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

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Abstract:- In present scenario buildings with floating column is a typical feature in the modern multi-storey construction in urban India. Such features are highly undesirable in a building built in seismically active areas .This paper aims to investigate the effect of a floating column under earthquake excitation for various soil conditions and as there is no provision or magnification factor specified in I.S. Code, hence the determination of such factors for safe and economical design of a building having floating column. Sometimes, to meet the requirements these type 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 behavior of the RC multistory buildings with and without floating column is considered. The analysis is carried out for the multi-storey buildings of G+3 situated at zone iv , Using ETABS Software. Linear Dynamic Analysis is done for 2D multi storey frame with and without floating column to achieve the above aim i.e. the responses (effect) and factors for safe and economical design of the structure under different earthquake excitation.

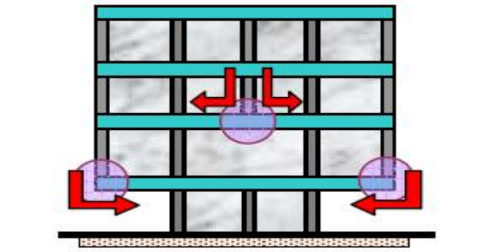
Keywords – Floating Column, Linear Analysis, Response Spectrum Analysis, Magnification Factor.

1. INTRODUCTION

Many urban multi-storey buildings in India today have an open storey as an unavoidable feature. This is primarily being adapted to accommodate parking or reception lobbies in the first storey. 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 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 storeys 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.

1.1Floating 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.



There are many projects in which floating columns are adopted, especially above the ground floor, where transfer girders are employed, so that more open space is available in the ground floor. These open spaces may be required for assembly hall or parking purpose. The transfer girders have to be designed and detailed properly, especially in earth quake zones. The column is a concentrated load on the beam which supports it. As far as analysis is concerned, the column is often assumed pinned at the base and is therefore taken as a point load on the transfer beam. STAAD Pro, ETABS and SAP2000 can be used to do the analysis of this type of structure. Floating columns[1] are competent enough to carry gravity loading but transfer girder must be of adequate dimensions (Stiffness) with very minimal deflection. Looking ahead, of course, one will continue to make buildings interesting rather than monotonous. However, this need not be done at the cost of poor behavior and earthquake safety of buildings. Architectural features that are detrimental to earthquake response of buildings should be avoided. If not, they must be minimized. When irregular features are included in buildings, a considerably higher level of engineering effort is required in the structural design and yet the building may not be as good as one with simple architectural features. Hence, 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 or some remedial features can be suggested. The columns of the first storey can be made stronger, the stiffness of these columns can be increased by retrofitting[2] or these may be provided with bracing to decrease the lateral deformation.

Some pictures showing the buildings built with floating columns:

1.2. Objective and scope of present work:

The objective of the present work is to study the behavior of multi-storey buildings with floating columns under earthquake excitations. Finite element method is used to solve the dynamic governing equation. Linear time history analysis is carried out for the multi-storey buildings under different earthquake loading of varying frequency content. The base of the building frame is assumed to be fixed. Newark's direct integration scheme is used to advance the solution in time.

2. FINITE ELEMENT FORMULATION:

The finite element method (FEM)[3], 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.

3. REVIEW OF LITERATURES

Current literature survey includes earthquake response of multi storey building frames with usual columns. Some of the literatures emphasized on strengthening of the existing buildings in seismic prone regions.

Maison and Neuss [4], Members of ASCE have preformed the computer analysis of an existing forty four story steel frame high-rise Building to study the influence of various modeling aspects on the predicted dynamic properties and computed seismic response behaviours. The predicted dynamic properties are compared to the building's true properties as previously determined from experimental testing. The seismic response behaviours are computed using the response spectrum (Newmark and ATC spectra) and equivalent static load methods.

Also**, Maison and Ventura** [5], Members of ASCE computed dynamic properties and response behaviours OF THIRTEEN-STORY BUILDING and this result are compared to the true values as determined from the recorded motions in the building during two actual earthquakes and shown that state-of-practice design type analytical models can predict the actual dynamic properties.

Arlekar, Jain & Murty [7], said that such features were highly undesirable in buildings built in seismically active areas; this has been verified in numerous experiences of strong shaking during the past earthquakes. They highlighted the importance of explicitly 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 [6], studied responses of multi-story flexibly connected frames subjected to earthquake excitations using a computer model. The model incorporates connection flexibility as well as geometrical and material nonlinearities in the analyses and concluded that the study indicates that connection flexibility 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 [8] performed pseudodynamic tests on an RC structure displacement, and fundamental time period this analysis has been carried using the software ETABS repaired with CFRP laminates. The opportunities provided by the use of Carbon Fiber Reinforced Polymer (CFRP) composites for the seismic repair of reinforced concrete (RC) structures were assessed on a full-scale dual system subjected to pseudo dynamic tests in the ELSA laboratory. The aim of the CFRP[10] repair was to recover the structural properties that the frame had before the seismic actions by providing both columns and joints with more deformation capacity. The repair was characterized by a selection of different fiber textures depending on the main mechanism controlling each component. The driving principles in the design of the CFRP repair and the outcomes of the experimental tests are presented in the paper. Comparisons between original and repaired structures are discussed in terms of global and local performance. In addition to the validation of the proposed technique, the experimental results will represent a reference database for the development of design criteria for the seismic repair of RC frames[9] using composite materials.

