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Study on Optimum Location of R.C. Shear Wall in a High Rise Soft Storey Structure Subjected to Seismic Force

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Abstract: This paper is an analysis study focuses on the effect of soft storey configuration in the building and Remedying it by using RC shear wall. Shear walls are structural element members provided in the high Rised Multistorey Building to seismic action during earth quake. They are generally provided in the taller structure to with stand against the total collapse of structure under earth movement. It is most important to determine efficient and ideal location of shear wall.. The linear dynamic analysis (Response spectrum analysis) is adopted for various symmetrical structural models having (G+14) 15 storey high rise building. The results of responses obtained from the models, are in terms of storey drift, lateral displacement, storey shear and bending moment variation are compared with different configurations are tabulated. It are often effectively concluded that the supply of shear walls can reduce the consequences of sentimental storey to a way greater extend. Shear walls play an inevitable role in reducing the soft storey effect in the buildings, as the height of the building increases, the factors evaluated in this paper exert a major impact on the building's stability, thus necessitating the need for in depth study in this area.
Keywords: Soft storey, Linear Response Spectrum analysis and RC Shear wall.

I. INTRODUCTION

The buildings with open ground storey configurations have shown higher tendency for collapse during earthquakes due to thanks to the soft storey effect. This effect is mainly due to Increased flexibility of soft storeys as compared to normal floors. The stiffness of the building are going to be reduced thanks to the presence of open ground storey configuration and since of this, large bending moments and shear forces act at that storey. Now-a-days this sort of open ground storey configuration is being preferred to tackle the matter of parking lot. In such buildings, major percentage of the base shear is required to be resisted by the beam-column joints of the ground storey. So it is very important to relieve the effect of soft storey in buildings to a greater extend. In order to realize this, various structural arrangements are often provided within the buildings. The most commonly adopted method is providing shear walls. In the present study, hypothetical RCC buildings of medium rise (G+14) building having open ground floor storey with floating column at the centre bay in X direction both sides of its longer length, considered for providing shear wall structural arrangements incorporated in them. Also the present study explores the seismic evaluation of a soft story at ground floor with and without shear wall at various ideal location is determined using Response spectrum analysis and the comparison is made to reveal the differences.

II. METHODOLOGY

Linear dynamic analysis shall be performed to obtain the design lateral force (design seismic base shear, and its distribution to different levels along the height of the building, and to various latereal load resisting elements) for all buildings, other than regular buildings lower than 15m in seismic Zone II. In this study dynamic analysis is performed by Response Spectrum method using STAAD Pro V8i software. The analysis of model for dynamic analysis of buildings should be such that If there should be irregularity in the structural configuration either plan irregularity or vertical irregularity, as defined in IS code: 1893-2002 . Dynamic Analysis shall be performed to get the planning seismic force, and its distribution in several levels along the peak of the building, and within the various lateral load resisting element for the following buildings:

III. MODELING OF BUILDING

The models of the building under study are analyzed under Linear Dynamic analysis (RESPONSE SPECTRUM METHOD) using STAAD Pro v8 analysis package. For modeling the structure following assumptions are taken such as beams and columns as frame elements, floor slab as regid horizontal plane, RC shear wall as vertical plane element, the materials used are assumed as homogenous, isotropic and linearly elastic other elements such as infill walls are considered as negligible and foundation of the structure as regid. Mostly in Residential buildings, floor plan will be same for all floors. . So the buildings were considered with same plan altogether floors. Shear walls of same section were used for same height of buildings throughout the peak

A. Description Of The Building Frame

The building consists of fifteen storey high rise structure.. All columns in all models are assumed to be fixed at the base for simplicity. The ground floor is open for car parking and there is No in-fill walls. The floor to floor height is 3.0 m. Slab is modeled as rigid plane element of 0.15m thickness for all stories considered. Live load on floor is taken as 6 kN/m2 and Dead load on roof is 4 kN/m2. Weathering course on roof is 1.5 kN/m2. . The seismic weight is calculated as per IS code provision. The unit weight of RCC is taken as 25 kN/m3. The concrete used is M-25 grade and the building is SPMR (Special Moment Resisting Frame) type and situated in seismic zone five having medium soil and intended for residential use.

