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A Research on Comparing the Seismic Effect on Shear wall building and Without- Shear Wall Building – A Review

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Abstract – Earthquakes are most volatile and distressing of all natural disasters. Amongst all methods applied for earthquake resistant multi storied structures shear walls are the most adopted. Shearwall is a structural component located at different places in a building from foundation level to top parapet level, used to defend against lateral forces i.e parallel to the plane of the wall. Shear walls are structural members which are used to avert lateral forces due to earthquake and wind. In this paper review of different researchers on the concept of multistoried building with and without shear wall is paraphrased. In India, most adopted type of earthquake resistant structures is with shear wall. These structural walls may differ based on their design and utility and their position in any building plays an important role for resisting lateral force.

Key Words: Shear Wall, Non- Shear wall Building, Earthquake, Lateral Forces etc.

1. INTRODUCTION

Earthquake in general had a long history of deadly devastations in the past. Basically the response of the structure due to ground motion is an essential factor to analyze and design any earthquake resistant structure. The loads or forces which a structure subjected to earthquake motions are called upon to resist, the distortions induced by the motion of the ground on which it rests. Earthquakes can be measured in terms of energy release i.e. measuring amplitude, frequency, and location of seismic waves and also by evaluating intensity i.e. considering the destructive effect of shaking ground on people, structures and natural features.

The properties of a building are lateral stiffness, lateral strength and ductility. Lateral stiffness refers to the initial stiffness of the building, even though stiffness of the building reduces with increasing damage. Lateral strength refers to the maximum resistance that the building offers during its entire history of resistance to relative deformation. Ductility towards lateral deformation refers the ratio of the maximum deformation and the idealized yield deformation. The effect of the vertical component of ground motion is generally considered not to be significant and is neglected except in cantilevers.

1.1 Shearwall and its properties:-

Shearwall is a structural member positioned at different places in a building from foundation level to top parapet level, used to resist lateral forces i.e parallel to the plane of the wall. There are different materials by which shear wall can be constructed but reinforced concrete (RC) buildings often have vertical plate-like Reinforced concrete walls (Figure 1) in addition to slabs, beams and columns. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along both length and width of buildings.

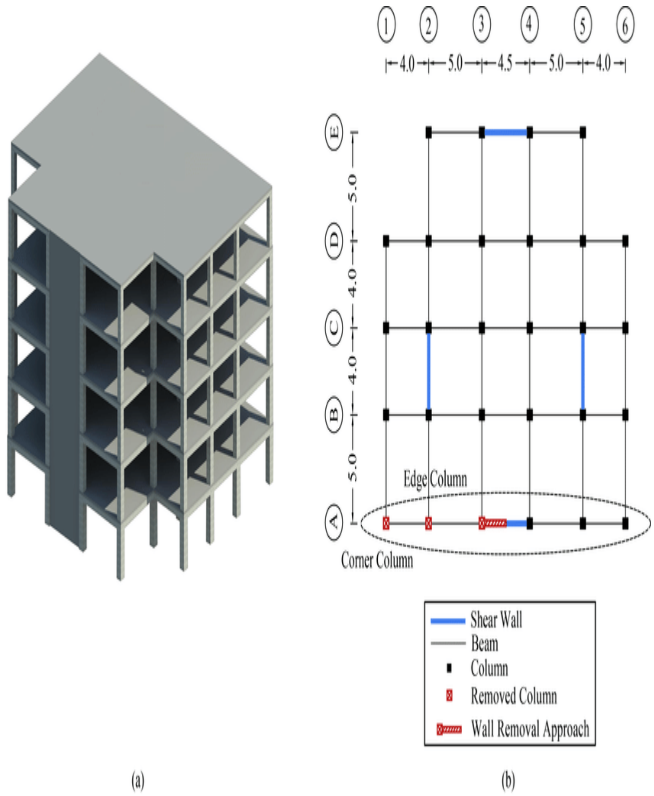

Figure 1:- Shear wall in building

These walls are more important in seismically active zones because during earthquakes shear forces on the structure increases. Shear walls should have more strength and stiffness. Shear walls provide adequate strength and stiffness to control lateral displacements. Shear walls perform dual action that is they as lateral as well as gravity load-bearing elements. Concrete Shear wall buildings are usually regular in plan and in elevation.

