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Comparative Seismic Study of G+10 Building with and without Floating Column

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***Abstract*: Behaviour of multi-storey building with and without floating columns is studied on the basis of displacement, shear, drift, stiffness and overturning moments. A G+10 storey building under the seismic zone V is analyzed using ETABS software. The Response Spectrum Analysis is carried out with 3D model using the software ETABS. This parametric study may be helpful for systematic and economical design for the structure with and without floating column.**

***Keywords*: ETABS, Floating Columns, RC frames, Response Spectrum Analysis.**

1. Introduction

The floating column is a vertical member which rest on a beam and this beam transfers the load to the columns below it as they do not transfer the load directly to the foundation. They are used for site situation, architectural view and column-free space. It can be analyzed by using STAAD Pro, ETABS and SAP2000. But these columns are highly disadvantageous in a building built in the seismic zone since the true columns below their level are not constructed carefully and it results in failure of the structure.

Provision of the floating column can be stated as most of the buildings are covering the maximum possible area of land as per the available bylaws. Since balconies are not considered in floor space index, balconies are over hanged on the upper stories beyond the column footprint area at ground floor for such conditions, floating columns are provided along the overhanging perimeter of building and in maximum cases architect demands for the aesthetic view of building so for that many of the columns are terminated at certain floors and floating columns are used.

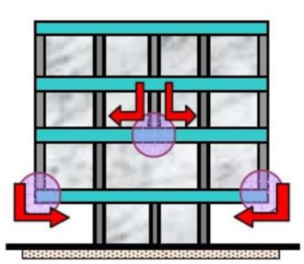

Fig. 1. Floating column [Source: A. P. Munda et. al.]

2. Literature Review

Ashish S. Agrawal & S. D. Charkha (2012) studied 25 multi-storey building in 5th earthquake zone which was analyzed by altering the different position of shear wall with various shapes to evaluate the bending moment, base shear and story drift. They use the software ETABS for analyzing the whole building. In the case of no eccentricity, the deflection of a building is uni-directional but with slight eccentricity, the building shows non-uniform deformation due to the effect of torsion and external moment.

M. R. Wakchaure (2012) studied about the seismic analysis of reinforced concrete frames of G+9 multi-storey building using software ETABS. They analyze the behaviour of infill walls with the help of the equivalent strut method. They studied the effect of masonry walls and analyze the multi-storey buildings with a linear dynamic method. With the help of ETABS, they analyze base shear, storey drift and displacement of that multi-storey building. They evaluated the results that infill walls have less displacement and time period but more base shear.

A. P. Munda and S. G. Sawdatkar (2014) studied the comparison of seismic analysis of multi-storey building with or without floating columns, the vertical member which has no foundation and rests on beam and this beam transfer the load to the column below it. To explain this theory they took a building of seven floors. Then they carried out a 3D analysis of both the structures, with and without floating column and in this process, they considered three model cases as:

Case 1, in this case, all the columns are in rest position and no columns are floated.

Case 2a in this case they describe that all the columns are not resting on the ground floor but some rest on the first floor.

Case 2b this case is similar to the case 2a but the difference is in this struts are provided below the floating columns to provide stability and to balance the moments.

By analyzing the above cases they conclude that the deflection in case 2a i.e. with floating column is more than the case 2b i.e. floating column with struts. So in multi-storey buildings, the deflection is largely overcome since struts

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provide stability to the column and balance the moment.

Prerna nautiyal et al (2014) studies to calculate the seismic effect of a reinforced concrete frame with a floating column for various soil conditions. Linear dynamic analysis is done in 2d multi-storey frame with and without floating column. She analyses the things by considering two objects i.e. G+3 and G+ 6 models. Response spectrum analysis (RSA) for varying soil condition has shown that the base shear demands for medium soil are found higher than that of the hard soil in both the objects. It was evaluated by using Staad pro software. This study concluded that response spectrum analysis shows the result that the demand of base shear for intermediate soil is found greater than that of the stiff soil in both cases.

