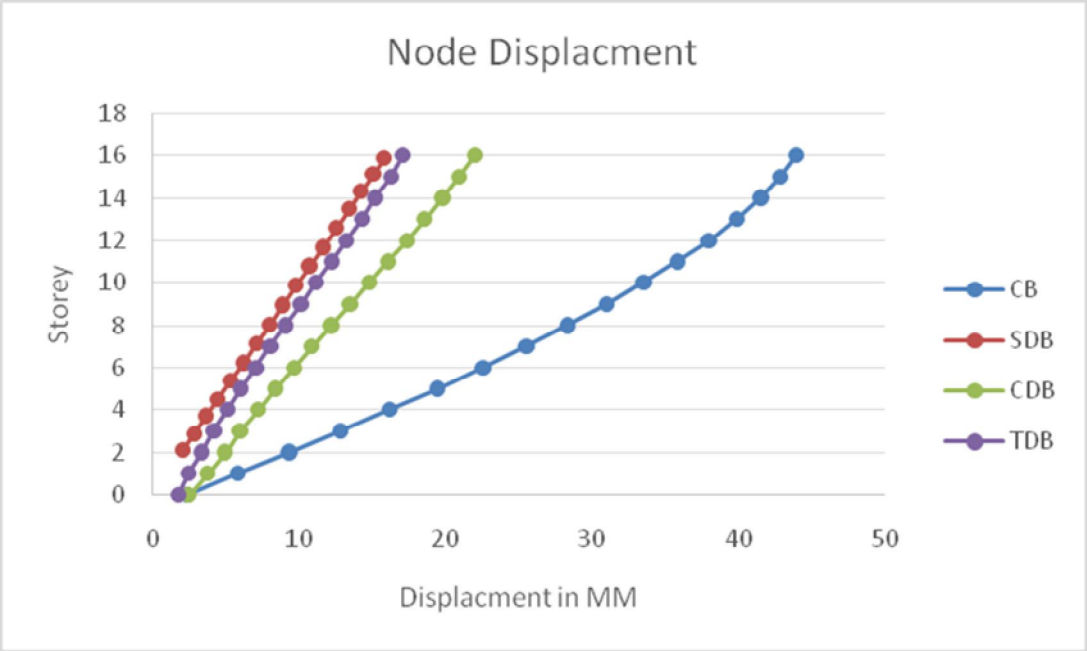
Table 3 Node displacement for seismic Analysis

	STORY	CB	SDB	CDB	TDB
NODE DISPLACMENT IN X DIRECTION (mm)	16	43.894	15.825	22.034	17.052
	15	42.849	15.089	20.956	16.295
	14	41.509	14.278	19.828	15.214
	13	39.867	13.445	18.625	14.319
	12	37.958	12.565	17.391	13.223
	11	35.818	11.664	16.106	12.238
	10	33.481	10.762	14.827	11.146
	9	30.971	9.835	13.509	10.114
	8	28.303	8.934	12.235	9.06
	7	25.488	8.005	10.924	8.026
	6	22.526	7.126	9.693	7.03
	5	19.413	6.211	8.414	6.025
	4	16.16	5.369	7.248	5.108
	3	12.783	4.469	6.028	4.172
	2	9.309	3.692	4.973	3.342
	1	5.788	2.854	3.792	2.447
	0	2.362	2.102	2.529	1.773

