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Seismic Analysis of Irregular Multistoried Structure with Shear Wall

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Abstract:

Shear wall is a structural element used to resist lateral loads in the high rise buildings. Shear walls act as major earth quake resisting members and simultaneously resist the gravity loads Shear walls are specially designed structural walls include in the buildings to resist horizontal forces that are induces in the plane wall due to wind, earth quake and other forces. They are mainly flexural members and usually provided in high rise buildings to avoid the total collapse of the high rise buildings to avoid the total collapse of the high rise buildings under seismic forces. In this study a 20 storey irregular building in zone V is presented in which same shear wall with same crossection area is considered which is analyzed by changing the various location to find the optimum position of shear wall for determining the parameters like storey shear, displacement, storey drift and acceleration is done by using standard FEM software ETAB in which beams and columns were replaced by the shear wall.

Keywords: Shear wall, Irregular building, ETABS, analysis of structure, High rise buildings

1. Introduction

Recently there has been a considerable increase in the tall buildings both residential and commercial and the modern trend is towards more tall and slender structures. Therefore for tall buildings it is essential that the structure must be sufficiently stiff to resist the lateral loads caused by wind and seismic motion. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. The shear wall structures have been recognized as one of the most efficient structural system for such a purpose.

Shear walls are vertical elements of the horizontal force resisting system. Shear walls 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 properly, and they will have the strength and stiffness to resist horizontal forces.

In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples are the reinforced-concrete wall or vertical truss. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants create powerful twisting (torsion) forces. These forces can literally tear (shear) a building apart. Reinforcing a frame by attaching or placing a rigid wall inside it maintains the shape of the frame and prevents rotation at the joints. Shear walls are especially important in high rise buildings subjected to lateral wind and seismic forces. In the last two decades, shear walls became an important part of mid and high-rise residential buildings. As part of an earthquake resistant building design, these walls are placed in building plans reducing lateral displacements under earthquake loads. So shear-wall frame structures are obtained.

2. Related Work

P. S. Kumbhare, A. C. Saoji(2012) has carried out study on the effect of seismic loading on placement of shear wall in medium rise building at different alternative location. They have analyzed residential medium rise building for earth quake force by considering two type of structural system i.e. Frame and dual system. They have studied on effectiveness of positioning of shear wall and carried out analysis by using standard package ETAB for the comparison of the parameters like shear force, bending moment, displacement ,storey drift and storey shear by replacing the column with the shear wall. They found that shear wall frame interaction systems are very effective in resisting lateral forces induced by earthquake. They found the significant effect on shear force and bending moment of column at different levels of the building by shifting the shear wall location. Placing shear wall away from centre of gravity resulted in increase in the most of the members forces. It follows that shear walls should be coinciding with the centroid of the building. They found that frame type structural system become economical as compared to the dual type structural system can be used for medium rise residential building situated in high seismic zone.

Ashish S. Agrawal, S. D. Charkha (2012) has carried out study on 25 storey building in zone V with some preliminary investigation which is analysed by changing various position of shear wall with different shapes for determining parameters like storey drift, axial load and displacement. They used standard ETAB package for the analysis. From the results of analysis they come to conclusion that placing Shear wall away from centre of gravity resulted in increase in most of the members forces. And they found that displacement of the building floor at storey 25 has been reduced due to presence of shear wall placed at centre. When they placed lift core at eccentric position it develops displacement in both the direction with application of seismic force in Y direction and they came to know that drift is increased as height of building increased and reduced for top floor. Location of shear wall effects static and dynamic axial load on the column. The displacement of building is uni-directional and uniform for all the grids in the case of Zero eccentricity for seismic loading. With the increase in eccentricity, the building shows non-uniform movement of right and left edges of roof due to torsion and induces excessive moment and forces in member. [2].