S. Sabari and V. J. Praveen (2014) investigated the dynamic response of multistory building with a floating column. They highlighted the importance of recognizing the presence of the floating column. They used FEM analysis for carrying out 2D multistory frames with and without floating column to study the responses of the structure under different earthquake excitation having different frequency content keeping the PGA and time duration factor constant. They computed all other factors like inter storey drift, base shear, column axial force, roof displacement for both the frames with and without floating column.

3. Methodology

Seismic analysis is a division of structural analysis and it is the estimation of the response of a building (or non-building) structure during earthquakes. It is a most important part of the method of structural design, earthquake engineering or structural assessment and modifies in regions where earthquakes are common.

The structure has the full capacity to wave back and forwards during an earthquake (or even a severe wind storm). This is identified as the fundamental mode, and it is the lowest rate of recurrence of building response.

Response Spectrum Method is considered for the analysis of building studied here. Details of these models are described in following section. The seismic analysis based on Indian standard 1893:2016 (part-1) is described as follows.

A. Response Spectrum Analysis (Linear Dynamic Analysis)

A response spectrum is a design of the peak or steady-state response (displacement, velocity or acceleration). It is a linear-dynamic statistical analysis method which processes the role from each natural mode of vibration to specify the likely maximum seismic response of a fundamentally elastic structure.

While performing the seismic analysis and design of structure which is to be constructed at a particular site, the actual time history record is required. Yet, it is impossible that overall have such all records at each and every location. Moreover, analysis of structures cannot be accepted as simply based on the summit value of the ground acceleration as the response of the structure. It builds upon the occurrence composed of ground motion and it's having its own dynamic properties. The earthquake Response Spectrum is the largely accepted tool in the seismic analysis of structures having many computational advantages in using this method of seismic analysis for calculation of displacements and member forces in structural systems.

4. Model Description

In the modelling of G+10 multi-storey building, the following cases are to be considered-

- Building with Normal Column.
- Building with Hanging or Floating Column.
- Building with Floating column along with the Shear wall.

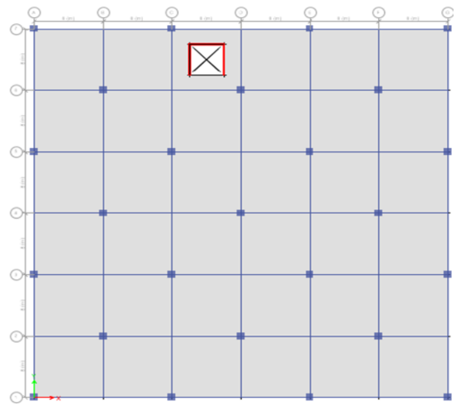
Fig. 2. Plan View of building with Floating Column

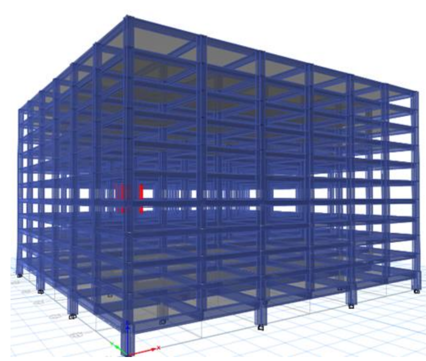
Fig. 3. 3-D View of building with Floating Column

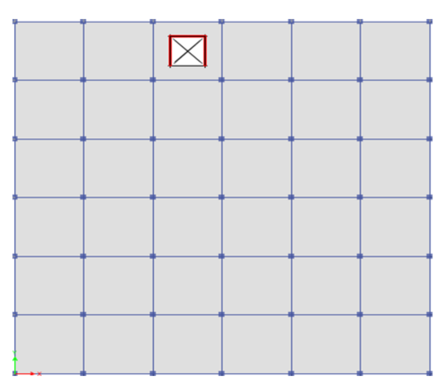
Fig. 4. Plan View of building without Floating Column

