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Comparative Study on Expanded Polystyrene (EPS) Core Reinforced Concrete Sandwich Panels based and R.C.C Brick Infill Structure

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Abstract: Now a day Expanded Polystyrene (EPS) Core Reinforced Concrete Sandwich Panels (RCSP) is become more popular building material, Due to it's low Weight, low Thermal Conductivity and low construction time. Also it provide more work ability for the mass production of building.

EPS Core (80mm to 120mm) RCSP Panel consist of EPS Core Between two layers of Reinforce concrete, 2mm to 3mm diameter welded coated steel wire mesh use as a Reinforce in concrete. Two Welded wire mesh is connected buy shear connecter of 2mm to 4mm diameter.

Up to four story Expanded Polystyrene (EPS) Core Reinforced Concrete Sandwich Panels (RCSP) is using as load bearing wall. And construct structure without beam and column.

In this study focus is on comparing G+3 Building using Expanded Polystyrene (EPS) Core Reinforced Concrete Sandwich Panels (RCSP) Located at North Indian city of Sonepat. With Reinforced cement concrete framed structure consist Brick masonry as infill material. In this study building is considered for analysis which is located in zone 5 earth quake region. Static analysis is done using SAP2000 software, soil conditions are to be soft and importance factor is to be taken as 1.2. Various parameters studied like lateral displacement of building, storey drift, base shear, and moment's and shear force diagrams for a particular beam for both case. Results are represented in graphical as well as in tabular form. The structural members are modelled with the SAP2000 software package. Dead load and live load is considered as per code IS 875:1987 part 1 &2.

Keyword: Concrete sandwich Panel, Diagonal Strut, Non-Linear Time History Analysis.

I. INTRODUCTION

Expanded Polystyrene (EPS) is use for insulation purpose in industrial and commercial use. In market Expanded Polystyrene (EPS) is popular with name of thermocol. EPS is made from styrene. For construction purpose required size of panel are cut from the block of EPS. Coated steel wire mesh are attached to both sides through shear connecter. After panel are transport to working site that are installing according to plan of building. shotcreting concrete or mortar according to strength required. After shotcreting EPS Panel known as Expanded Polystyrene (EPS) Core Reinforced Concrete Sandwich Panels (RCSP).

RCSP are connected to plinth beam through rebar according to structural engineering requirement. Size and Depth of foundation are decide as per the soil condition and load of structure.

In presents study competition are doing between EPS core RCSP structure and RCC Brick infill structure. In study there is taking same section and size of plinth beam, Also same location of foundation. For both model dead load and load are applying according to IS 875:1987 part 1 &2.

For analysis purpose according to code IS 1893:2016. Brick infill consider as equivalent diagonal strut In witch diagonal strut resist compressive force only & strut are connected with frame through Hinge joint. Thickness of diagonal strut is equal to brick wall's thickness and Width is decide as per IS code.

Width of equivalent diagonal strut is depend on moment of inertia of adjoin column, length of diagonal strut, Elasticity of Masonry infill and Angle between horizontal and column. In this study for every wall evaluate the width of diagonal strut.

For analysis purpose to carry out Non-Linear Time history Analysis for 3 different time history. And after various parameter study like story displacement, Bending moment & Shear force in Beam and Base Shear. In This study Time History of Three station Gopeshwar, Joshimath and Ukimath taken for 1999 Chamoli earthquake.

II. LITERATURE REVIEW

Adil Ahmad , Yogendra Singh[1] studied detailed seismic safety evaluation of a proposed 4 storey (G+3) Expanded Polystyrene (EPS) core sandwich wall panel building has been performed using pier analysis and finite element method in sap2000.And In this case study model of an EPS core panel based G+3 building constructed in the North Indian city of Sonepat has been developed in SAP 2000. and manual calculate For pier analysis. Modal's walls and floor slabs are modelled as shell elements, and neglect EPS core and the steel wire mesh have been neglected in the linear analysis. Dead load and live loads apply according to IS: 875 (Part 3)-1987 and earthquake forces apply according to IS 1893 (Part 1):2002. After analysis of fem an manual calculation the stress plots show that the stresses are within the permissible limits of RCC walls (IS 456:2000).

