Study of Lateral Load Resisting Systems of Variable Heights in All Soil Types of High Seismic Zone

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Abstract— A natural hazard like Earthquake causes damage to or collapse of buildings if not designed for lateral loads resulting due to Earthquake. Hence for seismic resistance for high rise structures it is important to provide exclusive Lateral Load Resisting System (LLRS) which will supplement the behavior of moment resisting frames in resisting the lateral load. The dual structural system consisting of special moment resisting frame (SMRF) and concrete shear wall has better seismic performance due to improved lateral stiffness and lateral strength. A well designed system of shear walls in a building frame improves its seismic performance significantly. Steel bracings are also one of the successful lateral load resisting system. The use of steel bracing systems for strengthening or retrofitting seismically inadequate reinforced concrete frames is a viable solution for enhancing earthquake resistance. In the present study, we have used square grid of 20m in each direction of 5m bay in each direction, software used for the analysis is ETABS 7.0, and the work has been carried out for the different cases using shear wall and bracings for the different heights, maximum height considered for the present study is 75m. The modeling is done to examine the effect of different cases along with different heights on seismic parameters like base shear, lateral displacements and lateral drifts. The study also has been carried out for the different zones and different soil as specified in IS 1893-2002. Response of buildings with different heights is presented in table and graphs. Such a study may help to provide guidelines to assess more accurately the seismic vulnerability of building frames and may be useful for seismic design.

Keywords: Lateral Load Resisting System, High Seismic Zone

I. INTRODUCTION

Concrete is an ideal building material, combining economy, versatility of form and function, and noteworthy resistance to fire and the ravages of time. The raw materials are available in practically every country, and the manufacturing of cement is relatively simple. It is little wonder that in this century it has become a universal building material. Tall buildings are the most complex built structures since there are many conflicting requirements and complex building systems to integrate. Today's tall buildings are becoming more and more slender, leading to the possibility of more sway in comparison with earlier high-rise buildings. From the first high rise buildings constructed in the late 19th century until the modern day skyscrapers, the structure has played an important role in the overall design. Increasing height and slenderness brought about a change in the structural engineers focus from static gravity loads to horizontal dynamic loads generated by wind and earthquakes. Thus the impact of wind and seismic forces acting on them becomes an important aspect of the design. Improving the structural systems of tall buildings can control their dynamic response. With more appropriate structural forms such as shear walls and braced structures, and improved material properties, the maximum height of concrete buildings has increased in recent decades. Therefore, the time dependency of concrete has become another important factor that should be considered in analyses to have a more reasonable and economical design.

II. LITERATURE REVIEW

1) Shaik Kamal Mohammed Azam, Vinod Hosur, Seismic Performance Evaluation of Multistoried RC framed buildings with Shear wall. The dual structural system consisting of special moment resisting frame (SMRF) and concrete shear wall has better seismic performance due to improved lateral stiffness and lateral strength. A well designed system of shear walls in a building frame improves its seismic performance significantly. The configurations of RC moment resisting framed building structure with different arrangements of shear walls are considered for evaluation of seismic performance, so as to arrive at the suitable arrangement of shear wall in the structural framing system for better seismic resistance. The results of the study indicate that the provision of shear walls symmetrically in the outermost moment resisting frames of the building and preferably interconnected in mutually perpendicular directions forming a core will lead to better seismic performance. Reinforced concrete (RC) structural walls, conventionally known as shear walls are effective in resisting lateral loads imposed by wind or earthquakes. They provide substantial strength and stiffness as well as the deformation capacity (capacity to dissipate energy) needed for tall structures to meet seismic demand. It has become increasingly common to combine the moment resisting framed structure for resisting gravity loads and the RC shear walls for resisting lateral loads in tall building structures.
2) Anuj Chandiwala Earthquake Analysis of Building Configuration with Different Position of Shear Wall From the past records of earthquake, there is increase in the demand of earthquake resisting building which can be fulfilled by providing the shear wall systems in the buildings. For achieving economy in reinforced concrete building structures, design of critical section is carefully done to get reasonable concrete sizes and optimum steel consumption in members. In the present paper the researcher, had tried to get moment occur at a particular column including the seismic load, by taking different lateral load resisting structural systems, different number

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of floors, with various positions of shear wall for earthquake zone III in India has been found. Among different location of shear wall (F- shear wall at end of "L" section) gives best result. Main reason is end portion of flange always oscillate more during earthquake. Here shear wall directly obstruct this end oscillation, hence reduce overall bending moment of building.

