# IMPLICATIONS OF MAJOR INTERNATIONAL CODAL DESIGN PROVISIONS FOR OPEN GROUND STOREY BUILDINGS

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**Abstract -** *Parking is a major concern for residential apartments in populated cities. Therefore, the building is being used in the land store for the building. The "Open Ground Story" (OGS) building is a building that is free to any Infilled building wall of ground water. Such buildings are very common in India for parking purposes. Common design practices are ignored infill wall strength and energy in infilled frame buildings in structural modeling. Such designs will usually be conservative in the form of fully tight structures. But in the case of an OGS-frame building, the behavior is different. In the OGS Spit Building, there is a slightly shiny, large drift (especially in geo-politics) compared to bare frames, and the failure of soft structures on the underground floor. In the current study, a common ten Storied OGS Framed Building is considered and the building is considered as a seismic zone-vim. For Ground Star Colors, the design teams are evaluated by Indians, Euro, Israel, Bulgarian code, and Koshak.L. (2009) on the basis of various Indian codes. Various OGS frames MF as 1.0, 2.1 (Israel) 2.5 (Indian), 3.0 (Bulgarian), 3.79 (Kaushik et al, 2009) and 4.68 (Euro). The performance of each building is studied using the process of laminate analyzed by Cornell and Al (2002), the uncertainty of concrete, steel and shiny walls is calculated. Third computational model has been developed in the semicolon (2012) program to analyze the analysis of the dynamics of each media. According to the Indian Code, for compilation of thirty natural history (ISO 1893-2002) was selected and the reaction was modified to select spectrum. In the current study, the construction of each building is made of bad breath curves*

*On the first floor of the OGS Building, it is found to be more risky when the soil level columns are designed in 2.5, 3.0 or more MF. Star Ground and the first Star Israel code applies, which makes the stars closer to the ratio of the proportion of the loading ability of the staff to demand a similar shear.*

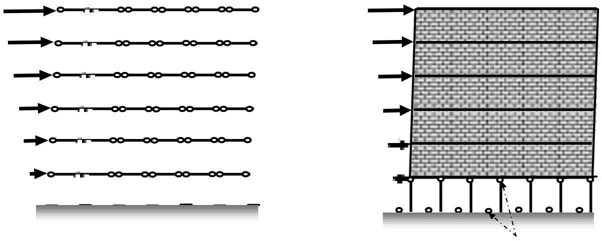
***Key Words*****:** Fragility curves, Open ground storey (OGS), Multiplication Factor (MF), Peak Ground Acceleration (PGA), Probabilistic Seismic Demand Model (PSDM)

## 1.1 Overview

Especially in developing countries in India, because of the increase in population, the need for change in urban areas becomes very important. While parking the building, the parking space plays an important role. Providing adequate parking space, building land is used in the building. In such buildings Ground Floor does not have any bending walls, but all are filled up on the floor, which is known as Open Ground Story (OGS) Building. Most of the apartments are such and the use of infill wall is essentially brick mineral. The upper stories of these buildings are harsh and the inter-colonial flow will be small, resulting in large curves, shear forces and the stocking column of the land will be in tilt moments. Therefore, the demand for strength on the columns in the land-building of buildings is very high. In most of these buildings, the previous earthquake has declined in many countries. Failure of OGS buildings is considered due to the storied system in the ground floor. In the ground floor, there is a high strain in the ground floor column under seismic loading due to lateral hardness and sudden decrease in mass. In most cases, the ground-story columns were either seriously damaged or completely failed, causing buildings to be damaged. Due to the presence of walls in the upper upper floor, apart from the approval of the land, the upper floors make the open ground more harsh than the floor. Thus, the upper floors move almost simultaneously in the form of a block, and most of the building's horizontal displacement is in the soft ground shop itself separates the behavior of the frame and OGS building filled during the Bhuj earthquake (2001). It can be seen that in the building of the left side the building on the left is infrared with minor cracks in the walls. The building on the right is an OGS frame, which has completely demolished due to the soft-stacked system in the ground floor due to the absence of the Infill wall.

