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Deflection Control of High-Rise Building Using Bracing & Shear wall

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ABSTRACT: The intention of this study is to find the best suitable structural system to resist the earthquake and then explore the effectiveness of bracing system and shear wall in order to minimize the impact of the structural damage due to the earthquake. Due to limited availability of the land, there is increased incidence of high-rise buildings and thus lateral loads come into the picture. Therefore, now more often, we need to take lateral loads into consideration while designing buildings, especially skyscrapers. Same concept also holds good for earthquake loads. A building, which is designed for lateral loads like that of wind load, can also resist the earthquake forces up to some extent. The structure is analysed for earthquake load in both the types of structural system i.e. with bracing and shear wall and then it is compared with reinforced concrete frame system. Both the systems help in controlling the deflection by increasing the stiffness of the structure. In this project, study of 5-storey, 10-storey, and 20-storey buildings are presented with some investigations which are analysed in both zone-3 and zone-5. In this study complete analysis and design used with STAAD Pro V8i. Comparison of these models for different parameters like amount of concrete used, amount of steel used and cost of the structure carried out. Deflection and bending moments are calculated on different structural systems in order to figure out the better structural system in resisting the earthquake loads.

KEYWORDS: Lateral Load, Bracing, Shear wall, Stiffness, High Rise Building, Deflection

I. INTRODUCTION

Reinforced concrete building is most common type of construction in India. When tall buildings are constructed, those building have issues to undergo lateral deflection because of lateral load and moment at base. Bracings and shear walls are provided as a structural member to resist lateral loads due to earthquake and wind by increasing the stiffness of high rise building in place of infill walls. A shear wall is a structural member composed of braced panels to counter the results of lateral load performing on a structure. Wind and seismic loads are the most general loads that shear walls are designed to carry. Cross bracing is a system used to RC-frame in which the support of the diagonals breaks down. Due to cross-bracing, one can increase the capacity of a building to face seismic activity. The shear wall accepts a shear of proportional to lateral playback for its rigidity. Behaviours of RC frames with bracings or with shear wall have been studied by number of researchers experimentally and analytically. Conclusion is made by them that shear wall and bracing members influence the seismic response significantly. Use of shear wall or bracing members improves the performance of RC frame structure. A shear wall decreases lateral deflections, storeys drift and bending moments in the frame and thus reduces the probability of collapse. In different earthquake zones, behaviour of members is different. Earthquake zones according to IS CODE: 1893.1.2016 is considered. During the earthquake, it is the destruction of buildings and structures that primarily cause life-loss. The huge amount of damage related to earthquake and the resulting loss of life reflects poor manufacturing practice in India.

II. RELATED WORK

Mohd Imran et. al. (2019) in this paper, a parametric study is performed on multi-storeyed building with and without outrigger systems, located in seismic zone IV. It is intended to describe the performance characteristics such as lateral displacement, time period, base shear etc. The study is carried out on a building with the help of different mathematical models considering shear walls and braces as outrigger systems at different locations for improving the seismic performance of the building without any outrigger system. Analytical models represent all existing components that influence the mass, strength, stiffness and deformability of structure. In this research, the response spectrum analysis is carried out on all the mathematical 3D model using the software ETABS 2015 and the comparisons of these models are presented. Finally, the optimum location of outrigger system is suggested.

Manjeet Dua (2018) performed an analyse on a (G+15) storey building frame in Seismic zone-II using STAAD Pro V8i 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.

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. They analysed a 10 storey building, 40m in height for earthquake load using ETABS software. 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 S. B., Kore P. N. and Swami P.S. (2016), in this paper 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 is analysed in both minor and major direction. This approach focuses on the planning of A-braces in a particular bay, level and its combination, which ultimately reduces lateral deflection so that the economy can eventually be achieved in comparison to the frame of the same moment.^[19]

