Seismic Analysis of RCC Structure with Floating Column on Different Position

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Abstract— The present work focuses on behaviour of structure with and without provision of floating column and it is necessary to check whether the structure is safe or unsafe with floating column when it is built in seismically active areas and to check the complexities due to floating columns and also to find the building with floating columns is economical or uneconomical. The modelling and analysis is done as per Indian standards codes for G+ 10 OMRF (Ordinary RC moment resting frame) structure. Equivalent static analysis is done as per IS 1893 (part 1): 2002 for earthquake zone III using the STAAD Pro V8i S5 software. The results of the performance and analysis of the structure are then represented graphically form and is compared to determine the best performance of the building against lateral stiffness. A comparative analysis is done in terms of Base shear, Displacement, maximum bending moments in X and Z directions and maximum torsions in beams, Axial forces and moments in Y and Z directions in columns.

Key words: Floating Column on Different Position, RCC Structure

I. Introduction

The most prominent tall buildings are called 'high-rise building' in most countries and 'tower blocks' in Britain and some European countries. Generally, a high-rise structure is considered to be one that extends higher than the maximum reach of available fire-fighting equipment. or about seven to ten stories. Many urban multi-storey buildings in India today have open first storey. This is primarily being adopted to accommodate parking or reception lobbies in the first storey. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height. The behaviour of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground. The earthquake forces developed at different floor levels in a building need to be brought down along the height to the ground by the shortest path; any deviation or discontinuity in this load transfer path results in poor performance of the building. Buildings with vertical setbacks (like the hotel buildings with a few stories wider than the rest) cause a sudden jump in earthquake forces at the level of discontinuity.

A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground. Floating column is also a vertical member which rests on a horizontal member i.e. beam. The beams in turn transfer the load to other columns below it. Column that floats or hangs with above stories to provide more open space is known as Floating column.

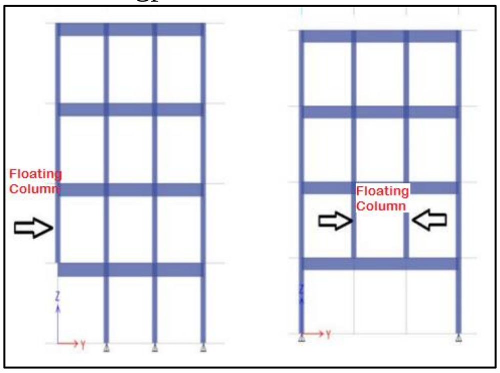

Fig. 1: Floating Column

Floating columns are implemented, especially above the base floor, so that added open space is accessible for assembly hall or parking purpose. But such column cannot be implemented easily to construct practically. The floating column is used for the purpose of architectural view and site situations. Since balconies are not counted in floor space index (FSI), buildings have balconies overhanging in the upper stories beyond the column foot print areas at the ground storey. In such cases, floating columns are provided along the overhanging perimeter of the building.

II. Modeling and Analysis

In order to understand the effect of different positions of floating columns in a structure and to compare the seismic response of all the models, the modelling has been done using STAAD-PRO V8i S5. Floating columns are provided at 3 different positions and shear wall are also provided to increase the stiffness of the building. Complete analysis is carried out for dead load, live load & seismic load. All combinations are considered as per IS 1893:2002. The building is assumed to be symmetric in plan. Therefore, a single plane frame has been adopted to be illustrative of the building along one direction for the design and analysis. Length and width of the building is considered as 27.04 m and 26.16 m respectively. Each storey height is considered as 3.1m. Height of the building is 34.1 m. Material grades of M40 & Fe415 were used for the design.

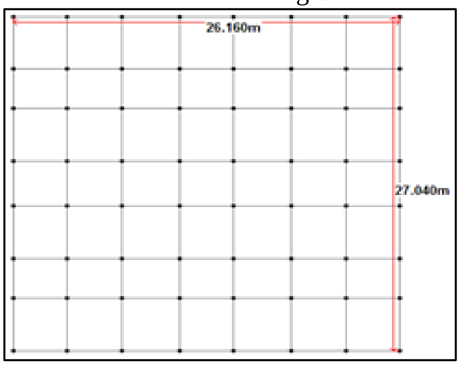

Fig. 2: Plan of Actual Building

A. Different Models Used for Analysis are Listed Below

1) Model 1

This is basic model without floating columns and shear wall (Figure 3).

