Significance of Different Locations of Shear Wall In Multi-Storey Structure With Seismic Analysis

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Abstract- *Growth of urbanisation is seen significantly increasing which leads to more burden on cities. With increasing population and limited land resource; the need of high rise buildings is increased. Hence it is necessary to provide efficient, economical structural system for high rise building.*

Shear wall is always considered as significant component of structural system in case of multi-storey building.In past decades, shear walls are one of the most appropriate and important structural component in multi-storied building. Therefore, it would be very interesting to study the structural response and their systems in multi-storied structure. Shear walls contribute the stiffness and strength during earthquakes which are often neglected during design of structure and construction.

Generally, multi-story high rise buildings suffer higher lateral displacement in the presence of Wind and Earthquake loads. It becomes important to reduce such lateral movement within the acceptable limits. Larger the displacement, higher the induced moments, shear and discomfort. Shear wall plays important role in aforementioned parameters.

Shear walls have high in-plane stiffness thus it resists the lateral loads and control the deflection more efficiently. Shear walls are flexible in the orthogonal plane and can distribute the lateral loads in their own plane by developing resistance against moment and shear. The efficiency and performance also depends on the positioning of the shear walls, So it is necessary to understand effective location of shear wall.

This study shows the effect of shear walls at different locations which significantly affect the vulnerability of structures. In order to test this, G+8 storey building was considered with different locations of shear walls and analyzed for various parameters like base shear, storey drift ratio, lateral displacement, bending moment and shear force. Significance of shear wall has been studied with the help of different models. For modeling and analysis of models, FEM based software ETABS 2015 were used.

The analysis of all models was done using Equivalent static method. The comparison of results has been done based on same parameters like base shear, storey drift ratio, lateral displacement, bending moment and shear force.

Keywords- RC wall, Shear wall, Stiffness, SMRF, ETABS

I. INTRODUCTION

Generally, multi-story high rise buildings suffer high lateral displacement for Wind and seismicloads.Reinforced concrete building can adequately resist both horizontal and vertical load. Larger the displacement, higher the induced moments, shear and discomfort. Shear wall plays important role in aforementioned parameters.Whenever there is requirement for a multistory building to resist higher value of seismic forces, lateral load resisting system such as shear wall should be introduced in a building. Vertical plate like RC wall introduced in building in addition to beam, column and slab are called shear wall. Shear wall can be provided both along the length and width of the building. Properly designed building with shear wall has shown good performance in past earthquake. Shear walls have high in-plane stiffness thus it resists the lateral loads and control the deflection more efficiently. Shear walls are flexible in the orthogonal plane and can distribute the lateral loads in their own plane by developing resistance against moment and shear. The efficiency and performance also depends on the positioning of the shear walls, So it is necessary to understand effective location of shear wall.

Few literature reviews [P.P.Chandukar (2013), Shahzad Jamil Sardar (2013), VermaS.K. (2014), Varsha R. Harne(2014), Anil Baral (2015), Ms. Priyanka Soni (2016), A. Ravi Kumar (2017), Sanisha Santhosh (2017)] are available which discuss the positioning of shear wall. However more intenseresearch is required for fixing the ideal location of shear wall in multistory building. Hence this paper presents the analysis of 8 storey building with different position of shear wall using both equivalent static method.

What are different things considered in this project?

- **No hypothetical grid frame**
- **live case study**
- **Response spectrum analysis**
- **major structural parameters apart from displacement**

1.1 Shear Wall

Adequate stiffness is to be ensured in high rise buildings for resistance to lateral loads induced by wind or seismic events. Reinforced concrete shear walls are designed for buildings located in seismic areas, because of their high bearing capacity, high ductility and rigidity. In high rise buildings, beam and column dimensions work out large and reinforcement at the beam-column joins are quite heavy, so that, there is a lot of clogging at these joints and it is difficult to place and vibrate concrete at these places which does not contribute to the safety of buildings. These practical difficulties call for introduction of shear walls in High rise buildings.

