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A Review on High Rise Building with Shear Wall under Seismic Loading

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Abstract: ***This dissertation study involves the behavior of shear wall in high rise building under seismic loading. In recent decades the most appropriate structural form in recent decades are shear wall and tube structure which have caused the height of concrete building to be soared. Construction made of shear wall high in strength; they are highly efficient in taking load in earthquake prone area as they have peculiar behavior towards various types of loads. In this project we are going to study three case with different height located in different seismic zones for earthquake is to be studied using software package ETABS. The earthquake load is to be calculated and applied to multi-storied building, model results are calculated analyses for appropriate location of shear wall, effect of type of shear wall and building with shear wall and without shear wall. Shear walls have proved to be very successful in resisting strong earthquake so far.***

Keywords: Shear Wall, ETABS, High Rise, Seismic Analysis, Response spectrum

1. Introduction

Life of a person is the most precious thing in the world. Disasters are unexpected, so life of people is in danger due to some natural disasters. Among all the natural disasters, Earthquake causes maximum loss of life. We are heavily dependent upon the civic amenities; earthquake can disturb them in major way. Sudden rapid shaking of the earth when the energy stored in the rock is released is an Earthquake. **"Earthquake doesn't kill people but buildings do."**

The construction of shear walls can minimize damage caused by the effects of lateral forces caused by earthquakes and strong winds. Shear walls are structurally integrated into vertical roofs / floors and other side walls, providing three-dimensional stability to the building. Seismic structures are structures designed to withstand earthquakes, but no structure is completely immune to seismic damage, but the goal is to build structures that perform better during seismic activity.

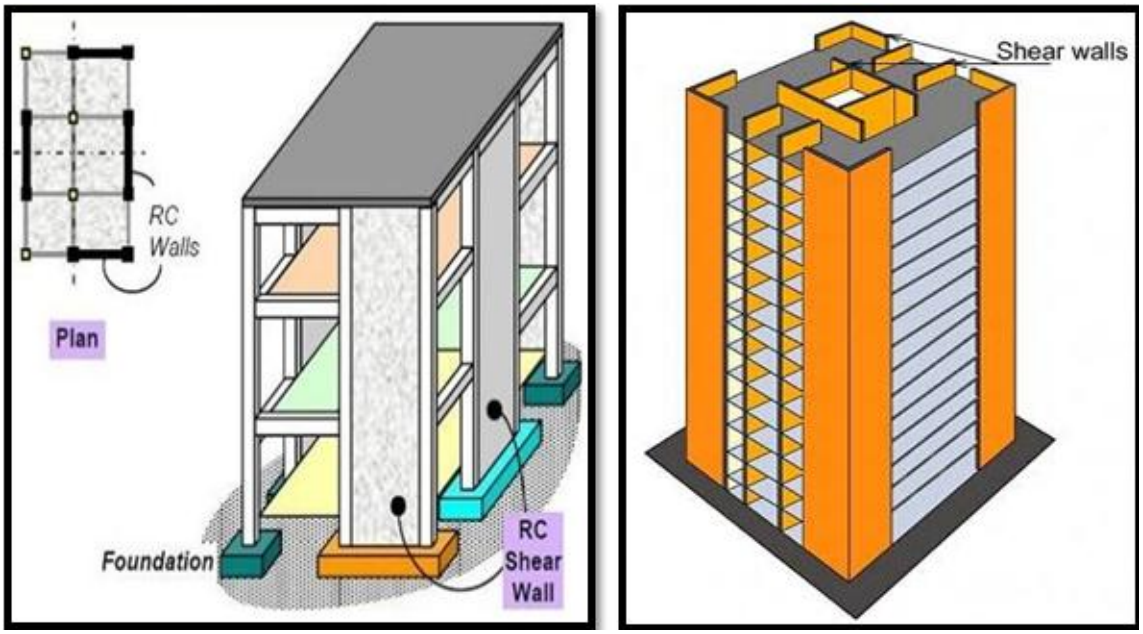


Figure 1: Reinforced concrete shear wall in building
Ref: Murty C. V. R (28)

2. Literature Review

1) Pradyut Anand studied the factors which help in optimizing the cost of the structure with minimum lateral deflection and total cost of the structure by the help of shear walls at different positions. The deflection is within limits and that had eventually led to a total cost

saving of Rs.12.5 lacs and Rs.25 lacs in G+10 and G+15 structures respectively.

