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Collapse Fragility Evaluation of Steel Frame Structure – A Review

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***Abstract*: This paper analyses the technique like response history analysis, time history analysis and pushover analysis for performance based design of moment resisting steel framed structure as per IS 1893-2002 subjected to earthquake loading. For this, a two bay four storied moment resisting frame is designed for forces/loads according to IS 875 (seismic zone III).There different past recorded earthquake are used for time history analysis and staad pro software is used for modeling and analysis.**
***Keywords*: Moment resisting steel frame, Response history analysis, Earthquake force, Non Linear Dynamic Analysis, Time History Analysis, Euro code 8, Pushover analysis.**

I. INTRODUCTION

Now day's steel structures are widely used for all the constructions. It is necessary to design a structure which can resist or reduce the impact of seismic force which comes on the structure. Experience gained from Bhuj earthquake 2001 demonstrates that the most of buildings collapsed were found deficient to meet out the requirements of the present day codes. Indian codes of practice for earthquake resistant design (IS: 1893) are revised periodically. In this paper an office building of G+3storey is analysed for earthquake resistant design. Three types of analysis are carried in this paper. The first analysis method is the response spectrum analysis, the next one is time history analysis and the other one is pushover analysis. All the three analysis are carried out using the method of IS 1893-2002 and Euro code 8. The designed building is analysed is in staad pro software. The capacity curves and the demand curves are drawn from the data's obtained through the analysis. With the development of these two curves the fragility curves are developed, the fragility curves are required to know about the collapse state of the structure. According to FEMA 356 there are three collapse states; immediate occupancy level, life safety level and the collapse prevention level.By analysing the structure in staad pro software the building is located in a region or level of immediate occupancy

II. ANALYSIS

The analysis part is to be done manually and using the software. The design base shear is calculated on the basis of IS1893-2002, Eurocode 8 and FEMA 356. For this study three analysis are to be performed, they are responce history analysis, time history analysis and the pushover analysis.

III. LITERATURE REVIEW

Various literatures reviewed on fragility curves are carried out below.

A. Giorgio Lupoi (2012)

A method is presented for the evaluation of the seismic fragility function of realistic structural systems. The method is based on a preliminary simulations which involves the nonlinear dynamic analyses performed to establish probabilistic characterization of the demands on the structure, followed by the solution of a general system reliability problem with correlated demands and capacities. The result is compare with the fragility curves which obtained by plain Monte Carlo simulation. The method is demonstrated with two types of structures, first one I s steel-concrete box girder viaduct with RC piers subjected to both uniform and non uniform excitations, and the next is a three-dimensional RC building structure subjected to bidirectional excitation.

B. G. P. Cimellaro et.al (2013)

In this journal an alternative method is introduced to calculate fragility functions that considers multiple limit states parameters, such as combinations of response variables of accelerations and inter story drifts. Limit states are defined using a generalized multidimensional limit states function that allows considering dependencies among limit thresholds modeled as random variables in the calculation of fragility curves that are evaluated as function of the return period. The study investigates the sensitivity of the proposed approach for evaluating fragility curves when uncertainties in limit states are considered. Influence of structural and response parameters, such as stiffness, damping, acceleration and displacement thresholds, ground motion input, and uncertainties in structural modeling, are also investigated. The proposed approach can be considered as an alternative approach for describing the vulnerable behavior of non-structural components.

C. Craig Jenkins(2015),

Damage to non-structural systems during an earthquake can leave a building inoperable, causing economic losses, and extensive downtime. Among these non structural systems, partition wall damage has been reported frequently during past earthquakes while the seismic response of these systems is poorly understood.In this study, responses and behaviors of partition walls were critically assessed through several design variables including: 1) framing systems, 2) partition wall heights, 3) partition wall geometries, 4) openings in partition walls, and 5) top connections. Experimental fragility curves were developed based on damage caused from inter-story drift. Along with fragilities, out-of-plane acceleration amplification factors for partition walls were computed. .

D. Dimitrios G. Lignos (2014)

Provide a process for estimating the uncertainty in estimation of collapse capacity of buildings in seismic excitation using Monte Carlo simulation and FOSM method. The structure used in this study is a 4-story steel moment-resisting frame designed based on current seismic provisions whose collapse prediction has been validated through a collapse test of a 1:8 scale model structure at the University of Buffalo's NEES Equipment Site. It is shown that the uncertainty in estimation of collapse capacity due to uncertainty in estimation of deformation parameters of beams and columns that control component nonlinear behavior is moderately dependent on the correlation between these parameters. For the 4-story steel moment-resisting frame used in this study the uncertainty in estimation of collapse capacity due to component modeling uncertainties varies between 0.25 and 0.35 for correlation between these parameters ranging from 0.3 to 1.0. This is due to the fact that for the 4–story structure, the P-Δ effect is the major reason for collapse rather than building component deterioration.

