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# Performance of RC Framed Shear Wall Building with its Different Orientation under the Effect of Earthquake and Wind Loads.

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**ABSTRACT:** Earthquakes Reinforced concrete framed buildings are capable for resisting both vertical and horizontal load acting on them. However, when buildings are tall, it is difficult to workout sizes of structure. There is difficulties to place and vibrate concrete at these places which does not contribute the safety of structure. These difficulties make introduction of shear wall. It has system is one of the most commonly used internal load resisting system in high rise buildings. Shear wall has very high in plane strength and stiffness which can be used to simultaneously resist large horizontal loads and supports gravity loads. Therefore incorporation of shear wall has become assured in multi-storey buildings built in region likely to experienced earthquake of high intensity or high winds. There are lots of literatures available to design and analyze the shear wall. However, the decision about an arrangement of shear wall in multi-storey building is not much discussed in any literatures, in this study; therefore main objective is to determine the position of shear walls in multi-storey building. An earthquake load is applied to a building of twenty sixth storied located in zone III. The analysis is performed using ETABS software. Axial forces, shear force, bending moment, storey displacement and time period are computed and location of shear walls is established.

**KEYWORDS:** ETABS2013, Response Spectrum Analysis, Seismic Responses and Shear wall.

## I. INTRODUCTION

Reinforcement concrete framed buildings are adequate for resisting both the vertical and horizontal load acting on them. However, when buildings are tall, it is difficult to workout sizes of beams and columns. There is lot of congestion at these joint places and vibrate concrete at these places which does not contribute the safety of building. These practical difficulties call for introduction of shear wall. Shear walls are usually used in tall buildings and have been found to be immense use to avoid total collapse of buildings under seismic forces. Shear walls are deep, relatively thin, vertically reinforced column commonly used in structure to resist the effect of gravity load. Shear wall starts from foundation to top of building. Their thickness varies between 150 mm to 400 mm (maximum). These walls provides more strength and stiffness to the building in the building in the direction of the direction of orientation which reduces the lateral displacement therefore, it will reduce the damage to the structure. Usually shear wall is provided along both length and width of building. Incorporation of shear wall has become inevitable in multi-storey buildings built in region likely to experienced earthquake of high intensity or high winds. Therefore it is very necessary to effective, efficient and ideal location of shear wall. In case of low-rise buildings effects of earthquake is not so important during designing. But as height of building goes on increasing, the effect of earthquake is increases. The effects can be found out by analyzing buildings under earthquake. For determination of seismic responses it is necessary to carry out seismic analysis of the structure using different available methods namely Linear Static Analysis, Nonlinear Static Analysis, Linear Dynamic Analysis and Time History Analysis. An analysis of the seismic response of the structure to the effect of earthquake excitations of different arrangement of shear wall is to be performed. This data is helpful in preparation of design procedure for calculating responses of earthquake forces on building and for achieving lateral displacements, base shear and storey drift within serviceability limits for both damage and occupant comfort. The outcome of this study will be useful to civil engineers to understand the behaviour of multi-storey buildings for different arrangement of shear wall and also, to get feel of effect of zones. Therefore, it is necessary to study variations in seismic behaviour of multi-storey RC building for different arrangement of shear wall in terms of various responses such as lateral displacement, base shear and storey drifts.

## II. RELATED WORK

Reddy and Tupat [1] analyzed multi-storied building for earthquake loads in various zones based on IS 1893 and for wind load IS 875 code used. The wind loads are estimated based on the design wind speed of that zone with a variation of 20%. The wind loads so obtained on the building have been compared with that of earthquake loads. Finally it was found the wind loads are more critical than the earthquake loads in most of the cases.

Chandurkar and Pajgade [2] analyzed 10 storied RC building for all four zone using ETABS v 9.5.0, it was observed that constructing building with shear wall in short span at corner was economical as compared with other models. From this it was concluded that large dimension of shear wall was not effective in 10 storied building. It was observed that changing the position of shear wall affect the attraction of forces, so that wall must be in proper position. If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall. Providing shear walls at adequate locations substantially reduces the displacement due to earthquake.

Agrawal and Charkha [3] analyzed 25 storied RC building zone V considering different positions and shapes of shear wall using ETABS. It was determined different parameters such as storey drift, axial load, displacement, etc. It was concluded that location of shear wall affects on static and dynamic axial load on column. In case of zero eccentricity for seismic loading, the displacement of building was unidirectional and uniform for all grids.

Chandiwala [4] analyzed 10 storied RC residential building for Zone III using software SAP2000. It was tried to get moment at a particular column including the seismic load by taking different lateral load resisting structural systems, different number of floors, with various positions of shear wall. It was found that among different location of shear wall, shear wall at the end of "L" section gives best results. It reduced overall bending moment of building.

