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SHEAR WALLS: DELECTION AND STABILITY COMPARISON IN DIFFERENT BUILDING FRAMES

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ABSTRACT- As we all know about the disastrous effect of earthquake in past decade, it is important to consider the effect of seismic (earthquake) loads while constructing any medium or high rise building. Hence to reduce this adverse effect of earthquake loads on building and to increase the stability, shear walls are provided. Shear walls are structural members that provide stability and resistance to the structure subjected to lateral forces generally wind and seismic loads, especially in high rise buildings. They provide adequate strength and stiffness to the whole lateral displacement of the structure due to laterally subjected loads. These structural members can be constructed from reinforced concrete, timber/plywood and also from unreinforced masonry. They can be external or internal walls around lift shafts or stairs and sometimes both. Shear walls have proved to be very successful in resisting strong earthquake loads so far. In this paper we have aimed to study the effect of providing shear walls on stability and deflection in 5 and 10 storey building frames and comparing it with the same building frames without shear walls subjected to lateral forces. We have compared the same building frames in V earthquake zone. A 3-D analysis of shear wall structures has been carried out using the STAAD.pro v8i software and results are presented.

KEY WORDS-seismic loads, STAAD.pro, reinforced concrete, lateral force, shear wall, unreinforced masonry

I. INTRODUCTION

Vibrations which are caused under the earth's surface generate waves which disturb the earth's surface; these vibrations are generally termed as earthquakes. Lateral loads result from wind or earthquake actions and both can cause a settlement of improperly braced building.Nearly60% of India lying in earthquake prone zone. That's why there is a need of increase of understanding the behaviour of earthquake, constructing and developing earthquake resistant structures. Earthquake forces experienced by a building result from ground motions which can be fluctuating or dynamic in nature. The magnitude of an earthquake force depends on the magnitude of an earthquake, distance from the earthquake source (epicentre), local ground conditions that may increase ground shaking, the weight (or mass) of the structure, and the type of structural system and its ability to bear such loading. Residential buildings generally perform reasonably well in earthquakes but are more unsafe in high-wind load prone areas.

(A). Why Are Buildings With Shear Walls Favoured In Seismic Zones?

Reinforced concrete (RC) buildings generally have a vertical plate-similar to RC walls known as Shear Wallsin addition to slabs, beams and columns. These walls often start at foundation level and are constant throughout the building height. Their thickness can be as minimum as 150mm, or as maximum as 400mm in high rise buildings. Shear walls are generally provided across both length and width of buildings. Shear walls are like vertically-oriented wide beams which can carry earthquake loads to the foundation. However earlier even buildings with excess amount of walls that were not specially designed for seismic performances were saved from settlement. Shear wall buildings are a desired choice in many earthquake prone countries, like Chile, New Zealand and USA. Shear walls are easy to construct, because reinforcement detailing of walls is relatively simple and therefore can be easily applied at site. Shear walls are effective both in terms of construction, cost and detailed buildings.

II. LITERATURE REVIEW

Manjeet Dua (2018) performed an analyses on a (G+15) storey building frame in II Seismic zone using STAAD Pro and compared the displacements observed in model once with shear wall and again without shear wall at different locations. It was observed that the best location of shear wall in multi storey building is near the core of the building. By providing shear wall, the structural seismic behaviour will be affected to a great extent and hence the strength and stiffness of building will be increased.

A Ravi Kumar et. al.(2017) conducted a thorough study for determining the solution for shear wall location in multi storey building based on its elastic and elasto - plastic behaviours. He analysed a 10 storey building,40m in height for earthquake load using ETABS.He decided that shear walls are one of the most successful building elements in resisting lateral forces during earthquake and for a developing nation like India shear wall construction is considered to be a foundation for construction industry.

Tanawade et. al. (2016) analyzed elastic seismic response of reinforced concrete frames with reinforced concrete bracing member in K or A at different level braced pattern with G+11 building with 5 bay structures in both minor and major direction. This approach focus on the planning of A-braces in a particular bay, level and its combination, which ultimately reduce lateral direction so that economic can eventually by achieved in compression to the frame of the same moment.

A.B. Karnale et. al. (2015) analysed different configurations of shear wall for 6 storey and 14storey frame. In this paper, researchers presented the results for different configurations of shear walls for 6 storey and 14 storey building using ETABs software. An analysis of structure was done between the effects observed due to height of structure and it was found that shear wall is more effective in high rise buildings than in low rise buildings.

Varsha R. Harne (2014) analysed a six storey building subjected to earthquake loading in zone II using STAAD Pro and calculated earthquake load using seismic coefficient method (IS 1893 Part II). Four divergent cases were examined consisting of structure without shear wall, structure with L type shear wall, structure with shear wall across perimeter, structure with cross type shear wall. The lateral deflection of column for building frames with shear wall is reduced as compared to other types of shear walls .It was found that shear wall along circumference is most effective among all the shear walls considered.

Ugale Ashish B. and Raut Harshlata R (2014) conducted an analysis on behaviour of steel plate shear wall in G+6 building frame located in seismic zone III using STAAD Pro and compared it with a Building frame without shear wall. The building frame with steel plate shear wall showed very less deflection, shear force and bending moment and overall stiffness was found to be increased. It was found that Steel plate shear walls cover less space than RCC Shear wall.

