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Suitability of Codal Design Provisions For Open Ground Storey Buildings

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ABSTRACT: As part of this investigation, a typical OGS-framed building will be examined, and the building is located in Seismic Zone V. Different standards, such as the Indian and Euro codes, are used to analyze the design stresses for the ground-floor column members.. Designs for various OSG frameworks will take into account MFs of 1, 2, 5, and 4.68 (Euro). The fragility analysis approach, developed by Cornell et al., will be used to evaluate each building's performance (2002). A Probabilistic Seismic Demand Model (PSDM) based on a power law is used to construct fragility curves for each building in this study. Fragility curves will be used to compare the performance of any building designed according to various codes.

Keywords: Seismic Demand Model Probabilistic Open-Ground Storey Multiplication Factor (PSDM)

INTRODUCTION

A fully infilled framed building and an OGS framed building react very differently when subjected to lateral loads, with the OGS framed building behaving far better. Frame motion and well-distributed plastic hinges upon failure are the hallmarks of a bare frame's lateral rigidity, which is significantly lower than that of a completely filled frame. The truss motion is introduced when the frame is completely filled. Despite the larger base shear, a fully filled frame exhibits less inter-storey drift (due to increased stiffness). A fully infilled framed building and an OGS framed building respond quite differently when subjected to lateral loading. Frame motion and well-distributed plastic hinges upon failure are the hallmarks of a bare frame's lateral rigidity, which is significantly lower than that of a completely filled frame.

Whentheframeisfully infilled,trussactionisintroduced.Afully infilledframeshowslessinter-storeydrift,althoughit attracts higherbase shear(dueto increased stiffness).

1.1 MultiplicationFactor(MF)provisionsinv arious codes

Buildings of this sort can be called extreme soft-storey structures, and additional preparations must be made to strengthen the lateral stiffness or strength of the soft/open storey in most practical scenarios Infill walls' infill strength and stiffness are not considered here. In the soft/open storey, several code requirements call for MF to increase the bending moments and shear forces of the bare frame for the columns.

1.1.1 IndianstandardsIS-1893:2002

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In 2002, the IS 1893 code was amended to incorporate new design suggestions for OGS buildings following the Bhuj earthquake. Soft-storeys (a type of vertical irregularity) are those in which the lateral stiffness of one storey is less than 70% the stiffness of the adjacent storey or less than 80% of the average lateral stiffness of the three storeys above the storey under consideration, as per IS 1893 (2002). if the lateral stiffness is less than 60% of the storey above or less than 70% of the average stiffness of the three storeys above, it is referred to as an extreme soft-story. The extreme soft-story kind of vertically uneven buildings includes stilts or open-ground storey buildings.

1.1.2Euro Code 8EN 1998-1:2003

In contrast to other standards, the Euro Code does not recommend screening for characteristics such as vertical irregularity. According to Euro code 8 (2003), columns in the lower floors with less infill should have their resistance increased in proportion to the weakness of the masonry infill (MI). There is a multiplicative effect on seismic forces in the lower storey (the ground floor of the OGS building) when the infill walls are drastically reduced when compared to the adjacent storeys (MF). As a result, seismic design forces in only the columns are increased by the following factor in later research (Fardis and Panagiotakos 1997), which shows that raising the beam resistance will further increase the seismic demands on the columns.

$$\left[1 + \frac{\Delta V_{RW}}{\Sigma V_{Ed}}\right] \leq q$$

the ground floor MI's lateral resistance is reduced by VRW compared to the upper story MI's lateral resistance. VRW is equal to the resistance of the masonry in the first storey of an OGS building, and VEd is the sum of seismic shear forces acting on all structural vertical parts of the storey concerned .'s It's called a "behavior factor," and its value can range from 1.5 to 4.68 based on the type of building systems, ductility classes, and plan regularity in a given building.

Table 1.1 : Multiplication factors (MF) as per various codes

Code	Criteria	Expression for MF	MF considered
Indian	$\frac{K_i}{K_{i+1}} < 0.7$	2.5	2.5
Euro	Drastic reduction of infill in any storey	$\left[1 + \frac{\Delta V_{RW}}{\sum V_{ED}}\right]$ 1.5 – 4.68	4.68

3. **SCOPEOFTHESTUDY**

Reinforced concrete multistory framed buildings that are regular in plan are the focus of this study. •

The present study is based on ten storey six bay case study and the buildings with basement, shear wall and stiff plinth beams are not included in this study.
Non-integral, non-load-bearing brick masonry infill walls are assumed.

