National Journal of Advanced Research
ISSN: 2455-216X
Impact Factor: RJIF 5.12
www.allnationaljournal.com
Volume 4; Issue 3; September 2018; Page No. 10-13

Comparing the effect of earthquake on high rise buildings with & without shear wall and flanged concrete column using STAAD Pro

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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. This research is related to comparison of shear wall type structure with moment resisting type of building. The present study states three type of models, moment resisting frame, Shear wall building concentrically located along X- axis on outer periphery of building and Concrete column flange concentrically located on outer periphery along the X-axis. Models of the three structures with same loading were created on STAAD. Pro and were analyzed and further they were compared for their suitability. For 10 storey building and 3 bays along X-axis of 4m each and 4 bays along Z-axis of 4m each were considered and loads were applied as per the IS specifications.
The analysis was conducted as per the specifications of IS standards IS 13920, IS 1893, IS 875, IS 456. From the result it is seen that there is decrease of approximately 10% in Lateral storey shear and Base shear when the moment resisting frame was introduced with shear wall. Thus, possessed 10% less lateral force and base shear. The results of Axial force, bending moment, Node displacement were found satisfactorily less than the moment resisting frame. If cost is been compared, then can be stated as conomical in all sense since for the same configuration and load it greater stability and stiffness as checked from the node displacement results.

Keywords: shear wall, flanged concrete column, STAAD Pro, earthquake

1. Introduction
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. This research is related to comparison of shear wall type structure with moment resisting type of building. The present study includes three types of models with 10 storey building, moment resisting frame i.e. model 1, Shear wall building i.e. model 2, and Concrete column flange i.e. model 3. Models of the three structures with same loading be create on STADD Pro and be present analyzed and further they will be compared for their suitability and loads be applied as per the IS specifications. The analysis will be conducted as per the specifications of IS standards IS 13920, IS 1893, IS 875, IS 456.
Shear wall 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. When lateral displacement is large in a building with moment frames only, structural walls, often commonly called shear walls, can be introduced to help reduce overall displacement of buildings, because these vertical plate-like structural elements have large in-plane stiffness and strength. 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.

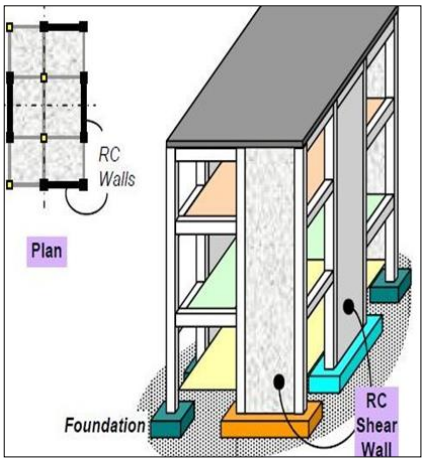

Fig 1: Reinforced Concrete Shear Wall

1.1 Advantages of Shear Walls in RC Buildings

1. Shear wall resist horizontal lateral force and provide earthquake resistance.
2. It possesses very large in-plane stiffness which resist lateral load.
3. Shear walls are helpful in controlling deflection.
4. RCC shear walls are easy to construct reinforcement detailing.
5. It minimizes earthquake damage to structural damage and non-structural damages.
6. 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.
7. Walls carrying vertical loads should be designed as columns. Basically, walls are designed in the same manner as columns, but there are a few differences. A wall is well-known from a column by having a length that is more than five times the thickness.
8. Shear walls should be designed as vertical cantilevers, and the reinforcement arrangement should be checked as for a beam.

1.2. Objectives

The primary objectives of this project can be summarized as follows:

1. To analyze an earthquake resistant structure.
2. To analyze same structure with rectangular shear wall for earthquake resistance.
3. To analyze same structure column and beam structure with flanges to the column as shear wall in other words we can say it shear wall with opening. 4. Comparing the effect earthquake forces for shear wall building and flanged column building.
4. Establishing a comparison between the three types of structure and analyzing the result and establishing a needful resemblance with effectiveness.

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.

B. Ramamohana Reddy [1]. Analyzed earthquake resistant structures with Shear wall by Stadd Pro software. The building behavior was checked for rigidity factor, reactions, shear center, shear force and bending moment. The analysis for shear wall location in multi-storey building based on its both elastic and elastic-plastic behaviors were also considered. The earthquake load was calculated and applied for the same building of 3 bays and 3 floors. Model results were obtained and analyzed for the effective location of shear wall. They compared the result and found that the provision of shear wall in the building will make the structure completely earth quake resistant in zone II and Further founded that the results of manual and STAAD Pro are almost same, the STAAD. Pro results save considerable amount of reinforcement.

P. P. Chandurkar [2]. Modeled and analyzed a building with and without the Shear-wall in E-tabs Software and the results were compared. 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 was 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. They observed that in 10 story building, 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. They observed that the shear wall is economical and effective in high rise building. They observed that change in 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.