P.P.Chandurkar et.al. (2013) present a paper in determining the shear wall location of four different types of models varying with earthquake load with zones II, III, IV, V as per IS : 1893 : 2002 and calculated lateral displacement, story movement and total cost required for ground floor are calculated by replacing column with shear wall. It was found that shear wall in short span at corner in model 4 was profitable and effective in high rise buildings. Shear wall with large dimensions are effective in high horizontal forces and providing shear wall at desirable location, displacements can be minimized due to earthquake.

Anshuman S.et al.(2011) performed elastic and elasto-plastic analyses using STAAD Pro and SAP V 10.0.5(2000) on a fifteen storey building located in earthquake zone IV and calculated bending moment and storey drift in both the cases. Shear forces and bending moment were considerably reduced after providing shear wall. It was observed that the inelastic analysis performance point was small and within elastic limit therefore results obtained using elastic analysis are adequate.

III. METHODOLOGY

In this study we consider a regular plan of a general building as shown in fig and analysing it. All stories including ground storeys having 3.5m floor to floor height. Area of plan of building is 30m*16m. Structures are having 5-bay in X-direction and each bay is having a length of 6m and in Z-direction number of ways are 3 with different length two bays are having length of 6m and middle bay is having a length of 4m.In this study two types of columns are taken. The outer four corners are square columns having size 0.45m*0.45m and the other columns are rectangular in shape having dimension 0.5m*0.3m.Size of beams is 0.45m*0.3m. Slabs with a thickness of 200mm are used. A floor finishing of 50mm is provided. Supports of the structure are made fix at the bottom.The main wall is having a thickness of 0.23m. Height of main wall and partition wall is same as the height of stories. Shear wall are provided in some models and the thickness of shear wall is taken 0.23m. Building is located in earthquake-zone - ZONE V.
Soil condition are considered medium stiff and a damping ratio of 5% and importance factor is taken. Dead loads and live loads are applied accordingly. Earthquake loads are applied as per IS 1893 (Part -1) 2002.

Similarly models are considered for G+4 (with shear wall), G+9 (without shear wall) and G+9 (with shear wall) as shown in figures below.

