Seismic Analysis of Multistory Building with and without Floating Column

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Abstract – *Many buildings in recent times have planned and constructed for architectural complexities such as building with floating columns at various levels and locations. These floating columns are highly disadvantageous in building which is built in seismically prone areas. The earthquake forces which are developed at different levels in building need to be carried down along the height to ground by shortest path, but due to floating column there is discontinuity in the load transfer path which results in poor performance of building.*

In this study the analysis of G+5 storey normal and floating column building is considered and analysis is done using ETABS-2015.

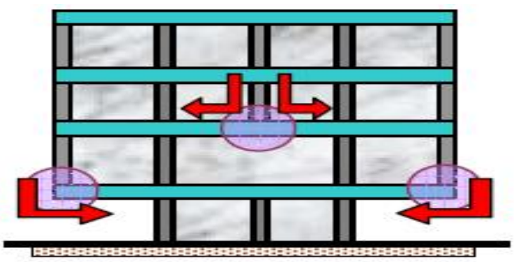
This study is also to find whether the structure is safe or unsafe with building with floating column is built in seismically active areas and to find floating column building is economical or uneconomical.

Key Words: Floating column, Normal building, ETABS

1. INTRODUCTION

A column is supposed to be vertical member starting from foundation level and transferring the load to the ground. The term floating column is a vertical element which at its lower level rests on a beam which is horizontal member. The beam in turn transfers the load to other column below.

There are many buildings in which floating columns are adopted, especially above the ground floor, where transfer girders are employed, so that more open space is available in the ground floor. This open space may be utilized as party hall, assembly hall and for parking purpose. The transfer girder has to be designed and detailed properly, especially in the earthquake zones. The column acts as concentrated load on beam. As far as analysis is concerned, the column is often assumed pinned and therefore taken as point load on the transfer beam.



Hanging or Floating Columns

1.1 OBJECTIVE OF STUDY

The main objective of the proposed work is

- To study the behaviour of multistory buildings with floating columns under earthquake excitations.
- To find whether the structure is safe or unsafe with floating column when built in seismically active areas and also to find floating column building is economical or uneconomical.

2. MODEL DESCRIPTION

The structure considered here is a regular building with plan dimension of 24mX24m, In this case a ground plus five storied (G+5) normal RC building were selected for the study, the buildings are considered to be located in Zone V as per IS 1893-2002. Table 1 shows the details of model and load considered.

Table -1: Geometrical dimension of building

Dimension of building			
Number of storey	G+5	G+5	
Height of each floor	3mt	3mt	
Height up to plinth	1.5mt	1.5mt	
Beam dimension	230mmX450mm	Up to G+1 230mmX450mm	230mmX450mm
Column dimension	230mmX450mm	Up to G+3 230mmX450mm	230mmX450mm
Thickness of Slab	150mm	150mm	
Thickness of exterior wall	230mm	230mm	
Thickness of interior wall	150mm	150mm	
Seismic Zone	5	5	
Zone factor	0.36(V)	0.36(V)	

Importance factor	1	1
Type of soil	Medium soil	Medium soil
Response reduction factor	5	5
Live load	3kN/m2	3kN/m2
Floor finish	1.5kN/m2	1.5kN/m2
Floor load on roof	1.5kN/m2	1.5kN/m2
Wall load on exterior beam	12kN/m	12kN/m
Wall load on interior beam	6kN/m	6kN/m
Grade of Concrete	30	30
Grade of steel	Fe500	Fe500

Model-1:

Here a G+5 building with all interior columns which is nothing but a normal building is considered as model 1 with dimension of beams as 230mmX450mm and column as 230mmX450mm. For the overall building the dimension of beams and columns are kept same.

Model-2:

This building is obtained by removing the interior columns at the ground floor of model-1 building without changing in the dimensions of beams and columns. Model-2 building members are failed to withstand for the applied gravity loads and lateral loads.

