WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Efficiency of Circular Opening as Compared to Rectangular and Square Opening Considering Punching Shear behavior of Flat Slab

Jaicky Gurnani [a], Ashwajeet Wasnik [b], Montu shahu [b], Shriram Mahajan [b], Pranay landge [b]

[a] Assistant Professor, Civil Engineering, Nagpur university, Nagpur, India.
[b] B.E. Students, Civil Engineering, Nagpur university, Nagpur, India.

ABSTRACT

There are total 15 slabs panel are tested under provision of openings of different shapes and sizes, all the openings are provided at central location and checking the punching shear capacity of flat slabs. There are three types of opening shape considered are rectangular, square and circular. This paper is based on the comparison of punching shear value of constant area of opening of different shapes and mostly focused on the punching shear value of circular openings. The areas of opening under consideration is not exactly same but very nearby because of that the size of opening is not approximate or would not in round off state. The dimensions of slabs are (6000mmx 6000mmx 220mm) and size of column is (500mmx 500mm). This slab is designed as per the code provision of IS 456:2000. The slabs are analytically design in Software CSI Safe16 which also provide additional result such as deformation, maximum bending moment, displacement along with punching shear value.

1. Introduction

Flat slabs are supported via columns barring the usage of beams are turning into famous a properly desire in modern-day period. The advantages of flat slabs building are by and large identified and this kind of construction design is broadly used in building of workplace buildings, commercial, in auto parking's. Because of the absence of beams the slab thickness is less, so the necessities of the fabric are additionally much less and peak of the shape is additionally saved. Flat slabs have sure difficulty such as it is no longer substantially nice in opposition to the punching shear failure and usually fail in that. The amplify of shear stresses surrounding the column reasons punching shear failure which is a brittle failure or surprising failure due to the fact nearer the columns negative bending moment is dominant due to which cracks or deflection is now not without problems are manifest at pinnacle surface.

There are quite a few motives through which it is quintessential to create openings on flat slab for the architectural reason or for the provision of air conditioning, electrification machine or to furnish staircase, etc. these opening has excellent have an impact on punching shear conduct of slabs.

Slab panels are design and tested under drop condition. A drop panel is an area around the column having increased the slab thickness to improve the structural capacity of slab.

2. Objective

- Comparing the circular opening with square and rectangular opening under nearer to same area.
- Check the punching shear value of slab under variation of opening. Are the openings dimensions and cross-sectional is certainly matters?
- Study the efficiency of circular openings with constant areas but variation in shapes of openings.
- Obtaining a suitable result to provide a beneficial assist for future study.

3. Analytical work

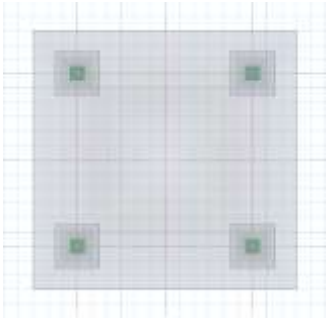

Fig. 3.1. Slab without opening

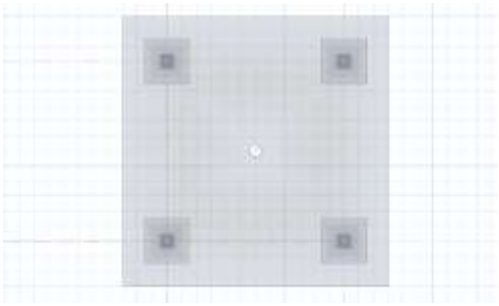

Fig. 3.2. Slab with opening of (400mm Dia)

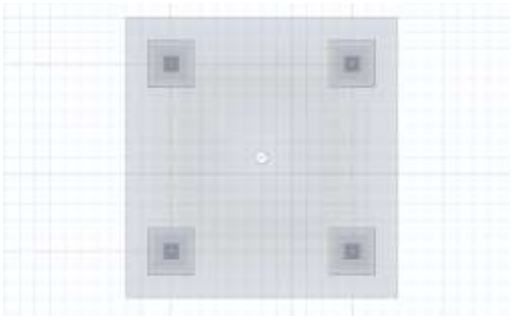

Fig. 3.3. Slab with opening of (500mm Dia)

