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Comparison and Optimization of 8 Storeys Ordinary Moment Resisting Frame and Special Moment Resisting Frame Building

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***Abstract*:In this paper comparison of Ordinary Moment Resisting Frame (OMRF) and Special Moment Resisting Frame (SMRF) has been done for parameters like Storey Shear, Storey Drift, Base Shear, Bending moment in Beams and Column, Axial force in Column& design of Beam and Column. Design and detailing of reinforcement for MRF has been done as per IS 456:2000 while for SMRF design and detailing of reinforcement has been done as per the provisions of IS 13920:1993.**
Keywords: **OMRF, SMRF, Response Reduction Factor, Ductility, Etabs 2015.**

I. INTRODUCTION

As people are migrating towards the urban areas in search of better opportunities there is a scarcity of space for accommodation hence it is needed to go for vertical construction i.e. multi-storied building. Natural disasters such as Earth-quake affect the stability of these structures. Past experiences reveal that majority failures of the structures are due to faulty design, hence proper analysis and design is compulsory to safeguard the loss of life and property.

Moment resisting frame: It is a frame in which members and joints are capable of resisting forces primarily by flexture. As per IS 1893:2002 they can be classified as:

A. Ordinary Moment Resisting Frame: It is a moment resisting frame not meeting special ductile detailing requirement for ductile behavior. Response reduction factor (R) is taken as 3 in OMRF

B. Special Moment resisting Frame: It is a moment resisting frame specially detailed to provide ductile behavior. Response reduction factor (R) is taken as 5 in SMRF.The objective of the present study is to investigate & compare the performance of SMRF and OMRF. For this purpose, a G+8 building of 23.4m X 27.87 m having (5 bay X 7 bay) lying in earthquake zone (iv) has been modeled and analyzed using Etabs 2015 software. The design criterion for OMRF is given in IS 456:2000 while for SMRF in IS 456:2000 and IS 13920:1993.

II. LITERATURE REVIEW

Ambika-Chippa ,PrernaNampalli (2014)[2]: In this paper they have analysed the moment resisting frame with and without shear wall for different seismic zones .It has been concluded that story drift and base shear of structure increases as we go to higher seismic zone, storey drift & base shear increases as the number of bays increases for the same zone, story drift and base shear for frame with shear wall is less as compared to frame without shear wall.

DervimOzhendekci&NuriOzhendekci (2012)[3]: In this paper they haveStudied the effect of change in span, in moment resisting steel frame. For the purpose three 10-story building was analysed with different span arrangement and designed according to Turkish seismic code. It has been concluded that for long span upper storey beam remain elastic, elastic upper story beam causes higher plastic rotation in lower stories.

Amit Kumar Yadav(2017)[5]: In this paper heStudied the effect of earthquake of all zones on regular and irregular structure. It has been observed that for irregular frame with infill wall & without infill the bending moment is more as compared to regular framed structure without infill.

Mohammad H.Jina (2014)[6]: In this paper heStudied the effect of masonry wall in G+9 framed structure, equivalent diagonal strut method was used for modelling brick wall according to FEMA 273. In this method infill was replaced by diagonal strut. It has been concluded that the axial force in the column increases while the story displacement and story drift decreases with increase in stiffness of infill.

Dev. Raj paudel&Santosh Kumar Adhikari(2017)[8]:In this paper theyStudied the effect of masonry wall on RC framed building, for this purpose two buildings of G+5 and G+9 which were modelled located at seismic zone v. It has been concluded that time period of oscillation for infill building is less as compared to bare frame building for both models.

III.METHODOLOGY

This paper deals with the comparative study of SMRF and OMRF (G+8) building. The comparison of result in terms of moment, Shear force, Storey displacement and storey drift has been made. Following steps were applied in the study

Step 1: Selection of building geometry, bays and number of stories.
Step 2: Selection of Response Reduction factor (R) i.e.(OMRF & SMRF)
Step 3: Considering the following load combination.