## 1.2 OPEN GROUND STOREY (OGS)

The presence of intrusive walls in the upper floors of the OGS Building increases the hardness of the building globally, as seen in a specific infilled ready building. Due to the increase of global hardness, the demand for base shear increases on the building. In the case of building the typical infilled frame, the increased base shear is shared by both frames and infill walls in all the floors. In the OGS buildings, where the infinite walls are not present in the ground floor (no truss action), the increased base shear is completely resistant to the ground storage column, around the walls without any load loading. . In the Ground Storozol column, increased shear forces in the increased shear forces will generate momentum and curvature more, resulting in a significant decline at the level of the first floor. Large lateral deflection increases the bending moments due to the P-Δ effect. The durable plastics of the plastic develop on the top and bottom end of the storied pillars. The upper floors will remain undesirable and will move like a rough body. The damage is mostly concentrated in the ground-level column, and it is called the typical "soft-storied collapse". As shown in Figure 1.1, it is also called 'Manjila Tantra' or 'Column Tantra' in the Ground Structure. These buildings are considered weak due to the sudden decrease of hardness or strength (vertical irregularity) in the ground floor compared to building a normal infilled frame. As a result of the presence of soft story, there is a lot of localized drift, which causes a huge loss or collapse of the story during severe earthquake. Most lateral playbacks were deposited in the clearance of soft and weak ground due to the presence of heavy mass on upper stories and the absence of the ground floor and infills in plastic bracelets.



(a) bare frame (b) OGS frame

**Figure** 1.1 : Difference in behaviour between bare frame and OGS building

## 2. DETAILS OF CASE STUDY BUILDINGS

A common ten-floor six-floor OGS RC frame which represents a symmetrical building in the plan is considered in the current study. The grades of concrete and steel are respectively taken as M25 and Fe415. Specific bay width and column height are selected as 3 meters and 3.2 meters respectively. Slab thickness is 150mm. At the level of all floors except for the top floor, 3 KN / M2 is considered to be a live load, where it is considered 1.5 KN / M2. According to IS 1893 (2002) seismic load is taken. It is believed that the building is located in the seismic zone V, in which the Z = 0.36 and the R-value in the idea and analysis of the medium soil is considered as 3 for the normal RC moment resistant frame (OMRF).

In the selected building plan, both are considered symmetrical in orthogonal directions. The torsional reaction of the building is neglected and hence the same plane frame is considered to be representative of the building with one direction. The total width of the building is 18.0 meters, which has 6 bays, the width of each bay is 3.0 meters. The total height of the building is 32.0 meters, with 10 floors, the height of each floor is 3.2 meters. The parapet wall of 0.6 meters is considered. It is believed that the typical pillar and beam size is 350mm x 350 mm and 230mm x 350mm. Since the building is an OGS frame, so the column of the store is to be designed due to the qualitative factors of various codes like Indian, Euro, Bulgarian, Israel.

### 2.1. Multiplication Factors (MF) As Per Various Codes

Details of the MF adopted according to various inter-national codes and recent literature (Kaushik et al., 2009) are shown in Table 1. It is believed that the designations used for each frame are also shown. Design forces are found in the bare frame as the weight of pearls. The combination designs in the code Ground floor columns alone are enhanced by qualitative factors for the design of the columns. The frame designed using MF = 1.0 is named as OGS 1.0. The Ground Story column of the frame designed with MF = 1.0 is approximately 350 x 350 mm, which has increased to 750 x 750mm because the MF is 2.5. The departmental height of all designed frames is shown in the picture.

**Table -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 × 1250 | 3.86 | 48 no's of 40 mm Dia |
| 10 storey 6bay,OGS(M.F=2.1) | Israel | 650 × 650 | 3.8 | 20 no's of 32 mm Dia |
| 10 storey 6 bay,OGS(M.F=3.97) | Kaushik et. al. (2009) | 1100 × 1100 | 3.72 | 56 no's of 32 mm Dia |

## 2.2. DEVELOPMENT OF FRAGILITY CURVES

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

### 2.2.1 Latin Hyper Cube Sampling(LHS)

To consider the uncertainty in the material properties, the characteristic strength of concrete, $f_{ck}$, the yield strength of the steel, $f_y$ and the compressive strength of masonry fm are taken as the random variable. The statistical details (Table 2) of the parameters, $f_{ck}$ and $f_y$ have been taken from Ranganathan (1999) and that for masonry is taken from Kaushik et. al. (2007). From the mean and std deviations of each random variables, a set of 30 values of random variables are generated using LHS sampling method. This is carried out in MATLAB program. The sets of thirty statistically equivalent analytical models generated for the three random variables are tabulated in the Table 3.

