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EFFECTS OF OPENINGS IN SHEAR WALL ON SEISMIC RESPONSE OF MULTI-STORIED BUILDING

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Abstract: -Shear wall buildings are a popular choice in many earthquake prone countries, like Chile, New Zealand and USA. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and non-structural elements. Door or window openings can be provided in shear walls. In this study an attempt is made to analyses the effect of opening configuration on the seismic behavior of shear walls. Hence it is need to provide shear wall to increase strength and stiffness to withstand against lateral loads and how openings in shear wall affects stiffness of structure. In the present study, a G+15 storey building is analyzed using software ETABS by dynamic (Response Spectrum) analysis. All the analyses has been carried out as per the Indian Standard code IS 1893:2016. The comparative results showed that the, time period, top displacement, base shears, story drift and forces in columns and beams depend on the position of shear wall and openings arrangement system.

Keywords:- shear wall, seismic response,time period, top displacement, base shears, story drift , forces in columns, beams,lateral loads

I. INTRODUCTION

In general most of the Reinforced concrete frame buildings with masonry infill walls have been widely constructed for residential or commercial or industrial purposes through the worldwide. Masonry infill generally consists of brick masonry, stone masonry or concrete block walls, which are constructed between columns and beams of a RC frame structure. These wall panels strength and stiffness are generally not considered while design process and theses treated as non-structural components in the building. It can be observed that if the effect of infill is taken into account in the analysis and design of structure, the resulting structure may be economical and viable. Sufficient experimental and analytical research is reported in various literatures, which attempts to explain the behavior of infilled frames. Moreover, infill, if present in all storeys gives a significant contribution to the overall performance and strength of structure, therefore the influence of masonry wall is of great importance.Presence of openings cannot be avoided in RC wall buildings from the functional requirements point of view. However, openings pose serious problems of stiffness irregularities in walls. Both stiffness and deformation characteristics of wall are significantly degraded due to the presence of openings. Presence of large openings makes the portions of the wall above the openings to act as coupling beams or spandrels which significantly increase the ductility demand of the walls. Large and unsymmetrically placed openings should beavoided in the walls. Openings should be kept as small as possible and its uniform distribution should be maintained.

II.SCOPE OF WORK

- ✓ The scope of this paper includes to get better idea on the seismic performance of building with shear wall.
- ✓ The scope of this project includes to generate fundamental research information on the seismic performance of building structural systems with openings in shear wall.
- ✓ The structure should withstand the moderate earthquakes, which may be expected to occur during the service life of structure with damage within acceptable limits.
- ✓ To assess performance of building with shear wall
- ✓ Comparing different opening configuration in shear wall
- ✓ The main assumptions adopted are as follows; in all cases, the building element size are kept constant and the foundation is assumed totally fixed to the ground.

III. METHODOLGY

Step1:

BUILDING DESCRIPTION :

A RC framed building plan (Seismic Zone IV) is selected for the present study. The building is fairly symmetric in plan and in elevation. This building is a G+15 storey building (48m high) and is made of Reinforced Concrete (RC) Special Moment Resisting Frames (SMRF). Fig.1 presents typical floor plans showing different column and beam locations. The cross sections of the structural members are equal in all frames and all storie

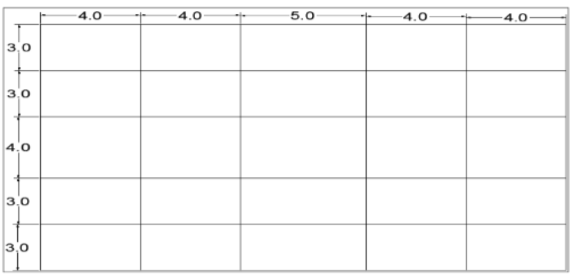

Fig. 1. Typical Floor Plan

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Step 2:

a)Structural Modeling :

Modelling a building involves the modelling and assemblage of its various load-carrying elements. Themodel must ideally represent the mass distribution, strength, stiffness and deformability.

Seven models have been considered for the purpose of the study

1. ***Fifteen storey(G+15) building without shear walls.Fifteen storey(G+15) building without shear walls.***
2. ***Fifteen storey(G+15) building with shear walls in central core.***
3. ***Fifteen storey(G+15) building with shear walls in corners***
4. ***Fifteen storey(G+15) building with shear walls in central core and regular opening.***
5. ***Fifteen storey(G+15) building with shear walls in corners with regular opening***
6. ***Fifteen storey(G+15) building with shear walls in central core and staggered opening.***
7. ***Fifteen storey(G+15) building with shear walls in corners with staggered opening***

b)Defining load combinations

According to IS 1893 (Part 1) 2016 for the limit state design of reinforced and prestressed concrete structures, the following load combinations have been defined.

The basic load combinations given by the code as per clause 6.3.4.1 are as follows

1. 1.2(DL+LL±(EQX±0.3EQY±0.3EQZ))
2. 1.2(DL+LL±(EQY±0.3EQX±0.3EQZ))
3. 1.5(DL±(EQX±0.3EQY±0.3EQZ))
4. 1.5(DL±(EQY±0.3EQX±0.3EQZ)
5. 0.9DL±1.5(EQX±0.3EQY±0.3EQZ)
6. 0.9DL±1.5(EQY±0.3EQX±0.3EQZ

j

IV.MODELING

Thestructureselectedforthis project is a simple RCC buildingwiththe following description asstated below.