1.5(D.L+L.L)
1.2(D.L+L.L±EQ_X)
1.2(D.L+L.L±EQ_Y)
1.5(D.L±EQ_X)
1.5(D.L±EQ_Y)
0.9D.L±1.5EQ_X
0.9DL±1.5EQ_Y

Step 4: Modelling the building using Etabs Software.
Step 5: Comparative study of results in terms of moment, Shear force, Storey displacement and storey drift.
Step 6: Design of Beam & Column.

IV.PLANNING OF FRAMED STRUCTURE

For designing and comparison of OMRF and SMRF structure the following data has been assumed.
A framed structure of 27.87m X 23.4 m has been taken. There are 6 X 7 bay (X-Z plane).shown in fig 1 & fig.2 respectively.

In X direction	AB	BC	CD	DE	EF	
	5 m	6.87 m	4.13 m	6.57 m	5 m	
In Z direction	1-2	2-3	3-4	4-5	5-6	6-7
	4.13 m	4.13 m	3.44 m	3.44 m	4.13 m	4.13 m

In the groundStorey there is a provision of parking. And the Storey height of ground floor is 3.5m. For all other floor the Storey height is 3.0m.
The total height of the building is 24.5 m.

Details of Building Element:

Contents	OMRF	SMRF
Roof Beam	250mm X 450mm	250mm X 400mm
Beam section (except roof)	300mm X 450mm	250mm X 400mm
Corner column section	350mm X 400mm	350mmX350mm
column section (except corner)	350mm X 600mm	350mmX550mm
Slab thickness	120mm	120mm
Live load on slab	3 kN/m^2	3 kN/m^2
Dead load of parapet wall	3 kN/m	3 kN/m
Dead load of other wall	6.76 kN/m	6.76 kN/m
Zone factor	0.24	0.24
Grade of concrete	M20	M20
Response reduction factor (R)	3	5
Grade of Steel	Fe 415	Fe 415

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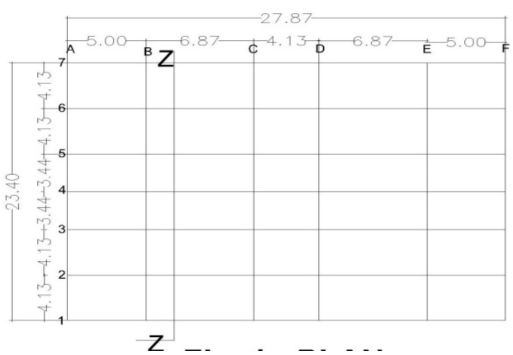


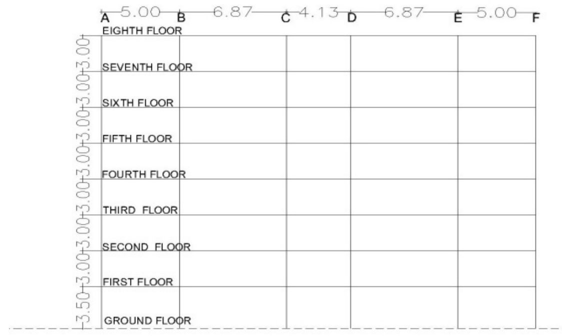
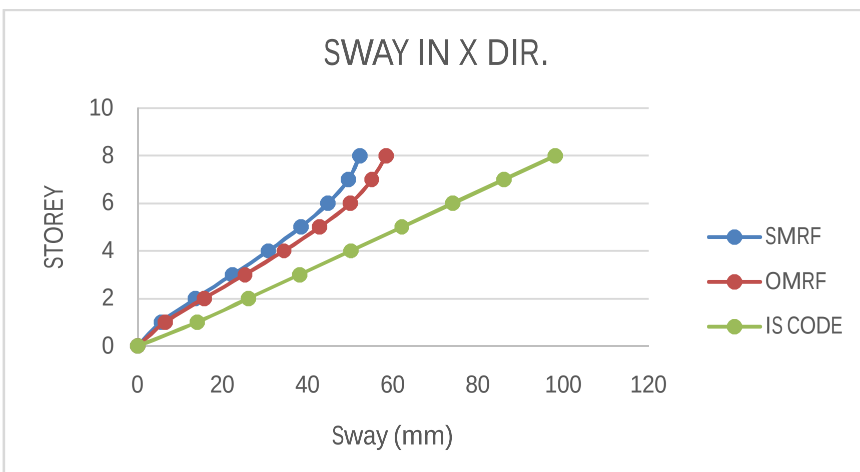


