Seismic Analysis of Multistorey Building With And Without Shear Wall At Various Earthquake Zones

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Abstract-*Reinforced Concrete Frames are the most commonly adopted buildings construction practices in India. With growing economy, urbanization and unavailability of horizontal space increasing cost of land and need for agricultural land, high-rise structures have become highly preferable in Indian buildings scenario, especially in urban. With high-rise structures, not only the building has to take up gravity loads, but also lateral forces. Many important Indian cities fall under high risk seismic zones; hence strengthening of buildings for lateral forces is a prerequisite. In this study the aim is to analyse the response of a high-rise structure to ground motion in various earthquake zones using static Analysis. For that different models that is, bare frame and frame with shear wall at different location is analysed using ETAB software. Change in displacement, storey drift and time periods are compared and the best position of shear wall is obtained.*

Keywords*-*Shear Wall, Displacement, Storey Drift, ETAB.

I. INTRODUCTION

Earthquake is the result of a sudden realiese of energy in the earth's crust or upper mantle that generating seismic waves. It has always been a threat to human civilization from the day of its existence, devastating human lives, property and man-made structures. The very recent earthquake that we faced in our neighbouring country Nepal has again shown nature's fury, causing such a massive destruction to the country and its people. It is very necessary for survival to ensure the strength of the structures against seismic forces. It is very necessary for survival to ensure the strength of the structures against seismic forces. Therefore there is continuous research work going on around the globe, developing new and better techniques that increase seismic performance of building. Obviously, Building design with special technique resist damage during seismic activity which increase construction cost, but for safety against seismic forces it is a prerequisite.

Reinforced Concrete frames are the most common construction practices in India, with increasing numbers of high-rise structures. There are many important Indian cities that fall in highly active seismic zones. It should be analyzed and designed for ductility and should be designed with extra lateral stiffening system to improve their seismic performance and reduce damages. Two of the most commonly used lateral stiffening systems that can be used in buildings to keep the deflections under limits are bracing system and shear walls.

The use of steel bracing system is a viable option for retrofitting a reinforced concrete frame for improved seismic performances. Steel braces provide required strength and stiffness, takes up less space, easy to handle during construction, can also be used as architectural element and is economic. Steel braces are effective as they take up axial stresses and due to their stiffness, reduce deflection along the direction of their orientation.

Shear wall is a vertical member that can resist lateral forces directed along its orientation. Shear walls are structural system consisting of braced panels, also known as Shear Panels. Concrete Shear walls are widespread in many earthquake-prone countries like Canada, Turkey, Romania, Colombia, and Russia. It has been in practice since 1960's, used in buildings ranging from medium- to high-rise structures. Shear walls should always be placed symmetrically in the structure and on each floor, including the basement. Reinforced concrete Shear walls transfer seismic forces to foundation and provide strength and stiffness.

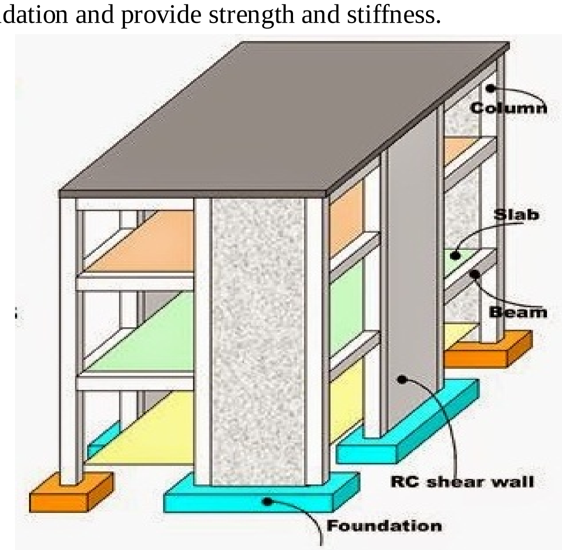


Figure 1: Building showing Shear Wall

II. BUILDING MODELING

For this study, a 15-story building with a 3-meters height for each story, slightly irregular in plan is modeled. These buildings were designed in compliance to the Indian Code of Practice for Seismic Resistant Design of Buildings .The buildings are assumed to be fixed at the base and the floors acts as rigid diaphragms. The sections of structural elements are square and rectangular. Storey heights of buildings are assumed to be constant including the ground storey having plinth height of 0.45m. The buildings are modeled using software ETAB. Five different models were studied with different positioning of shear wall in building. Models are studied in all four zones comparing lateral displacement, story drift, in all zones for all models.