1.2 Advantages of Shear Walls in RC Buildings:

- Shear wall resist horizontal lateral force and provide earthquake resistance
- It possess very large in-plane stiffness which resist lateral load
- Shear walls are helpful in controlling deflection.
- RCC shear walls are easy to construct – reinforcement detailing
- It minimizes earthquake damage to structural damage and non-structural damages.
- Well-designed shear walls not only provide adequate safety but also provide great measure of protection against costly non-structural damage during moderate seismic damages.

2. LITERATURE REVIEW

Concrete shear walls are most common and useful type of shear wall for any multistoried building. Many researchers and scholars had researched on the shear wall configuration in any building and types of shear wall. The ability of shear wall to resist lateral forces generated by earthquake and wind force is studied. An effort had been made to study these literatures and conclude over this topic.

Dr.B.Kameshwari et.al[1] analysed the influence of drift and inter storey drift of the structure on various configuration of shear wall panels on high rise structures. The bare frame was compared with various configurations like i) Conventional shear wall ii) Alternate arrangement of shear wall iii) Diagonal arrangement of shear wall iv) Zig Zag arrangement of shear wall v) Influence of lift core shear wall. From the study it was found that Zig Zag shear wall enhanced the strength and stiffness of structure compared to other types. In earthquake prone areas diagonal shear wall was found to be effective for structure.

B. R. Reddy et.al[2] used Stadd Pro software for analysis and design of earthquake resistant structures using Shearwall. According to their research work, **c**onstructions made of shear walls not only provide lateral strength but also increase the strength parameters and effectiveness to bare horizontal loads. Shear walls have a peculiar behavior towards various types of loads. Research work was adopted to the college building of VITS block, Deshmukhi Hyderabad city using shear wall. The building behavior was checked for rigidity factor, reactions, shear center, shear force and bending moment. The solution for shear wall location in multi-storey building based on its both elastic and elas-to-plastic behaviors were also considered. The earthquake load were calculated and applied for the same building of 3 bays and 3 floors. Model results are calculated and analyzed for the effective location of shear wall. After comparing the result it was found that the provision of shear wall in this building will make the structure completely earth quake resistant in zone II of Hyderabad. Further it is also found that the results of manual and STAAD Pro are almost same, the STAAD Pro results saves considerable amount of reinforcement.

P. Chandurkar et.al.[3] investigated about a building with Shearwall and without Shearwall were considered and compared. As per their research work Structural walls provide an efficient bracing system and offer great potential for lateral load resistance. The properties of these seismic shear walls dominate the response of the buildings, and therefore, it is important to evaluate the seismic response of the walls appropriately. According to their study, main focus was to determine the solution for shear wall location in multi-storey building. Effectiveness of shear wall had been studied with the help of four different models. One model was bare frame structural system and other three models were dual type structural system. When earthquake load were applied to the building of ten stories located in zone II, zone III, zone IV and zone V, parameters like Lateral displacement, story drift and total cost required for ground floor were calculated in both the cases replacing column with shear wall. E- Tabs software was adopted for analysis. From the analysis, it is observed that in 10 story building, constructing building with shear wall in short span at corner (model 4) is economical as compared with other models. Thus large dimension of shear wall is not effective in 10 stories or below 10 stories buildings. It was observed that the shear wall is economical and effective in high rise building. From the research work it was observed that changing the position of shear wall will affect the attraction of forces, so that wall must be in proper position. Also 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.

M. D. Kevadkar and P. B. Kodag[4] have done lateral load analysis of R.C.C. Building (G+12) by considering 3 models. Out of this 1st model is without bracing and shear wall, 2nd model with different shear wall system and 3rd Model with Different bracing system the computer aided analysis is done by using E-TABS to find out the effective lateral load system during earthquake in high seismic areas. The performance of the building is evaluated in terms of Lateral Displacement, Storey Shear and Storey Drifts, Base shear and Demand Capacity (Performance point).