**Table 2**: Details of random variables used in LHS scheme

| Material | Variable | Mean | CON % | Distribution | Remark |
|---|---|---|---|---|---|
| Concrete | $f_{ck}$(MPa) | 30.28 | 21.0 | Normal | Uncorrelated |
| Steel | $f_y$(MPa) | 468.90 | 10 | Normal | Uncorrelated |
| Mansory | $f_m$(Mpa) | 6.60 | 20 | Normal | Uncorrelated |

**Table 3**: $f_{ck}$, $f_y$ and $f_m$ for 30 models generated using LHS scheme

| Model no | $f_{ck}$ (MPa) | $f_y$ (MPa) | $f_m$ (MPa) |
|---|---|---|---|
| 1 | 29.30 | 468.23 | 6.14 |
| 2 | 29.53 | 468.38 | 6.58 |
| 3 | 29.65 | 468.46 | 6.81 |

| | | | |
|---|---|---|---|
| 4 | 29.73 | 468.52 | 7.06 |
| 5 | 29.81 | 468.57 | 7.22 |
| 6 | 29.87 | 468.61 | 6.62 |
| 7 | 29.92 | 468.65 | 5.65 |
| 8 | 29.97 | 468.69 | 6.34 |
| 9 | 30.02 | 468.72 | 6.20 |
| 10 | 30.06 | 468.75 | 7.55 |
| 11 | 30.10 | 468.78 | 6.39 |
| 12 | 30.14 | 468.81 | 6.90 |
| 13 | 30.18 | 468.83 | 6.51 |
| 14 | 30.22 | 486.86 | 7.00 |
| 15 | 30.26 | 468.89 | 6.30 |
| 16 | 30.30 | 468.91 | 5.98 |
| 17 | 30.34 | 468.94 | 5.86 |
| 18 | 30.38 | 468.97 | 6.77 |
| 19 | 30.42 | 468.99 | 6.54 |
| 20 | 30.46 | 469.02 | 6.47 |
| 21 | 30.50 | 469.05 | 7.13 |
| 22 | 30.54 | 469.08 | 6.73 |
| 23 | 30.59 | 469.11 | 6.66 |
| 24 | 30.64 | 469.15 | 7.34 |
| 25 | 30.69 | 469.19 | 6.25 |
| 26 | 30.75 | 469.23 | 6.86 |
| 27 | 30.83 | 469.28 | 6.95 |
| 28 | 30.91 | 469.34 | 6.43 |
| 29 | 31.03 | 469.42 | 6.69 |
| 30 | 31.26 | 469.57 | 6.07 |

### 3. COMPARISON OF FRAGILITY CURVES

The PSDM models are used for generating fragility curves of each building frame. The PSDM models and corresponding fragilities are presented in the Fig 1 to 2.

The use of qualitative factors increases the strength and stiffness of the Ground Storozole column. It is celebrated with figures. MF = uplift capacity designed with 1.0 for the PGA 3g OGS frame is 77% for IO display level, close to almost 9% and 0% for the CP level LS level. Ground-level columns have been multiplied by multiplying 2.5 times the SF of BM and Bayer fare, and ground-level columns have increased their column sections. The performance of the frame increased in comparison to the building designed with 4.7, MF = 1 (increase in probability of reduction in interstate flow). For PGA of 3.0g, the probability of the additional for three is almost zero. The performance levels include IO, LS and CP are similarly observed for remaining matters such as Bulgarian (fig. 1), Euro (fig. 2).