3) Viswanath K.G, Prakash K.B., Anant Desai Seismic Analysis of Steel Braced Reinforced Concrete Frames Steel braced frame is one of the structural systems used to resist earthquake loads in multistoried buildings. Many existing reinforced concrete buildings need retrofit to overcome deficiencies to resist seismic loads. The use of steel bracing systems for strengthening or retrofitting seismically inadequate reinforced concrete frames is a viable solution for enhancing earthquake resistance. Steel bracing is economical, easy to erect, occupies less space and has flexibility to design for meeting the required strength and stiffness. In the present study, the seismic performance of reinforced concrete (RC) buildings rehabilitated using concentric steel bracing is investigated. The bracing is provided for peripheral columns. A four storey building is analyzed for seismic zone IV as per IS 1893: 2002. The effectiveness of various types of steel bracing in rehabilitating a four storey building is examined. The effect of the distribution of the steel bracing along the height of the RC frame on the seismic performance of the rehabilitated building is studied. The performance of the building is evaluated in terms of global and story drifts. The study is extended to eight storied, twelve storied and sixteen storied building. The percentage reduction in lateral displacement is found out. It is found that the X type of steel bracing significantly contributes to the structural stiffness and reduces the maximum interstorey drift of the frames.

The concept of using steel bracing is one of the advantageous concepts which can be used to strengthen or retrofit the existing structures. Steel bracings can be used as an alternative to the other strengthening or retrofitting techniques available as the total weight on the existing building will not change significantly. Steel bracings reduce flexure and shear demands on beams and columns and transfer the lateral loads through axial load mechanism. The lateral displacements of the building studied are reduced by the use of X type of bracing systems. The building frames with X bracing system will have minimum possible bending moments in comparison to other types of bracing systems.

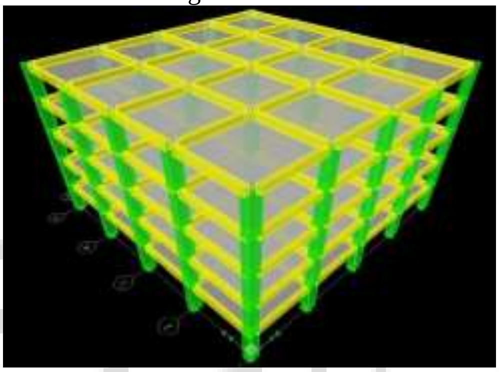
III. LATERAL LOAD RESISTING SYSTEMS

Using an appropriate structural system is critical to good seismic performance of buildings. While moment-frame is the most commonly used lateral load resisting structural system, other structural systems also are commonly used like structural walls, frame-wall system, and braced-frame system. Sometimes, even more redundant structural systems are necessary, e.g., Tube, Tube-in-Tube and Bundled Tube systems are required in many buildings to improve their earthquake behaviour. These structural systems are used depending on the size, loading, and other design requirements of the building. One structural system commonly used poses special challenges in ensuring good seismic performance of buildings; this is the Flat slab-column system. The system makes the building flexible in the lateral direction and hence the building deforms significantly even under small levels of shaking. Further, it has relatively low lateral strength, and therefore ductility demand during strong earthquake shaking tends to be large; many times, such levels of ductility cannot be incorporated in buildings with flat slab-column system. This structural system should not be used without introducing in the building stiff and strong lateral force resisting elements, like structural walls and braces.

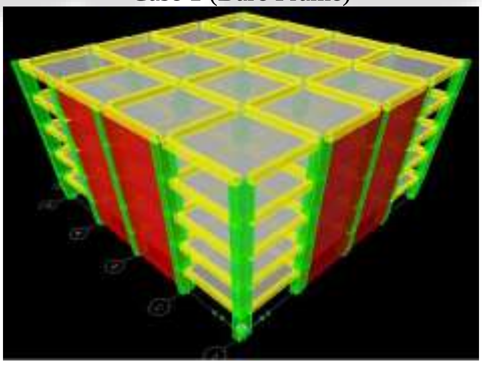
1) Moment Resisting Frames
2) Shear Walls
3) Bracings
4) Dual Systems

Different Cases of Study

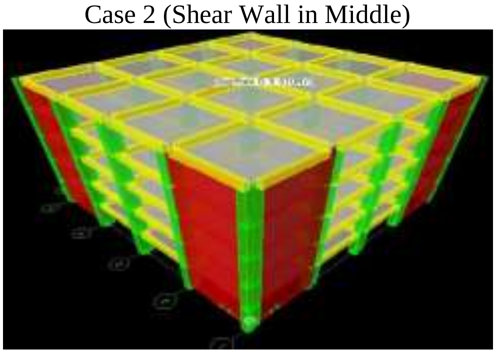
- Case 1: Bare Frame.
- Case 2: Shear Wall in the Middle.
- Case 3: Shear Wall at the Corners.
- Case 4: Bracings in the Middle.
- Case 5: Bracings at the Corners.