Table 1. Various structural system models

Sl.No.	Building Configuration Cases	Abbreviation
1	Ground floor soft storey structure without shear wall.	A
2	Ground floor soft storey structure with shear wall at outer pheryphery on all four sides.	B
3	Ground floor soft storey structure with shear walls at all four corners.	C
4	Ground floor Soft storey structure with shear wall at lift.	D
5	Ground floor Soft storey with ‘C’ type shear wall along shorter side of the building.	E
6	Ground floor soft storey with plane shear wall along shorter side of the building.	F

B. Model Diagrams

1) *Information about Model:* For Modeling, we took Special moment resisting RC frame of 15 storey with each bay length of 3m along X and Y direction in which total number of bays were 3bays along Z direction and 6 bays along X direction. Moreover, the base story height is 3m uniform through out all floors. For analysis of the soft story under seismic effect, seven models have been selected. The selected models selected are bare frame with slab. The base floor height was taken as 3m uniform to all models. The Ground floor bay is fully open for parking space and there is a floating column bay at the centre of the outer pheryphery in X dirction both sides.

Table 2. DATAS

Details of parameter	Assumed Data
Soil type	Medium soil
Response Reduction Factor	Five
Property of the Material	concrete
Seismic Zone	Five
Importance Factor	one
Floor to Floor height	3m
Total building height	45m
Beam sizes	600 x 550, 300 x 450
Column sizes	600 x 550
Floor Slab thickness	150 mm
RC Shear wall thickness	150 mm
R C Building with special moment resisting frame (SMRF)	R=5
Natural period Ta Time Period in X direction 0.95 s Time Period in Z direction 1.35 s	0.09h/d^0.5
Importance Factor (I)	1.5(critical and life line structure)

IV. RESULTS AND DISCUSSION

A. Results

Table :3 Maximum Nodal Displacement At Joints In X And Z Direction

CASE	X- DIRECTION	Z - DIRECTION
A	22.09	29.36
B	13.25	14.76
C	16.22	19.44
D	14.01	20.80
E	13.27	10.07
F	16.10	12.23

Table : 4 Maximum Bending Moment Of Beam In X Direction

CASE	MOMENT Y	MOMENT Z
A	811	781
B	375	510
C	317	678
D	965	885
E	201	485
F	217	811

Table 5 : Maximum Torsional Moment (Knm)

CASE	TORSION
A	34.50
B	30.39
C	15.00
D	81.00
E	12.70
F	34.00

Table : 6 Maximum Shear Force Of Beam In X Direction

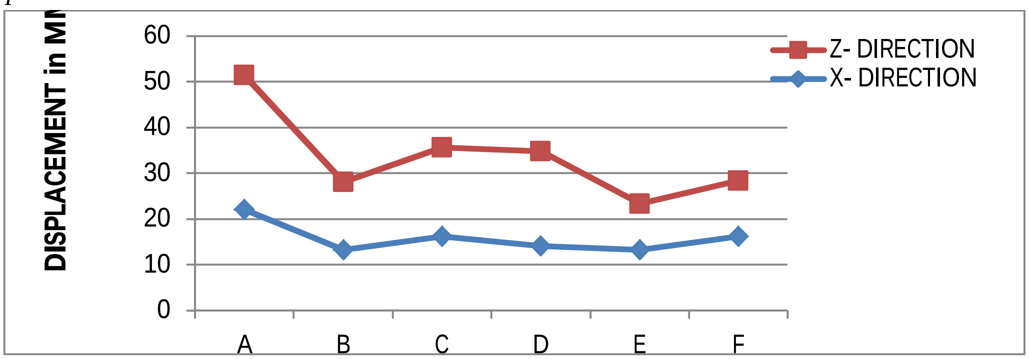
MODELS	Fy	Fz
A	435	453
B	332	244
C	452	207
D	541	515
E	305	104
F	471	140