III. METHODOLOGY

3.1 DESCRIPTION OF MODEL

In this study a building having regular plan is considered for analysis as shown in fig. All storeys including ground storey having 3.5 m floor to floor height is considered for the analysis. Area of plan of building is 480 m². Structures are having 5-bay in X-direction and each bay is having a length of 6 m and in Z-direction number of bays are 3 with different length two bays are having length of 6 m and middle bay is having a length of 4 m. Three types of columns are considered in this study. Some columns are rectangular and some columns are square as per structure requirement. Two types of beams having different cross sections are used. Sizes of beams are 230 mm × 450 mm and 300 mm × 450 mm. Slabs with a thickness of 200 mm are used. A floor finishing of 50 mm is provided. Supports of the structure are made fix at the bottom. Three types of walls are used – main wall, partition wall and parapet wall. The thickness of wall varies as main wall is having a thickness of 230 mm, partition wall and parapet walls are half of the main wall thickness. Height of main wall and partition wall is same as the height of storeys. Parapet wall is considered with a height of 1m. Shear walls are provided in some models and the thickness of shear wall is taken 230 mm. In some other models cross bracings are provided these bracings are having steel-I section ISMB-100. Building is located in two types of earthquake-zones (Zone-III and in zone-V). Soil condition are considered medium stiff and a damping ratio of 5% and importance factor is taken 1. Dead loads and live loads are applied accordingly. Earthquake loads are applied as per IS 1893 (Part -1) 2016.

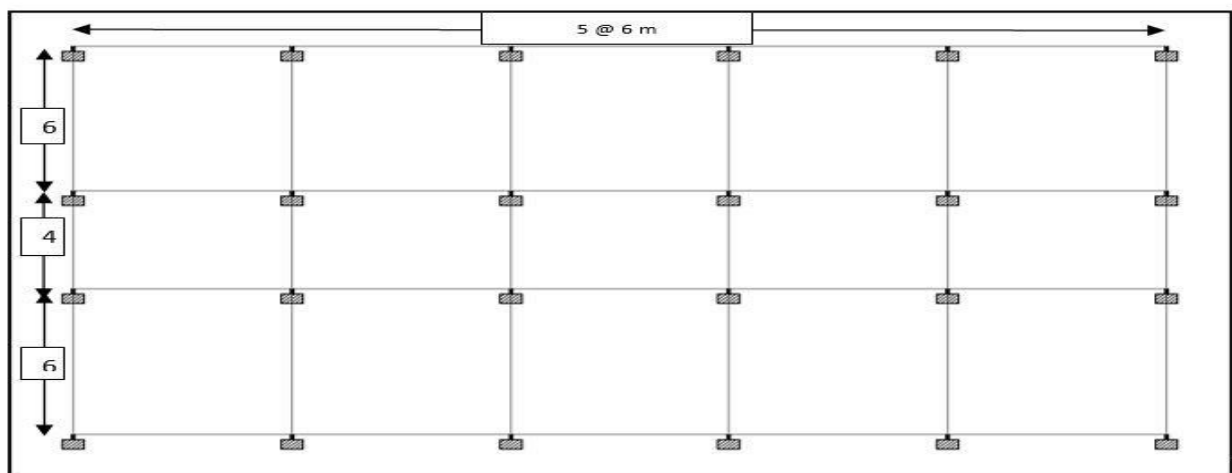


Fig 3.1 Plan of Model (All dimension in meters)

