Effect of Shear Walls at Different Locations with Varying Thickness in Multistorey Buildings

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Abstract - *Structural design of buildings for seismic loading is primarily concerned with structural safety during major earthquakes, but serviceability and the potential for economic loss are also of concern. A shear wall is a wall that is used to resist the shear, produced due to lateral forces. Many codes made the shear wall design for high rise buildings a mandatory. Shear walls are provided when the centre of gravity of building area and loads acted on structure differs by more than 30%. To bring the centre of gravity and centre of rigidity in range of 30%, concrete walls are provided i.e. lateral forces may not increase much. These shear walls start at foundation level and extend throughout the building height. Shear walls are oriented in vertical direction like wide beams which carry earthquake loads downwards to the foundation and they are usually provided along both width and length of the buildings.*

The purpose of the present work is to compare the seismic behavior of multistory buildings without shear walls and with shear walls at different locations with varying thickness. The analysis is performed using software Staad.Pro V8i for seismic loads in zone V. The object of the present work is to compare the behaviour of multi-storey buildings with and without shear walls under seismic forces. For this purpose C and T shapes of shear walls are considered at corner of building, at edge of building and at centre of the building with varying thickness of 150mm, 250mm and 350mm. Shear walls have been provided to reduce the values of lateral displacement and storey drift. From the analysis results it is observed that by providing T and C shape shear wall storey drift and lateral displacement values reduces as compared to without shear wall models from both the methods of analysis. Storey drift and lateral displacement by dynamic analysis are less in comparison to static analysis. Hence it may be preferable to adopt dynamic analysis method in practice. It is concluded that for better performance of building thickness of shear wall should be larger.

Key Words: Shear Walls, Storey Drift, Lateral Displacement, Dynamic Analysis, Locations

1. INTRODUCTION

A shear wall is a wall that is used to resist the shear, produced due to lateral forces. Many codes made the shear wall design for high rise buildings a mandatory. Shear walls are provided when the center of gravity of building area and loads acted on structure differs by more than 30%. To bring the center of gravity and center of rigidity in range of 30%, concrete walls are provided i.e. lateral forces may not increase much. These shear walls start at foundation level and extend throughout the building height. Shear walls are oriented in vertical direction like wide beams which carry earthquake loads downwards to the foundation and they are usually provided along both width and length of the buildings. Shear walls in structures located at high seismic regions require special detailing. The construction of shear walls is simple, because reinforcement detailing of walls is relatively straight forward and easy to implement at the site. Shear walls are effective both in construction cost and effectiveness in minimizing earthquake damage to the structural and nonstructural elements also.

1.1 Functions of Shear Walls

Shear walls must provide the necessary lateral strength to resist horizontal earthquake forces. When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them. These other components in the load path may be other shear walls, floors, foundation walls, slabs or footings. Shear walls also provide lateral stiffness to prevent the roof or floor above from excessive side-sway. When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff will usually suffer less non-structural damage.

1.2 Efficiency of Shear Walls

Efficiency of a shear wall is purely depends upon its rigidity or its stiffness. A solid shear wall is more efficient than a shear wall with openings. But sometimes it is not possible to construct a shear wall without openings such as openings for doors, windows etc.

In case of openings to improve the efficiency of shear wall, connect the piers of shear walls by spandrels. Pier is nothing but the portion of shear wall between two openings and spandrel is the portion of shear wall above the opening. The resulting wall appeared by interconnecting spandrels of piers of shear walls is known as coupled shear wall. Provision of openings in balanced pattern can also make the shear wall efficient.

In flanged shear walls, the walls will meet at right angles to each other. This type of shear walls are less efficient since they are effected by seismic forces in both principal directions of the building.

2. OBJECTIVES

In the present dissertation work different cases of multistory buildings having shear walls with varying thickness have been taken to study the behavior under seismic loading. The objectives of the present work are:

1. To study the types of shear walls and its seismic behavior for multistorey building.
2. To study the seismic behavior of multistorey building having shear walls at different locations and varying thickness.
3. To analyze a multistorey building with different types of shear wall at different locations with varying thickness and to compare its parameters for seismic zone V.

