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SEISMIC ANALYSIS OF MULTISTOREYED BUILDINGS WITH AND WITHOUT FLOATING COLUMNS

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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.The study is carried out on a building with floating columns. The plan layout of the building is shown in the figure. The building considered is a residential building having G+9. Height of each storey is kept same as other prevalent data.

Keywords—*floating column, time history, response spectrum, floor displacement, inter storey drift, base shear, ETABS*

I.INTRODUCTION

Many urban multi-storey 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 process of urbanization has been a common feature throughout the past decades. Urbanization and Growth of high rise buildings is the need of current population and earthquakes have the potential for causing the greatest damages to those tall structures. Hence, it is necessary to take in to account the seismic load for the design of high-rise structure.

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 at its lower level rests on a beam which is a horizontal member. 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. The beams in turn transfer the load to other columns below it. In such columns the loads were considered as a point load.

There are many projects in which floating columns are already adopted, especially above the ground floor, so that more open space is available on the ground floor. These open spaces may be required for assembly hall or parking purpose. The column is a concentrated load on the beam which supports it. The structures already made with these kinds of discontinuous members are endangered in seismic regions. But those structures cannot be demolished; rather study can be done to strengthen the structure. The stiffness of these columns can be increased by retrofitting or these may be provided by bracing to decrease the lateral deformation. Many high rise buildings are planned and constructed with architectural complexities. The complexities are nothing but soft storey, floating column, heavy load, the reduction in stiffness, etc.

Conventional Civil Engineering structures are designed on the basis of strength and stiffness criteria. The strength is related to ultimate limit state, which assures that the forces developed in the structure remain in elastic range. The stiffness

is related to serviceability limit states which assure that the structural displacement remains with the permissible limits. In case of earthquake forces the demand is for ductility. Ductility is an essential attribute of a structure that must respond to strong ground motions. Ductility is the ability of the structure to undergo distortion or deformation without damage or failure which results in dissipation of energy. Larger is the capacity of the structure to deform plastically without collapse, more is the resulting ductility and the energy dissipation. This causes reduction in effective earthquake forces.

Fig 1 Hanoi Museum in Vietnam

II.OBJECTIVE

- To study the behavior of multi storey buildings with and without floating columns under earthquake excitations.
- To compare the behavior of buildings with floating columns provided inside and at the corners of the building.
- To determine the storey drift, lateral displacement and storey shears of the building using STAAD PRO.

III.METHODS OF ANALYSIS

The analysis can be performed on the basis of external action, the behavior of structure or structural materials, and the type of structural model selected. Based on the type of external action and behavior of structure, the analysis can be further classified as:

A. Equivalent static analysis:

All design against seismic loads must consider the dynamic nature of the load. However, for simple regular structures, analysis by equivalent linear static methods is sufficient. This is permitted in most codes of practice for regular, low- to medium-rise buildings. This procedure does not require dynamic analysis, however, it account for the dynamics of building in an approximate manner. The static method is the simplest one as it requires less computational efforts and is based on formulates given in the code of practice. First, the design base shear is computed for the whole building, and it is then distributed along the height of the building. The lateral forces at each floor levels thus obtained are distributed to individual's lateral load resisting elements.The main objective of structural analysis is to determine internal forces, stresses and deformation of structures under various load effect.

B. Dynamic Analysis:

Dynamic analysis of structure is a part of structural analysis in which behavior of flexible structure subjected to dynamic loading is studied. Dynamic load always changes with time. Dynamic load comprises of wind, live load, earthquake load etc. Thus in general we can say almost all the real life problems can be studied dynamically. If dynamic loads changes gradually the structure's response may be approximately calculated by a static analysis in which inertia forces can be neglected. But if the dynamic load changes quickly, the response must be determined with the help of dynamic analysis in which we cannot neglect inertial force which is equal to mass time of acceleration (Newton's 2nd law).