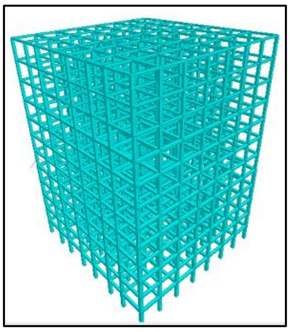

Fig. 3: 3D View of Actual Building

2) Model 2

This is basic model without floating columns and shear wall are provided at centre of the building (Figure 4).

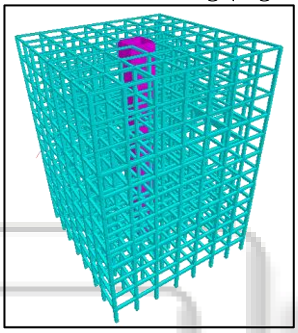

Fig. 4: Shear wall at centre of building

3) Model 3

This is basic model without floating columns and shear wall are provided at 4 sides of the building (Figure 5).

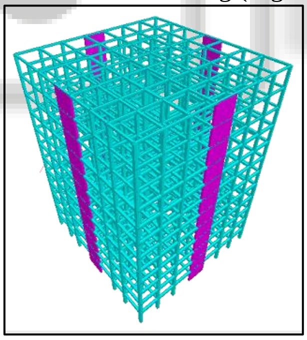

Fig. 5: Shear wall at 4 sides of building

4) Model 4

In this model floating columns are provided at outer periphery of the building and shear wall are provided at centre of the building (Figure 6).

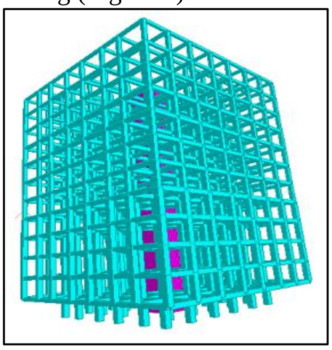

Fig. 6: Floating column at outer periphery and shear wall at center of the building

5) Model 5

In this model floating columns are provided at outer periphery of the building and shear wall are provided at 4 sides of the building (Figure 7).

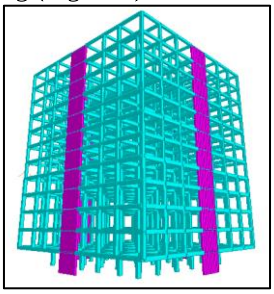

Fig. 7: Floating column at outer periphery and shear wall at 4 sides of the building

6) Model 6

In this model floating columns are provided at 1st intermediate series of columns and shear wall are provided at center of the building (Figure 8).

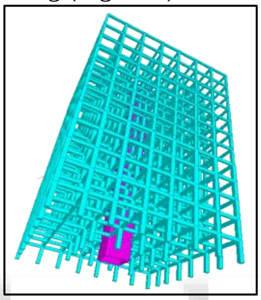

Fig. 8: Floating column at 1st intermediate position of columns and shear wall at centre

7) Model 7

In this model floating columns are provided at 1st intermediate series of columns and shear wall are provided at 4 sides of the building (Figure 9).

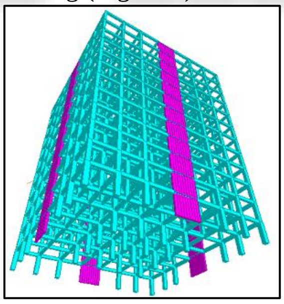

Fig. 9: Floating column at 1st intermediate position of columns and shear wall at 4 sides of the building

8) Model 8

In this model floating columns are provided at 2nd intermediate series of columns and shear wall are provided at centre of the building as in model 2 (Figure 10).

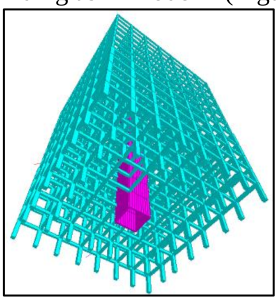

Fig. 10: Floating column at 2nd intermediate position of columns and shear wall at center of the building

9) Model 9

In this model floating columns are provided at 2nd intermediate series of columns and shear wall are provided at 4 sides of the building (Figure 11).