2) B. Ramamohna Reddy et al concluded that shear wall and its provided location for studied building will take care of earthquake load and make building earthquake resistant. Reinforcement and existing dimensions of columns and beams of building are sufficient to care of the strength requirement s developed due to dead loads, seismic loads and live loads. Whenever an opening is expected the bar diameter is increased and lateral ties are provided inside the wall to replace the lintel beam for extra stability.
3) Shaikh Akhil Ahamad et al conducted the dynamic analysis on type-III (i. e., soft soil) for a irregular structure in plan in all the zones as specified and it is concluded that the structure with shear walls (i. e., Case C) placed symmetrically will show better results in terms of all the seismic parameters when compared with the structures.
4) Aman saini, Rajendra et al compared 12 storey high-rise building with and without shear wall, located in seismic zone III. In study we can compare the shear wall and without shear wall building, then analysis the better result which one more efficient.
5) Anoshiravan Afzali investigated direct effects of frequency content on high rise buildings. Six reinforced concrete buildings of 10, 15, 20, 25, 30 and 35 storey buildings were built using software Open sees and there seismic behavior under various frequency were investigated and concluded that the low frequency content records have the highest effects on buildings, high rise buildings performed better than shorter structure in term of shear.
6) Rajat Bongilwar et al studied the G+8 building was considered with and without shear walls and analyzed for various parameters like base shear, storey drift ratio, lateral displacement, bending moment and shear force. They concluded that the shear wall in multi storey building is more effective in increasing the overall seismic response. Shear wall increase the strength of structure.
7) Deepna U et al studied the seismic performance of high rise buildings and optimizing thickness of reinforced cement concrete shear wall. Steel plate shear wall and composite shear wall is carried out using software Etabs and concluded that the base shear slightly reduces when thickness for reinforced cement concrete shear panel and still plate is decreased. The thickness reinforced cement concrete panel and steel plate are not influencing the storey drift for the basement structures.
8) S. A. Halkude et al investigated the varying percentage length of a shear wall with aspect ratio (L/B) for seismicity and concluded that with increasing length of shear wall the stiffness of structure also increases, for square type of building having length of shear wall 10 to 20% plan dimension shows the efficient seismic performance.
9) A Murali Krishna et al analyzed the optimum location of shear wall in an unsymmetrical high rise buildings and different location of shear wall with different shapes are analyzed and concluded that the provision of shear wall and shape of shear wall has significant effect on storey drift in middle storey, the column which are located away from shear wall has high bending moment and less shear force.
10) S. Vijaya Bhaskar Reddy analyzed the shear wall system and framed tube system are considered for 30, 40, 50, 60 storey structures by using Staad Pro-2005 and concluded that the lateral roof displacement in the 30-storey structures with shear wall system and framed tube system are very close (about 2%). The shear wall system is much economical as compared to framed tube system.
11) Mahendra Kumar considered a five storey building which is subjected to Earthquake loading zone V to determine parameters like storey displacement, storey acceleration and base shear. Models were studied in V zone comparing lateral displacement, base shear and storey acceleration in X and Y direction for all structural models under consideration. The carried out study has shown that shear walls are able to decrease lateral top displacement of each modeled building and the harmful impacts during earthquakes. According to analysis best location of shear wall is building with shear walls at corners on each side on inner side.
12) Zhen Wang et al studied 40-storey public housing building in Hong Kong was used for case study. A finite element (FE) model was developed to simulate the structural performance of the precast concrete shear walls and validated using results of cyclic loading tests. This paper result shows the developed finite element model is effective to reproduce the structural performance of precast shear wall and the building in which used the precast shear wall it get strong enough to resist wind and seismic loading. The result show the precast shear wall is more effective than modular construction.
13) Arabzadeh et al carried out comprehensive experimental study of composite steel plate shear wall (CSPSW) was carried out and results are presented. Hinged and rigidly connected specimens with 1: 4 and 1: 3 scales were subjected to cyclic loading and push-over. The main parameters in the testes were gap around the RC panel, direction of reinforcement, number of bolts and RC panels, steel plate thickness and the specimen length to the width ratio. If the number of bolts increases, CSPSW buckling load acceleration will increase. Using RC planes at both sides improves the main properties of specimens like energy dissipation and strength, while decreasing its ductility. Bolts should be designed for combined shear and bending forces, except for the bolts at the centre of the panel, to which designing of the bolt for shear alone is enough.
14) Arthi S and Jaya KP studied an eight-story RC precast building located in Chennai was taken to study the performance of shear wall-slab connection under reverse cyclic loading. STAAD PRO software was used for the modeling and analysis of this structure. The resultant forces around the exterior shear wall-slab joint due to different load combinations defined as per IS 1893 part (1)-2002 were computed. The structural behavior of precast shear wall – diaphragm connection was compared with the monolithic under seismic loading. This study is aimed to developed 3D model. Using ABAQUS software. And the precast dowel connection between the shear wall and slab showed

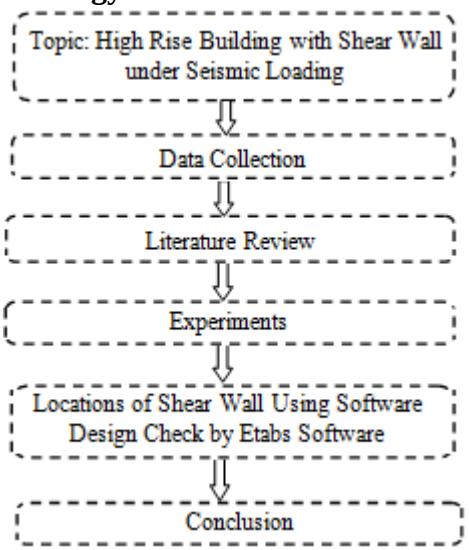
superior performance concerning ductility, strength, stiffness, and energy dissipation. This paper was concluded that the provision of dowel as shear reinforcement in the precast shear wall – slab join. Region would be effective in high risk seismic region.