Adil Ahmad , Yogendra Singh[2] Studied practically experimentally studied are doing on 21 specimens are constructed using factory made corrugated EPS panels and wire mesh.The specimens are constructed using different construction (pouring and spraying of concrete) methods, with varying combinations of wythe thicknesses, boundary conditions (presence and detailing of RC beams along the supported edges), and alignment of corrugations in the EPS core. Specimens are tested under four-point bending, with simply supported condition, in displacement control mode. After analysis they conclude that The behavior of NEB specimens (without any edge beam) is distinctly different from REB and MEB specimens. NEB specimens have lower moment of resistance and undergo large deformation. The cracking pattern of MEB specimens is different from REB specimens and these have higher moment capacity but less ductility. The poured concrete specimens crack at higher load in comparison to sprayed concrete specimens.

Ari Wibowo , Indradi Wijatmiko, and Christin R. Nainggolan[3] Are doing practical experiment on specimens witch designed as structural walls composing low-rise building which were commonly found in house or school precast buildings. They are taken 2 specimens RCW4 (EPS panel thickness of 40 mm) and RCW8 (EPS panel thickness of 80 mm). And on that specimen investigate the lateral load-drift behaviors and collapse mechanism.

After analysis they conclude that. Specimen RCW4 with a thinner EPS panel developed more classic flexural behavior with drift capacity maxed at about 1.3%, whilst specimen RCW8 only managed to reached 1.0% with dominant yield penetration behavior due to thinner concrete cover of sloop foundation. However, the tests were stopped at 20% drop of peak load instead of further failure at axial load collapse. hence the results can still be considered satisfactory for low-to-moderate seismic regions but might not be sufficient for high seismic regions.

Fabrizio Gara , Laura Ragni, Davide Roia, Luigino Dezi[4] Investigation carried out on a construction system based on in-situ sandwich panels with non-shear connectors. They doing Compression tests with axial and eccentric loads on full scale panel specimens with different slenderness ratios. and also diagonal compression tests were performed on square specimens in different configurations. They conclude that High ultimate loads decreasing for increasing values of the slenderness ratios for axial and eccentric compression test. And in diagonal compression tests, simple wall panels, prestressed wall panels and panels with transversal stiffening walls were tested. In all these cases high cracking loads were observed. The panels also showed a high capacity for stress redistribution due to metallic mesh inside the concrete layers.

M Fabrizio Gara, Laura Ragni, Davide Roia, Luigino Dez[5] Are evaluate property of floor EPS Sandwich panel through experimat.For testing they built Six panels for flexural tests and two wall–floor nodes Test. In wall-floor panel 600mm long and 160 mm wide floor is connected perpendicular wall panel. Which was 2700mm long and 150 mm wide. They conclude that the experimental results and the numerical simulations of the flexural tests under increasing loads allowed to identify a tri-linear behavior with a very small uncracked phase.

III. RESEARCH METHODOLOGY

For Expanded Polystyrene (EPS) Core Reinforced Concrete Sandwich Panels (RCSP) based G+3 building is located in North Indian city sonepat. For same Architectural drawing both Expanded Polystyrene (EPS) Core Reinforced Concrete Sandwich Panels (RCSP) based building 's Model No1 and Brick infill Reinforced cement concrete frame building's Model No 2 developed in SAP2000.

Dimension of building are 12m width in X-Direction,14.36m long in Y-direction And 13.05 m high, Height of every floor is consider 3m. In both case use same size and length of plinth beam. In analysis consider Dead Load and Live Load as per IS: 875 (Part 1 &2)-1987, For analysis considered Seismic Zone -V and soft soil. Response reduction factor is taken 3. Damping of structure is taken as 5 percent and Important factor is taken as 1.2. For Non- Linear Time History Analysis.