E. Dimitrios G. Lignos (2013)

Presents fragility functions to estimate the probability of reaching or exceeding different damage states in reduced beam section _RBS_ beam-to-column moment connections of steel moment resisting frames. The fragility functions are developed using results from 71 experimental tests that have been conducted on RBS connections during the past 14 years. The main sources of uncertainty considered are specimen-to-specimen variability of the interstory drifts associated with the various damage states and the epistemic uncertainty arising from using a limited number of experimental data and from interpreting experimental results. Quantitative measures for each of these two kinds of uncertainty were developed using statistical procedures. For a given peak interstory drift ratio the fragility functions developed herein permit the estimation of the probability of experiencing five different levels of damage in RBS moment connections.

F. Rodrigo Retamales(2014),

As part of the Network for Earthquake Engineering Simulation Research (NEESR)-Grand Challenge Project Simulation of the Seismic Performance of Non-structural Systems, an experimental program was carried out to evaluate the seismic responses, failure mechanisms, and fragilities of cold-formed steel framed gypsum partition walls. Understanding the seismic behavior of building interior partition walls is important because damage to these non-structural components can initiate at relatively lowstory drift levels, potentially degrading the overall functionality of the building and contributing toward earthquake economic losses. To this end, in-plane quasi-static and dynamic tests were conducted on 36 partition walls constructed using common construction details. Variables examined on the 16 configurations tested include framing thicknesses, stud connections to top and bottom tracks, wall intersection details, and partial height walls among others. In addition, new details are proposed to increase the drift demands at which damage is first observed and to minimize the propagation of damage through the wall. The failure mechanisms observed for the different wall configurations are reported and a seismic fragility database for groups of partitions dependent on the construction details is generated. Fragility functions are provided for three distinct damage states based on the level of repair required for the partition wall. The resulting fragility database partially fills a critical need to more accurately estimate nonstructural damage and consequential losses in buildings during earthquakes.

G. Lucia Tirca(2013)

Concentrically braced frames (CBF) are among the most popular structural systems used in Eastern Canada for low- and middle-rise buildings. Across southern Quebec, in the area of St. Lawrence and Ottawa river valleys, existing vulnerable buildings, designed and built prior to the development of modern seismic design codes are at risk due to an increase in earthquake activity. This study is focused on the seismic assessment of a 3- and 6-storey CBF buildings located in Montreal and Quebec that were designed based on the 1980 Canadian code provisions. Using incremental dynamic analysis and the fitted fragility curves, the probability of failure of selected structures are estimated. It is concluded that both low- and middle-rise CBF buildings located in Montreal and Quebec are exposed to earthquake damage risk.

H. Saied Mojiri(2015)

With the North American seismic codes moving toward adopting performance-based seismic design (PBSD) approaches, there is a need to develop seismic probabilistic risk assessment (PRA) tools for different construction systems, including reinforced masonry (RM). The current study focuses on the development of analytical fragility curves based on the performance of RM walls tested under base excitation generated by a shake table. The study has two phases. In the first phase, the seismic response of the RM shear walls is modeled using a simplified analytical model that was calibrated using previously reported shake table experimental results. The second phase of the study focuses on the development of fragility curves, as an essential component of a PRA framework, for two-story lightly reinforced masonry walls. The study is a part of a larger ongoing PRA research program to provide the needed seismic performance data to facilitate the inclusion of different RM construction categories within the next generation of PBSD codes in North America.

I. Reza Akbari (2013)

Has studied the behavior of framed building by conducting Push over Analysis, most of buildings collapsed were found deficient to meet out the requirements of the present day codes. Then G+3 building was modeled and analyzed, results obtained from the study shows that properly designed frame will perform well under seismic loads.

J. Zou X. K (2001)

Performed seismic analysis using Equivalent Lateral Force Method for different reinforced concrete (RC) frame building models that included bare frame, in filled frame and open first story frame. In modelling of the masonry Infill panels the Equivalent diagonal Strut method was used and the software ETABS was used for the analysis of all the frame models. In filled frames should be preferred in seismic regions than the open first story frame, because the story drift of first story of open first story frame is Very large than the upper stories, which might probably cause the collapse of structure. The infill Wall increases the strength and stiffness of the structure. The seismic analysis of RC (Bare frame) structure lead to under estimation of base shear. Therefore other response quantities such as time period, natural frequency, and story drift were not significant. The underestimation of base shear might lead to the collapse of structure during earthquake shaking .

