Performance Based Evaluation of Floating Column Building by Elastic Analysis

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Abstract--- *In the present scenario, the structures with floating columns are the typical features in the multi-storey construction. As the load path in the floating columns is not continuous, they are more vulnerable to the seismic activity. Sometimes, to meet the requirements these type of aspects cannot be avoided though these are not found to be of safe. Hence, an attempt is taken to study the behavior of the structure during the earthquake. In this study, the seismic behaviors of the RC multistory structures with and without floating column are considered. The analysis is carried out for the multi-storey structures of G+5 situated at zone iii, Using ETABS Software.*

Keywords--- *Floating Column, ETABS, Equivalent Static Method, Response Spectrum Analysis.*

I. INTRODUCTION

EARTHQUAKEcause the rapid ground motions in all directions, radiating from the epicenter. These ground motions causes the structure to quiver band induces inertia forces in them. Earthquake exposes the limitation in the structures. The structures, which may emerge as strong, may disintegrate like houses of cards during seismic activity. Because of the lack of knowledge of the seismic performance of the buildings several wrong practices remained continued, till a seismic activity exposes these. There are copious examples enlisted in the design information of past earthquakes in which causes of collapse of reinforced concrete building has been imprudence in configuration loads. A column is a vertical constituent starting from foundation level and transferring the load to the earth. The term floating column is also defined as a vertical element which rests on the beam. Structures with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation.

A. Floating Column

Floating column is also a vertical member, The Columns Float or move in above stories such that to provide more open space is known as Floating columns. Floating columns are implemented, especially above the base floor, so that added open space is accessible for assembly hall or parking purpose.

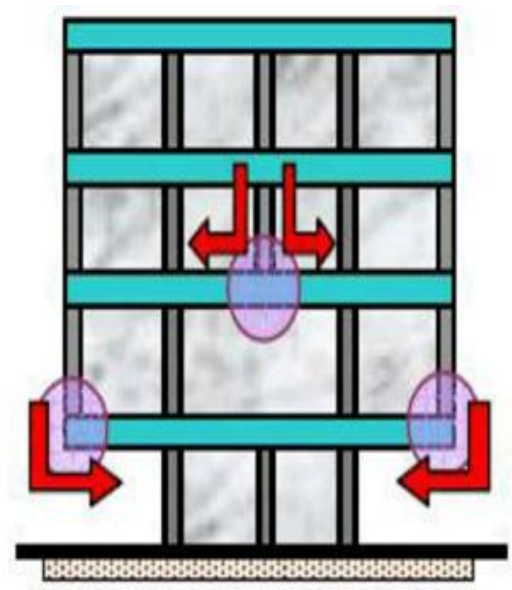

Figure 1: Floating Column

For the study of the floating column many projects have been undertaken where the transfer of load is through the girders. Floating columns are usually adopted above the ground storey level. So that maximum space is made available in the ground floor which is essentially required in apartments, mall or other commercial structures where parking is a major problem.

II. METHODOLOGY

To determine seismic behavior of the Buildings with and without floating columns for zone III the basic components like inter storey drift, lateral displacement, and fundamental time period this analysis has been carried using the software ETABS 13.1.1 for the analysis purpose Equivalent static method, and Response spectrum methods are adopted.

A. Building Modeling

In this structure model RC multi storied constructions of four reports is viewed with and without floating columns are for the analysis the typical top of the floors is regarded as 3.6m and the peak of the base storey is taken as 4.8m. To prevent the tensional response below the pure lateral forces the buildings are stored symmetric in both the orthogonal way in plan. The plan and elevation of the structure considered is as shown in the figure.