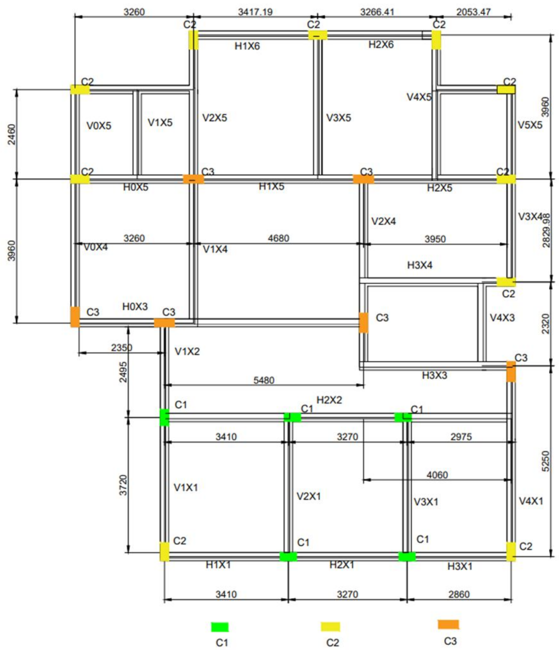

Fig. 1 Plan of building & location of column

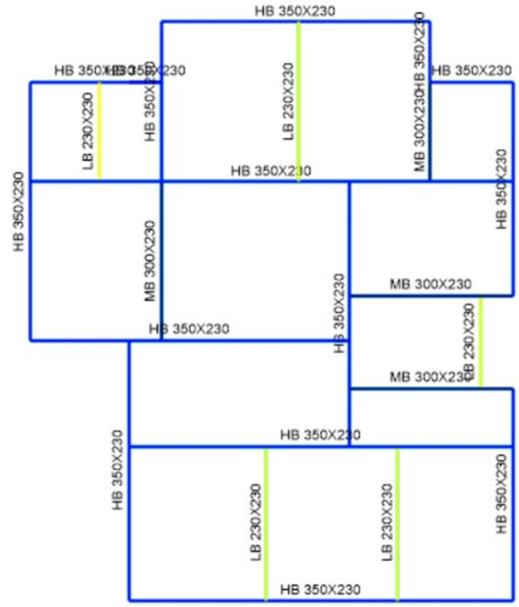

Fig. 2 Section of Beam

TABLE 1 Dimension of Beam And Column

NAME	DIMENTION
Beam LB	230X230
Beam MB	300X230
Beam HB	350X230
Column C1	230X450
Column C2	230X500
Column C3	230X550

For both Model Grade of concrete taken as M-25 and for reinforcing steel, Fe415 grade of steel is used EPS Core panel consist of 80 mm EPS core placed between two welded wire mesh witch is connected by shear connector(3 diameter wire). Welded wire mese is made of 3mm diameter galvanised steel wire, In wire mesh provide 80mm spacing in horizontal direction and 75mm spacing in vertical direction. M-25 grade micro concrte0 is shotcreting 35 mm in both side of wall and 50 mm and 35 mm in top and bottom layer in slab. Expanded Polystyrene (EPS) Core Reinforced Concrete Sandwich Panels are placed on the plinth beam and connected with the extra steel bar. For analysis purpose define. In Brick infill Reinforced cement concrete frame building brick masonry used as a infill material for outer and partition wall. RC Frame is design as per IS code. For analysis purpose considering as equivalent diagonal compression strut as per IS 1893:2016. In witch as equivalent diagonal compression strut resist compressive force only & strut are connected with frame through Hinge joint. Thickness of diagonal strut is equal to brick wall's thickness and Width is decide as

$E_m=550f_m$

E_m= Elasticity of Masonry infill.