Buildings engineered with structural walls are almost always stiffer than framed structures, reducing the possibility of excessive deformation and hence damage. RC multi storied buildings are adequate for resisting both the vertical and horizontal load. When such buildings are designed without shear walls, beams and column sizes are quite heavy. Shear walls may became imperative from the point of view of economical and control large deflection. Lateral forces.

Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important to have sufficient strength for the structure against vertical loads. Earthquake and wind forces are the only major lateral forces that affect the buildings. The function of lateral load resisting systems or structure form is to absorb the energy induced by these lateral forces by moving or deforming without collapse. The determination of structural form of a tall building or high rise building would perfectly involve only the arrangement of the major structural elements to resist most efficiently the various combinations of lateral loads and gravity loads.The taller and more the slender a structure, the more important the structural factors become and the more necessary it is to choose an appropriate structural form or the lateral loading system for the building. In high rise buildings which are designed for a similar purpose and of the same height and material, the efficiency of the structures can be compared by their weight per unit floor area.

II. SEISMIC METHODS OF ANALYSIS

The analysis process can be categorized on the basis of three factors: the type of externally applied loads, the behavior of structure/ or structural materials and the type of structural model selected. A two or three dimensional model which includes bilinear or trilinear loaddeformation diagrams of all lateral force resisting elements are first created and gravity loads are applied initially. A predefined lateral load pattern which is distributed along the building height is then applied. The lateral forces are increased by some members yield. Based on the type of external action and behavior of structure, the analysis can be further classified as

1. Linear static analysis
2. Non-linear static analysis
3. Non-linear dynamic analysis
4. Linear dynamic analysis

Linear static analysis or equivalent static analysis can be used for regular structures with limited height. Linear dynamic analysis can be performed by response spectrum method or by the elastic time history. The significant difference between linear static and linear dynamic analysis is the level of force and their distribution along the height of the structure. Non-linear static analysis is an improvement over linear static or dynamic analysis in the sense that it allows inelastic behavior of the structure and provides information on the strength, deformation and ductility of the structure. Non-linear static analysis can be performed by push over analysis. A non-linear dynamic analysis or in elastic time history analysis is the only method to describe the actual behavior of a structure during an earthquake. Nonlinear dynamic analysis is most accurate method to determine the seismic responses of structures. In this method the structure is subjected to actual ground motion which is the representation of the ground acceleration versus time. The ground acceleration is determined at small time step to give the ground motion record. Then the structural response is calculated at every time instant to know its time history and the peak value of this time history is chosen to be design demand. Hence, "A mathematical model directly incorporating the nonlinear characteristic of individual component and element of the building shall be subjected to earthquake shaking represented by ground motion time history to obtain forces and the displacement". Since numerical model directly accounts for the effect of material nonlinearity, inelastic responses and calculated internal forces will bereasonably approximate to those expected during the design earthquake.

Objectives

1. To prepare SMRF model and application of loads using E-Tabs
2. To perform static analysis and Response spectrum analysis
3. To Study selected structural parameters.
4. To carry out Inferences with analysis

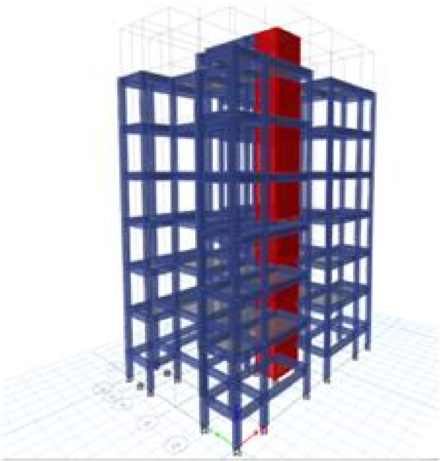
2.1 Methodology

To analyse impact of shear wall location three major structural parameters are considered as Maximum story displacement, Story drift and story stiffness. Symmetrical multi-storey building is studied for shear wall at core and at sides. Modelling and analysis done with the help of E-Tabs and aforementioned parameters are compared.