1) Response Spectrum Analysis:

Response spectrum method is the linear dynamic analysis method. This method is applicable for those structures where modes other than the fundamental one affect significantly the response of the structure. In this method the peak responses of a structure during an earthquake is obtained directly from the earthquake responses (or design) spectrum. The response of Multi- Degree- of–Freedom (MDOF) system is expressed as the

superposition of modal response, each modal response being determined from the spectral analysis of Single - Degree- of – Freedom (SDOF) system, which are then combined to compute the total response. Modal analysis leads to the response history of the structure to a specified ground motion; however, the method is usually used in conjunction with a response spectrum. The maximum response is plotted against the undamped natural period and for various damping values, and can be expressed in terms of maximum relative velocity or maximum relative displacement.

2) Time History Method:

Time History analysis is a step by step analysis of the dynamic response of the structure at each increment of time when its base is subjected to specific ground motion time history. To perform such an analysis a representative earthquake time history is required for a structure being evaluated. It is used to determine the seismic response of a structure under dynamic loading of representative earthquake.

A linear time history analysis overcomes all the disadvantagesof modalresponse spectrum analysis, provided non-linear behavior is not involved. This method requires greater computational efforts for calculating the response at discrete time. One interesting advantage of such procedure is that the relative signs of response qualities are preserved in the response histories. This is important when interaction effects are considered in design among stress resultants. Here dynamic response of the plane frame is modeled to specified time history compatible to IS code spectrum and Sumatra earthquake.

IV. STRUCTURAL MODELING AND ANALYSIS

The behaviors of the multi storey building with and without floating column have been carried out under earthquake excitation. The building is modelled for Sumatra earthquake and response spectrum analysis.

The building considered here consists of fifteen storeys, i.e.G+9. The building is modeled using the software STAAD PRO. The analytical models of the building include all the component that influence the mass, strength, stiffness and deformability of structure. The building structural system consists of beam, column, slab, wall, foundation, retaining wall, elevator, and staircase. The nonstructural elements that do not significantly influence the building behavior are not modeled. Beams and columns are modeled as two nodded beams. The floor slabs are assumed to act as diaphragms, which ensure integral action of all vertical load resisting elements. The wall load is uniformly distributed over beams. Walls are considered to be rigidly connected to beams and columns. In the modeling, material is considered as an isotropic material. The 3D building model generated in STAAD PRO is shown in figure

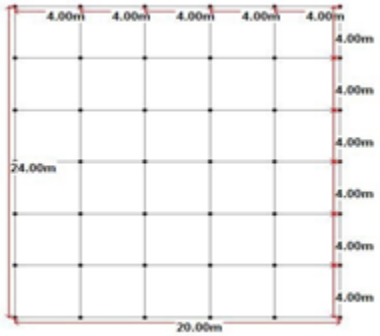
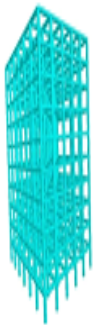


Fig 4.1TOP VIEW

MODEL 1 - Rectangular Building without any floating column

FIG 4.2 Elevation of building without floating columns

FIG 4.3 3d view of the model without floating column



Model 2: Square Building with floating column at first floor

FIG 4.4 Elevation of building with floating column at first floor

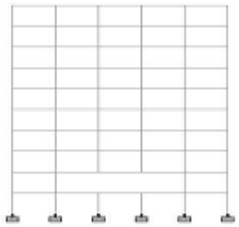
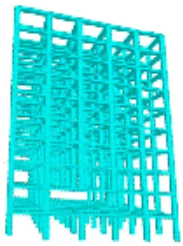


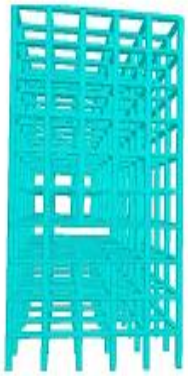
FIG 4.5 3d view of the model with floating column at first floor



Model 3: Square Building with floating column at third floor

FIG 4.6 Elevation of building with floating column at third floor

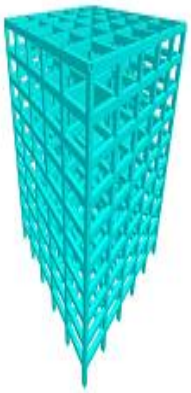
FIG 4.7 3d model of building with floating column at 3rd floor



Model 4 : Square Building with floating column at fifth floor

FIG 4.8 Elevation of building having floating column at 5th floor

FIG 4.12 3d view of building with floating column at 5th floor



V.RESULTS AND DISCUSSIONS

The results of the comparative analysis between a building without floating column and with floating column will be carried on the basis of base shear and storey displacements.