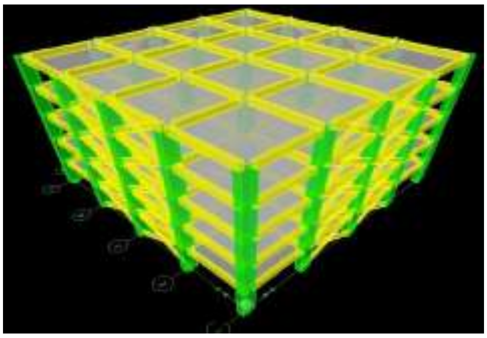
Case 1 (Bare Frame)



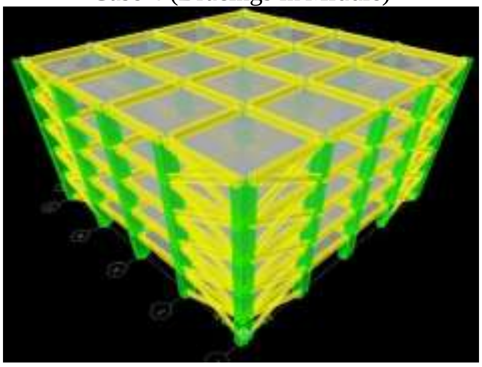
Case 2 (Shear Wall in Middle)



Case 3 (Shear Wall at Corners)



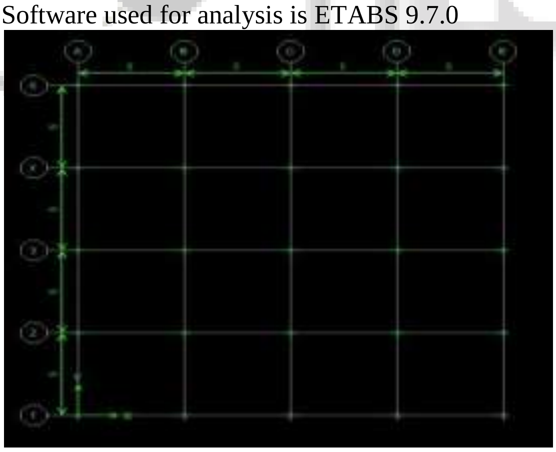
Case 4 (Bracings in Middle)



Case 5 (Bracings at Corners)

IV. PROBLEM DEFINITION

1) Square grid of 20m each in both X and Y direction.
2) Grid contains 4 bays of 5m each in both X and Y direction.
3) Height of each story 3m.
4) Height of building is varied from 15m, 30m, 45m, 60m and 75m.
5) Software used for analysis is ETABS 9.7.0



Plan of the Building

A. Details of the Problem:

1) Materials used:

1) M50 grade of concrete.
2) Fe 415 steel.

Frame properties:

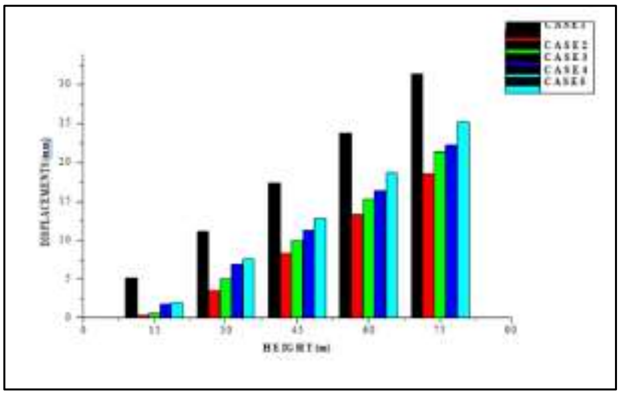
1) Beams 0.3m X 0.6m.
2) Columns 0.5m X 0.9m.(Story 1 to 10)
   0.5m X 0.75m. (Story 11 to 20)
   0.5m X 0.6m. (Story 21 to 25)
3) Slabs 0.125m.
4) Shear wall thickness 0.3m.
5) Bracings ISMB 500.

Live load: 3.5 kN/m2
Dead load of wall as UDL: 14 kN/m2
Damping: 5%
The study has been carried out for all the seismic zones and all types of soils.

