# Behaviour of R.C. Structure with and Without Provision of Shear Wall Including Openings Against Lateral Loads

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## Abstract

Now a day, the population is biggest problem in India, to overcome that, there is need of vertical development instead of horizontal development. And therefore there is a demand of Tall structures. Structural frame only are not sufficient to stand against various loading act on the building. In RC building, Shear wall is the most appropriate structure form, which improves structural behavior in tall buildings. This resists lateral loads like wind & earthquake force efficiently and therefore studying of the shear wall in structural system is necessary. In this study the behavior of the R.C. building with shear wall is analyzed by providing openings in the shear wall and the resultant parameters like displacement, time period, stiffness etc. are compared by using structural software ETABS.

**Keyword- Displacement, Lateral Loads, Opening, R.C. Building, Shear Wall, Stiffness & Strength**

## I. INTRODUCTION

R.C. frame building with shear wall is most common approach to satisfy the population needs and for safety of the structure under any loading conditions. Shear wall in the R.C. building is generally provided to protect the structure under lateral loading conditions like Earthquake load, wind load etc. Behaviour of such type of R.C. building with provision of shear wall is different than the common R.C. structures. So it is necessary to analyze the structure with provision of shear wall. The current work is focused on the comparative study of building without shear wall, building with shear wall and building with shear wall having different percentage of openings. Building without shear wall and building with shear wall having different conditions in framework so performance of the building differs on different loading circumstances. Components of building with shear wall having different kind of openings are also dissimilar. In this work the analysis of the R.C. building with & without shear wall and having different percentage of opening is carried out in terms of lateral displacement, base shear, story drift, in linear analysis by considering Indian standard provisions of code IS:1893(Part-1):2002. The complete modelling, analysis, and design is done by using structural analysis software ETABS.

The advantages of provision of shear wall in R.C. frame structures are:

1) Shear wall is defined as a wall designed to resist lateral forces in its own plane.
2) Shear wall are quite stiff in its own plane and flexible in the perpendicular plane. Therefore, it can transfer force in its own plane by developing movement and shear resistance.
3) Shear walls increase the stiffness of the building so that horizontal deflections due to earthquake forces are minimized.
4) Shear walls are like vertically-oriented wide beams that carry earthquake loads downwards to the foundation.

## II. ANALYSIS CONSIDERATION

Building having same plan but with different provisions of shear wall with and without different percentage of opening are analyzed in ETABS and their results are compared.

Following cases are considered for analysis.

1) Case1: Building without shear wall
2) Case2: Building with provision of shear wall at two weaker sides.
3) Case3: Building with provision of shear wall at all sides.
4) Case4: Building with shear wall at two sides with different size of opening in shear wall.
5) Case5: Building with shear wall at each side with different size of opening in shear wall.

For the building model following details is taken in consideration:

*A. Analysis of R.C. Frame Building in ETABS*

| | |
|---|---|
| *Column Size* | *350 mm X 800 mm* |
| *Beam Size* | *230 mm X 450 mm* |
| *Slab Size* | *150 mm thick* |
| *No. of Bays* | *7 nos. in x-direction*<br>*5 nos. in y-direction* |
| *C/C Span length* | *4 m in x-direction*<br>*3 m in y-direction* |
| *Storey Height* | *3 m* |
| *Floor Finish* | *1 kN/m$^2$* |
| *Live Load* | *2 kN/m$^2$* |
| *Seismic Data* | *Zone III-Moderate (Zone factor: 0.16)* |
| *Soil Type* | *II – Medium* |
| *Response Reduction Factor (R)* | *5* |
| *Importance Factor (I)* | *1* |
| *Damping Percentage* | *5% Damping* |
| *Grade of Concrete & Steel* | *M20 & Fe415* |

