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RESEARCH ARTICLE

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SEISMIC RESPONSE OF COMPLEX BUILDINGS WITH FLOATING COLUMN FOR ZONE II AND ZONE V

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ABSTRACT

The scope of present work is to study the importance of explicitly recognizing the presence of the floating column in the analysis of building and also, along with floating column some complexities were considered for ten storey building at different alternative location and for lower and higher zones. Alternate measures, involving stiffness balance of that storey where floating column is provided and the storey above, are proposed to reduce the irregularity introduced by the floating columns. The high rise building is analyzed for earthquake force by considering two type of structural system. Frame with only floating column and floating column with complexities for reinforced concrete building. Finally, analysis results in the high rise building such as storey drifts, storey displacement, and storey shear were compared in this study. Analysis was carried out by using Extended Three Dimensional Analysis of Building Systems (ETABS) version 9.7.4 software.

KEYWORDS: Floating column, Soft storey, Irregular Building, Earthquake Behavior, Complexities.

INTRODUCTION

A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground. The term floating column is also a vertical element which at its lower level rests on a beam which is a horizontal member. Buildings with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer path. The beams in turn transfer the load to other columns below it. Such columns where the load was considered as a point load.

There are many projects in which floating columns are already adopted, especially above the ground floor, so that more open space is available on the ground floor. These open spaces may be required for assembly hall or parking purpose. The column is a concentrated load on the beam which supports it. The structures already made with these kinds of discontinuous members are endangered in seismic regions. But those structures cannot be demolished; rather study can be done to strengthen the structure. The stiffness of these columns can be increased by retrofitting or these may be provided by bracing to decrease the lateral deformation. Many high rise buildings are planned and constructed with architectural complexities. The complexities are nothing but soft storey, floating column, heavy load, the reduction in stiffness, etc.

MODELING OF THE BUILDING

The entire work consists of four models (Model FC, Model FC+4, Model FC+HL, Model FC+4+HL). And these models were modeled and analysed for lower (II) and higher (V) seismic zones for medium soil condition. The results are tabulated for base shear, story drift and lateral displacements.

The model having only floating column, the model having a floating column by increasing the height of the storey, the model having a floating column by heavy load on the slab where floating column is provided, and a last model in which floating column is provided by rising the storey height a heavy load on slab, these four models were analysed by changing the location of floating column firstly in the middle, outer and in edge of the frame of building. The plans of the models are shown in figs 1, 2, 3. The models considered the present study are:

Model FC: Where **only Floating Column** is provided in a particular location, particular floor and in a particular zone.

Model FC+4: **Where Floating Column** is provided by **rising the Story Height by 4 m** in a particular location, particular floor and in a particular zone.

Model FC+HL: Where **Floating Column** is provided by applying **Heavy Load** on the slab, particular floor and in a particular zone. (Heavy load may be swimming pool, water tank or machinery room etc...)

Model FC+4+HL: Where **Floating Column** is provided by **rising the Story Height by 4 m** along with provision of **Heavy Load** in a particular location, particular floor and in a particular zone.

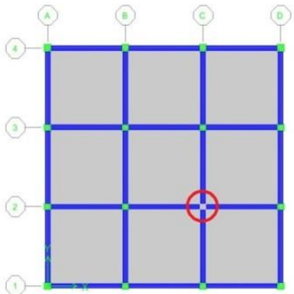

Fig 1: Floating Column in the middle of interior frame. (Red circle)

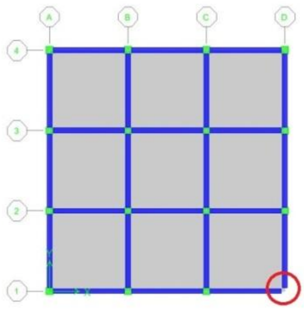

Fig 2: Floating Column in edge of exterior frame. (Red circle)

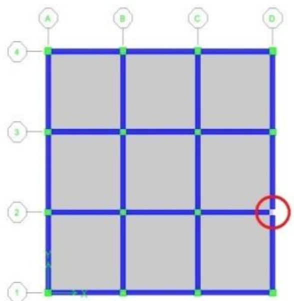

Fig 3: Floating Column in the outer face of exterior frame. (Red circle)

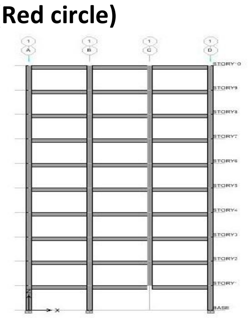

Fig 4: Floating column in the middle of the ground floor for Model FC. (In XZ plane).

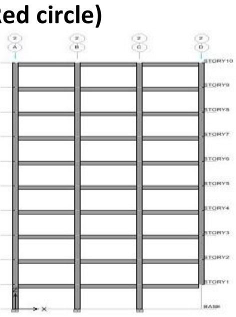

Fig 5: Floating column in edge of the ground floor for Model FC. (In XZ plane).

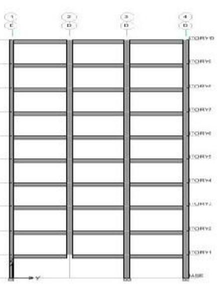

Fig 6: Floating column in the outer face of the ground floor for Model FC. (In ZY plane).

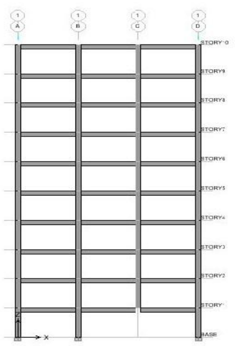

Fig 7: Floating column in the middle of the ground floor for
Model FC.

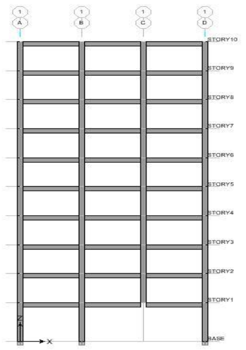

FIG 8: Floating column in the middle of the ground floor for
Model FC+4.

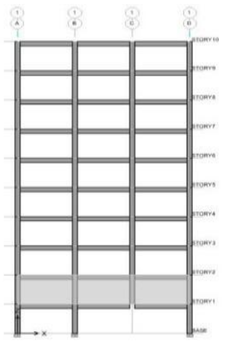

FIG 9: Floating column in the middle of the ground floor for
Model FC+HL.