3. Terms and definitions

3.1. Shear wall

Shear walls are often introduced in multistoried buildings to resist lateral forces when frame systems alone are insufficient. The term “shear wall” as used for elevator shafts, stairwells and central core units, in addition to plane walls. Analysis for lateral loads of buildings containing shear walls is generally carried out by assigning all lateral loads to the shear walls, since it was felt that the very big difference in stiffness between the shear walls and the frame would cause the shear walls to accept the total lateral loads. Adding shear walls is one of the most common structure-level retrofitting methods to strengthen existing structures. This approach is effective for controlling global lateral drifts and for reducing damage in frame members. In order to reduce time and cost, shotcrete or precast panels can be used.

3.2. Purpose of constructing shear wall

Shear walls are not only designed to resist gravity / vertical loads (due to its self weight and other living / moving loads), but they are also designed for lateral loads of earthquakes / wind. The walls are structurally integrated with roofs / floors (diaphragms) and other lateral walls running across at right angles, thereby giving the three dimensional stability for the building structure. Shear wall structural systems are more stable. Because, their supporting area (total cross-sectional area of all shear walls) with reference to total plans area of building, is comparatively more, unlike in the case of RCC framed structures. Walls have to resist the uplift forces caused by the pull of the wind. Walls have to resist the shear forces that try to push the walls over. Walls have to resist the lateral force of the wind that tries to push the walls in and pull them away from the building.

3.3. Overall Geometry of shear walls

Shear walls are oblong in cross sections, i.e., one dimension of the cross-section is much larger than the other. While rectangular cross-section is common, L- and C-shaped sections are also used. Thin-walled hollow RC shafts around the elevator core of buildings also act as shear walls, and should be taken advantage of, to resist earthquake forces. Fig 1 shows geometry of shear wall commonly used.

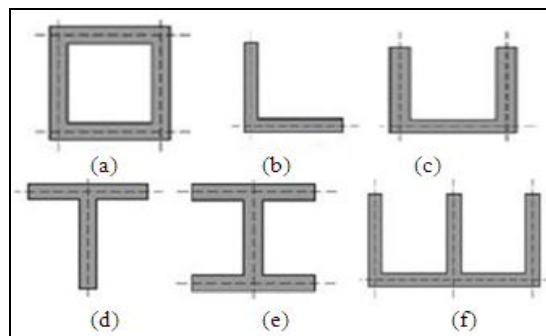


Figure 1: Geometry of shear wall (a) Box shape, (b) L-shape, (c) U-shape, (d) T-shape, (e) I-shape, (f) W-shape

4. Proposed Work

The main objectives of this project work includes the following

- The main objective of the present study is to determine dynamic characteristic of typical RC frame tall structure for the combination of bare frame, lift core, Shear wall. Modelling and analysis is carried out using FEM software.
- To find the optimum position of shear wall with same crosssectional area on structural response under seismic loading
- The modal analysis is conducted to know mode shapes
- Response spectrum is generated for zone v as per IS 1893 (Part 1) 2002 used for Equivalent static analysis and response spectrum analysis.
- Equivalent static analysis is carried out for zone v to determine base shear and shear strength coefficient of models while response spectrum analysis helps to define the corresponding seismic response of the building.
- To determine parameters such as base shear, displacement, mode shapes, acceleration are obtained

5. Modeling and Analysis of Different Structure

For this study, a 20 storey irregular building 8 bays of 6 m along X axis and 6 bays of 6 m along Y axis considered. The structural data is tabulated below

Height of each storey	3.35m
Shear wall thickness	400mm
Grade of concrete	M25
Grade of steel	Fe 415
Depth of slab	175mm
Size of beam	500X700mm
Size of column	850X850mm from base to storey level 10 750X750mm from storey level 11 to 15 650X650mm from storey level 16 to 20

5.1. Loading Consideration

The following loading standards are considered on the models during analysis Gravity loading: (IS 875 Part 1 and Part 2) Gravity load consist of dead load due to structural self weight, Live load and floor finish is considered as 3kN/m² and 1.5kN/m² floor slab Lateral loading: Lateral load consist of earth quake load both in X and Y axis as per the IS 1893-2002.