Model-3:

As model-2 building is failed, so another building is created by changing the dimension of the members to make building to withstand the applied gravity loads and lateral loads. The building with changes in columns and beams is considered as model-3 building. For Mode-3 building, up to G+3 floors all column dimensions are taken as 450mmX450mm, remaining all floors may have column size of 230mmX450mm. Also all the beams will have 230mmX450mm except G+1 beam which are 300mmX450mm.

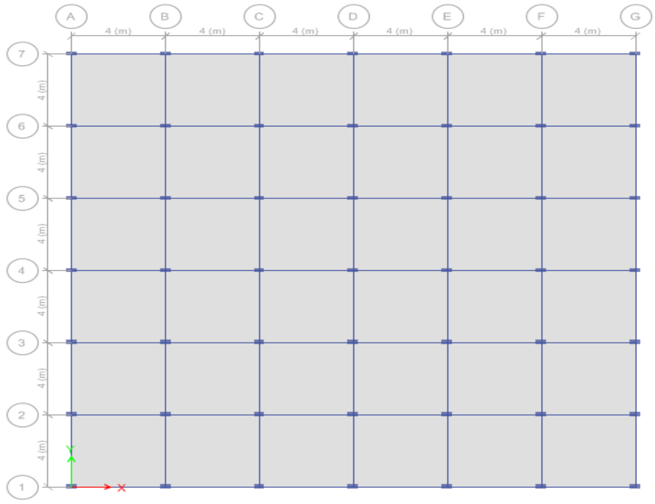


Fig-1 The Plan of Normal (G+5) storey building (Model-1)

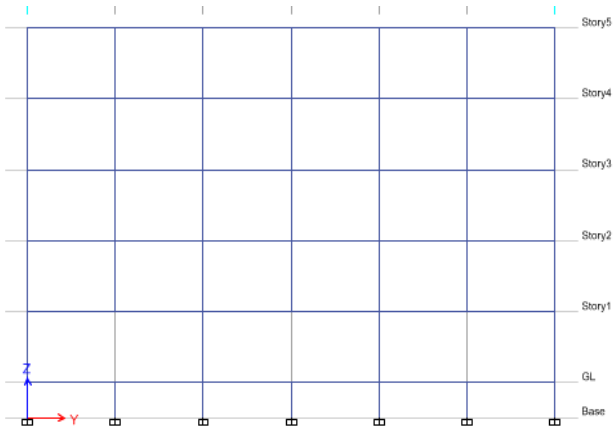


Fig-1.1 Elevation of Normal (G+5) storey building (Model-1)

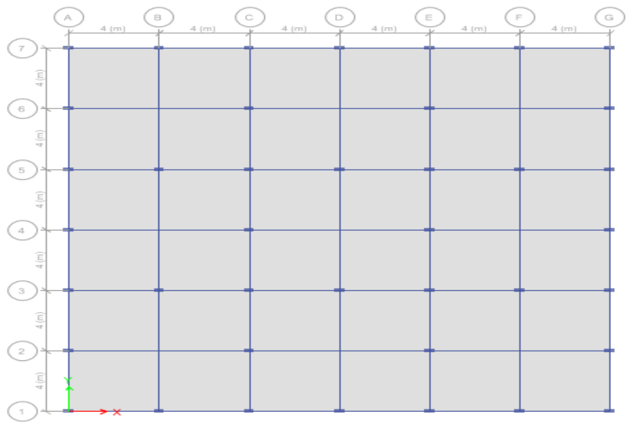


Fig-2 Plan of building with Columns removed in interior frame (Model-2)

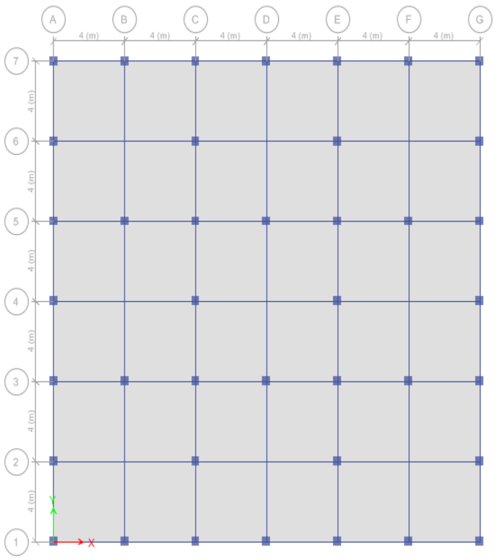


Fig-3 Plan of building with columns removed in interior frame with changes in dimension (Model-3)