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B. Section Properties

Table 1: Building Data

Structure	*OMRF*
No. of storey	G+5
Type of building	Commercial
Seismic zone	III
MATERIAL PROPERTIES	
Grade of concrete	M_{20} and M_{30} (for cantilever beam)
Grade of steel	Fe 415
Young's modulus of M20 and M30 concrete, E	22.32 x 106 Kn/m^2 and 27.38 x 106 Kn/m^2
Density of concrete	25 Kn/m^2
Young's modulus of brick masonry	2100 x 103 Kn/m^2
Density of brick masonry	20 Kn/m^3
MEMBER PROPERTIES	
Thickness of slab	0.120 m
For 6 storey structure	0.25 x 0.50 m 0.65x1.40m(cantilever beam) 0.45x0.75 m(Model I and II) 0.50x0.50m (core columns) 0.35x0.50m(floating columns) 0.60x0.60m(periphery columns)
Wall thickness	0.25m
Roof finishes	2.0KN/m^2
Floor finishes	1.0 Kn/m^2
Live load intensities	
Roof	1.5 Kn/m^2
Floor	3.0 Kn/m^2
Earthquake Live load on slab as per clause 7.3.1 and 7.3.2 of IS 1893(part I)-2002	
Floor	0.25x3.0= 0.75 KN/m^2
Roof	0 KN/m^2

Table 2: Geometry of the Considered Model

No. of Storeys	6
No. Bays in X direction	6
Bay width in X direction	6m
No. of Bays in Y direction	6
Bay width in Y direction	6m
Bottom Storey Ht	4.8m
Storey Ht	3.6m
Cantilever length for floating column structure	1.5m

C. Plans and Models

Plans and 3D models considered for the analysis purpose shear walls with different shape and different locations in the building

