Communications on Applied Nonlinear Analysis
ISSN: 1074-133X
Vol 32 No. 10s (2025)

Earthquake Impact Analysis on Open Ground Storey Framed Buildings

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Article History:
Received: 12-01-2025
Revised: 15-02-2025
Accepted: 01-03-2025

Abstract: Ground Speed increase (PGA), Probabilistic Seismic Interest Model (PSDM) Parking spot for private condos in populated urban communities involves central issue. Thus the pattern has been to use the ground story of the actual structure for stopping. "Open Ground Story" (OGS) structures are those sorts of structures where the ground story is liberated from any infill brick work walls. These kinds of structures are exceptionally normal in India for stopping arrangements. The strength and firmness of infill walls in infilled outline structuresare disregarded in the primary displaying in ordinary plan practice. The plan in such cases will commonly be moderate on account of completely infilled outlined building. Yet, the way of behaving is different on account of OGS outlined building. OGS outlined building issomewhat stiffer than the exposed casing, has bigger float (particularly in the ground story),and flops because of delicate story-system at the ground floor. In the current review, a run of the mill ten celebrated OGS outlined building is thought of and the structure considered is situated in Seismic Zone-V. The main story of OGS building is viewed as more defenseless when the ground story segments alone are planned with a MF of 2.5, 3.0 or more.The Israel code applies MF to both ground story and first story, which make every one of the tales all the more near have uniform shear interest to limit proportion across the narrativesin a seismic stacking.

Keywords: Probabilistic Seismic Demand Model (PSDM), Fragility Analysis, Seismic Zone-V, Ground Motion, Peak Ground Acceleration (PGA), Inter-story Drift, Soft Story Failure, Fragility Curves, Shear Demand.

1. Introduction

Due to population growth, especially in developing countries like India, the need for space has become critical in metropolitan areas. When organising a structure, the need for parking places demands a large amount of work. The structure's ground floor is used to provide enough parking spaces. Open Ground Story (OGS) constructions are those that have filled walls throughout every upper story but no filled walls in the ground story (Figure 1.1). This type of loft is the most common, and the infill walls that are used are primarily block construction.

1.2 OGS (OPEN GROUND STOREY)

As with a typical in-filled outlined building, the OGS building's top stories feature infill walls that increase the structure's global solidity. The base shear interest on the structure increases due to the increase in global hardness. The two casings and infill walls in each story share the enlarged base shear due to standard in-filled outline construction. In OGS buildings, where there are no infill walls in the ground story (no bracket activity), the ground story sections entirely resist the increased base shear, making heap sharing by adjacent infill walls impossible.

Moderately larger floats at the main floor level will result from the increased shear powers in the ground story segments activating enlarged twisting minutes and subsequently higher forms. Due to the P-Δ influence, the massive horizontal redirections further enhance the bowing minutes. At the top and bottom ends of the ground story parts, plastic pivots are created. The upper storeys would remain immaculate and move almost as one cohesive unit. The damage is typically concentrated in the ground story parts; this is known as the 'gentle storey breakdown'.

1.3 MULTIPLICATION FACTOR (MF) PROVISIONS IN VARIOUS CODES

In the great majority of common sense situations, OGS structures can be regarded as outrageous delicate story types of structures. They are designed with unusual arrangements in mind to increase the horizontal firmness or strength of the delicate/open tale. The stiffness and strength of the infill walls are being disregarded here. For the sections in the delicate/open tale by MF, the alternative code recommendation is to increase the twisting minutes and shear powers of revealed outline.

1.4 NEED FOR THE CURRENT ASSESSMENT

As discussed in previous segments, the augmentation factors suggested by selected worldwide codes and recent examination studies are unreliable. The display of the architectural designs created by the various MFs that the international codes have suggested may be one-of-a-kind. Examining the general exhibits of OGS buildings that are scheduled using the increasing factors suggested by global codes and their noteworthy implications served as the impetus for this analysis.