1) Base shear:

TABLE5.1

S.no	SEISMIC WEIGHT	BASE SHEAR	TIME PERIOD
MODEL 1	52959.43	2206.64	0.96
MODEL 2	52590.00	2205.50	0.96
MODEL 3	52844.92	2201.87	0.96
MODEL 4	52755.85	2198.16	0.96

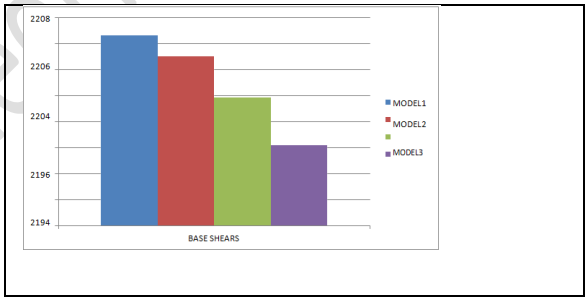


FIG 5.1 VARIATION OF BASE SHEAR

Displacements at different heights

a) In x-directions(in mm)

TABLE 5.2

S No	9m	15m	21m	27m
Model 1	4.9035	8.2946	11.2413	13.2791
Model 2	5.0020	8.6681	11.4293	13.3431
Model 3	5.1114	10.2266	13.2287	15.3226
Model 4	5.2360	11.3086	15.9596	18.0762

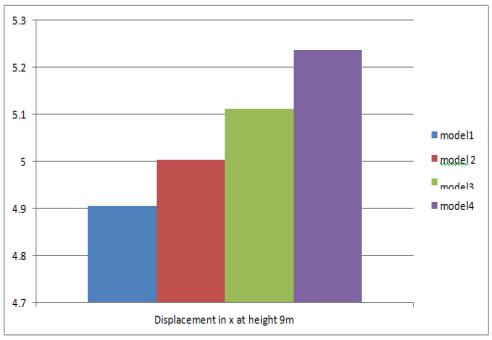


FIG 5.2
Variation of displacement at height 9 metres

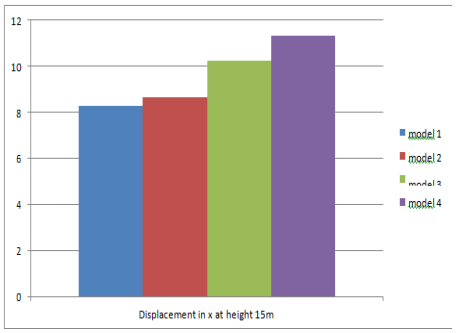


FIG 5.3

Variation of displacement at height 15 metres

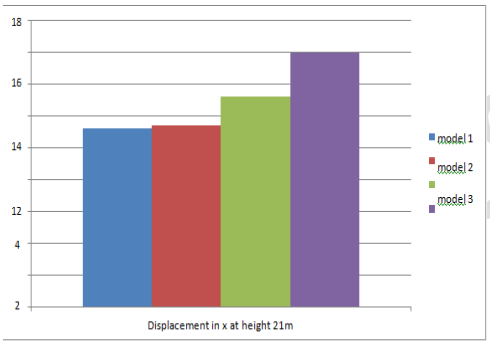


FIG 5.4
Variation of displacement at height 21metres

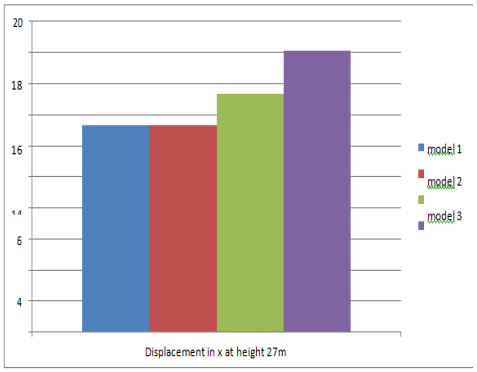


FIG 5.5
Variation of displacement at height 27 metres

B) In z-directions(in mm) :