Anshuman.S et al.[5] determined the solution for shear wall location in multistory building based on its both elastic and elastoplastic behaviors. An earthquake load is calculated and applied to a building of fifteen stories located in zone IV. Elastic and elastoplastic analyses were performed using both STAAD Pro 2004 and SAP (2000) software packages. Shear forces, bending moment and story drift were computed in both cases and location of shear wall was established based upon the results.

Romy Mohan et al.[6] presented Dynamic Analysis of RCC buildings with Shear Wall. for analysis consider the two multi storey buildings, one of six and other of eleven storeys have been modeled using software package SAP 2000 for earthquake zone V in India. Six different types of shear walls with its variation in shape are considered for studying their effectiveness in resisting lateral forces. This paper also deals with the effect of the variation of the building height on the structural response of the shear wall.

Manoj S. Mendhekar et.al.[7] stated the economic means by which lateral load resistance can be achieved in a multistoried building. In their study, seismic behavior, modes of failure, and factors influencing the structural response of buildings were discussed. Many expressions were developed to estimate the flexural strength of slender rectangular shear wall sections with uniformly distributed vertical reinforcement. In this study various aspects of analysis and design of a shear wall are discussed, also different types of shear wall are discussed with their failure modes. Algebraic expressions for calculating flexural strength of shear wall sections were developed and load-moment interaction diagram were generated using this expressions. The results obtained by both the methods were quite favorable. Also details of coupled shear wall were stated and the difference between solid shear wall and coupled shear wall (shear wall with opening) was studied. Also the relations to calculate the forces in shear wall for its design were shown. From their study it was clear that flanged shear wall sections were further extended for analysis and design and are most suitable.

Syed.M.Katami et.al[8] presented the results of time history analysis which addressed the effect of openings in shear walls near- fault ground motions. A model of ten storey building with three different types of lateral load resisting system: Complete shear walls, shear walls with square opening in the centre and shear wall with opening at right end side were considered. From the results it was observed that shear walls with openings experienced a decrease in terms of strength. The maximum lateral displacement of complete shear wall is 17% less than that of shear walls with openings at centre whose displacement is found to be 8% less than that of shear walls with openings at right end.

Venkata Sairam Kumar.N et.al.[9] reviewed various papers on shear walls and stated that shear walls are structural systems which provide stability to structures from lateral loads like wind, seismic loads. These structural systems are constructed by reinforced concrete, plywood/timber unreinforced masonry, reinforced masonry at which these systems are sub divided into coupled shear walls, shear wall frames, shear panels and staggered walls. The paper was made in the interest of studying various research works involved in enhancement of shear walls and their behaviour towards lateral loads. As shear walls resists major portions of lateral loads in the lower portion of the buildings and the frame supports the lateral loads in the upper portions of building which is suited for soft storey high rise building. Building which are similar in nature constructed in India, as in India base floors are used for parking and garages or officers and upper floors are used for residential purposes. They have concluded with a broad note that researches was carried mainly on application of cyclic load tests and behaviour of different types of shear walls in cyclic application of loads. Researchers studied various parameters like enhancement of stiffness, drift, development forces in buildings and also to observe perfect location of shear wall location in building frame for construction. It was seen that any type of building which is tall and can be affected with lateral forces like earthquake and wind forces can be constructed with shear walls. Shear walls can be used as lateral load resisting systems and also retrofitting of structures. Internal shear walls are more efficient than external shear walls when compared with cyclic load tests by researchers.

Varsha.R.Harne[10] considered a six storey RCC building which is subjected to Earthquake loading in zone II to determine the strength of RC wall by changing the location of shear wall using STAAD.Pro. Seismic coefficient method is used to calculate the earthquake load as per IS 1893 – 2002 (Part I). Four different models like structure without shear wall, structure with L type shear wall, structure with shear wall along periphery, structure with cross type shear wall were modeled for analysis. Compared to other models the shear force and bending moment, for structure with shear wall along the periphery is found to be maximum at the ground level and roof level respectively. Hence the shear wall provided along the periphery of the structure is found to be more efficient than all other types of shear wall.