3. METHODOLOGY

The purpose of the present work is to compare the seismic behavior of multistory buildings with shear walls at different locations with varying thickness. The analysis is performed using software Staad.Pro V8i for seismic loads in zone V.

The object of the present work is to compare the behaviour of multi-storey buildings with shear walls under seismic forces. For this purpose C and T shapes of shear walls are considered at corner of building, at edge of building and at centre of the building with varying thickness of 150mm, 250mm and 350mm. Shear walls have been provided to reduce the values of lateral displacement and storey drift.
The building plan is considered square in shape with size 24m x 24m. The building is of (G + 11) configuration, having storey height of 3.0m. The columns are provided in 4m x 4m grid form. Shear walls are placed at the centre of plan, at corners of plan and at middle edge of plan.

The sizes of beams are taken as 300mm x 450mm throughout the height of building.
The sizes of columns are taken as 450mm x 450mm throughout the height of building.
The thickness of shear wall is taken as 150mm, 250mm and 350mm.
The thickness of slab considered is 150mm and brickwall is 200mm.
The grade of concrete is M-25 and steel is Fe-415 considered.

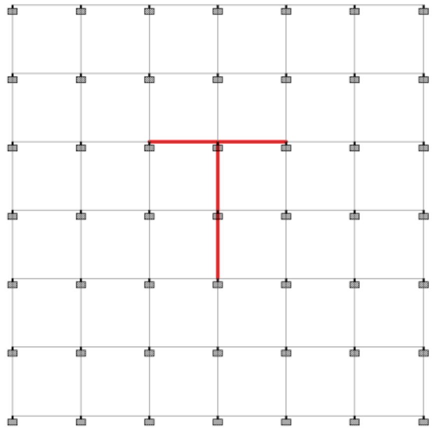

Fig -1: T shear wall at centre

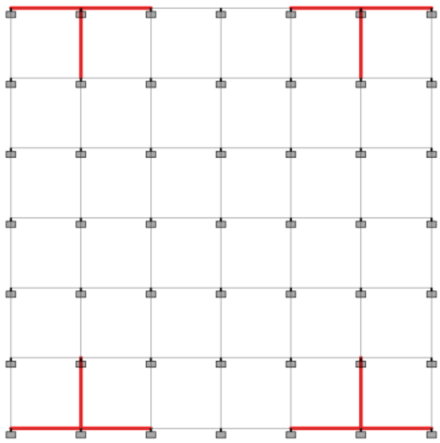

Fig -2: T shear wall at corner

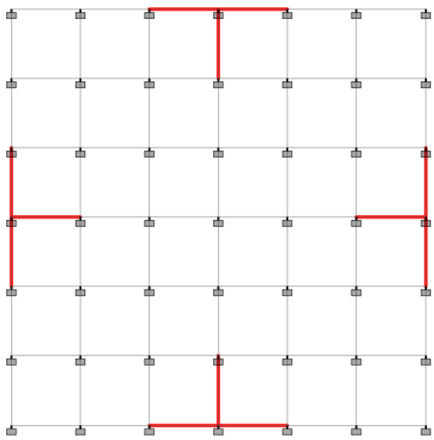

Fig -3: T shear wall at middle edge

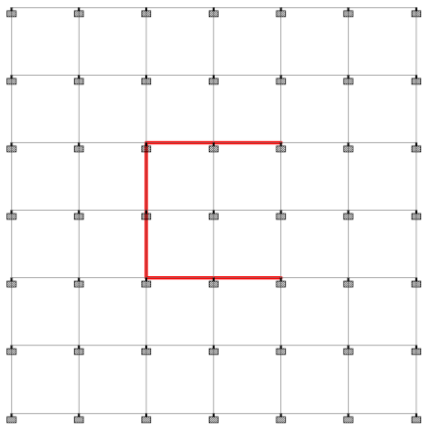

Fig -4: C shear wall at centre

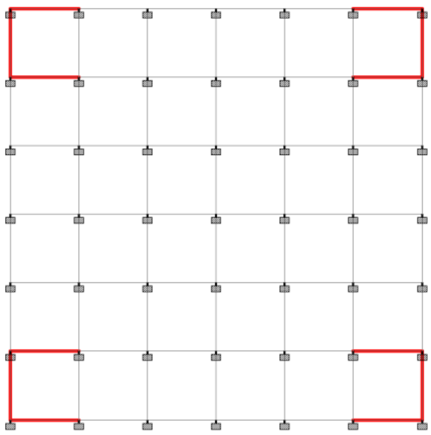

Fig -5: C shear wall at corner

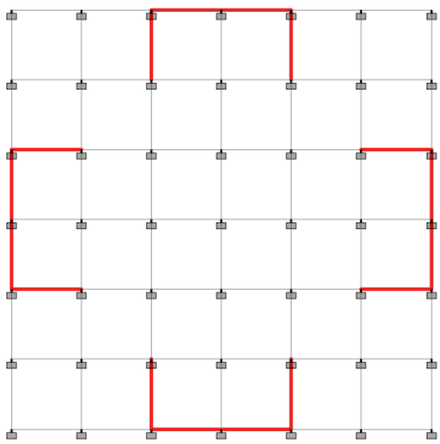

Fig -6: C shear wall at middle edge

4. RESULT AND DISCUSSIONS

4.1 Effect of Parameters Studied on Storey Drift

1. According to IS:1893:2002 (part I), maximum limit for storey drift with partial load factor 1.0 is 0.004 times of storey height. Here, for 3m height and load factor of 1.5, though maximum drift will be 18mm.
2. It is observed from results that for all the cases considered drift values follow around similar path along storey height with maximum value lying somewhere near about the second and third storey.
3. From the results obtained it is observed that the value of storey drift reduces with the increase in thickness of shear wall. As the thickness of shear wall increases from 150mm to 350mm the mass of structure gets increased and hence it becomes stiffer due to which storey drift is reduced.
4. It is observed that in models where shear wall is located at centre and also at edge, the value of storey drift reduces in case of C shear wall as compared to T shear wall. Although in model having shear wall at corners, the values of storey drift increases in case of C shear wall as compared to T shear wall.
5. Also it is observed that drift values of dynamic analysis are less in comparison to static analysis. Hence it may be preferable to adopt dynamic analysis method in practice.
