International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

Comparative Study on Seismic Behaviour of Multi Storey Building with and Without Floating Column

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Abstract*: Many urban multistorey building in India today have open first storey as an avoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the first storey. Floating column also provided for the purpose to increase the floor space index. Floating column is a vertical element which its lower level rests on a beam which is a horizontal member. This paper deals with the study of the building with and without floating columns. Existing residential building comprising of G+ 5, G+7 & G+9 structures has been selected for carrying out the project work. The load distribution on the floating columns and the various effects due to it is also been studied in the paper. In this paper we are dealing with the comparative study of seismic analysis of multi-storied building with and without floating columns. The equivalent static analysis is carried out on the entire project mathematical 3D model using the software STAAD. Pro V8i and the comparison of these models are been presented. This will help us to find the various analytical properties of the structure.*

Keywords: Multi storey building, Normal building, Lateral displacement, Storey drift

1. Introduction

Many urban multistorey building in India today have open first storey as an avoidable feature. This is primarly being adopted to accommodate parking or receptiom 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 of stiffness and mass along the height. Floating column also provided for the purpose to increase the floor space index.

Floating column is a vertical element which its lower level rests on a beam which is a horizontal member. The beams in turn transfer the load to other columns below it. There are many projects 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. The open spaces are required for assembly hall or parking purpose.

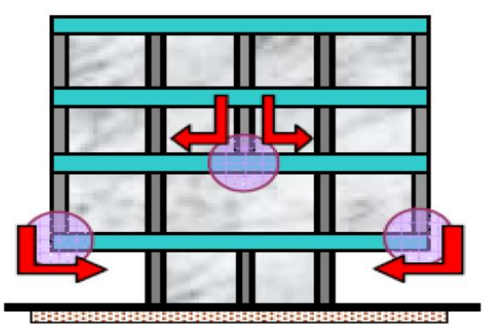

Figure 1: Floating column

2. Objectives

1) To study the earthquake excitation of the building by varying the height of the building with or without floating column.
2) To study the structural response of the building by fundamental time history analysis and spectral method of analysis.

3. Methodology

Methodology employed is Equivalent static analysis method

3.1 Modelling of Building

Here the study is carried out for the behaviour of G+5, G+7 and G+9. Floor height provided as 3.5m. And also properties are defined for the frame structure. Six models including G+5, G+7 and G+9 building with and without floating column are created. Properties are different for different models. The general software STAAD Pro V8i has been used for the modelling. It is more user friendly and versatile program that offers a wide scope of features like static and dynamic analysis, non- linear dynamic analysis and non-linear static pushover analysis, etc.

3.1.1 Building Plan and Dimension Details

The Following are the specification of buildings. The complete detail of the structure including modelling concepts is given below: To model any structure in STAAD Pro V8i the first step is to specify the nodal co-ordinate. Then beams, columns and the plate elements were modelled. The wall load is uniformly distributed over beams. Then assign the properties for beams, columns and the plates. Walls are considered to be rigidly connected to beams and columns. For plate elements thickness is assigned. After assigning the sectional property to the member it is important to assign it with member properties. Material properties include modulus of elasticity, Poisson's ratio, weight density, thermal coefficient, damping ratio and shear modulus. In the modelling material is considered as an isotropic material.

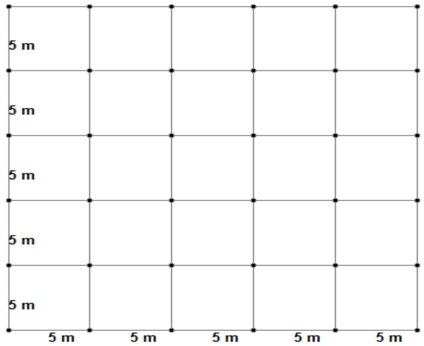

Figure 2: Plan of the building (25m × 25m)

Table 1: Geometric details and dimension of the building models

Member dimension			
slab	Thickness		230mm×500mm
Beams	Normal building		230mm×500mm
	Floating column building	Interior beams	230mm×500mm
		Cantilever projection at edge	650mm×850mm
Columns	Normal building		350mm×500mm
	Floating column building	Top 2 floors	350mm×500mm
		All floors except top 2 floors	700mm×900mm