1.5 OBJECTIVE

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

To develop Probabilistic Seismic Demand Model for the designed buildings. To develop fragility curves for the designed OGS buildings

- **Literature Review** Several studies have explored the comparative analysis of materials:
- **Rao et. al. (1982)** carried out practical and theoretical research on in-filled frames with openings reinforced by lintel beams. The lintel covering the aperture was found to have no effect on the lateral rigidity of an in-filled frame. Karisiddappa (1986) and Rahman (1988) investigated how single-story RC frames with brick infill walls behaved in relation to openings and where they were located.

- **Arlekar et al.** reported on the behaviour of the OGS building, which is an RC-framed structure, under seismic loading (1997). Equivalent Static Analysis and Response Spectrum Analysis were used to examine a four-story OGS building in order to determine the resulting forces and displacements. It was demonstrated that the OGS frame behaves very differently from the bare frame.
- **Riddington and Smith (1997)** examined the impact of various characteristics, including plan aspect ratio, relative stiffness, and number of bays, on the behaviour of an in-filled frame.
- **Scarlet (1997)** examined the OGS buildings' seismic force qualification. It was suggested to multiply the base shear for OGS buildings by a certain factor. This process necessitates modelling the infill walls' stiffness in the study. A multiplication factor ranging from 1.86 to 3.28 was suggested by the study for the case of six to twenty storeys.
- **Deodhar and Patel (1998)** noted that although the brick masonry in an in-filled frame is designed to be non-structural, it can nonetheless have a significant impact on the building's lateral reaction.
- **Davis and Menon (2004)** concluded that the structural force distribution of an OGS building is dramatically altered by the inclusion of masonry infill panels. When masonry infill is present on the top floors of the building, the stiffness of the structure increases, increasing the total storey shear force. Additionally, the ground floor columns' bending moments increase (by more than two fold), and the soft storey mechanism—the creation of hinges in the ground floor columns—is the mode of failure.
- **Das and Murthy (2004)** concluded that the damage sustained by the RC framed members of a fully in-filled frame during earthquake shaking is typically reduced when infill walls are present in a structure. Lower story columns, beams, and infill walls are more susceptible to damage than upper story structures.
- **Asokan (2006)** examined how the lateral stiffness and strength of a building are altered when masonry infill walls are present in the frames. This study suggests using a plastic hinge model for infill walls in nonlinear performance-based building analyses. It also finds that combining the suggested hinge property with the ultimate load technique yields a more accurate estimate of the building's inelastic drift.
- **Tavares et. al (2012)** carried out research in eastern Canada to determine the fragility curves for various bridge classes. In order to determine the likelihood of bridge damage, bridge-system fragility curves are created taking into account the vulnerability of important components. Cornell et al. (2002) proposed a power law to illustrate the relationship between the intensity of ground motion and bridge damage.

3. DEVELOPEMENT OF FRAGILITY CURVE

3.1 INTRODUCTION

This section's first section uses Cornell et al. (2002) to manage the delicacy bends by comparing the power measure (IM) to the Designing Interest Boundary (EDP). This was completed by taking into account 30 models of 10 storey 6 bay, each of which has unique material features such as steel fy, stone work fm, and cement fck.This should be achievable through testing and validating findings from the dynamic time history analysis of thirty selected models, which are finished by selecting thirty distinct ground movements. This section's second section deals with the selection of ground motions and transitions into the Indian Range; these are far-field choices that are explained in this section. According to FEMA-356, the next building execution levels have been evaluated.