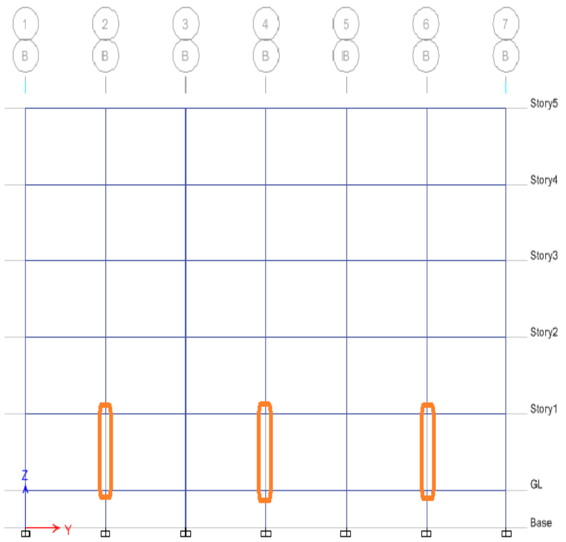


Fig-3.1 Elevation of building with columns removed in interior frames

3. Comparisons

3.1 Storey Displacement

By the application of lateral loads in X and Y directions the structure can be analysed for various load combinations given by clause 6.3.1.2 of IS 1893:2002. For the given load combination maximum displacement at each floor is noted in X and Y direction and are shown in the form of graph.

Table-3.1 Displacement values of 3 Models subjected to Seismic load in X direction.

Storey Number	Model 1	Model 2	Model 3
Ground floor	0.9	0.9	0.7
Storey 1	5.8	6.5	5.1
Storey 2	11.2	11.9	9.7
Storey 3	16.1	17.5	14.3
Storey 4	20	20.9	18.8
Storey 5	22.4	24.7	21.6

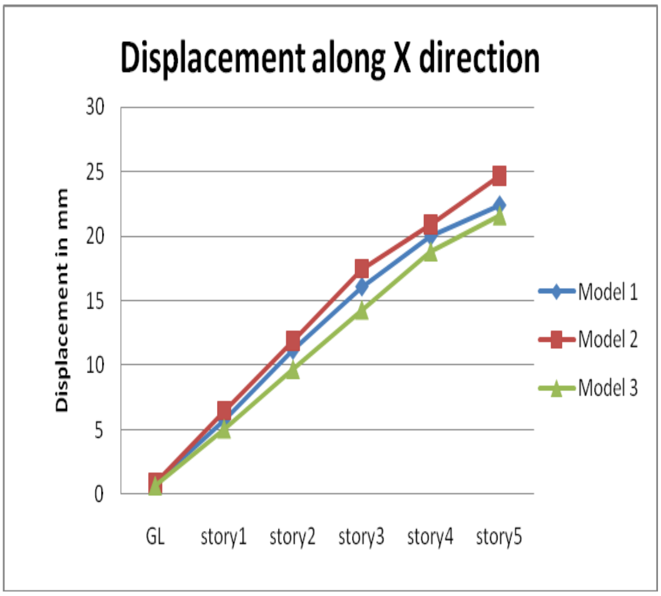


Fig-3.1 Displacement values of 3 Models subjected to seismic load along X direction.

