International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 08, August-2018

REVIEW PAPER ON SEISMIC ANALYSIS AND BEHAVIOUR OF MULTI-STOREY RC BUILDING WITH AND WITHOUT SHEAR WALLS

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Abstract — ***Earthquakes are unpredictable devastating natural disasters which are caused due to movement in the earth's crust. These causes sudden intense shaking of ground and formation of seismic waves. These seismic waves can cause huge devastation to structures. As a matter of fact, most deaths that are caused by earthquakes are due to structure collapse. So, there must provide special attention to improve seismic performance of buildings. Shear walls are one of the most widely used lateral load resisting systems. The provision of shear walls at adequate locations improves seismic performance of buildings. Shear walls are very useful in buildings as they not only provide stability to the structure but also reduces displacements, drifts and bending in structural members. The placement and type of shear wall that should be provided is a major concern in seismic behavior of buildings. In this review paper, we have studied and summarized research work of various researchers regarding seismic behavior of multi-storey buildings with and without shear walls. The various factors which affects seismic behavior of buildings are studied from literature and other sources. The scope of study is to find out comparative between normal buildings and shear wall buildings with investigation of effect of changing shear wall location in multi-storey buildings.***

Keywords- Earthquakes, Seismic performance, Shear walls, Displacements, Storey-drift.

I. INTRODUCTION

Earthquakes are natural disasters as they can occur at any time and place. These can cause tremendous damage to structures. The occurrence, intensity and location of earthquakes are very difficult to predict. The buildings are usually designed to bear dead loads, live loads, wind loads etc. so these are not safe against seismic loads caused due to earthquakes. Due to this there is need of lateral load resisting systems that can sustain these lateral loads and save the structure from being damaged. Nowadays taller buildings are constructed rapidly in the world as they are more slender and sway than earlier buildings. Taller buildings are affected by higher values of seismic forces caused by earthquakes and wind loads. These lateral forces acting are a matter of concern, as these can deform or collapse the structure. So there is a need to adopt such systems which can resist these lateral forces and loads. There are different lateral load resisting systems that are used in buildings to resist lateral loads. Some commonly adopted methods involve use of moment resisting frames, brace frame, shear walls etc. The earthquake analysis is done by using various methods. The seismic analysis type that should be used for analysis depends upon various factors such as– external action, the type of structural model selected, the behaviour of structure and structural materials. The different analysis methods for earthquake analysis are static and dynamic analysis. These include linear and non–linear analysis procedures. In this review paper, seismic behaviour of multi-storey building with different location of shear walls is studied.

According to IS code 1893 part-I:2002 "criteria for earthquake resistant design of structures" is to ensure that structures can bear-

- Minor earthquakes that occur frequently without damage.

- Moderate earthquakes without structural damage as non-structural damage may occur and

- In case of major earthquakes, the structure can resist it without collapse.

A. Building configuration-

According to IS 1893 (Part 1):2002 buildings possess following types of configurations-

1. Regular Configuration

2. Irregular Configuration

1. Regular configuration-

A building is said to be regular if it possesses simple regular geometry and uniformly distributed mass and stiffness in plan as well in elevation. Regular buildings suffer less damage as compared to buildings with irregular configurations. Regular buildings have no physical discontinuities in plan or vertical configuration or in their lateral force systems. The regular building configuration is shown in fig 1.

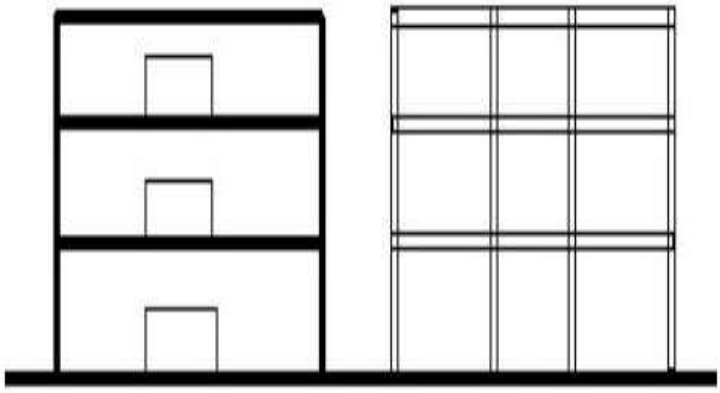

Fig 1. Regular building configuration

2) Irregular Configuration-

A building is said to be irregular if it possesses physical discontinuities in plan or in vertical configuration. A building with irregular configuration contains either plan irregularity or vertical irregularity. Some of common irregularity types are- torsion irregularity, stiffness irregularity, mass irregularity, vertical geometric irregularity etc. Some of the plans of irregular type building configuration is shown in fig 2.