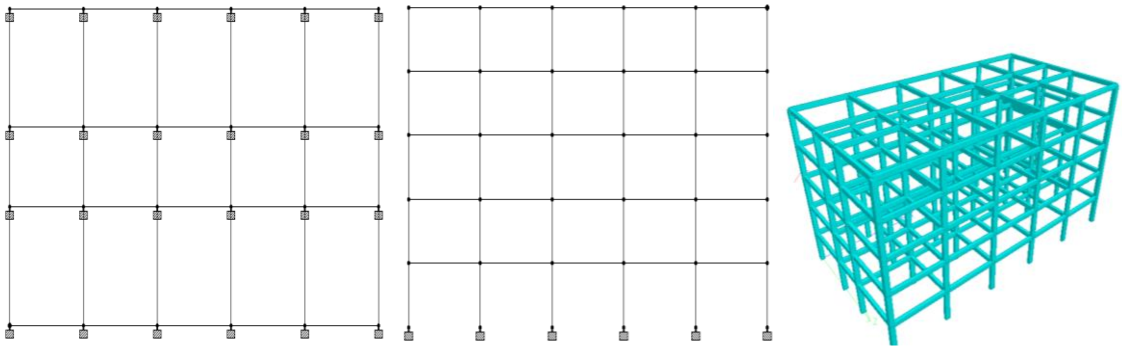

Figure 1. Plan and 3D View of a (G+4) Storey Building Frame Without Shear Walls

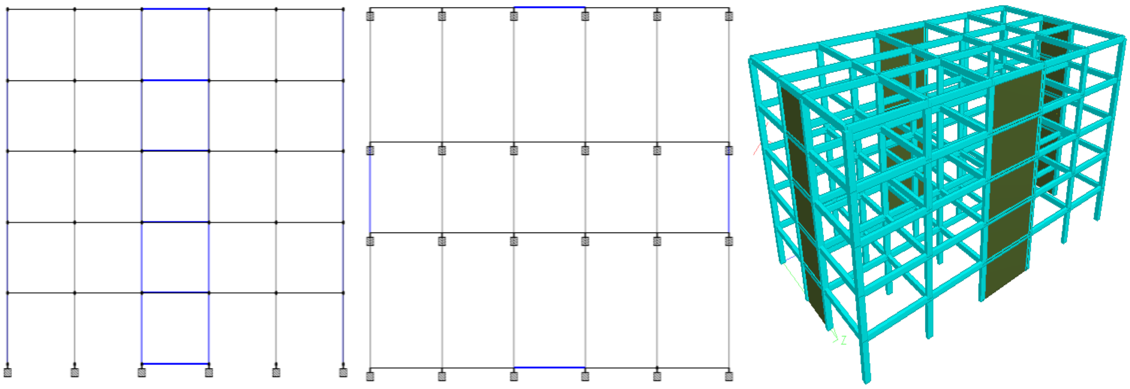

Figure 2. Plan and 3D View of a (G+4) Storey Building Frame With Shear Walls

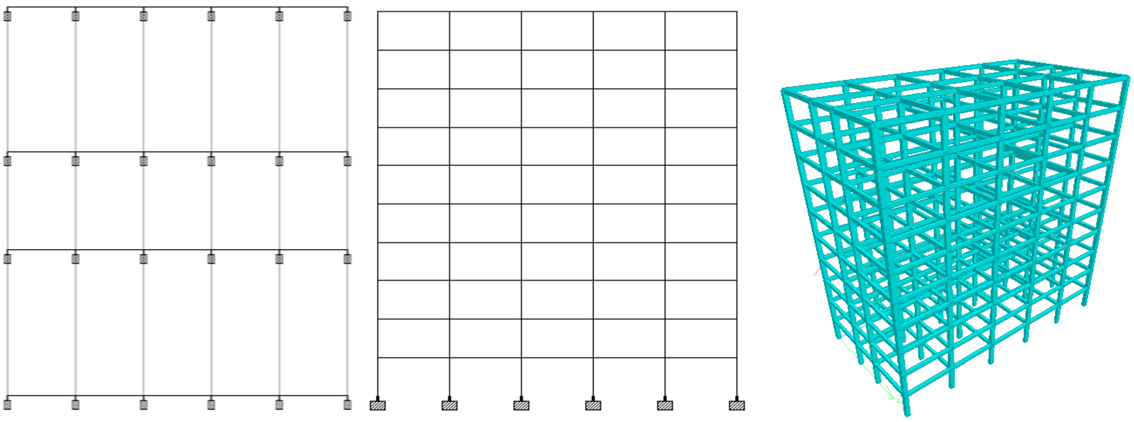

Figure 3. Plan and 3D View of a (G+9) Storey Building Frame Without Shear Walls

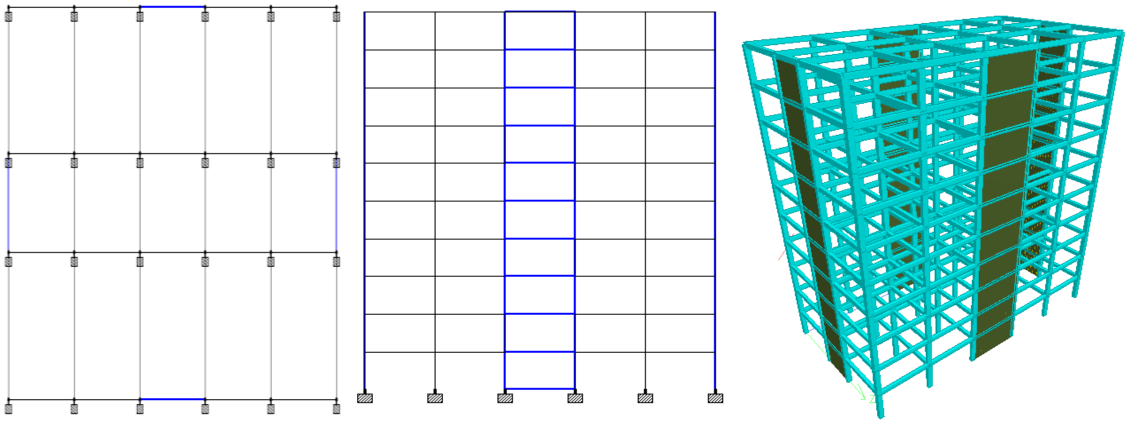

Figure 4. Plan and 3D View of a (G+9) Storey Building Frame With Shear Walls

IV. RESULT

Deflection in the building frames with and without shear walls is analysed as mentioned below in Table I.

TABLE I
DEFLECTION IN BUILDING FRAMES

STRUCTURE	LOAD COMBINATIONS	X (MM)	Y (MM)	Z (MM)	RESULTANT (MM)
5 STOREY WITHOUT SHEAR WALL	(DL+LL+SL)*1.2 [X]	77.37	-3.181	0.116	77.440
	(DL+LL+SL)*1.2 [Z]	-0.295	-2.002	111.025	111.043
5 STOREY WITH SHEAR WALL	(DL+LL+SL)*1.2 [X]	11.334	-2.695	0.000	11.709
	(DL+LL+SL)*1.2 [Z]	-0.309	-2.343	19.577	19.719
10 STOREY WITHOUT SHEAR WALL	(DL+LL+SL)*1.2 [X]	201.800	-13.258	0.163	202.235
	(DL+LL+SL)*1.2 [Z]	-0.413	-7.860	295.714	295.819
10 STOREY WITH SHEAR WALL	(DL+LL+SL)*1.2 [X]	63.754	-11.085	-0.012	64.711
	(DL+LL+SL)*1.2 [Z]	-0.313	-7.551	116.605	116.850

V. CONCLUSION

After analysing and comparing we have observed that

- Deflection occurred in building frames with shear wall is very less in comparison with those without shear walls.
- The stability of building frame with shear wall has increased.
- Structure with shear walls is more resistant to earthquake loads.

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