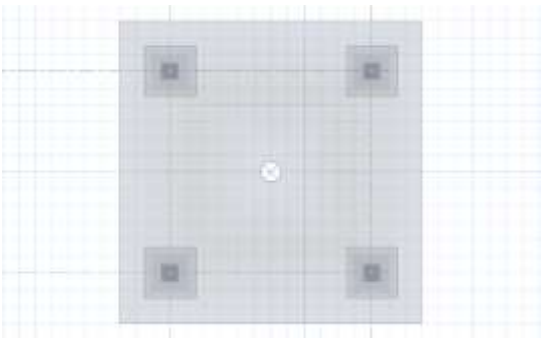

Fig. 3.4. Slab with opening of (600mm Dia)

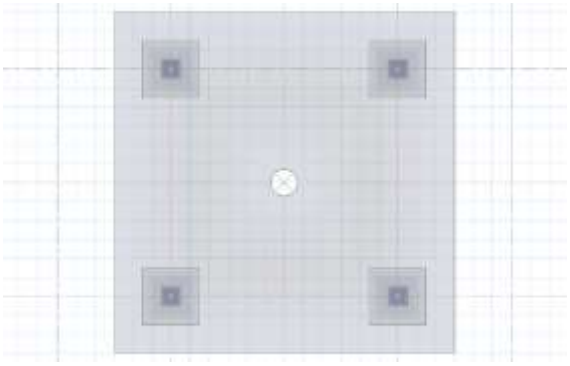

Fig. 3.5. Slab with opening of (700mm Dia)

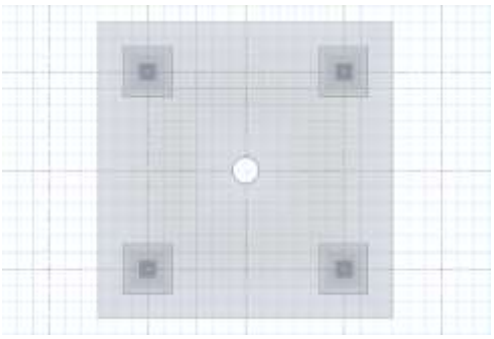

Fig. 3.6. Slab with opening of (800mm Dia)

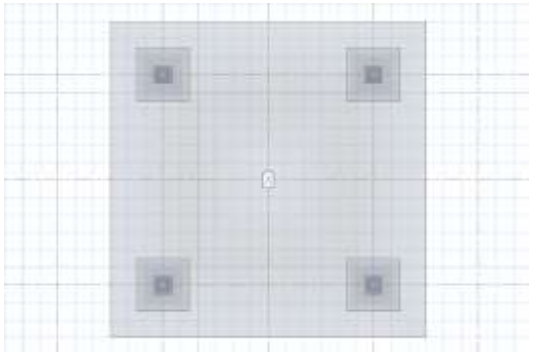

Fig. 3.7. Slab with opening of (295mmx 426mm)

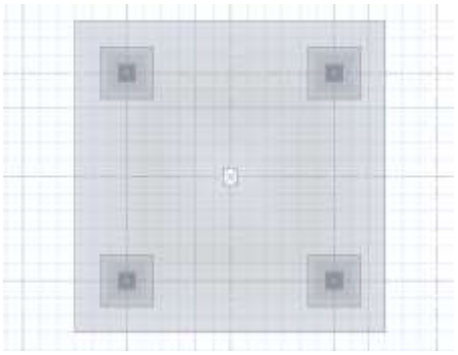

Fig. 3.8. Slab with opening of (388mmx 506mm)

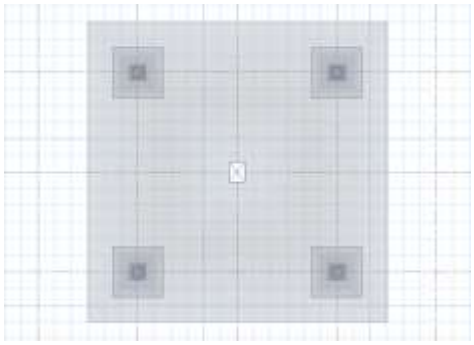

Fig. 3.9. Slab with opening of (465mmx 608mm)