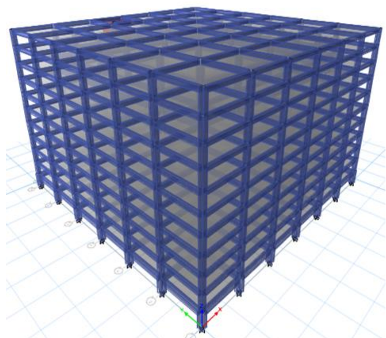

Fig. 5. 3-D View of building without Floating Column

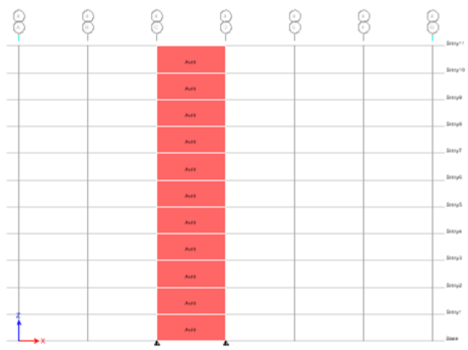

Fig. 6. Elevation view of Building with Floating Column along with Shear Wall

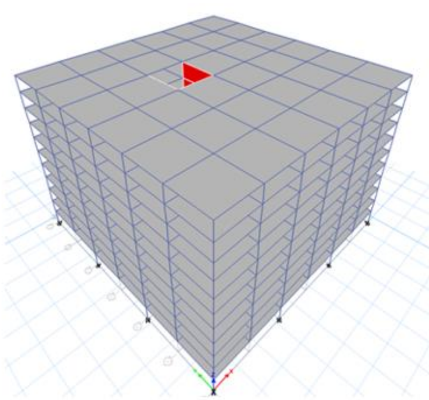

Fig. 7. 3-D view of Building with Floating Column along with Shear Wall

Table 1
RC Frame Data details considered for the analysis

The geometry of the structure	Detail/ value
Number of Grid in X direction	7
Number of Grid in Y direction	7
Spacing of Grid line in X direction	3m
Spacing of Grid line in Y direction	3m
Number of Storey	G+10
Typical Storey height	3m
Ground Floor height	3m
Size of Beam (above ground floor)	400 x 700mm
Size of Beam (at ground floor)	500 x 1000mm
Size of Column (above ground floor)	700 x 700mm
Size of column (at ground floor)	900 x 900mm
Wall thickness	200mm
Types of Soil	Medium
Types of support	Fixed
Zones	IV & V
Dead Load	1.5kN/m^2
Live Load	4kN/m^2
Combination Method	CQC
Response Reduction Factor	5
Importance Factor(I)	1
Damping Ratio	5%

5. Results and Discussion

A G+10 storey building is modeled and analyzes using ETAB software. In this analysis, different seismic zones of India with various site conditions are considered.

The Response spectrum analysis is used for finding Displacements, Storey Drifts, Stiffness, Storey Shear and Overturning Moments.

A. Maximum Storey Displacement

Storey displacement is the lateral displacement of the storey relative to the base.

Fig. 8 shows the variation in displacement of building with Normal Column (NC), Floating Column (FC) and Floating Column with Shear Wall (FCSW) in X–direction. The maximum displacement occurs in top storey i.e. storey 11 and minimum at the base.

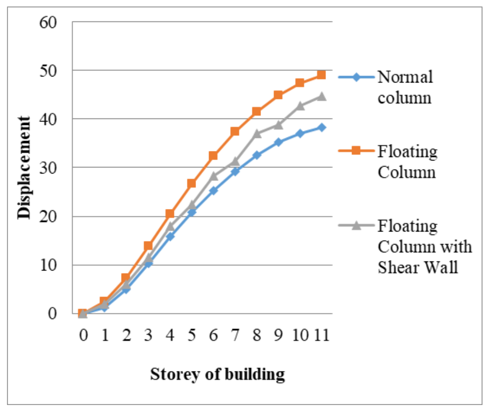

Fig. 8. Maximum Storey Displacement of Normal Column, Floating Column & Floating Column along with Shear Wall

B. Storey shear

Storey shear depends on the magnitude and the allocation of story ductility weight over the height of ordinary frames on the design story shear strength distribution.