Table-3.1 Displacement values of 3 models subjected to seismic load in Y direction

Storey Number	Model-1	Model-2	Model-3
Ground floor	1.2	1.1	0.6
Storey 1	8.8	10.1	4.6
Storey 2	16.5	17.6	8.8
Storey 3	23.5	24.3	13.1
Storey 4	29.1	29.7	21.8
Storey 5	32.4	33.9	26.9

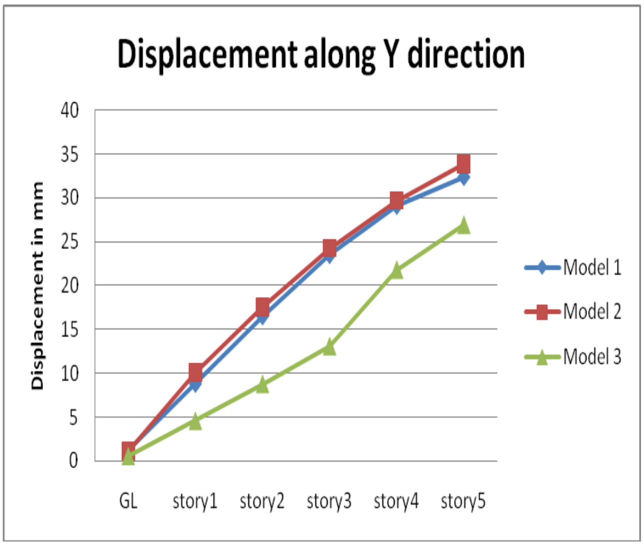


Fig-3.2 Displacement values of 3 models subjected to seismic load along Y direction.

From the above graph it is observed that the model-2 building has more displacement when compared to a model-1 building in both X and Y directions. So model-2 is unsafe when compared to a model-1 building.

Also Model-3 building has lesser displacement than model 1 building as the dimension of beams and columns of building is varied. So model-3 building is safe in X and Y direction.

3.2 Comparison of quantity of steel and concrete*:*

For the three model buildings, a comparison of quantity of steel and concrete are made based on the results obtained by the analysis and design of both the buildings. Here the quantity of steel and concrete are compared only in the model 1 and 3 building because the model-2 building is unsafe and fails during design check.

For the model 1 and 3 building only the quantity of steel and concrete in beams and columns are calculated because as the thickness of slab, brick walls and all other are same and loading is also same then the comparison makes no difference between the two buildings. The sizes of beams and columns are varied in the both buildings so the comparison is based only for beams and columns.

3.2.1 Calculation of Quantity of concrete

Table-3.2.1 Quantity of concrete

Model	Quantity of concrete (Tones)	Quantity of concrete (%)
RC building	292.3357	1
Building with FC	358.971	22.79

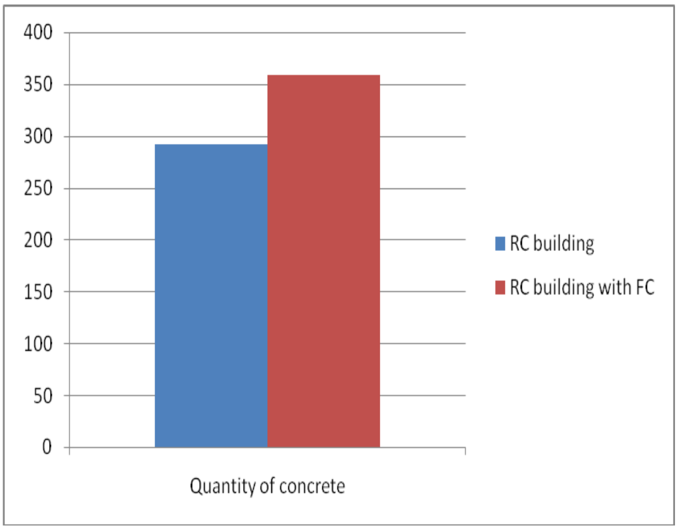


Fig-3.2.1 Quantity of concrete

3.2.2 Calculation of Quantity of steel

Table 3.2.2: Quantity of Steel

Model	Quantity of steel (Tones)	Quantity of Steel (%)
RC building	12.66	1
RC building with FC	18.28	44.39