Specifications

General specifications	
No. of storeys	G + 14
Floor to floor height	3m
Column size	(300 * 300) mm^2 (300 * 600) mm^2
Beam size	(250 * 500) mm^2
Thickness of slab	160 mm
Grade of concrete for beam and slab	M25
Grade of concrete for column and shear wall	M30
Grade of steel for longitudinal reinforcement	Fe415
Grade of steel for transverse reinforcement	Fe250
Thickness of shear wall	230 mm
Seismic data	
Response reduction factor	5
Soil type	medium
Time period	Program calculated

The plan building models are given below

Model 1 – Bare framed structure without shear wall.
Model 2 – Dual system with shear wall on each corner sides having total length L = 36m.
Model 3 -- Dual system with shear wall around lift area having length L = 12m
Model 4 – Dual system with shear wall on intermediate corner having length L = 26m
Model 5 – Dual system with shear wall at middle of the plan having length L = 24m

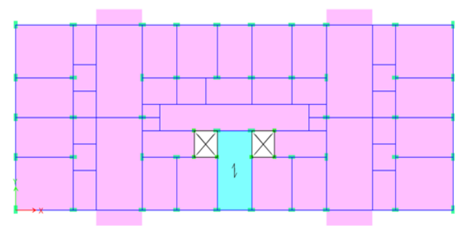


Figure 2: model 1

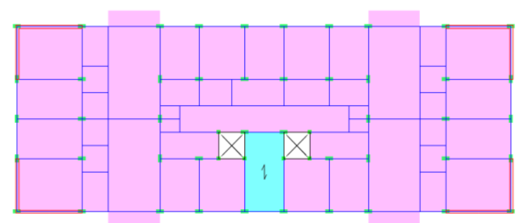


Figure 3: model 2

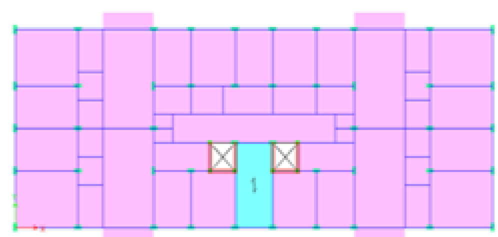


Figure 4: model 3

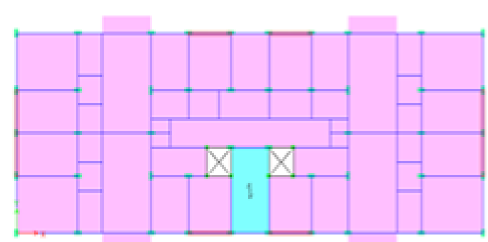


Figure 4: model 4

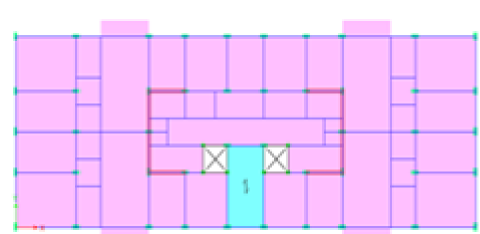
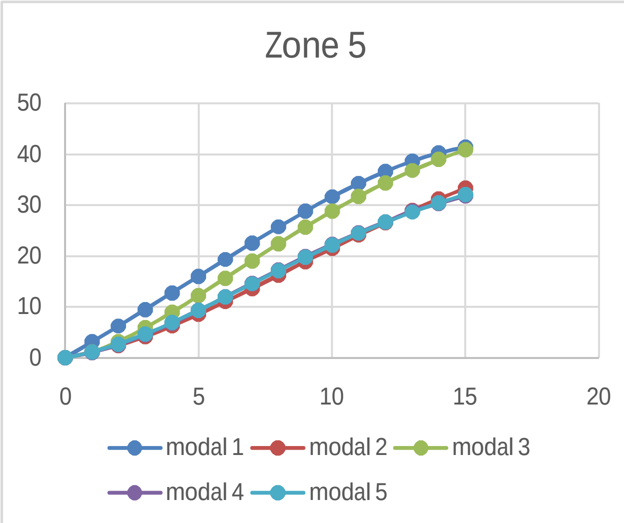


