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Comparative Study of Different Locations of Shear Wall in Multi-storey Building by Using STAAD Pro

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ABSTRACT

A shear wall can be defined as a vertical structural member that resists lateral forces in the plane of the wall through shear and flexure. Shear wall are vertical stiffening element designed to resist lateral force exerted on a building by wind or earthquakes. When shear walls are provided at a proper location in a building they can prove to be very efficient at the same time they can act as a partition wall. It is important to select a location of shear wall that will offer the optimum resistance against the lateral forces and the design of shear wall is very complicated and time consuming. For these reason structural software plays an important role in design and construction of high rise structure.

In this study, a G+10-storey building with grid size 3.5 m x 3.5 m is considered. The number of grids in X direction is 5 and in Y direction is 10 .The total plan size is 17.5 m x 35 m. This building is designed in compliance to the Indian Standard code of practice for seismic resistant design of building IS1893-2002. The buildings are assumed to be fixed at the base and the floors acts as rigid diaphragms. The height of Ground floor is 4.5m and above the ground is 3.5m. The Depth of foundation is 2.5 m .Building is modelled using the software STAAD.Pro. Four models are studied with different positioning of shear wall with different location in the building like at centre, at two opposite side and at each corner. Models are studied for zones III comparing lateral displacement, story drift, shear force and bending moment zones for all models. From this study, From Out of all four models, Shear wall at corner behaves best.

Keyword: - Shear Wall, Location, STAAD Pro, Earthquake Analysis, Multistory Building, Bending Moment, Shear Force.

1. INTRODUCTION

In the present situation land scarcity and increasing cost of land is the major problem in big cities that we are facing, which has led to advancement in construction techniques and with urbanization, high-rise construction has become a necessity. With the increase in height of building, lateral forces on these structures also increases, and possesses challenges for seismic design so these buildings are needed to be properly designed for these forces, or else it may lead to the failure of the structures. To overcome these lateral forces the beams and column should be design with rigidity and larger in size which directly increase the cost of a building. For economic seismic design the concept of shear wall was introduced.

A shear wall building is similar to an ordinary framed building. However, it differs significantly when it comes to transference of lateral load. Shear wall are vertical stiffening element designed to resist lateral force exerted on a building by wind or earthquakes. Columns are compression elements whereas shear wall is compression as well as shear resisting elements. Shear walls are usually provided along both length and wide of buildings. Shear walls are like vertically-constructed wide columns that carry earthquake loads downwards to the foundation. The thickness can be as low as 150mm, or as high as 400mm in high rise buildings (depends on structure). If the ratio of length to the breadth is less than 4 then it is considered as shear wall.

When shear walls are provided at a proper location in a building, they can prove to be very efficient at the same time they can act as a partition wall. It is important to select a location of shear wall that will offer the best resistance against the lateral forces also reduces the stresses in the structure.in this study, building considered is a G + 10 residential building situated in seismic zones III which is highest zone in Maharashtra. Building is modelled by using software STAAD Pro.

2. OBJECTIVE

- To compare the RCC building without and with shear wall.
- To study the importance of location of shear wall in a building in earthquake zone area.
- To learn various aspects of structural software, STAAD Pro generally used in civil engineering.
- To compare the values displacement, story drift, bending moment and shear force

3. EXPERIMENTAL PROGRAM

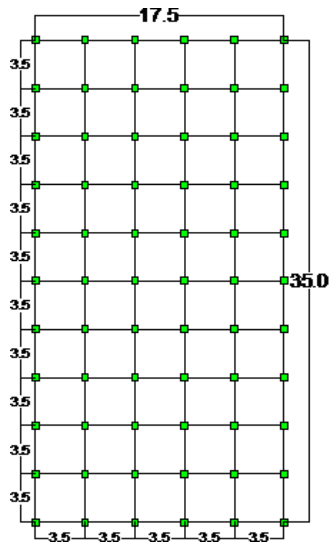

Fig -1 Building Plan

In this study, a G+10-storey building with grid size 3.5 m x 3.5 m is considered. The number of grids in X direction is 5 and in Y direction is 10 as shown in fig.1.The total plan size is 17.5 m x 35 m. This building is designed in compliance to the Indian Standard code of practice for seismic resistant design of building IS1893-2002. The buildings are assumed to be fixed at the base and the floors acts as rigid diaphragms. The height of Ground floor is 4.5m and above the ground is 3.5m. The Depth of foundation is 2.5 m .Building is modelled using the software's STAAD Pro. Four models are studied with different locations of shear wall in the building such as,

- Model Without Shear Wall
- Model With Centre H Shear Wall
- Model With Side Shear Wall
- Model With Corner Shear Wall
- Models are studied for zones III comparing lateral displacement, shears force, bending moment and story drift for all models.