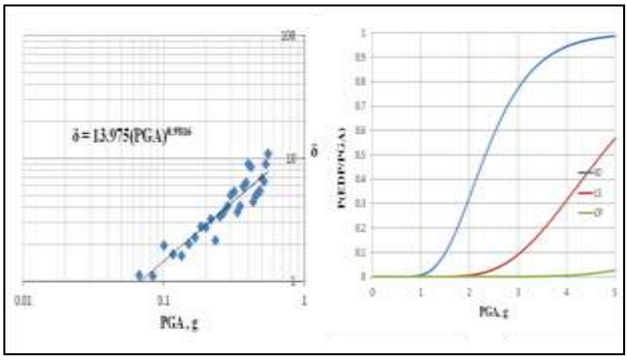



**Fig -1**: OGS Frame M.F=1 (a) PSDM (b) Fragility Curve

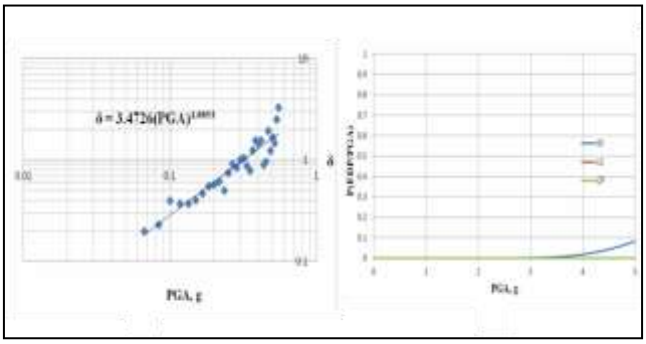



**Fig -2**: OGS Frame Indian M..F = 2.5 (a) PSDM (b) Fragility Curve

### 4. Comparison Of Fragility Curves With Damage Parameter As Inter-Storey Drift At Various Storeys (At Ground Storey, First Storey, Second Storey And Third Storey)

Since there is a need to study the performance of other floors besides ground stations, as high capacity of inter-storey drift has been developed for other floors for IO demonstration level. These delicacy curves are shown in Figure 3 to 8.

Figure 3 shows the consonant curve for the OGS frame designed for MF = 1.0 for different floors. It has been seen that the ground floor is weak compared to the floor. Figure 4 According to the Indian Code, the quality of the building designed using a qualitative factor, 2.5 shows the possibility of intelligent possibility. This shows that the first floor is more vulnerable than the other and the shops of the land. This means that the performance of the above floors should also be addressed while using qualitative factors. The same behavior (Figures 5 , 6 and 8) is celebrated for all other codes except for the Israeli code (as shown in Figure 8). In addition to Israel code, only qualitative factors are applied at the bottom of the ground, which is more in the range of 2.5 to 4.68. But Israeli code applies a factor of 2.1 for both land and first floor, which reduces more possibilities (Figure 8) and equally in all the floors compared to other conditions.

