Seismic Analysis of Building with Floating column: A Brief Survey

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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. Thus an analysis has to be done in order to avoid deformation of RC structures with floating column.**

FEM codes are developed for 2D multi storey frames with and without floating column using MATLAB to validate the study with STAAD Pro. Thus after validation modal analysis of RC structure with and without floating column has been performed and different frequencies for different modes were obtained. After modal analyses Seismic along with response Spectra analysis is performed to calculate the storey drift and response with and without floating column.

Index Terms: **FEM, Storey Drift , Storey Shear , Storey Displacement , STAAD Pro**

I. Introduction

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.

II. LITERATURE SURVEY

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 [1984]{1}, Members of ASCE have preformed”**the computer analysis of anexisting 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.

Maison and Ventura[1991]{2}**,** 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[1997]{16} said that such features were highly undesirable in buildingsbuilt 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 thepresence 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, **[1997]**{3}studied “**responses of multi-story flexibly connected frames subjectedto 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[2005]{4} performed **“pseudodynamic testonan RC structure 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 pseudodynamic tests in the ELSA laboratory. The aim of the CFRP 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 using composite materials.

Vasilopoulos and Beskos[2006][15] performed **"rational and efficient seismic designmethodology for plane steel frames using advanced methods of analysis in the framework of Eurocodes 8 and 3"** . This design methodology employs an advanced finite element method of analysis that takes into account geometrical and material nonlinearities and member and frame imperfections. It can sufficiently capture the limit states of displacements, strength, stability and damage of the structure.
Bardakis&Dritsos[2007][5]evaluated **"the American and European procedural assumptions forthe assessment of the seismic capacity of existing buildings via pushover analyses"**. The FEMA and the Euro code-based GRECO procedures have been followed in order to assess a four-storeyed bare framed building and a comparison has been made with available experimental results.
Mortezaeiet al[2009][6]recorded data from recent earthquakes which provided evidence thatground motions in the near field of a rupturing fault differ from ordinary ground motions, as they can contain a large energy, or ''directivity" pulse. This pulse can cause considerable damage during an earthquake, especially to structures with natural periods close to those of the pulse. Failures of modern engineered structures observed within the near-fault region in recent earthquakes have revealed the vulnerability of existing RC buildings against pulse-type ground motions. This may be due to the fact that these modern structures had been designed primarily using the design spectra of available standards, which have been developed using stochastic processes with relatively long duration that characterizes more distant ground motions. Many recently designed and constructed buildings may therefore require strengthening in order to perform well when subjected to near-fault ground motions. Fiber Reinforced Polymers areconsidered to be a viable alternative, due to their relatively easy and quick installation, low life cycle costs and zero maintenance requirements.

Ozyigit[2009][7]performed **"free and forced in-plane and out-of-plane vibrations of frames areinvestigated"**. 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 [2009][8]studied the **"economic benefit of a given retrofitprocedure 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.

CONCLUSION

1. 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.
2. 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.
3. The inter storey drift also increases as the increase in the number of storeys. The storey drift is more for the floating column buildings because as the columns are removed the mass gets increased hence the drift.
4. 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.

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