3.2 SAMPLING

Testing is concerned with identifying a subgroup of individuals within a population in order to assess the characteristics of the total population. The brickwork, steel, and cement materials used in the development won't have material properties that are quite similar. Its nature will differ because of the way it was made, the environment, the craftsmanship, and other factors. Therefore, it is ineffective to think about the same compressive strength throughout the evaluation when analysing the design. Thus, testing for craftsmanship and steel as well as cement weaknesses must be done. Two sections comprise the extensive examination:

(I) Likelihood Examining Technique and

(II) Non-Likelihood Examining Technique

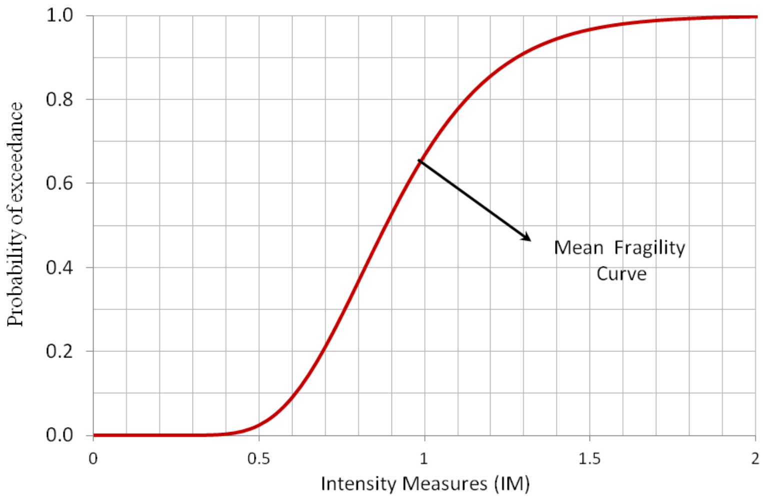


Figure 3.1: Fragility Curve

3.3 LATIN HYPER CUBE SAMPLING (LHS)

The arbitrary inspection procedures are especially amazing and useful while conducting probabilistic research. However, in certain cases, the problem under investigation is exceedingly complex, and it may take a very long time to evaluate the problem for a single preliminary (N=1). As a result, the time required to complete hundreds or thousands of reproductions may not be feasible.

3.4 BUILDING PERFORMANCE LEVELS

Building performance can be described qualitatively in terms of the

- Safety afforded to building occupants, during and after an earthquake.

- Cost and feasibility of restoring the building to pre-earthquake conditions.
- Length of time the building is removed from service to conduct repairs.
- Economic, architectural, or historic impacts on the community at large.

These performance characteristics will be directly related to the extent of damage sustained by the building during a damaging earthquake.

3.5 DEVELOPMENT OF FRAGILITY CURVES FLOW CHART

The flowchart represents how the fragility curves are drawn using Cornell et. al (2002) method how the procedure is followed are shown in Figure 3.3