6. Permissible limit for storey drift is 18mm. From the results it is observed that from storey drift point of view all the models are safe within permissible limit from both the methods of analysis.

4.2 Effect of Parameters Studied on Lateral Displacement

1. According to IS:456:2000, maximum limit for lateral displacement is H/500, where H is building height. Here for 12 storey building model it is 72mm.
2. It is observed from results that for all the models considered displacement values follow around similar gradually increasing straight path along storey height. Lateral displacement is maximum at the top storey and least at the base of structure.
3. From the results obtained it is observed that the value of lateral displacement reduces with the increase in thickness of shear wall. As the thickness of shear wall increases from 150mm to 350mm the mass of structure gets increased and hence it becomes stiffer due to which value of lateral displacement is reduced.
4. It is observed that in models where shear wall is located at centre and also at edge, the value of lateral displacement reduces in case of C shear wall as compared to T shear wall. Although in model having shear wall at corners, the values of lateral displacement increases in case of C shear wall as compared to T shear wall.
5. Also it is observed that values of lateral displacement by dynamic analysis are less in comparison to static analysis. Hence it may be preferable to adopt dynamic analysis method in practice.
6. Permissible limit for lateral displacement is 72mm. From the results it is observed from point of lateral displacement that all the models with T and C shear walls are safe within permissible limit from both the methods of analysis.

5. CONCLUSIONS

Within the scope of present work following conclusions are drawn:

For all the cases considered storey drift values follow around similar path along storey height with maximum value lying somewhere near about the second and third storey. For all the models considered lateral displacement values follow around similar gradually increasing straight path along storey height with value maximum at the top storey and least at the base of structure. By providing T and C shape shear wall storey drift and lateral displacement values reduces as compared to without shear wall models from both the methods of analysis. Storey drift and lateral displacement by dynamic analysis are less in comparison to static analysis. Hence it may be preferable to adopt dynamic analysis method in practice. It is concluded that for better performance of building thickness of shear wall should be larger. At the centre and edge position of shear wall, C shape shear wall gives better results as compared to T shape shear wall. Whereas at the corner position T shape shear wall performed well as compared to C shape shear wall. From both the analysis methods all the models having shear walls at all the locations and for all the thickness, are safe within permissible limits.

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