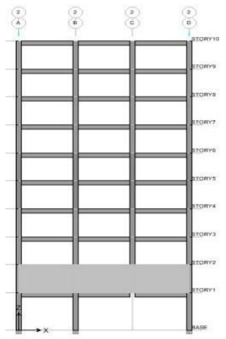

FIG 10: Floating column in the middle of the ground floor for
Model FC+4+HL

The figs 1,2 and 3 shows the plans which showing the location of the floating column, similarly the figs 4,5 and 6 shows cross sectional elevations of the particular plans. And the figs 7, 8, 9 and 10 shows the different models or the different complexities which are considered for the analysis purpose.

ETABS 9.7.4 version software is used for the analysis of all structural systems by linear static method for zones II and V. Hence the results are tabulated by focusing the parameters like, lateral displacements, base shear and story drift.

METHODOLOGY

The present study is done by using ETABS 9.7.4. It is a fully integrated program that allows model creation, modification, execution of analysis, design optimization, and results review from within a single interface. ETABS9.7.4 is a standalone finite element based structural program for the analysis and design of civil structures. It offers an intuitive, yet powerful user interface with many tools to aid in quick and accurate construction of the models, along with sophisticated technique needed to do more complex projects.

Table 1: Building Data

PARAMETERS	**Model FC**	**Model FC+4**	**Model FC+HL**	**FC+4+HL**
Soil Type	Medium soil (II)	Medium soil (II)	Medium soil (II)	Medium soil (II)
Seismic Zone	II and V	II and V	II and V	II and V
Response Reduction Factor	5	5	5	5
Importance factor	1	1	1	5
Height of Building	30 m	31 m	30 m	31 m
Floor Height	3 m	3 m and 4m	3 m	3 m and 4 m
Thickness of Slab	150 mm	150 mm	150 mm	150 mm
Beam Size	300X450 mm	300X450 mm	300X450 mm	300X450 mm
Column Size	450X450 mm	450X450 mm	450X450 mm	450X450 mm
Slab Thickness	150mm	150mm	150mm	150mm
Live Load	3.5 KN/m^2	3.5 KN/m^2	3.5 KN/m^2	3.5 KN/m^2
Heavy live load	-	-	10 KN/m^2	10 KN/m^2
Floor Finish	1 KN/m^2	1 KN/m^2	1 KN/m^2	1 KN/m^2
Heavy Dead load	-	-	10 KN/m^2	10 KN/m^2
Spacing of columns	5 m c/c	5 m c/c	5 m c/c	5 m c/c
Support condition	Rigid	Rigid	Rigid	Rigid
Material Properties	M25 Grade of Concrete	M25 Grade of Concrete	M25 Grade of Concrete	M25 Grade of Concrete
	Fe 415 Grade of Steel	Fe 415 Grade of Steel	Fe 415 Grade of Steel	Fe 415 Grade of Steel

RESULTS AND DISCUSSION

The present study is to compare, how the behaviour of a building having only floating column and having a floating column with complexities. The floating column locations are also varied to find the optimum position. For zone II and V, live load and dead loads were varied for heavy load condition. Analysis is carried out for various complex systems and the results are presented in the form of tables and figures and are discussed in the present chapter. The results are obtained in terms of Displacements, Storey shear, Storey drifts, for different parameters varied.

Floating column is provided in the middle of the ground floor.

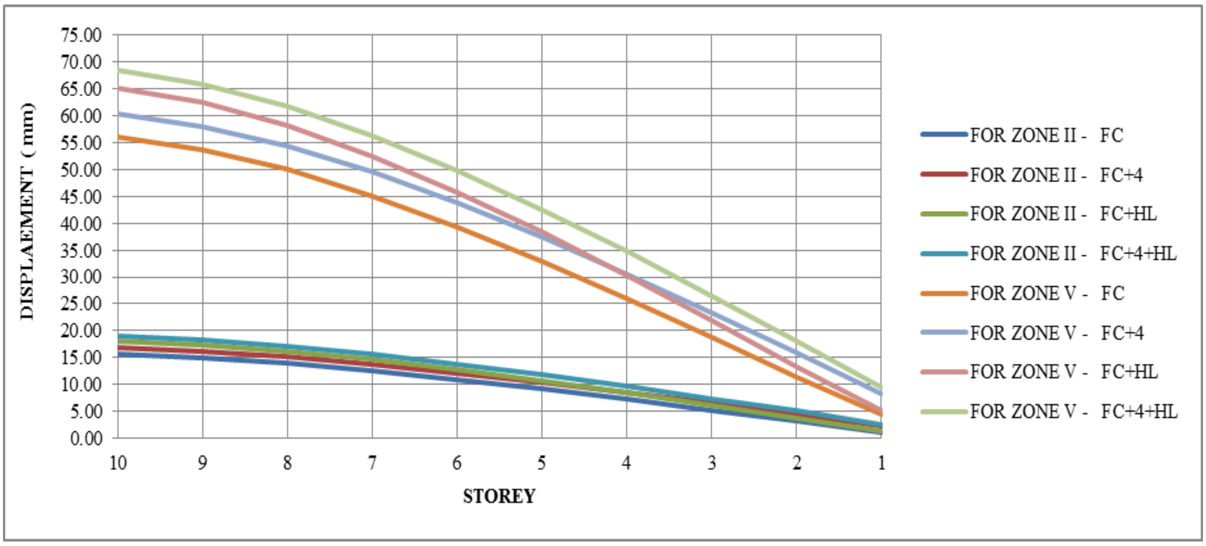

Fig 11: Comparison of Lateral Displacements.

