Study of Behavior of Seismic Evaluation of Multistoried Building having Floating Column

Yash Raj Rana [1], Nidhi Gupta [2]
1-M.Tech Student, Structural Engineering, Dept. of Civil Engineering
2-Assistant Professor, Dept. of Civil Engineering
R.K.D.F Institute of Science and Technology, Bhopal

Abstract - ***In present construction world, buildings with floating column is a common feature that we can see in the modern multi-storey structures. Such features are highly undesirable in a building built in earthquake prone areas. This research paper investigates the effect of a floating column under earthquake excitation for various soil conditions and will also help in determination of drift for safe and economical design of a building having floating column. Sometimes, it is not possible to meet the requirements are not avoided although these are not safe. Therefore, an attempt has been made to study the behavior of the building during the earthquake. Here, the seismic behavior of the reinforced concrete multistory buildings with and without floating column is considered. The analysis is carried out for the high rise building of G+5 situated at zone 4 by using ETABS. Linear Dynamic Analysis is done for 2D multi storey frame with and without floating column to find out solutions to abovesaid problem.***

Keywords: ***Floating Column, Linear Static Analysis, Linear Dynamic Analysis , Drift.***

I. INTRODUCTION

In modern India , avoidance of open storey in multi-strorey building cannot be done. The opened storey feature in building provides area for the parking, reception lobbies etc. Generally, the behavior of building depends upon on how earthquake forces coming from inside the earth, in addition to this, it is also based on the overall shape, size and geometry of the respective building. The developed earthquake forces in the building are brought down along the shortest route and any deviation in this leads to the poor performance of the building. The vertically unsymmetrical buildings i.e. hotel buildings, hospital buildings etc causes a sudden jump in earthquake forces at the level of discontinuity. Generally, this type of tall building is having fewer columns or walls as compared to the other floors.

Many buildings, having open ground storey at the bottom level, are severely damaged or collapsed in Gujarat during 2001 Bhuj earthquake. Here, some of the columns do not go to the foundation and discontinue in the load transfer path.

A column is a vertical member,that starts from foundation and ends at terrace level, uses for transferring of the load to the ground. A floating column is also vertical member of structure and it transmits the load to beam and then beam transfers this loads to the connecting columns on which it rests.

Many projects are having this kind of feature where some of the columns are ended at the first floor. So that, right amount of space will be available for parking, assembly halls at the ground floor. These transfer girders are to be designed and detailed correctly in seismic zones. The load coming through column is concentrated load that comes on the beam where it is pinned. ETABS, STAAD Pro and SAP2000 are used for this kind of the structure.

Floating columns are capable enough to carry gravity loading but transfer girder must be of adequate stiffness with minimal deflection. Basically, these type of columns are provided in the building to make it architecturally sound but we cannot do this on the cost of poor behaviour and earthquake safety of buildings. Some of the architectural features that are detrimental to earthquake must be avoided. If not, they must be minimized.

When irregularity i.e. vertical or horizontal are impregnated into the building then it will be compulsory to have higher engineering effort.

Therefore, the structure made up of this kind of vertical member are endangered in earthquake zones. But those type of structures cannot be demolished, rather study will be done to strengthen it and required remedial measures will be incorporated. The columns, that are already made, can be made stronger by increasing the stiffness.

The main objective of the present work is to study the behavior of floating columns of multi-storey buildings under the earthquake excitations.

II. SYSTEM MODEL

In this research work, 6 storey building is considered with and without floating columns for the analysis. The typical height of the floors is considered as 3.5m and height of the ground storey is taken as 4.5m to avoid the tensional response under the pure lateral forces the buildings are kept symmetric in both the orthogonal directions in plan. The building plan considered is shown in Figure 1.

III. PREVIOUS WORK

This research work includes earthquake response of multi storey building frames with usual columns. Some part of the work emphasizes on strengthening of the existing buildings in seismic prone areas.

Maison and Neuss of ASCE have performed the computer analysis of an existing forty four story steel frame high-rise Building to study the influence of various modelling aspects on the predicted dynamic properties and computed seismic response behaviours. The predicted dynamic properties are compared to the true properties of the building as previously determined from experimental testing. The behaviour of seismic response is calculated by response spectrum method and equivalent static methods.

Maison and Ventura, Members of ASCE, computed dynamic properties and response behaviours OF 13 storey building and these results are compared to the true values as determined from the recorded motions in the building during two actual earthquakes later on come to conclude that how state-of-practice design type analytical models can predict the actual dynamic properties.

Arlekar, Jain & Murty said that such kind of architectural features were highly undesirable in buildings built in seismically active areas; this has been confirmed in the numerous shakes experienced during the previous earthquakes. Both of them have highlighted to recognizing the presence of the open first storey in the analysis of the building, involving stiffness balance of the open first storey and the storey above, were proposed to reduce the irregularity introduced by the open first storey.

Awkar and Lui learnt responses of multi-story flexibly connected frames subjected to earthquake excitations using a computer model. The model includes flexibility of connections as well as the geometrical and material nonlinearities in the analysis and to conclude that flexibility of connection tends to increase upper stories inter-storey drifts but reduce base shears and base overturning moments for multi-story frames.

Balsamoa, Colombo, Manfredi, Negro & Prota executed pseudodynamic tests on an RC structure repaired with CFRP laminates. Thereafter assessment of Carbon Fiber Reinforced Polymer (CFRP) composites for the seismic repair of reinforced concrete (RC) structures were on a full-scale dual system subjected to pseudo dynamic tests in the ELSA laboratory. The aim of the CFRP repair was to know the structural properties that the frame had before the seismic actions by providing both columns and joints with more deformation capacity. In the end, Comparisons between original and repaired structures are discussed in terms of global and local performance.