Bhruguli H. Gandhi[11] researched for the behavior of shear wall with opening under seismic load action. In this research, it is stated that shear walls are generally located at the sides of buildings or arranged in the form of core that houses stairs and lifts. Due to functional requirements such as doors, windows, and other openings, a shear wall in a building contains many openings. In most of the apartment building, size and location of openings in shear wall are made without considering its effect on structural behavior of the building. In this research, study is carried out on 6- story frame-shear wall buildings, using linear elastic analysis with the help of finite element software, StaddPro under earthquake loads in equivalent static analysis. Six different types of models were created and analysed, starting from first, Concentric opening 20%, concentric opening 40%, concentric opening 50%, concentric opening 60%, Eccentric opening 20%, Zigzag opening 20%. The results reveal that stiffness as well as seismic responses of structures is affected by the size of the openings as well as their locations in shear wall. It is also explored that top lateral drift of the system can also be reduced thickening the element in the model around the opening of shear wall. From the research percent of opening increases deflection increases up to 40% in proportion but after that as percentage of opening increases deflection increases more rapidly. For 20% opening Eccentric zigzag has lesser deflection and Eccentric Straight has maximum deflection and concentric loading has less deflection than Eccentric Straight. Also opening increases bottom stresses also increases proportionally up to 40% then after Stresses increases vastly.

S.M. khatami et.al.[12] investigateted the effect of flange thickness on nonlinear behavior of flanged shear walls. Four T-shape flanged shear walls were studied and analyzed using finite element method. The total volume of each model is similar, such that when thickness decreases in the model, the length of wing increases. The results indicated that in the presence of lateral loads, the thickness has a significant effect on the shear absorption, ductility, displacement and crack pattern of the flanged shear walls. Numerical results show that shear walls with thick flanges behave more efficient than walls with thin flanges. It was found that, lateral strength resisted by shear walls with thin flanges is 1250 kN which is 14 percent decrease compared with thick flanged wall. Moreover, nonlinear behavior of flanged shear wall with thick flanges shows that strength and ductility are equivalent. Finally, the analyses indicated that while flange is in pressure, the global behavior is much more improved compared with condition which is in tension. The comparison of models indicated that finite element model used in this study is capable of predicting the nonlinear behavior of the models when these are different thickness. Results of analysis in four models and load- displacement of them indicated that model named -2500TSW had better behavior. It had resisted about 1248 kN. This load is 14% higher than other models. Also, ductility of this model showed a good agreement. Ductility in the model-2500TSW model is 4.58 which is 3% higher than model-3100TSW. Results of analysis showed that model-3100TSW had better strength after yield, which was 18% higher than model-2500TSW. Crack pattern in all of models showed that increase of thickness could decrease crack in shear wall.

3. CONCLUSIONS

From the above study it can be concluded that, different researchers had studied different type of problems related to earthquake and addressed that shear wall are more prominent to resist lateral force due to earthquakes. Analysis by software's such as StaddPro, Etabs etc. are also combined along with manual studies. Models are generated and shear walls are located at different positions in building to find the least displacement of the structure due to shear walls. Openings in shear wall are also an issue of concern of study of shear wall buildings. Generally openings provided in shear walls increase displacement in building. Moreover some researches stated that change in positions of shear wall effect the attraction of forces. Location of shear wall in any building substantially reduces displacements and reduces impact on the structure. Thus building without shear wall is a subject of concern and need to be retrofitted in places of high earthquake and wind impact.

Future scope of studying this type of research work is an essential part of this review paper. Study of effect of shear wall building and without-shear wall building can be studied further by introducing a flange to column. Comparison can be made with a building without shear wall, with shear wall and with column flanges type structure. Moreover placement of shear walls at different locations is an essential aspect to be thought of for further study.

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