Table 1: Comparison of Storey sway between OMRF and SMRF at roof level

Storey	Elevation (m) (H)	Due to Earthquake in X direction (mm)		Due to Earthquake in Z direction (mm)		IS 1893:2002 clause 7.1.11 (H/250) (mm)
		OMRF	SMRF	OMRF	SMRF	
8th Storey	24.5	58.4	52.2	65.1	52	98
7th Storey	21.5	55	49.5	62.3	49.5	86
6th Storey	18.5	50	44.7	57	45.3	74
5th Storey	15.5	42.8	38.3	49.5	39.3	62
4th Storey	12.5	34.4	30.7	41	32.1	50
3rd Storey	9.5	25.2	22.3	31	24.2	38
2nd Storey	6.5	15.6	13.6	20.8	15.87	26
1st Storey	3.5	6.5	5.5	10.3	7.5	14
Base	0	0	0	0	0	0



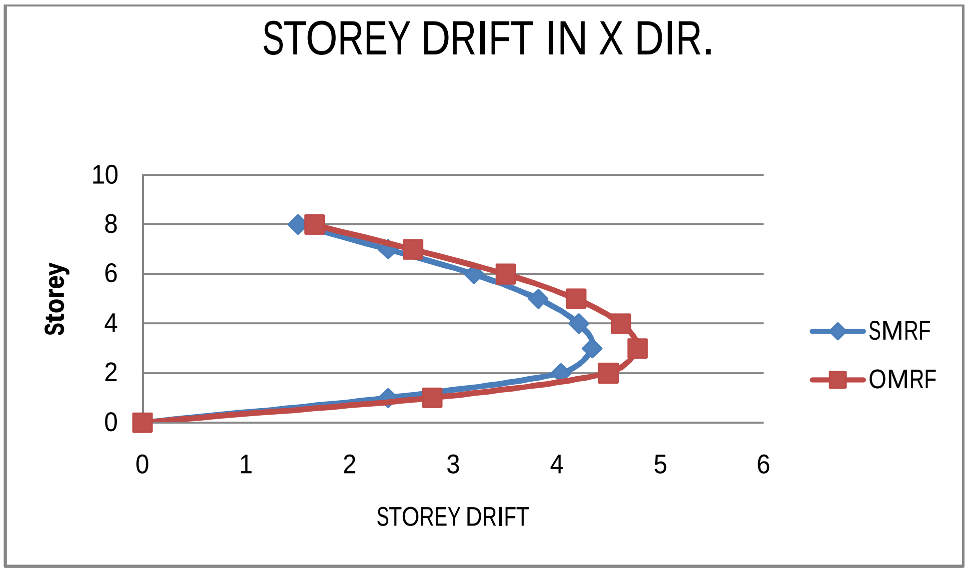
Graph 1- Comparison of Storey sway between OMRF and SMRF in X direction

Storey Drift- It is defined as ratio of displacement of two consecutive floor to height of that floor. It is very important term used for research purpose in earthquake engineering.

Storey Displacement- It is total displacement of i^{th} storey with respect to ground and there is maximum permissible limit prescribed in IS codes for buildings.