$F_m=.433f_b^{.64}f_{mo}^{.36}$

F_b= compressive strength of brick.

f_{mo}= compressive strength of mortar.

$W_s=.175\alpha_h^{-.4}L_{ds}$.

L_{ds}= Length of Diagonal strut.

$\alpha_h=h*[(E_m*t*\sin2\theta)/(4E_f*I_c*h)]^{(1/4)}$.

θ=Angle between horizontal and column

I_c=Moment of Inertia of adjoining column.

TABLE 2 Width Of Diagonal Strut.

Number	NAME	Width Of DS (mm)Taken
1	H1X1	550
2	H2X1	550
3	H3X1	500
4	H2X2	550
5	H3X3	500
6	H0X3	450
7	H3X4	600
8	H0X5	550
9	H1X5	700
10	H2X5	650
11	H0X6	450
12	H1X6	550
13	H2X6	500
14	H3X6	400
15	V1X1	600
16	V2X1	500
17	V3X1	500
18	V4X1	750
19	V1X2	450
20	V4X3	350
21	V0X4	350
22	V1X4	550
23	V2X4	500
24	V3X4	600
25	V0X5	450
26	V1X5	400
27	V2X5	450
28	V3X5	600
29	V4X5	500
30	V5X5	600

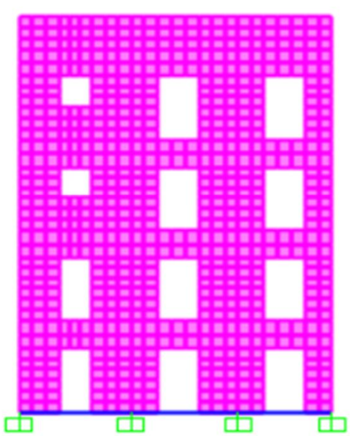

Fig. 3 Elevation of Model 1

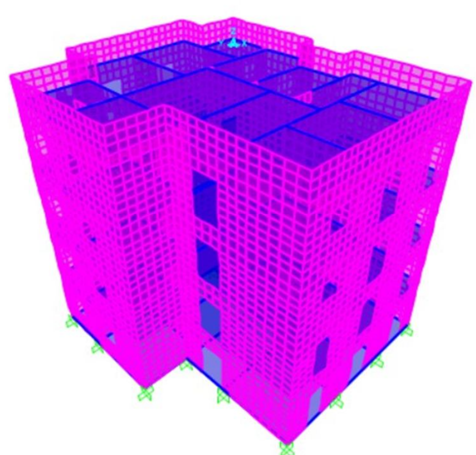

Fig. 4 Render view of Model 1

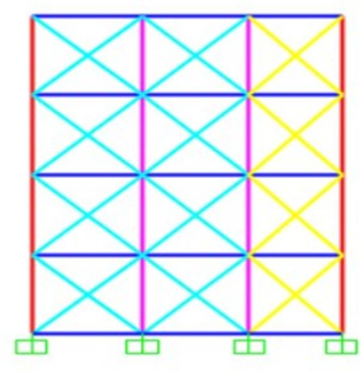

Fig. 5 Elevation of Model 2

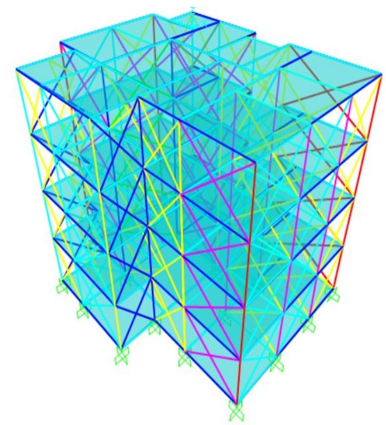

Fig. 6 Render view of Model 2

IV. RESULT AND DISCUSSION.

Nonlinear time history analysis, which explores more accurate responses of structure, is performed for all the models by direct integration technique, using the real ground motion data of earthquake. In this study after the analysis of 5 different time history data are evaluate for maximum story displacement , base shear and maximum bending moment and shear force in Beam are developing .