*B. Plan and 3D View of the Building:*

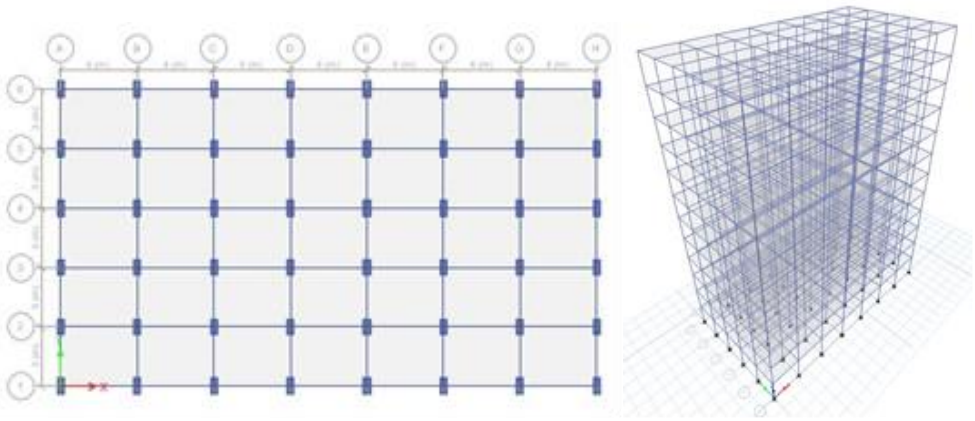

Fig. 1: Plan and 3D View of Building

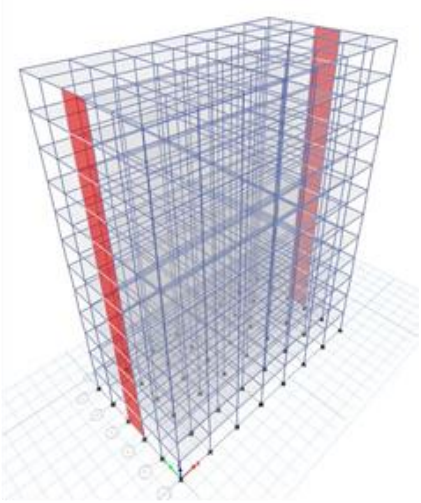

Fig. 2: Provision of Shear wall at two sides

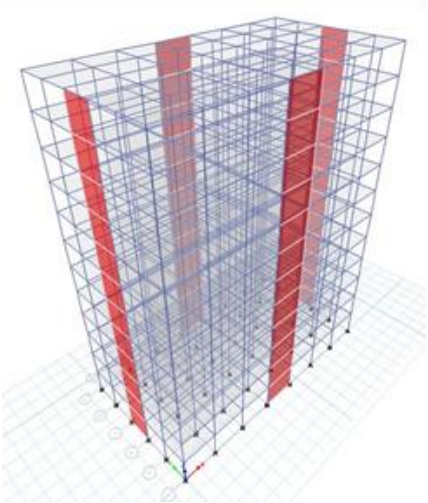

Fig. 3: Provision of Shear wall at four sides

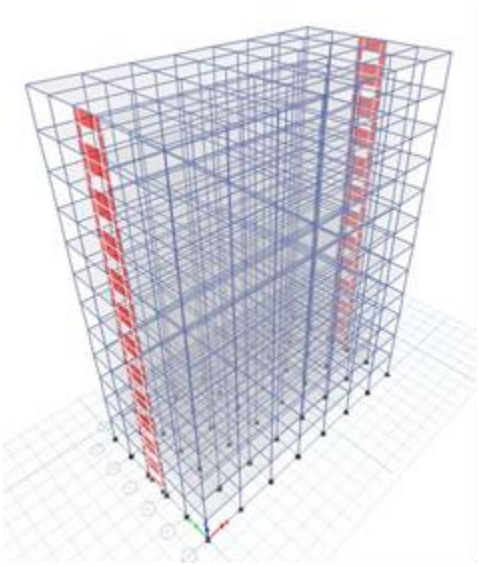

Fig. 4: Provision of Shear wall at two sides with Openings

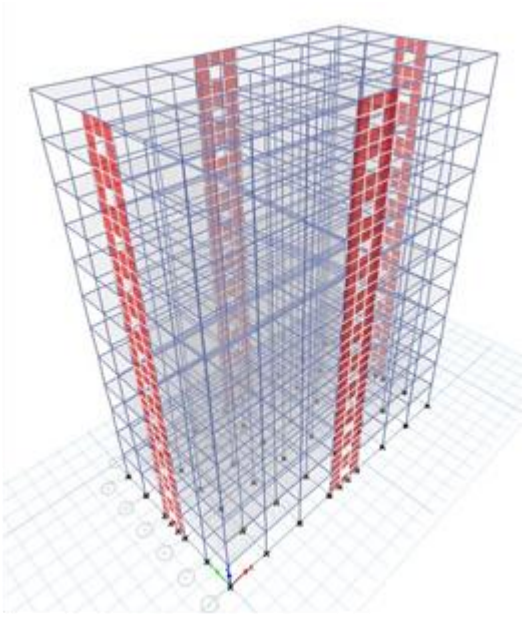

Fig. 5: Provision of Shear wall at four sides with Openings