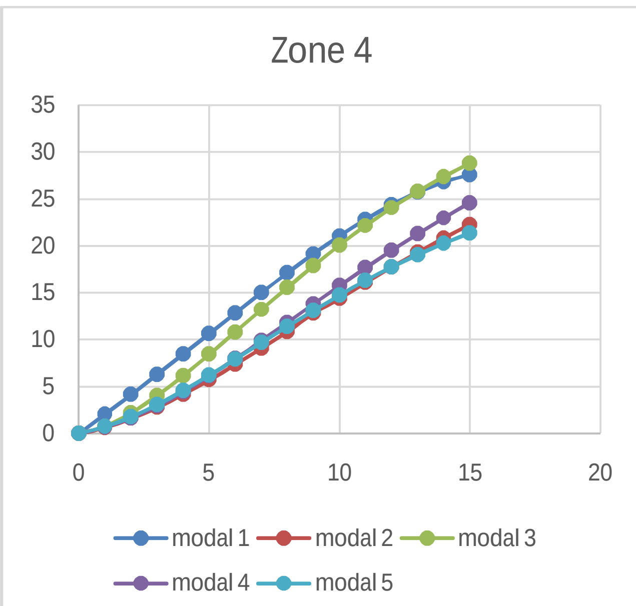
Figure 5: model 5

III. RESULT AND DISCUSSION

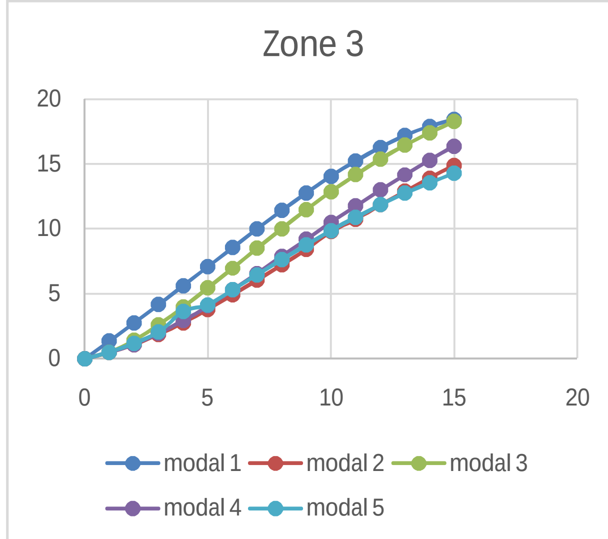
1 Lateral Displacement



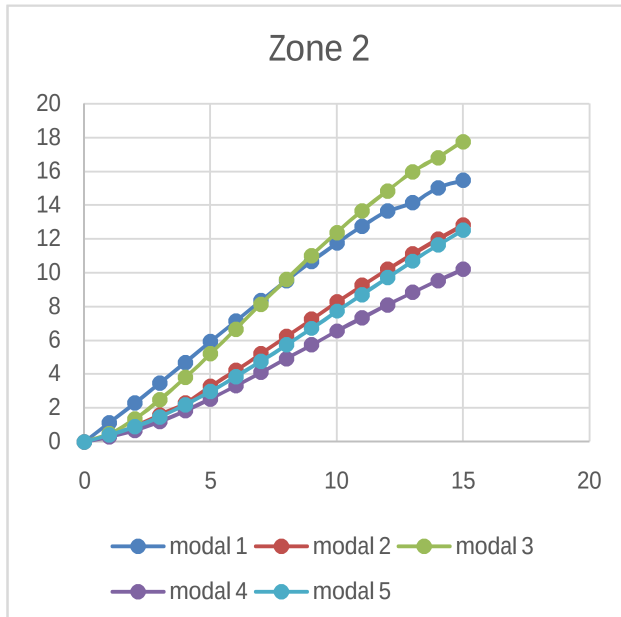
Graph 1: Variation of Displacement in zone 5 along y direction



