A Review of Open Ground Multistorey Building Structure for Different Seismic Zone Conditions

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ABSTRACT

Open ground storey (OGS) buildings are buildings on stilt floors which provide for vehicle parking space in the ground floor. Such buildings where the mass and stiffness are not uniform are called irregular buildings and are known to perform poorly under seismic loading. As a result, the Indian code for evaluating earthquake loads on buildings penalizes these buildings by requiring their ground storey to be designed for two-and-a-half times the estimated base shear for a similar non-open ground storey building with no conditions on required stiffness. However, this may lead to undesirable performance because the ground storey columns are likely to get heavily reinforced and as a consequence have reduced levels of ductility. Also, since most of the lateral deformation of the building is likely to be concentrated at the ground storey, the storey deformation is likely to exceed the stipulated values even under minor or moderate earthquakes thus causing performance problems. In this study, the performance of G+4, G+5 and G+10 storeyed OGS plane frames, designed and detailed as per the Indian Codes, and by response spectrum analysis can be selected for analysis work.

Keywords: Open Ground Storey, Multi Storey, Response Spectrum Analysis, Lateral Deformation.

1. Introduction

Those surveys from claiming a few existing structures Previously, India remarks that there would existing OGS structures that would have planned for seismic parallel loads Likewise for every configuration code Yet not Toward acknowledging the Amplification figure of quality 2. 5. It might have been distinguished therefore that those mf of quality 2.5 if not a chance to be connected of the beams as on account this may be liable should bring about the shaping from claiming 'strong beam-weak column' circumstances (with the plastic pivot framing at those section end, as opposed the pillar end).

Fig 1.1 Typical examples of OGS building

Some studies supported such analysis [4] and [5] have shown that, compared with the 'bare frame' analysis, the OGS building frame has following implications.

- The lateral stiffness of the building frame increases
- The fundamental time period decreases
- The base shear demand increases
- The fundamental mode shape is significantly altered
- Higher curvatures are induced in ground storey columns
- Shear forces and bending moments in the ground storey columns increases

Open ground storey building is inherently poor structure with abrupt change in stiffness and strength at the ground storey level. The problem occurred because of neglecting the presence of masonry infill wall and only bare frame elements are considered while designing open ground storey building. Hence, the effect of inverted pendulum has not been taken into account. Many improved and important design provisions and guidelines have been formulated in Indian Standard IS 1893 (2002) regarding open ground storey buildings after studying the case of Bhuj earthquake occurred in 2001.

2. Literature Review

In this Chapter focuses on the literature review on behaviour of OGS buildings, analytical and experimental studies on shear walls and modelling of reinforced concrete elements.

Wen and Song (2003) [1] had carried out the redundancies of SMRF and dual systems by considering various structural configuration (number of bays and shear walls), ductility capacity, uncertainty in demand and capacity, interaction between walls and moment frames, and three-dimensional (3-D) motions and found that in a dual system the number of shear walls had a small effect on structural reliability under earthquake.

Zhao and Abolhassan (2004) [2] discussed the advantages and disadvantages of traditional RC Shear walls and steel walls. They found that composite shear walls, that is, steel plate shear wall with RC wall attached to one side of it using bolts can mitigate most of the disadvantages of both RC and steel shear walls and take advantage of the best characteristics of the 2 construction materials affected the maximum base shear caused by earthquakes of steel and concrete.

Davis et al. (2004) [3] studied the seismic performance of two typically existing buildings situated in moderate seismic zones of India by performing linear static analysis, response spectrum analysis and nonlinear pushover analysis. In one building irregularity in plan and vertical irregularity like soft storey were found and another building was symmetric in nature. The equivalent strut method was used to modelled infill walls.

Kaushik et al. (2006) [4] conducted experiments on unreinforced masonry infill for obtaining compressive stress- strain behaviour. Nonlinear stress-strain curves had been obtained for bricks, masonry, mortar six control points had been plotted on the stress-strain curves of masonry, which were used to define the performance limit states of the masonry infill.

Rana et al. (2004) [5] performed a nonlinear static analysis of a 19-storey reinforced concrete building with total area of 430,000 Sq. ft. located in San Francisco. The building was typically designed as per 1997 Uniform Building Code with shear walls as a lateral resisting system to check the provisions and guidelines of the Life Safety performance level when subjected to design earthquake and results were presented in this work.

Lee et al. (2007) [6] studied the response of seismic parameters of three different models of 17-storey reinforced concrete wall building with various types of irregularity at the bottom storey when subjected to the same series of scaled earthquake motions. The first model consists of moment resisting frame symmetrical in nature and next model had an infill shear wall in the middle frame and last one, third had an infill shear wall provided only in exterior frames. Based on test observations, following conclusions were out forward and presented that the calculated fundamental time periods for other models than moment resisting frames and shear wall were found to be reasonable in UBC 97 and AIK 2000.

Esmaili et. al. (2008) [7] studied the structural aspects of one of the tallest RC buildings, located in the high seismic zone, with 56 stories. In which shear wall system with irregular openings were utilized under both lateral and gravity loads, concluded that confinement of concrete in shear walls is a good way to provide more level of ductility and getting more stable behavior.

Ashraf et. al. (2008) [8] proposes that the proper placement of shear wall at a point of coinciding center of gravity and centroid of the building by carrying out experiment on multi-storey building by changing shear walls location which were subjected to lateral and gravity loading in accordance with UBC provisions.

Karemore and Rayadu (2015) [9], In urban ground storey of frame building is generally kept open (i.e. soft storey) for parking or reception lobbies. Upper storey has brick infill panels which provide certain stiffness to upper storey of structure, this increases forces, displacement, storey drift and ductility demand in ground storey. OGS (i.e. open ground storey) buildings are generally collapse during the earthquake due to soft storey effect.

Indian Standard IS 1893:2002 allows analysis of OGS buildings without considering infill stiffness but in compensation of stiffness discontinuity, magnification factor 2.5 is to be multiplied to shear force and bending moments of beams and column calculated under seismic loads of bare frame. (i.e. ignoring infill stiffness).

Chen et al., (2016) [10], clarified the impact and reaction of floor acceleration because of seismic forces. He explained that due to seimic forces there is a jumping occurs n the floor. An experiment was conducted on individuals by taking jumoing forces and taking 506 records. Every individual was considered as single degree freedom system with varioing frequency and damping ratio calculated using response spectrum method and after a curve was plotted as per the results obtained and design spectrum curvewas obtaine by statistical. The design spectra considered 0.5hz-15 hz.

3. CONCLUSION

- In present decades, the infill walls within the frames refers the behavior of the building under lateral loads. However, it's common experience observe to ignore the stiffness of infill wall for analysis of framed building.
- The infill wall strut is provided the ability to reduce the lateral load and increase the base shear and base moment value in structures.
- In this work, the infill wall strut has been placed at open first storey building to provide the maximum stiffness to the structure as compared to bare frame or normal OGS frame structure.
- The various results are calculating in further work after analysis and these results are validated and compared bare frame and infill OGS frame and improve the design for future application.
- The scope of this work is to know and proposed suitable structure which can used in different seismic zone with different multi storey structure with better performance as compared to bare frame or normal OGS frame structure.

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