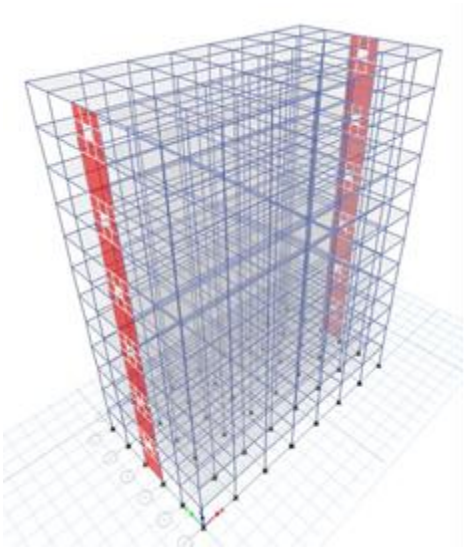

Fig. 6: Provision of Shear wall at two sides with alternate opening

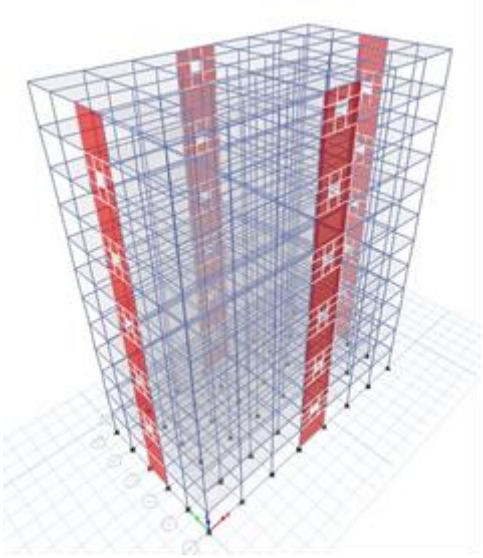

Fig. 7: Provision of Shear wall at four sides with alternate openings

Analysis of this R.C. frame buildings with and without shear wall having different opening openings is carried out in ETABS software and analysis results of building in case of deflection, base shear, storey drift, moments on column, time period is presented below in tabular form.