Table 4.3: Comparison of Storey drift between OMRF and SMRF at roof level

Storey	Elevation (m)	Due to Earthquake in X direction		Due to Earthquake in Z direction	
		OMRF	SMRF	OMRF	SMRF
8thStorey	24.5	1.66	1.5	1.44	1.17
7thStorey	21.5	2.61	2.37	2.66	2.15
6thStorey	18.5	3.51	3.2	3.68	2.98
5thStorey	15.5	4.19	3.82	4.4	3.57
4thStorey	12.5	4.62	4.21	4.9	3.96
3rdStorey	9.5	4.78	4.34	5.1	4.17
2ndStorey	6.5	4.5	4.04	5.2	4.19
1stStorey	3.5	2.8	2.37	4.4	3.22
Base	0	0	0	0	0



Graph 2- Comparison of Storey drift between OMRF and SMRF in Z direction

Table 3: Comparison of Base shear between OMRF and SMRF at floor level

Storey	Elevation (m)	Due to Earthquake in X direction (kN)		Due to Earthquake in Z direction (kN)	
		OMRF	SMRF	OMRF	SMRF
8thStorey	24.5	1220	709	1220	709
7thStorey	21.5	2657	1527	2657	1527
6thStorey	18.5	3721	2132	3721	2132
5thStorey	15.5	4468	2557	4468	2557
4thStorey	12.5	4953	2833	4953	2833
3rdStorey	9.5	5234	2993	5234	2993
2ndStorey	6.5	5365	3067	5365	3067
1stStorey	3.5	5404	3089	5404	3089
Base	0	5404	3089	5404	3089

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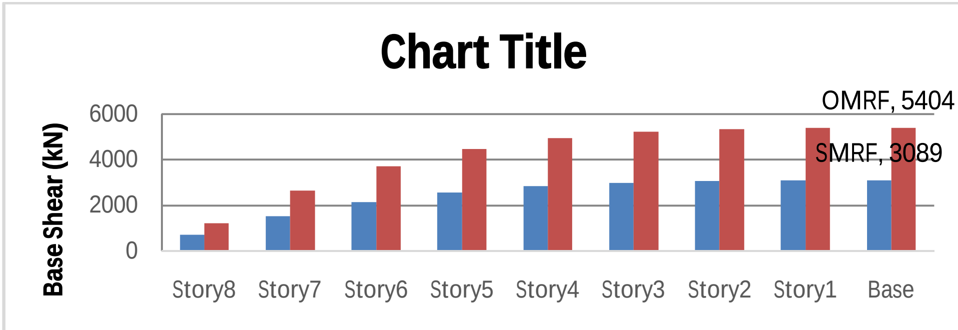
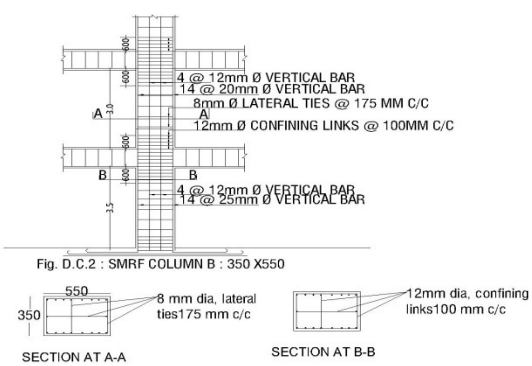
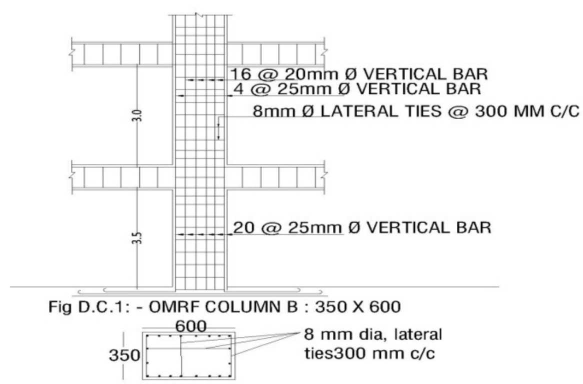


Graph 3- Comparison of base shear between OMRF and SMRF in Z direction

Comparison of steel required and provide in column B for SMRF and OMRF (in terms of Area)