Graph 2: Variation of Displacement in zone 4 along y direction



Graph 3: Variation of Displacement in zone 3 along y direction



Graph 4: Variation of Displacement in zone 2 along y direction

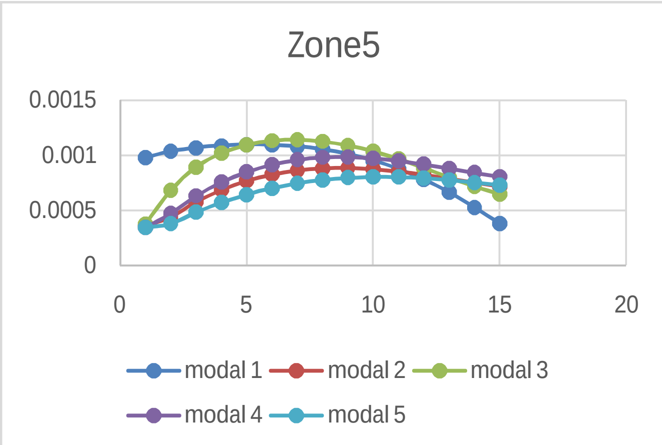
After comparing results, it is observed that Shear wall models reduced the displacement up to 40% as compared to the model 1 which is bare frame without shear wall.Model 1 which is Frame without shear wall gives maximum displacement as compared to the models having shear wall.Model 5 having shear wall at middle of plan gives good results than other models.If the dimensions of shear wall are large then more amount of displacement are reduced by shear wall.

2. Story Drift Ratio

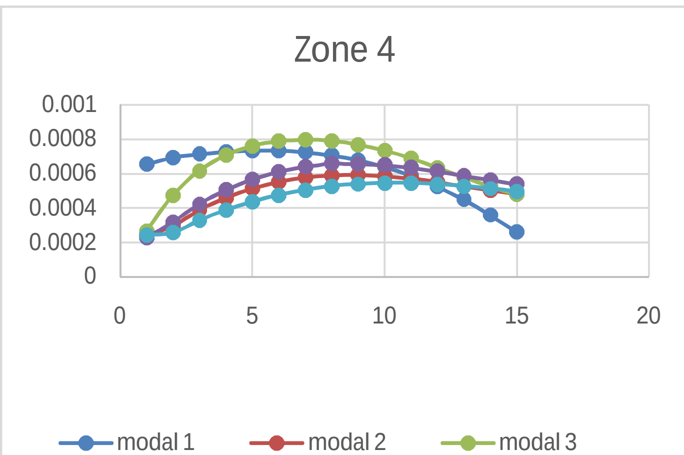
Story drift is the displacement of one level relative to the other level above or below. Story drift ratio according to the zones of each model is shown in fig. In Software value of story drift is given in ratio.

Story drift ratio =

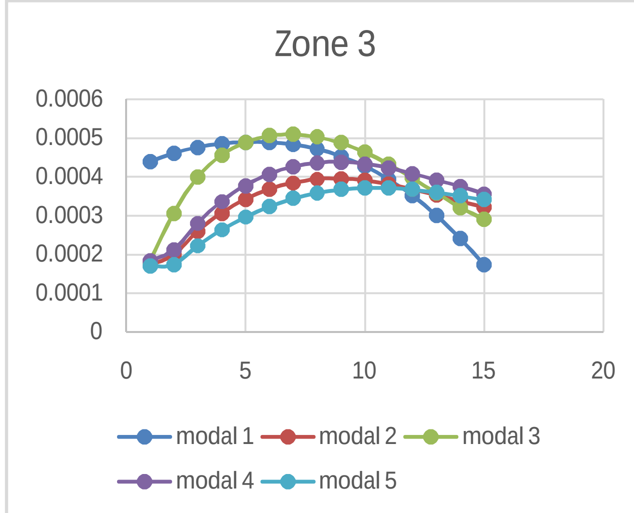
$$\frac{\text{difference between displacement of two stories}}{\text{height of one story}}$$