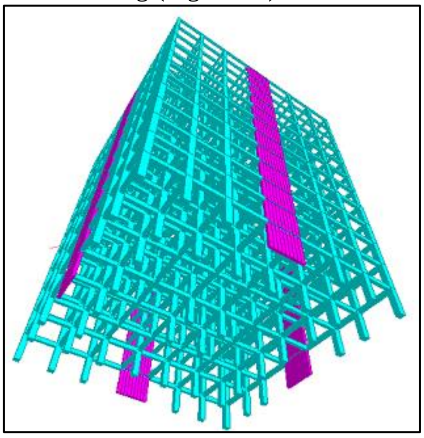

Fig. 11: 3D view of building with floating column at 2nd intermediate position of columns and shear wall at 4 sides of the building

III. Results and Discussion

Comparison of the analytical results between the structure with and without floating column for various parameters such as Joint Displacement, base shear, storey drift, bending moment & axial force are represented in graphical format.

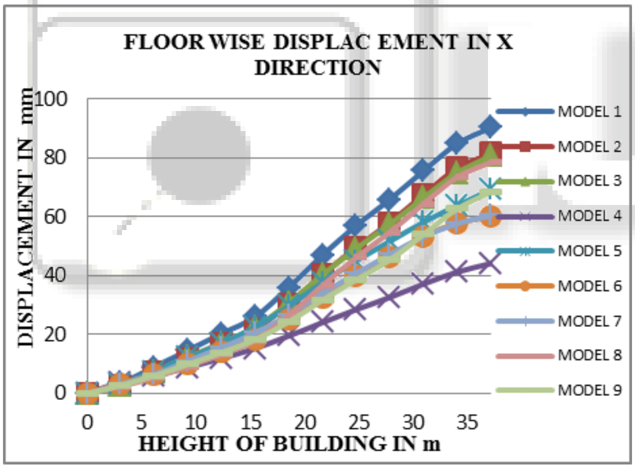

Fig. 12: Variation of floor wise lateral displacement of various structures in X direction

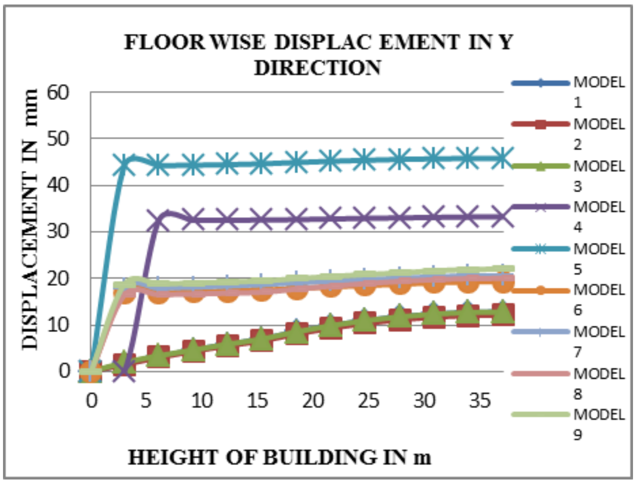

Fig. 13: Variation of floor wise lateral displacement of various structures in Y direction

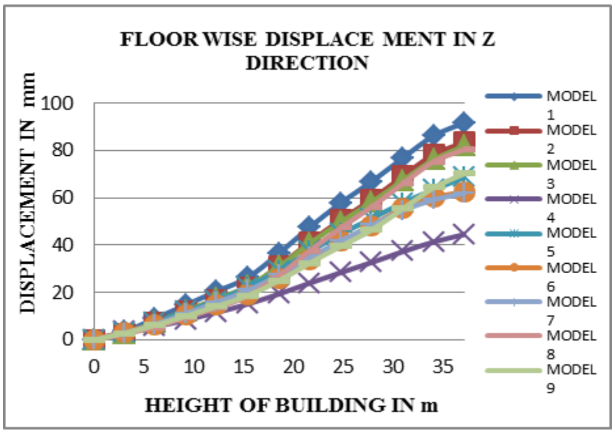

Fig. 14: Variation of floor wise lateral displacement of various structures in Z direction

