"SEISMIC ANALYSIS OF MULTISTOREY BUILDING WITH AND WITHOUT FLOATING COLUMN"

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ABSTRACT: Modern multi-storey buildings are constructed with irregularities such as soft storey, vertical or plan irregularity, floating column and heavy loads. These types of structures have become a very common construction practice in urban India. It is observed that most of the RC structures with such irregularities constructed are highly undesirable in seismically active areas from the results of past earthquake studies. These effects occurred due to various reasons, such as non-uniform distribution of mass, stiffness and strength. This study explains the seismic analysis of a multi storey building with floating column constructed in seismically active areas observing its reactions to the external lateral forces exerted on the building in various using the Staad Pro software. Thus highlighting the alternative measures involving in improvising the nonuniform distribution in the irregular building such as multi-storied building with floating column, and recommended the safer design of such building in seismically active areas considering the results observed from storey displacement, Base shear, Bending Moment, Shear Force, Deflection.

Key words: Floating column, Seismic analysis, Staad Pro.

1. Introduction

India is a developing country, where urbanization is at the faster rate in the country including adopting the methods and type of constructing buildings which is under vast development in the past few decades. As a part of urbanization multi-storey buildings with architectural complexities are constructed. These complexities are nothing but soft storey, floating column, heavy load, the reduction in stiffness, etc. Now a day's most of the urban multi-storey buildings have open first storey as an unavoidable feature. Accommodation of parking or reception lobbies is the primary use of this open first story in the multi-storey buildings constructed. But Conventional Civil Engineering structures are designed on the basis of strength and stiffness criteria. Usually the ground storey is kept free without any constructions, except the columns which transfer the building weight to the ground. "A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground, and the term "Floating Column" is also a vertical element which at its lower level rests on a beam which is a horizontal member".

2. Methodology

2.1 Modelling Of RC Building

This paper studies with the response spectrum analysis of the multi-storey building with floating column at different positions of the building. As per the code IS 1893-2002 (part 1) the response spectrum analysis of multi-storey building is summarized. The models details are,