Table 7 : Storey Drift Of Models At Different Height

HEIGHT(m)	MODEL A	MODEL B	MODEL C	MODEL D	MODEL E	MODEL F
3	0.0005	0.0001	0.0001	0.0005	0	0
9	0.0016	0.0002	0.0006	0.0014	0.0002	0.0003
15	0.0014	0.0001	0.0006	0.0016	0.0001	0.0003
21	0.0012	0.0001	0.0006	0.0016	0.0001	0.0003
27	O.0011	0.0001	0.0006	0.0017	0.0001	0.0004
33	0.0011	0.0001	0.0006	0.0017	0.0001	0.0004
39	0.0010	0.0001	0.0005	0.0017	0.0001	0.0004
45	0.0010	0.0001	0.0005	0.0015	0.0001	0.0004

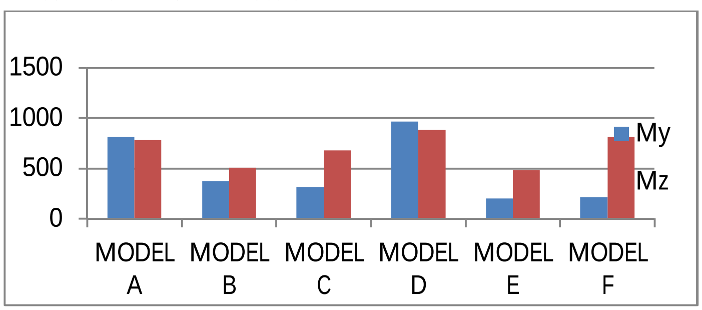
B. Bar Chart / Graph

1) Maximum Displacement In Models At X And Z Direction



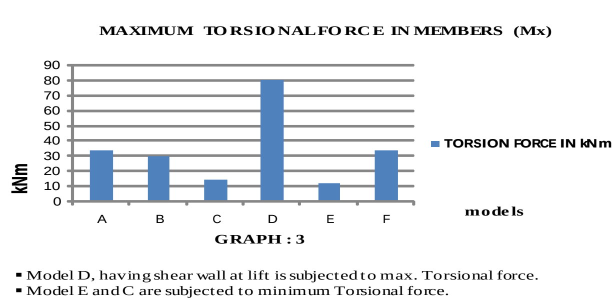
Graph: 1 , Showing maximum displacement in Model A and minimum displacement in Model E.

2) Maximum Bending Moment In Beam At Y And Z Direction



Graph: 2 Showing The maximum Bending moment in beam along x direction is at model A and the minimum at Model E.

3) Maximum Torsional Moment In Column



Graph: 3, Showing the Maximum torsion moment at Model D and Minimum torsion moment At Model E.

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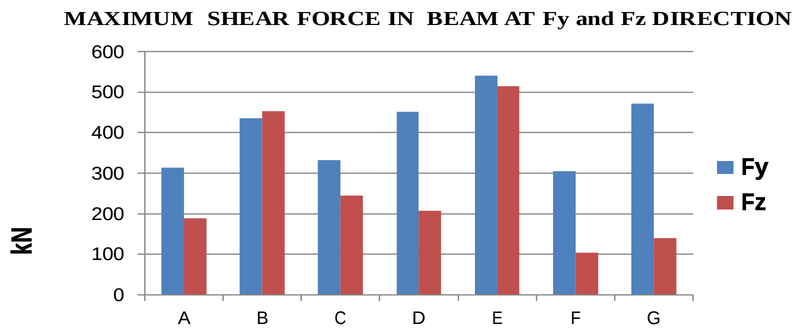
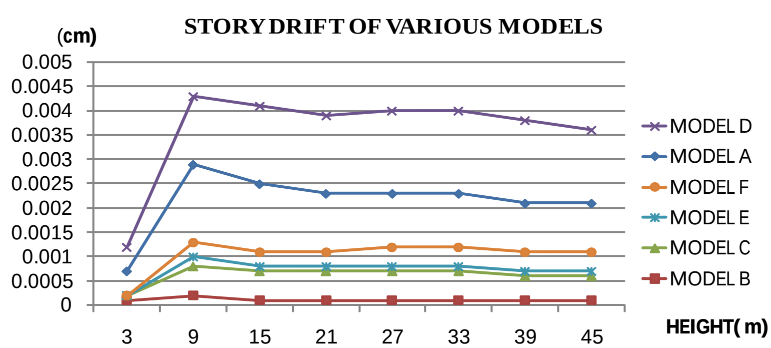
4) Maximum Shear Force In Beam



GRAPH : 4

Graph: 4 , Showing Maximum shear force in Model D and Minimum shear force at Model E.

