

Seismic Performance of RC Building Slab with and Without Opening

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Abstract— The reinforced concrete building slabs are provided with openings in general buildings. These openings are not taken into account while analyzing the building structures for loads. Especially in case of seismic analysis, these openings invariably affect the performance and response of structure. In this study, an attempt is made to compare the performance of building structure having different percentage of opening in slab. The performance is assessed by applied earthquake load and finding displacement of building.

Key words: openings, RC slabs, seismic analysis, seismic response

I. INTRODUCTION

It is common practice observed in practice that reinforced concrete (RC) slabs are provided with openings of some dimensions. These openings tend to affect the performance of building.

Seventeen different slabs of RCC tested experimentally in [1] showed that solid slabs undergo brittle failure than typical quality cement. The results showed that with increase in amount of reinforcement, punching strength of slab increased. Test comes about demonstrated that as the level of support is expanded, the punching quality of the slabs is additionally expanded. It was found that utilizing the cubic base of the solid compressive quality to anticipate the punching resistance of the solid slabs by and large yields preferable results over the square root expression utilized as a part of North American codes.

In similar study [2] on six prototype RC slabs of one way distribution having openings, strengthened with carbon fiber-reinforced polymer (CFRP) under concentrated linear loads. The results when compared to solid slab showed that CFRP system is effective in improving the load carrying capacity as well as stiffness of RC slabs having opening,

In laboratory tests [3] conducted on eleven slab having openings under a UDL, it was observed that slabs with openings can be strengthened efficiently with CFRP sheets. The performance is found to be better than steel reinforced slabs. The numerical as well as analytical results were in good agreement with the experimental results.

In various other studies like [4-6], similar behavior of slabs with opening is observed.

II. DETAILS OF BUILDING MODEL

The building model is of reinforced concrete having 4 storey and 3 bay in each direction. The height of each storey is 3 m and width of bay is 8 m in each direction. The slab is offlat slab type as shown in Fig. 1. The complete three dimensional model is shown in Fig. 2.

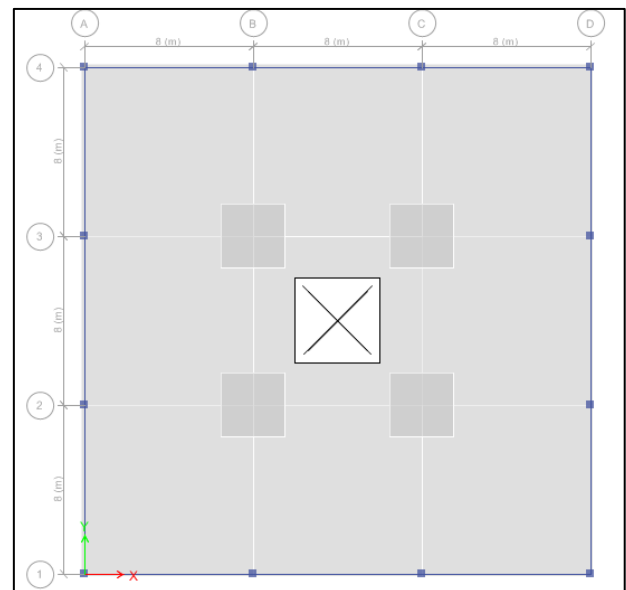


Fig. 1: Plan view geometric details of slab with opening n centre

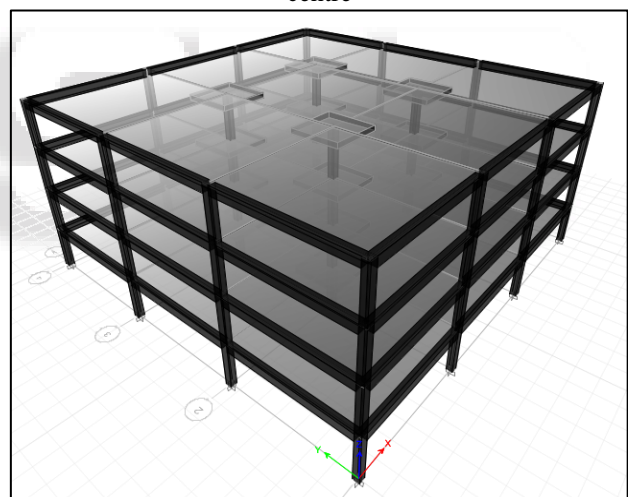


Fig. 2: 3D view of building model

This building model is then provided with openings of varying percentage. The openings are provided in centres and sides which are termed concentric (Con) and eccentric (Ecc) respectively.