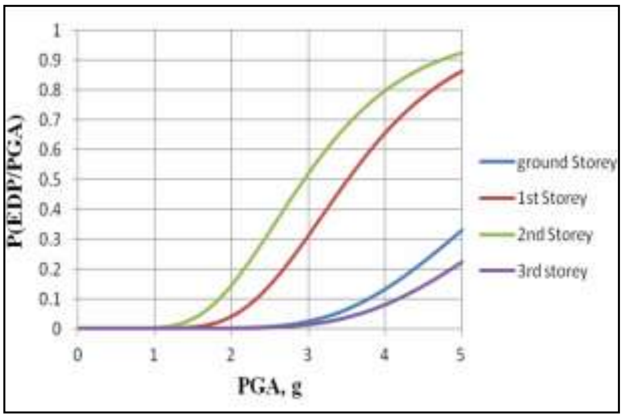



**Figure 3-** Fragility curve for M.F = 1 OGS frame for IO performance level

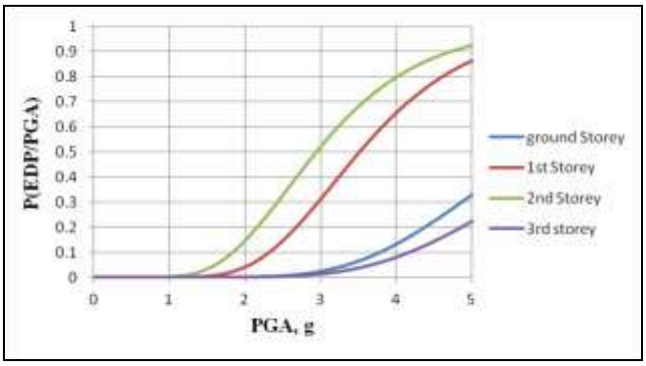



**Figure 4:** Fragility curve for Indian (M.F=2.5) OGS frame for IO performance level

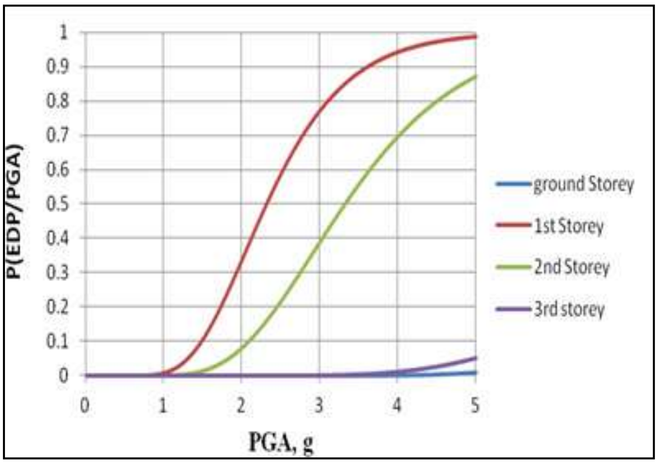



**Figure 5:** Fragility curve for Bulgarian (M.F=3) OGS frame for IO performance level

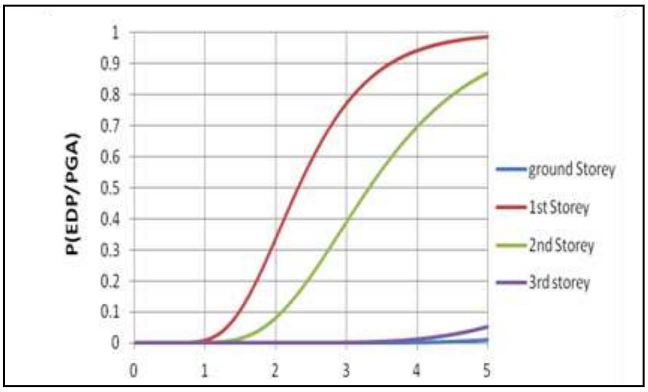



**Figure 6:** Fragility curve for Euro (M.F=4.68) OGS frame for IO performance level

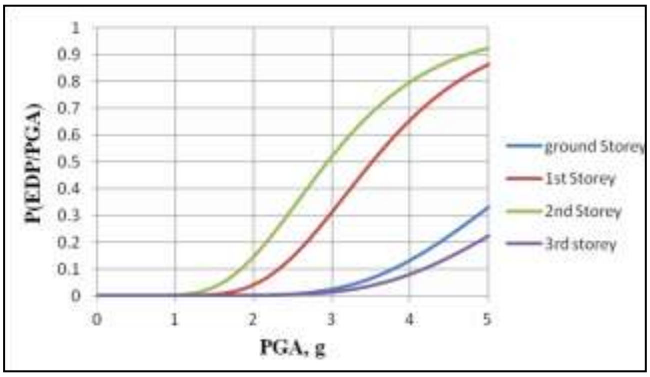



**Figure 7:** Fragility curve for Euro (M.F=2.1) OGS frame for IO performance level

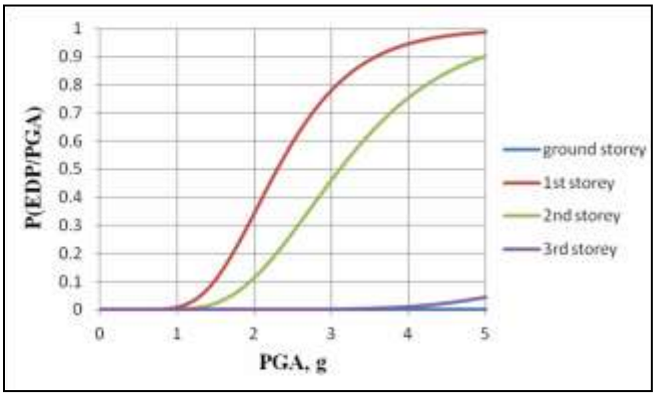



**Figure 8:** Fragility curve for Kaushiket. al, 2009 (M.F=3.97) OGS frame for IO performance level

### 5. Comparison Of Fragility Curves With Damage Parameter As Inter-Storey Drift At Various Storeys (At Ground Storey, First Storey, Second Storey And Third Storey)

For different codes, the comparison of the fragility curve for each floor is made to understand the behavior Fig.9 Represents the ground floor discovery curve for various codes. Since Israel code uses the MF factor 2.1, therefore, the resultant lucidity is higher in the ground shop than other codes. Figure 10 represents the fragility curve of the first floor, which shows that except for the Israeli code, the possibility of cross-stage flow for all the codes is the same. Except Israel Code, no other code considers MF to be for the first floor. In other words, the first floor of all the frames designed by the additional code of Israel code is similar to generating the same probability. Figure 11 is considered that delicate curve is represented for the second floor of all frames. It can be seen that the fragility of the second floor is the same as all the codes.

