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EXPERIMENTAL INVESTIGATION ANALYSIS WITH FLOATING COLUMN IN MULTISTOREY BUILDING

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ABSTRACT

In present scenario buildings with floating column is a typical feature in the modern multistory construction in urban India. Such features are highly undesirable in building built in seismically active areas. This study highlights the importance of explicitly recognizing the presence of the floating column in the analysis of building. Alternate measures, involving stiffness balance of the first storey and the storey above, are proposed to reduce the irregularity introduced by the floating columns.

FEM codes are developed for 2D multi storey 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. The time history of floor displacement, inter storey drift, base shear, overturning moment are computed for both the frames with and without floating column.

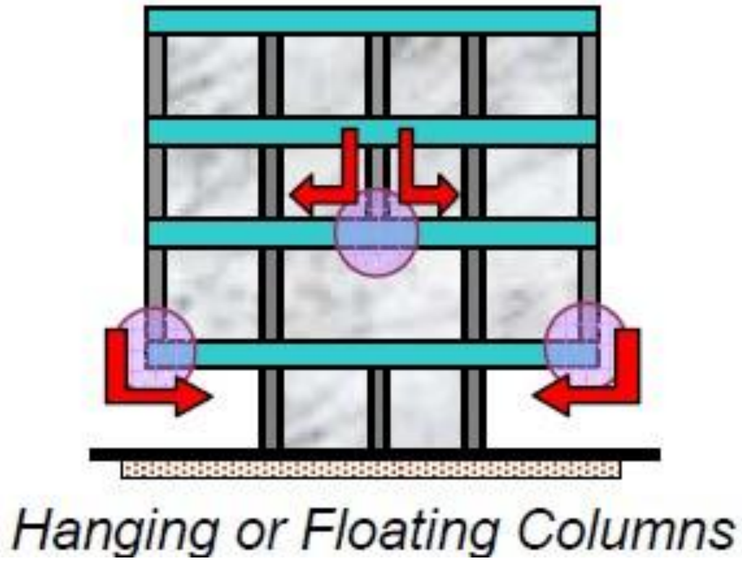
INTRODUCTION

Many urban multistorey buildings in India today have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking or reception 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 is dependent on the distribution of stiffness and mass along the height.

The behavior of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground. The earthquake forces developed at different floor levels in a building need to be brought down along the height to the ground by the shortest path; any deviation or discontinuity in this load transfer path results in poor performance of the building. Buildings with vertical setbacks (like the hotel buildings with a few storey wider than the rest) cause a sudden jump in earthquake forces at the level of discontinuity. Buildings that have fewer columns or walls in a particular storey or with unusually tall storey tend to damage or collapse which is initiated in that storey. Many buildings with an open ground storey intended for parking collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake. Buildings with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer path.

What is floating column

A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground. The term floating column is also a vertical element which (due to architectural design/ site situation) at its lower level (termination Level) rests on a beam which is a horizontal member. The beams in turn transfer the load to other columns below it.



FINITE ELEMENT FORMULATION

The finite element method (FEM), which is sometimes also referred as finite element analysis (FEA), is a computational technique which is used to obtain the solutions of various boundary value problems in engineering, approximately. Boundary value problems are sometimes also referred to as field value problems. It can be said to be a mathematical problem wherein one or more dependent variables must satisfy a differential equation everywhere within the domain of independent variables and also satisfy certain specific conditions at the boundary of those domains. The field value problems in FEM generally has field as a domain of interest which often represent a physical structure. The field variables are thus governed by differential equations and the boundary values refer to the specified value of the field variables on the boundaries of the field. The field variables might include heat flux, temperature, physical displacement, and fluid velocity depending upon the type of physical problem which is being analyzed.

Static analysis

Plane frame element

The plane frame element is a two-dimensional finite element with both local and global coordinates. The plane frame element has modulus of elasticity E, moment of inertia I, cross- sectional area A, and length L. Each plane frame element has two nodes and is inclined with an angle of θ measured counterclockwise from the positive global X axis as shown in figure. Let C=cosθ and S= sinθ.

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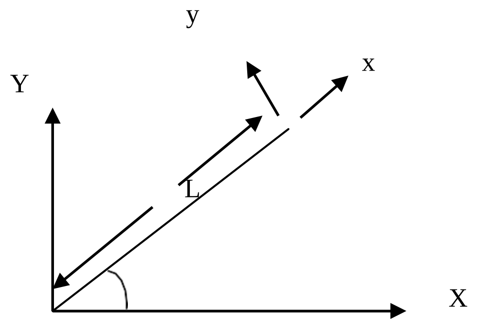

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Fig. 3.1 The plane frame element

It is clear that the plane frame element has six degree of freedom – three at each node (two displacements and a rotation). The sign convention used is that displacements are positive if they point upwards and rotations are positive if they are counterclockwise. Consequently for a structure with n nodes, the global stiffness matrix K will be 3n X 3n (since we have three degrees of freedom at each node). The global stiffness matrix K is assembled by making calls to the MATLAB function Plane Frame Assemble which is written specially for this purpose.