5) Storey Drift Of Various Models



- **The Min. Story drift observed at models B,C and E.**
- **The Max. Story drift occurs at model D.(Lift wall) and A.**

GRAPH : 5

C. Discussions

The Analysis Results observed in the form of storey displacement ,Storey drift, Torsional moment, Bending Moment, Shear Force and Peak Storey shear are presented in this chapter and variation of these results have been discussed. The variation of these results with respect to several model structures with shear wall having at different locations in seismic zone V are studied in this chapter. The following results observed from analysis are tabulated as below:

1) The maximum displacement in Model A and minimum displacement in Model E is observed.
2) The Storey Drift ratio is less in bottom floor and maximum at the top floor
3) The Torsional momemt resistance is less in Model E than other models.
4) The shear Force value is less in Model E over other Models.
5) The Maximum Bending moment in Beam being in Model E.

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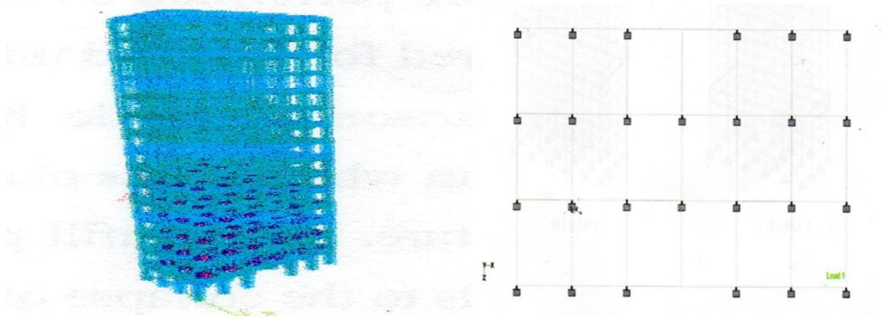
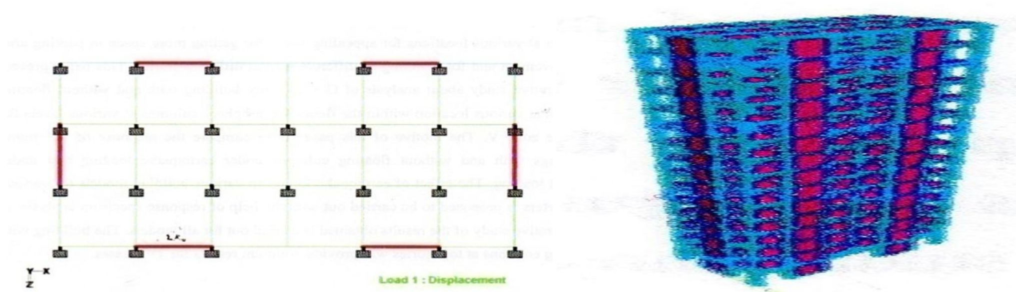
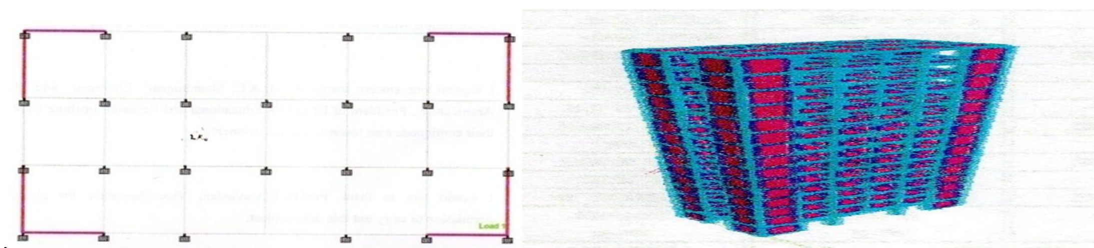
Models