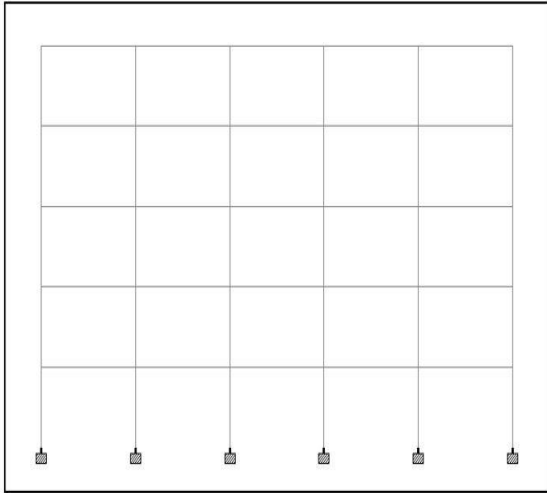


Fig 3.2 Elevation of General Model

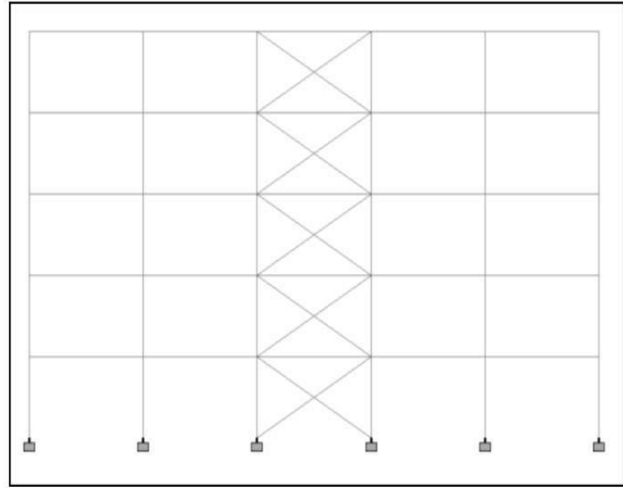


Fig3.3 Elevation of Braced frame structure

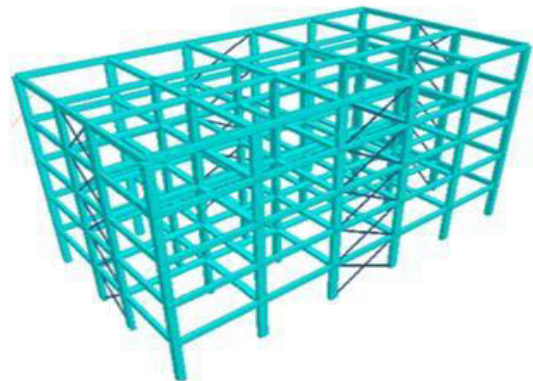
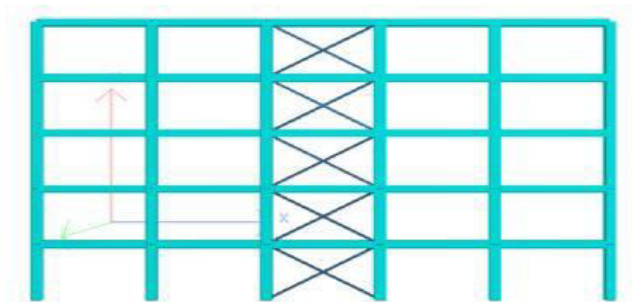


Fig. 3.4 RC Frame Structure with bracing

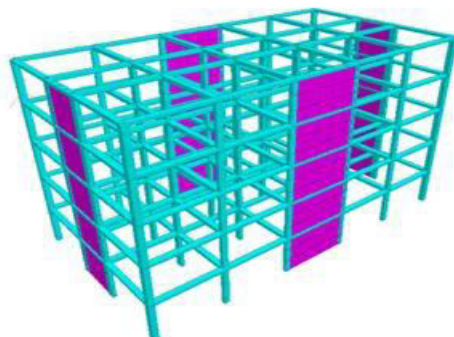
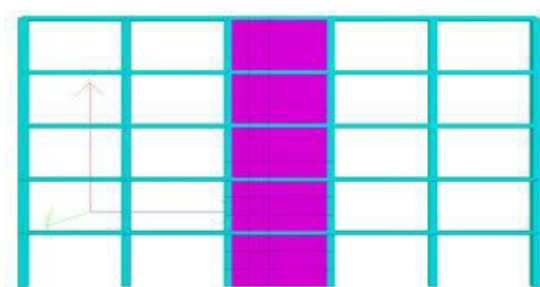


Fig 3.5 RC Frame Structure with shear wall

IV. EXPERIMENTAL RESULTS

Reduction in Deflection with RC-Frame

As shown in the following graphs when bracings and shear walls are used at the place of simple framed structure then deflection is getting reduced. It can be seen from the following results that when we talk about zone-3 maximum percentage reduction in deflection up to 49% for Braced frame and up to 58.78% reduction for shear wall as compare to RC-frame.