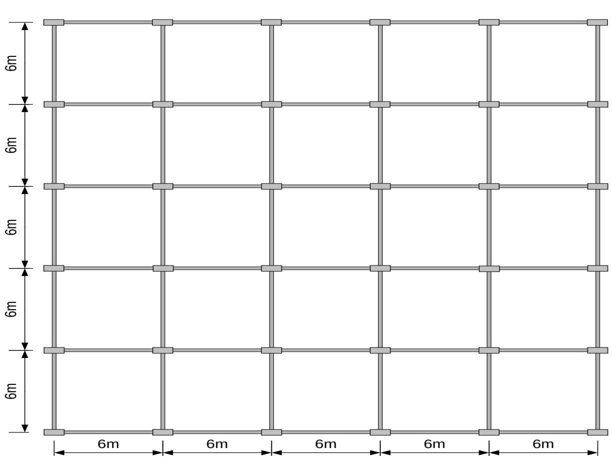

Figure 2: Plan of Model I

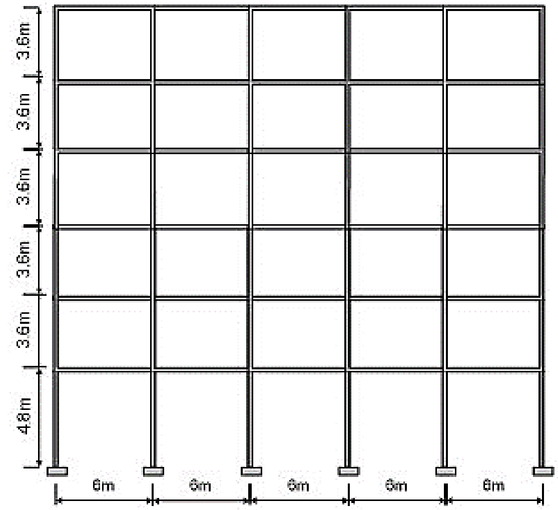

Figure 3: Elevation of G+ 5 Model I

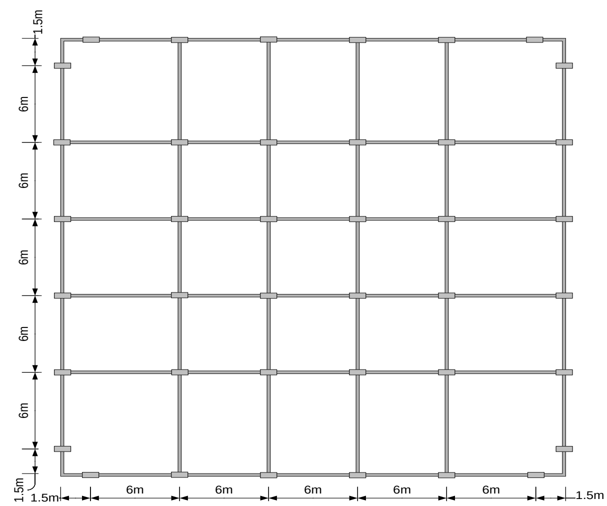

Figure 4: Plan of Model II

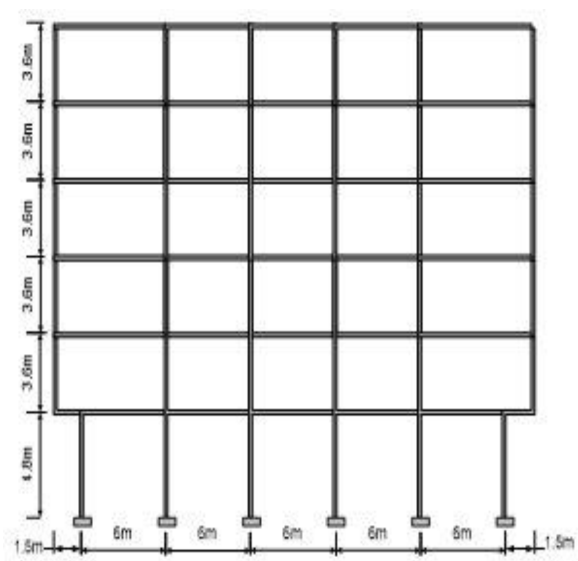

Figure 5: Elevation of G+ 5 Models II

D. Load Combinations Considered for the Building Analysis

Table 3: Load Combinations as per IS 1893(Part1):2002

Load Combination	*Load Factors*
Gravity analysis	1.5 (DL+LL)
Equivalent static analysis	1.2 (DL+ LL ± EQ_Y) 1.2 (DL+ LL ± EQ_X)
Response spectrum analysis	1.2 (DL+ LL ± SP_Y) 1.2 (DL+ LL ± SP_X)

Where,

DL= Dead load

LL = Live load

EQX, EQY= Earthquake load in the X and Y directions, respectively.

RSX, RSY = Earthquake Spectrum in the X and Y directions, respectively.

III. Results and Discussions

A. Natural Time Period

The fundamental natural period of the building is calculated by the following expression as given in the code IS 1893(part I): 2002

$T=0.075x\ h^{0.75}$ (1) for the bare frame

$T = 0.09h/\sqrt{d}$- (2) for the in filled frame

h represent the overall height of the building d represent the base dimension of the building in the direction of vibration considered.

The calculation of the lateral load and its distribution along the height of the building is carried out according to the IS 1893(part I): 2002 the earthquake load analysis is considered in both the transverse and longitudinal direction for the equivalent static method.

Table 4: The Natural Time Period Obtained from Seismic Code IS 1893 (part1):2002 and Analytical (ETABS) are Shown in Table

Building	*Models*	*Gravity analysis*		*Seismic analysis*	
		Codal	*Analysis*	*Codal*	*Analysis*
G+5	I	0.782	1.949	0.782	1.691
	II	0.782	2.046	0.782	1.831

B. Lateral Displacements

Lateral displacement profile for building models obtained from the equivalent static and response spectrum methods are shown in figures.

Table 5: Lateral Displacement for the Four Storey Building for the Load Combination 1.2(DL+LL± EL) in Longitudinal Direction

Storey	*Equivalent static method*		*Response spectrum method*	
	Model		*Model*	
	I	*II*	*I*	*II*
6	37.78	66.25	32.09	50.92
5	34.17	59.44	29.45	46.08
4	28.84	48.09	25.41	38.18
3	22.00	33.32	19.94	27.60
2	14.30	17.38	13.35	15.30
1	6.65	5.99	6.36	5.79