RESULT AND DISCUSSION

The behavior of building frame with and without floating column is studied under static load, free vibration and forced vibration condition. The finite element code has been developed in MATLAB platform.

4.1 Static analysis

A four storey two bay 2d frame with and without floating column are analyzed for static loading using the present FEM code and the commercial software *STAAD Pro*.

Example 4.1

The following are the input data of the test specimen: Size of beam – 0.1 X 0.15 m

Size of column – 0.1 X 0.125 m Span of each bay – 3.0 m Storey height – 3.0 m

Modulus of Elasticity, E = 206.84 X 10^6 kN/m^2

Support condition – Fixed Loading type – Live (3.0 kN at 3^{rd} floor and 2 kN at 4^{th} floor)

Fig. 4.1 and Fig.4.2 show the sketchmatic view of the two frame without and with floating column respectively. From Table 4.1 and 4.2, we can observe that the nodal displacement values obtained from present FEM in case of frame with floating column are more than the corresponding nodal displacement values of the frame without floating column. Table 4.3 and

4.4 show the nodal displacement value obtained from STAAD Pro of the frame without and with floating column respectively and the result are very comparable with the result obtained in present FEM.

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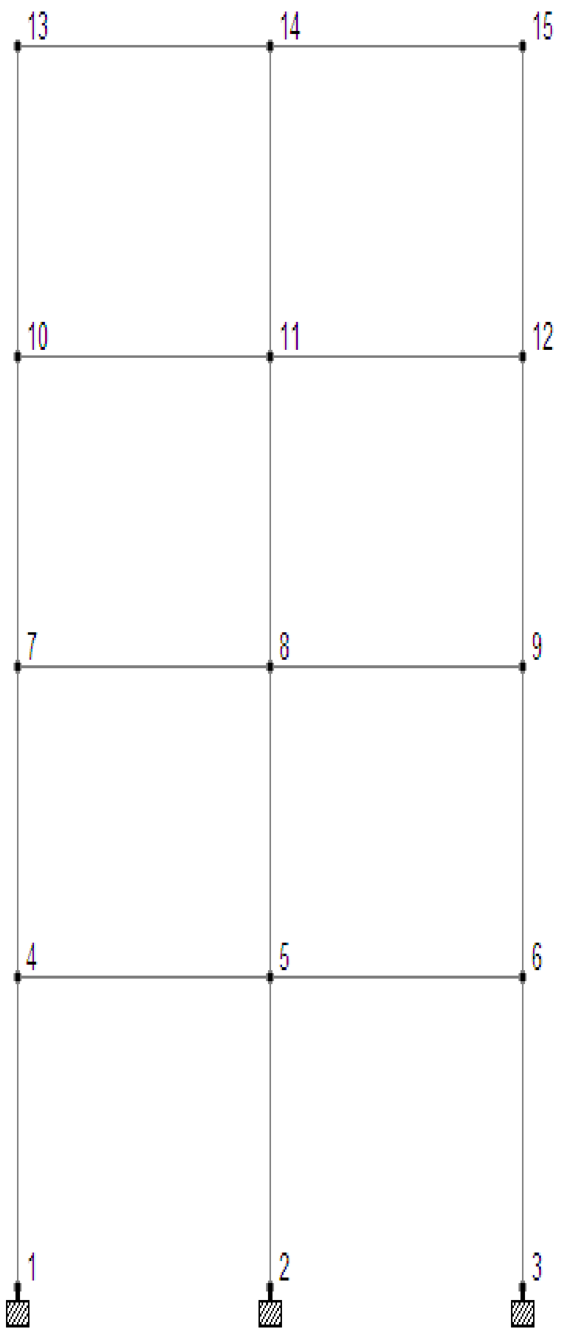
. **Fig. 4.1** 2D Frame with usual columns **Fig.4.2** 2D Frame with Floating column



