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Performance Based Evaluation of Floating Column Building by Push Over Analysis

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ABSTRACT

In the present scenario, the buildings 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 types 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 building during the seismic activity. In this study, the seismic behaviours of the RC multistorey buildings with and without floating column are considered. The analysis is carried out for the multi-storey buildings, Using ETABS Software.

Keywords : Floating Column, Push Over Analysis.

I. INTRODUCTION

Earthquake exposes the weak point in structures. The buildings, which can appear to be more desirable adequate, may just disintegrate like houses of playing cards for the period of earthquake. Because of the lack of knowledge of the earthquake behavior of the buildings, many mistaken practices stay persisted, till an earthquake exposes these. There are countless examples enlisted in the damage reports of previous earthquakes where factors of failure of reinforced concrete structure have been irregularities in configurations. One such construction practice, generally utilized in our cities and exposed in the course of “Gujarat Earthquake of January 26, 2001”, is the presence of floating columns in buildings. These are the structures having cantilevered beams projected out of the columns at the floor stage. The collapse/harm of a quantity of such Structures in Ahmedabad, which is more than 300 km far away from the epicenter, has raised critical concern about the safeguard of structures with floating columns.

II. METHODS AND MATERIAL

1. 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.

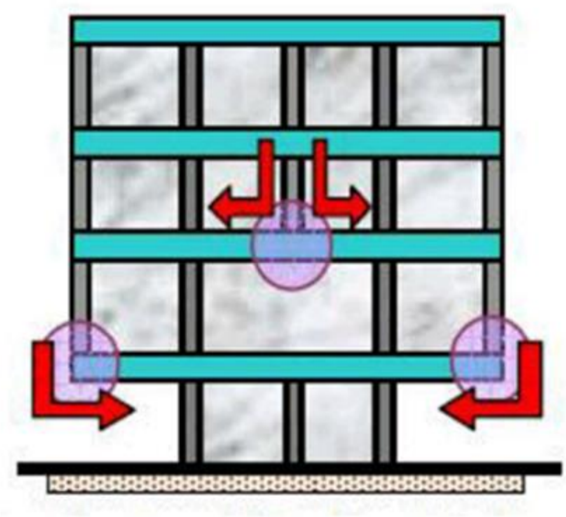

Figure 1. Floating Column

The constructing with floating columns have each in-plane as well as out-of-plane irregularities in strength and stiffness and hence are seismically vulnerable. This sort of building does no longer create any challenge beneath vertical loading specifications. However during a seismic activity a transparent load route does not exist for transmitting the lateral forces to the basis. Lateral forces accrued in higher flooring throughout the seismic activity have to be transmitted by means of the projected cantilever beams.

2. Metholodgy

To determine seismic behaviour of the Buildings with and without floating columns for zone III the basic component fundamental time period, this analysis has been carried using the software ETABS 13.1.1 for the analysis purpose Push over analysis adopted..

A. Building modeling

In this structure model RC multi storied the layout plan of the reinforced concrete natural moment resisting body structure of 3 storeyed, building with out and with floating columns are shown in Fig.2,3,4,5, with exposed ground floor and without reinforced brickwork infill walls within the higher storeys are select. The lowermost storey elevation is saved 4.8 m and a top of 3.6 m is stored for the entire further storeys, lengths in X, Y ways are saved as 6 m.