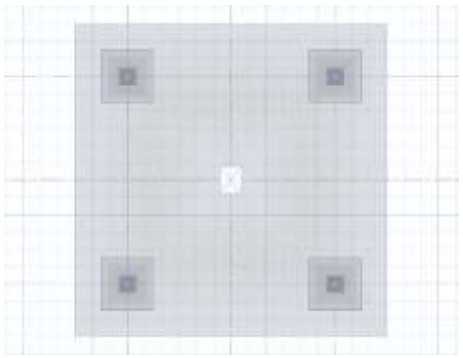

Fig. 3.10. Slab with opening of (626mmx 803mm)

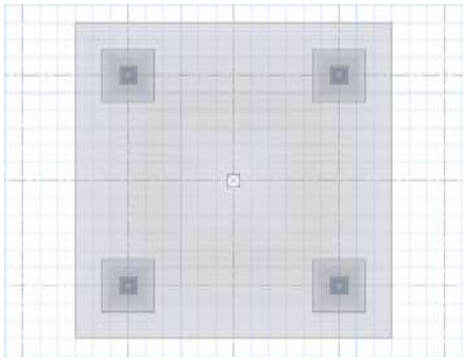

Fig. 3.11. Slab with opening of (355mmx 355mm)

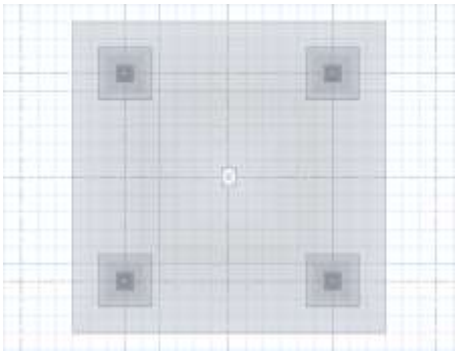

Fig. 3.12. Slab with opening of (400mmx 500mm)

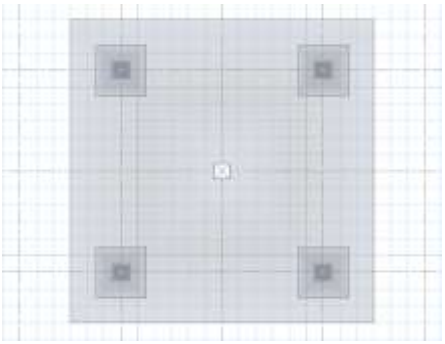

Fig. 4.13. Deflection of slab with opening (445mmx 445mm)

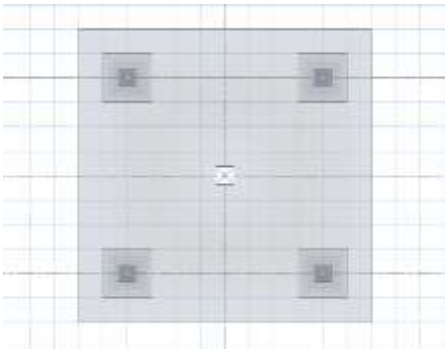

Fig. 3.14. Slab with opening of (532mmx 532mm)

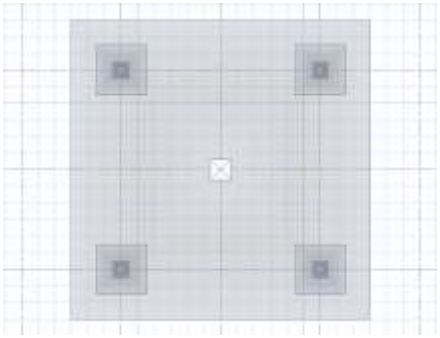

Fig. 3.15. Slab with opening of (620mmx 620mm)

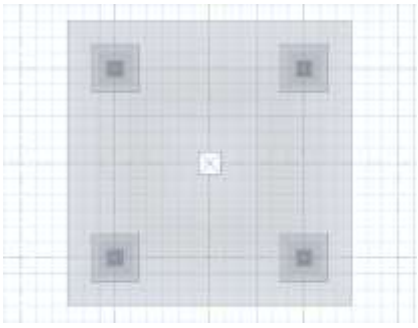

Fig. 3.16. Slab with opening of (709mmx 709mm)

Table 1 – Showing dimensions of openings.