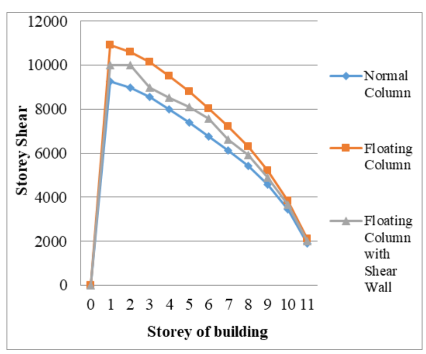

Fig. 9. Maximum Storey Shear of Normal Column, Floating Column & Floating Column along with Shear Wall

Fig. 9 shows the variation in Storey Shear of building with Normal Column (NC), Floating Column (FC) and Floating Column with Shear Wall (FCSW) in X–direction. The maximum Shear occurs in storey 1 and then it gets decreasing upto top storey i.e. storey 11.

C. *Maximum Story Drift*

Fig.10 shows the variation in Storey Drift of building with Normal Column (NC), Floating Column (FC) and Floating Column with Shear Wall (FCSW) in X – direction. The maximum Storey Drift occurs in storey 4 and minimum at top storey i.e. storey 11.

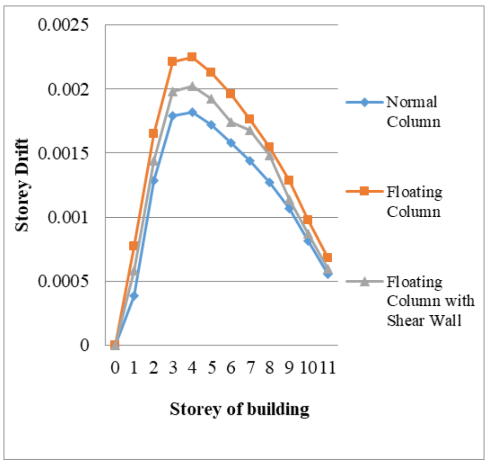

Fig. 10. Maximum Storey Drift of Normal Column, Floating Column & Floating Column along with Shear Wall

D. *Maximum Storey Stiffness*

Fig.11 shows the variation in Storey Stiffness of building with Normal Column (NC), Floating Column (FC) and Floating Column with Shear Wall (FCSW) in X–direction. The maximum Storey Stiffness occurs in storey 1 and then there is a drastically decrease in stiffness in storey 2 and then the decrease in stiffness becomes almost constant which is minimum at top storey i.e. storey 11.

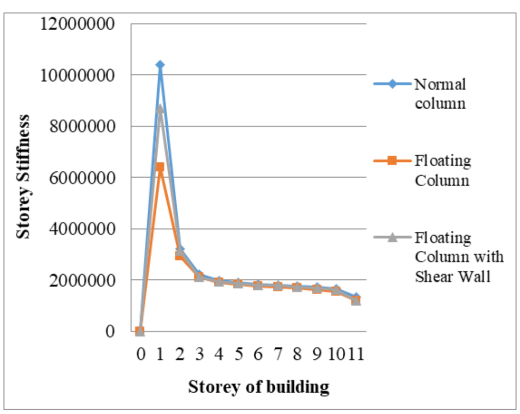

Fig. 11. Maximum Storey Stiffness of Normal Column, Floating Column & Floating Column along with Shear Wall

E. *Storey Overturning Moments*

Fig.12 shows the variation in Storey Overturning Moments of building with Normal Column (NC), Floating Column (FC) and Floating Column with Shear Wall (FCSW) in X – direction. The maximum Storey Overturning Moments occurs in base and minimum at top storey i.e. storey 11.

