Seismic Analysis Of Framed Structures – A Review

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Abstract— Seismic analysis of framed structures like concrete, steel ,wood (timber)etc., to know the response of the structure to the earthquake waves or seismic waves. This paper discuss about the analysis of various structures by various methods like finite element method, push over analysis, non-linear static analysis, non-linear dynamic analysis, response spectrum method, equivalent static method and using various software like ETABS. Structures analysed to find shear capacity, lateral displacements, ductility and storey drift of the framed structures. This helps readers such as civil engineers, architects for further analysis of framed structures.

Keywords—framed structures, non-linear static and dynamic analysis, equivalent static method, finite element method.

I. Introduction

Seismic analysis is a subset of structural analysis and is the calculation of the response of a building structure to earthquakes. It is part of the process of structural design, earthquake engineering or structural assessment in regions where earthquakes are prevalent. During earthquake many of the buildings collapse due to lack of understanding of the inelastic behaviour of structure. Elastic analysis gives only elastic capacity of the structure and indicates where the first yielding occurs. It cannot give any information about redistribution of forces and moments and failure mechanism. Analysis can be done in various earthquake zones. The latest version of seismic zoning map of India given in the earthquake resistant design code of India IS 1893(part I) 2002 assigns four levels of seismicity for India in terms of zone factors.

II. Methods of seismic analysis

- Equivalent static analysis
- Response spectrum analysis.
- Pushover analysis.
- Nonlinear static analysis.
- Nonlinear dynamic analysis.

III. Literature Review

Umesh P.Patil et al., (2015) have analysed the seismic behaviour of this g+5 RCC framed structure with and without floating columns. For analysis three models and three methods were used Equivalent static method, Response spectrum and Time history method were used for analysis ETABS-2013 Software was used. The parameters evaluated were Base shear, Storey drift and Displacement. The multi-storey building with shear walls which had performed better than other models in resisting earthquake as per IS 1893:2002.

K.K.Sangle et al., (2012) was aimed to compare the results of seismic analysis of high rise steel building with different pattern of bracing system and without bracing system. Natural frequencies, fundamental time period, mode shapes, inter story drift and base shear are calculated with different pattern of bracing system. Based on the analysis steel framed structures with bracing systems have been performed well.

M.P. Santisi d'Avila et al(2018) have analysed a finite element modelling technique, taking into account the effects of soil-structure interaction (SSI) is proposed for structural analysis and design. The proposed model confirm that a building is less stressed by a seismic wave having a frequency content close to the building principal frequency, if it is placed on a soil with a very different fundamental frequency, rather than in the case where soil and structure frequency content are close together.

P. Ceresa et al., (2009) focused on the development of a flexure–shear model for RC beam–column elements. Aim of this research work is to arrive at the definition of a numerical model sufficiently accurate and, at the same time, computationally efficient, which will enable implementation within a finite element package for nonlinear dynamic analysis of existing non-seismically designed RC structures that are prone to shear-induced damage and collapse.

Sheng Penga et al., (2018) have constructed the four composite steel–concrete frame columns to investigate the seismic performance of seismic-damaged composite steel–concrete frame columns strengthened with carbon fiber reinforced polymer. The test consisted of pre-damage loading, rehabilitation with carbon fiber reinforced polymer and destruction tests under lateral cyclic loading. Strengthening the seismic-damaged composite steel-concrete column with CFRP sheets can improve its ductility.

P. Lestuzzi et al., (2009) have presented a novel equivalent planar-frame model with openings. The model deals with seismic analysis using the Pushover method for masonry and reinforced concrete buildings. The model has proven its capability to satisfactorily predict the maximum strength. The calculated maximum strengths, in particular for the masonry structure, could be judged as good results since the model is based on simplified approaches in comparison to finite element models.

F. Vieux-Champagne et al.,(2014) have analyzed the seismic performance of timber-framed structures filled with natural stones and earth mortar by introducing three scales of experiments during which both cyclic and monotonic loadings are considered. This work tends to confirm the good seismic resistant behaviour and better ductility exhibited by the timbered masonry structures.

Hyun-Su Kim et al.,(2005) have analysed the high rise structure with shear walls regardless of the number, size and location of openings in the wall is proposed in this study. The proposed method uses super elements, substructures and fictitious beams. It was confirmed that the proposed method can provide results with outstanding accuracy requiring significantly reduced computational time and memory.