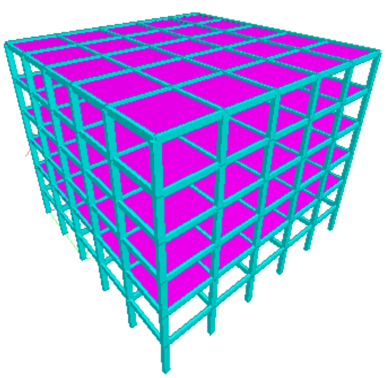

Figure 3: Three dimensional view of G+5 Building without floating column

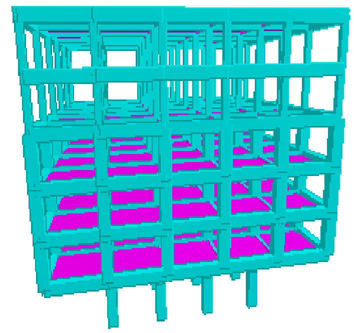

Figure 4: Three dimensional view of G+5 Building with floating column

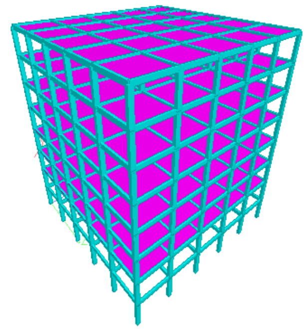

Figure 5: Three dimensional view of G+7 Building without floating column

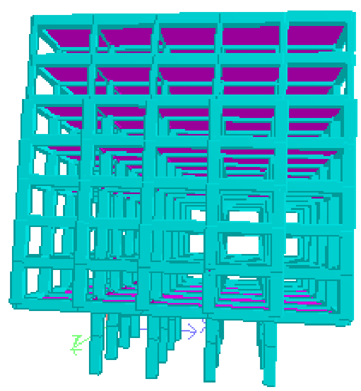

Figure 6: Three dimensional view of G+7 Building with floating column

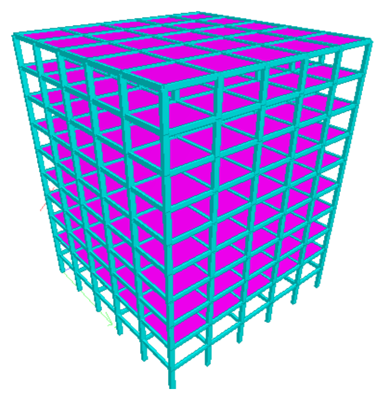

Figure 7: Three dimensional view of G+9 Building without floating column

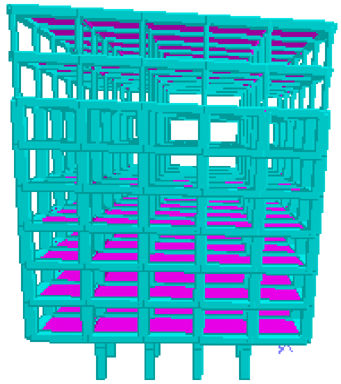

Figure 8: Three dimensional view of G+9 Building without floating column

3.2 Load Formulation

In the present project works following loads are considered for analysis. Dead Loads (IS- 875 PART 1) and Live Loads (IS 875 PART 2). Gravity loads on the structure include the self-weight of beams, columns and slabs other permanent members. The self-weight of beams, columns (Frame members) and slabs (Area section) were automatically considered by the program itself. Seismic weight has been calculated and added. The Seismic Weight of the whole building was the sum of the seismic weights of all the floors. The seismic weight of each floor was its full dead load plus appropriate amount of imposed load. While computing the seismic weight of each floor, the weight of columns in any storey was equally distributed to the floors above and below the storey. The live load was considered for seismic weight calculation as per Table – 8, IS 1893 (Part-1) 2002.

3.3 Analysis

After assigning the loads to the structure, analysis is done to evaluate the shear force bending moment and dynamic results in form of storey drift, section displacement and lateral forces. After analysis design can be executed in STAAD.Pro V8i as it includes various international codes and the structure can be designed using these codes. Equivalent Static Analysis is the approach defines a series of forces acting on a building to represent the effect of earthquake ground motion, typically defined by a seismic design response spectrum. It assumes that the building responds in its fundamental mode. The response is read from a design response spectrum, given the natural frequency of the building.

Deflection is the degree to which a structural element is displaced under a load. It may refers to an angle or a distance. Deflection of the building will happen during the earthquake.

4. Comparison of Results

After analysing the results obtained then it will be compared and find the seismic performance of the building with and without floating columns.

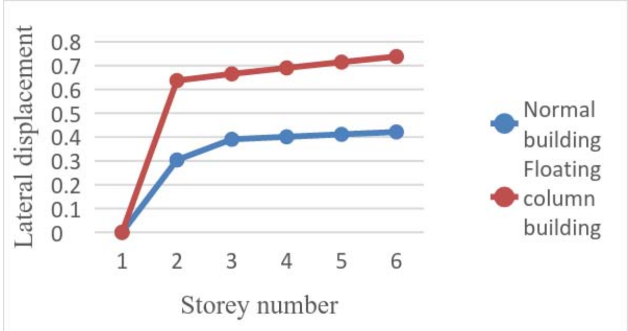

Figure 9: Lateral Displacement of G+5 Buildings (mm)