• In the modeling, asymmetrical infill walls and infill panels for window and door apertures are both ignored.

4. **OBJECTIVEOFTHESTUDY**

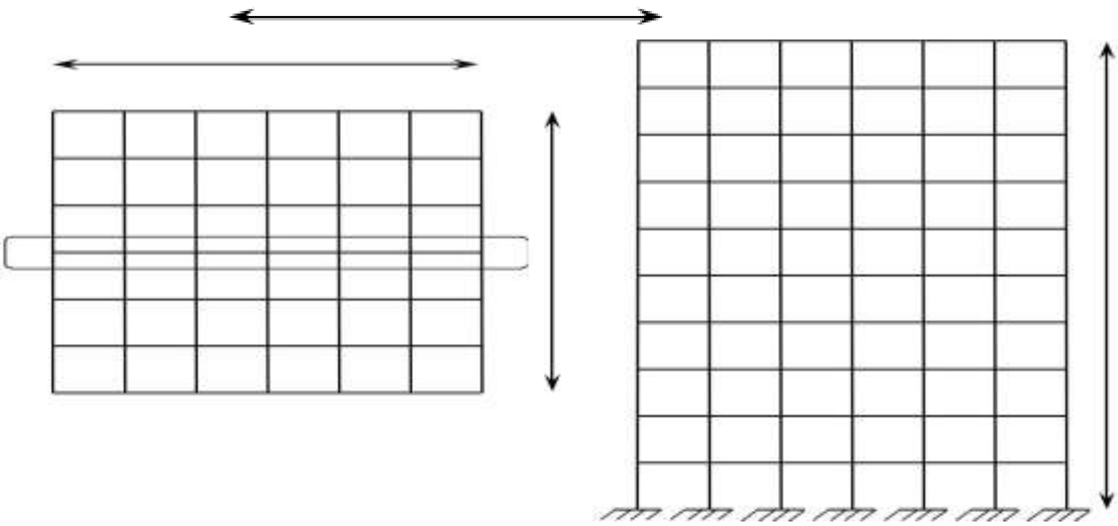
Aim 1: To investigate the seismic performance of typical OGS buildings developed according to appropriate provisions of international codes in a probabilistic framework (Indian • Euro).
A Probabilistic Seismic Demand Model for the designed buildings will be developed.
The creation of fragility curves for the OGS structures that have been conceptualized.

5. **METHODOLOGY**

There are a number of measures that can be taken in order to accomplish the goals. The first step is to choose a frame.
Design the frame in accordance with IS 456 and IS 1893 in step 2.Next, in accordance with Cornell et al., construct fragility curves for the fabricated frames (2002)
4th Step: The FEMA – 356 performance standards of a building are taken into account.
The fragility curves acquired in step 5 are analyzed to draw conclusions.

DETAILSOFCASESTUDYBUILDINGS

In this study, a conventional ten-story, six-bay OGS RC frame is investigated, which represents a symmetric building in plan. M25 and Fe415 are the designations given to the concrete and steel grades, respectively. In terms of bay width and column height, the standard values are 3m and 3.2m. The thickness of the slab is 150 mm. All floor levels except the top floor are deemed to have a live load of 3 kN/m2. IS 1893 is used to calculate seismic load.(2002).Since it is located in seismic zone V with a Z = 0.36 and medium soil, the analysis uses R = 3 for a standard RC moment-resisting frame to examine this building (OMRF).
We're going to assume that the chosen structure is symmetric in all four directions. In this case, the torsional response of the building is ignored and a single plane frame is used to depict the building in one direction. The building's entire width is 18.0 m, divided into 6 bays with a 3.0 m width. There are ten floors, each with a height of 3.2 m, totaling 32.0 m, for a total of 32.0 m. A 0.6-meter parapet wall is under consideration. These are the typical dimensions for the columns and beams that are examined. The ground story columns must be developed taking into account the Multiplication
Factor for various codes, such as Indian and Euro, because the structure is an OGS frame.6 bay@3.0



l used as random variables to estimate the degree of uncertainty in material parameters. The parameters fck and fy statistical data (Table 6) derive from Ranganathan (1999) and the murals statistics (Table 6) came from Kaushik et al. Al (2007). Each random variable is sampled using the LHS sampling method, which generates a set of 30 random variable values. Use the MATLAB software to accomplish this.

