International Journal of Scientific Research & Engineering Trends
Volume 9, Issue 1, Jan-Feb-2023, ISSN (Online): 2395-566X

A Review On Multistoried Earthquake Resistant Building

M.Tech. Scholar Shyam Kumar, Prof. Afzal Khan
Department of Civil Engineering
Millennium Institute Of Technology And Science, Bhopal

Abstract- The economic growth and rapid urbanization in hilly region has accelerated the real estate development and resulted in increase in population density in the hilly region enormously. Therefore, there is popular and pressing demand for the construction of multi-storey buildings in that region. A scarcity of plain ground in hilly area compels the construction activity on sloping ground. Hill buildings behave different from those in plains when subjected to lateral loads due to earthquake. Such buildings have mass and stiffness varying along the vertical and horizontal planes, resulting the centre of mass and centre of rigidity do not coincide on various floors. Also due to hilly slope these buildings step back towards the hill slope and at the same time they may have setback also, having unequal heights at the same floor level the column of hill building rests at different levels on the slope.

Keywords- Multistorey, Earthquake Resistant Building, rapid urbanization.

I. INTRODUCTION

The economic growth and rapid urbanization in hilly region has accelerated the real estate development and resulted in increase in population density in the hilly region enormously. Therefore, there is popular and pressing demand for the construction of multi-storey buildings in that region. A scarcity of plain ground in hilly area compels the construction activity on sloping ground. Hill buildings behave different from those in plains when subjected to lateral loads due to earthquake. Such buildings have mass and stiffness varying along the vertical and horizontal planes, resulting the centre of mass and centre of rigidity do not coincide on various floors. Also due to hilly slope these buildings step back towards the hill slope and at the same time they may have setback also, having unequal heights at the same floor level the column of hill building rests at different levels on the slope.

The seismic response of multi-storey buildings can be improved by incorporating a shear wall. Shear walls systems are one of the most commonly used lateral load resisting systems in high-rise buildings. Shear walls have very high in plane stiffness and strength, which can be used to simultaneously resist large horizontal loads and support gravity loads, making them quite advantageous.
Adequate stiffness is to be ensured in high rise buildings for resistance to lateral loads induced by wind or seismic events. Reinforced concrete shear walls are designed for buildings located in seismic areas, because of their high bearing capacity, high ductility and rigidity.

In high rise buildings, beam and column dimensions work out large and reinforcement at the beam-column joins are quite heavy, so that, there is a lot of clogging at these joints and it is difficult to place and vibrate concrete at these places which does not contribute to the safety of

buildings. These practical difficulties call for introduction of shear walls in High rise buildings. Buildings engineered with structural walls are almost always stiffer than framed structures, reducing the possibility of excessive deformation and hence damage. RC multi storied buildings are adequate for resisting both the vertical and horizontal load. When such buildings are designed without shear walls, beams and column sizes are quite heavy. Shear walls may became imperative from the point of view of economical and control large deflection. Lateral forces, that is, the forces applied horizontally to a structure derived from winds or earthquakes cause shear and overturning moments in walls.

The shear forces tend to tear the wall just as if you had a piece of paper attached to a frame and changed the frame's shape from a rectangle to a Parallelogram. The changing of shape from a rectangle to parallelogram is referred to as racking. At the end of shear walls, there is a tendency for the wall to be pushed down at the end away from the force. This action provides resistance to overturning moments. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important to have sufficient strength for the structure against vertical loads. Earthquake and wind forces are the only major lateral forces that affect the buildings. The function of lateral load resisting systems or structure form is to absorb the energy induced by these lateral forces by moving or deforming without collapse. The determination of structural form of a tall building or high rise building would perfectly involve only the arrangement of the major

structural elements to resist most efficiently the various combinations of lateral loads and gravity loads.

The taller and more the slender a structure, the more important the structural factors become and the more necessary it is to choose an appropriate structural form or the lateral loading system for the building. In high rise buildings which are designed for a similar purpose and of the same height and material, the efficiency of the structures can be compared by their weight per unit floor area.