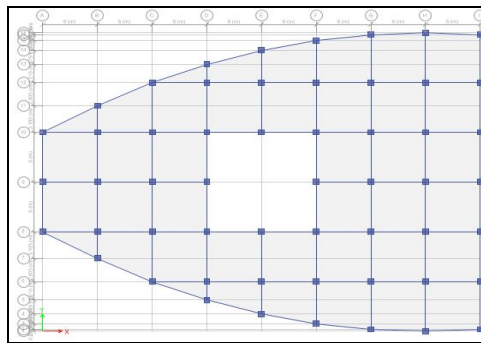
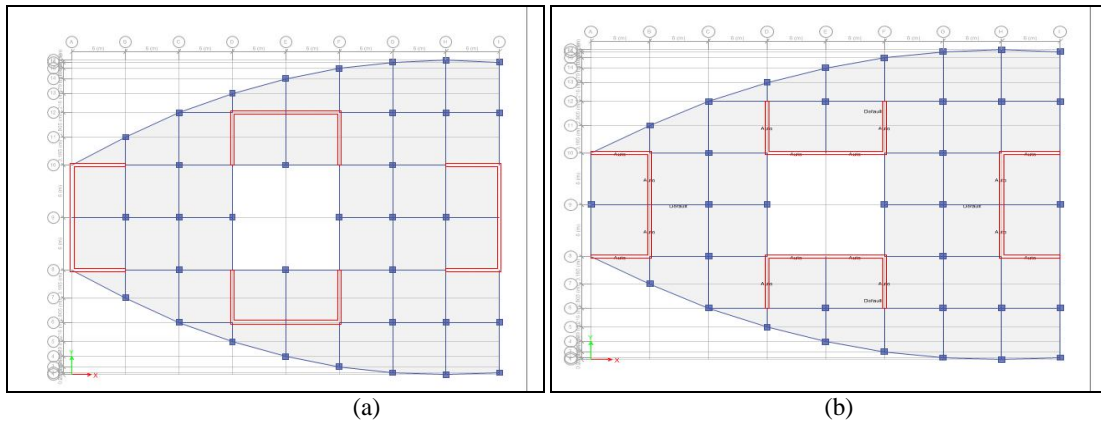
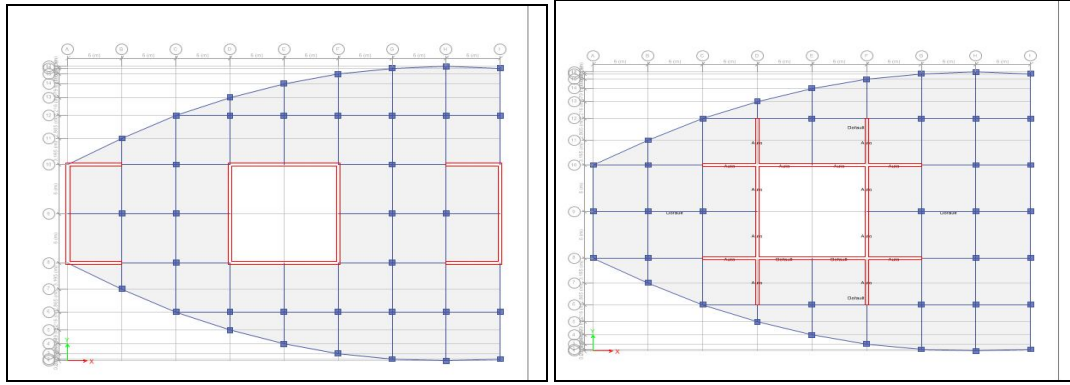