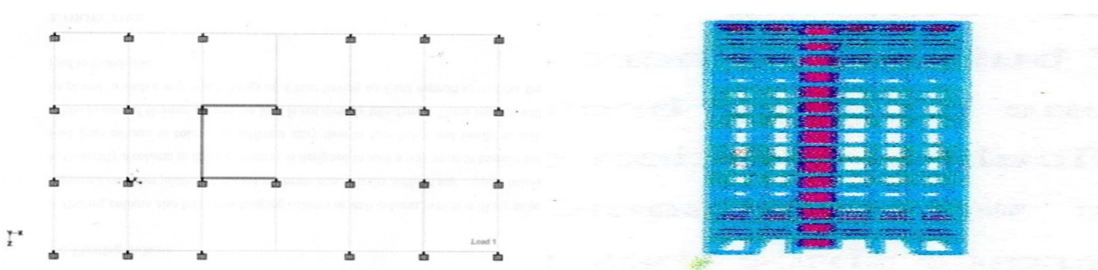
MODEL A : Ground floor soft storey structure without shear wall.



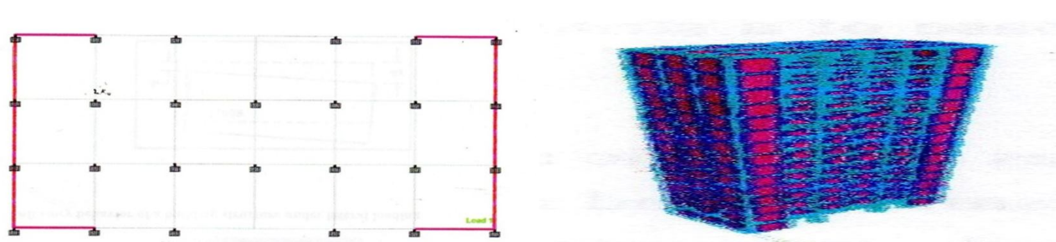
MODEL B : Ground floor soft storey structure with shear wall at outer pheryphery on all four sides.



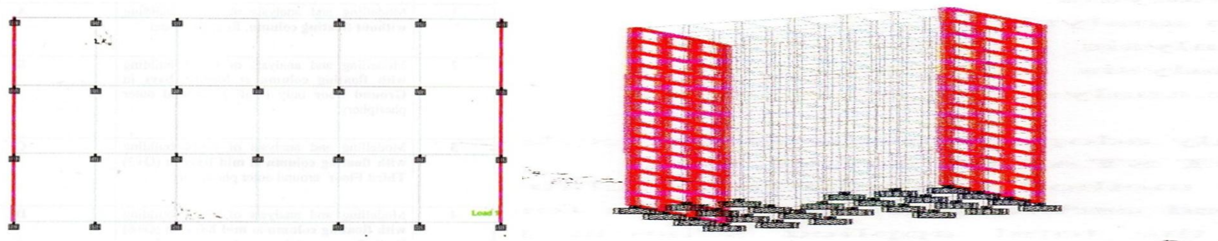
MODEL C : Ground floor soft storey structure with shear walls at all four corners.



MODEL D : Ground floor Soft storey structure with shear wall at lift wall.



MODEL E : Ground floor Soft storey structure with ‘C’ type shear wall along shorter side of the building.



MODEL F : Ground floor soft storey structure with plane shear wall along shorter side of the building.

V. CONCLUSIONS

The effects of soft storey configuration in the buildings are studied and focus is given on the various ideal location of RC shear wall to remedy it. The performance of the building is evaluated in terms of lateral displacement, storey drift, storey shear and bending moment variation. The results for different models are compared with the normal structure, it can be concluded that:

A. The Location of shear wall in a structure increases the stiffness and reduces the Lateral displacement and storey drift.
B. It is observed that the storey drift is less in bottom stories and increases towards first, second,Third floor and gradually decreases towards top floor.
C. Comparing the results, it is found that providing C type shear wall along the pheryphery of the structure in Z direction as Model E is most effective over other models in terms stiffness, story drift, nodal displacement, lateral shear, moment distribution and torsional moment consideration.
D. The direction and placement of shear wall in a rectangular high rise structure attract the forces, therefore the shear wall positioning must be in a ideal location.
E. As the height of the building increases, the provision of shear wall becomes inevitable as these techniques reduce the bending moment concentration at the open ground storey up to a great extend.