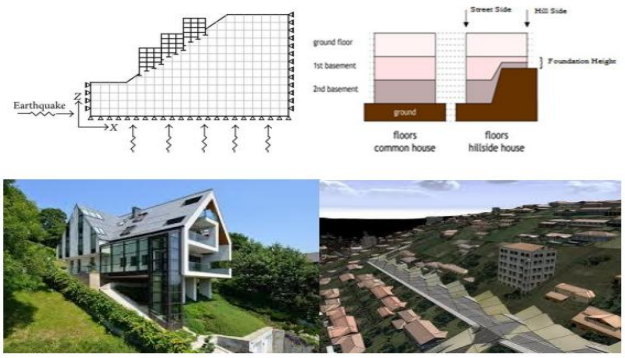


Figure 1: Buildings on sloping ground

1. Shear Wall In Rcc Building

Shear wall is defined as vertical structural member who can resist a combination of moment, shear and axial load induced by gravity load and lateral load transfer to the wall from other structural member. RCC walls including shear walls are the usual multi-Storied Buildings requirements. Coinciding centroid and mass centre of the building during design is the ideal for a Structure. An introduction to shear wall represents a most efficient solution to stiffen a structural system of building as the main function of a shear wall is to increase the lateral load resistance. Cross-sections of Shear walls can be used are rectangular shapes to more irregular cores such as channel, T, L, barbell shape, box etc. The use of shear wall structure is gaining popularity day by day in high rise building, especially in the construction of service apartment or office/ commercial tower. It has been proved, that shear wall system is efficient structural system for multi storied building in the range of 30-35 storeys.

Shear Walls are uniquely composed structural walls incorporated in the buildings to restrict horizontal forces that are convey in the plane of the wall due to wind, earthquake and distinctive forces. They are fundamentally flexural members and normally gave in high rise structures to avoid the total fall of the tall structure under the seismic forces. Walls can be designed as plain concrete walls when there is only compression with no tension in the section. else, they should be composed as reinforced concrete walls. The value of the Shear Walls in the confining of structures has sometimes been recognized. At the point when arranged in favourable places of structures, they give an sufficient power to oppose horizontal force resisting system, while at the same time satisfying other functional requirements.

For structures up to 20 stories the utilization of shear walls is a decisions matter. For structure is more than 30 stories, shear walls may become basic from view point of economy and avoid of lateral deflection, Because a vast part of side long force on the structure and the lateral shear force usually from it is often assigned to such structural walls is known as “Shear Walls”. Shear walls are behaves like vertical oriented wide beams that convey earthquake forces downwards to the establishment. That is the reason, it is always suitable to reliable them in structure built in regions likely to earthquake of high amount of intensity or large winds.

Shear walls are provided to resist horizontal earthquake forces and to increase the rigidity of building. When shear wall has enough strength, it will transfer the horizontal forces to the next element in load path below. These elements in the load path may be another shear walls, slabs, floors, foundation walls, or footings. The stiffness of shear wall will prevent floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff, usually suffer less non-structural damage. Reinforced concrete (RC) buildings usually have vertical plate-like RC walls known as Shear Walls (Figure2) additionally to slabs, beams and columns.

These walls typically begin at foundation level and square measure continuous throughout the building height. Their thickness will be as low as 150mm, or as high as 400mm in high rise buildings. The overwhelming success of buildings with shear walls in resisting robust earthquakes is summarised within the quote: “We cannot afford to make concrete buildings meant to resist severe earthquakes while not shear walls.” Mark Fintel, a noted consulting engineer in USA.

RC shear walls give massive strength and stiffness to buildings within the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces harm to structure and its contents. Since shear walls carry massive horizontal earthquake forces, the overturning effects on them area unit massive. Shear walls in buildings should be symmetrically located in decide to cut back ill-effects of twist in buildings. They may be placed symmetrically on one or each directions in arrange. Shear walls area unit more effective.

Shear walls should give the mandatory lateral strength to resist horizontal earthquake forces. Once shear walls square measure strong enough, they'll transfer these horizontal forces to future part within the load path below them. These alternative components within the load path are also other shear walls, floors, foundation walls, slabs or footings. Shear walls additionally give lateral stiffness to prevent the roof or floor on top of from excessive side-

sway. Once shear walls square measure stiff enough, they'll stop floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff can sometimes suffer less non-functional damage.