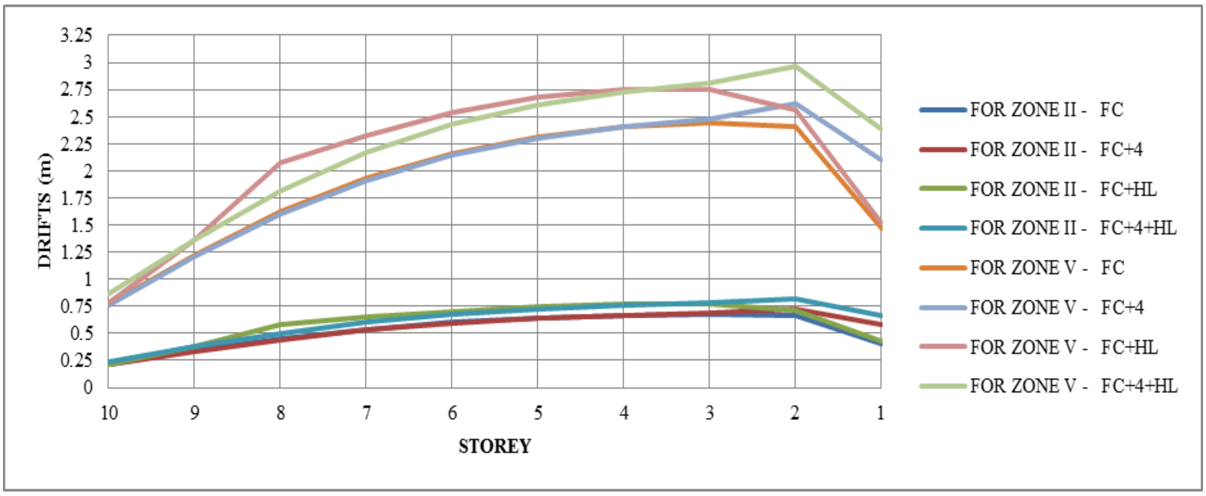

Fig 12: Comparison of Storey Drifts.

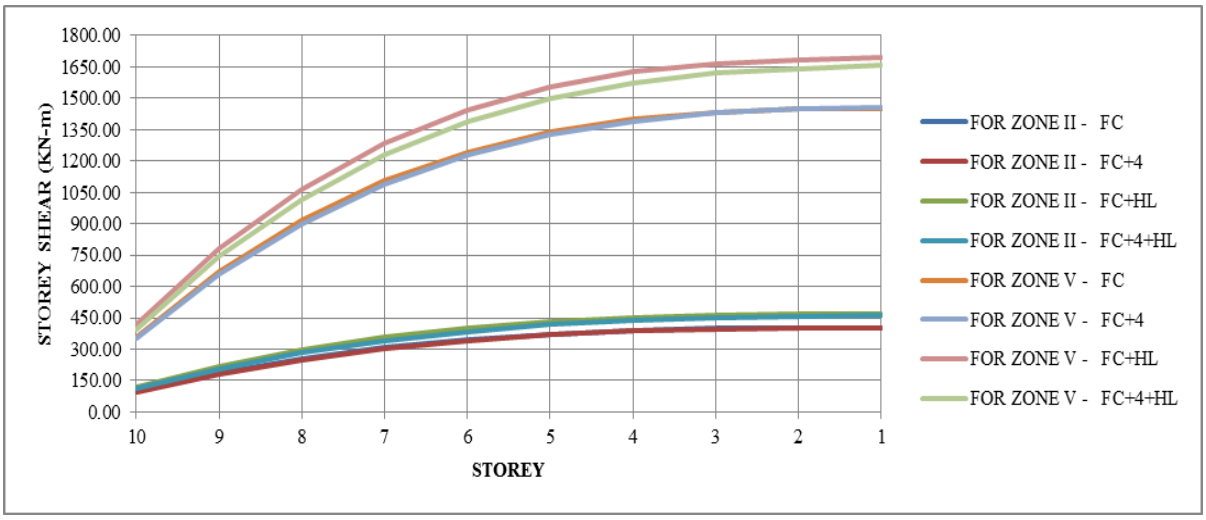

Fig 13: Comparison of Storey Shear.

Floating column is provided in the middle of eight floor.

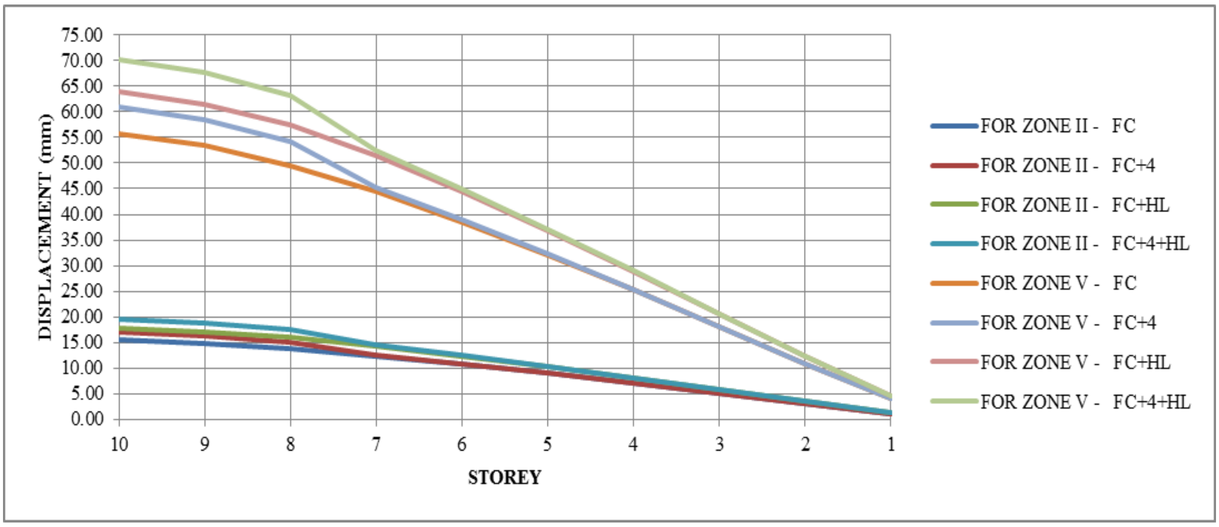

Fig 14: Comparison of Lateral Displacements.