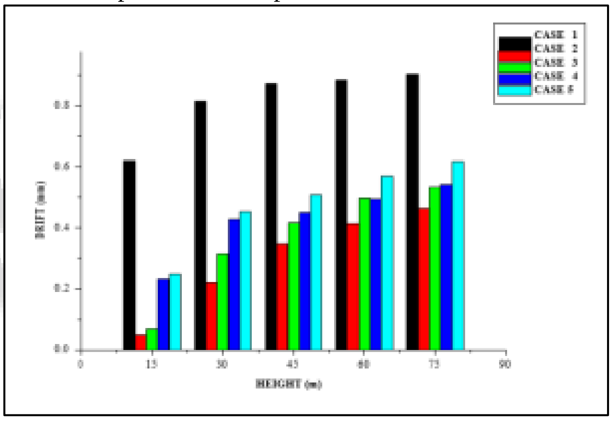
V. RESULTS AND DISCUSSIONS

A. Zone 5 Results:

1) Zone 5 Hard Soil

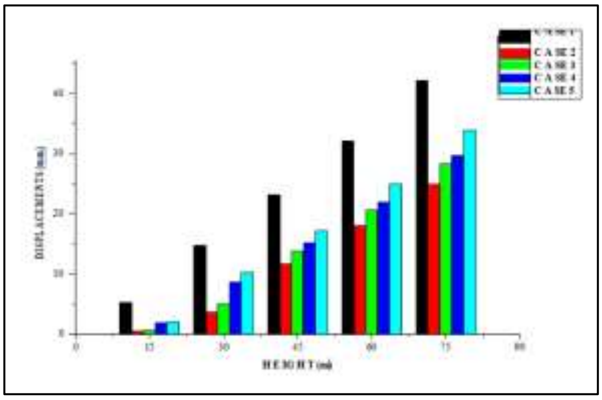


Displacement Graph for Zone 5 Hard Soil



Drift Graph for Zone 5 Hard Soil

2) Zone 5 Medium Soil



Displacement Graph for Zone 5 Medium Soil

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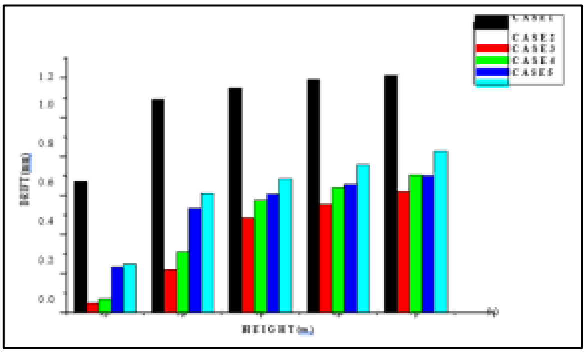
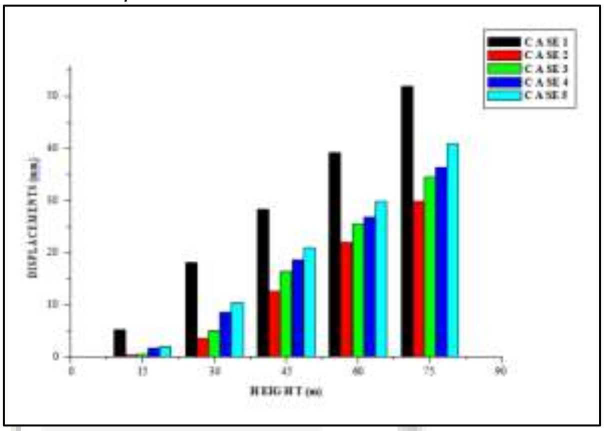
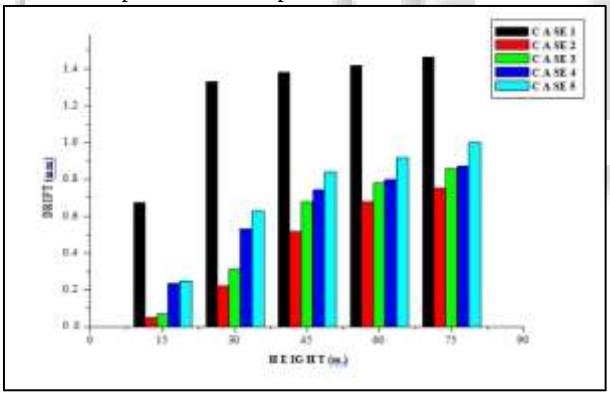


Drift Graph for Zone 5 Medium Soil

3) Zone 5 Soft Soil



Displacement Graph for Zone 5 Soft Soil



Drift Graph for Zone 5 Soft Soil

VI. CONCLUSION

In the present study, response spectrum analysis is carried out on different cases and is carried out on different seismic zones of India and different types of soils. The conclusions that can be drawn from the results discussed in the previous chapter are as follows:

1) Least lateral displacements and drift is given by zone II and maximum is given by zone V.
2) Lateral displacements and drift increases as the soil type changes form hard to soft.
3) Base shear also increases as the soil type changes from hard to soft.
4) Lateral displacements and drift increases as the height of the building increases.
5) Case 1(Bare Frame) produces larger lateral displacements and drift compared to all other cases.
6) Lateral displacements and drift is significantly lower after inserting shear wall and bracings.
7) From the study it is clear that CASE 2 (Shear Wall in Middle) is performing better and more efficient than all other cases in different zones and different types of soils.
8) Case 3 (Shear Wall at corners) and Case 4 (Bracings in middle) results doesn't very much.

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