A Review on Comparing the Effect Earthquake on High Rise Building with Shear Wall and Flanged Concrete Column

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Abstract- **Earthquake never kills people but the defective structures do. The stability and stiffness of any structure is the major issue of concern in any high rise buildings. Shear walls are structural members which resist lateral forces predominant on moment resisting frame. Shear walls are most preferred structural walls for earthquake resistance. So the use of STAAD-PRO will make it easy.**

Index Terms- **Software Analysis, High rise Building, Structure Elements, STADD PRO 3D.**

I. INTRODUCTION

Earthquake in general had a long history of deadly devastations in the past. Every year all over the world number of earthquake strikes the earth with low and high intensities. Earthquakes are most unpredictable and devastating of all natural disasters. Earthquakes are vibrations or oscillations of ground surface caused by temporary disturbance of the elastic or gravitational equilibrium of the rocks at or beneath the surface of the earth. This disturbances and movements cause elastic impulses or waves. These waves are known as seismic waves and classified as body waves- travels within the body of earth and surface waves- over the surface of the earth. 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. Intensity is measured on modified Mercalli intensity scale. Based on the peak ground acceleration or movement there are certain zones of the earth, named as seismic zones. In India there are four zones, II, III, IV, V – last one being the most devastating.[14] The Indian subcontinent has a history of earthquakes. The reason for the intensity and high frequency of earthquakes is the Indian plate driving into Asia at a rate of approximately 47 mm/year.

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. The response (i.e., the magnitude and distribution of the resulting forces and displacements) of a structure to such a base motion is influenced by the properties of the foundations of the structure and surrounding structures, as well as the character of the existing motion. As the ground on which the building rests is displaced, the base of the building moves with it. However, the inertia of the building mass resists this motion and causes the building to suffer a distortion. This distortion wave travels along the height of the structure in much the same manner as a stress wave in a bar with a free end. The continued shaking of the base causes the building to undergo a complex series of oscillations. When the ground shaking is at a much slower rate than the structure's natural oscillations, the behavior will be quasi-static; the structure simply moves with the ground with its absolute displacement amplitude, approximately the same as that of the ground. If ground motion is much faster than the natural oscillations of the structure, then the mass undergoes less motion than the ground.

Literature review

Following are the literature reviews are based on the study.

B. R. Reddy et.al used Stadd Pro software for analysis and design of earthquake resistant structures using

Shearwall. According to their research work, constructions 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 elasto-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. P. Chandurkar et.al. 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.

Manoj S. Mendhekar et.al. 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.

Venkata Sairam Kumar.N et.al. 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.

Bhruguli H. Gandhi 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. 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.

II. METHODOLOGY

Analysis of any structure for resisting earthquake is the basic need of this study. In this project analysis of a seismic resistant structure is a need of concern, and thereby establishing a comparison between structures with normal shear wall with flanged concrete column. In high rise structures most adoptable type to resist earthquake is to provide shear wall. Basically many analysis and design software's can be adopted to analyze and design any earthquake resistant structure. There are many methods for analysis and design such as equivalent static method, response spectrum method and time history method. Among all these methods in this study only equivalent static method is adopted. In this study STADDPro is used for analysis.

4.2 Indian Standard code provisions:-
Indian Standard codes are the base reference by which analysis and design are carried out. Following are the various IS codes which are used for analysis and design of Earthquake resistant structure with and without shear wall.

4.3 Partial Safety Factors:-
Partial Safety factors for limit state design of reinforced concrete structures are given in Clause no. 6.3.12 Page No.13 of IS 1893 (Part 1): 2002. Following load combinations should be adopted for limit state design of reinforced concrete structures subjected to earthquake loading.

1) 1.5 (DL+IL)
2) 1.2 (DL+IL$\pm$ EL)
3) 1.5 (DL$\pm$ EL)
4) 0.9 DL $\pm$ 1.5 EL

4.4 Equivalent Lateral Force Method: -
This method of finding design lateral forces is also known as the static method or the equivalent static method or the seismic coefficient method. This procedure does not require dynamic analysis, however, it accounts for the dynamics of building in an approximate manner. First, the design base shear is computed for the whole building, and it is then distributed along the height of the building. The lateral forces at each floor level thus obtained are distributed to individual lateral load-resisting elements. Vertical distribution of base shear to different floor levels (IS 1893 Part-1, Clause 7.71). The design base shear (V_b) is distributed along the height of the building as per the following expression:

4.5 Design of shear walls:-
Shear wall construction is an economical method of bracing buildings to limit damage. For good performance of well designed shear walls, the shear wall structures should be designed for greater strength against lateral loads than ductile reinforced concrete frames with similar characteristics; shear walls are inherently less ductile and perhaps the dominant mode of failure is shear. With low design stress limits in shear walls, deflection due to shear forces is small. However, exceptions to the excellent performance of shear walls occur when the height-to-length ratio becomes great enough to make overturning a problem and when there are excessive openings in shear walls. Also, if the soil beneath its footing is relatively soft, the entire shear wall may rotate, causing localized damage around the wall. IS 13920 gives detailed requirements for designing a shear wall. Following are the design steps of cantilever shear walls.

III. CONCLUSION

Concluded remarks on the present study for various models analysed in STADD Pro for earthquake resistance.

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