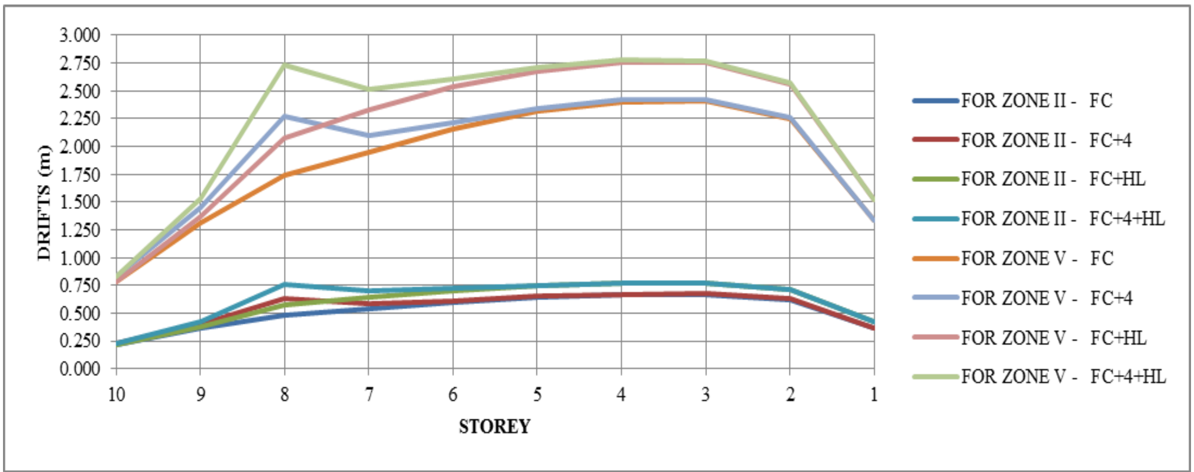

Fig 15: Comparison of Storey Drifts

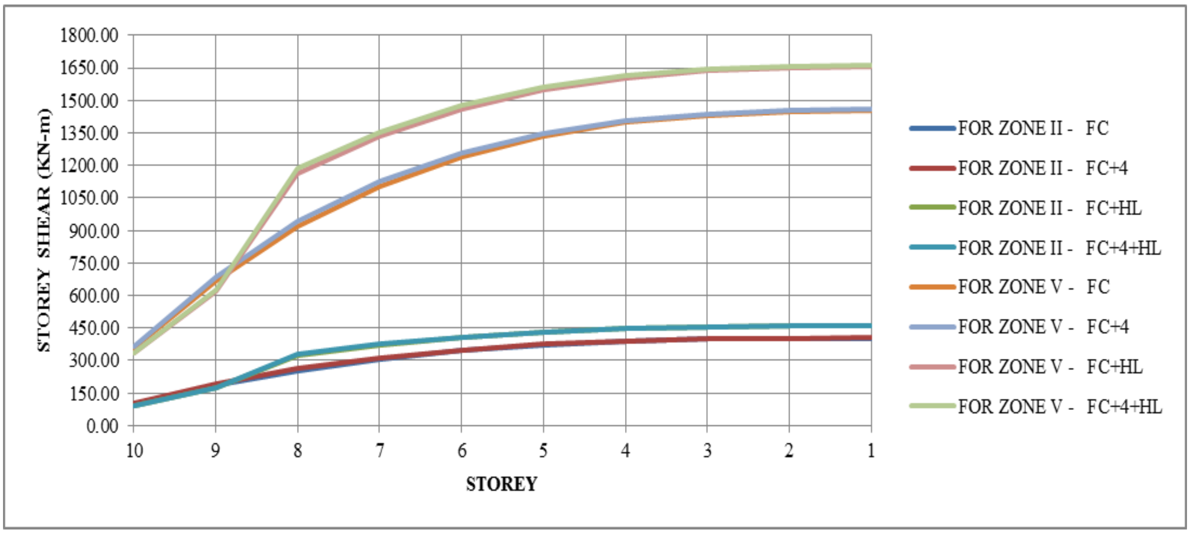

Fig 16: Comparison of Storey Shear

Floating column is provided in edge of the ground floor.

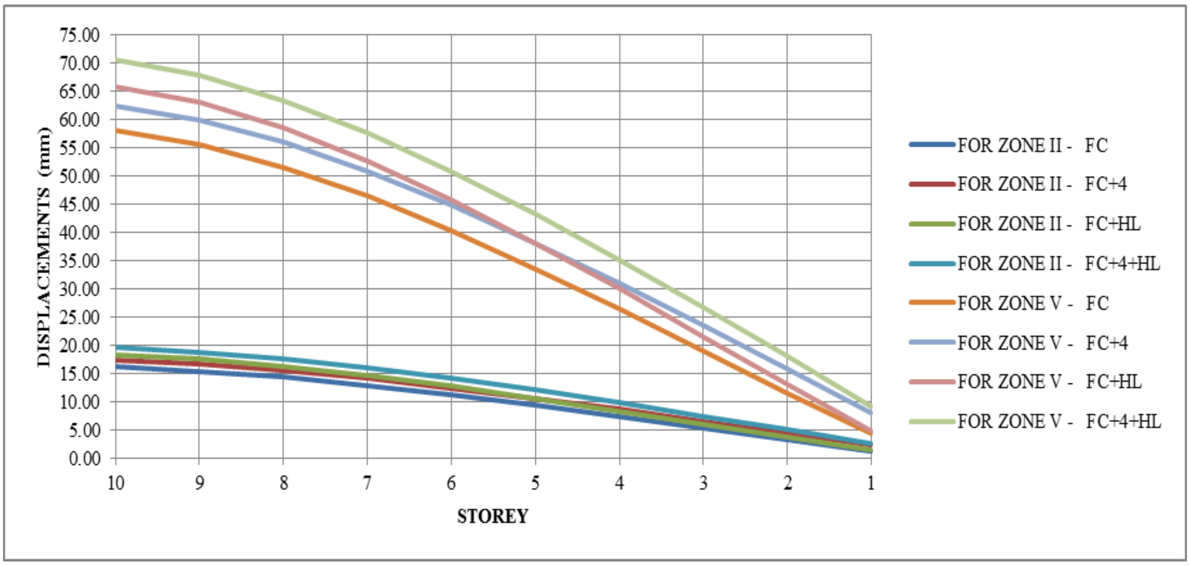

Fig 17: Comparison of Lateral Displacements.