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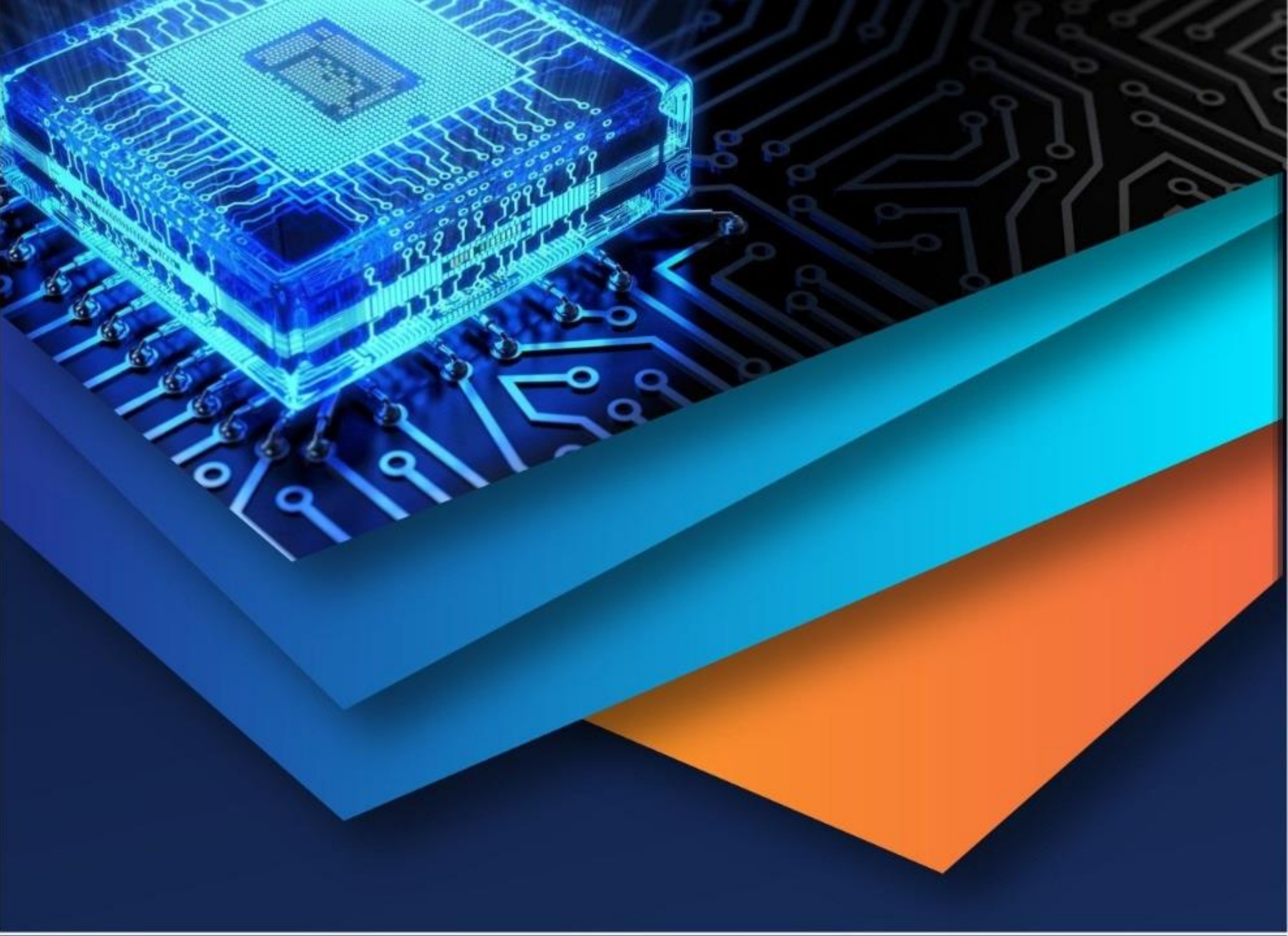

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