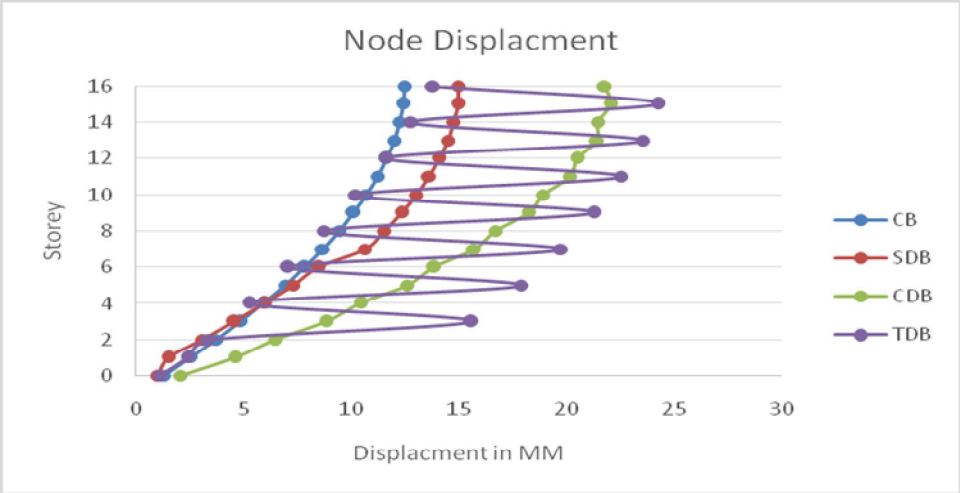
C. Node Displacement for Wind effect

Table 4 Node Displacement for Wind forces

	STORY	CB	SDB	CDB	TDB
NODE DISPLACMENT IN X DIRECTION (mm)	16	12.491	14.993	21.804	13.83
	15	12.422	14.972	22.075	24.287
	14	12.261	14.764	21.481	12.819
	13	12.013	14.52	21.436	23.555
	12	11.675	14.108	20.524	11.603
	11	11.251	13.65	20.161	22.564
	10	10.74	13.032	18.934	10.252
	9	10.145	12.368	18.257	21.316
	8	9.466	11.54	16.718	8.749
	7	8.705	10.658	15.73	19.786
	6	7.865	8.535	13.888	7.104
	5	6.947	7.308	12.595	17.921
	4	5.954	5.996	10.461	5.289
	3	4.89	4.61	8.871	15.619
	2	3.758	3.082	6.461	3.396
	1	2.563	1.53	4.646	2.418
	0	1.308	1	2.054	1.122



Graph 2 Storey vs Displacement for Seismic Analysis



Graph 3 Storey Vs displacement for Wind Analysis

1) Node Displacement for Seismic Forces

Node displacement decreases 62 % average at each story in Square diagrid building when is compare to conventional building with similar plan area.

Node displacement decreases 40% average at each story in Circular diagrid building when is compare to conventional building with similar plan area.

Node displacement decreases 62% average at each story in Triangular diagrid building when is compare to conventional building with similar plan area.

2) Node Displacement for Wind Forces

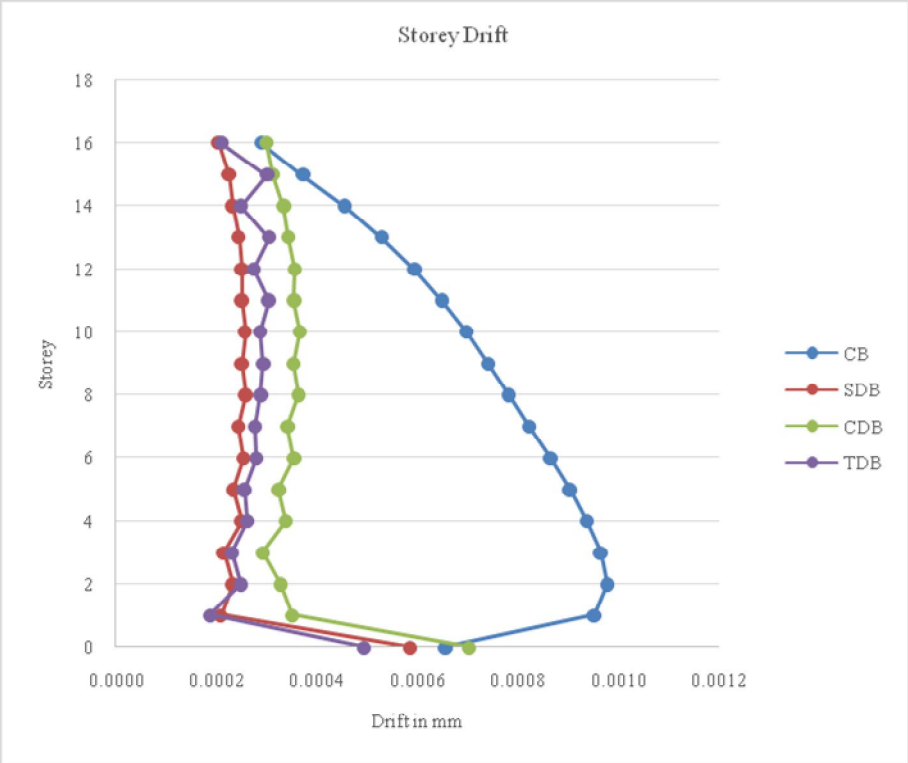
Node displacement increases 20 % average at each story in Square diagrid building when is compare to conventional building with similar plan area.

Node displacement increases 70% average at each story in Circular diagrid building when is compare to conventional building with similar plan area.

Uneven increment seen at each story in Triangular diagrid building when is compare toconventional building with similar plan area.

D. Story Drift

	STORY	CB	SDB	CDB	TDB
STORY DRIFT IN X DIRECTON(MM)	16	0.0003	0.0002	0.0003	0.0002
	15	0.0004	0.0002	0.0003	0.0003
	14	0.0005	0.0002	0.0003	0.0002
	13	0.0005	0.0002	0.0003	0.0003
	12	0.0006	0.0003	0.0004	0.0003
	11	0.0006	0.0003	0.0004	0.0003
	10	0.0007	0.0003	0.0004	0.0003
	9	0.0007	0.0003	0.0004	0.0003
	8	0.0008	0.0003	0.0004	0.0003
	7	0.0008	0.0002	0.0003	0.0003
	6	0.0009	0.0003	0.0004	0.0003
	5	0.0009	0.0002	0.0003	0.0003
	4	0.0009	0.0003	0.0003	0.0003
	3	0.0010	0.0002	0.0003	0.0002
	2	0.0010	0.0002	0.0003	0.0002
	1	0.0010	0.0002	0.0004	0.0002
	0	0.0007	0.0006	0.0007	0.0005



Graph 4 Storey Drift for Seismic Analysis

V. CONCLUSION

Response spectrum analysis results provides a more realistic behaviour of structure response and diagrid structure is more effective in lateral load resistance Seismic and wind analysis of conventional building with different shapes of diagrid building with equivalent plan area at seismic zone III is carried out and the following conclusions are drawn from the study:

1) Total base shear increasesin circular shape of diagrid building and decreases in square and triangular shape of diagrid building when compare with conventional building for seismic analysis.