## III. RESULTS

### *A. Joint Displacement*

Joint displacement at storey 12 under the load combination D.L. +EQX- for X-direction and load combination D.L. +EQY- for Y-direction is as follows:

| *Building Case* | *Displacement in X-Direction (mm)* | *Displacement in Y-Direction (mm)* |
|---|---|---|
| *Building without shear wall* | *72.4* | *53.6* |
| *2 weaker side shear wall* | *68.8* | *34.9* |
| *11.11% opening in shear wall* | *69* | *35.2* |
| *20% opening in shear wall* | *69* | *35.5* |
| *alternative opening in shear wall* | *68.8* | *35* |
| *4 side shear wall* | *40.4* | *34.8* |
| *10% opening in shear wall* | *41.1* | *35.1* |

| | | |
|---|---|---|
| *20% opening in shear wall* | *41.9* | *35.4* |
| *alternative opening in shear wall* | *40.7* | *34.9* |

*B. Base Shear*

Base shear for the different building case is shown in table below:

| *Building Case* | *Base shear (kN)* |
|---|---|
| *Building without shear wall* | *1912.8652* |
| *2 weaker side shear wall* | *1897.1321* |
| *11.11% opening in shear wall* | *1894.2893* |
| *20% opening in shear wall* | *1892.0151* |
| *alternative opening in shear wall* | *1895.6489* |
| *4 side shear wall* | *1927.1367* |
| *10% opening in shear wall* | *1920.8825* |
| *20% opening in shear wall* | *1915.197* |
| *alternative opening in shear wall* | *1924.1209* |

*C. Moment on Column Adjacent To the Shear Wall*

Moment on the column adjacent to the shear wall is as per following table:

| *Building Case* | *Moment (kN-m)* |
|---|---|
| *Building without shear wall* | *15.988* |
| *2 weaker side shear wall* | *16.8319* |
| *11.11% opening in shear wall* | *12.9137* |
| *20% opening in shear wall* | *7.9409* |
| *alternative opening in shear wall* | *12.5793* |
| *4 side shear wall* | *16.6249* |
| *10% opening in shear wall* | *13.017* |
| *20% opening in shear wall* | *8.048* |
| *alternative opening in shear wall* | *14.0336* |

*D. Story Drift*

Storey drift for the different building case for load combination 1.5D.L +1.5EQX+ is shown in the table:

| *Building Case* | *Storey Drift* |
|---|---|
| *Building without shear wall* | *0.00265* |
| *2 weaker side shear wall* | *0.002563* |
| *11.11% opening in shear wall* | *0.002527* |
| *20% opening in shear wall* | *0.002526* |
| *alternative opening in shear wall* | *0.002528* |
| *4 side shear wall* | *0.001011* |
| *10% opening in shear wall* | *0.001041* |
| *20% opening in shear wall* | *0.001087* |
| *alternative opening in shear wall* | *0.001016* |

*E. Time Period*

Time period for the different building for Modal cases is as follows:

| *Building Case* | *Mode 1 (sec)* | *Mode 2 (sec)* | *Mode 3 (sec)* |
|---|---|---|---|
| *Building without shear wall* | *2.276* | *1.785* | *1.709* |
| *2 weaker side shear wall* | *2.255* | *1.507* | *1.3* |
| *11.11% opening in shear wall* | *2.259* | *1.517* | *1.311* |
| *20% opening in shear wall* | *2.259* | *1.528* | *1.324* |
| *alternative opening in shear wall* | *2.255* | *1.511* | *1.305* |
| *4 side shear wall* | *1.586* | *1.507* | *1.198* |
| *10% opening in shear wall* | *1.605* | *1.518* | *1.21* |
| *20% opening in shear wall* | *1.629* | *1.529* | *1.224* |
| *alternative opening in shear wall* | *1.594* | *1.511* | *1.202* |

## IV. CONCLUDING REMARK

Provision of the shear wall in R.C. frame building affect the behavior of the structure as it can be concluded by the results. For the G+11 storey R.C. building the provision of shear wall in two sides changes the displacement about 5 to 8%, but when shear walls are provided in all sides the displacement of the building is greatly reduced by 40 to 50%. Moment on column adjacent to shear wall is also increased by 4 to 6%. Storey drift of building is reduced by 50 to 60% by providing shear wall in four sides. Time period for different mode case is also reduced by 25 to 35% by provision of shear in all sides.

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