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# Impact of Shear Wall Location on the Response of RC Framed Building

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## Abstract

The objective of this study was to understand the impact of storey walls on the Response of RC Framed Building. The shear wall provides huge stiffness against lateral load, making the structure less vulnerable during the Earthquake. The location of the shear wall plays a vital load defending seismic force on the building. The research method was experimental research. In this paper, the most favorable position of the shear wall was determined by creating different alternates ALT-1, ALT-2, ALT-3 and ALT-4. The results of storey drift, lateral sway and base share were computed with the base model. Finite element software ETABS was used for the linear dynamic analysis and design of 11 storey building. The results show that Lateral sway and storey drift declined with the introduction of a shear wall with a central location exhibiting the most desirable result. The implication of this study would be beneficial to the Engineering Department of OCEM, students, researchers, and scholars to know the impact of Shear Wall Location on the Response of RC Framed Buildings.

**Keywords:** *Base shear, Framed Building, Lateral sway, Shear Wall Location, Storey drift*

## 1. INTRODUCTION

The basic aim of the seismic analysis was to identify the safe structure of wall and fulfill its intended purpose. Share wall is the best structural element for high-rise buildings to lessen the effect of earthquakes as it contributes huge lateral stiffness making the structure safe. Shear walls in buildings have to be situated in plan symmetrically to decrease the adverse impacts of twists in buildings.

Shear walls are normally constructed from materials like concrete and masonry. When the shear wall is not announced in such a building, beams and columns are larger. The objective of this study was to identify the impact of Shear Wall Location on the Response of RC Framed Buildings.

Mishra et al. (2018), the storey displacement is the least when shear walls are placed in the periphery of the building. The existence of the shear wall in the bare frame alignment and the filled frame structure revises the lateral force behavior of the RC framed building to a large extend. Vidyashree et al. (2017), storey displacement is maximum at the top storey, and storey drift value increases until the maximum value and starts to decrease with the increase of height of the storey in the model. Without shear walls building has more dislocation, story drift and reduced stiffness compared to the five models with the shear wall.

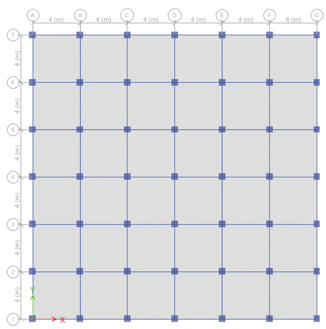
Anshuman et al.(2011), the top deflection was reduced and reached within the permissible deflection after providing the shear wall in any of the 6th & 7th frames, and applies in the 1st and 12th frames in the shorter track. They further highlighted that both turning moment and shear force in the 1st and 12th frames were reduced after providing the shear wall in any of the 6th & 7th frames.

It was also the same in the 1st and 12th frames in the shorter direction**.** Kumar et al. (2014) highlighted that shear walls could be used as lateral load-resisting systems and retrofitting structures. The internal shear walls are more cost-effective than external shear walls compared to cyclic load tests. Gandhi (2015)**,** the percent of the opening increases deflection up to 40% in proportion, but deflection increases more rapidly as opening increases. The 20% eccentric zigzag opening has reduced deflection, and the eccentric straight has highest deflection and concentric loading

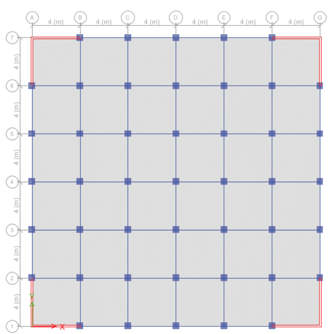
Chandiwala (2012), the Shear wall directly obstructs end oscillation, hence decreasing the overall turning moment of the building. Venkatesh and Bai (2011), the thickness of shear forces does not impact decreasing shear stresses, and interior shear walls' performance is reasonable associated to exterior shear walls. In retrofitting methods, external shear walls are considered as an alternative to internal shear walls.

## 2. BUILDING CONFIGURATION

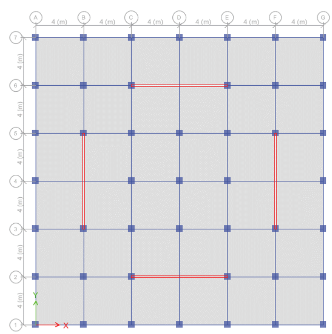
An 11-storey building is considered with a square plan dimension so that result analysis would be easier. Alternate models are created with different locations of the shared wall; the plan for all the alternatives is shown in Figure 1. The width and thickness of the shear wall are kept constant in all models.