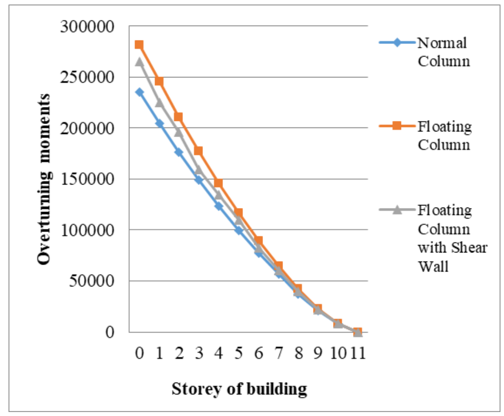

Fig. 12. Maximum Storey overturning moment of Normal Column, Floating Column & Floating Column along with Shear Wall

Table 2
Maximum values of various parameters obtained after analysis of building with normal column, floating column & floating column with shear wall

S. No.	Parameters	Building with normal column	Building with floating column	Building with floating column along with shear wall
1.	Max. Storey Displacement (mm)	38.31	48.95	44.68
2.	Max. Storey Drift (mm)	0.001820	0.002246	0.002020
3.	Max. Storey Shear (kN)	9248.63	10926.78	9982.74
4.	Max. Storey Stiffness(kN/m)	10404959	6379872.06	8698541.57
5.	Max. Overturning moments (kN-m)	235038.08	281578.02	265452.45

Table 2 describes the maximum values of building based on displacement, drift, shear, stiffness and overturning moments. It also explains that how the values are changing for different cases.

6. Conclusion

Following conclusions are drawn from above analysis with the results of G+10 storied building under Seismic Zone V using Response Spectrum analysis with Normal Column, Floating Column and Floating Column with Shear Wall:

1. Maximum Storey displacement in Floating Column is 27.77% more than the maximum displacement in Normal Column. But when building with floating column along with shear wall is used then maximum displacement is being reduced by 11.16%.
2. Maximum Storey drift in Floating Column is 23.406% more

than the maximum Storey Drift in Normal Column. But when building with floating column along with shear wall is used then maximum storey drift is being reduced by 12.426%.

3. Maximum Storey shear in Floating Column is 18.14% more than the maximum Storey Shear in Normal Column. But when building with floating column along with shear wall is used then maximum storey shear is being reduced by 10.21%.
4. Maximum Storey stiffness in Floating Column is 38.68% less than the maximum Stiffness in Normal Column. But when building with floating column along with shear wall is used then maximum storey stiffness is being increased by 22.28%.
5. Maximum Overturning Moments in Floating Column is 19.80% more than the Maximum Overturning Moments in Normal Column. But when building with floating column along with shear wall is used then maximum overturning moments is being reduced by 6.86%.
6. Further it can be concluded on the basis of above points that floating column is very dangerous for earthquake prone areas. But it can be used along with shear wall.

References

[1] Agarwal Pankaj, Shrikhande Manish (2009), "Earthquake resistant design of structures", PHI learning private limited, New Delhi.
[2] Arlekar Jaswant N, Jain Sudhir K. and Murty C. V. R, (1997), "Seismic Response of RC Frame Buildings with Soft First Storeys". Proceedings of the CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, 1997, New Delhi.
[3] Awkar J. C. and Lui E.M, "Seismic analysis and response of multistory semirigid frames", Journal of Engineering Structures, Volume 21, Issue 5, Page no: 425-442, 1997.
[4] Balsamoa A, Colombo A, Manfredi G, Negro P & Prota P (2005), "Seismic behavior of a full-scale RC frame repaired using CFRP laminates". Engineering Structures 27 (2005), 769–780.
[5] Bardakis V.G., Dritsos S.E. (2007), "Evaluating assumptions for seismic assessment of existing buildings, "Soil Dynamics and Earthquake Engineering 27 (2007) 223–233.
[6] Brodericka B.M., Elghazouli A.Y. and Goggins J, "Earthquake testing and response analysis of concentrically-braced sub-frames", Journal of Constructional Steel Research, Volume 64, Issue 9, pp. 997-1007, 2008.