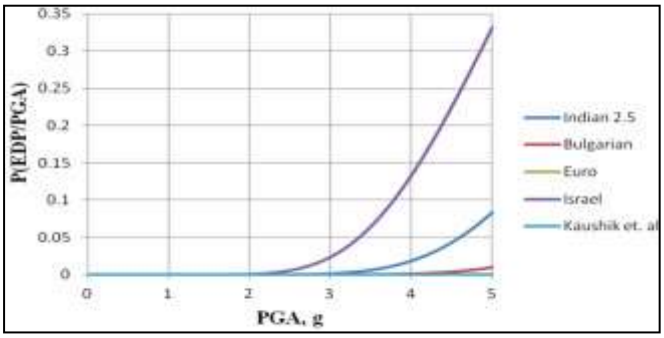



**Figure 9:** Fragility Curve of ground storey

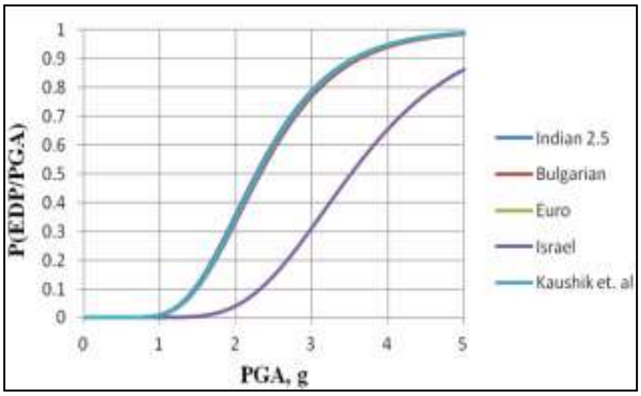



**Figure10:** Fragility Curve of first storey

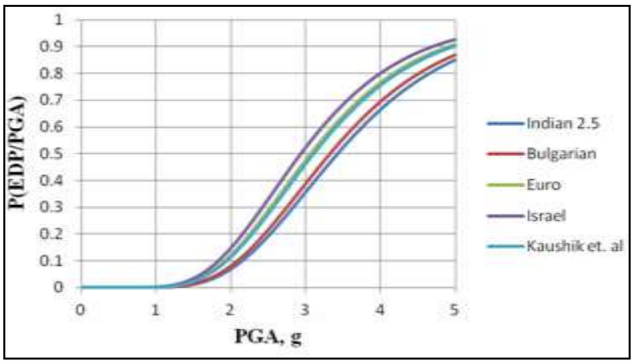



**Figure11:** Fragility Curve of second storey

## 6. CONCLUSIONS

The main findings from follow-up study are:

• Depending on the different codes, the performance of specific OGS buildings considering various magnification factors is studied using fragility curves.

• Uncertainties in concrete, steel and masonry have been included using LHSKM.

It is found that the performance of the OGS frame is increasing in the growing sequence of magnification factors used by different codes for all performance levels in terms of Ground Story Flow.

• In all cases of buildings designed using different codes, except for the first floor, less than 80% is less than the Israeli Code Ground Shop.

• It is found that due to strengthening the ground floor, the relative vulnerability of the first floor increases.

• Except Israel Code, no other code considers MF to be for the first floor. In other words, the first floor of all the frames designed by additional code of Israel code is similar to generating the same probability.

• Only the use of the magnification factor in the ground floor can not provide necessary performance in all other stories. This study has found that OGS buildings have been designed using Israeli code, which is considered to be a magnification factor in the adjacent bottom, which performs better than others. This indicates that the implementation of the magnification factor in adjacent floors may require improvement in the performance of the OGS buildings.

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