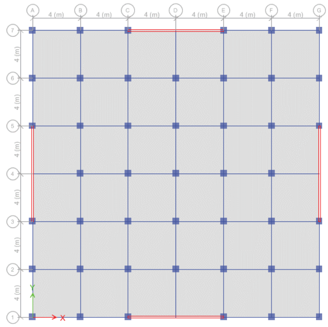
Plan of Base Model



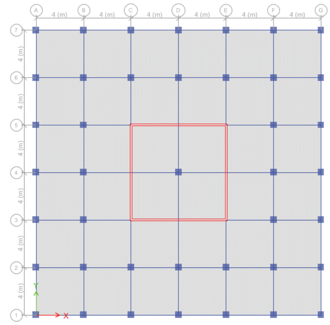
Alt -1



Alt -3



Alt -2



Alt -4

**Figure 1. Plan of all the models**

**Table 1. Example of building configuration**

| | |
|---|---|
| Building System | RCC Framed Structure |
| Building Type | Multi-Storey Commercial complex building |
| Number of Storey | 11 Storey |
| Floor Height | 3.5m |
| Column Size | 550mm X 550mm |
| Beam Size | 450mm X 300mm |
| Slab Thickness | 165mm |
| Shear Wall Thickness | 150mm |
| Outer Wall Thickness | 230mm |
| Partition Wall Thickness | 115mm |
| Concrete Grade | M30 |
| Steel Grade | Fe500 |
| Importance factor | 1.5 |
| Seismic Zone | V |

## 3. METHODS OF ANALYSIS

The equivalent static analysis is a simplified technique that substitutes the dynamic loading effect of an anticipated earthquake by a constant force spread horizontally on the building formation. In this technique, it is considered that the building responds in its own fundamental mode when the vibrations due to earthquakes are generated. For this to be valid, the building must be low-rise and symmetrical to prevent underground torsional motion. This technique of analysis can use to buildings whose seismic reaction in each route is not considerably affected by contributions from modes higher than the basic mode

## 4. RESULTS AND DISCUSSION

Five models with the same plan dimension and size of structural elements with alternate positions of share wall are analyzed. Results are extracted and compared to base shear, storey drift and lateral sway.

### 4.1 Base shear

The base shear in all the models achieved from linear dynamic assessment as per IS code 1893 (part 1): 2016 are presented in Figure 2. Base shear increases as the share wall location move inward, with the highest value in alternate 4 with the core share wall. The base model receives nearly half the share quantity than the last alternate. A larger base shear value is obtained as seismic weight and horizontal seismic coefficient increase in shear wall models (see Figure 2).

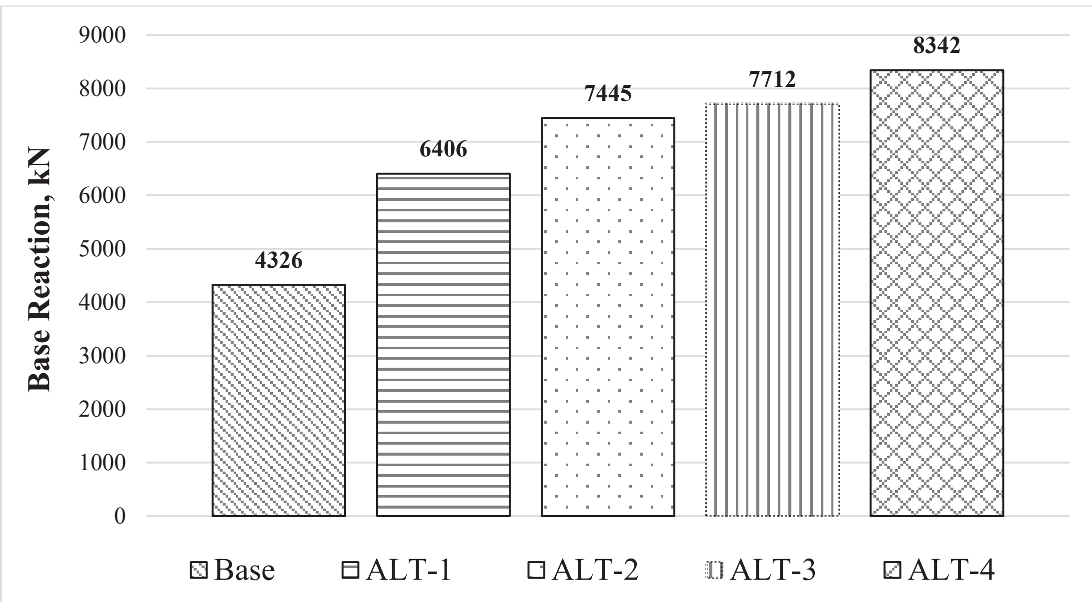



**Figure 2. Base shear in all alternate models**

## 4.2 Storey Drift

Storey drift, also referred to as inter-storey drift, is the displacement of a storey concerning the adjacent storey when the lateral loads act upon it. The storey drift of any storey in a building should not outstrip 0.004 times the storey height.