Table6.6.1.1:DetailsofrandomvariablesusedinLHSscheme

Material	Variable	Mean	COV(%)	Distribution	Remarks
Concrete	f_{ck}(MPa)	30.28	21.0	Normal	Uncorrelated
Steel	f_y (MPa)	468.90	10.0	Normal	Uncorrelated
Masonry	f_m (Mpa)	6.60	20	Normal	Uncorrelated

6.3 PROBABILISTICSEISMICDEMANDMODEL(PSDM)

It was suggested by Cornell et. al (2002) that the estimation of the parameter parameter of themean parameter of the engineering demand (EDP) can be represented by the power law model asstatedin Eq. 4.1.

$$\widehat{EDP} = a(IM)^b$$

In this study, the first stage of shift (δ) is considered as a parameter of technical degradation(PDE)and maximum ground acceleration (PGA) asa measure ofintensity(IM).

Figure6.3.1:PSDMmodelsofall theOGSframes

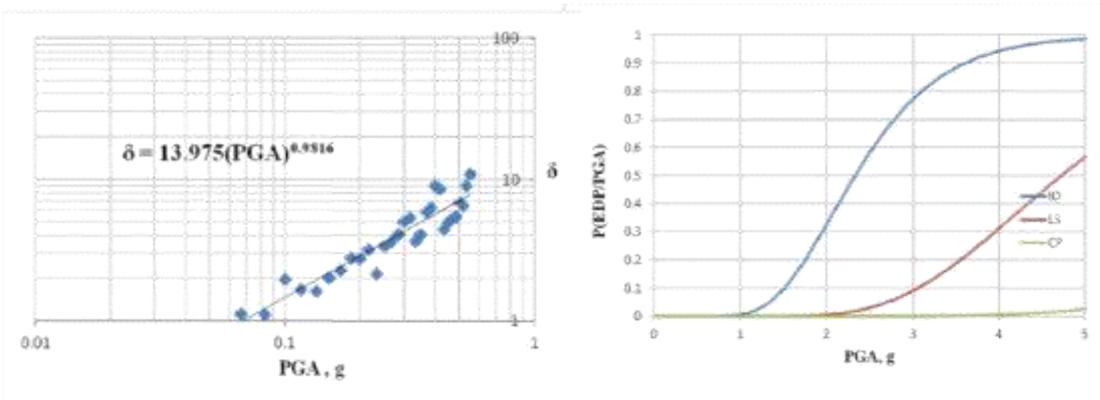
Table6.3.1:ParametersofProbabilisticseismicdemandmodel(PSDM)forOGSframeswithvaryingMFforvarious codes

NameofBuildings	a	b
Indian1.0	13.975	0.9816
Indian2.5	3.4726	1.0853
Euro	0.5261	0.9659

6.4 COMPARISONOFFRAGILITYCURVES

ThePSDMmodelsand correspondingfragilities are presentedin theFigures6.4.1to 6.4.3

