ANALYSIS OF MAJOR INTERNATIONAL CODAL DESIGN PROVISIONS FOR OPEN GROUND STOREY BUILDINGS

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ABSTRACT

In this paper enlightening the problem Parking space for residential apartments in populated cities is a matter of major concern. Hence the trend has been to utilize the ground storey of the building itself for parking. "Open Ground Storey" (OGS) buildings are those types of buildings in which the ground storey is free of any infill masonry walls. These types of buildings are very common in India for parking provisions. The strength and stiffness of infill walls in infilled frame buildings are ignored in the structural modeling in conventional design practice.

Keywords— *Fragility curves, Open ground storey (OGS), Multiplication Factor (MF), Peak Ground Acceleration (PGA), Probabilistic Seismic Demand Model (PSDM)*

INTRODUCTION

Need of space became very important in urban areas due to increase in population especially in developing countries like India. Need of parking space takes important vital role while planning a building. To provide adequate parking spaces, ground storey of the building is utilized. These types of buildings (Figure 1.1) having no in filled walls in ground storey, but in-filled in all upper storey's, are called Open Ground Storey (OGS) buildings. The majority of apartments are of this type and the infill walls used are of mainly brick masonry. Upper stories of these buildings are stiff and the inter-storey drifts will be small, resulting in large curvatures, shear forces and bending moments of the ground storey columns. Hence, the strength demand on the columns in the ground storey of the buildings is very high.The majority of this type of buildings had collapsed in the past earthquakes in many countries. The failure of OGS buildings is observed to be due to storey mechanism in the ground storey. The sudden reduction in lateral stiffness and mass in the ground storey results in higher stresses in the ground storey columns under seismic loading. In most cases, ground-story columns were either damaged severely or failed completely, thereby damaging the buildings.

OBJECTIVES

The salient objectives of the present study have been identified as follows:

I. To study the seismic performance of typical OGS buildings designed as per applicable provisions in international codes in a Probabilistic Frame Work

Indian
Euro
Bulgarian
Israel

J. To develop Probabilistic Seismic Demand Model for the designed buildings

K. To develop fragility curves for the designed OGS buildings

NEED FOR THE PROPOSED WORK

The multiplication factors proposed by selected international codes and recent research works are not consistent as discussed in previous sections. The performance of the buildings designed by the various MFs proposed by the international codes may be different. The motivation for the present study is to compare the relative performances of OGS building designed using the multiplication factors proposed by international codes and its major implications.

LITERATURE REVIEW

The literature review is divided into two parts. The first part of this Chapter deals with an overview of seismic behaviour of infill walls and open ground storey building. The second part of this chapter deals with the Previous Studies on the development of Seismic Fragility Curves.

Under lateral loading, the frame and the infill wall stay intact initially. As the lateral load increases, the infill wall gets separated from the surrounding frame at the unloaded (tension) corner. However at the compression corners the infill walls are still intact. The length over which the infill wall and the frame are intact is called the length of contact. Load transfer occurs through an imaginary diagonal which acts like a compression strut. Due to this behaviour of infill wall, they can be modeled as an equivalent diagonal strut connecting the two compressive corners diagonally. The stiffness property should be such that the strut is active only when subjected to compression. Thus, under lateral loading only one diagonal will be operational at a time. This concept was first put forward by Holmes (1961).

Rao et. al. (1982) conducted theoretical and experimental studies on infilled frames with opening strengthened by lintel beams. It was concluded that the lintel over the opening does not have any influence on the lateral stiffness of an infilled frame. Karisiddappa (1986) and Rahman (1988) examined the effect of openings and their location on the behaviour of single storey RC frames with brick infill walls.

The behaviour of RC framed OGS building when subjected to seismic loads was reported by Arlekar et. al. (1997). A four storied OGS building was analyzed using Equivalent Static Analysis and Response Spectrum Analysis to find the resultant forces and displacements. It was shown that the behaviour of OGS frame is quite different from that of the bare frame.