2.1.1 Model 1: G+4 building without floating column i.e. normal building

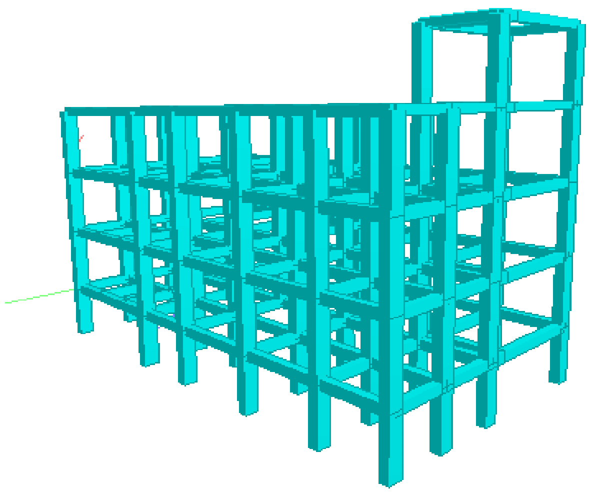

Fig. 2: 3-D view in STAAD.Pro without floating column

2.1.2 Model 2: G+4 building with floating column at Edge column position

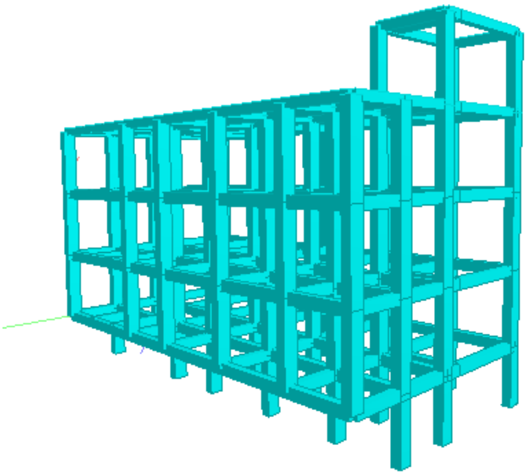

Fig. 3: 3-D view in STAAD.Pro with floating column at Edge column position

2.1.3 Model 3: G+4 building with floating column at Centre portion

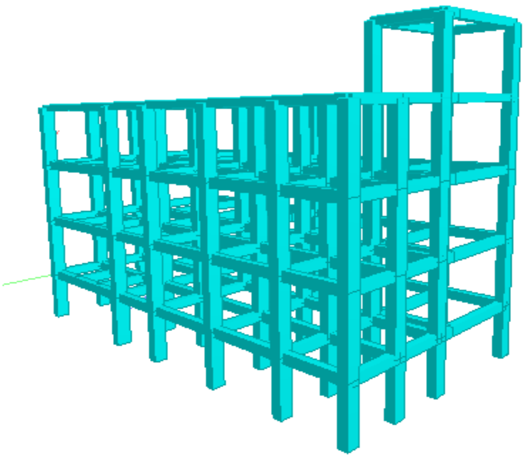

Fig. 4: 3-D view in STAAD.Pro with with floating column at Centre portion

2.2 Input Data

Comparison of the results observed in the three models that is Maximum displacements, Base shear, Response spectrum analysis of the normal building, floating column building . The dimensions and the factors considered in the modelling and analysis are as shown in the following tables,

Table 1: Multi-Storey Building Geometrical Dimensions

1.	Type of structure	Multi storey RC Frame
2.	Seismic zone	III
3.	Type of soil	Medium
4.	No. of stories	G+4
5.	Depth of slab	200 mm
6.	Materials	Fe500, M30
7.	Unit weight of RCC	25 kN/m3
8.	Unit weight of masonry	6 kN/m3

3. Results and discussion

3.1 General

A comparative study and analysis is performed between a normal column building that is the building with all regular columns and other structural and non-structural members in it and on the other hand a floating column building at various zones as per the specifications in IS- 1893(2002)part 1. A detail study is carried out on the floating column building to find out the variations in the structural response of the building with floating columns at “parallel positions, at one edge column position and at the center portion”, observed from the parameters like maximum displacements in the building at each floor, story drifts and the results obtained are beyond the deformation limits.

In the analysis of the models with recommendations, the following are the assumptions made. Thus, from these considerations, the models are analysed as discussed below,

3.2 Result Comparison

In the present study, the effect of varying the location of floating columns floor wise of multi storey RC building on various structural response quantities of the building using static analysis. The results are compared in tabular form and graphically for the analysis of the building without floating columns and with floating columns. From model 1, model 2 and model 3 the floating column is present at the Edge and center portion of the frame modeled and analyzed. The results obtained are by considering the parameters like maximum displacements and story drifts of the structure modeled, and the results obtained are discussed as below.

3.2.1 Storey Displacement

Storey displacement is the lateral movement of the structure caused by lateral force.

Table 2: Maximum Story Displacement in X-Direction

Story	Height (m)	Max. Displacement in X-Direction (in mm)		
		Model 1	Model 2	Model 3
Base	2.6	1.96	2.62	2.04
Story 1	5.9	6.80	7.57	7.01
Story 2	9.2	11.67	12.97	11.99
Story 3	12.5	16.22	17.37	16.63
Story 4	15.8	20.05	22.42	20.20

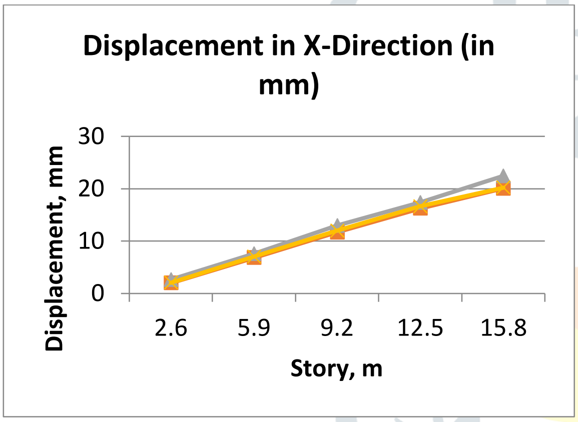

Fig. 5: Maximum displacements of the floating column at X-Direction

Table 3: Maximum Story Displacement in X-Direction

Story	Height (m)	Max. Displ. in Z-Direction (in mm)		
		Model 1	Model 2	Mode l 3
Base	2.6	1.37	3.60	1.88
Story 1	5.9	5.09	14.31	5.23
Story 2	9.2	9.31	25.54	9.55
Story 3	12.5	13.77	36.77	14.09
Story 4	15.8	18.95	41.66	19.36