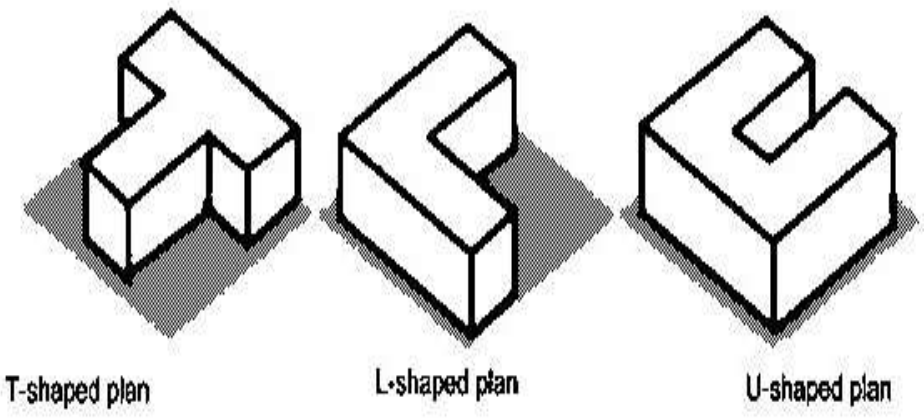

Fig 2. Irregular building configuration

B. RC Shear walls-

The use of shear walls is most common in buildings nowadays. These are mainly constructed from foundation level and their thickness lies between 150-400mm. A shear wall is generally a large reinforced concrete wall or a column with large dimensions. These are constructed in order to resist large lateral loads and displacements that are being caused to the structure due to earthquake loads. Shear walls are useful as they provide stability and lateral stiffness to the structure. Shear walls plays an important role in reducing lateral sway of the building. Shear walls with varying cross-sections such as- T, L, Barbell etc. can also be used. The construction of shear walls requires proper designing and detailing in higher seismic regions. Therefore, the location of shear wall is such that it should be efficient and effective. The shear walls restrict the drift of structure and prevents it from collapsing. Thus, a structure with shear wall performs better during

seismic loading. Figure 3 shows an RC multi-storey building with shear walls. The various structural members like column, slab, beams, shear walls are shown in figure 3.

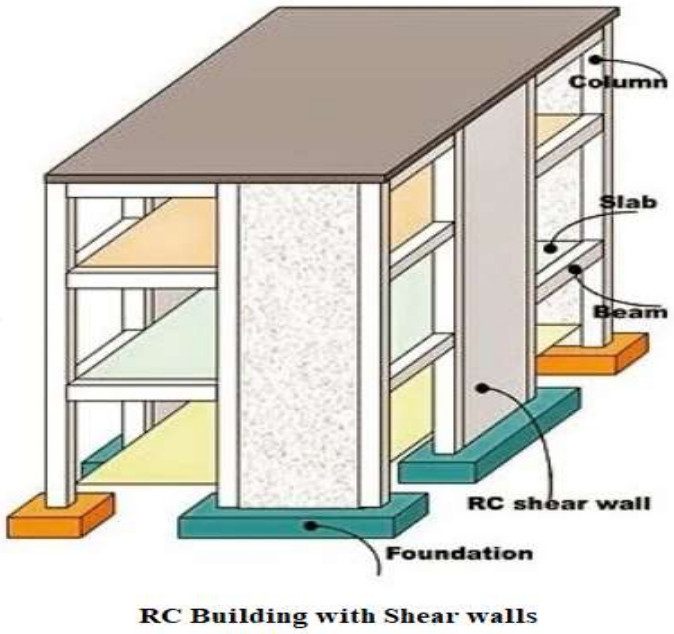

Fig 3. Multi-storey RC building with shear walls

C. Functions of shear walls and advantages-

Shear walls perform an important role in improving seismic performance of buildings. In fig 4 the main functions of shear walls are shown, which are as follows-

1)Shear walls strengthens the building and provides strength to resist lateral shear.