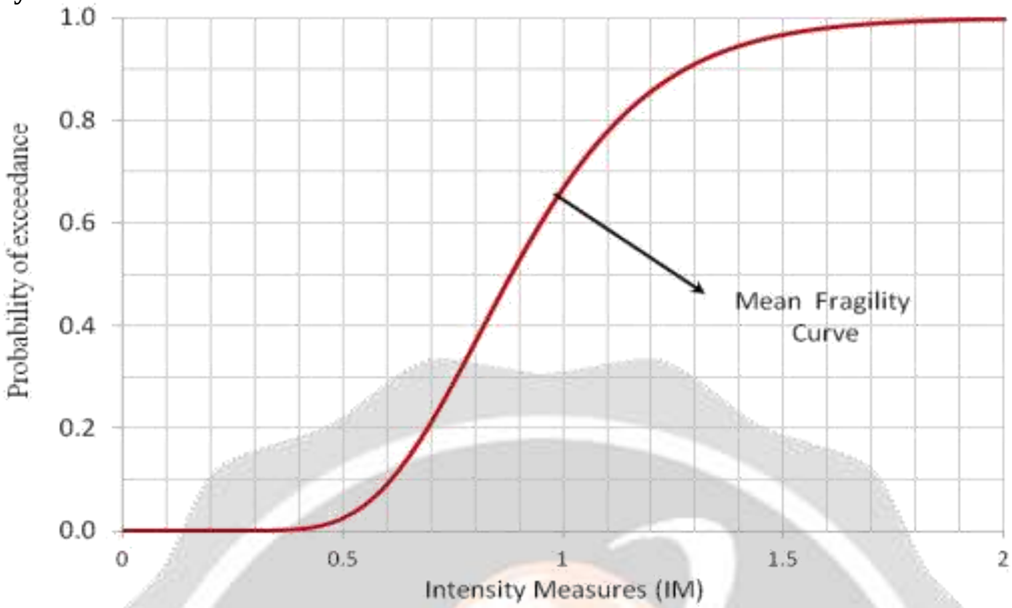
The effect of different parameters such as plan aspect ratio, relative stiffness, and number of bays on the behaviour of infilled frame was studied by Riddington and Smith (1997).

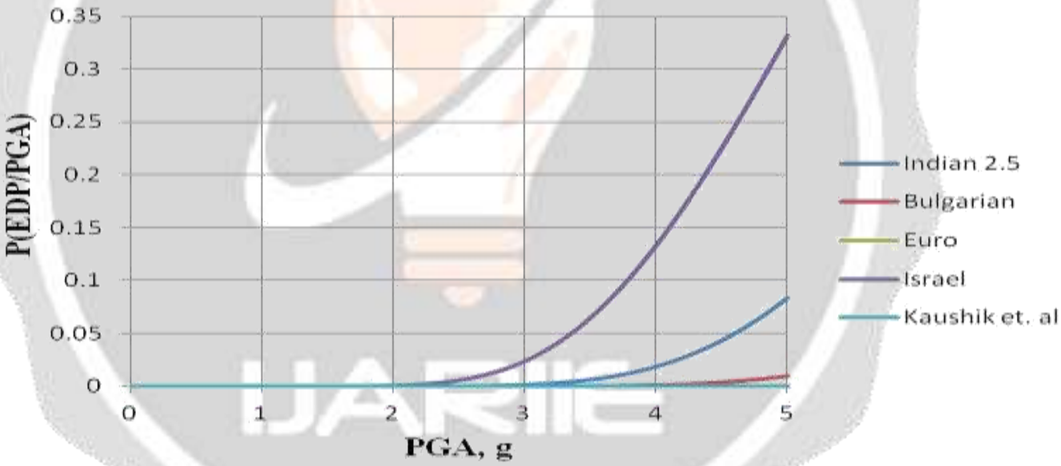
Scarlet (1997) studied the qualification of seismic forces in OGS buildings. A multiplication factor for base shear for OGS building was proposed. This procedure requires modeling the stiffness of the infill walls in the analysis. The study proposed a multiplication factor ranging from 1.86 to 3.28 as the number of storey increases from six to twenty.

Deodhar and Patel (1998) pointed out that even though the brick masonry in infilled frame are intended to be non-structural, they can have considerable influence on the lateral response of the building.

Davis and Menon (2004) concluded that the presence of masonry infill panels modifies the structural force distribution significantly in an OGS building. 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 (more than two fold), and the mode of failure is by soft storey mechanism (formation of hinges in ground floor columns).

Fragility curve





MODEL CONSIDERED FOR ANALYSIS

A Comparison of fragility curve for each storey for different codes is made to understand the behaviour further more. Figure represents the fragility curve of ground storey for various codes. As the Israel code uses the MF factor of 2.1, the resulting fragility is more at ground storey compared to that of other codes.

CONCLUSIONS

Followings are the salient conclusions obtained from the present study:

- The performance of typical OGS buildings designed considering various magnification factors according to different codes are studied using fragility curves.

- Uncertainties in concrete, steel and masonry are incorporated using LHS scheme. It is found that the performances of the OGS frames, in terms of ground storey drift is increasing in the increasing order of magnification factors used by various codes for all the performance levels.

- In all the cases of the buildings designed using various codes, the first storey is about 80% more vulnerable than the ground storey except for Israel code.

- It is found that relative vulnerability of first storey increases due to strengthening of the ground storey.

- Except Israel code, no other code considers MF for first storey. In other words, the first storey of all the frames designed by codes other than Israel code remains same to yield same exceedance probability.

- Application of magnification factor only in the ground storey may not provide the required performance in all the other stories. It is found from the study that the OGS buildings designed using Israeli code, which considered the magnification factor in the adjacent storey, performed better compared to that of others. This indicates that the implementation of magnification factor in the adjacent storeys may be required to improve the performance of OGS buildings.

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