The pattern of storey drift is similar in all models, as seen in Figure 3, where the base model has the uppermost value, which decreases by 45% in Alternate 1. Shear wall models have identical behaviour attaining maximum drift at the $6^{th}$ storey. 13% less than the preceding model in Alt 2 and 3 exhibits a similar drift amount. It is 10% greater than succeeding Alternate 4. The building with a central core shear wall has the least storey drift making it the most desirable position (see Figure 3).

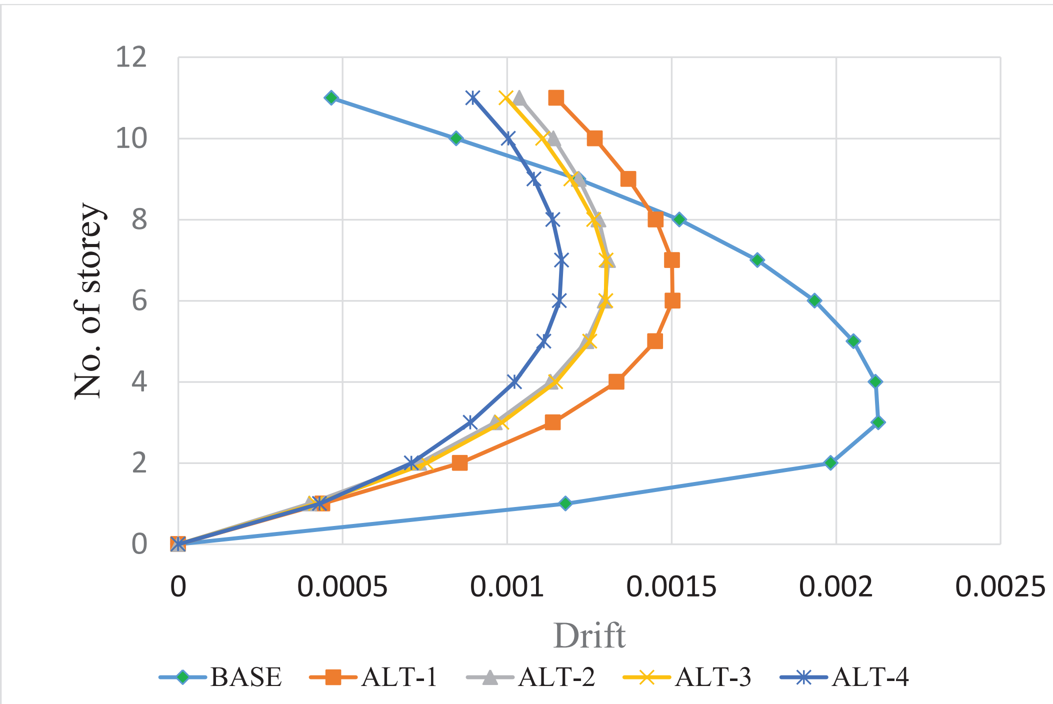



**Figure 3. Storey Drift in all Alternate Models**

## 4.3 Lateral Sway

Lateral sway also referred to as storey displacement, is the displacement of a top storey concerning the bottom of the structure. Cl. 20.5 of IS 456: 2000 restricts the lateral sway at the top equal to, where the total height of the building is H. It is witnessed from figure 4 that the lateral sway is maximum in the base model with no shear wall, which drastically decreases in succeeding models comprising a shear wall and least in Alternate 4. Sway drops by around 20% in the first alternate than the base model; afterwards 12% fall is evident in Alternate 2 and Alternate 3 with almost equal sway. Finally, the least of all 37mm displacement is seen in the last alternate with the core shear wall. It is a decline of 10% from the prior model and around 40% less than the base model (see Figure 4).

