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Analytically Design and Tested the Flat Slab with Drop and Without Drop under Punching Shear Strength Considerations

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***Abstract:** Two types of flat slab are tested one having drop and another having no drop. Shape of openings-(circular, rectangular and square) having sizes of openings (500mm dia, 400mm x 500mm, 445mm x 445mm) respectively. Dimension of slab panel is (6000mmx 6000mm x 220mm) and the drop having size (3000mmx 3000mm). size of column – (500mmx 500mm). The provision of location of openings is at center of the slab panel. Software CSI Safe16 is used to analytically design and check the result. End result is based on punching shear value, deflection, Maximum shear force and maximum bending moment.*

I. INTRODUCTION

Flat slab is an aesthetically appealing structure in which beam participation are absent and slab is directly rested on column. In this condition when no beam is present in the slab the transmission of loads and moments in that small portion of connection is higher, which ultimately create very dangerous situation because the shear stress concentration developed in this region is higher, result to punching failure for the slab. The brittle failure is observed in flat slab because of punching shear, hence to avoid the complete failure of the structure different arrangement of reinforcements and some special provision are provided. Chances of punching failure reduce by increasing the thickness of the slab, by providing bent and straight bar at the bottom side, drop or capital and column head. The column is widened at the portion of top head are called column head. The column is generally widened at an angle of 45 degree on either side monolithically attached with the slab. It increases the shear strength of slab and reduce the clear or effective span, thus the moment in slab is also reduce. Because of more moments near the column, the slab is thickened in that portion by providing a drop. The drop is also called as capital of the column. The length of drop in each direction not less than one third of the panel in that direction. Drop panel increase the shear strength and increase the flat slab negative moment capacity. Stiffening of the flat slab occur which caused reduction of the deflection.

II. OBJECTIVE

1) To check the importance of drop to safe the structure against failure and for good serviceability.
2) Check the punching shear value of slab under drop and without drop condition.
3) Study the variation in deformation, shear force and bending moment result.
4) Changes in the shape and sizes of the opening are done to get more clear result.

III. ANALYTICAL WORK

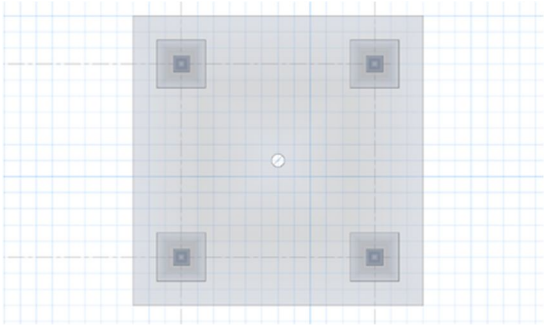

Fig. 3.1. Slab with drop - opening of (500mm Dia)

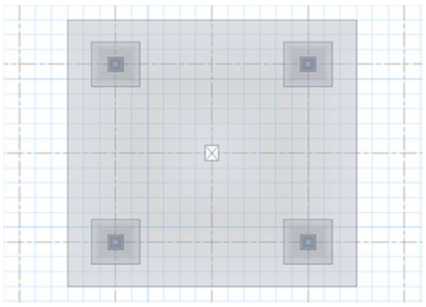

Fig. 3.2. Slab with drop - opening of (400mmx 500mm)

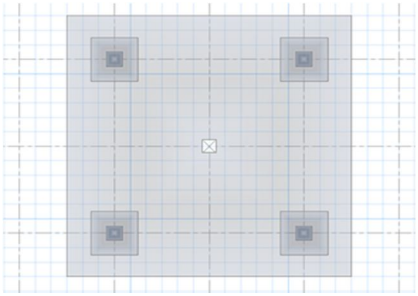

Fig. 3.3. slab with drop - opening of (445mmx 445mm)

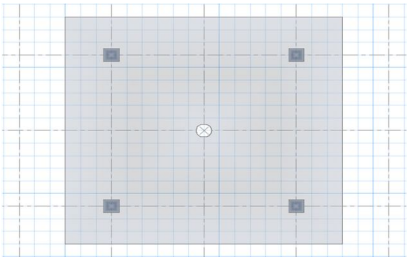

Fig. 3.4. Slab without drop - opening of (500mm Dia)

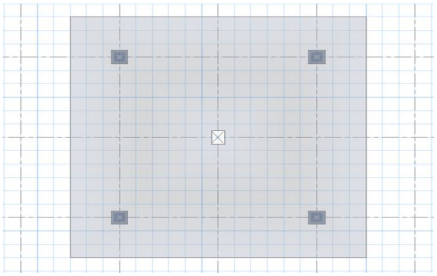

Fig. 3.5. Slab without drop - opening of (400mmx 500mm)