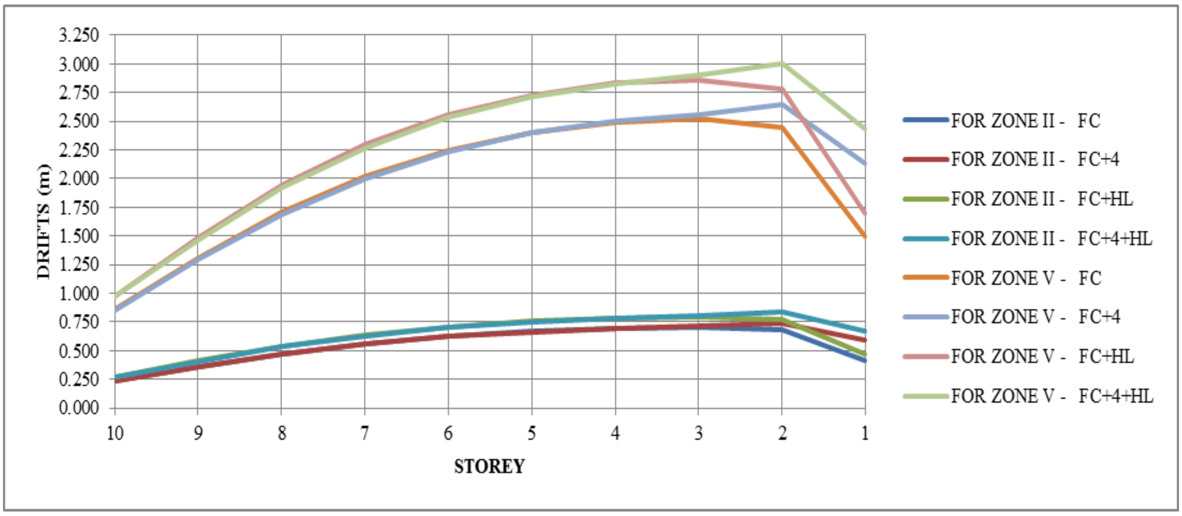

Fig 18: Comparison of Storey Drifts.

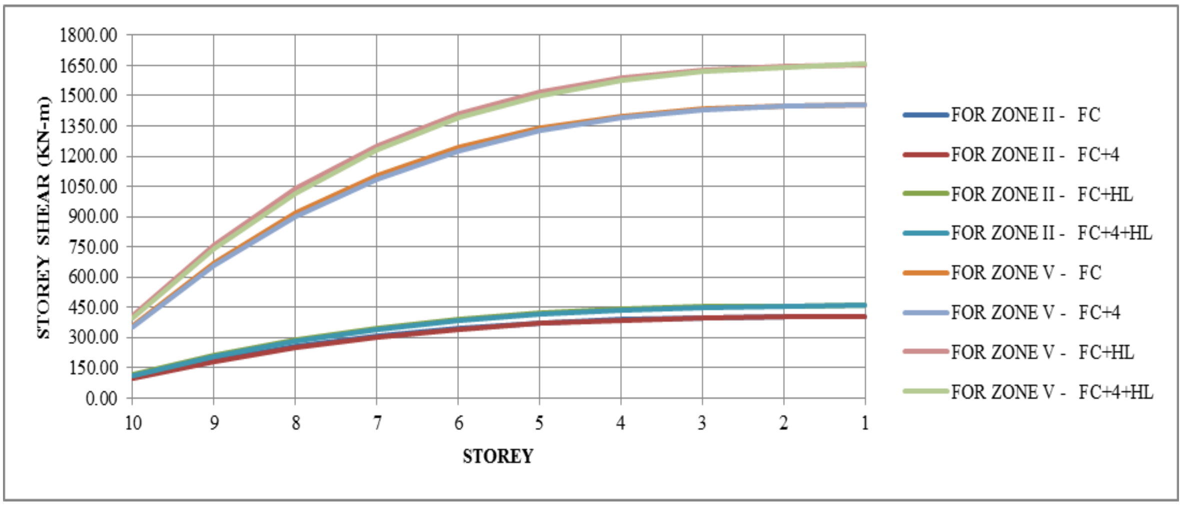

Fig 19: Comparison of Storey Shear

Floating column is provided in edge of eight floor.