Ozyigit investigated the performance of free and forced in-plane and out-of-plane vibrations of frames.The cross-section of beam was circular and in a straight and curved part. A concentrated mass is located at different points of the frame with different mass ratios. FEM is used to analyze the problem.

Williams, Gardoni & Bracci studied the economic benefit of a given retrofit procedure using the framework details. A parametric analysis was conducted to determine how certain parameters affect the feasibility of a seismic retrofit.

IV. PROPOSED METHODOLOGY

The regular 6 story building is having 4 bays of width 3m. The structure is made up of Reinforced Cement Concerte. The important structural parameters are given in Table-1.

TABLE 1. PRELIMINARY DATA

Length x Width	12m x 12m
No. of storeys	6
Storey height below first floor	4.5m
Storey height above first floor	3.5m
Beam	500mm x 500mm
Column 1-6 storeys	500mm x 500mm
Slab thickness	130mm
Support conditions	Fixed
Beam Releases	Axial force

The loads acting on the structure are Dead Load , Live Load and Earthquake Load.

Dead Load (DL) includes self - weight of the building , Floor Finishes and Wall Loads.
Wall Thickness – 115 mm
Live Load - 2 kN/m^2
Floor Finish - 1 kN/m^2
Wall Load – 6.9 kN/m^2 (As per the calculation)

Soil Type – II
Plastering is not considered
Grade of Concrete – M30
Grade of Steel - Fe500

Earthquake Load Analysis Parameters
T = 0.560 sec
R = 3
Z = 0.16
I = 1

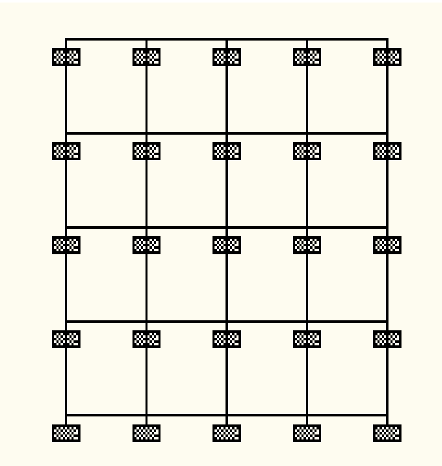

Fig.1 Plan of the regular structure considered

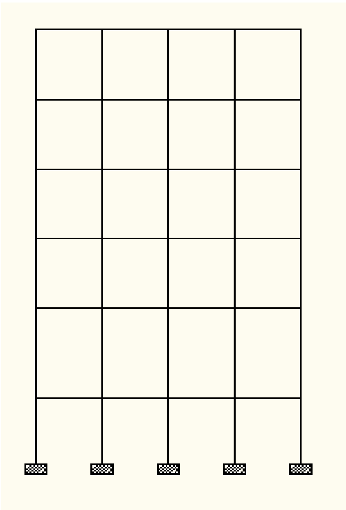

Fig.2 Elevation of the regular structure

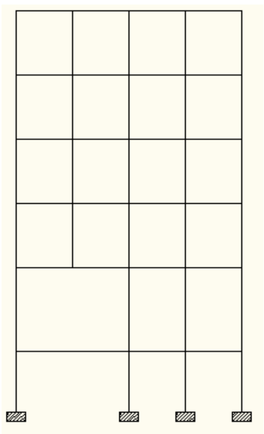

Fig.3 Elevation of the structure having floating columns

V. SIMULATION/EXPERIMENTAL RESULTS

The natural time period obtained from seismic code IS1893:2002 & analytical(ETABS) are shown in the Table-2.

TABLE 2: NATURAL TIME PERIOD

Building	Models	Linear Static Analysis		Linear Dynamic Analysis	
		Code	Analysis	Code	Analysis
G+5	I	0.56	0.635	0.56	0.635
	II	0.56	0.398	0.56	0.398

Drift for building models obtained from the equivalent static and response spectrum methods are shown in figures Table-2. Drift for the sixth storey of the building for the load combination 1.2(DL+LL± EL) in longitudinal direction.

TABLE 3: DRIFT

Storey	Drift			
	Equivalent Static Method		Response Spectrum Method	
	I	II	I	II
6	0.00027	0.000283	0.000188	0.000242

VI. CONCLUSION

In this research work, the behaviour of the multi-storey building with and without floating columns are analyzed for gravity, static and dynamic linear analysis. The comparison is made between the seismic parameters i.e. lateral displacement, base shear, fundamental time period and inter-storey drift for the regular building and the building having floating columns. We can see the difference between the natural time periods obtained empirical expressions and analytical expressions. Therefore, the dynamic analysis is to be done before analyzing these type of structures.

It can be concluded from the analysis that the natural time period depends on the building configuration. Drift tends to increase when there is a increase in vertical irregularities. There is more increase in the drift for the floating column buildings compared with the regular building. There is increase in with the increase in number of storey.

From the above research, we found that storey drift is more for the floating column buildings because as the columns are removed the mass gets increased so that that the drift. Increase in the mass and stiffness leads to increase in the base shear. Hence, the base shear is more for the floating column buildings as compared to the conventional buildings.

Conclusively, we can say that the floating columns are to be avoided in the earthquake prone areas as far as possible.

VII. FUTURE SCOPES

In future , we will work on horizontal irregularity as well as combination of both horizontal and vertical irregularity in the multi-storey building and the effect of abovesaid parameters on the structural terminologies such as storey drift, base shear, natural time period etc.

In addition, we will learn the safe and economic aspects of the multi-storey building with floating columns.

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