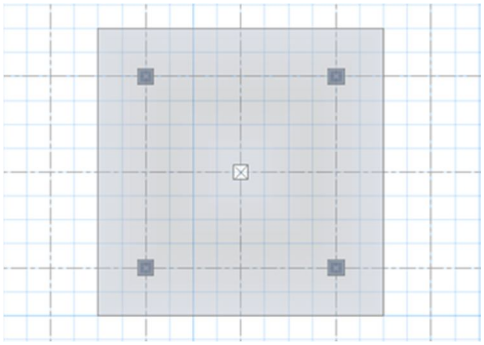

Fig. 3.6. slab without drop - opening of (445mmx 445mm

Table 1 – Showing dimensions of openings.

Slab	Column (mm)	Size of openings	Shape of openings	Location
FLwd1	500mmx 500mm	500mm dia	Circular	At center
FLwd2	500mmx 500mm	400mm x 500mm	Rectangular	At center
FLwd3	500mmx 500mm	445mmx 455mm	Square	At center
FLwod1	500mmx 500mm	500mm dia	Circular	At center
FLwod2	500mmx 500mm	400mm x 500mm	Rectangular	At center
FLwod3	500mmx 500mm	445mmx 445mm	Square	At center

IV. ANALYTICAL RESULT

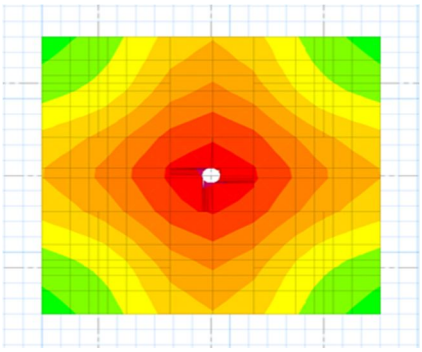

Fig. 4.1. Deflection of slab with drop - opening (500mm dia)

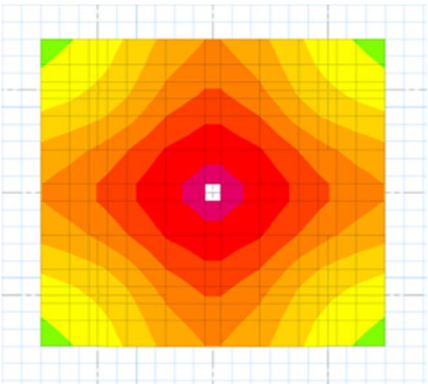

Fig. 4.2. Deflection of slab with drop - opening (400mm x 500mm)

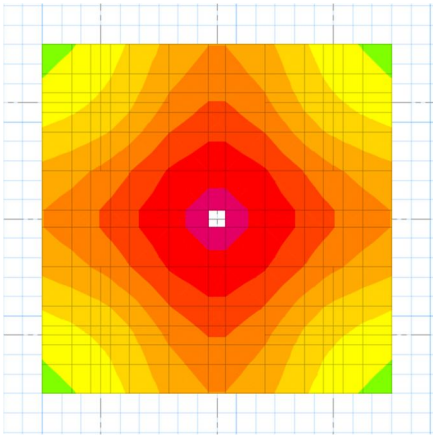

Fig. 4.3. Deflection of slab with opening (445mm x 445mm)

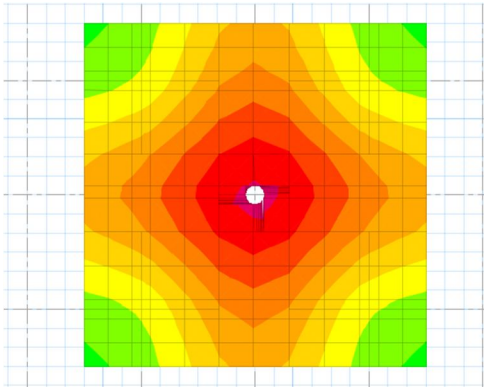

Fig. 4.4. Deflection of slab without drop - opening (500mm dia)

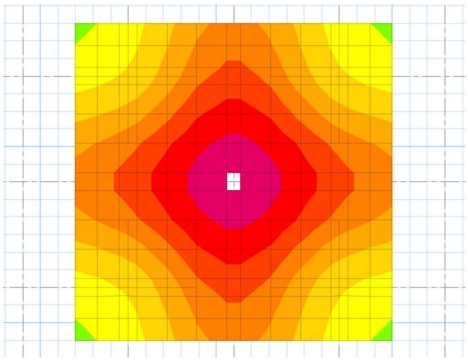

Fig. 4.5. Deflection of slab without drop - opening (400mm x 500mm)