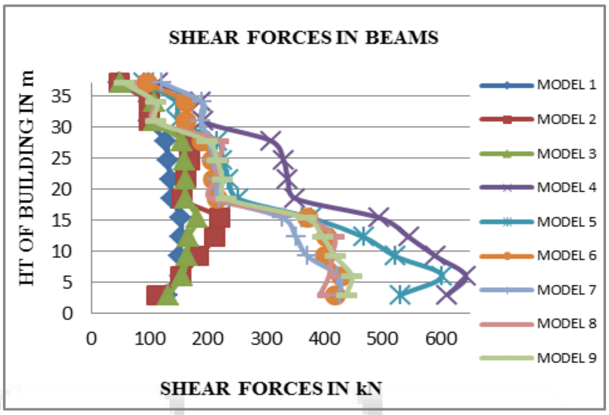

Fig. 15: Variation of shear forces in kN for beams for all the structures

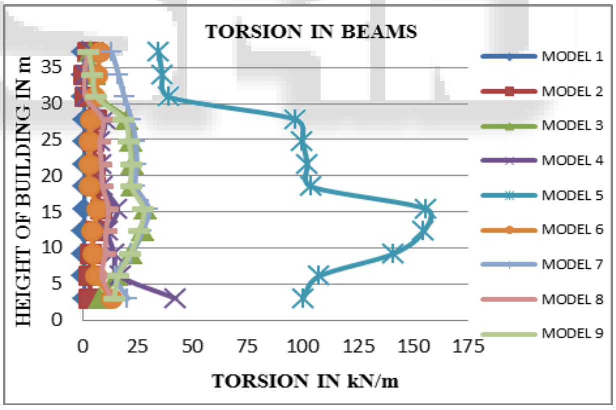

Fig. 16: Variation of torsion in kN-m for beams for all the structures

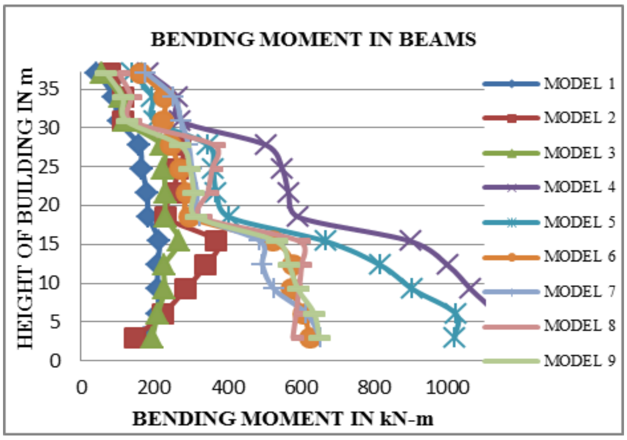

Fig. 17: Variation of bending moments in beams in kN-m for all the structures

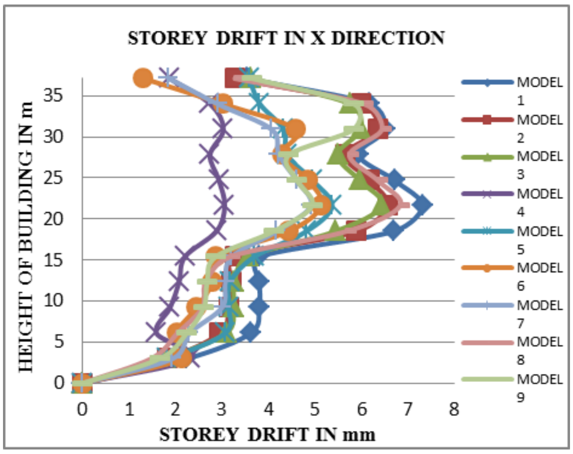

Fig. 18: Variation of storey drifts in mm in X direction for all the structures

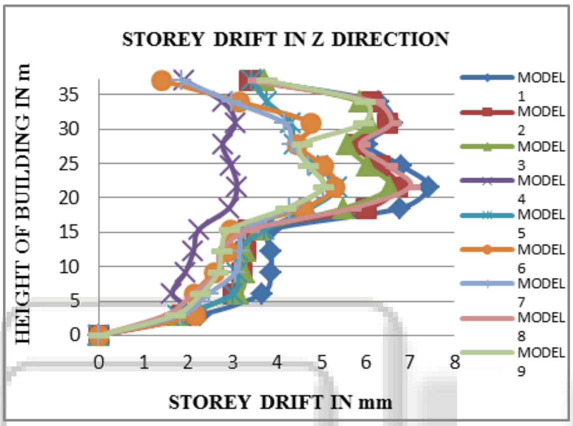

Fig. 19: Variation of storey drifts in mm in Z direction for all the structures

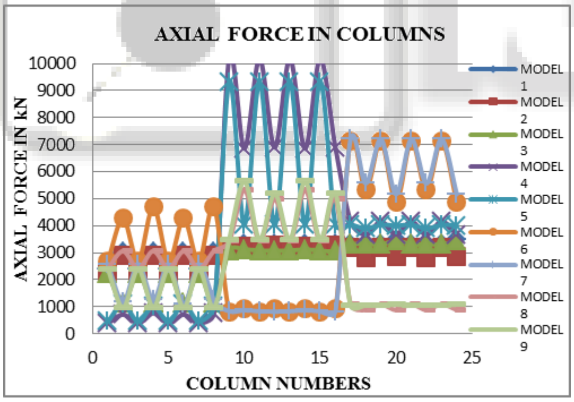

Fig. 20: Variation of axial forces in kN for particular beams for all the structures

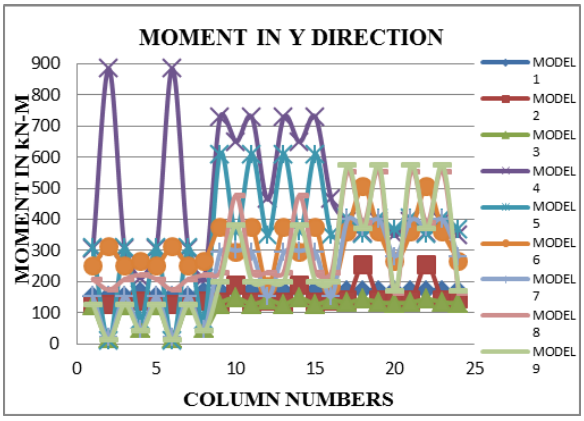

Fig. 21: Variation of moments in kN-m for particular columns in Y dir for all the structures

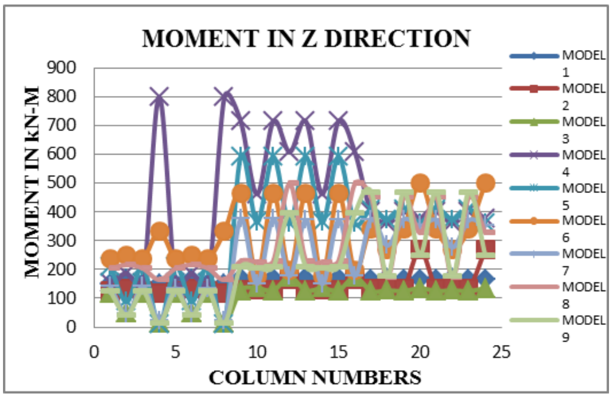

Fig. 22: Variation of moments in kN-m for particular columns in Z direction for all the structures

IV. CONCLUSION

1) Shear walls are much efficient in reducing lateral displacement of a structure as drift and horizontal deflection produced in shear wall structure are much less than that produced in bare frame and plane frame.
2) Provision of shear wall provides large stiffness to the structure by reducing the damage to the structure.
3) Position of shear wall shows statically significant effect on behaviour of structure during earthquake excitations.