Romy and Prabha [5] modeled two multi-storey buildings along with variation in building height, one of six and other of eleven storey using SAP 2000 software for earthquake zone V in India. Six different types of shear walls with its variation in shape studying for their response in resisting lateral forces. Dynamic responses under prominent earthquake, El-Centro earthquake have been investigated. Finally highlighted the accuracy and exactness of time history analysis in comparison with the most commonly adopted response spectrum analysis and equivalent static analysis was done

## III. METHODOLOGY

For better performance of building during earthquake, it is necessary to know how the building behaves during earthquake and for that seismic analysis of building is required. The seismic analysis of building is done by two methods-static analysis and dynamic analysis. Static analysis does not give us clear idea of how structure is going to behave during earthquake but gives approximate forces and displacements. Dynamic analysis gives somewhat accurate results.

### 1 Equivalent Static Analysis

All design against seismic loads must consider the dynamic nature of the load. However, for simple regular structures, analysis by equivalent linear static methods is insufficient. This is permitted in most codes of practice for regular, low-to medium-rise buildings. This procedure doesn't require dynamic analysis, however, it account for the dynamics of building in comparative manner. The static method is the simplest one-it requires less computational efforts and is based on formulae given in the code of practice. First, the design base shear is computed for the whole building, and it is then distributed along the height of the building. The lateral forces at each floor levels thus obtained are distributed to characteristic lateral load resisting elements.

### 2 Response Spectrum Method

Response spectrum method is the linear dynamic analysis method. In this method the summit structural responses of a structure during an earthquake is obtained directly from the earthquake responses spectrum. The representation of the maximum responses of idealized SDOF systems having certain period and damping, while earthquake ground motion. The maximum response is plotted against the undamped natural period and for different damping values, and can be expressed in terms of maximum relative velocity or maximum relative displacement

### 3 Structural modeling and analysis

The G+25 RC multistory framed building considered for analysis to know the realistic behavior during earthquake with the general form of plan shown in fig. Plan dimensions in X and Y direction are 24.05m and 28.10m respectively. The buildings are consisting of columns with dimension 230mm x 1000mm for all stories and beam with dimension 230mm x 600mm. The floor slabs are taken as 150mm thick. The thickness of shear wall is taken as 230 mm. In case of design of shear wall it is necessary to assign pier and spandrel label to obtain the longitudinal reinforcement. The height of all

floors is 3.0m. Foundation height is 1.5m considered soil type is hard. Modal damping 5% is considered with SMRF and I=1. The columns are assumed to be fixed at the ground level. Material concrete grade is M30 and at the same time steel Fe 500 is used.

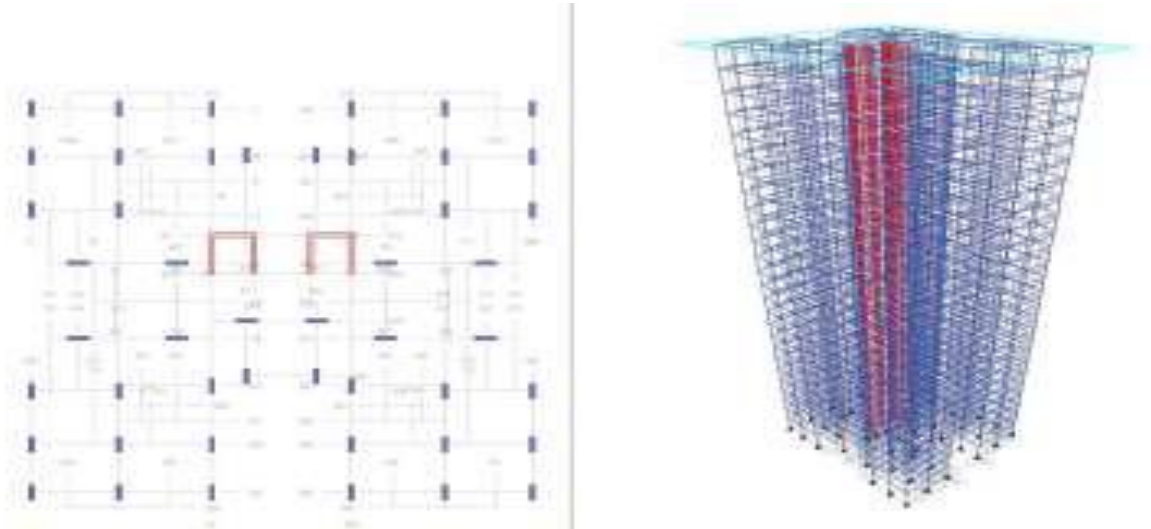


Fig -1: Plan and Elevation of G+25 RC multistoried framed Building in ETABS2013

The building is analyzed for different position of shear walls. To find the effective position of shear walls different models are prepared and analyzed. First model is solid RC multistoried frame building while second model consist of shear wall arrangement at corner of the building that is L shaped. Third model in which framed Building with Shear wall in X and Y Direction and fourth model in which framed Building with Shear wall in X and Y Direction and shear wall placed at centre of the building. ETABS2013software is used for analysis these four model.