Figure6.4.1:OGSFrameM.F=1 (a)PSDM(b)FragilityCurve



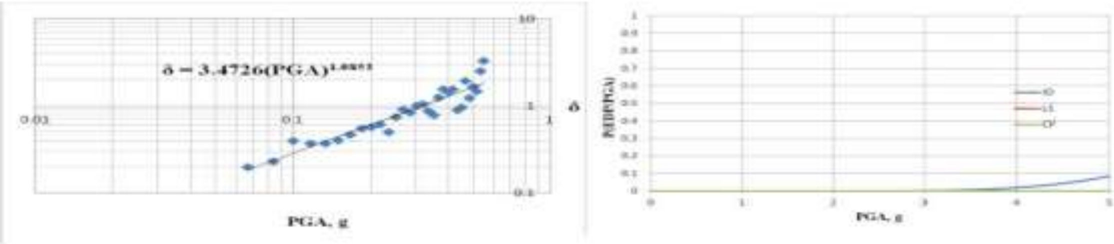


Figure6.4.2:OGSFrameIndianM..F=2.5(a) PSDM(b)FragilityCurve

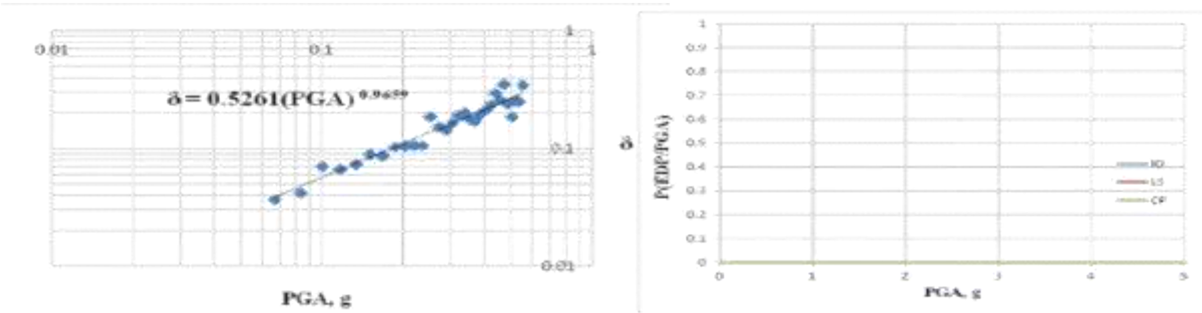


Figure6.4.3:OGSFrameEuroM.F =4.68(a)PSDM(b)Fragilitycurve

6.5 Comparisonoffragilitycurveswithdamageparameterasinter-storeydriftatvariousstoreys(atgroundstorey.Firststorey, SecondStoreyandThirdStorey)

As it is required to study the performance of storeys other than ground storey the exceedanceprobability of inter-storey drift for the other storeys for IO performance level are developed.Thesefragilitycurves areshownin

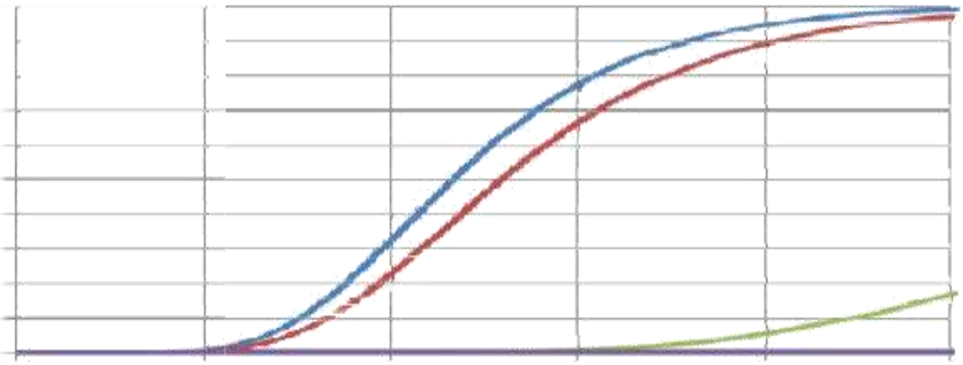


Figure6.5.1:FragilitycurveforM.F= 1 OGSframe for IOperformancelevel

6.6 COMPARISONOFFRAGILITYCURVEFOREACHSTOREYSFORDIFFERENT CODES

AComparisonoffragilitycurveforeachstoreyfordifferentcodesismadetounderstandthe behaviourfurther more.