IV. CONCLUSIONS

Doing all the relevant analysis in accordance with IS1893-2002 and eurocode 8 it is evident that the base shear value is increased and the structure is enough to with stand the earthquake force which come on the structure. By doing the pushover analysis it is found that the building is come under immediate occupancy zone. The story drifts are passed all levels in meters.

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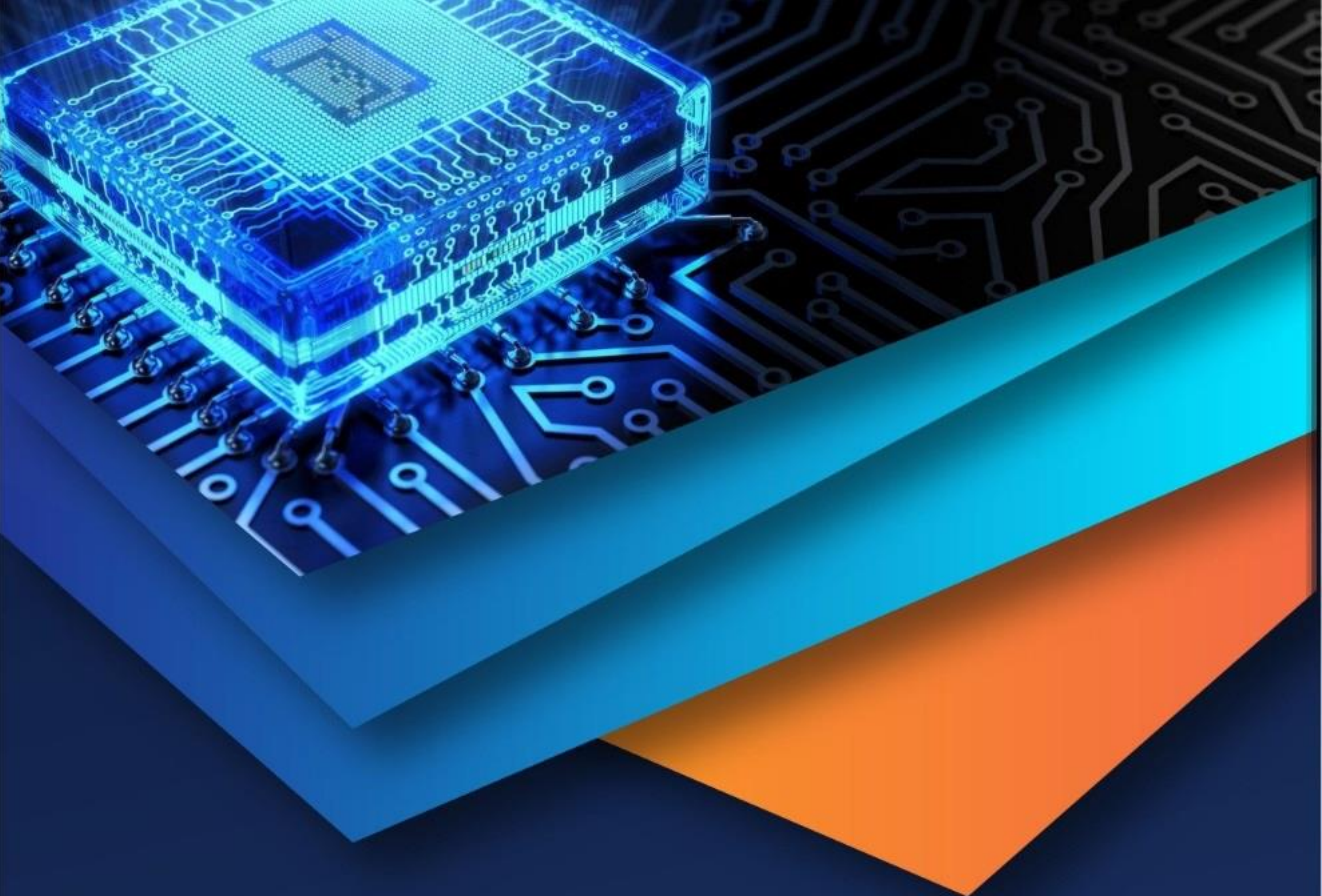

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