2. Advantages Of Shear Walls In Rc Buildings

Properly designed and detailed buildings with shear walls have shown very good performance in past earthquakes. The overwhelming success of buildings with shear walls in resisting strong earthquakes is summarized in the quote: "we cannot afford to build concrete buildings meant to resist severe earthquakes without shear walls." Mark fintel, a noted consulting engineer in a shear walls in high seismic regions requires special detailing. However, in past earthquakes, even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse. Shear wall buildings are a popular choice in many earthquake prone countries, like Chile, New Zealand and USA. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and non-structural elements (like glass windows and building contents).

3. Structural Forms Or Types Of Shear Walls

Monolithic shear walls are classified as short, squat or cantilever according to their height to depth ratio.

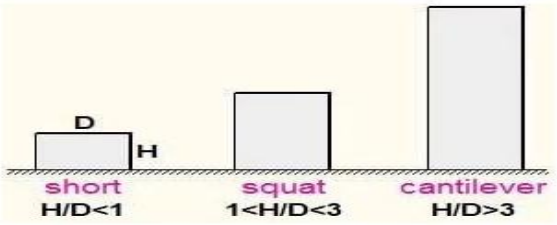


Fig. 2 Shear wall types

Generally shear walls are either plane or flanged in section, while core walls consist of channel sections.

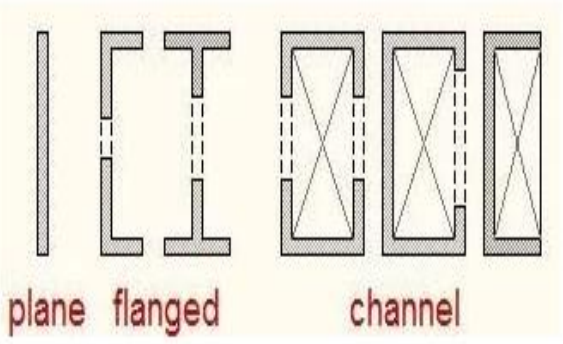


Fig.3 Shear wall channels.

In many cases, the wall is pierced by openings. These are called coupled shear walls because they behave as individual continuous wall sections coupled by the connecting beams or slabs.

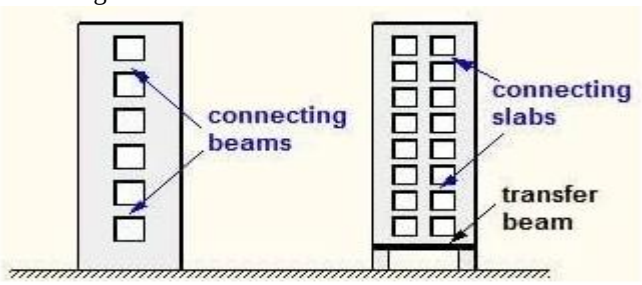
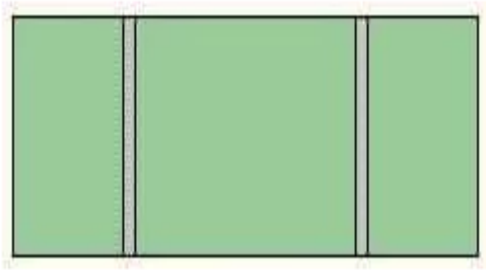


Fig. 4 Connecting shear walls.

Normally the walls are connected directly to the foundations. However, in a few cases where the lateral loads are relatively small and there no appreciable dynamic effects, then they can be supported on columns connected by a transfer beam to provide clear space.

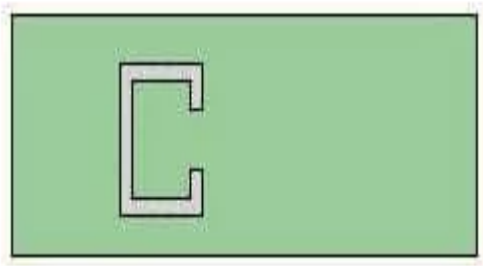
4. Location Of Shear Walls In A Building

The shape and plan position of the shear wall influences the behaviour of the structure considerably. Structurally, the best position for the shear walls is in the centre of each half of the building. This is rarely practical, however, since it dictates the utilization of the space, so they are positioned at the ends.