Storey	Min. Area of longitudinal steel required		Area of longitudinal steel provided	
	OMRF (mm^2)	SMRF (mm^2)	OMRF (mm^2)	SMRF (mm^2)
1st Storey	8820	6237	9817	7324
2nd Storey	6552	4620	6990	4850
3rd Storey	5880	3696	6283	4172
4th Storey	4536	2849	4926	2916
5th Storey	3360	1540	3996	2036
6th Storey	2100	1540	2613	2036
7th Storey	1680	1540	2262	2036
8th Storey	1680	1540	2262	2036





Comparison of steel required and provide in Beam for SMRF and OMRF (in terms of Area)

Storey	Min. Area of longitudinal steel required						Area of longitudinal steel provided					
	OMRF (mm^2)			SMRF (mm^2)			OMRF (mm^2)			SMRF (mm^2)		
B7B6	2561		2328	1733		1674	2714	515	2400	1772	402	1772
	1752	509	1509	1024	392	964	1772	515	1772	1030	402	1030
B6B5	2189		2189	1581		1581	2400	402	2287	1772	402	1659
	1350	362	1350	856	333	862	1772	402	1634	1030	402	1030
B5B4	2270		2247	1581		1581	2287	402	2287	1659	402	1659
	1330	362	1590	984	333	984	1634	402	1634	1030	402	1030

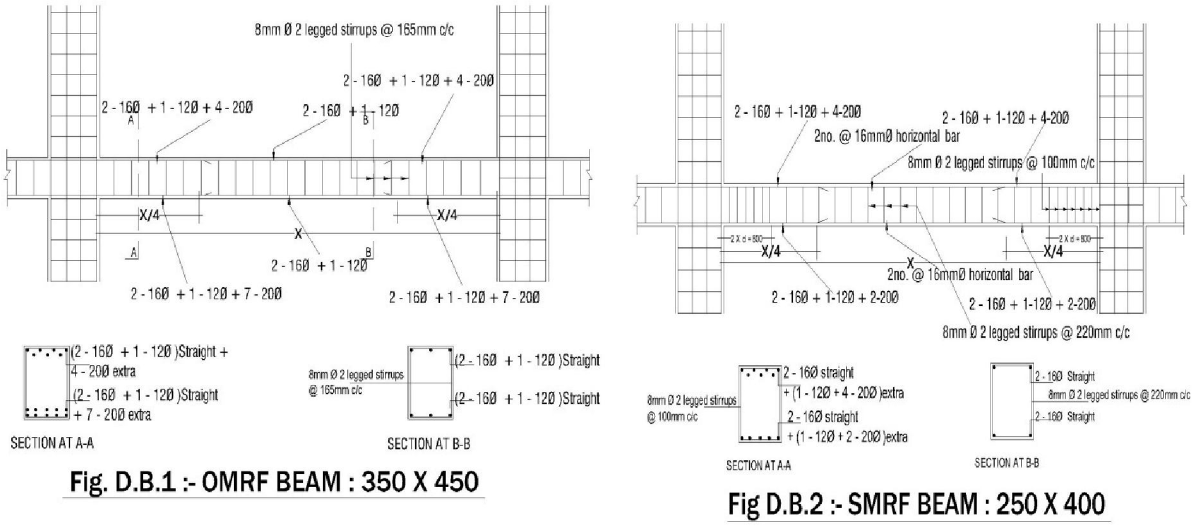


Fig. showing Steel provided in beam B7B6 for OMRF AND SMRF

V. CONCLUSION

The storey sway increases with increase in number of stories (that is with height in both cases SMRF and OMRF but in SMRF the sway is less for same Storey)

The Base shear in SMRF structure was found to be less as compared to OMRF structure.

The section of beam and column required for SMRF was found to be less as compared to OMRF.

Area of steel required in SMRF for main (vertical) reinforcement in column is less as compared to OMRF column but lateral steel provided at vicinity of joints as confinement steel is additional in SMRF which provides more safety in joint failure during Earth quake.