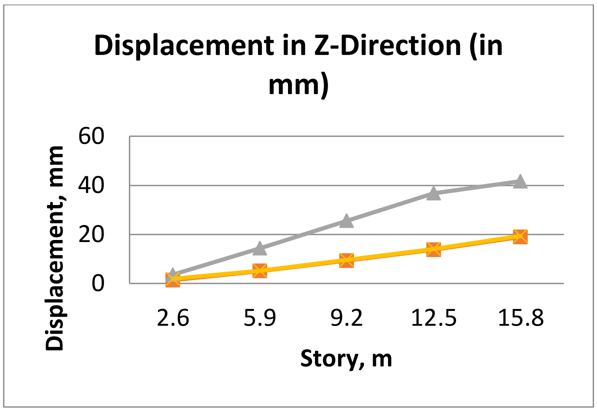

Fig. 6: Maximum displacements of the floating column at Z-Direction

3.2.2 Storey Drift

Story drift is the lateral displacement of one level relative to the level above or below

Table 4: Maximum Story Drift in X-Direction

Story	Height (m)	Max. Drift in X-Direction (in mm)		
		Model 1	Model 2	Model 3
Base	2.6	1.96	2.62	2.04
Story 1	5.9	4.91	4.94	4.96
Story 2	9.2	4.87	5.40	4.98
Story 3	12.5	4.55	4.39	4.64
Story 4	15.8	3.82	5.05	3.57

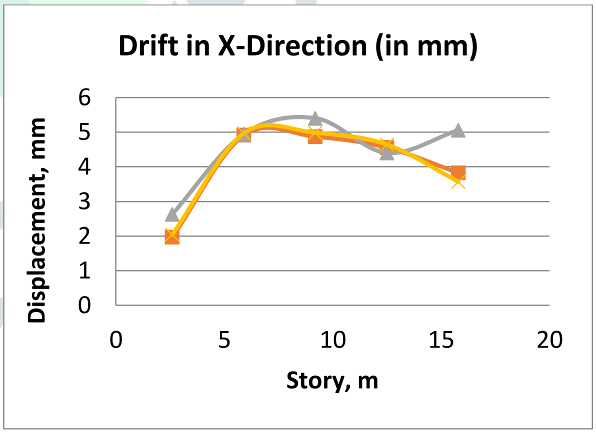

Fig. 7: Maximum Story drift of the floating column at X-Direction

Table 5: Maximum Story Drift in Z-Direction

Story	Height (m)	Max. Drift in Z-Direction (in mm)		
		Model 1	Model 2	Model 3
Base	2.6	1.37	3.60	1.88
Story 1	5.9	3.72	10.70	3.35
Story 2	9.2	4.22	11.23	4.31
Story 3	12.5	4.46	11.22	4.54
Story 4	15.8	5.18	4.89	5.27

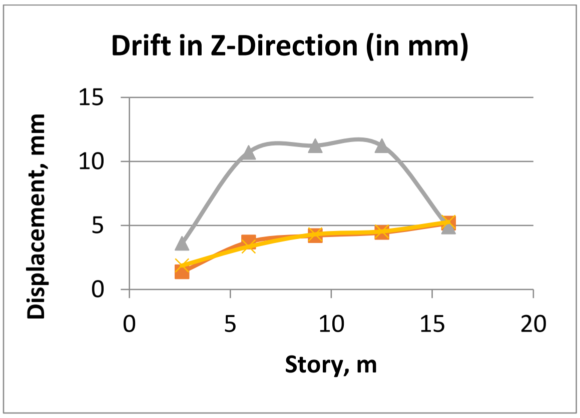

Fig. 8: Maximum Story drift of the floating column at Z-Direction

3.2.3 Base shear

Base shear is the horizontal reaction at the base against horizontal earthquake load. This base shear is acting at the base or supports of the structure or wherever structure is fixed.