A. Story Displacement

For Maximum Storey Displacement EPS Core Reinforced Concrete Sandwich Panel (RCSP) based Structure has compare to Brick infill RCC Structure 57.46% less value shown for TH 1, 58.18% less value shown for TH 2, 54.62% less value shown for TH3.

Table 3 Story Displacement

TIME HISTORY	T1		T2		T3	
MODEL NO	M1	M2	M1	M2	M1	M2
STORY4	0.681	1.601	0.383	0.916	0.378	0.833
STORY3	0.515	1.36	0.294	0.726	0.284	0.698
STORY2	0.35	0.965	0.203	0.438	0.19	0.48
STORY1	0.173	0.451	0.105	0.192	0.096	0.215

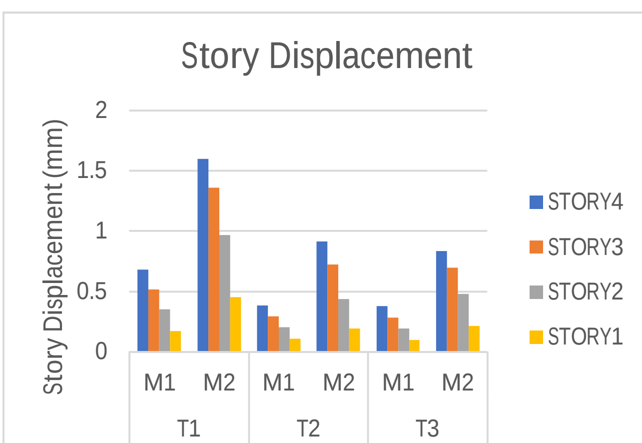

Fig. 7 Story Displacement in Model 1 & 2

B. Base Shear

For Maximum Base Shear EPS Core Reinforced Concrete Sandwich Panel (RCSP) based Structure has compare to Brick infill RCC Structure 32.42% more value shown for TH 1, 51.98% more value shown for TH 2, 34.43% more value shown for TH3.

Table 4 Base Shear

TIME HISTORY	T1		T2		T3	
MODEL NO	M1	M2	M1	M2	M1	M2
Base Shear	294.46	198.99	88.79	42.63	88.6	58.09

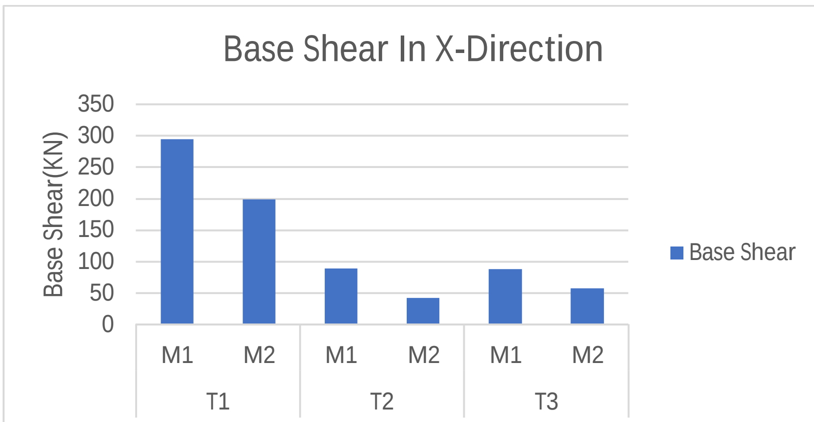

Fig. 8 Base Shear.