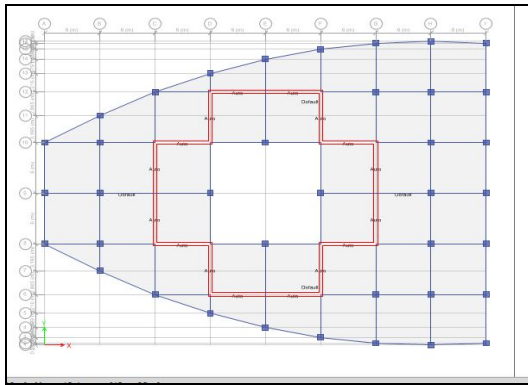
Figure 2: Plan view of irregular shape building



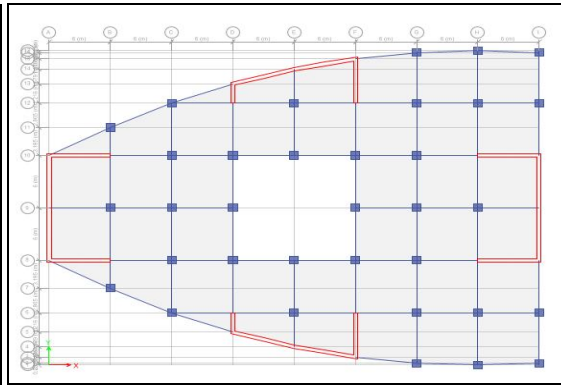


(c)

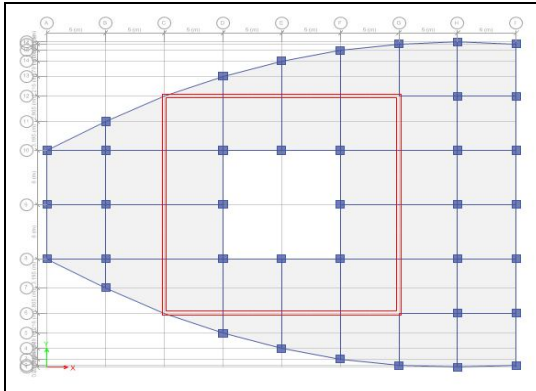
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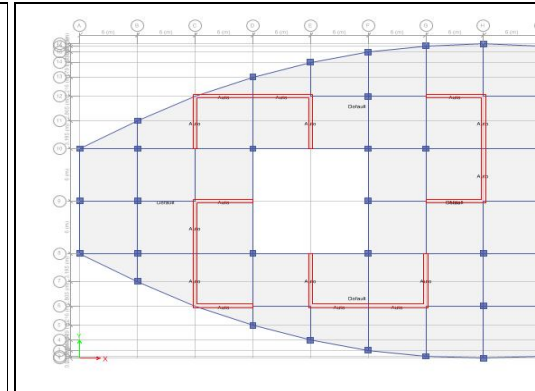
(e)



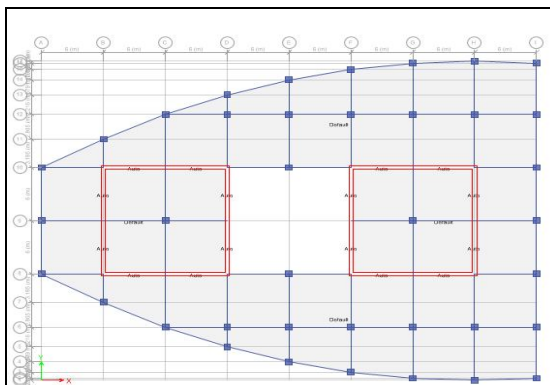
(f)



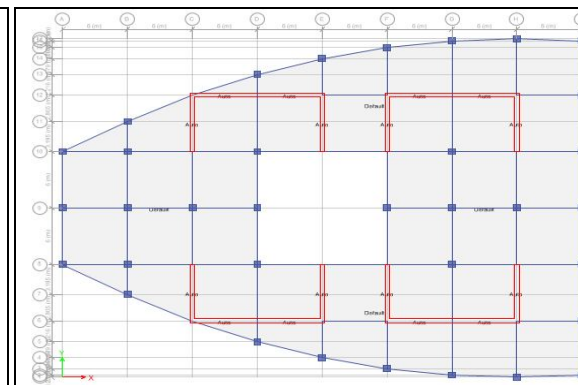
(g)