2)These makes structure stiffer to lateral loads and reduce lateral sway of building thus reduces damage to the structure during earthquake attacks.

3) Shear walls reduce moments and induced torsion during earthquakes.

Shear walls are advantageous in buildings as these are easy to construct, lightweight, cost effective and minimizes damage to the structural elements. Shear walls makes structure more stable. These also resists force of wind that exerts pressure on walls.

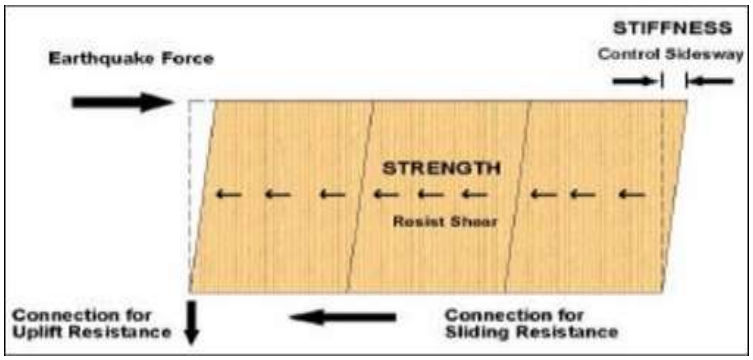

Fig 4. shear wall functions

II. LITERATURE REVIEW

AshishS. Agarwal and S.D. Charkha (2012)- This study represents analysis of 25 stories building in zone-V by changing various positions of shear walls to determine parameters like story drift, axial load and displacements. The analysis is done using standard package ETABS. From the analysis it has been concluded that member forces increases as we place shear wall away from center of gravity. The displacement reduced at story 25 due to presence of shear wall at

Centre. The story drift increases as there is increase in height of building and reduced for top floor. The static and dynamic axial load on the column is affected by Shear wall location. The building shows uni-directional displacement for all the grids in seismic loading. As there is increase in eccentricity, the building shows non-uniform movement for right and left edges of roof due to torsion, excessive moment and force gets induced in member.

Ehsan Salimi Firozabad et.al in (2012)- In this paper the main aim is to determine the shear wall configuration effect on seismic performance of buildings. Dynamic analysis procedure is adopted and method of analysis is Time history method. The comparison of top storey displacements for various models with shear wall is done in this paper. The design of models is according to IS codes and modeling is done using SAP 2000. Four buildings with different number of stories and with six different configurations of shear wall in zone-V is considered for analysis. It has been concluded that the different position of shear wall reduces the top story drift at least twice than other floors. The maximum drift of 0.004 is satisfied for the buildings according to IS codes. This also stated that by providing more shear wall, it will not guarantee better seismic behavior of buildings.

Prof. S.S.Patil et.al in (2013)- In this study high- rise building with different lateral load resisting system is analyzed by Equivalent static method. The study is done on G+ 14 stories building in zone-IV. A parametric study have been carried out for bare frame, brace frame and shear wall frame. The brace frame and shear wall frame contain four cases each. Brace frame models are- Bracing at exterior frame of Z direction, in X-direction, both X and Z direction and at end corners of both X and Z direction throughout height respectively. While shear wall models are- Shear wall at exterior frame of Z direction, In X direction, In both X and Z direction and at end corners of X and Z direction throughout height respectively. The conclusions showed us that decrease in story drift and in time period has been observed in models 2 and 3 for both brace frame and shear wall frame. Base shear is more for models 2 and 3 for both brace frame and shear wall frame. The shear wall located at exterior frame of X and Z direction is found to be most effective.

P. P Chandurkar and Dr. P. S. Pajgade (2013)- In this study seismic analysis of RCC building with and without shear wall is done. The modeling is done using ETABS non-linear v 9.5.0. Four models were studied with different positions of shear walls. The models are studied in all four earthquake zones. The comparison is done in terms of lateral displacement, story drift, concrete quantity required, steel and total cost required in all zones for all models. It has been observed that in 10-storey building shear wall in short span at corner is more economical and large dimension of shear wall is not effective in 10-storey or below 10-storey buildings. Providing shear walls at adequate positions reduces the displacements due to earthquakes. It has been also stated that by providing large dimensional shear wall major amount of horizontal forces are taken by it.