Table 5 BM & SF In Beam

Beam	V2X1		H3X4		V2X4	
MODEL NO	M1	M2	M1	M2	M1	M2
Max (+ve) BM (KN.M)	5.29	2.84	35.86	4.7	50.54	17.4
Max (-ve) BM (KN.M)	18.81	5.488	45.44	21.22	65.68	27.83
Max (+ve) SF (KN)	53.23	8.57	134.77	33.02	162.1	28.19
Max (-ve) SF (KN)	43.93	8.3	34.62	9.31	176.91	42.89

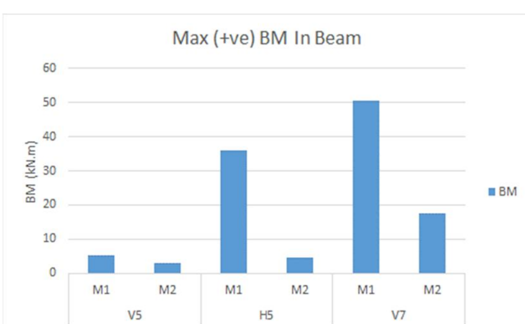

Fig. 9 Max (+ve) BM In Beam

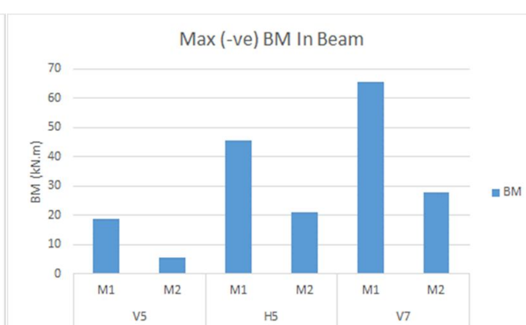

Fig.10 Max (-ve) BM In Beam

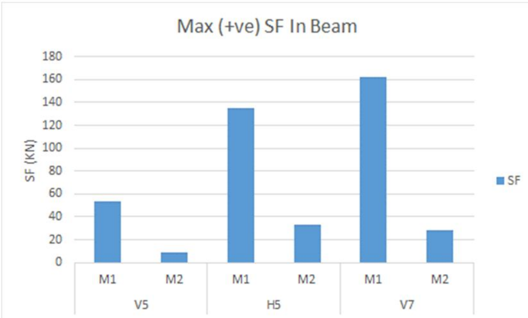

Fig. 11 Max (+ve) SF In Beam

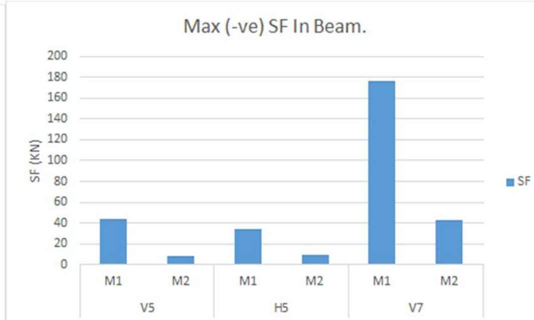

Fig. 12 Max(-ve) SF In Beam

V. CONCLUSION

This Analysis and design result of G+3 storied Displacement EPS Core Reinforced Concrete Sandwich Panel (RCSP) based and R.C.C with brick infill structure has been studied and represent here. The comparison result of these building model are as follows.

1) The displacement in EPS Core RCSP based Structure is merely less than RCC Structure, both are in permissible limit as prescribed by the codal provisons.
2) It was found that maximum Bending moment value in Beam of EPS Core RCSP based structure 50% to 70% more compare to R.C.C with brick infill structure.
3) It was found also that Maximum Shear Force value in in Beam of EPS Core RCSP based structure 70% to 80% more compare to R.C.C with brick infill structure.
4) In EPS Core RCSP based Structure load from four story load of slab through RCSP wall and load of RCSP wall is transferring to plinth beam witch is responsible for the generating more bending moment and shear force in plinth beam. Compare to RCC Structure where at each story load of slab and wall are transferring to column through the beam.
5) For EPS Core RCSP based structure has 30% to 52% more base shear shown compare to the R.C.C with brick infill structure.