Sr.No.	Description	Dimension
1.	Storyheight	3m each
2.	Number ofstorey	16 (Excludingthe plinth and substructure and including the Ground floor)
3.	Depth of foundation from groundlevel	1.5m
4.	Column size	800 mm x 500 mm
5.	Beam size	300 mmx 700 mm
6.	Thickness of Slab	150mm
7.	Thickness of shear wall	250mm
8.	Densityofconcrete	25kN/m^3
9.	Live load onroof	1.5kN/m^2
10.	Live load onfloors	2.5 kN/m^2
11.	Brick wallon peripheralbeams	230 mm
12.	Brick wallon internal beams	230 mm
13.	Densityof brick wall	20kN/m^3

M30 grade concrete and Fe415 steel.

Following codes areusedforthis project consideration.

ISCode for DeadLoad- IS 875 Part 1

ISCode for SeismicLoad- IS 1893 : 2016 Part 1

Seismic design Parameters:

Forthe presentstudyfollowingvalues forseismicanalysisare assumed. Forthe presentstudyfollowingvalues forseismicanalysisare assumed. The values are assumed on thebasisof referencestepsgiveninIS1893-2016 and IS456:2000. SinceNagpur orvidarbhais less vulnerable to earthquakes, for this present studyassigning**zoneIV**for severeseismicintensityas stated in table 2 ofIS1893 – 2016.

1. Zonefactor forzoneIV–0.24
2. Importancefactor forresidential building=1.2
3. Special Reinforced Concrete Moment resistingFrame (SMRF)
4. Response reduction factor forRCC framewith SMRF=5
5. Typeof soil = Medium (TypeII)
6. Dampingpercent = 5 %(0.05)
7. Thickness of brick wall=230 mm
8. Brick infill panel buildingtype.

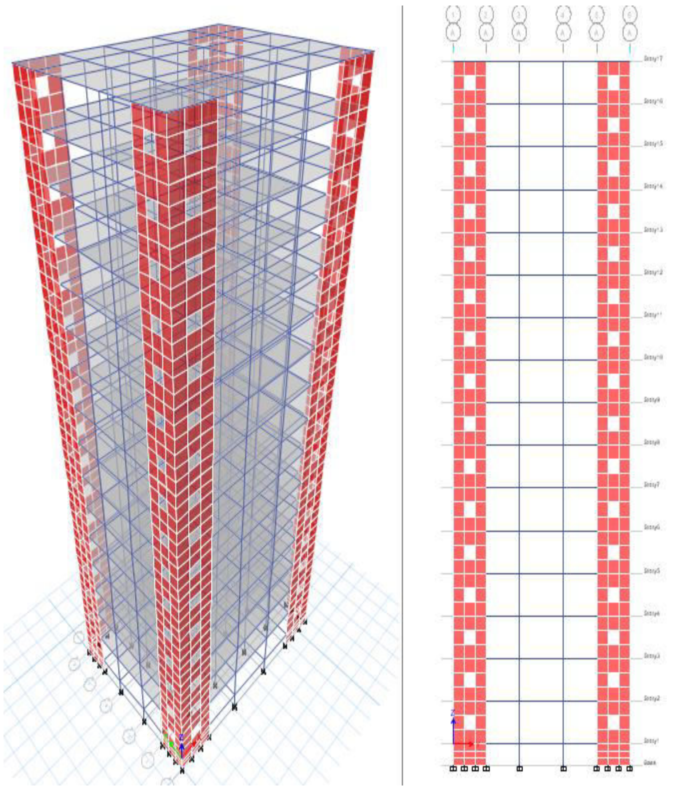

Fig.2 Fifteen storey (G+15) building with shear walls in corners and regular openings

V .RESULT

5.2 Base shear

The response spectrum method had been adopted for seismic analysis in ETAB 2016. The Table No..2. shows maximum base shear in X and Ydirection for above mentioned models.

Type of Model	X Direction	Y Direction
Normal Frame	4217.58	3745.4
Frame with central core	4159.78	3699.48
Central core with regular opening	4134.16	3675.66
Central core with staggered opening	4146.66	3686.67
Frame with corner shear wall	4023.88	3576.97
Corner shear wall with regular opening	3985.74	3542.45
Corner shear wall with staggered opening	4009.88	3564.63

Table No. 2 : Base Shear(KN)

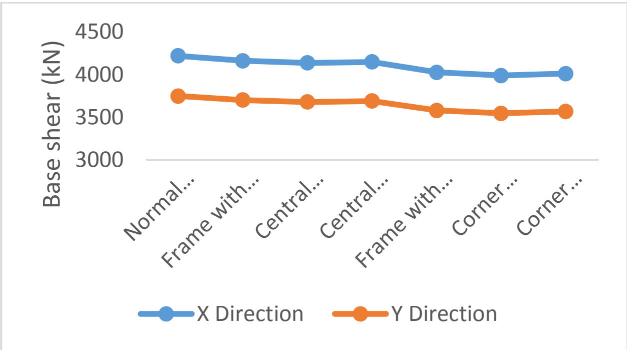

Fig. 3: Base shear (kN)

Fig 3 shows comparison of base shear in KN for all models. It shows that base shear is higher for normal frame without shear wall than frame with shear wall. Among frame with shear wall at center and corner, shear wall at corner shows lower base shear. Also due to opening in shear wall, base shear is reduced to 20%.

VI. CONCLUSIONS

i. It is observed from the various research works that there is no doubt that the shear walls contribute in enhancing the structural strength. However, the contribution of partial shear walls must be well identified so that while analyzing models for real structures, the composite action of the frame and shear would be realized.

ii. RC frame with RC shear wall is having less value of base shear than frame without shear wall.

iii. The presence of shear wall can affect the seismic behavior of frame structure to large extent, and the shear wall increases the strength of stiffness of structure.

iv. It is found that maximum displacement for frame without shear wall is higher than that of with-shear wall case. Also opening in shear wall in regular position reduced lateral displacement than opening in staggered position.

v. The stiffness is reducing with increase in opening in shear wall.

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