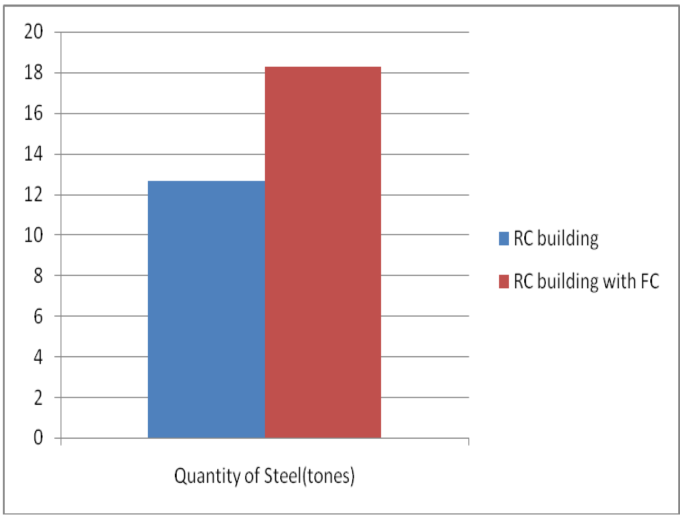


Fig-3.2.2 Quantity of steel

From the above tables it is noted that the quantity of rebar steel of model-3 building is 44% more than model-1 building. Also the quantity of concrete of model-3 building is 22% more than model-1 building. By the above comparison as both the quantity of steel and concrete are more in case of model-3 building, it is uneconomical than model-1 building.

4. CONCLUSIONS

The study compares the difference between normal building and a building with floating column. The following conclusions were drawn based on the investigation.

- By the application of gravity and lateral loads in X and Y direction at each floor, the displacements of floating column building in X and Y directions are less than the normal building. Thus to improve seismic performance of the multi-storey building with floating column lateral bracings, shear walls may be provided.
- After the analysis of buildings, the floating column building has 44% more rebar's steel and 22% more concrete quantity than a normal building. So the floating column building is uneconomical to that of normal building.

The final conclusion is that do not prefer to construct floating column buildings. Also cost of construction is increased. So avoid constructing floating column buildings.

REFERENCES

1. A Textbook on"Earthquake Resistance Design of Structures" by Pankaj Agarwal and Manish Shrikhande.
2. Isha Rohilla,Gupta S.M, et.al, " Seismic response of multi-storey irregular building with floating column",
3. Sreekanth Gandla Nanabala, Pradeep Kumar Ramancharla, Arunakanthi E "Seismic analysis of normal building and floating column building"*IEEE trans, Power System*, vol.19, no.1, pp. 356-365,2014.
4. Mundada.A.P and Sawdawar.S.G., " Comparative seismic analysis of multistory building with and without floating column", *International Journal of current Engineering and technology*, Vol-4,No5,pp 3395-3400
5. Nikil Bandwal, Anant Pande et,al. "To study seismic behavior of RC building with floating columns", *International Journal of Scientific Engineering and Technology Research*", Vol.03, issue 08,May 2014, pp 132-138
6. Srikanth M.K, Yogeendra R, Holebagilu, "Seismic response of complex buildings with floating columns for zone II and V"*IEEE Trans. Power Syatem*, vol.19.No 1,pp.356-365,2014
7. Prerna Nautiyal, Saleem Akhta et.al, "Seismic response evaluation pf RC frame building with floating columns considering different soil conditions",*International Journal of Current Engineering and technology*, vol.4, N0.1,Feb-2014 pp 132-138
8. Sabari S, Praveen J.V., "Seismic analysis of multistoey building with floating column" *IEEE Trans. Power System,*vol.19, No.1, pp 356-365, 2014
9. Kavya.N, Manjunatha.K et.al, " Seismic evaluation of multi-story RC building with and without floating column", *International Journal of Engineering Research and Technology*, Vol.4.,issue 6,sep-2015,pp 361-365.

BIOGRAPHIES

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