i. 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

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

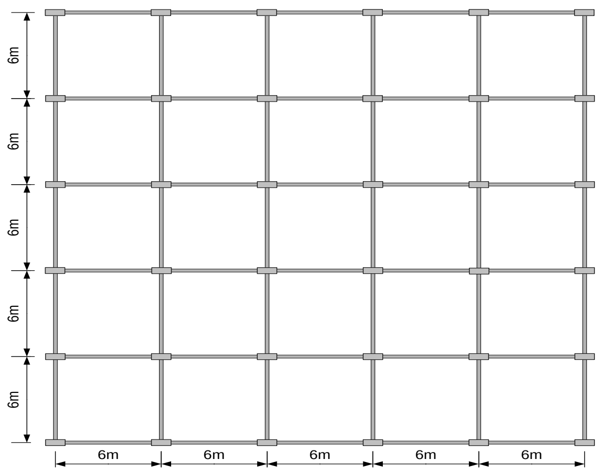

Figure 2. Plan of Model I

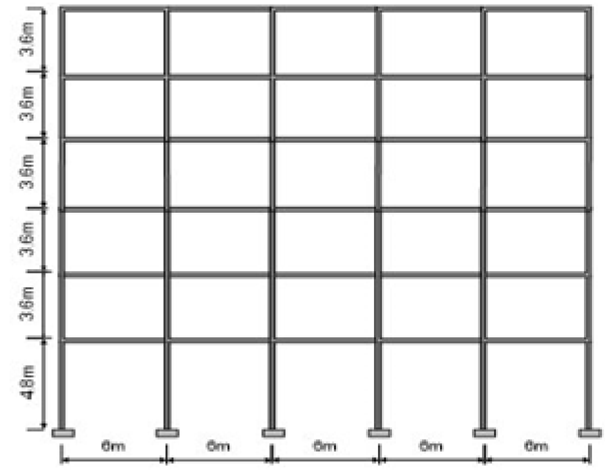

Figure 3. Elevation of G+ 5 Model I

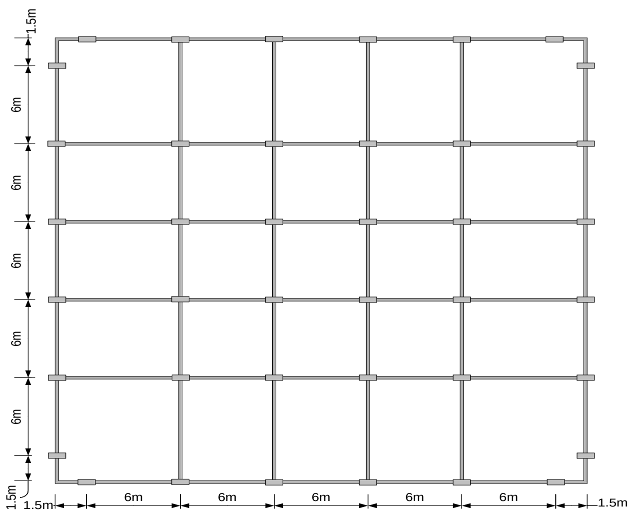

Figure 4. Plan of Model II

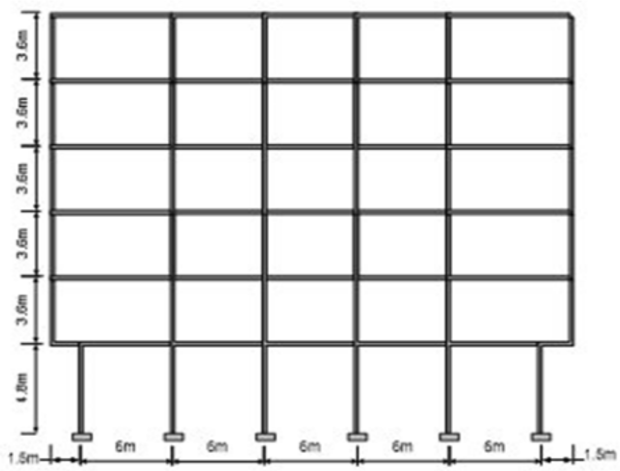

Figure 5. Elevation of G+ 5 Models II

B. Aim of the push over evaluation

The non-liner static curve signifies the lateral deformation as the function of force applied to the building. Vicinity of hinges in several phases can also be bought from no liner static curve as proven in Fighre-6. Where

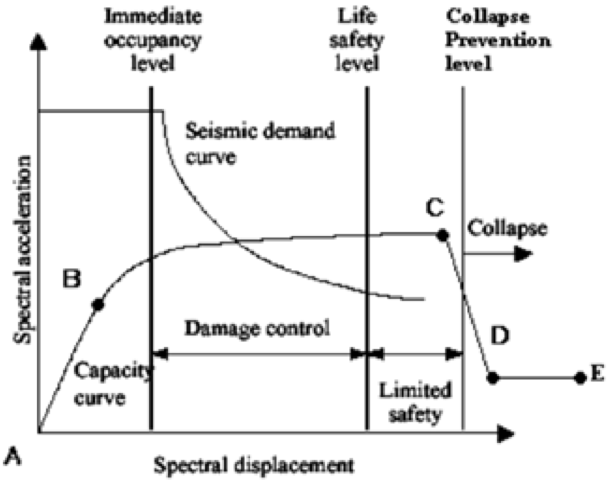

Figure 6. Plastic hinge formation at different states

Operational (A-B)

Backup utility services maintain functions, very little damage.

Instantaneous Occupancy (B-IO)

Structure remains safe to occupy, any repairs are minor.

Lifestyles protection (IO-LS)

In this building remains steady and significant reserve capacity, hazardous nonstructural harm is controlled.

Collapse Prevention (LS-CP)

Collapse Prevention, method the structure is on the verge of experiencing partial or whole failure.

III. RESULTS AND DISCUSSION

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.

Table 3 : 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. Pushover analysis

The results of pushover analysis are shown in Table 4 ,5 From the Table 4 to 5 it can be seen that the structure designed by equivalent static method at performance point are safe under pushover evaluation in both X and Y planes for all models analysed, thus the performance of these models are satisfactory and they do not require retrofitting. The numbers of hinges formed are more when the pushover is done in the shorter direction.

Table 4 : Performance point and Hinge status in longitudinal direction for six storeyed building for seismic analysis

Model	Performance point		Hinge locations				
	Displacement (mm)	Base Force (kN)	A-B	B-IO	IO-LS	LS-CP	Total
I	152.93	4701.05	850	182	120	0	1152
II	49.57	13353.58	1650	66	36	0	1752
III	115.90	6081.37	990	295	91	0	1376
IV	49.31	13481.44	1847	60	49	20	1976

Table 5 : Performance point and Hinge status in transverse direction for six storeyed building for seismic analysis

Model	Performance point		Hinge locations				
	Displacement (mm)	Base Force (kN)	A-B	B-IO	IO-LS	LS-CP	Total
I	182.08	3982.95	936	116	100	0	1152
II	66.23	8512.55	1626	53	41	32	1752
III	126.90	5393.81	1106	168	102	0	1376
IV	49.51	13647.02	1836	61	65	14	1976

IV. CONCLUSION

In this dissertation work, the behavior of the structures with and without floating columns are analysed for seismic condition. The seismic parameters such as fundamental time period, push over analysis are studied and the comparisons between these parameters are given between the regular structure and structure with floating column.

1. From the above research papers, Conclusion are made that up various techniques of the nonlinear static analysis are studied out of which push over analysis is the accurate and efficient process of analysis yet some parameters are yet to be evaluated in it.
2. 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.
3. The performance level of all the models is found within the collapse prevention level and the numbers of plastic hinges in the collapse prevention level at performance point for earthquake designed structures are less then the gravity designed structures.

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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