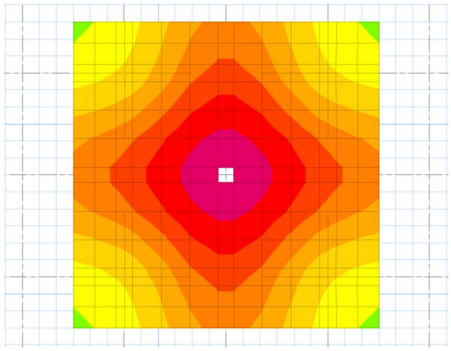

Fig. 4.6. Deflection of slab without drop - opening (445mm x 445mm

Table 2.1. Result containing punching shear value

Slab	Column (mm)	Size of openings (mm)	Shape of openings	Location	Punching shear value	Deflection (mm)
FLwd1	500 x 500	500mm dia	Circular	At center	0.8592	6.1279
FLwd2	500 x 500	400 x 500	Rectangular	At center	0.856	5.3376
FLwd3	500 x 500	455 x 455	Square	At center	0.8561	5.3382
FLwod1	500 x 500	500mm Dia	Circular	At center	1.1815	6.4256
FLwod2	500 x 500	400 x 500	Rectangular	At center	1.1734	5.7332
FLwod3	500 x 500	445 x 445	Square	At center	1.1733	5.7338