The complete details of these are shown in Table 1 for concentric type and Table 2 for eccentric type.

Label	Opening	Openng area	% Opening
ConA	0	0	0.00%
ConB	2	4	0.69%
ConC	4	16	2.78%
ConD	6	36	6.25%
ConE	8	64	11.11%
ConF	10	100	17.36%
ConG	12	144	25.00%

Table 1: Detailss of openings for concentric type

EccA	0	0	0.00%
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EccB	2	4	0.69%
EccC	4	16	2.78%
EccD	6	36	6.25%
EccE	8	64	11.11%
EccF	10	100	17.36%
EccG	12	144	25.00%

Table 2: Details of building for eccentric type

III. METHODOLOGY OF ANALYSIS

The linear static method of analysis is adopted for seismic analysis. The procedure is as given in IS 1893:2002, the Indian Standard Seismic code. The static lateral load are calculated based on seismic coefficients and weights.

The whole modelling and analysis procedure is performed in CSI Etabs software [7].

IV. RESULTS AND DISCUSSIONS

A. Displacement Contours of Slab

The displacement contours are obtained by considering slab as flexible thin shell. The displacement contours shown in Fig. 2 to Fig. 4 clearly show that performance of building with openings is affected with presence of openings.

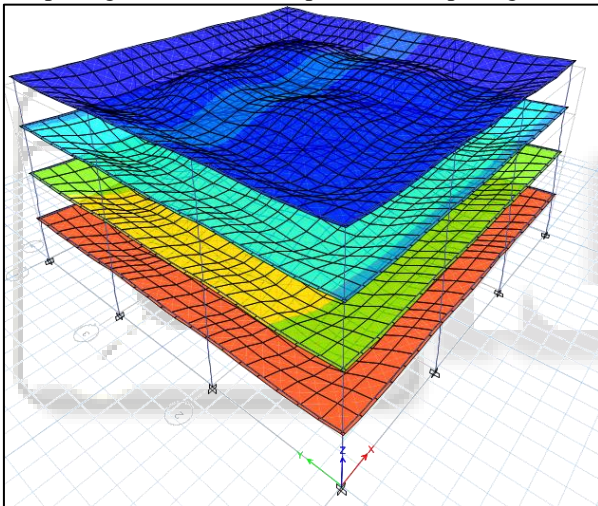


Fig. 3: Displacement of slab without opening

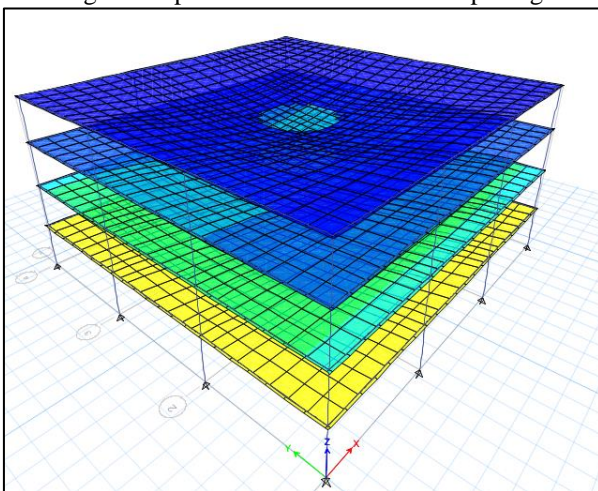


Fig. 4: Displacement of slab with small opening

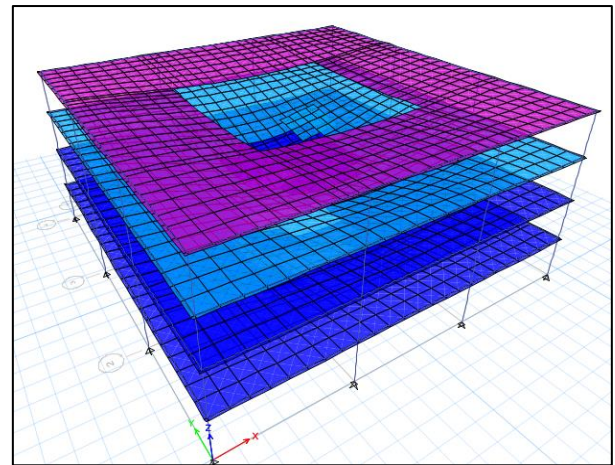


Fig. 5: Displacement of slab with large opening

B. Storey Displacement