Alokkumar A. Mondal [3]. Compared shear wall type structure with moment resisting type of building in STAAD. They presented three type of models, moment resisting frame i.e. model 1, Shear wall building concentrically located along X-axis on outer periphery of building i.e. model 2, and Concrete column flange concentrically located on outer periphery along the X-axis i.e. model 3. Models of the three structures with same loading were created on STAAD Pro and were analyzed and compared for their suitability. For 10 storey building and 3 bays along X-axis of 4m each and 4 bays along Z-axis of 4m each were considered and loads were applied as per the IS specifications. The analysis was conducted as per the specifications of IS standards IS 13920, IS 1893, IS 875, IS 456. it is found that there is decrease of approximately 10% in Lateral storey shear and Base shear when the moment resisting frame was introduced with shear wall. Thus, the model 2 and model 3 possessed 10% less lateral force and base shear as compared to the model 1. Also, the results of axial force, bending moment, Node displacement were found satisfactorily less than the moment resisting frame. The model 3 was found to be economical.

Mr. Alokkumar A. Mondal [4]. Reviewed the Effect of Earthquake on Shear wall building and Non-Shear Wall Building and concluded that, shear wall are more prominent to resist lateral force due to earthquakes. They found that openings provided in shear walls increase displacement in building. They concluded 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. Hence, they concluded that building without shear wall is a subject of concern and need to be retrofitted in places of high earthquake and wind impact.

Shyam Bhat M[5] Studied and compared the earthquake behavior of buildings with and without shear wall. A 50 storey building was modeled using software STAAD Pro. Models were studied in all four zones comparing lateral displacement and base shear for all structural models under consideration.

Model 1 – Framed structure. Model 2– The building with shear walls one on each side. Model 3– The building with shear walls on corner. Model 4– The building with shear walls at centre. It was found that top displacement of model 4 was less than the other models in all four zones.

Ali Fathalizadeh [6] in this article we have reviewed shear walls as an effective way for resisting lateral loads in tall buildings. Then two most popular types of shear walls, steel and concrete walls, are reviewed and their construction methods are discussed. At the end we have concluded that shear walls are one of the most effective and operational solutions for resisting earthquake and wind forces. With buildings rising in stories, engineers are trying to find new systems for designing and constructing structures with better performance and functionality. Shear walls are one of the best solutions for resisting lateral loads, which can be constructed by reinforced concrete or steel plates and can be used in both concrete and steel framed structures. Shear walls are either plane or flanged in section and best position for them is in the center of each half of the building. They are easy to construct and make the structure more ductile and safer against earthquake and wind forces.

Bhruguli H. Gandhi [7] 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, Staad Pro under earthquake loads in equivalent static analysis. Six different types of models were created and analyzed, starting from first, Concentric opening 20%, concentric opening 40%, concentric opening 50%, concentric opening 60%, Eccentric opening 20%, and 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.

3. Research 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 STADD Pro is used for analysis. The proposed work is planned to be carried out in the following manner

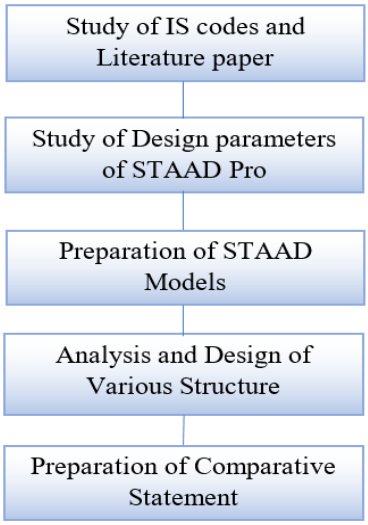

Fig 2

4. Problem formulation

Research is currently ongoing. Analysis will be done by using STAAD model for different span arrangements. The structure selected for this project is a simple office building (Banking hall type) with the following description as stated below. Different loads such as Dead Load, Live Load, and Earthquake Load will be applied on STAAD model at appropriate location as per codes used for Loading. IS Code for Dead Load: - IS 875 Parts 1, IS Code for Dead Load: - IS 875 Parts 2, IS Code for Seismic Load: - IS 1893 Part (1 to 4). For the present study following values for seismic analysis are assumed. The values are assumed on the basis of reference steps given in IS 1893-2002 and 13920-1993 and IS 456:2000. Since Nagpur or Vidarbha is less vulnerable to earthquakes, for this present study assigning zone III for moderate seismic intensity as stated in table 2 of IS 1893 – 2002. All the results obtain from STADD Pro structural software and these results are compared in tabular form.

5. Flanged concrete column

1. In any structure there is need of opening for proper access from one room to other room and from one floor to another floor, where flanged concrete column is used.
2. Moreover shear walls with openings are not generally preferred because they are unable to transfer loads and generally fail.
3. Shear wall with openings are also known as coupled shear wall.

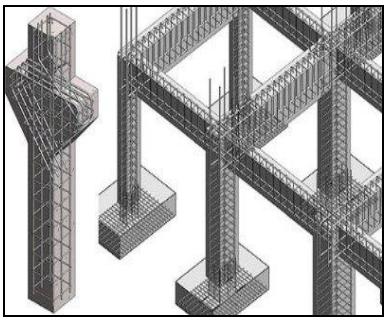

Fig 3: Flanged Concrete Column

6. Conclusion

1. Changing the position of shear wall will affect the attraction of forces, so that wall must be in proper position.
2. If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall.
3. Providing shear walls at adequate locations substantially reduces the displacements due to earthquake.
4. 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.
5. Analysis by software's such as Stadd Pro, 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.
6. 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.
7. 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.
8. 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 non-shear wall building can be studied further by introducing a flange to column.
9. 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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