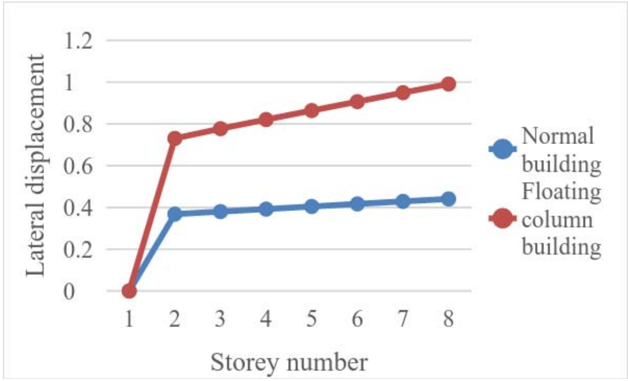

Figure 10: Lateral Displacement of G+7 Buildings (mm)

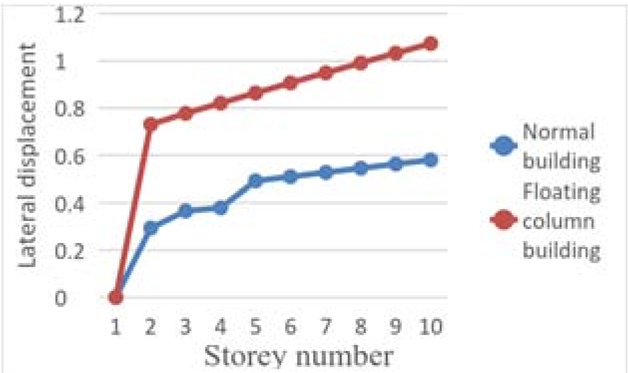

Figure 11: Lateral Displacement of G+9 Buildings (mm)

From Fig 9, Fig 10 and Fig11 it is clear that storey displacement is higher in floating column building than the normal building.

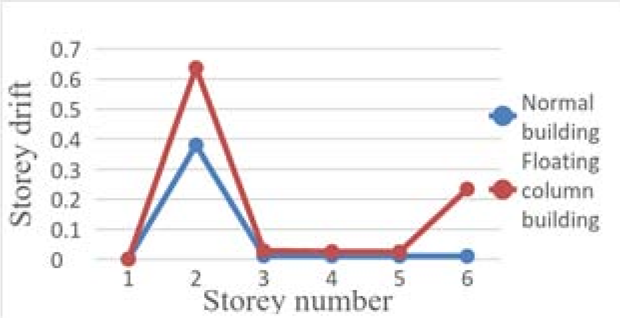

Figure 12: Storey drift of G+3 Buildings

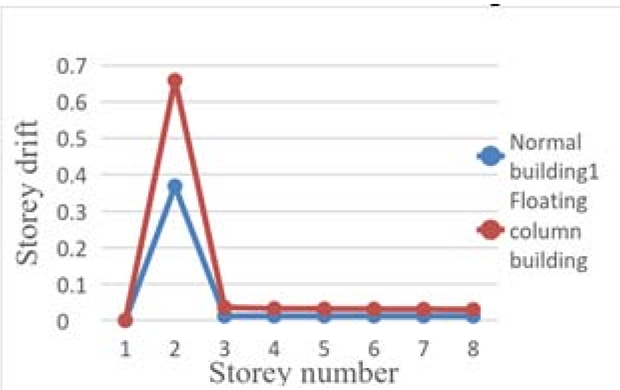

Figure 13: Storey Drift of G+7 Buildings

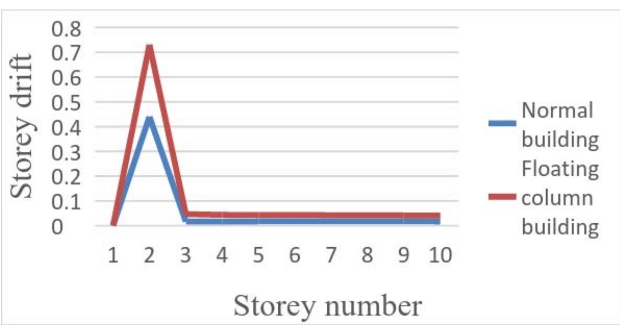

Figure 14: Storey Drift of G+9 Buildings

From Fig 12, Fig 13 and Fig 14 it is clear that storey drift is higher for floating column building.

5. Conclusions

In this paper the study is carried out for the seismic behaviour of multi-storey building with and without floating column. After analysis the conclusions obtained are,

- Referring the result summary of the frame structure, it can be seen that the lateral displacements, storey drift for the floating column building is higher than those developed in the normal building. On the basis of safety criteria, the lateral displacement, storey drift for the floating column building should be low as possible.
- It is found that model without floating column building can resist more base shear than model with floating column.
- The behaviour of model without floating column is better than model with floating column when the comparison is in terms of storey drift, base shear and lateral displacement.
- The performance of normal building is better than the floating column building.
- Provision of floating column is advantageous in increasing FSI of the building but is a risky factor and increases the vulnerability of the building.

6. Future Scope

- To perform a static non-linear (push-over) analysis and checked whether that plastic hinges will form at floating column.
- Design and estimation of building is necessary for checking the cost effectiveness of these measures used for improving the seismic performance of structure.

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