15) O. Esmaili. S. Epaekachi et al studied most appropriate structural forms are shear wall and tube structure, which have caused height of concrete building to be soared. In this paper author has discussed the structural aspects of one of the tallest building, with 56 stories. The structural aspects of high rise building with shear located in high seismic zone are studied. Some special aspects of high rise building of seismic load bearing system with considering some important factor are discussed in this paper. Effect of shear wall ductility is also discussed. It is concluded that a level of ductility for seismic bracing should be provided for energy absorption but there is an adverse effect on axial loads and this fact should be considered while designing the building. Shear walls for both gravity and bracing system is unacceptable neither conceptually nor economically.
16) B. Ramamohna Reddy, M. Visweswara Rao studied a an institute building which is often subjected to vibrations produced from the nearby quarry. Necessary precautions against vibration should be taken because if any earthquake happens there may be huge loss of life and property. Shear walls are the easiest way to provide resistance to vibrations and very easy to design. The building is designed by using STAAD PRO software. Reinforcement detailing of shear wall and bending moment and shear force for 8 bays are done. In this paper it is concluded that shear wall and its provided location for studied building will take care of earthquake load and make building earthquake resistant. Reinforcement and existing dimensions of columns and beams of building are sufficient to care of the strength requirements developed due to dead loads, seismic loads and live loads. Whenever an opening is expected the bar diameter is increased and lateral ties are provided inside the wall to replace the lintel beam for extra stability.
17) Mahdi Hosseini and N. V. Ramana Rao studied a forty storey building in zone V for earthquake using Etabs software. To ensure the adequate lateral load carrying capacity two methods are used for the earthquake analysis of building. To study the behavior of reinforced concrete building by dynamic analysis and location of shear walls with openings and without openings. In dynamic analysis Response Spectrum Method is used. Special design check is required for net cross sectional area of wall. Symmetrically located shear walls reduces ill-effect of twist in building. Size and location of building may vary from architectural and functional point of view, but center window openings are more suited then eccentric window openings and door openings. It is concluded that shear walls located along the exterior perimeter are more effective. Approximately 5% of deviation may result in presence of openings in shear wall. Centre window openings can be provided. Displacements, drifts and base shear values are in the range of 5%, so provision of shear wall with openings can be economical.
18) Hamdy. H. A. Abd-el-Rahim and Ahmed And EI-Raheem Farghaly concluded that building with shear wall and raft foundation projection is the most reliable system in resisting the accidental forces. By substantially decreasing the base shear in the column, effectiveness of shear wall is achieved due to which 50% of base shear is reduced. In raft there is increase in bending moment in both direction and in column there is distribution of seismic forces. Projection in raft foundation reduces internal forces in raft, but attention should be given to the corner columns because it produces enormous base shear. Shear wall and projection of raft proved to be highly advantageous in high rise building resting on weak soil.
19) D. W. Gawatre studied different irregularities in the plane and vertical direction and irregularities and torsional response by cross-sectional shape analysis L-shaped building for calculating additional shear during seismic force and twisting Column. This study was started to quantify the effects of irregularities of varying degrees. A structure designed for earthquakes with simplified analysis. The kind of irregularity considered (A) Horizontal irregularities Reentrant corners (b) Vertical irregularities Mass irregularities and concluded that re-entrant corner columns are needed to be stiffened for shear force in the horizontal direction perpendicular to it as significant variation is seen in these forces.

Objectives

1) To study the location of shear wall in high rise building.
2) Comparison between building with shear wall and without shear wall by software analysis.
3) To study the design consideration for shear wall.
   - Thickness
   - Reinforcement
   - Rigidity of shear wall
4) The effect of types of shear wall on structural response under seismic loading.
   - Simply rectangular type and the flange wall.
   - Coupled shear wall.
   - Shear wall with opening.
   - Core type shear wall.

3. Methodology



4. Conclusion

This paper discussed about various aspects of performance of shear wall presented by many of the investigators. The following suggestions were given to improve the performance of shear wall:

- Structure with shear wall at appropriate location is more important while considered displacement and shear.
- Shear walls with openings experienced decrease in terms of strength.
- Structure with shear walls placed symmetrically will show better results in terms of all the seismic parameters when compared with the structures
- Best location of shear wall is building with shear walls at corners on each side on inner side.
- Shear wall is more efficient and economical as compared to other structural elements.
- The precast shear wall is more effective than modular construction.
- The provision of dowel as shear reinforcement in the precast shear wall – slab join. It is more effective in high risk seismic region.
- Symmetrically located shear walls reduces ill-effect of twist in building.

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