3.1. Structural Configuration

- Type of frame : Special RC Moment Resistant Frame fixed at the base
- Ground Floor height : 4.5 m
- Above ground floor 3.5 m each story
- Thickness of slab : 130 mm
- Size of Beam : (300x350) mm
- Size of Column : (450x500)mm
- Materials : M30 concrete, Fe415 steel
- Thickness of Shear wall : 230 mm
- Thickness of outer brick wall: 230mm
- Thickness of inner brick wall: 115mm
- Density of Concrete : 25 KN/m^3
- Density of brick wall : 19.2 KN/m^3

3.2 Load Combination As Per Is 1893-2002

1. 1.5 (DL+LL)
2. 1.2 (DL+LL+EQX)
3. 1.2 (DL+LL-EQX)
4. 1.2 (DL+LL+EQY)
5. 1.2 (DL+LL-EQY)
6. 1.5 (DL+EQX)
7. 1.5 (DL-EQX)
8. 1.5 (DL+EQY)
9. 1.5 (DL-EQY)
10. 0.9 DL+1.5 EQX
11. 0.9 DL-1.5 EQX
12. 0.9 DL+1.5 EQY
13. 0.9 DL-1.5 EQY

The following figures show all the four models which are under taken for this study,

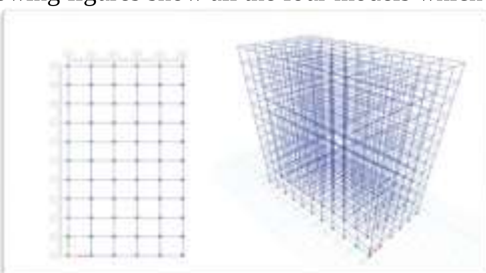

Fig.2 Model Without Shear Wall

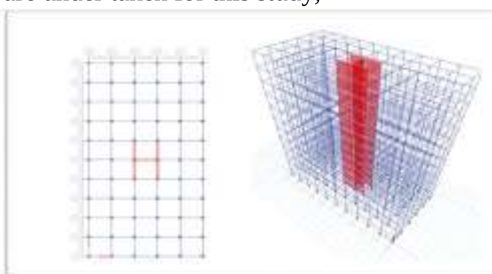

Fig.3 Model With Centre H Shear Wall

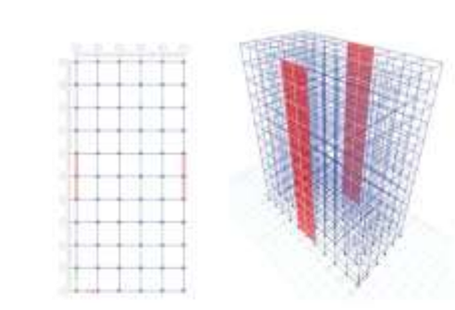

Fig.4 Model With Side Shear Wall

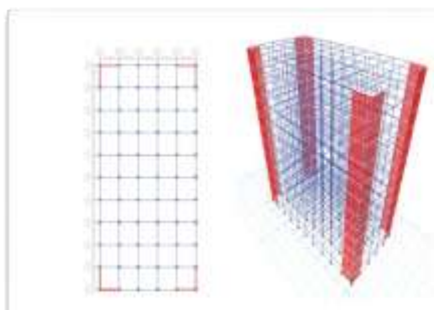

Fig.5 Model With corner Shear Wall

3.3 Analysis in STAAD Pro

In this study, the analysis is done by using STAAD Pro. The above mention data are use to analyzed all the models and some of the important images of software are shown below in fig 6 to fig 8.