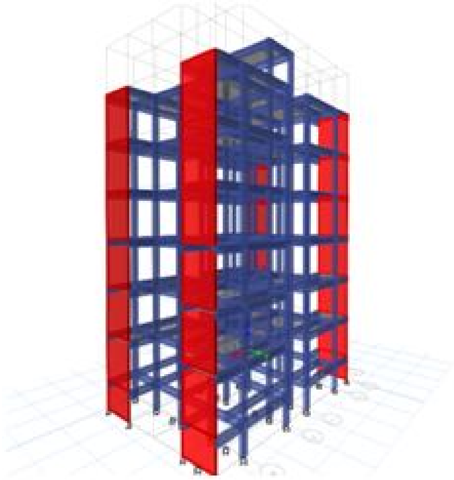
III. CASE STUDY AND LOADING PATTERNS

Model 1: Symmetrical building with shear wall at core
A G+8multi-storey building with shear wall is analysed with following loading conditions.

Dead load = Programme calculated
Live load = 3 KN/m2
Super dead Load = 2 KN /m2
Wind load and Seismic loads
Shear wall with 200 mm thickness
Materials: Concrete M20 Steel Fe500



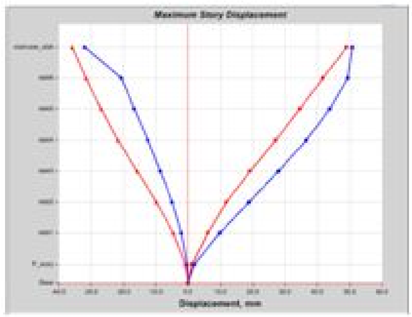
Model 2: Symmetrical building with shear wall at sides. A G+8 multi-storey building with shear wall is analysed with same loading conditions and materials. Shear wall location is considered as variable whereas other parameters used as constants.

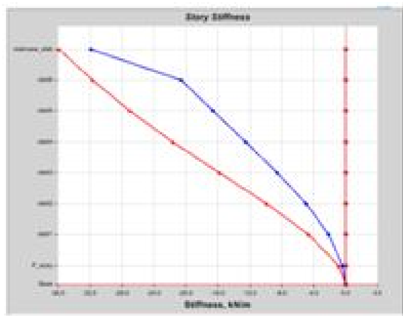


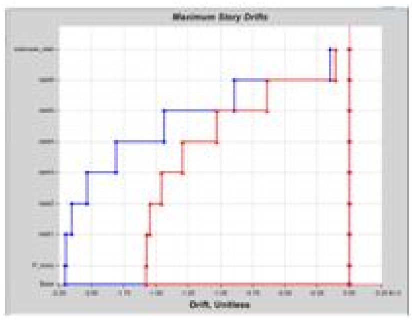
IV. RESULTS

- components of x- axis **- components of y- axis**

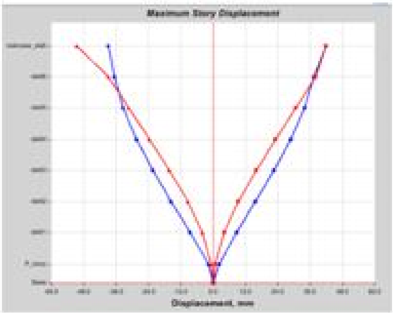
Results of Model 1:

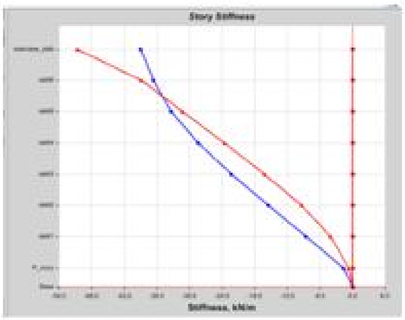


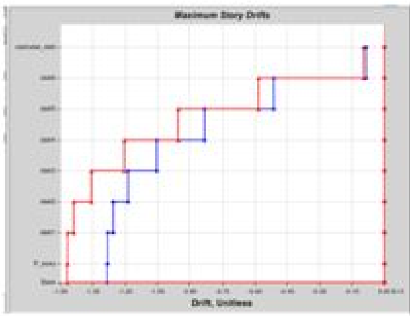




Results of Model 2

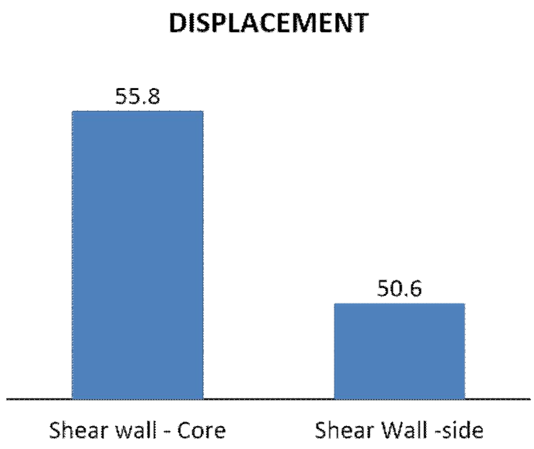




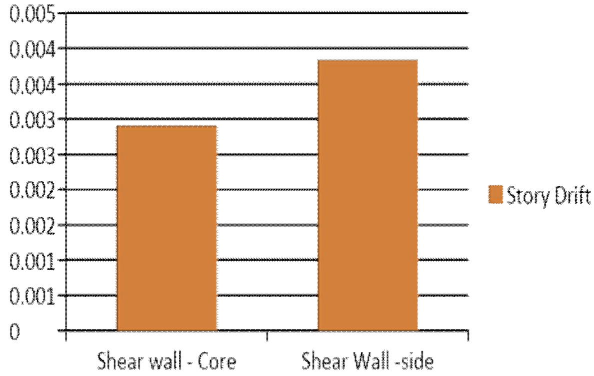


V. ANALYSIS RESULTS

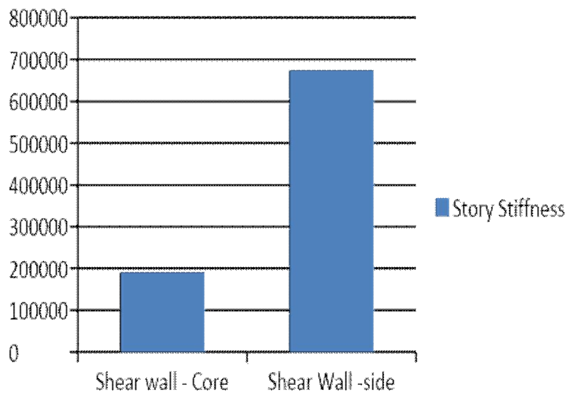
Sr.no	Structural Parameters	Shear wall - Core	Shear Wall -side
1	Displacement	55.80 mm	50.60 mm
2	Story Drift	0.002903	0.00384
3	Story Stiffness	190289 KN/m	674706 KN/m



As far as Story Displacement is concerned, it is observed more in case of shear wall at core. This is due to in model 2 four shear wall at corners are provided. It increases rigidity of building and ultimately stiffness of building.



Story drift is another significant structural parameter. Building with shear wall at sides show more drift as compared to building with shear wall at core.



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VI. CONCLUSION

Story drift is another significant structural parameter. Building with shear wall at sides show more drift as compared to building with shear wall at core. As far as Story Displacement is concerned, it is observed more in case of shear wall at core. This is due to in model 2 four shear wall at corners are provided. It increases rigidity of building and ultimately stiffness of building.. Story stiffness and displacement are inversely proportional hence building with shear wall at sides shows more stiffness as compared to building with shear wall at core.

VII. FUTURE SCOPE

1) Scope to use different types of shear walls
2) Scope to analyze different structural parameters
3) Scope to perform analysis for asymmetrical building

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