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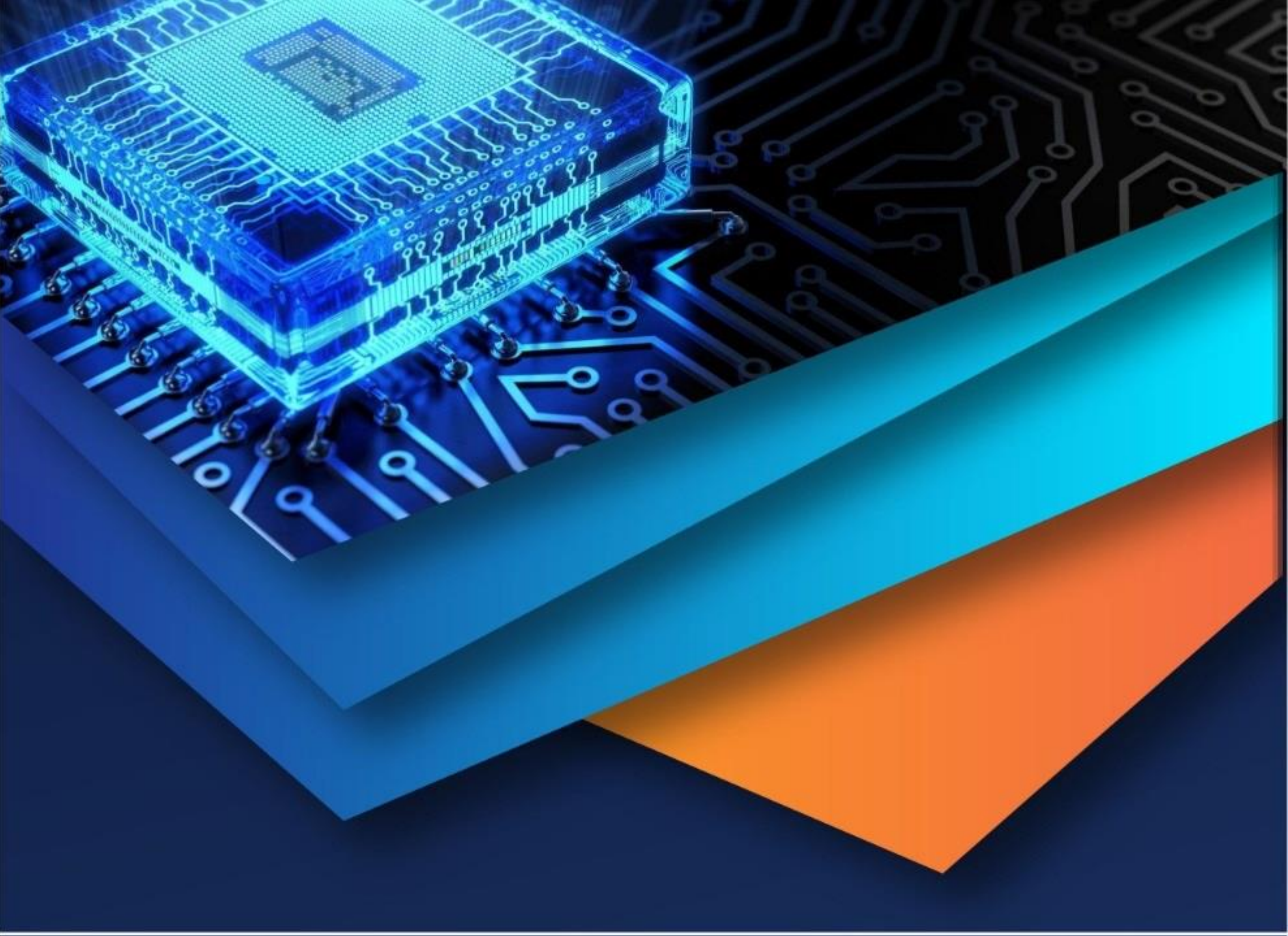

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