Table 6: Base shear in X direction

Model	Base shear in x direction in KN
Without f/c	610.82
F/c at edge column position	606.97
F/c at center position	610.19

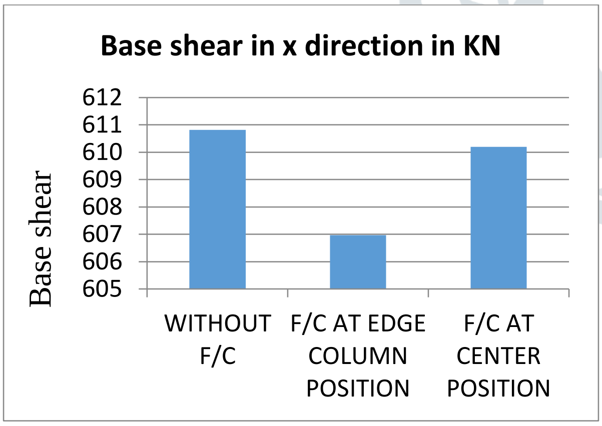

Fig. 9: Base shear at X-Direction

For Z-direction:-

Table 7: Base shear in Z direction

Model	Base shear in z direction in KN
Without f/c	610.82
F/c at edge column position	606.97
F/c at center position	610.19

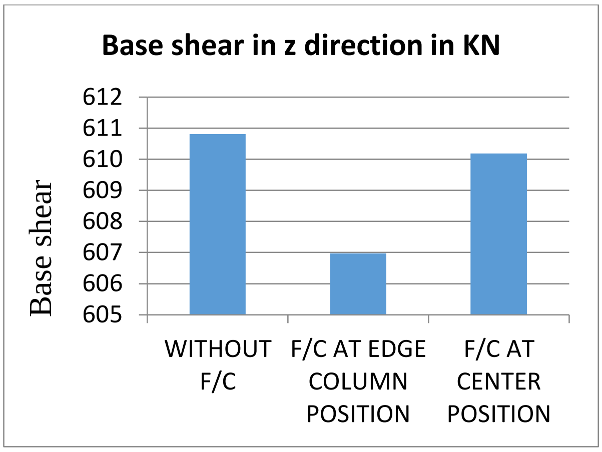

Fig. 10: Base shear at Z-Direction

3.2.4 Bending moment

Bending moment: Bending moment of G+4 structure for without floating column has been analyzed and on which first floor, second floor and third floor column is selected and the table is as shown below:

Table 8: Maximum BM of Without Floating Column

Load case	Column	Node	BM in Z direction (MZ) KN-m
101	96	9	63.621
101	173	153	48.63
101	250	187	30.49

Bending moment of G+4 structure for Edge Floating Column has been analyzed and on which first floor, second floor and third floor column is selected and the table is as shown below:

Table 9: Maximum BM of Edge Floating Column

Load case	Column	Node	BM in Z direction (MZ) KN-m
101	96	9	61.80
101	173	119	12.35
101	250	153	39.13

Bending moment of G+4 structure for Centre Floating Column has been analyzed and on which first floor, second floor and third floor column is selected and the table is as shown below:

Table 10: Maximum BM of Centre Floating Column

Load case	Column	Node	BM in Z direction (MZ) KN-m
101	100	47	116.01
101	167	119	77.75
101	254	201	59.21

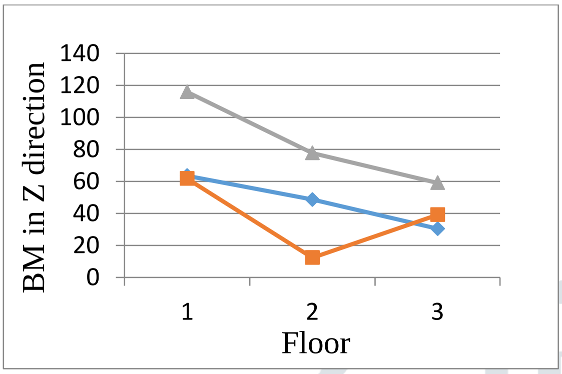

Fig. 11: comparison graph of Bending moment for all models

3.2.5 Shear Force

Shear force of G+4 structure for without floating column has been analyzed and on which first floor, second floor and third floor without floating column is selected and the table as shown below:

Table 11: Shear Force of Without Floating Column

Load case	Column	Node	SF in Y direction (FY) KN
101	96	9	31.90
101	173	119	26.77
101	250	187	15.85