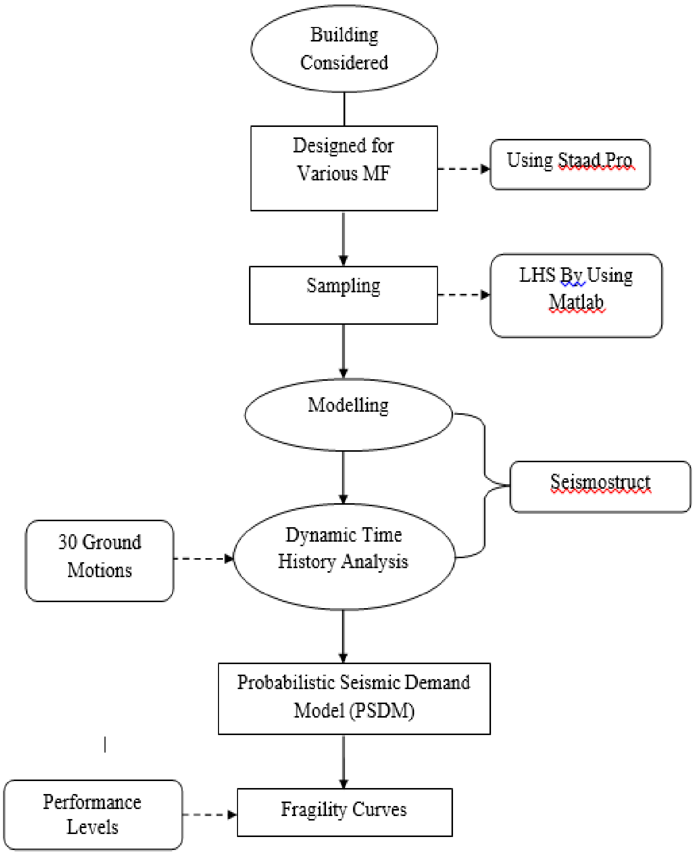


Figure 3.2: Flow chart for development of Fragility Curves

4. Results

4.1 DETAILS OF CASE STUDY BUILDINGS

In the current review, a typical ten-story, six-cove OGS RC outline that addresses a symmetric structure in plan is considered. Steel and cement grades are respectively M25 and Fe415. The section level and average sound width are selected as 3 and 3.2 metres, respectively. The piece is 150 mm thick. All floor levels take into account a live heap of 3 kN/m2, with the exception of the uppermost level, where it is regarded as 1.5 kN/m2. IS 1893 (2002) bears the seismic strain.The structure under consideration is located in seismic zone V, with a Z value of 0.36. Medium soil is taken into consideration, and in the examination, the R value is set at 3 for the standard RC second opposing casing (OMRF).

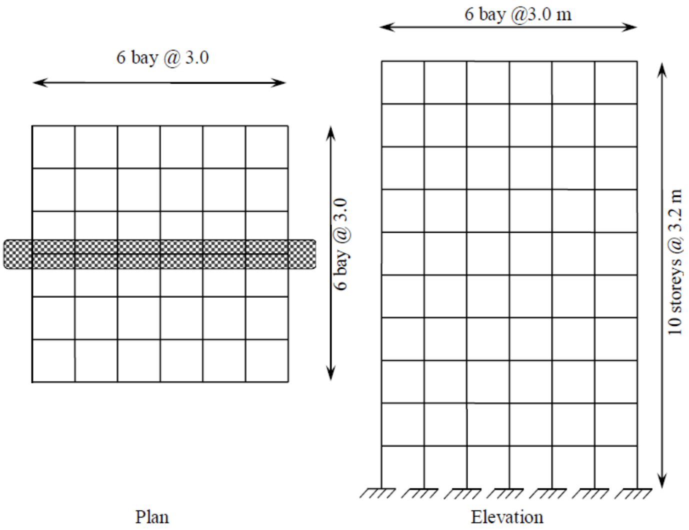
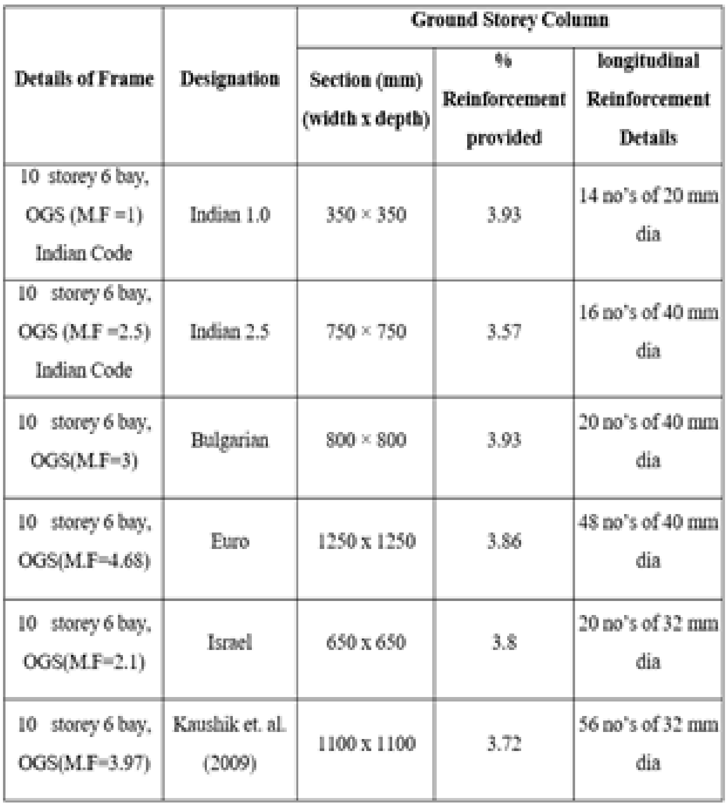