Ozyigit [11], performed free and forced in-plane and out-of-plane vibrations of frames are investigated. The beam has a straight and a curved part and is of circular cross section. A concentrated mass is also located at different points of the frame with different mass ratios. FEM is used to analyze the problem.

Williams, Gardoni & Bracci [12] 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. A case study was performed for the example buildings in Memphis and San Francisco using a modest retrofit procedure. The results of the parametric analysis and case study advocate that, for most situations, a seismic retrofit of an existing building is more financially viable in San Francisco than in Memphis.

4. METHODOLOGY

To determine seismic behavior of the Buildings with and without floating columns for zone IV the basic components like inter storey drift, lateral

V 9.7.1. for the analysis purpose Equivalent static method, and Response spectrum methods [13]are adopted.

4.1 Building Modeling

In this building model RC multi storied structures of 4 stories is considered with and without floating columns are for the analysis The typical height of the floors is considered as 3.6m and the height of the ground storey is taken as 4.8m. to avoid the tensional response under the pure lateral forces the buildings are Kept symmetric in both the orthogonal directions in plan.

4.2 Material Properties

The materials used for analysis of building models construction is reinforced concrete with M-25grade of concrete and Fe-415 grade of steel. And the stress-strain relationship is used as per IS 456:2000.

Material Properties	Values
Characteristic strength of concrete, fck	25 MPa
Yield stress for steel, fy	415 MPa
Modulus of Elasticity of steel, Es	20,0000 MPa
Modulus of Elasticity of concrete, Ec	25000 MPa

5. Results and discussions

5.1 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. The earthquake load analysis is considered in both the transverse and longitudinal direction for the equivalent static method.

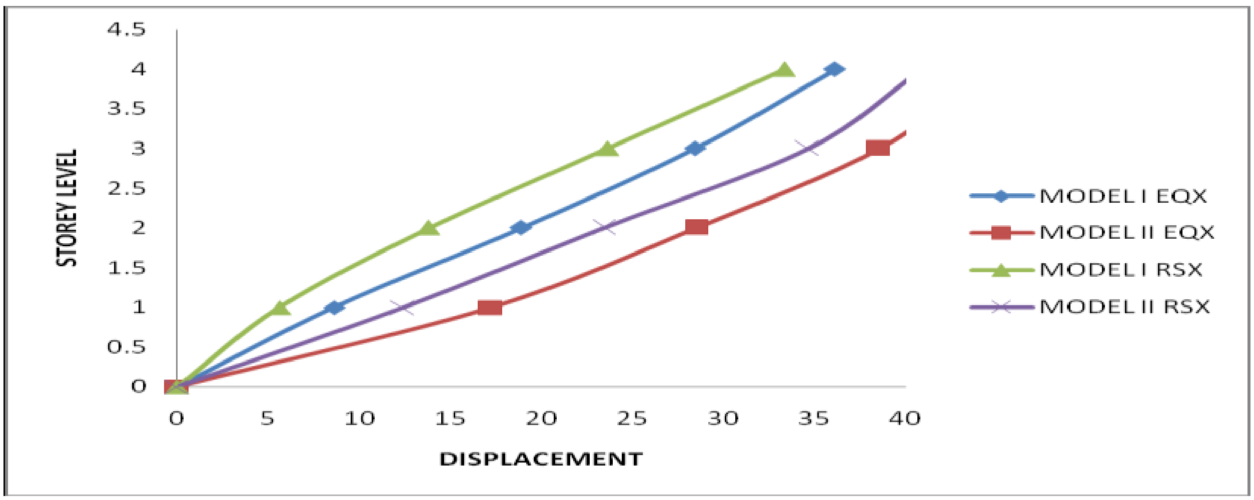
The natural time period[14] obtained from seismic code IS 1893 (part1):2002 and analytical (ETABS) are shown in table.

Building	Models	Gravity Analysis		Seismic Analysis	
				1.2 Combo	
		Code	Analysis	Code	Analysis
G+3	I	0.588	1.014	0.588	1.014
	II	11	1.157	11	1.157

5.2 LATERAL DISPLACEMENTS.

Lateral displacement profile for building models obtained from the equivalent static and response spectrum methods are shown in figures Table : Lateral displacement[15] for the four storey building for the load combination 1.2(DL+LL± EL) in longitudinal direction.

Storey	Displacement in mm			
	Equivalent Static Method		Response Spectrum Method	
	I	II	I	II
4	36.1	44.5	33.3	40.9
3	28.4	38.5	23.6	34.6
2	18.9	28.5	13.8	23.4
1	8.6	17.2	5.6	12.4



6. CONCLUSION:

In this dissertation work, the behavior of the buildings with and without floating columns are analyzed for seismic and gravity condition. The seismic parameters such as lateral displacement, base shear, fundamental time period and inter storey drift are studied and the comparison between these parameters are given between the regular building and building with floating column. 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 structures. And also it can be concluded from the analysis that the natural time period depends on the building configuration. Lateral displacement increases along the height of the building. There is more increase in the displacement for the floating column buildings compared with the regular building. The inter storey drift also increases as the increase in the number of storey's. The storey drift is more for the floating column buildings because as the columns are removed the mass gets increased hence the drift. As the mass and stiffness increases the base shear also increases. Therefore, the base shear is more for the floating column buildings compared to the conventional buildings. 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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