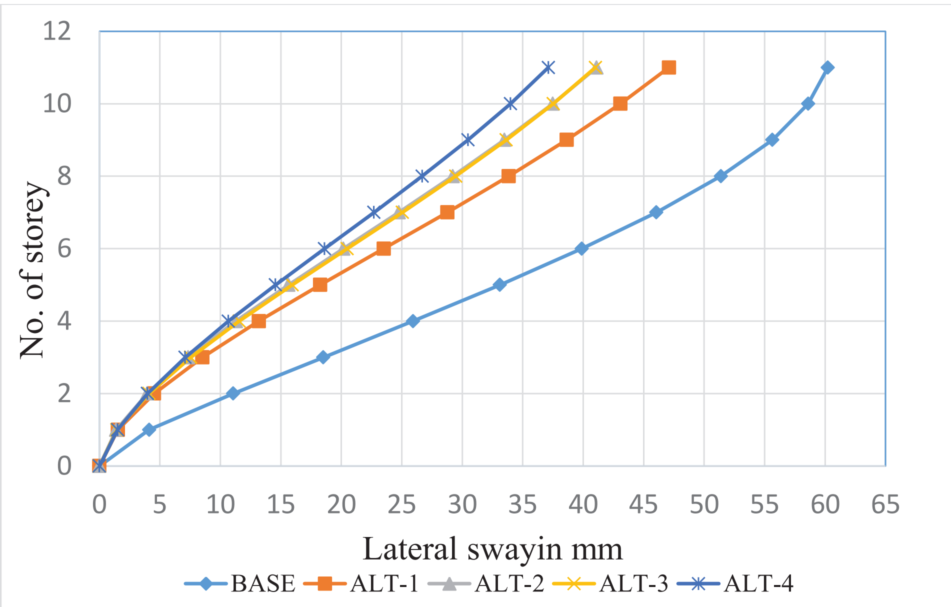



**Figure 4. Lateral sway in all alternates**

## 5. CONCLUSION

Shear walls are vertical elements of the horizontal force-resisting system, which are constructed to counter the effects of lateral load acting on a structure. In residential construction, Shear walls are straight external walls that typically form a box which provides all of the lateral support for the building. When shear walls are designed and constructed correctly, they will have the strength and stiffness to resist horizontal forces. The study compares parameters, for example, storey drift, storey shear, and displacement of a building under lateral loads based on the strategic positioning of shear walls. The effect of shear wall location on various parameters is to be compared. The static and response spectrum method is used to obtain the overall performance level of a structure

The results show that buildings with shear walls perform better in earthquakes as they exhibit lesser lateral sway and inter-storey drift; however, has greater base shear. Similarly, alternates 2 and 3 have no significant difference in their seismic behavior, and alternate 4 with the central core shear wall is the best alternative for the position of the shear wall. The results further indicate that shear walls in outer grids are seen as less effective than in inner grids.

The study by Singh, Victor, and Jain (2019) found that Shear walls are upright elements of the flat enery resisting system, which are built to deal with the consequences of lateral load working on a structure. In domestic construction, Shear walls are straight exterior walls that normally form a box which delivers all of the lateral assistance for the building.

When shear walls are constructed and composed appropriately, they will have the power and strength to avoid horizontal forces. In building building, a rigid vertical diaphragm can transmit lateral forces from exterior walls.

The floors, and roofs to the ground foundation in a direction parallel to their planes in building. Their study compares parameters, for example, storey drift, storey shear, and displacement of a building under lateral loads based on the strategic positioning of shear walls. The impact of shear wall setting on various parameters is to be evaluated. The constant and response spectrum technique is utilized to achieve the overall performance level of a structure.

Similarly, Acharya and Shrestha (2019) found that Shear walls perform a important role in increasing the seismic performance of the building. It is vital to establish the most effective position of shear walls. Shear wall composition must be correct because if not, it will affect an harmful effect instead. This paper aims to predict the impact of placing RC shear walls of several shapes on the structural reply of RC buildings resting on sloping ground.

**Recommendations**

This study shows that shear walls work better when placed in both directions than in cases where shear walls are placed in only one direction. Again, among all the cases, shear walls provide maximum resistance to lateral forces when placed along the periphery. So, for a symmetrical or nearly symmetrical high-rise building, it would be very effective to provide shear walls along the periphery in both directions.

- This study was performed for a 6-storey building in seismic zone II of OCEM. Future studies can be carried out for higher-storey buildings in other seismic zones of OCEM.
- This study considers all the important issues like storey shear, storey drift and movement, stiffness, and torsional irregularity. However, other parameters, for example, the soft storey effect, can be introduced for further analysis.
- This whole study is performed for a symmetrical structure. If the structure is unsymmetrical, the optimum location and orientation of the shear walls may vary.
- There are very few works entitled unsymmetrical structures. Therefore, there is a huge scope for further study-analysis of the optimum location of shear walls in unsymmetrical structures.
- This study was performed for a 6-storey building in seismic Zone V. Future studies can be carried out for higher-storey buildings in other seismic Zones.
- This study considers all the important parameters like storey shear, storey drift and displacement. However, other parameters, for example, Impact of the stiffness, and torsion can be introduced for further analysis.
- This whole study is performed for a symmetrical structure. If the structure is unsymmetrical, the optimum location and orientation of the shear walls may vary.
- There are very few works entitled unsymmetrical structures. Therefore, there is a huge scope for further study-analysis of the optimum location of shear walls in unsymmetrical structures.

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