The storey displacement plot clearly show the performance of various storeys. For present study, the storey displacement of concentric and eccentric type is shown in Fig. 5 and Fig. 6. It is observed that there is about triple in lateral displacement of building due to increasing amount of openings in both concentric and eccentric type of buildings.

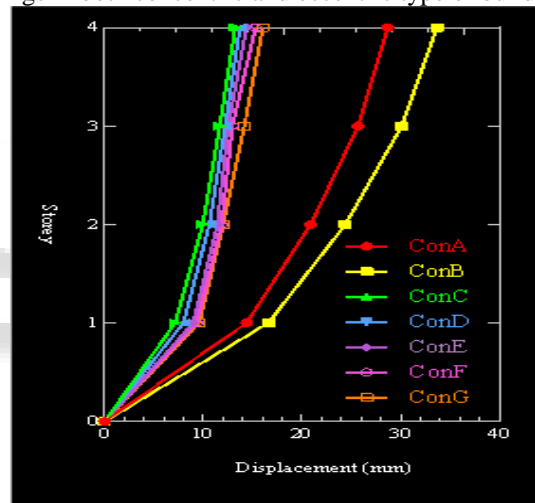


Fig. 6: Storey displacement results of building having concentric type of opening

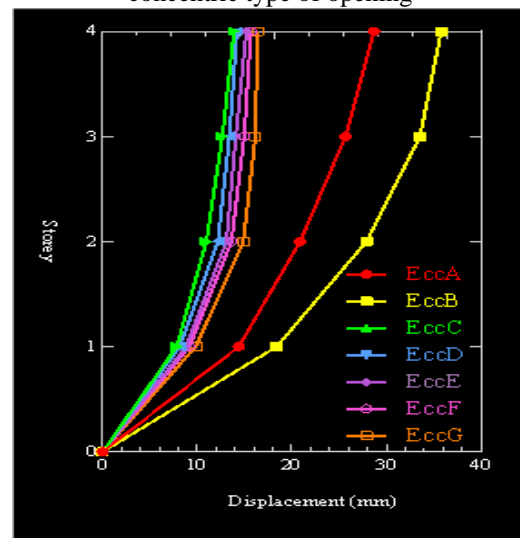


Fig. 7: Storey displacement results of building having eccentric type of opening

C. Comparison of Openings

Fig. 7 shows comparison of concentric and eccentric type of buildings. The graph shows that eccentric type of building under more deformations for various amount of openings.

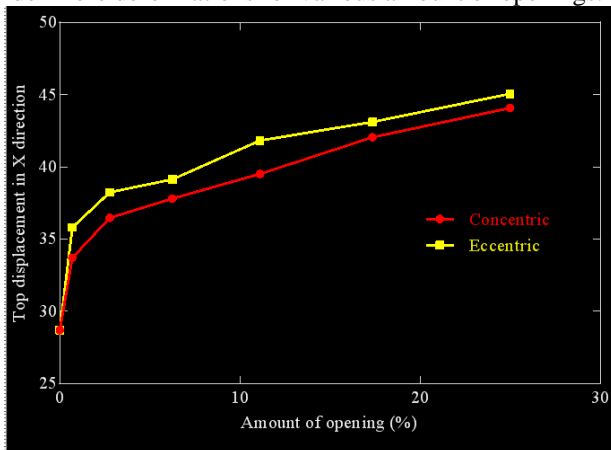


Fig. 8: Comparative results of buildings with concentric and eccentric opening

V. CONCLUSION

Openings in RC slabs and their effect on seismic performance of building is studied in this paper. Two different places - center and side are provided with openings and amount of opening is varied. The results given in terms of displacement contours and storey displacement are presented.

It is observed that there is considerable increase in displacement of building when amount of openings are increased. For 25% opening, there is triple increase in displacement. The similar pattern is observed in concentric and eccentric buildings.

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