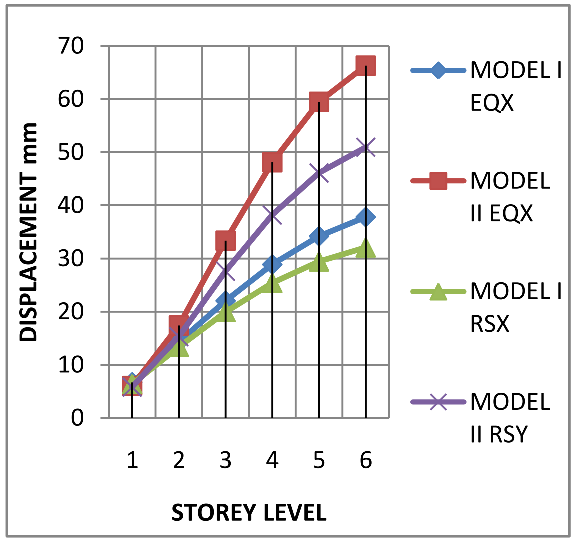

Figure 6: Lateral Displacement for the Four Storey Building for the Load Combination 1.2(DL+LL± EL) in Longitudinal Direction

C. Storey Drift

As per Clause: 7.11.1 of IS: 1893 (Part 1): 2002 (5) the storey drift for RC building is limited to 0.004 times the storey height, that is 0.4% of storey height

Table 6: Storey Drift for the Four Storey Building for the Load Combination 1.2 (Dl + Ll ± El) in Longitudinal Direction

Storey	*Equivalent static method*		*Response spectrum method*	
	Model		*Model*	
	I	*II*	*I*	*II*
6	3.61	6.81	2.64	4.84
5	5.33	11.35	4.04	7.9
4	6.84	14.77	5.47	10.58
3	7.7	15.94	6.59	12.3
2	7.65	11.39	6.99	9.51
1	6.65	5.99	6.36	5.79

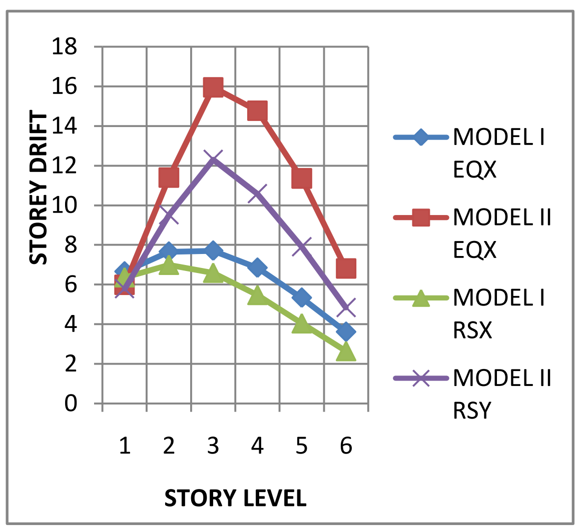

Figure 7:Storey Drift for the Four Storey Building for the Load Combination 1.2 (Dl + Ll ± El) in Longitudinal Direction

D. *Calculation of Base Shear*

Base shear and scaling factor for four storied building model as shown in table 7.

Table 7: Calculation of Base Shear

Model	*EQX*	*RSX*	*SF*	*EQY*	*RSY*	*SF*
I	3265.84	1012.37	3.22	3265.84	856.80	3.81
II	3815.32	958.75	3.98	3815.32	897.34	4.25

The analysis is carried out in both equivalent static method and Response spectrum method. From the above tables it is observed that the base shear values are directly proportional to the storey of the building. The building with the floating columns shows the high base shear value.

IV. Conclusion

In this dissertation work, the behavior of the structures with and without floating columns are analyzed for seismic and gravity condition. The seismic parameters such as lateral displacement, base shear, fundamental time period and inter storey drift are studied and the comparison between these parameters are given between the regular structure and structure with floating column.

1. The natural time periods obtained from the empirical expressions do not agree with the analytical natural periods. Hence, the dynamic analysis is to be carried out before analyzing these type of buildings. And also it can be concluded from the analysis that the natural time period depends on the structure configuration.
2. Lateral displacement increases along the height of the structure. There is more increase in the displacement for the floating column structures compared with the regular building.
3. The inter storey drift also increases as the increase in the number of storeys. The storey drift is more for the floating column structures because as the columns are removed the mass gets increased hence the drift.
4. As the mass and stiffness increases the base shear also increases. Therefore, the base shear is more for the floating column structures compared to the conventional structures.
5. Hence, from the study it can be concluded that as far as possible, the floating columns are to be avoided especially, in the seismic prone areas.

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