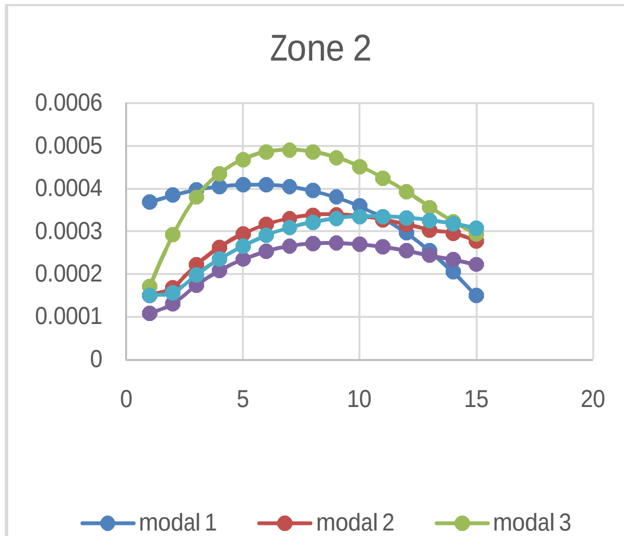
Graph 5: Variation of Storey Drift Ratio in zone 5 along y direction



Graph 6: Variation of Storey Drift Ratio in zone 4 along y direction



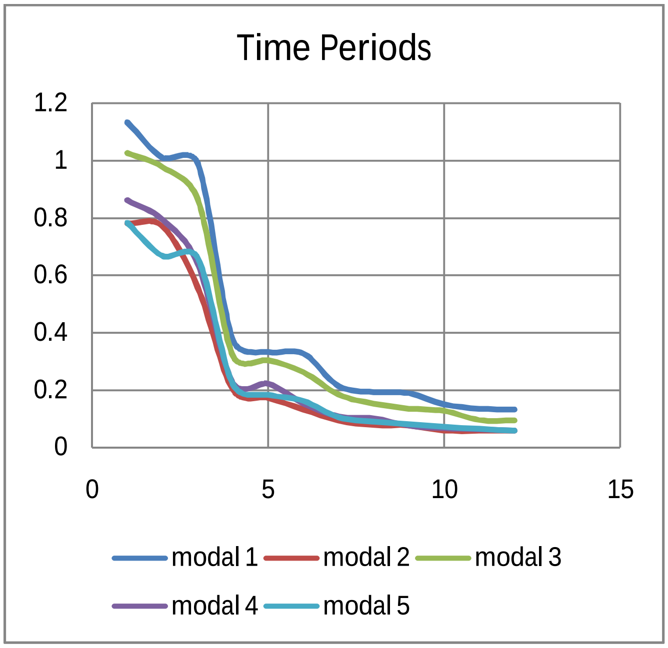
Graph 7: Variation of Storey Drift Ratio in zone 3 along y direction



Graph 8: Variation of Storey Drift Ratio in zone 2 along y direction

From the results, it is observed that Story Drift is maximum for model 1 which is bare frame without shear wall as compared to other models having shear wall at various locations.While comparing with story drift, it is maximum for model 1 as compared with other models.Model 5 has minimum value of story drift in all zones as compared with the other models.

3. Comparision Of Time Periods



Graph 9: Variation of Time Periods

In this study it was found that fundamental time period of the bare frame is longer than the time period of frames with shear wall. There is a gradual decrease in time period from bare frame to frame with shear wall.

IV. CONCLUSION

This project work was a small effort towards perceiving the how introducing a shear wall in a building can make in difference in protecting the building in earthquakes. Almost all the buildings in India are RC frame, and earthquake tremors are felt every now in some or the other part of the country. Hence through this project it was tried to appreciate the effectiveness and role of this small extra structural elements that can save both life and property, at least for most of the earthquakes.

From result obtained after analysis, it is concluded that

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. If we provide shear wall in structure at which column fails first, then it will reduced displacement to large extent.

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