4) The position of shear wall at center of building is favourable for lateral displacement in case of structures with floating column at outer periphery i.e. model 4. While position of shear wall at 4 sides of building are efficient in case of other positions of floating columns.
5) It can be concluded after analysis of structures with provision of floating column that displacement of models with floating column is more as compare to the displacement of models without floating column.
6) Shear force in beams goes on decreasing as the no of floors goes on increasing.
7) Torsion in beams for a model 5 (floating column at outer periphery and shear walls are provided at 4 sides of building) show largest value as compare to remaining models.
8) Bending moment in a beams for model 1, model 2 and model 3 i.e. models without floating column are less as compare to other models with floating column.
9) The storey drift of structure is decreases after provision of shear wall i.e. storey drift of model 1 (without shear wall) is more relatively compare to model 2 (shear wall at center of the building) and model 3 (shear wall at 4 sides of the building).
10) Axial forces in a column for model 4 and model 5 shows normal values for columns at outer periphery (i.e. for floating column) but suddenly increase for 1st intermediate position of a column and then again decreases and vice versa for model 6 and model 7. Model 8 and model 9 shows same behaviour that of model 4 and model 5.
11) Moment tin Y & Z direction for model 1, model 2 and model 3 does not shows much variation while moment in Y as well as Z direction for model 4 and model 5 shows more values as compare to other.

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