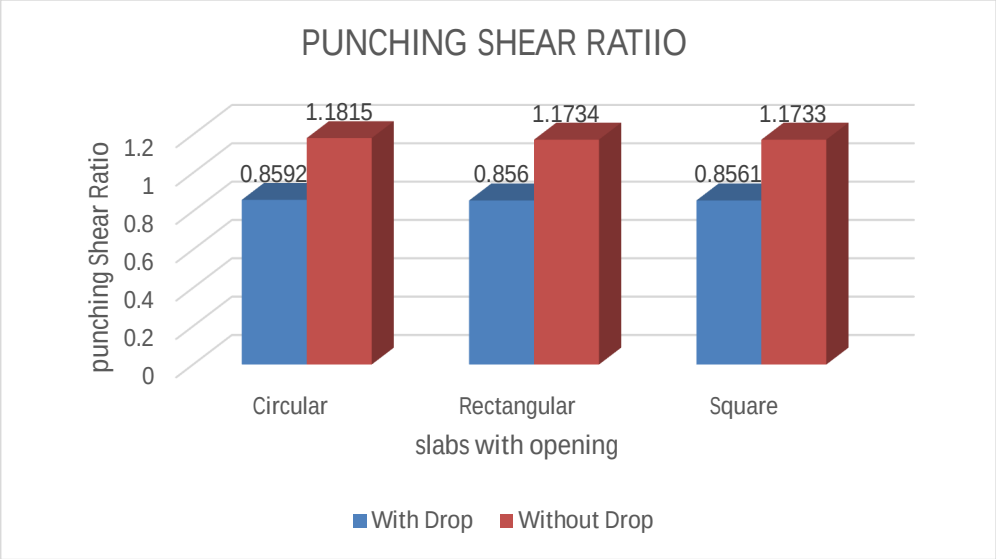

Fig. 4.7. Showing punching shear value of slab with and without drop

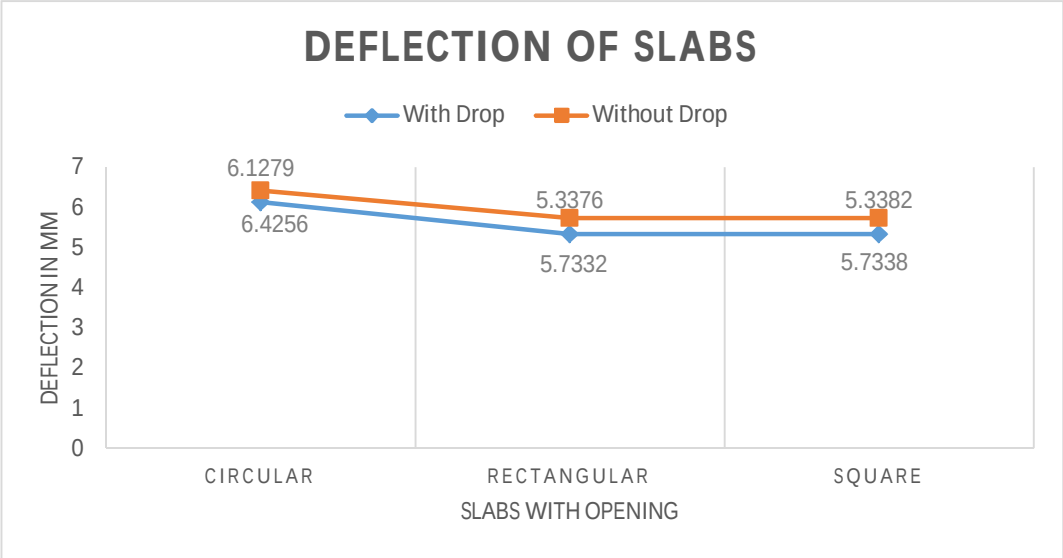

Fig. 4.8. Deflection value of slab with and without opening

Table 3. Showing maximum shear force and bending moment

Slab	Column (mm)	Size of openings (mm)	Shape of openings	Location	Maximum Shear Force	Maximum Bending Moment
FLwd1	500 x 500	400mm Dia	Circular	At center	301.974	132.93
FLwd2	500 x 500	295 x 425	Rectangular	At center	302.666	132.221
FLwd3	500 x 500	355 x 355	Square	At center	302.67	132.348
FLwod1	500 x 500	500mm Dia	Circular	At center	295.038	123.753
FLwod2	500 x 500	400 x 500	Rectangular	At center	295.22	123.657
FLwod3	500 x 500	445 x 445	Square	At center	295.2	121.716

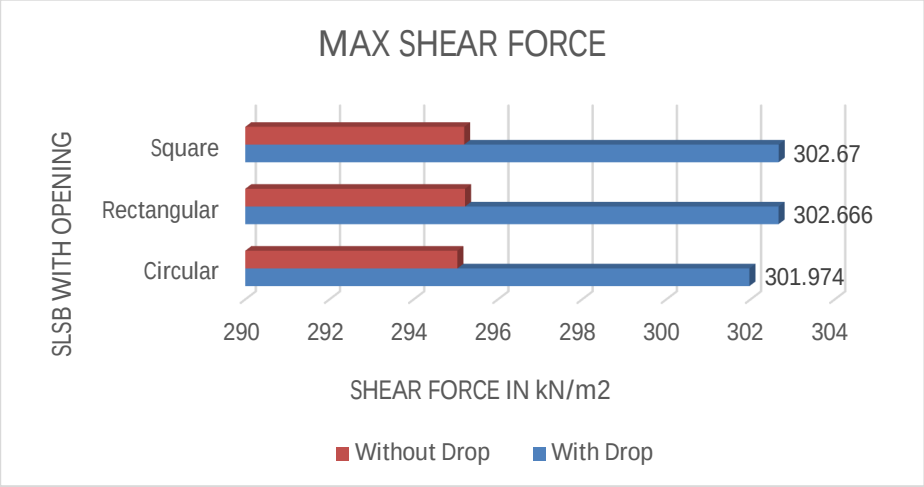

Fig. 4.9. Maximum shear value of slab with and without drop

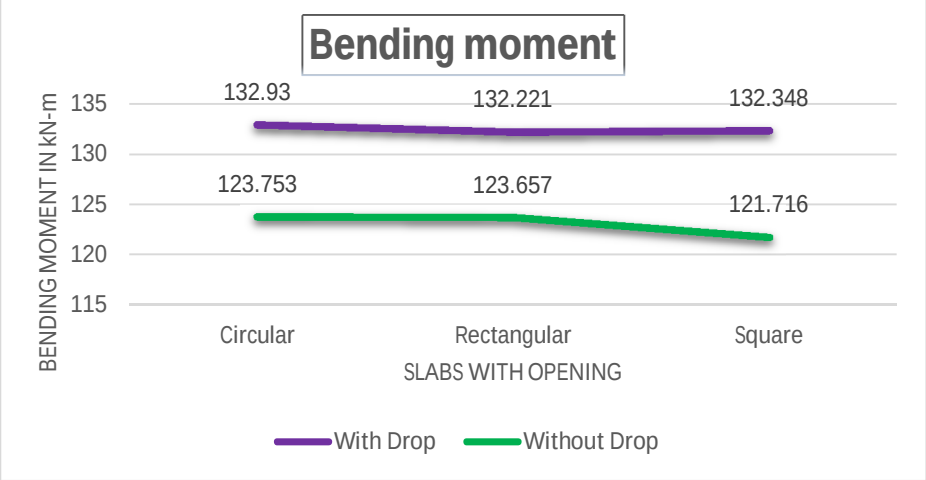

Fig. 4.10. Maximum bending moment value of slab with and without drop

V. CONCLUSION

1) In case of (slab without drop) panel, punching value exceed the permissible limit and hence the punching shear failure occurs. In other case (slab with drop) panel the punching shear value is within the permissible limit and hence the drop safe the slab against failure.