Slab	Column (mm)	Size of openings	Shape of openings	Location
FL_{wo}	500mmx 500mm	Without	-	-
FL1	500mmx 500mm	400mm Dia	Circular	At center
FL2	500mmx 500mm	295mmx 425mm	Rectangular	At center
FL3	500mmx 500mm	355mmx 355mm	Square	At center
FL4	**500mmx 500mm**	**500mm Dia**	**Circular**	**At center**
FL5	500mmx 500mm	400mmx 500mm	Rectangular	At center
FL6	500mmx 500mm	445mmx 445mm	Square	At center
FL7	**500mmx 500mm**	**600mm Dia**	**Circular**	**At center**
FL8	500mmx 500mm	465mmx 608mm	Rectangular	At center
FL9	500mmx 500mm	532mmx 532mm	Square	At center
FL10	500mmx 500mm	700mm Dia	Circular	At center
FL11	500mmx 500mm	549mmx 701mm	Rectangular	At center
FL12	500mmx 500mm	620mmx 620mm	Square	At center
FL13	500mmx 500mm	800mm Dia	Circular	At center
FL14	500mmx 500mm	626mmx 803mm	Rectangular	At center
FL15	500mmx 500mm	709mmx 709mm	Square	At center

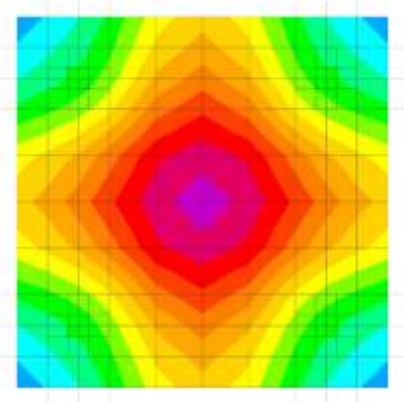

Fig. 4.1. Deflection of slab without opening.

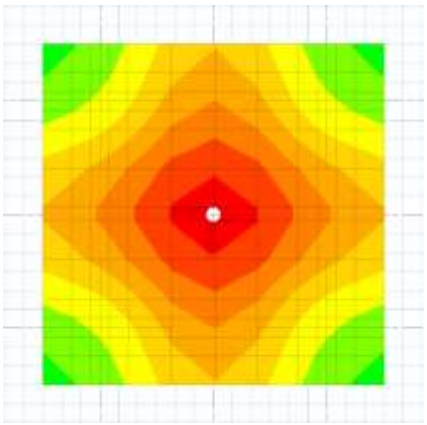

Fig. 4.2. Deflection of slab with opening (400mm **Dia**)

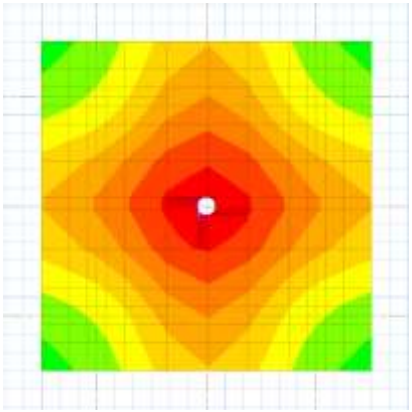

Fig. 4.3. Deflection of slab with opening (500mm **Dia**)

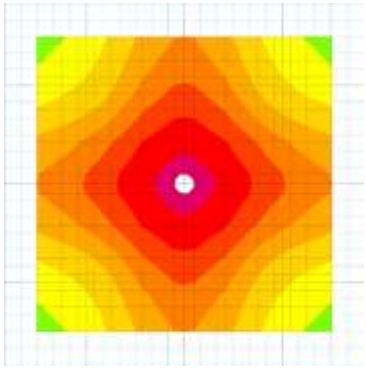

Fig. 4.4. Deflection of slab with opening (600mm **Dia**)