K. Rama Raju et.al in (2013)- This study involves limit state method of analysis for G+40 storey high-rise building under wind and seismic loads as per IS codes of practice. The response spectrum method is used for seismic analysis and wind load analysis is done using gust factor method. The building is modeled using STAAD.Pro software. According to paper the safety of building is checked against allowable limits for base shear, accelerations, storey drifts etc. The structure is found to be wind and earthquake sensitive and roof displacement and inter storey drifts exceeds the limits prescribed. While designing, some of the beams and column sections, the limit on maximum percentage of reinforcement in the member is exceeding the maximum percentage of reinforcement in the member. To satisfy these limits, increase in grade of concrete from M35 to M60 has been suggested.

Varha R Harne (2014)- In this study G+5 multi-storey building has been selected located in Nagpur city. The analysis is done using STAAD.Pro software. The models were prepared using different cross sections of RC shear walls, the various cases involve box type, L-type and cross type shear wall located at various locations such as- along periphery, at corners and at middle positions. It has been concluded that the lateral deflection in columns and top deflection in building gets reduced by providing L-type shear walls as compared to other models. The load combination of 1.5DL+1.5EQX is most critical combination for all models. The study concluded that shear wall at corners is more efficient than all other types.

M. Ashraf et.al in (2008)- This study is carried out on 25 storey building in order to determine the optimum configuration for changing shear wall location. The modeling is done using standard package ETABS v 9.5.0. Four different cases of shear walls with different locations are considered in this study. These models include- shear wall at center of building, shear wall at 25ft. from centroid, shear wall at 50ft. from centroid and shear wall at 75ft. from centroid in X-direction each. The method used in this analysis is finite element method. By analyzing the different models it has been concluded that shear wall placement should be such that the center of gravity of building and centroid of the building coincides. Shear wall placement away from center of gravity leads to increase in member forces. The torsion in beams and columns increases with enhancement in eccentricity of shear walls. By comparing forces induced in shear walls it has been concluded that eccentricity have major impact on shear walls.

Vikas Govalkar et.al in (2014)- In this research paper the effectiveness of RC shear wall in medium-rise building has been studied. The two system that are considered in the study are bare frame system and infilled bare frame system respectively. Four bare frame and four infilled bare frame models with different shear wall positions are taken for analysis. The analysis has been done on software STAAD.Pro. The comparison has been done for storey drift and axial

force in columns. The study concluded that shear wall systems are very effective in resisting lateral forces. The infilled frame type system is more economical than bare frame system. The storey drift reduces more in infilled bare frame system than bare frame system when shear walls are provided. The provision of shear walls reduces axial force in column effectively.

III. CONCLUSIONS

In this paper, we have studied various literatures and research papers regarding seismic behavior of multi-storey RC buildings with and without shear walls. It has been observed that different researchers considered different problems and structural elements regarding lateral load resisting systems in multi-storey buildings. However, the provision of shear walls in multi-storey buildings has been considered more prominent to resist lateral loads. The different studies involve building models with shear walls at different positions. It has been seen that providing shear walls the seismic behavior of buildings gets improved. The building with shear walls undergo less story drift, lateral displacements, bending moments and deflection as compared to building without shear walls due to earthquake loading. The building without shear walls suffer more damage to structural elements during seismic attacks. The shear wall buildings are more stable and stiffer than normal buildings. Some of the paper studies concluded that shear walls located at exterior frame found to be most effective in resisting lateral loads as it shows least deflection. Some studies concluded that providing shear walls at corners in L-shape gives better seismic performance than all other shear wall positions and it also reduces lateral defection of columns. Some studies claimed that shear walls at periphery gives suitable results for storey drifts than other shear wall positions. By reviewing all literatures, it has been concluded that shear walls are better option in multi-storey buildings for lateral load resistance. However, the most effective and economical position in multi-storey building has been disputed, which require further research. The future scope of this review paper involves comparative on seismic performance of multi-storey building with varying shear wall positions and to identify optimum shear wall position. This will help us in minimizing ill effects of earthquakes and boosts the confidence of structural engineers.

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