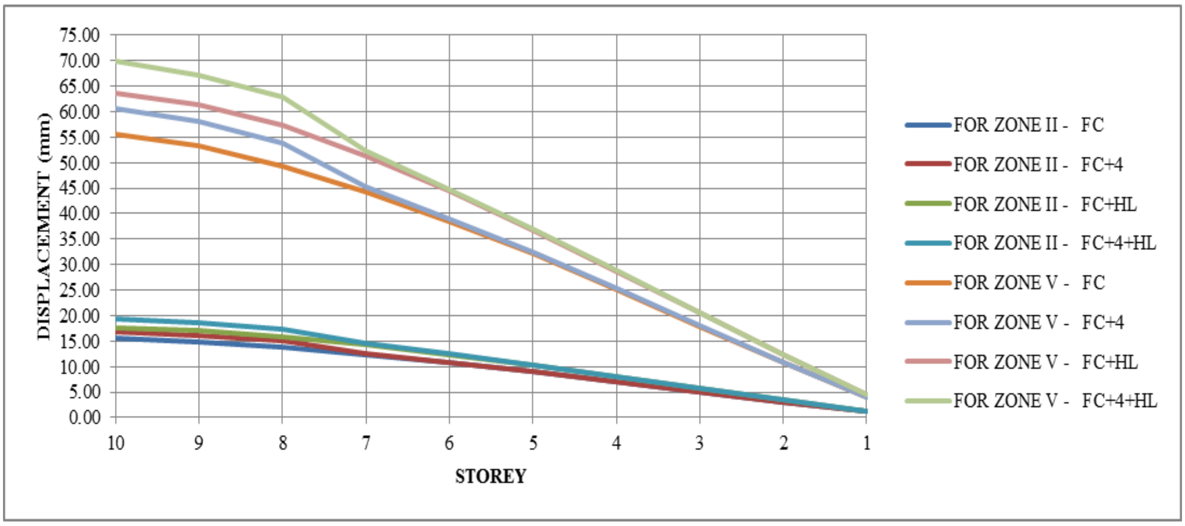

Fig20: Comparison of Lateral Displacements

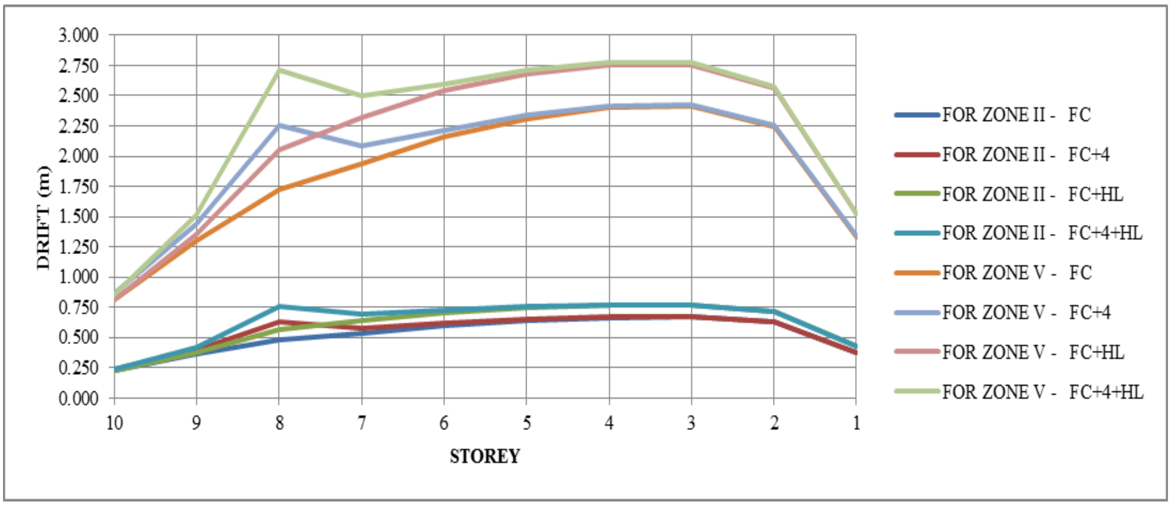

Fig 21: Comparison of Storey Drift

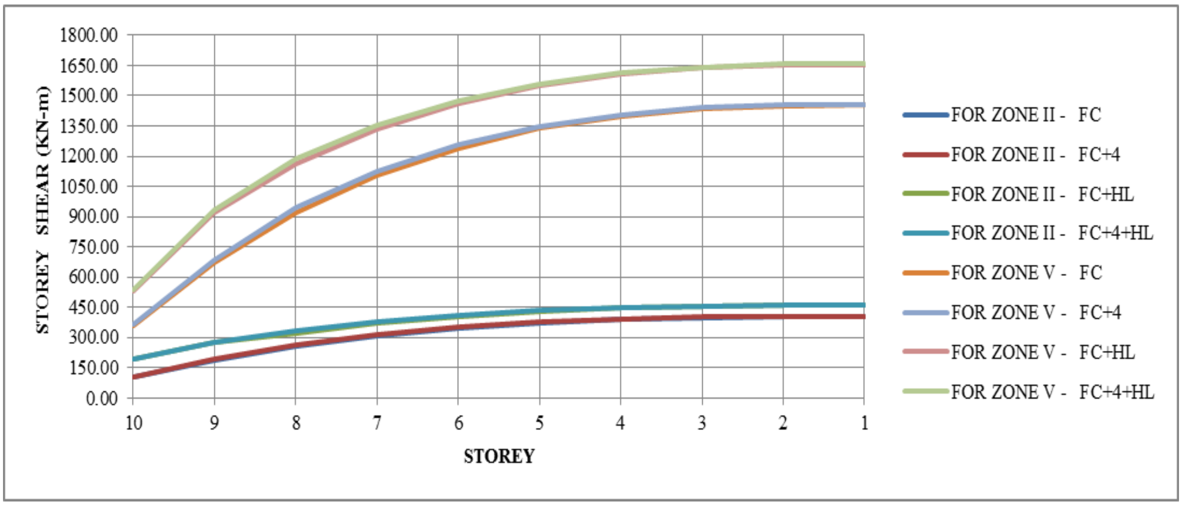

Fig 22: Comparison of Storey Shear

Floating column is provided in the outer face of the ground floor.