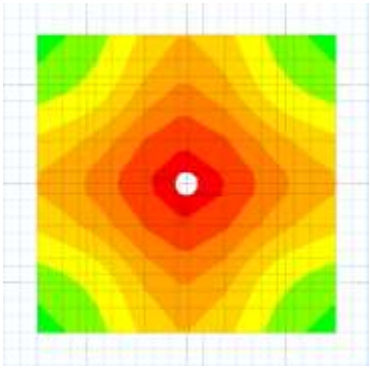

Fig. 4.5. Deflection of slab with opening (700mm **Dia**)

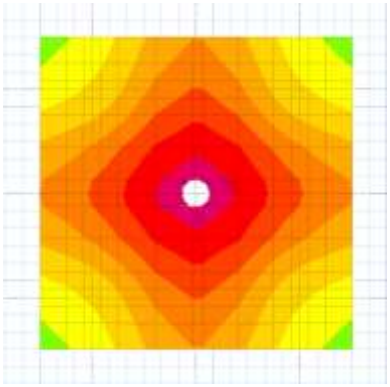

Fig. 4.6. Deflection of slab with opening (800mm **Dia**)

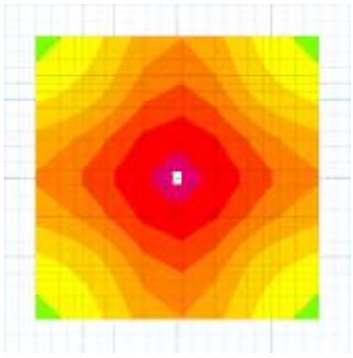

Fig. 4.7. Deflection of slab with opening (295mmx 425mm)

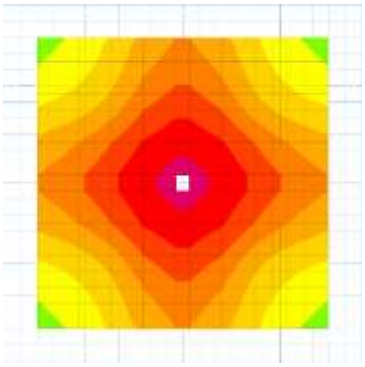

Fig. 4.8. Deflection of slab with opening (400mmx 500mm)

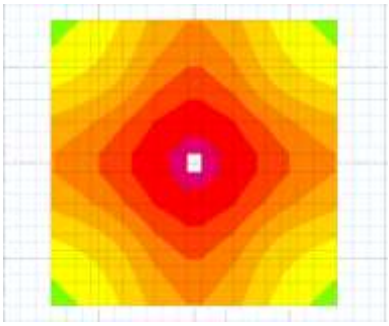

Fig. 4.9. Deflection of slab with opening (465mmx 608mm)

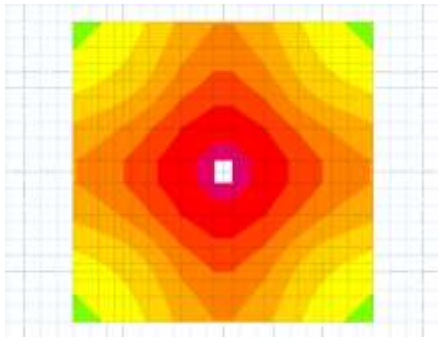

Fig. 4.10. Deflection of slab with opening (549mmx 701mm)

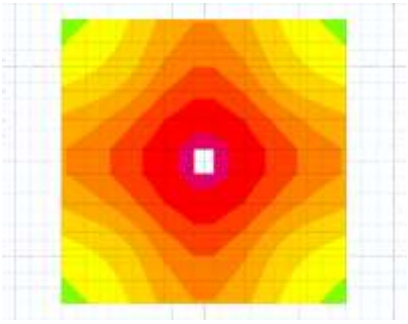

Fig. 4.11. Deflection of slab with opening (626x803m)

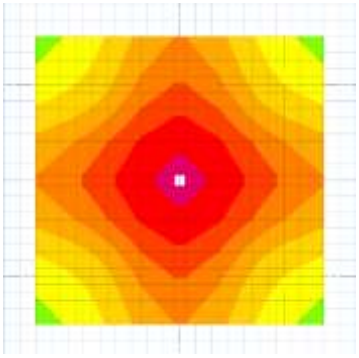

Fig. 4.12. Deflection of slab with opening (355mmx 355mm)