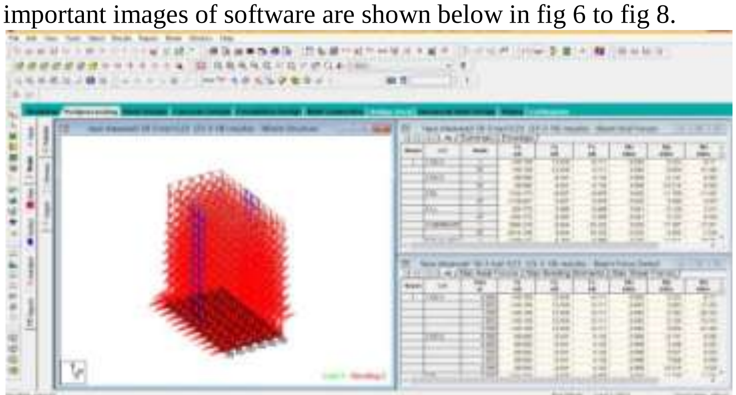

Fig 6 Model with Side Shear wall's Bending Moment

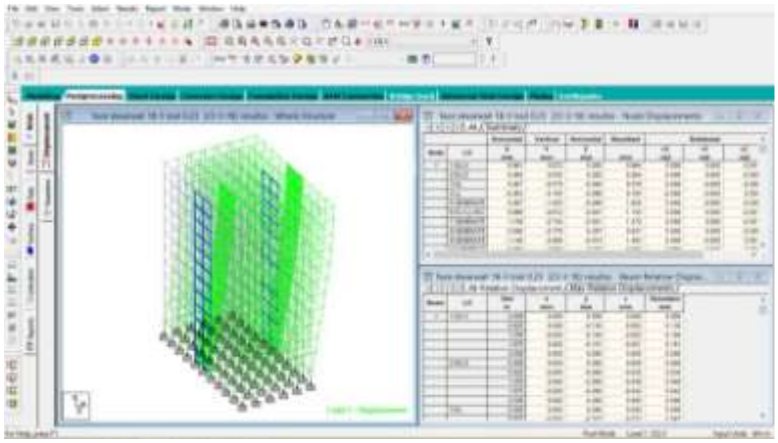

Fig 7 Model with Side Shear wall's Displacement

Fig 8 Model with Side Shear wall's Shear Force

4. RESULT

Result obtained from analysis is collected in shear wall panels. Also, maximum nodal displacement, maximum shear force, maximum bending moment, maximum storey drift are noted for the wall elements.

4.1 Displacement Comparison in X and Y Direction

The comparison of maximum displacement of all the four model are as shown in fig 9 and 10 , from it we can see that the model with corner shear wall shows least values of bending moment though in Y-direction it is almost same with side shear wall model.

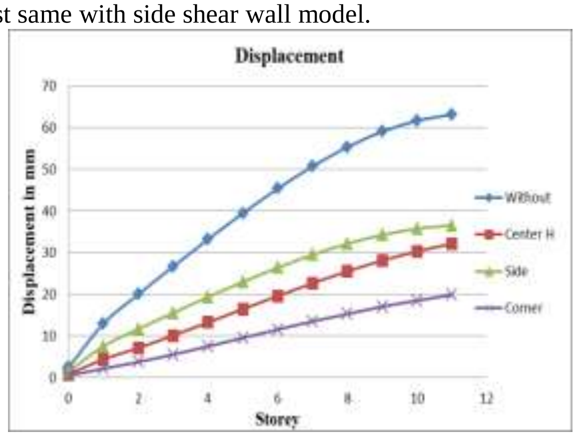

Fig.9 Displacement In X direction

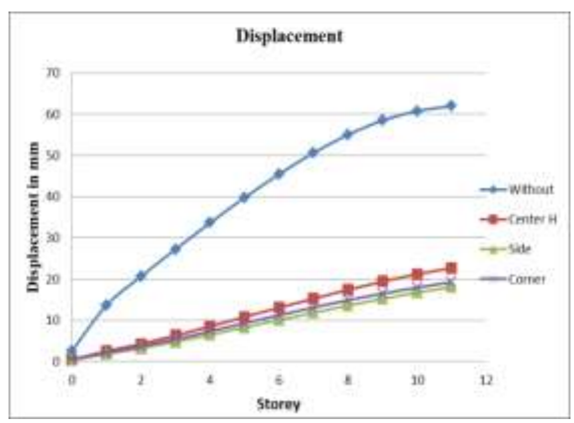

Fig.10 Displacement In Y direction

4.2 Comparison of Bending Moment

The comparison of Bending Moment within shear wall of the four models is as shown in fig 11, from it we can see that the model with corner shear wall shows least values of bending moment.