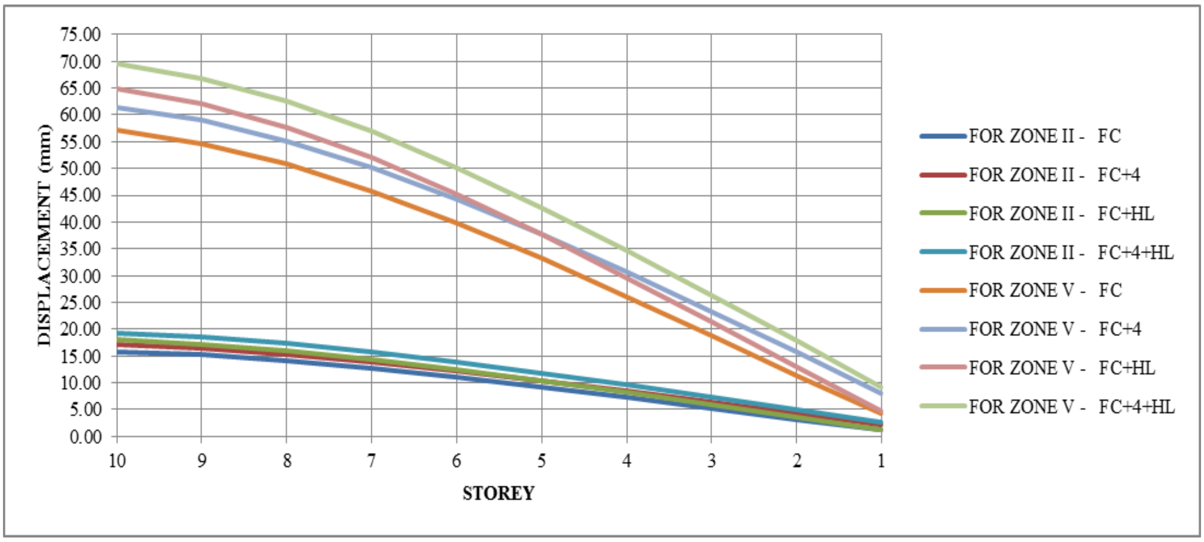

Fig 23: Comparison of Lateral Displacements

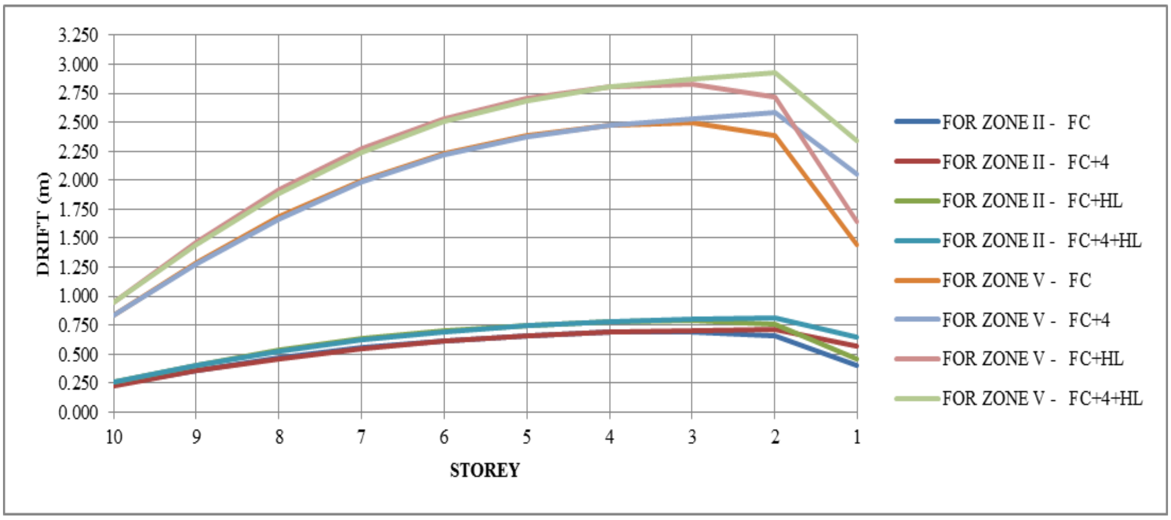

Fig 24: Comparison of Storey Drift

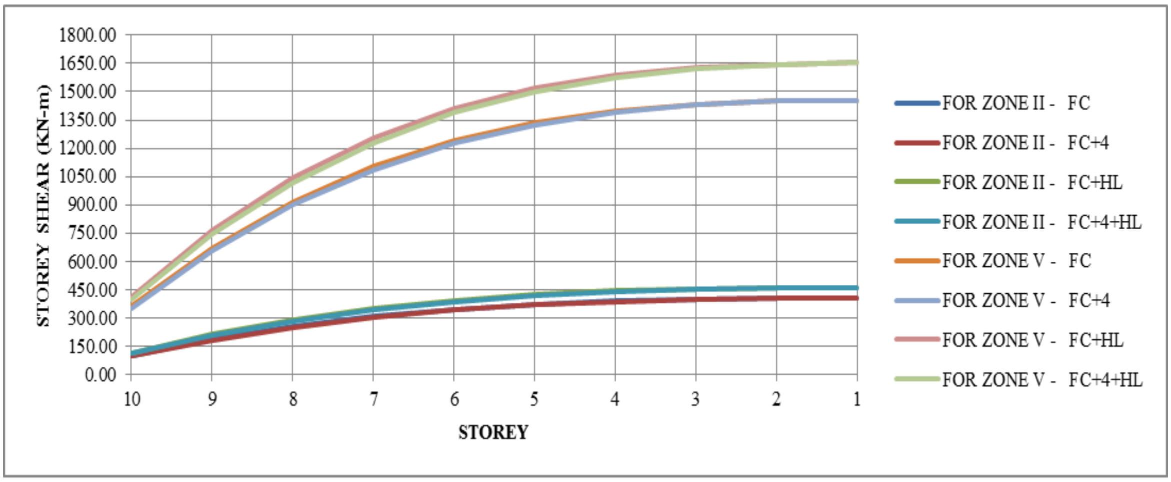

Fig 25: Comparison of Storey Shear

Floating column is provided in the outer face of eight floor.