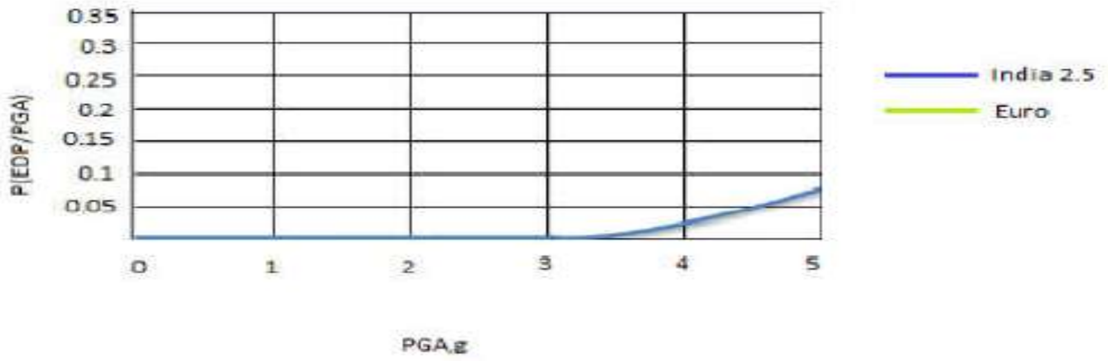


Figure6.6.1:FragilityCurve ofground storey

Figure6.6.2:FragilityCurve offirst storey

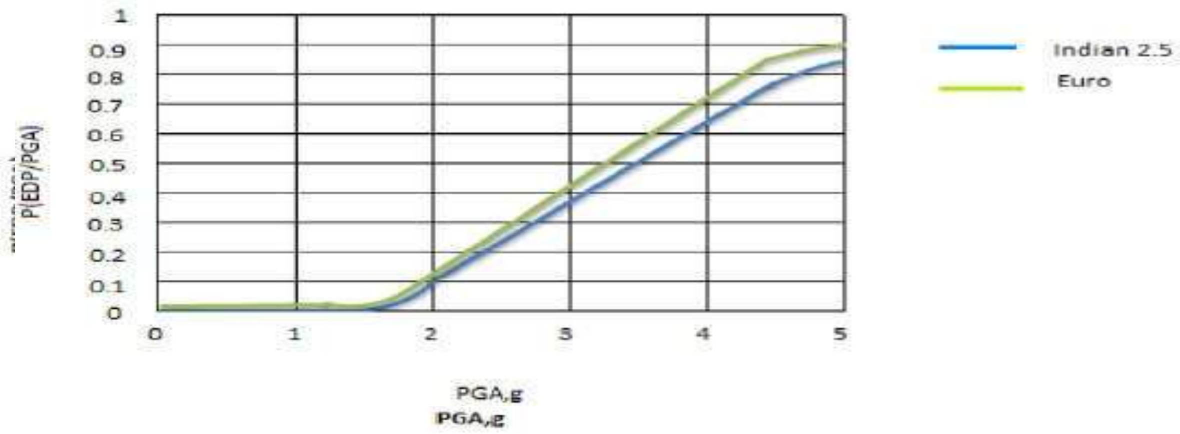


Figure6.6.3:FragilityCurve ofsecond storey

6. SUMMARYANDCONCLUSIONS

7.1 Summary

According to the IS 1893:2002 standard, open structures are deemed to be vertically inappropriate structures. Floor posts' power ratings are derived on an estimation ofSuch as India's and the euro's various codes of conduct. With respect to MF, the various OGS frames are meant to be either 1.0, 2.5 or 4.68. (Euro). The impact of each building is examined using Cornell et almethod .'s of fragility analysis (2002). There are concerns about concrete, steel, and walls. Computer models for nonlinear dynamic analysis of each scenario were built in Seismostruct (2012). Selects 30 natural history and change events to fit the Indian code's response spectrum (IS 1893-2002). The PSDM (Probable Seismic Model of Demand) is developed in this work by generating curves for each building based on the law of power. The break curves are used to compare the relative performance of any building designed according to different codes..

7.2 **CONCLUSIONS**

Herearethemainconclusionsfromthisstudy:

- The design of typical OGS objects designed taking into account different factors of increaseaccordingto different codes is used to studythe fracturecurves.
- Insecurities in concrete, steel and walls are built using an LHS scheme. It can be seen thatthe OGS frame performance, in terms of soil drift, increases the increasing order ofmultiplicationfactors used bydifferentcodesfor all levels ofperformance.
- In all cases of buildings designed according to different codes, the first floor is roughly 80%morevulnerable than thegroundfloor.
- Itisapparentthattherelativevulnerabilityofthefirstfloorincreasesduetofloorreinforcement.
- Theapplicationofelevationfactorsonly onthegroundfloorshouldnotprovidetherequiredperformanceinallotherstories.Thissuggeststhatimplementationofincrement factors at adjacent stages may be required to improve the performance oftheOGSbuilding.

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