#### IV. EXPERIMENTAL RESULTS

The parametric study of Critical Axial Force in column, storey displacement, Shear force, and Bending Moment Variation of building in different stories by response spectrum analysis for G+25 Floor RC structure is performed here. The results achieved from analysis are listed below and compared by graphical representation.

##### 1 Critical Axial Force in column

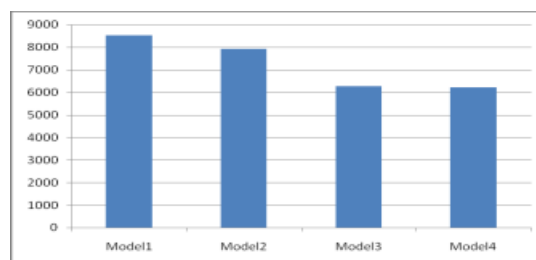


Fig -2: Comparison of Axial Force in Column

From above graph it is seen that the value of critical axial force in column for model 2, 3 and 4 decreases by 6.95%, 26.52%, and 27.17% respectively than model 1.

2. Critical Shear Force

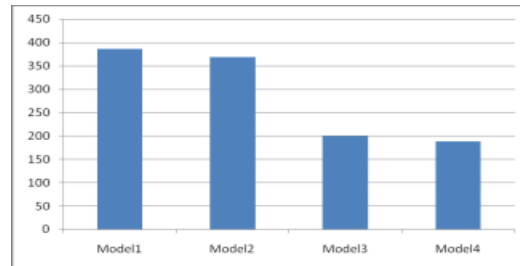


Fig -3: Comparison of Shear Force

From above graph it is seen that the critical value for shear force in column is maximum for model 1. It is respectively 4.68%, 48.49% and 51.47% less for model 2,3and 4.

3. Critical Bending Moment

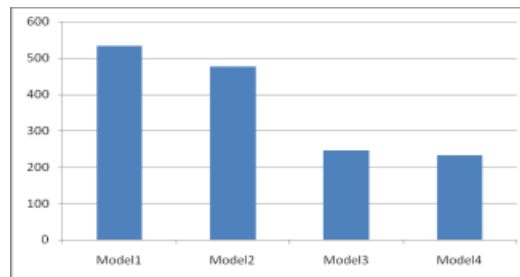


Fig -4: Comparison of Bending Moment

From above graph it is seen that the critical value for bending moment in column is maximum for model 1. It is respectively 10.53%, 53.89% and 56.3% for model 2,3and 4 than model 1.

4. Lateral Displacement

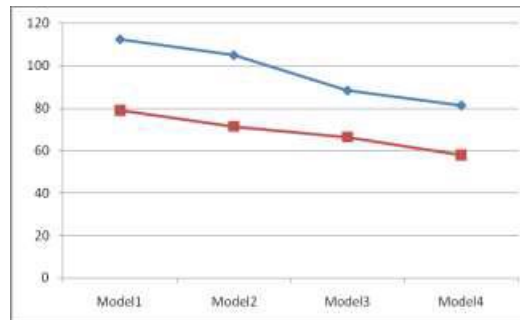


Fig -5: Comparison of Storey Displacement

The top storey displacement is maximum for model 1 and minimum for model 4 it is reduced by 6.64%, 21.41% and 27.67% for X direction and 9.62%, 16.06% and 26.86% for Y direction for model 2, 3 and 4 respectively than model 1.

5. Time Period

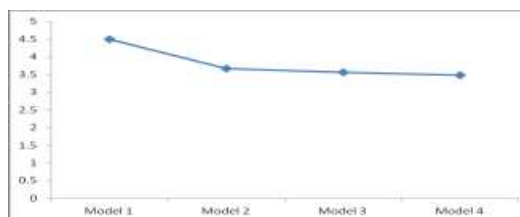


Fig -6: Comparison of Time period

The time period of model 2, 3 and 4 decreases by 16.66%, 19.01% and 20.92% than model 1.

## V. CONCLUSION

From all the above resurch, it is observed that in high rise RC building with shear wall of different position affects on different parameters such as displacement, axial force, shear force, bending moment and time period etc. Therefore in model 4 better results as compared to other models. That is shear wall located at the centre of building gives effective results as compared to other location. Also observed that changing the position of shear walls affects the attraction of forces, so that wall must be in proper location. Also Providing shear walls at adequate locations essentially reduces the displacements due to earthquake. For building with frame and shear walls model 4 that is shear wall located at the centre of building gives considerable percentage reduction in axial force, shear force, bending moment, storey displacement and time period. Therefore wall located at the centre of building is effective as compared to the other location of shear walls

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