Figure 4.1: Plan and Elevation of a building

Table 4.1: Design details for the example frames



Details of Frame	Designation	Ground Storey Column		
		Section (mm) (width x depth)	% Reinforcement provided	longitudinal Reinforcement Details
10 storey 6 bay, OGS (M.F =1) Indian Code	Indian 1.0	350 × 350	3.93	14 no's of 20 mm dia
10 storey 6 bay, OGS (M.F =2.5) Indian Code	Indian 2.5	750 × 750	3.57	16 no's of 40 mm dia
10 storey 6 bay, OGS(M.F=3)	Bulgarian	800 × 800	3.93	20 no's of 40 mm dia
10 storey 6 bay, OGS(M.F=4.68)	Euro	1250 x 1250	3.86	48 no's of 40 mm dia
10 storey 6 bay, OGS(M.F=2.1)	Israel	650 x 650	3.8	20 no's of 32 mm dia
10 storey 6 bay, OGS(M.F=3.97)	Kaushik et. al. (2009)	1100 x 1100	3.72	56 no's of 32 mm dia

4.2 DEVELOPMENT OF FRAGILITY CURVES

Fragility curves are developed as per the methodology explained in Chapter 3. The following sections explain the details of the process.

4.2.1 Latin Hyper Cube Sampling (LHS)

The compressive strength of brick work (fm), the yield strength of steel (fy), and the trademark strength of cement (fck) are considered as irregular variables when considering the vulnerability in the material properties. Ranganathan (1999) provided the factual details of the boundaries, fck, and fy, whereas Kaushik et al. (2007) provided the information regarding brick work. Using the LHS inspecting approach, a set of thirty upsides of irregular factors are generated from the mean and sexually transmitted disease deviations of each irregular factor. MATLAB is the programme used for this.

4.2.2 Ground Motion Data

Thirty structural models are created by arranging the thirty upsides of the material attributes. Technique dictates that thirty ground movements are needed for the thirty structure outlines. A collection of thirty Ground Movement Sets for Far-Fields are taken from Haselton and Deierlein (2007). The previous Section discussed the nuances of determining ground movement data for investigation. Using a programme called WavGen developed by Mukherjee and Gupta (2002), all ground motions are fully converted to IS 1893 (2002) range valid ground movements.

4.2.3 Modelling and Analysis

For each of the thirty structure outlines, it is anticipated to lead a nonlinear unique investigation in order to identify the best between-story float for PGA related. SeismoStruct (2007) provides a demonstration of each building's outline. SeismoStruct is a Limited Component bundle that takes into account both material inelasticity and mathematical nonlinearities to predict the massive relocation conduct of room outlines under static or dynamic stacking. Fiber-based spread versatility components are used in SeismoStruct's outline components.

4.2.4 Concrete

Mander et al. (1988) is the model used for concrete. This model of constant confinement is uniaxial nonlinear. It is necessary to establish five model calibrating parameters in order to completely characterise the mechanical properties of the material.

4.3 COMPARISON OF FRAGILITY CURVE FOR EACH STOREYS FOR DIFFERENT CODES

To better understand the behaviour, a correlation of delicacy bend is made for each narrative for different codes, the following delicacy is more grounded in comparison to other codes.