(a)

This shape and position of the walls give good flexural stiffness in the short direction, but relies on the stiffness of the frame in the other direction. This arrangement provides good flexural stiffness in both directions, but may cause problems from restraint or shrinkage. As does this arrangement with a single core, but which does not have the problem from restraint of shrinkage.



(b)
Fig. 5 Location of shear wall.

However, this arrangement lacks the good torsional stiffness of the previous arrangements due to the eccentricity of the core.

II. LITERATURE REVIEW

Hamdy et al. (2022) 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.
B. Ramamohna Reddy, M. Visweswara Rao (2022) 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.

B. Ramamohna Reddy (2022) 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.

N. K. Meshram, Gauravi M. Munde (2018) Looking to the past records of earthquake, there's increase within the demand of earthquake resisting building which might be consummated by providing the shear wall systems within the building. Additionally attributable to the foremost earthquakes within the recent pats the codal provisions revised and implementing additional weightage on earthquake style of structure. Usually shear wall will be outlined as structural vertical member that's ready to resist combination of shear, moment and axial load iatrogenic by lateral load and gravity load transfer to the wall from different support. Ferro concrete walls, that include raise wells or shear walls, square measure the standard needs of Multi structure Buildings.

III. CONCLUSION

R.C.C building can significantly resist bothvertical and horizontal load. In order to resist the highervalues of seismic forces in a multi storied building theshear walls which are lateral load resisters should beintroduced in a building. Shear walls are defined as verticalplate like reinforced concrete wall are introduced in abuilding in addition to beam column and slab. The shearwalls are mainly incorporated in a building to resist thelateral loads and to support the gravity loads. The overallbehaviour of the building is mainly influenced bypositioning of shear wall and the reinforced shear wall highin plane stiffness. It is very important to position the shearwall in an ideal location for effective and serviceableperformance of building.

From the study of literature presented in this paper, conclusions are drawn out on the responses of shear walls with and without openings in multi storey buildings as,Changing the position of shear wall will affect the attraction of forces, so that wall must be in proper position. If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall. Providing shear walls at adequate locations substantially reduces the displacements due to earthquake. Although shear capacity and lateral stiffness of the shear wall are reduced because of the openings, the ductility and energy-dissipation capacity can be improved and the seismic behaviours of the shear wall influenced by the frame constraint, the size, the location of opening etc. The shear wall located at core of building gives deflection in permissible limit but maximum base shear. So, it is more vulnerable to earthquake.

Storey drift of building provided with openings in shear wall is greater than shear wall without openings. Time

period is directly proportional to the openings in shear wall. As area of openings increases in shear wall, time period is also increases. Frequency decreases with increase in openings. Base shear is relatively less for shear walls with openings than shear walls without openings. The ductility and shear strength of the shear wall with openings is highly affected by reinforcement provided around openings. Compared with common shear wall, the researches on prefabricated composite shear wall with boundary frames and openings are relatively less.

REFERENCES

[1] Asnhuman.S, DipenduBhunia, Bhavin Ranjiyani (2011), "Solution of shear wall location in multi-storey building" International Journal of Civil and Structural Engineering Research.

[2] Shaik Kamal Mohammed Azam, Vinod Hosur (2013), "Seismic performance evaluation of multistoried RC framed buildings with shear wall." Journal of Scientific & Engineering Research, Volume 4, Issue 1.

[3] P.P.Chandurkar, Dr.P.S.Pajgade (2013), "Seismic analysis of RCC building with and without shear wall." International Journal of Modern Engineering Research, Vol.3.

[4] Chaitanya Kumar J.D., Lute Venkat (2013), "Analysis of multi storey building with precast load bearing walls" International Journal of Civil and Structural Engineering, Volume 4.