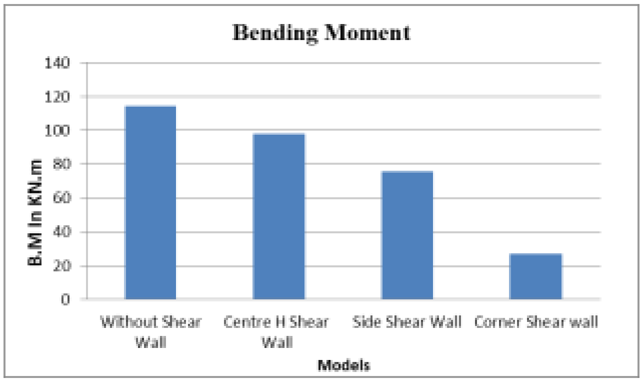

Fig 11 Bending Moment Comparison

4.3 Comparison of Shear Force

The comparison of Shear Force within shear wall of the four models is as shown in fig 12, from it we can see that the model with corner shear wall shows least values of shear forces.

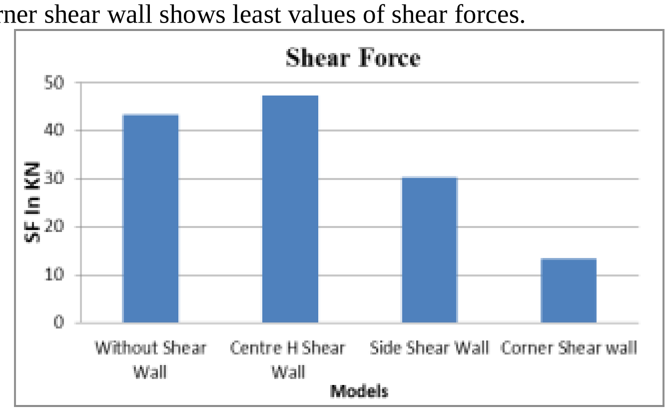

Fig 12 Shear Force Comparison

4.4 Comparison of Storey Drift

The comparison of Storey Drift within shear wall of the four models is as shown in fig 13, from it we can see that the model with corner shear wall shows least values of storey drift.

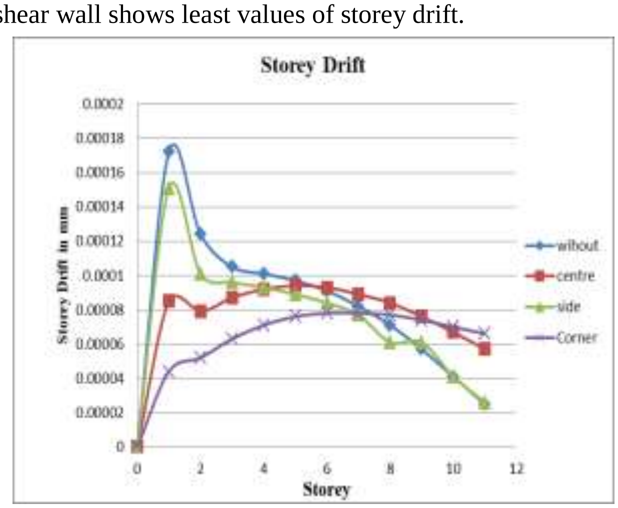

Fig 13 Storey Drift Comparison

5. CONCLUSIONS

A brief introduction about shear wall is presented in this paper, for checking the optimum location of shear wall in the building, so that it is safe in earthquake and reduces the stress in the structure. The conclusions drawn from the experimental program and analysis are listed below.

- The presence of shear wall affects the seismic behaviour of frame structure to large extends and shear wall increases the strength and stiffness of the structure, as it is clear from this study that models with shear wall are having better response to earthquake as compared to model without shear wall
- From this study we have concluded that the location of shear wall largely affects the behaviour of building in earthquake zone area.
- In comparison among the locations of shear wall in different models, the optimum location of shear wall is found in model with corner shear wall as compared to all other models.
- From the analysis of all four models the values of displacement, storey drift, bending moment and shear force are obtained to be minimal in model with corner shear wall as compare to all other models.

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