Seismic Response of Multi-Storied Building With Openings In Shear Wall

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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, time period, top displacement, base shears, story drift , forces in columns, beams, lateral loads

I. INTRODUCTION

The fast growth of the urban population and the consequent pressure on limited land has considerably influenced urban residential development. The high cost of land, the desire to avoid a continuous urban sprawl and the need to preserve important agricultural production land have all contributed to drive residential land commercial buildings upward that is vertical direction. The high structures are monuments of power and prestige, supreme achievements in engineering and design. But Major hazards caused by earthquake, winds in recent decades have brought increasing awareness among structural engineers and construction professionals to design these high rise structures for these lateral forces. In building construction, a rigid vertical member capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes, is the reinforced-concrete wall. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants; create powerful torsional forces, These forces can literally tear or shear a building apart. Providing a rigid wall inside frame system structure increases the stiffness of the frame and prevents rotation at the joints. Shear walls are especially important in high-rise buildings subject to lateral forces.

II. RESEARCH OBJECTIVE

- In the present study, a typical multi 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.
- Based on the literature of previous studies most effective positioning of shear walls has been chosen. Analysis is done on fifteen storey high and provided with a shear wall at the center core and corners of the building.
- This study is done on RC framed multistory building with RC shear walls with fixed support conditions.

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

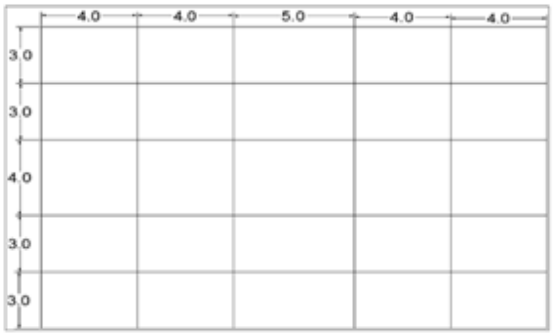

Fig. 1. Typical Floor Plan

tep 2:

Structural Modelling :

Modelling a building involves the modelling and assemblage of its various load-carrying elements. The model 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

IV. NEED OF STUDY

Earthquake causes enormous damage to the structures. The objective of seismic analysis is that the structure should be able to sustain minor shaking intensity without any damage, and makes the structure serviceable even after such event. Structure need to have suitable earthquake resistant features to safely resist large lateral forces which are imposed on them during earthquake 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.

V. MODELING AND ANALYSIS

The structure selected for this project is a simple RCC building with the following description as stated below.

Sr.No.	Description	*A. Dimension*
1.	Story height	***B.*** *3 m each*
2.	Number of storey	***C.*** *16 (Excluding the plinth and substructure and including the Ground floor)*
3.	Depth of foundation from ground level	1.5 m
4.	Column size	800 mm x 500 mm
5.	Beam size	***D.*** *300 mm x 700 mm*
6.	Thickness of Slab	***E.*** *150 mm*
7.	Thickness of shear wall	250mm
8.	Density of concrete	25 kN/m^3
9.	Live load on roof	1.5 kN/m^2
10.	Live load on floors	2.5 kN/m^2
11.	Brick wall on peripheral beams	230 mm
12.	Brick wall on internal beams	230 mm
13.	Density of brick wall	20 kN/m^3

M30 grade concrete and Fe415 steel
Following codes are used for this project consideration.
IS Code for Dead Load- IS 875 Part 1
IS Code for Seismic Load- IS 1893 : 2016 Part 1

Seismic design Parameters :

For the present study following values for seismic analysis are assumed. For the present study following values for seismic analysis are assumed. The values are assumed on the basis of reference steps given in IS 1893-2016 and IS 456:2000. Since Nagpur or vidarbha is less vulnerable to earthquakes, for this present study assigning zone IV for severe seismic intensity as stated in table 2 of IS 1893 – 2016.

1. Zone factor for zone IV – 0.24
2. Importance factor for residential building = 1.2
3. Special Reinforced Concrete Moment resisting Frame (SMRF)
4. Response reduction factor for RCC frame with SMRF = 5
5. Type of soil = Medium (Type II)
6. Damping percent = 5 % (0.05)
7. Thickness of brick wall = 230 mm
8. Brick infill panel building type.

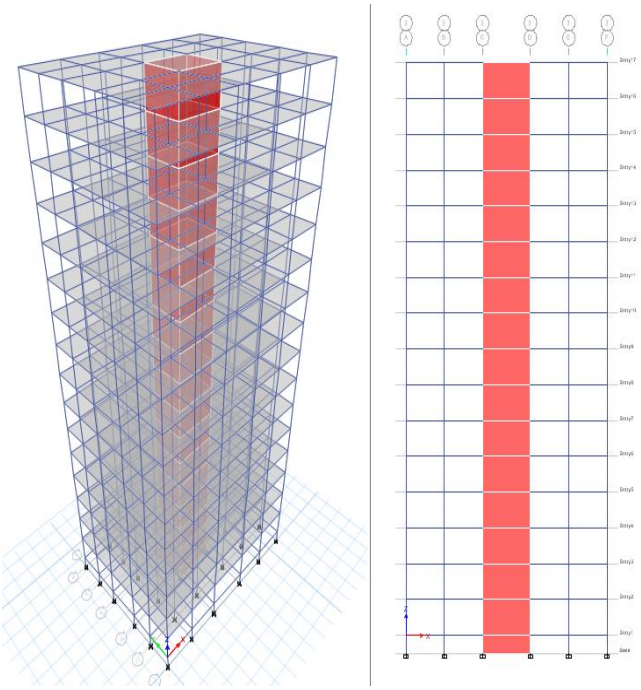

Fig.2 Fifteen storey (G+15) building with shear walls in central core

VI . RESULT

Maximum Lateral Displacement

The response spectrum method had been adopted for seismic analysis in ETAB 2016. The Table No.1 shows maximum lateral displacement in X and Y direction for above mentioned models.

Table 1 : Maximum Lateral Displacement (mm)

Type of Model	X Direction	Y Direction
Normal Frame	65.697	76.034
Frame with central core	39.379	45.954
Central core with regular opening	42.179	49.194
Central core with staggered opening	42.397	49.288
Frame with corner shear wall	44.975	52.196
Corner shear wall with regular opening	49.084	58.607
Corner shear wall with staggered opening	48.831	58.172

It shows that lateral displacement 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 center shows lower displacement. Also due to opening in shear wall, displacement is reduced to 30%.

VII. CONCLUSIONS

1. 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.

2. 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.

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

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