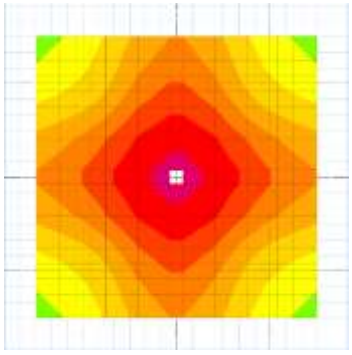

Fig. 4.13. Deflection of slab with opening (445mmx 445mm)

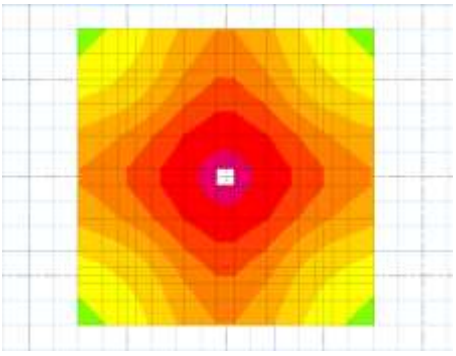

Fig. 4.14. Deflection of slab with opening (532mmx 532mm)

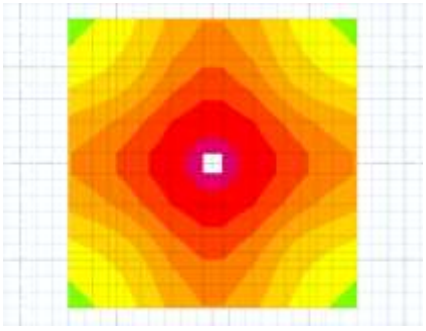

Fig. 4.15. Deflection of slab with opening (620mmx 620mm)

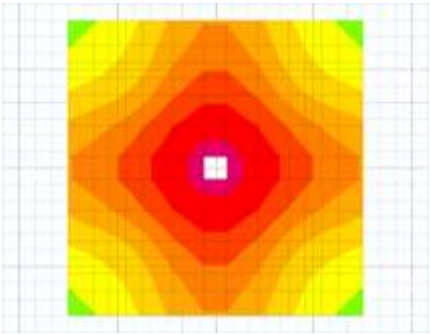

Fig. 4.16. Deflection of slab with opening (709mmx 709mm)

Table 2.1. Result showing punching shear value and Deflection.

Slab	**Column (mm)**	**Size of openings (mm)**	**Shape of openings**	**Location**	**Punching shear value**	**Deflection (mm)**
FL_{WO}	500 x 500	Without	-	-	0.8545	5.8583
FL1	500 x 500	400mm Dia	Circular	At center	0.8633	5.8451
FL2	500 x 500	295 x 425	Rectangular	At center	0.8547	5.314
FL3	500 x 500	355 x 355	Square	At center	0.8563	5.3275
FL4	500 x 500	500mm Dia	Circular	At center	0.8592	6.1279
FL5	500 x 500	400 x 500	Rectangular	At center	0.856	5.3376
FL6	500 x 500	445 x 445	Square	At center	0.8561	5.3382

FL7	500 x 500	600mm Dia	Circular	At center	0.8567	6.1254
FL8	500 x 500	465 x 608	Rectangular	At center	0.8555	5.3419
FL9	500 x 500	532 x 532	Square	At center	0.8555	5.3438
FL10	500 x 500	700mm Dia	Circular	At center	0.8581	5.7889
FL11	500 x 500	549 x 701	Rectangular	At center	0.8546	5.3413
FL12	500 x 500	620 x 620	Square	At center	0.8546	5.3236
FL13	500 x 500	800mm Dia	Circular	At center	0.8589	5.5945
FL14	500 x 500	626 x 803	Rectangular	At center	0.8534	5.3306
FL15	500 x 500	709 x 709	Square	At center	0.8534	5.3363