2) It concludes that the node displacement is decreases in all shapes of diagrid buildings when compare with conational type of building.

3) The values of storey drift are found to be within permissible limit i.e. not more than 0.004 times the storey height as per norms according to IS 1893:2002 (Part-1) for both analysis seismic and wind.

4) Its concluded Diagrid building shows less lateral displacement and drift in comparison to conventional building.

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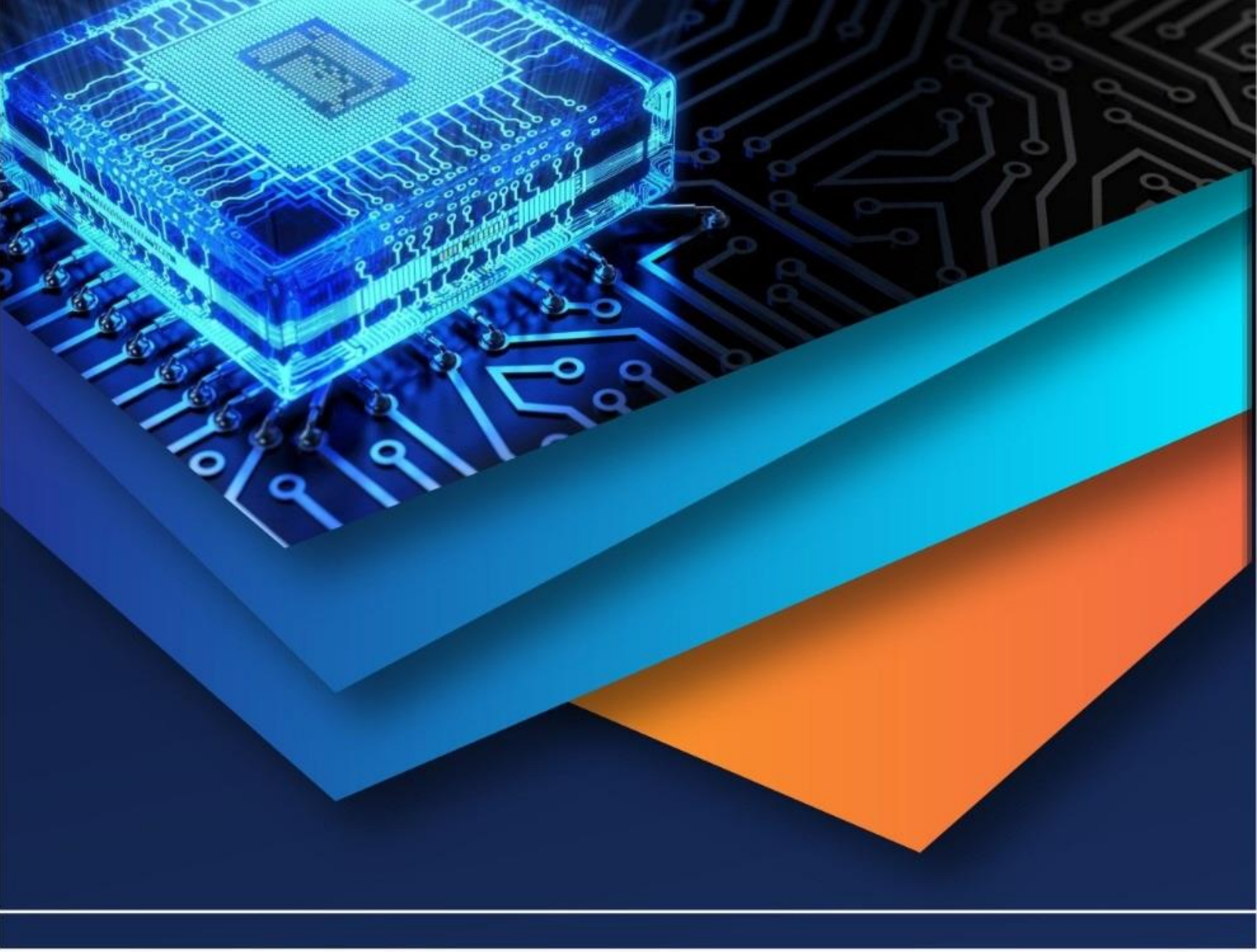

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