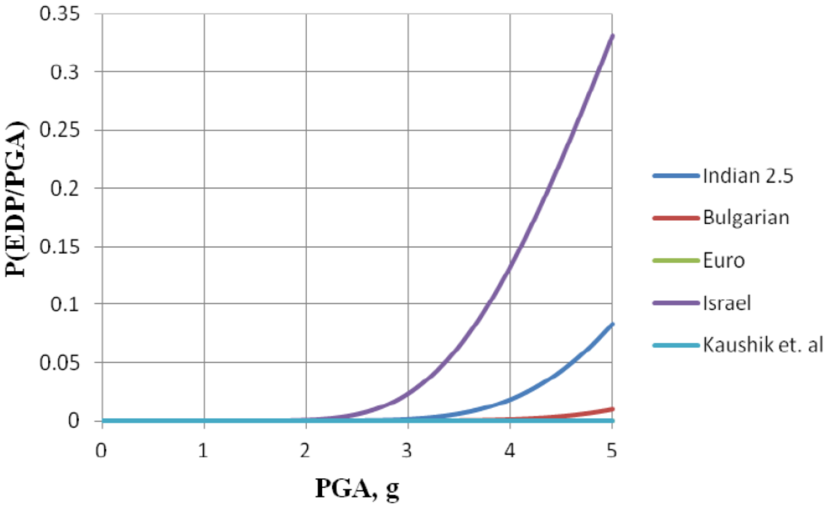


Figure 4.2: Fragility Curve of ground storey

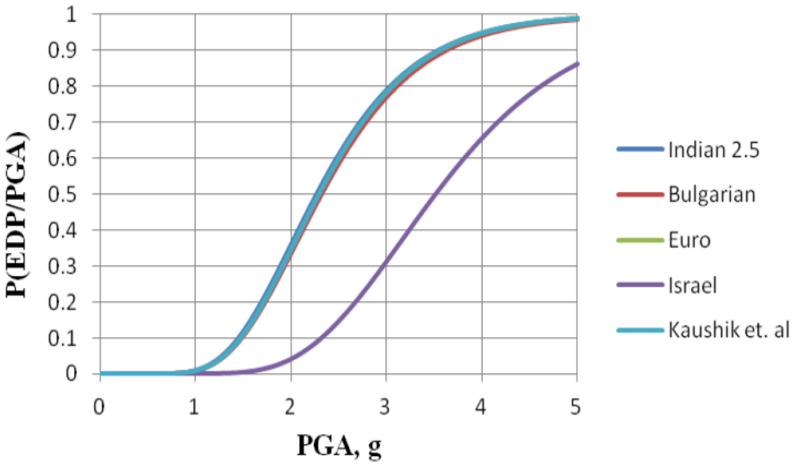


Figure 4.19: Fragility Curve of first storey

4.4 SUMMARY

With the aid of delicate bends, the seismic presentation evaluation of typical open ground story 2-D casings prepared with Increase factors in accordance with various codes is finished. In order to improve delicacy bend, a method described by Cornell et al. (2002) is applied in the current review. PSDM models are developed for every selected case. It is discovered that the between-story float at the ground floor decreases as MF grows. OGS 1.0's between-story float is thought to be the largest. For the structural outlines in the request, OGS 1.0, Israel (MF = 2.1), OGS 2.5, Bulgarian (MF = 3.0), Kaushik et al., 2009 (MF = 3.97), and Euro (MF = 4.68), the between-story float decreases.

5.Conclusion

Followings are the notable ends acquired from the current review:

- Common OGS structures are exhibited with an emphasis on using delicacy bends, as indicated by different codes, and planned with consideration for varied amplification factors.
- Using LHS conspire, vulnerabilities in brick, steel, and cement work are combined.
- It is discovered that the OGS outlines' exhibits are growing in terms of ground narrative float due to the growing demand for amplification elements including various codes for every presentation level.
- With the exception of the Israel code, the main level is about 80% less secure than the ground story in every case where the structures were designed using different codes.
- It is discovered that the ground story's fortification increases the first story's overall weakness.
- However, the Israel code is the only one that considers MF for the first story. Therefore, in order to produce the identical exceedance likelihood, the main narrative about the relative plethora of edges designed by codes other than the Israel code remains unchanged.

If an amplification factor is only used in the main story, it might not provide the appropriate presentation in the many different kinds of stories. The research reveals that the OGS structures that were designed using Israeli code and took into account the surrounding story's amplification performed better than the others. This proves that the implementation of amplification while taking into account the connected tales should function well for the display of OGS structures.

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