Seismic Risk Assessment of RCC Framed Structure with Vertically Irregular Buildings Shaped

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Abstract— The area of vertically irregular type of building is now having a lot of interest in seismic research field. . Many structures are designed with vertical irregularity for architectural views. Vertical irregularity arises in the buildings due to the significant change in stiffness and strength. Open ground storey (OGS) is an example of an extreme case of vertically irregularity. The typical OGS and stepped types of irregularities are considered in the present study.

Key words: Magnification Factors (MF); Open Ground Storey (OGS); Stepped Irregular Buildings, Seismostruct; Fragility Analysis, Reliability Analysis, Peak Ground Acceleration (PGA), Performance Levels

I. INTRODUCTION

Vertical irregularities in buildings are very common feature in urban area. In most of situations, buildings become vertically irregular at the planning stage itself due to some architectural and functional reasons. This type of buildings demonstrated more vulnerability in the past earthquakes. The topics related to of vertical irregularities have been in focus of research for a long time. Many studies have been conducted in this area in deterministic domain. Hence the focus of present study is to assess the relative performances of typical vertically irregular buildings in a Probabilistic domain. This type of irregularities arises due to sudden reduction of stiffness or strength in a particular storey. For high seismic zone area, irregularity in building is perhaps a great challenge to a good structural engineer. A large number of vertical irregular buildings exist in modern urban infrastructures. Among them Open ground storey as well as stepped types of buildings are very common in Urban India.

II. SCOPE & OBJECTIVE OF WORK

The RC framed Buildings are considered for the analysis by assuming regular in plan. The buildings considered (6-10 storey buildings) without basement, shear wall and plinth beams. The contribution of Infill walls are considered as non-integral with RC frames. The Out of plane action of masonry walls are neglected in the analysis. The asymmetric arrangement of infill walls are ignored of the buildings. The Soil structure interaction effects are not considered in the analysis. The Flexibility of floor diaphragms are neglected and considered as rigid diaphragm. The base of the column is assumed to be fixed in the analysis.

III. REVIEW OF LITERATURE

The fragility analysis for an irregular RC building under bidirectional earthquake loading has studied by Jeong and Elnashai (2006). For the consideration of the irregularities in structure, the torsion and bidirectional response are utilized as 3D structural response features to represent the damage states of the building irregularities is presented through a reference derivation. A three story RC frame is taken with asymmetric in plan with thickness of slab is 150 mm and beam depth is 500 mm to study the damage assessments. The sectional dimension of C6 is 750×250 mm whereas all other columns are 250×250 mm. Fragility curves are generated by calculating the damage measure with spatial (3D) damage index by statistical manipulation methods and lognormal distributions for response variables Earthquake records consist are of two orthogonal components (Longitudinal and Transverse) of horizontal accelerations and are modified from the natural records to be compatible with a smooth code spectrum. PGAs are taken from a range of 0.05 to 0.4g with a step of 0.05g. For accurate damage assessment of buildings is exhibiting torsion, Planar decomposition method is used where the building is decomposed into planar frame and analysed. The parameters such as top displacement, inter-story drift or a damage index are found out from numerical simulations results. The total damage index is calculated for the planar frames from the backbone envelope curve as a combination of damage due to in-plane monotonic displacement and strength reduction. Coefficient of variation (COV) is found be the ratio of standard deviation to mean value of damage index.

Davis and Menon (2004) examined the presence of masonry infill panels modifies the structural force distribution significantly in an OGS building. They considered verities of building case studies by increasing the storey heights and bays in OGS buildings to study the change in the behaviour of the performance of the buildings with the increase in the number of storey and bays as well as the storey heights. They observed that with the total storey shear force increases as the stiffness of the building increases in the presence of masonry infill at the upper floor of the building. Also, the bending moments in the ground floor columns increase and the failure is formed due to soft storey mechanism that is the formation of hinges in ground storey columns. Scarlet (1997) identified the qualification of seismic forces of OGS buildings. A multiplication factor for base shear for OGS building was proposed. The modelling the stiffness of the infill walls in the analysis was focused. The effect of in Multiplication factor with the increase in storey height was studied. He observed the multiplication factor ranging from 1.86 to 3.28 as the number of storey increases from six to twenty. Hashmi and Madan (2008) conducted non-linear time history and pushover analysis of OGS buildings. They concluded that the MF prescribed by IS 1893 2002 for such buildings is adequate for preventing collapse. Sahoo (2008) observed the behaviour of open-ground-storey of Reinforced concrete (RC) framed buildings having masonry at above storey by using Steel-Caging and Aluminum Shear-Yielding Dampers. He has introduced a simple spring-mass model for the design of braces for adequate strength and stiffness requirements of the strengthening system.

Honey (2018) studied a mid-rise RC frame building retrofitted with eccentric steel brace was observed through Fragility analysis. A six storey RC frame building, designed as per Turkish seismic design code 1975 located in a high-seismicity region of Turkey was taken in the study. In building typical beam and column was considered without shear wall. The steel braces (K,V&D type) they have used 4different distribution to observe the behaviour. The fragility curves were developed from the inter storey drift by means of nonlinear time history analysis. The fragility curves developed for the original building for different damage levels.200 earthquake data were considered that generated by using MATLAB program. Modelling was done as a 2D analysis by using a software SAP2000 nonlinear version 11.The median and standard deviation of the ground motion indices for each damage level were obtained by performing linear regression analysis for different performance levels. They observed the different damage levels as slight, moderate, major, and collapse for the building. The fragility curves were developed for before and after retrofitting with steel braces. They concluded after retrofitting with steel braces were less fragile compared to those before retrofit. And the distributions of the eccentric steel braces were slightly affecting the seismic reliability of the braced frames. First distributions (K1, V1, or D1) gave the greatest and fourth distributions (K4, V4, or D4) gave the least seismic reliability.

IV. Conclusion

The review of the study indicates that there are numerous research efforts found on the seismic behaviour of RC buildings, OGS buildings and on the modelling infill walls for linear and nonlinear analysis. Also with regard to seismic performance of the vertically irregular buildings, there are few studies conducted. But all this studies are based on a deterministic approach. The main motivation is to study the performance of the vertically irregular buildings and to fine tune the design guidelines as per the Indian standards. For example, with regard to an OGS building, the IS 1893(2002) suggests a multiplication factor of 2.5 for ground storey columns. The multiplication factor proposed by IS 1893 (2002) needs to be more of rational than an empirical number. The first part the present study will attempt to propose the multiplication factors for performance objectives of the OGS buildings. In the second part as seismic hazard analysis and reliability analysis, there are very few literatures are found based on the structures. The seismic hazard analysis is adopted for the OGS buildings and the stepped type buildings by considering the criteria from various codes by identifying the reliability index calculation for the buildings to evaluate the appropriate MF values for the design of the buildings belongs to various region of India.

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