Pankaj Pankaj et al., (2005) Two similar continuum plasticity material models are used to examine the influence of material modelling on the seismic response of reinforced concrete frame structures. The design NSA and RHA responses for the two material models are compared. It is found that the peak deformation response is fairly close, the internal force peak response from CDP is significantly lower than that obtained from DP.

A. Kadid et al., (2008). To evaluate the performance of framed buildings under future expected earthquakes, a non-linear static pushover analysis has been conducted. The results obtained from this study show that properly designed frames will perform well under seismic loads.

M. D. Symans et a.,(2008) This paper emphasis is on the application of passive energy dissipation systems within the framing of building structures. The principal function of a passive energy dissipation system is to reduce the inelastic energy dissipation demand on the framing system of a structure. The result is reduced damage to the framing system.

Liwei Gao et al.,(2005) An efficient and robust finite-element-based method for estimating nonlinear responses of complex three-dimensional structures with partially restrained connections under dynamic and seismic loading is presented. Numerical results show that the presence of partially restrained connections may not cause failure of a structure due to insufficient strength but may make serviceability constraints.

Daigoro Isobe et al., (2003) A new finite element code using the Adaptively Shifted Integration (ASI) technique with a linear Timoshenko beam element is applied to the seismic collapse analysis of reinforced concrete (RC) framed structures. The results reveal that this code can be used in the numerical estimation of the seismic design of RC framed structures.

Ashraf Ayoub et al.,(2008) The objective of this work is to develop a new model for nonlinear seismic analysis of wood building structures. The paper concludes with an analytical evaluation of the global behaviour of a wood building structure tested dynamically on a shake table using the proposed methodology. The study confirmed the accuracy of the methodology and the importance of incorporating degradation effects for global evaluation of the behaviour of wood structures.

Kapil Khandelwal et al.,(2009) The progressive collapse resistance of seismically designed steel braced frames is investigated using validated computational simulation models. Two types of braced systems are considered: namely, special concentrically braced frames and eccentrically braced frames. The simulation results show that while both systems benefit from placement of the seismically designed frames on the perimeter of the building, the eccentrically braced frame is less vulnerable to progressive collapse than the special concentrically braced frame.

Dong-Guen Lee et al.,(2002) In this study, an efficient method is proposed to analyse high-rise box system structures considering the effects of floor slabs. The proposed method will reduce computational time and memory in the analysis by using the sub-structuring technique and matrix condensation.

Jinkoo Kim et al., (2011) In this paper, the effect of viscous dampers on reducing progressive collapse potential of steel moment frames was evaluated by nonlinear dynamic analysis. The analysis results of 15-story analysis model structures showed that the viscous dampers, originally designed to reduce earthquake-induced vibration, were effective in reducing vertical displacement of the structures caused by sudden removal of a first-story column, and the effect was more predominant in the structure with longer span length.

P. P. Chandurkar et al.,(2013) The properties of these seismic shear walls dominate the response of the buildings, and therefore, it is important to evaluate the seismic response of the walls appropriately. In this present study, main focus is to determine the solution for shear wall location in multi-storey building. It is observed that in 10 story building, constructing building with shear wall in short span at corner is economical as compared with other models and the large dimension of shear wall is not effective in 10 stories or below 10 stories buildings. It is observed that the shear wall is economical and effective in high rise building.

G. Uva et al (2012) A sensitivity analysis was performed by assigning different Partial Safety Factors (PSF) to the mechanical parameters of infill walls, in order to investigate their effect on the overall structural response of the building. The presence of a strong infill, endowed with high strength and stiffness, significantly changes the structural response to horizontal actions. the presence of strong infills can overturn the expected structural responses and the results of the assessment procedure.

S.M. Wilkinson et al (2006) A materially non-linear plane-frame model is presented that is capable of analyzing high-rise buildings subjected to earthquake forces. The model represents each storey of the building by an assembly of vertical and horizontal beam elements. The results from static push-over analysis are compared with time–history results from the simplified model. The results verify that the model is capable of performing non-linear response history analysis on regular high rise buildings.

VI. CONCLUSION

These review papers suggest that the framed structures were analysed by various methods on various seismic zones. Thus the seismic analysis is one of the best methods for the buildings which are located in the earthquake prone regions. Hence the seismic analysis was helps to detect the lateral loads, base shear, displacements and storey drift for future construction of earthquake resistant structures.

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