Table 2.2 Showing maximum shear force and Maximum bending moment

Slab	**Column (mm)**	**Size of openings (mm)**	**Shape of openings**	**Location**	**Maximum Shear Force**	**Maximum Bending Moment**
FL_{WO}	500 x 500	Without	-	-	303.426	131.6404
FL1	500 x 500	400mm Dia	Circular	At center	303.624	132.6946
FL2	500 x 500	295 x 425	Rectangular	At center	302.881	133.2488
FL3	500 x 500	355 x 355	Square	At center	302.945	133.1806
FL4	500 x 500	500mm Dia	Circular	At center	301.974	132.9307
FL5	500 x 500	400 x 500	Rectangular	At center	302.666	132.2214
FL6	500 x 500	445 x 445	Square	At center	302.67	132.3481
FL7	500 x 500	600mm Dia	Circular	At center	301.673	132.8364
FL8	500 x 500	465 x 608	Rectangular	At center	302.346	132.81
FL9	500 x 500	532 x 532	Square	At center	302.345	132.2667
FL10	500 x 500	700mm Dia	Circular	At center	302.318	134.243
FL11	500 x 500	549 x 701	Rectangular	At center	301.956	132.9158
FL12	500 x 500	620 x 620	Square	At center	301.958	132.1432
FL13	500 x 500	800mm Dia	Circular	At center	301.804	134.449
FL14	500 x 500	626 x 803	Rectangular	At center	301.505	133.1122
FL15	500 x 500	709 x 709	Square	At center	301.506	133.1061