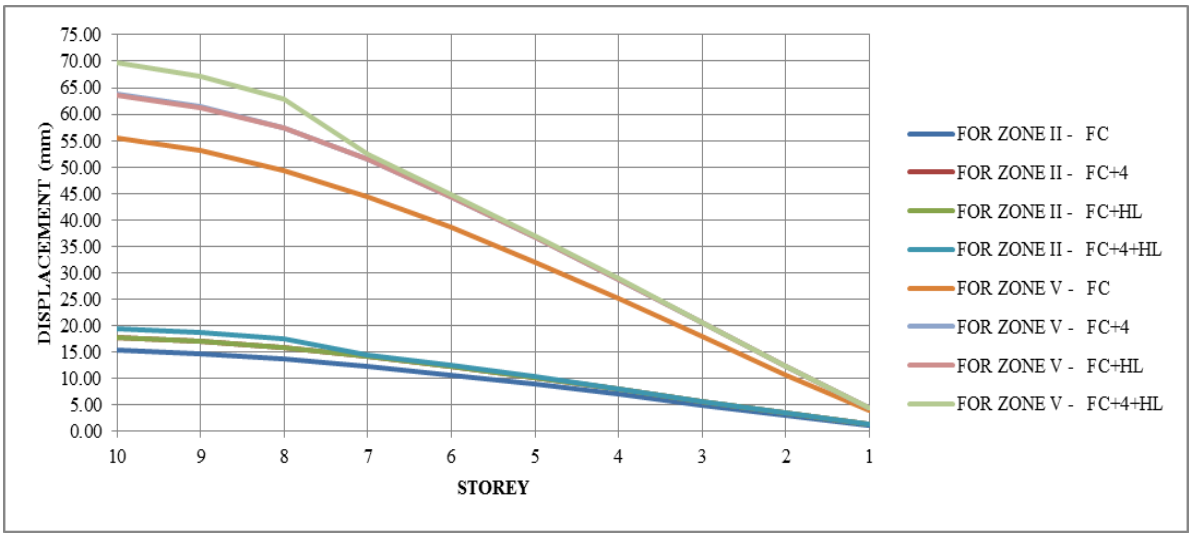

Fig 26: Comparison of Lateral Displacements

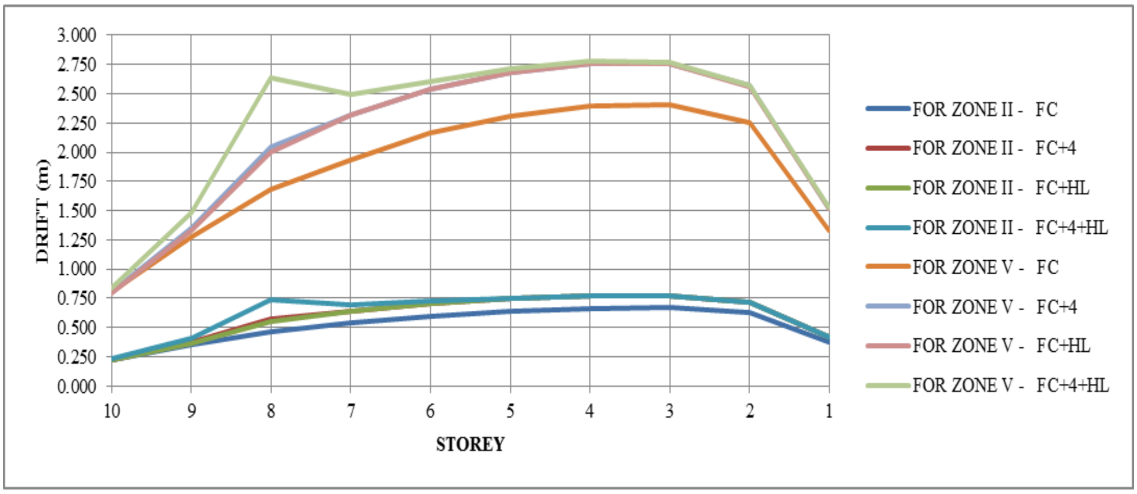

Fig 27: Comparison of Storey Drift

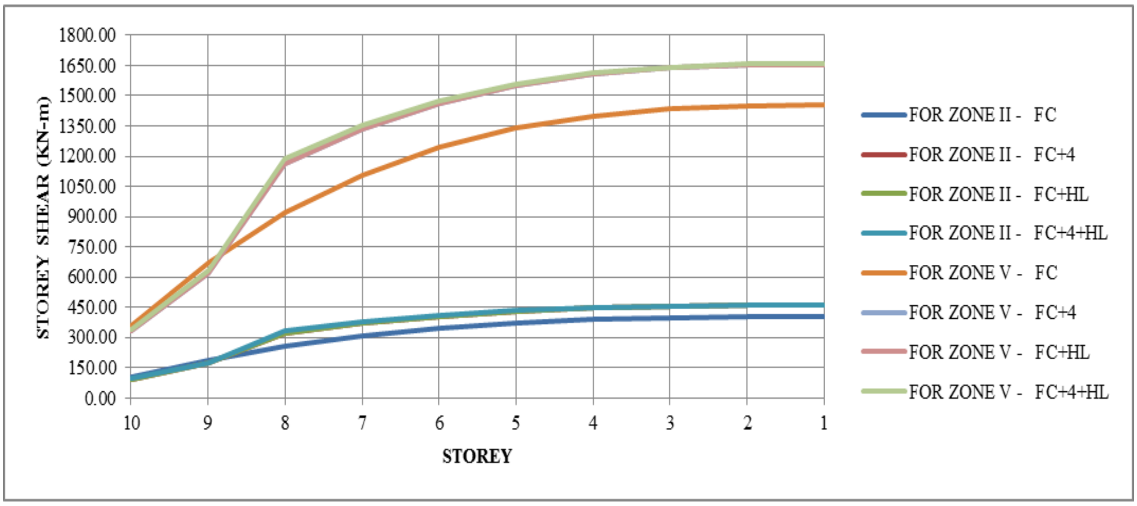

Fig 28: Comparison of Storey Shear

CONCLUSION

In the present investigation, an attempt has been made to compare the seismic behaviour of multi-storeyed structures with complexities, and the following are the conclusions are drawn from observing the above graphs. The analysis outputs were noted in terms of lateral displacements, storey drifts, and storey shear and were tabulated on the basis of linear seismic analysis. Based on the study the conclusions are as follows:

- The models FC+4, FC+HL, FC+4+HL are not preferred in higher zones because the more displacement value according to code. In lower zones all models were preferred but while designing special care should be taken.
- The displacement of the building increases from lower zones to higher zones, because the magnitude of intensity will be more for higher zones, similarly for drift, because it is correlated with the displacement.
- Storey shear will be more for lower floors, then the higher floors due to the reduction in weight when we go from bottom to top floors. And with this if we reduce the stiffness of upper floors automatically there will be a reduction in weight on those floors so in the top floors the storey shear will be less compared to bottom stories.
- The response of the building which is having only floating column will be less when compared to other (FC+4, FC+HL, FC+4+HL) models of the study.
- The maximum value of Displacement and Drift are more for the models FC+HL and FC+4+HL than the models FC and FC+4, due to increment in weight.
- Whether the floating columns on ground floor or in eight floors the displacement values increases when a floating column is provided in edge and middle than the outer face of the frame.
- The multi-storey building with complexities will undergo large displacement then the model having only floating column.
- In all models the displacement values are less for lower zones and it goes on increases for higher zone.
- There is a sudden change in storey shear in models FC+HL and FC+4+HL it is due to the heavy load on the slab, so there should not be any a sudden change in load in upper floors.
- The drifts are deviated more in model FC+4+HL compared to other models, particularly in above and below where floating column, which is provided in zone II and V so this model either be redesigned by replacing the properties of the model.

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