(h)



(i)



(j)

Figure 3: Model 1(a) Model 2(b) Model 3(c) Model 4(d) Model 5(e) Model 6(f) Model 7(g) Model 8(h) Model 9(i) Model 10(j)

6. Results

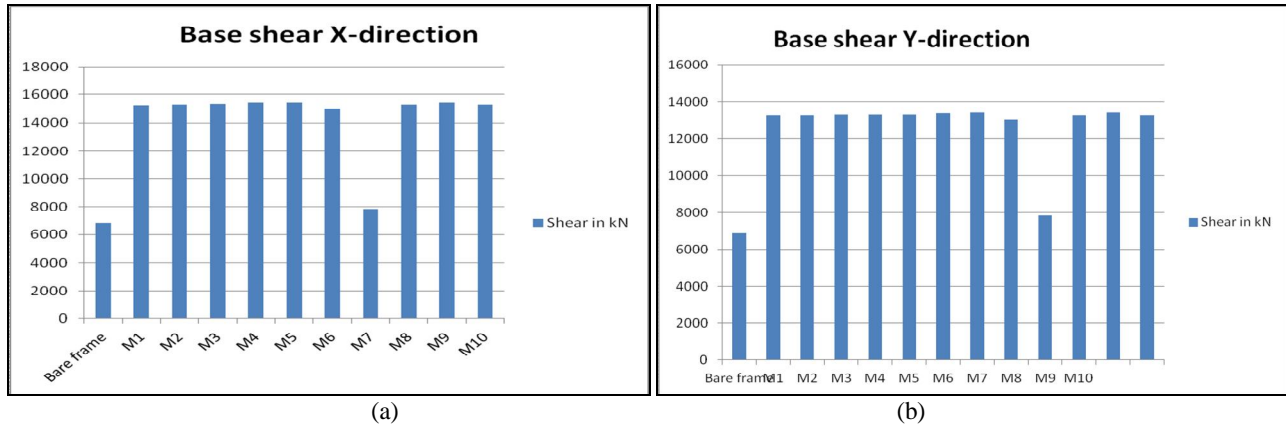


Figure 4: Base shear in X direction(a), : Base shear in Y direction(b),

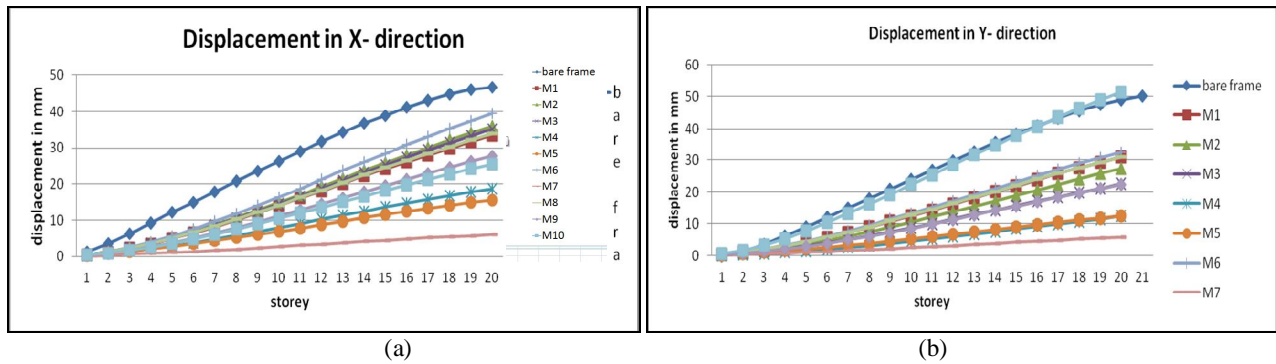


Figure 5: Displacement in X direction(a), : Displacement in Y direction(b),

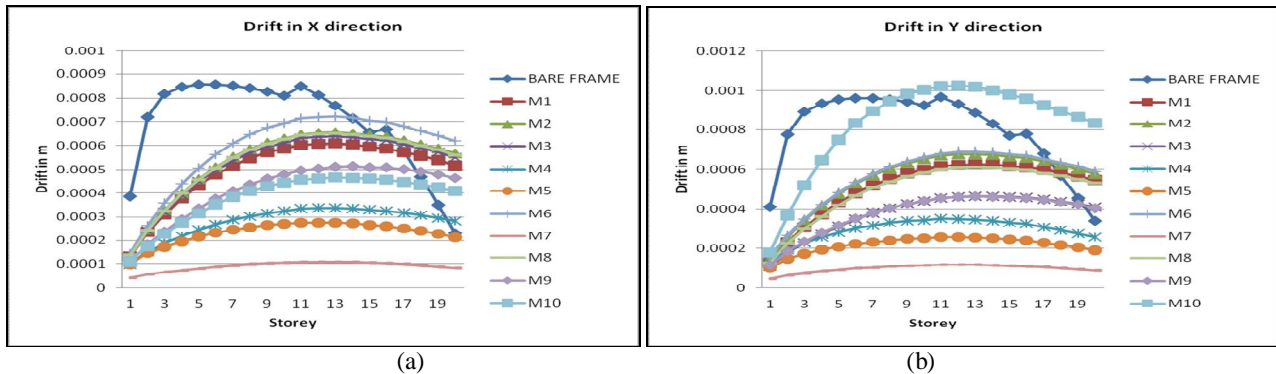


Figure 6: Drift in X direction(a), : Drift in Y direction(b),

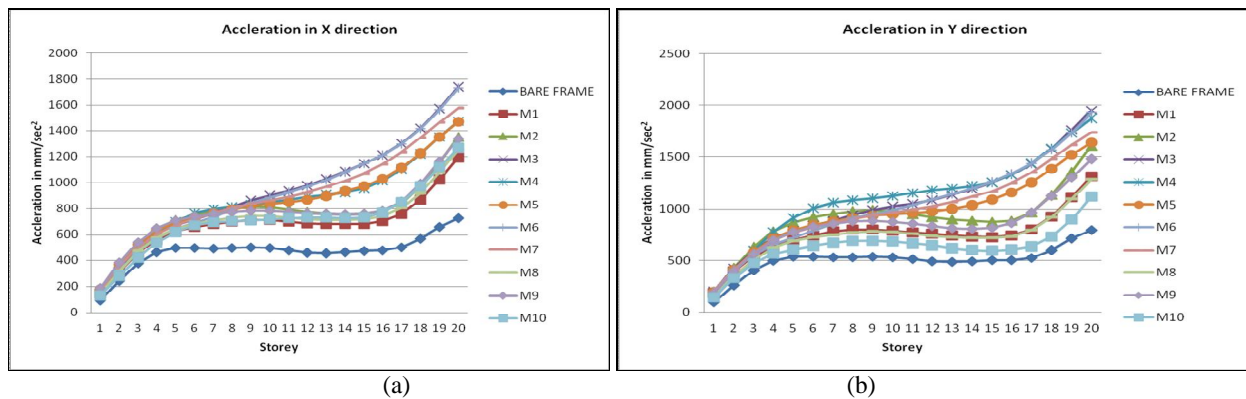


Figure 6: Acceleration X direction(a), : Acceleration Y direction(b),

7. Conclusion

- The seismic analysis of reinforced concrete frame irregular structure is done by both static and dynamic analysis to determine the optimum positioning of the shear wall
- In equivalent static analysis it has been found that model-7 shows lesser displacement as compared to the other models
- In equivalent static analysis it has been found that model-7 shows lesser drift as compared to other models
- Hence it can be said that shear wall provided for model 4,model 5and model 7 shows lesser displacements compared to other models
- Hence it can be said that model 7 is the optimum positioning of shear wall

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