Shear force of G+4 structure for edge floating column has been analyzed and on which first floor, second floor and third floor without floating column is selected and the table as shown below:

Table 12: Shear Force of Edge Floating Column

Load case	Column	Node	SF in Y direction (FY) KN
101	96	9	38.32
101	173	119	8.32
101	250	187	20.61

Shear force of G+4 structure for center floating column has been analyzed and on which first floor, second floor and third floor without floating column is selected and the table as shown below:

Table 13: Shear Force of Center Floating Column

Load case	Column	Node	SF in Y direction (FY) KN
101	100	47	59.13
101	167	119	44.00
101	254	201	33.36

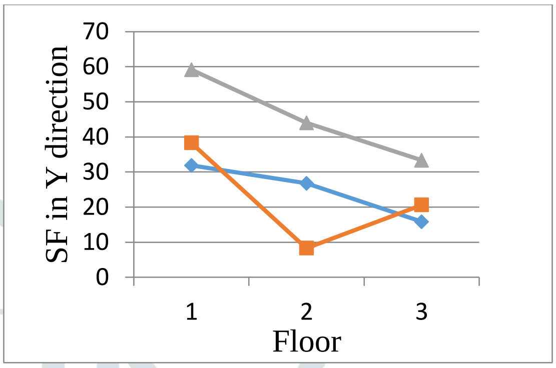

Fig. 12: comparison graph of Bending moment for all models

3.2.6 Deflection of Cantilever Beam

Deflection of Cantilever Beam governing in case of floating column structure. Cantilever should be safe to sustain required Static load and Dynamic load. Following result are noted after analysis of all structure.

Table 14: Deflection(mm) of cantilever Edge Beam

Load case	Beam	Y Direction (mm)	Z Direction (mm)
101	62	0.395	0.088
101	139	0.176	0.012
101	216	0.195	0.026
101	261	0.194	0.058

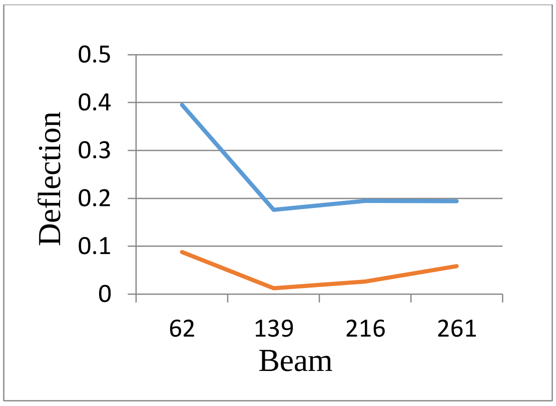

Fig. 13: Deflection of cantilever Edge Beam

Table 15: Deflection(mm) of cantilever Centre Beam

Load case	Beam	Y Direction (mm)	Z Direction (mm)
101	35	0.314	0.034
101	112	0.469	0.033
101	189	0.420	0.048
101	283	0.449	0.084

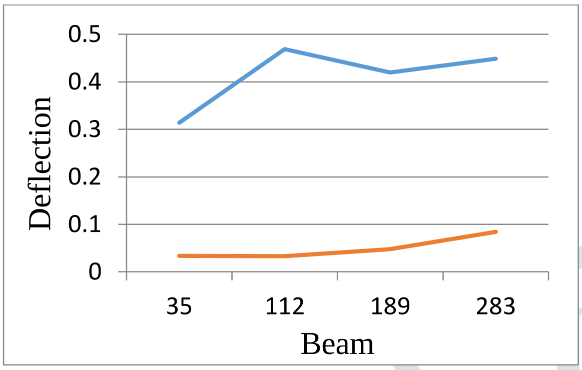

Fig. 14: Deflection of cantilever Center Beam

4. Conclusion

Following conclusions are drawn from the analysis,

- Generally, a building becomes expensive if it is designed to sustain any damage during a strong earthquake shaking.
- It is observed that the normal column building is more efficient when compared with other models i.e. floating column buildings.
- From the results it is observed that the building with floating column can be safe designed by increasing the dimensions of the beams and columns.
- It is observed that the building with normal column building have lesser displacements and story drifts when compared with the floating column models.
- The floating column building at one Edge column position have higher displacements and story drifts followed by floating column at parallel positions and finally the floating column at the centre portion.

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