2) Deformation is more in (slab without drop) panel, but this time shape of opening is also affected in deformation of slab. Deflection because of circular opening is more than (the rectangular and square opening)

3) Maximum Bending moment and maximum shear force also slightly vary in (drop without condition).

4) In our test result, we found out that the critical punching shear value and deflection value is greatly reduced by the provision of capital.

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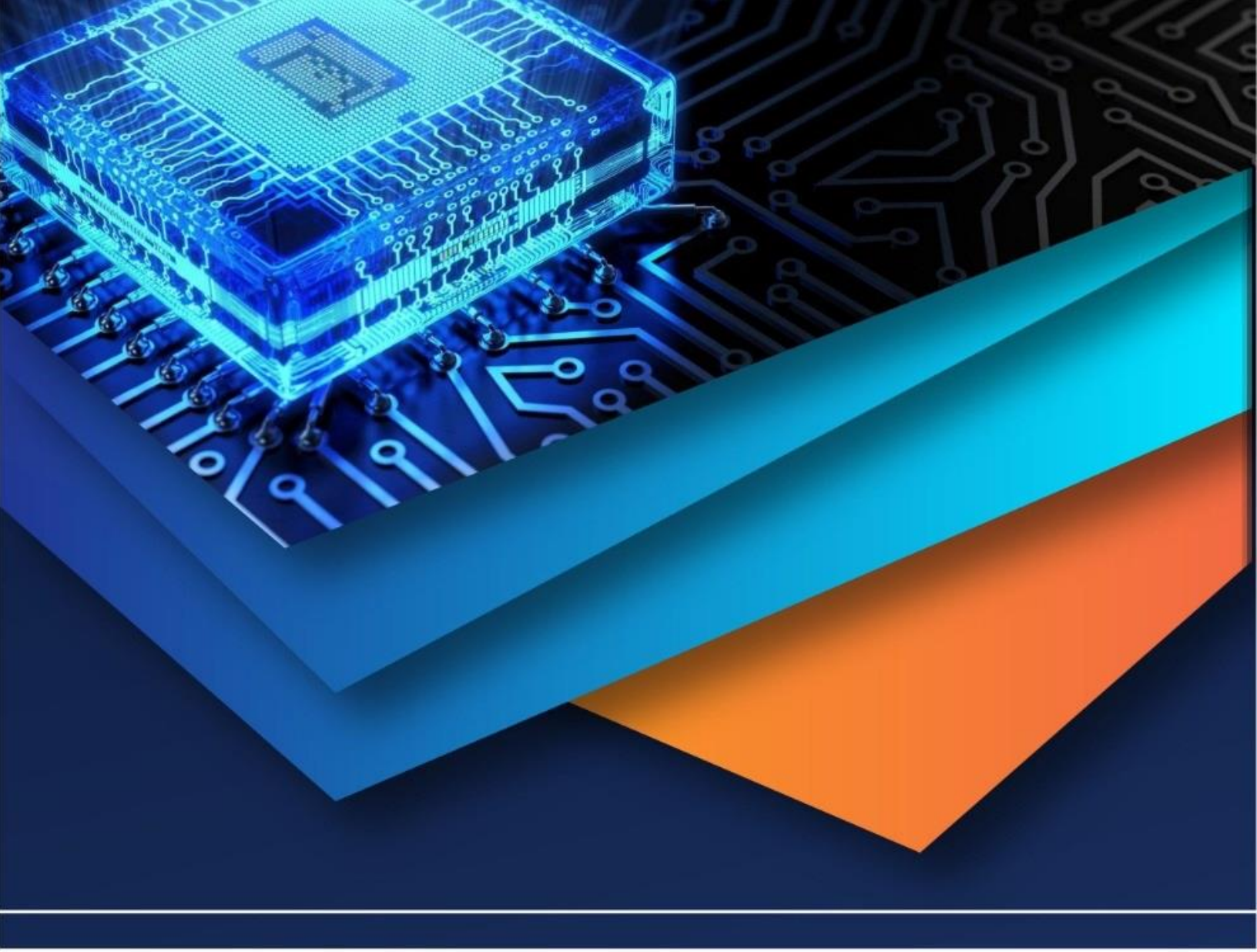

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