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State-of-the Art Review on Performance of RC Shear Wall

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ABSTRACT:
The shear wall is a structural component designed to withstand the lateral forces acting on a structure. These walls are especially of more importance in seismically active regions when shear force on structure increases due to the seismic activity. These walls have more strength, rigidity and resistance to the lateral load which is applied along its height. Buildings with shear wall that are properly designed and detailed have done very good job in the past during seismic activity. Various studies have been conducted on the design of the shear wall and its performance to seismic forces. The present study will review the available literature regarding the design and analysis of reinforced cement concrete shear wall.
Keywords: Shear wall, lateral forces, seismic activity, seismic performance.

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I. INTRODUCTION

Adequate stiffness is very important in high rise buildings to resist the lateral loads brought by wind or seismic events. Reinforced concrete shear walls are designed for buildings located in seismic areas, because of their high strength, stiffness and high ductility. A great portion of the lateral load on a building as well as the shear force resulting from load, are often assigned to structural elements made of RCC. Shear walls have very large in-plane stiffness and hence it can resist lateral load and control deflection very efficiently. Use of shear walls or their equivalent becomes important in certain high-rise buildings, if inter-storey deflections caused by lateral loadings are to be controlled. Properly-designed shear walls not only provide safety but also give a proper measure of protection against costly structural as well as non-structural damage during seismic activity. Shear walls provide large stiffness and strength to buildings, which effectively reduces lateral deformation of the structure and hence reduces damage to structure. The shear wall is one of the essential structural components placed in multi-storey buildings which are situated in earthquake zones as they have large resistance to lateral earthquake forces. RC shear walls should have sufficient ductility to avoid brittle failure under the action of strong lateral earthquake forces. In the present study, various researches were discussed on performance of shear wall based on its location, orientation and materials used for construction.

II. REVIEW OF AVAILABLE LITERATURES

Mr.K.LovaRaju(et.al) conducted nonlinear analysis of frames to identify effective position of shear wall in multi storey building. An earthquake load was applied to eight storey structure of four models with shear wall at different location in all seismic zones using ETABS. Push over curves were developed and has been found the structure with shear wall at appropriate location is more important while considering displacement and base shear

Syed.M.Katami et.al 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.

Dr.B.Kameshwari et.al 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 structures.

Nanjma Nainan et.al conducted analytical study on dynamic response of seismic resistant building frames. The effects of change in height of shear wall on storey displacement in the dynamic response of building frames were obtained. From the study it was concluded that it is sufficient to raise the shear wall up to mid height of building frames instead of raising up to entire height of the building.

Shahzad Jamil Sardar et.al modeled a 25 storey building zone V and analysed by changing the location of shear wall to determine various parameters like storey drift, storey shear and displacement using ETABS. Both static and dynamic analysis was done to determine and compare the base shear. Compared to other models, when shear wall placed at centre and four shear wall placed at outer edge parallel to X and Y direction model showed lesser displacement and inter storey drift with maximum base shear in addition strength and stiffness of the structure has been increased.

Eshan Salimi Firoozabad et.al determined the shear wall configuration on seismic performance of building. The top storey displacements for different configurations were obtained using SAP 2000. From the study it was observed that the top storey drift can be reduced by changing the location of shear wall and it was suggested that the quantity of shear wall could not influence the seismic behavior of buildings.

Varsha.R.Harne 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.

Anuj Chandiwala studied a 10 storey RC building located in seismic zone III which is on medium soil. The different building configurations were

i) Shear wall at end of L section
ii) L Shear wall at junction of 2 flange portion
iii) Two parallel L shear wall at junction of 2 flange portion
iv) Tube type shear wall at junction of 2 flange portion
v) Two parallel shear wall at end of flange portion.

From the analysis, it was observed that compared to other models shear wall placed at end of L section is best suited for base shear since end portion of the flange always oscillate more during earthquake.

Shahabodin. Zaregarizi conducted comparative investigation on using shear wall and infill to improve seismic performance of existing buildings. Static nonlinear analysis was done to compare the effectiveness of both methods. From the results, it was observed that concrete infills have considerable strength while brick one showed lower strength. On the contrary, brick infills accepted large displacement than concrete ones. It was concluded that the combination of brick and concrete infills reduced the negative effects when they both used individually.

Mithesh Surana et al. focused on estimation of seismic performance of shear wall and shear wall core buildings designed for Indian codes. Non-linear pushover analysis was used in this study. For modeling the shear wall, the commonly used models like wide column model and shell element model were validated using experimental results available in earlier literature. Both the models showed identical strength for shear wall and shear wall cores. In case of ductility capacity of shear wall and shear wall cores, wide column model underestimates whereas the shell element model overestimates. It has been found that stiffness obtained from moment-curvature analysis is matched with experimental results. But shell element model showed high stiffness initially and later it is reduced due to cracking and finally matched with experimental results. To evaluate the performance of "Dual systems" which is designed as per Indian code, these models were implemented. It has been noted that buildings with shear walls placed at periphery showed excellent performance than buildings with centrally placed shear wall core.

Chun Ni et al. described the performance of shear walls with diagonal or transverse lumber sheathing.

A total of 16 full-scale shear walls were tested to determine the effects of hold-owns, vertical load and width of lumber sheathing on in-plane shear capacity. The in-plane shear capacities of shear walls with double diagonal lumber sheathing are 2-3 times higher than that of shear walls with single diagonal lumber sheathing.

Michael R. Dupuis et al. analyzed seismic performance of shear wall buildings with gravity-induced lateral demands using OpenSees software. The inelastic response of concrete shear wall buildings was investigated. From the result, it was demonstrated that a seismic ratcheting effect can develop and amplify inelastic displacement demands. But the effect is more prevalent in coupled shear walls than cantilevered shear walls.

P.PChandurkar et al. did a detail study to determine the solution for shear wall location in multi-storey building with the help of four different models. The buildings were modeled using software ETAB Nonlinear v 9.5.0.After analysing ten storey building for earthquake located in zone-II, zone-III, zone-IV and zone-V essential parameters like lateral displacement, story drift and total cost required for ground floor were found in both the cases by replacing column with shear wall and conclusion was drawn that shear wall in short span at corner (model 4) is economical as compared with other models. It was observed that shear wall is economical and effective in high rise buildings and providing shear walls at adequate locations substantially reduces the displacement due to earthquake. If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall.

Wen-I Liao et al. conducted an experimental investigation on high seismic performance shear wall. The test results of four large-scale shear walls, (two shear walls under shake table tests and two shear walls under reversed cyclic loading) were presented. The response time histories for accelerations and displacements as well as the hysteretic loops were presented for the shear walls under dynamic loading induced by shake table. The force-displacement
hysteretic loops were presented for the shear walls under reversed cyclic loading. From the experimental results, it was found that the tested high performance shear walls have better ductility than that of conventional shear walls.

III. 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 considering displacement and base shear.
- ❖ Shear walls with openings experienced a decrease in terms of strength.
- ❖ Diagonal shear wall was found to be effective for structures located in earthquake prone areas.
- ❖ Raising of shear wall up to the entire height of building is not necessary and it is sufficient to raise the shear wall up to mid height of building
- ❖ Among the four models, (structure without shear wall, structure with L type shear wall, structure with shear wall along periphery, structure with cross type shear wall) shear wall provided along the periphery of the structure is found to be more efficient.

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