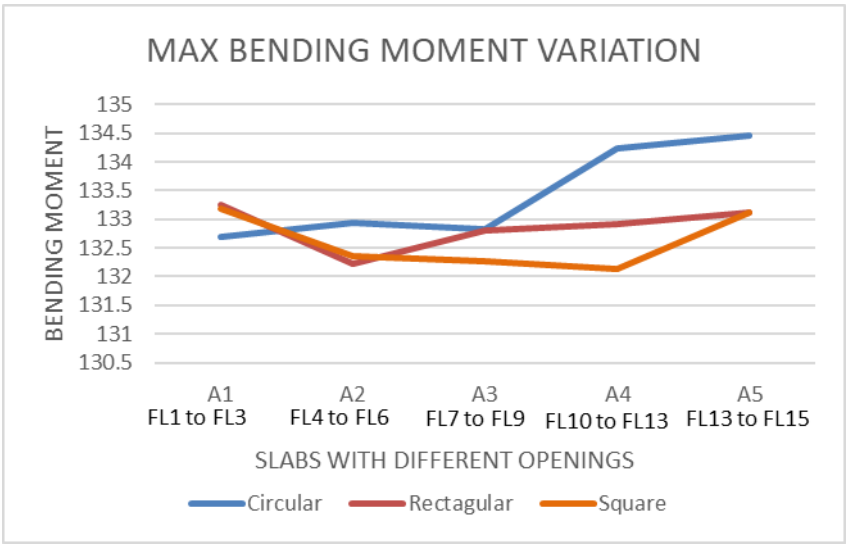

FIG.4.17. BENDING MOMENT VARIATION DIAGRAM WITH OPENING SHAPES

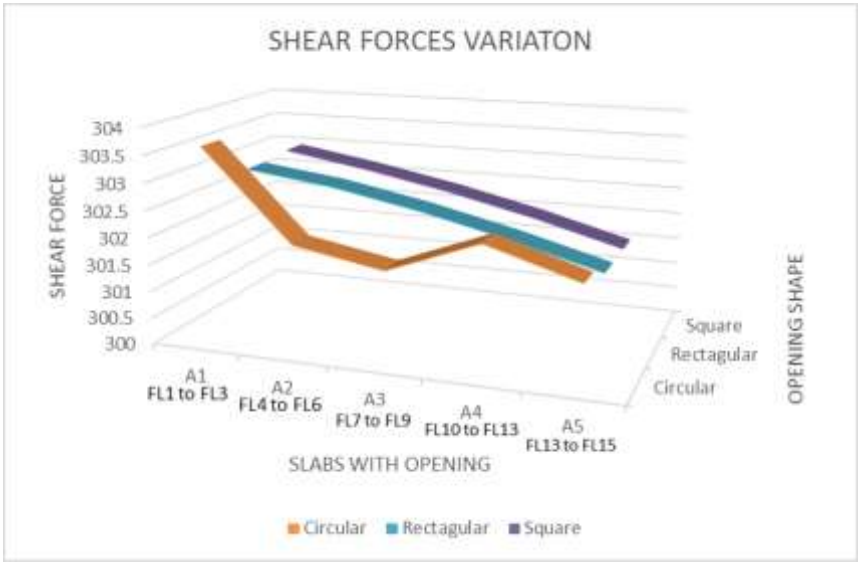

FIG.4.18. SHEAR FORCE VARIATION DIAGRAM WITH OPENING SHAPES

FIG.4.19. DEFLECTION VARIATION DIAGRAM WITH OPENING SHAPES

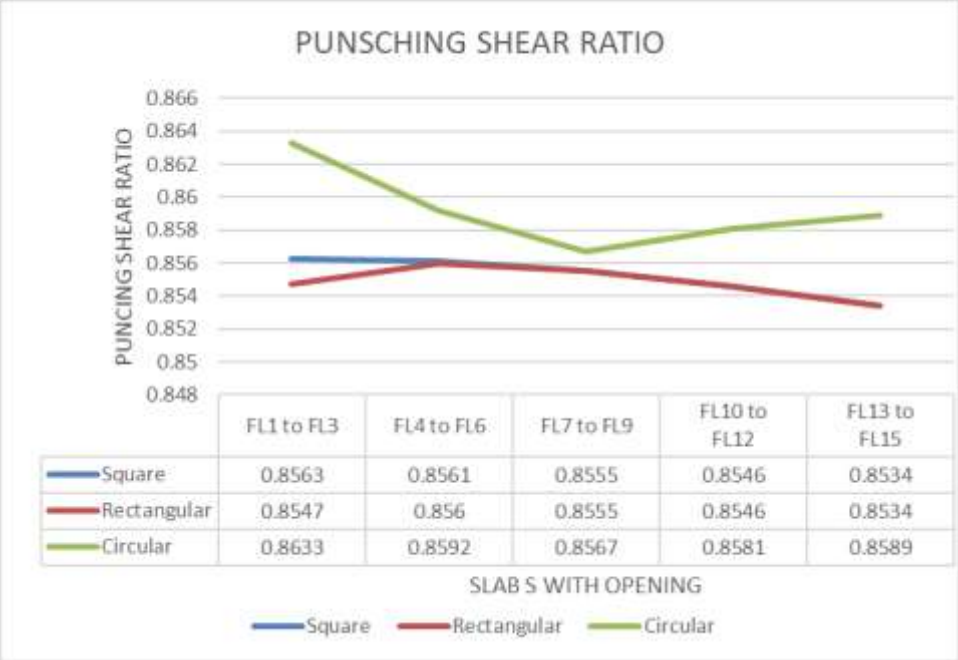

FIG.4.20. PUNCHING SHEAR VARIATION DIAGRAM WITH OPENING SHAPES

5. Conclusion

1. According to our results, punching shear behavior is not significantly impacted by the different opening area and shape. The value of punching shear of circular opening is slightly greater than (rectangle and square) opening which have not serious effect on the strength of the slab.

2. Deflection in case of circular opening is greater than rectangular and square opening having same area.

3. The maximum shear force and maximum bending moment has not serious effect considering the opening dimensions.

4. From the analytical result, punching shear, deflection, maximum shear force, maximum bending moment criteria. Deflection give a proper comparison-based result.

5. Under drop condition, punching shear strength not create a major problem with the opening shape and dimensions. But (rectangular and square) opening is preferable than circular opening in case of deflection criterion.

6. Reference:

1. IS 456 (2000): Indian Plain and Reinforced Concrete - Code of Practice [CED 2: Cement and Concrete] (Fourth Revision). BUREAU OF INDIAN STANDARDS.

2. Marques, M.G. , Liberati, E.A.P. , Gomes, R.B.

3. Punching Shear Strength Model for Reinforced Concrete Flat Slabs with Openings

4. Siqueira, J.P.A. , Melo, G.S.D.

5. Punching shear strength of reinforced concrete slabs, ACI Structural Journal (2008).

6. Seismic Design of Punching Shear Reinforcement in Flat Plates, Farmington Hills, USA, 2007.

7. Megally S, ghali A. Punching shear design of earthquake resistant slab column connections. ACI Struct J 2000;97.