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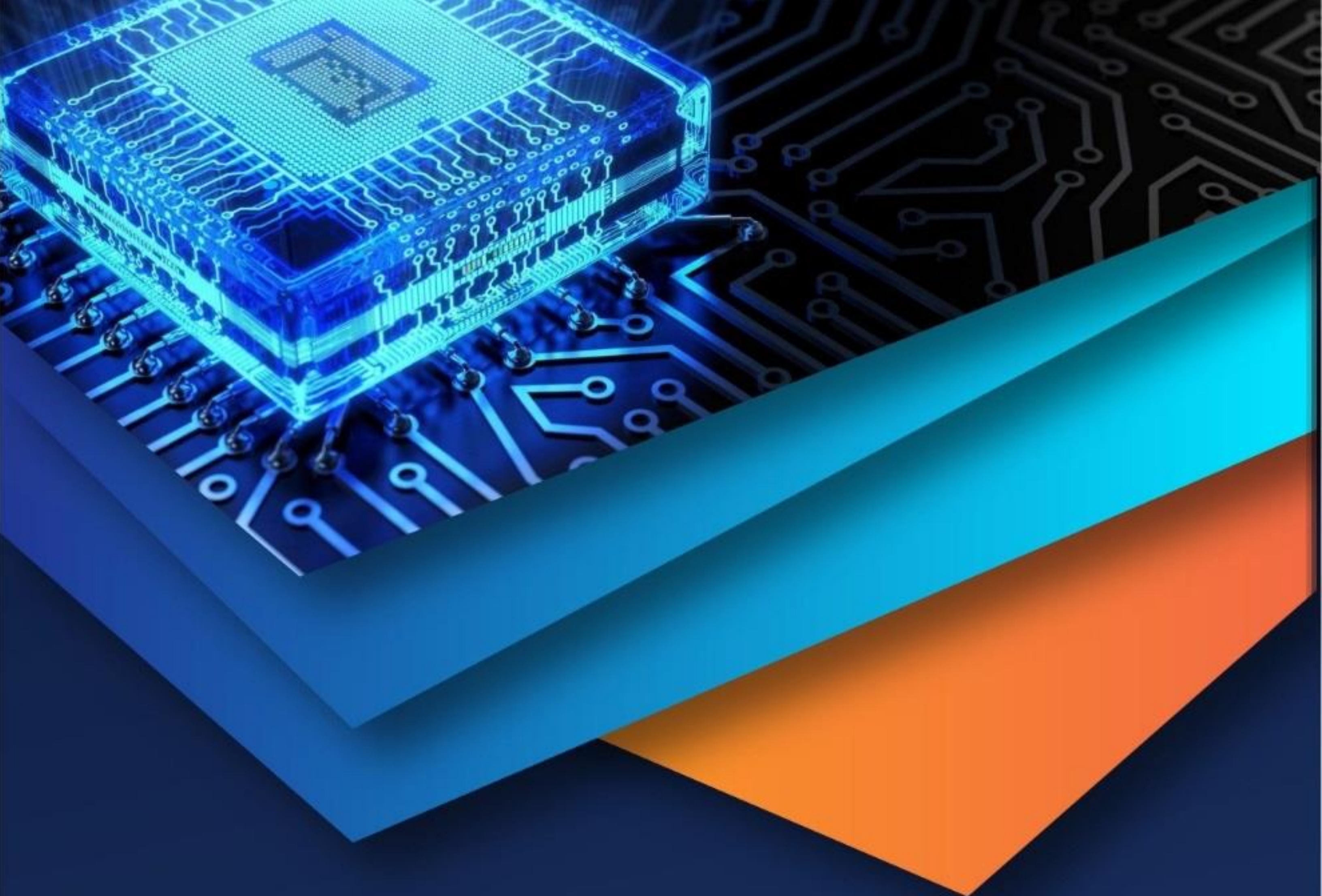

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