[5] Lakshmi K.O., Jayasree Ramanujan, Bindu Sunil, LajuKottallil, Prof. Mercy Joseph Poweth (2014), "Effect of shear wall location in buildings subjected to seismic loads." ISOI Journal of Engineering and Computer Science.

[6] M.S. Aainawala, Dr. P.S. Pajgade (2014) "Design of multistoried R.C.C. buildings with and without shear walls." International Journal of Engineering Sciences and Research Technology.

[7] Tarunshrivastava, Prof. Anubhav Rai, Prof. Yogesh Kumar Bajpai (2015), "Effectiveness of shear wall-frame structure subjected to wind loading in multi-storey building." International Journal of Computational Engineering Research, Vol.5.

[8] Mohd Atif, Prof. LaxmikantVairagade, Vikrant Nair (2015), "Comparative study on seismic analysis of multi storey building stiffened with bracing and shear wall" International Research Journal of Engineering and Technology, Vol. 2.

[9] Prasad Ramesh Vaidya (2015), "Seismic analysis of building with shear wall on sloping ground" International Journal of Civil and Structural Engineering Research, Vol.2.

[10] Jamal Ali, Abdul Qadir Bhatti, Mansoor Khalid, Junaid Waheed and Shaqran Zuberi (2015), "Analyze the effectiveness of shear walls in controlling lateral drift for medium to high rise structures (10 – 25 Storeys)." International Conference on Geological and Civil Engineering.

[11] Sunil Kumar Kalyani, Vishwanath. B. Patil (2015), Effect of Shear Wall Sections on Multi-storey Building with Satellite Bus-Stop having Floating Columns with Top Soft Storey, International Journal for Innovative Research in Science & Technology, Volume 2, Issue 02, pp. 169-174.

[12] MD Afroz Patel, Shaik Abdulla (2016), A Study on Positioning of Different Shapes of Shear Walls in L Shaped Building Subjected to Seismic Forces, International Journal of Engineering Research & Technology, Vol. 5 Issue 07, pp.480-487

[13] Dr.MD. Subhan (2016), Design of Shear Walls in Response Spectrum method and to Study Effect of Vertical Stiffness Irregularity on Multi-Storey, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Special Issue 9, 927-934.

[14] Sumanth G, Vasantha. (2016), Comparative Seismic Behaviour Analysis Of Structure With Shear Wall At Different Locations, International Research Journal of Engineering and Technology, Volume: 03 Issue: 08, 413-419.

[15] N. K. Meshram, Gauravi M. Munde (2018), Seismic Analysis of Shear Wall at Different Location on Multi-storey RCC Building, International Journal of Interdisciplinary Innovative Research & Development, Vol. 02 Issue 02,7-28.

[16] S. P. Sharma, J. P. Bhandar (2015), Literature Review on the Seismic Performance of Multi-Storey Building with Different Locations of Shear Wall and Diagrid, International Journal of Science and Research, Volume 6 Issue 6, 583-590.

[17] T. Gouthami, Dr. K. Rajashekar (2017), The Behaviour of Shear Wall of High-Rise Building, Under Seismic Load by Adopting Linear Dynamic Analysis, International Journal of Scientific Engineering and Technology Research, Vol.06, Issue 31, 1-6.

[18] Devipriya. J, Hariprasad T R (2014), Seismic Analysis of an Irregular Building With Shear wall at Different Locations, International Journal of Recent Engineering Research and Development, Volume No. 02 – Issue No. 05, 34-40.

[19] SoundariyaTumane, Vinay Mehta (2018), A Study on Time History Analysis of High Rise Building with Infill Panels, International Journal for Research in Applied Science & Engineering Technology, Volume 6 Issue 6, 369-378.

[20] S K Hirde, N K Shelar (2015), Effect of Positioning of RC Shear Walls on Seismic Performance of Buildings Resting on Plain and Sloping Ground, International Journal of Current Engineering and Technology, Vol.5, No.3, 1659- 1665.

[21] Mahdi Hosseini, N.V. Ramana Rao (2016), Seismic Analysis of Multi-Storey Building Structure with Shear Walls at the Center Core and Center of Each

Side of the External Perimeter, International Journal of Engineering and Management Research, Volume-6, Issue-6, 60-70.