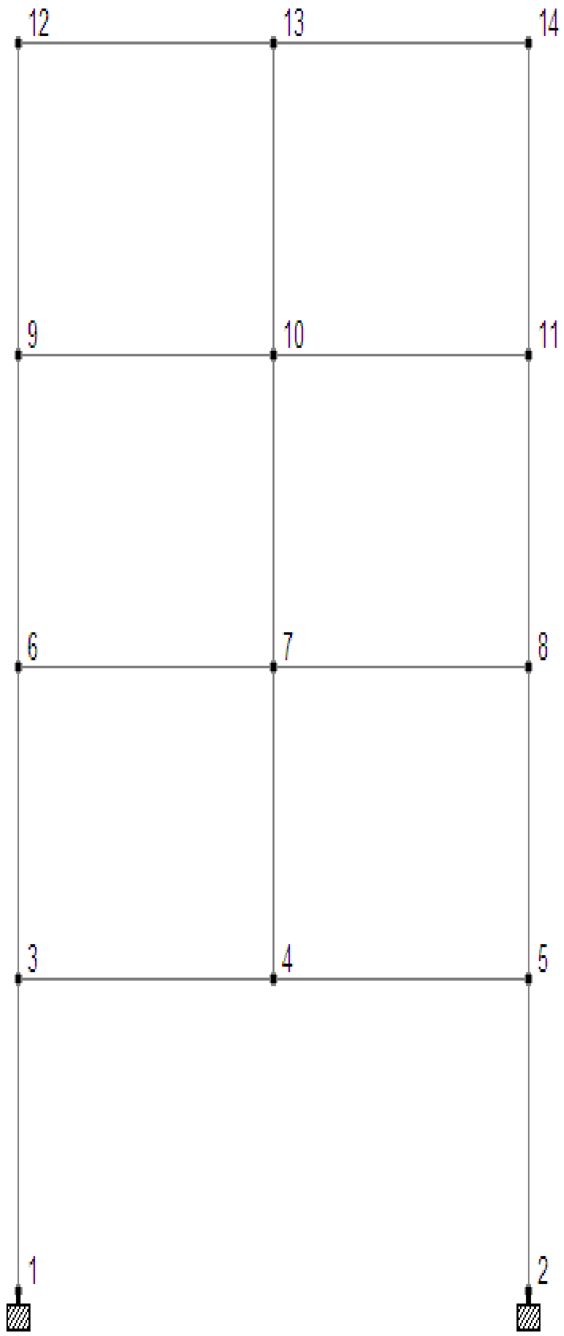


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Table 4.1 Global deflection at each node for general frame obtained in present FEM

Node	Horizontal	Vertical	Rotational
	X mm	Y mm	rZ rad
1	0	0	0
2	0	0	0
3	0	0	0
4	1.6	0	0
5	1.6	0	0
6	1.6	0	0
7	3.8	0	0
8	3.8	0	0
9	3.8	0	0
10	5.8	0	0
11	5.8	0	0
12	5.8	0	0
13	6.7	0	0
14	6.7	0	0
15	6.7	0	0

Table 4.2 Global deflection at each node for general frame obtained in STAAD Pro.

Node	Horizontal	Vertical	Rotational
	X mm	Y mm	rZ rad
1	0	0	0
2	0	0	0
3	0	0	0
4	1.4	0	0
5	1.4	0	0
6	1.4	0	0
7	3.6	0	0
8	3.6	0	0
9	3.6	0	0
10	5.6	0	0
11	5.6	0	0
12	5.6	0	0
13	6.8	0	0
14	6.8	0	0
15	6.8	0	0

Table 4.3 Global deflection at each node for frame with floating column obtained in present FEM

Node	Horizontal	Vertical	Rotational
	X mm	Y mm	rZ rad
1	0	0	0
2	0	0	0
3	2.6	0	0
4	2.6	0	0
5	2.6	0	0
6	4.8	0	0
7	4.8	0	0
8	4.8	0	0
9	6.8	0	0
10	6.8	0	0
11	6.8	0	0
12	7.8	0	0
13	7.8	0	0
14	7.8	0	0

Table 4.4 Global deflection at each node for frame with floating column obtained in STAAD Pro

Node	Horizontal	Vertical	Rotational
	X mm	Y mm	rZ rad
1	0	0	0
2	0	0	0
3	2.6	0	0
4	2.6	0	0
5	2.6	0	0
6	4.8	0	0
7	4.8	0	0
8	4.8	0	0
9	6.8	0	0
10	6.8	0	0
11	6.8	0	0
12	7.7	0	0
13	7.7	0	0
14	7.7	0	0

4. 2 Free vibration analysis Example 4.2

In this example a two storey one bay 2D frame is taken. Fig.4.3 shows the sketchmatic view of the 2D frame. The results obtained are compared with Maurice Petyt[21]. The input data are as follows:

Span of bay = 0.4572 m Storey height = 0.2286 m

Size of beam = (0.0127 x 0.003175) m Size of column = (0.0127 x 0.003175) m

Modulus of elasticity, E = 206.84 x10^6 kN/m^2 Density, ρ = 7.83 x 10^3 Kg/m^3

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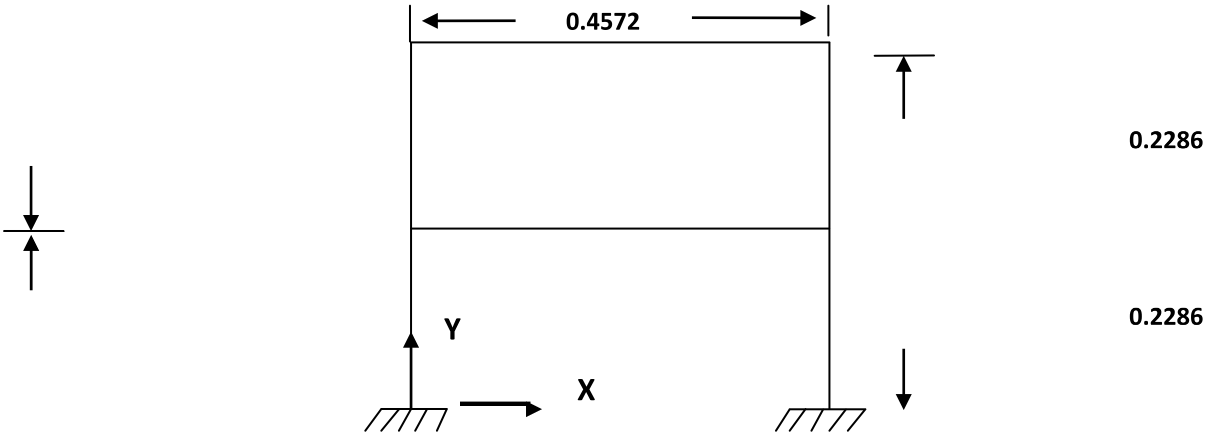
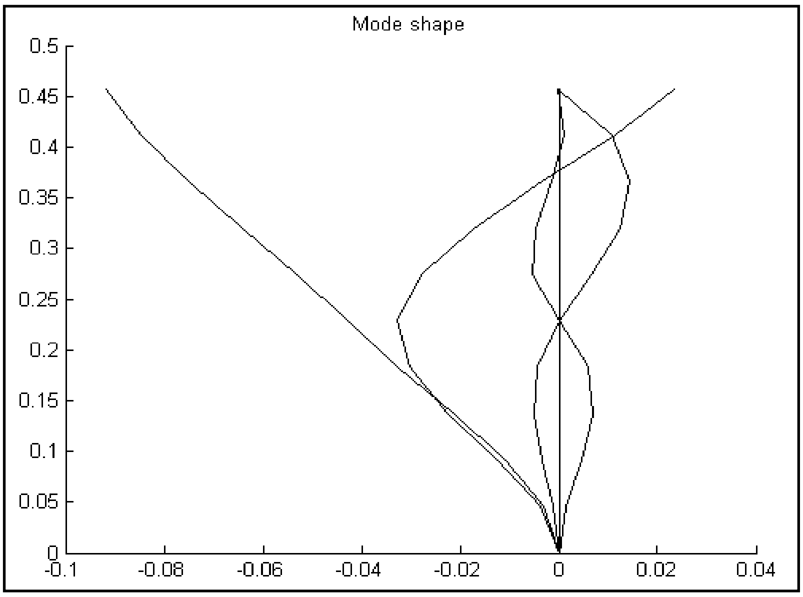


Table 4.5 shows the value of free vibration frequency of the 2D frame calculated in present FEM. It is observed from Table 4.5 that the present results are in good agreement with the result given by Maurice Petyt [21].

Table 4.5 Free vibration frequency(Hz) of the 2D frame without floating column

Mode	Maurice Petyt [21]	Present FEM	% Variation
1	15.14	15.14	0.00
2	53.32	53.31	0.02
3	155.48	155.52	0.03
4	186.51	186.59	0.04
5	270.85	270.64	0.08

Fig. 4.4 Mode shape of the 2D framework



CONCLUSION

The behavior of multistory building with and without floating column is studied under different earthquake excitation. The compatible time history and Elcentro earthquake data has been considered. The PGA of both the earthquake has been scaled to 0.2g and duration of excitation are kept same. A finite element model has been developed to study the dynamic behavior of multi story frame. The static and free vibration results obtained using present finite element code are validated. The dynamic analysis of frame is studied by varying the column dimension. It is concluded that with increase in ground floor column the maximum displacement, inter storey drift values are reducing. The base shear and overturning moment vary with the change in column dimension.

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, Page no: 997-1007,2008.
7. **Chopra, Anil k.** (1995), "Dynamics of structures", Prentice Hall.
8. **Daryl L. Logan** (2007), "A First Course in the Finite Element Method", Thomson, USA
9. **Fall H.G** (2006), "Direct Stiffness Method For 2D Frames-Theory of structure".