Similarly we talk about zone-5 maximum percentage reduction in deflection up to 38.24% for Braced frame and 58.81% reduction for shear wall as compare to RC-frame. We can say that bracings and shear are more effective to control the lateral deflection in high rise buildings and critical earthquake zones.

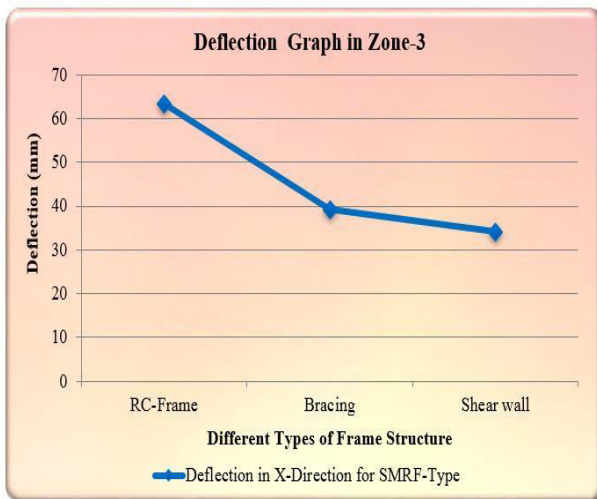


Fig. 4.1 Comparison of Deflection for 5-Storeys in Zone-3

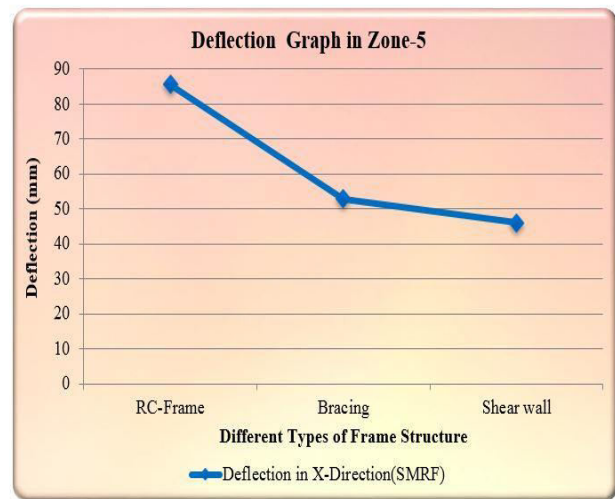


Fig 4.2 Comparison of Deflection for 5-storeys in Zone-5

Table 4.1 Deflection Comparison with RC-Frame in Zone-3

No. of storey	RC- Frame (mm)	Bracing (mm)	Shear Wall (mm)
5 Storey	63.405	39.153	34.127

Table 4.2 Deflection Comparison with RC-Frame in Zone-5

No. of storey	RC- Frame (mm)	Bracing (mm)	Shear Wall (mm)
5 Storey	85.505	52.809	45.968



Table 4.3 Maximum Percentage Reduction in Deflection with RC-Frame in Zone-3

No. of storey	Braced Frame	Shear Wall
5 Storey	38.25%	46.18%

Table 4.4 Maximum Percentage Reduction in Deflection with RC-frame in Zone-5

No. of storey	Braced Frame	Shear Wall
5 Storey	38.24%	46.24%

V. CONCLUSION

In this Analysis work, From the deflection point of view, it is analyzed that braced frame & shear wall structures reduces maximum deflection at top storey up to 49% & 58.78% respectively as compared to RC- frame in zone-3. Similarly, for zone-5 deflection reduces up to 38.24% & 58.81% in braced frame & shear wall respectively. Hence, it is concluded that shear wall structure is more effective in high rise building for reducing the maximum deflection.

Hence it is finally concluded from all the above results that, shear wall and bracing system in the structure is more resilient in the event of the earthquake. At times it is also the cost-effective solution for the earthquake resistant design of structures. From deflection point of view in high rise building shear wall structure is more suitable.

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