TABLE 5.3

S.No	9m	15m	21m	27m
Model 1	2.4376	4.3017	5.9274	7.0523
Model 2	2.5844	5.2896	6.1786	7.6567
Model 3	2.7399	5.5090	7.1862	8.3620
Model 4	2.9386	5.8180	8.6700	9.8753

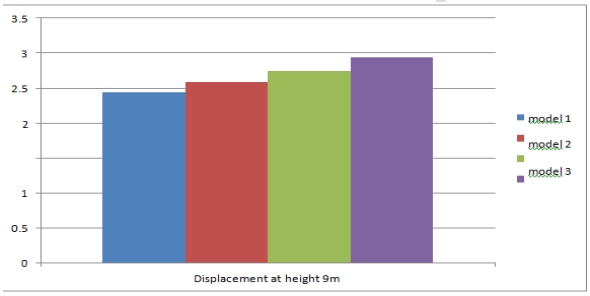


FIG 5.6
Variation of displacement at height 9 metres

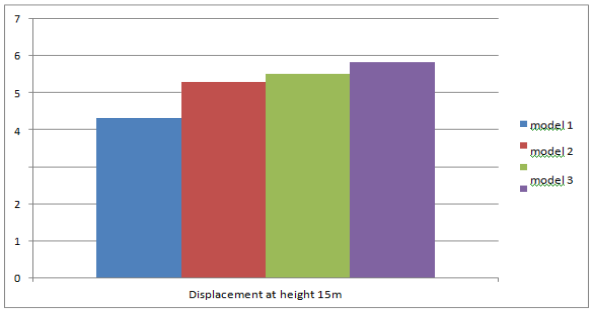


FIG 5.7
Variation of displacement at height 15 metres

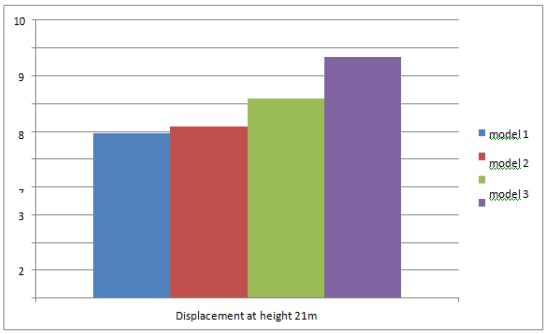


FIG 5.8
Variation of displacement at height 21 metres

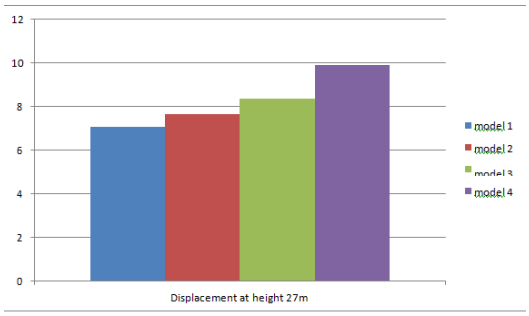


FIG 5.9
Variation of displacement at height 27 metres

VI.CONCLUSIONS

This paper has presented a general review of structural systems for tall buildings.Unlike the height-based classifications in the past, a system-based broad classification has been proposed. Various structural systems within each category of the new classification have been described with emphasis on innovation

On the basis of present study the following conclusions can be drawn:

- It was observed that that building with floating column has less base shear as compared to a building without floating column
- It was also observed that as floating column shifts from bottom storeys towards top storeys value of base shear decreases.
- It was also observed that building with floating column has more displacement as compared to a building without floating column.
- It was also observed that shifting of floating column from bottom to top storeys increases the values of displacements.
- It was observed that building with floating column has more storey drift than that compared with a building without floating column.
- It was also observed that shifting of floating column from bottom to top storeys increases the values of storey drifts.

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