Regular & Irregular Shape of Multi-Storey Building in Severe Seismic Zone

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Abstract-Earthquakes are caused generally by rupture of geological faults inside the earth, but also by other events such as volcanic movement, landslides, mine blasts, and atomic tests. Irregularities are characterized by vertical discontinuities in the geometry, distribution of mass, rigidity and strength. Plan irregularity is the even inconsistency in the design of vertical parallel drive opposing components, in this way creating a differential between the focal point of mass and focus of Inflexibility, that ordinarily result in huge torsional requests on structure. A G+9 storey building is modeled in ETABS 2016 software and comparison is made between regular structure and plan irregular structures with varying seismic zone levels ie., zone IV and Zone V, these models are analysed under response spectrum method. The comparison was made for base shear, storey drift, storey displacement and storey stiffness. From the results and graphs is clear that building with regular symmetric configuration give a better resistance against earthquake forces and offer a stable structure.

Index Terms-Earthquake, Symmetric Configuration, Irregular Configuration, Seismic Zones.

1. INTRODUCTION

The word earthquake is used to express any seismic occurrence whether natural or caused by humans that can produce seismic influence around any particular area. Earthquakes are caused generally by rupture of geological faults inside the earth, but also by other events such as volcanic movement, landslides, mine blasts, and atomic tests. Irregularities are characterized by vertical discontinuities in the geometry, distribution of mass, rigidity and strength. Setback buildings are a subset of vertically irregular buildings where there are discontinuities with respect to geometry. However, geometric irregularity also introduces discontinuity in the distribution of mass, stiffness and strength along the vertical direction. Majority of the studies on setback buildings have focused on the elastic response. The behaviour of these types of building is something different.

There is a need of more work to be done in this regard. So this research work is an attempt to reach on more accurate conclusion to reduce their effect on the structure. We observe that real structures are frequently irregular as perfect regularity is an idealization that rarely occurs in the practice. Regarding buildings, for practical purposes, major seismic codes across the globe differentiate between irregularity in plan and in elevation, but it must be realized that irregularity in the structure is the consequence of a combination of both types. It is seen that irregular structural configurations either in plan or in elevation were often recognized as one of the major causes of collapse during precedent earthquakes.

2. OBJECTIVES, SCOPPE AND METHODOLOGY

2.1. Objectives

- 1. The analysis of a multi-storeyed RC building having G+9 Storey is analysed with varying earthquake intensity.
- 2. To Model regular and irregular buildings in Etabs Software.
- 3. To analyse the regular and irregular building models with Response Spectrum analysing method for zone IV and V.
- 4. To compare the responses of regular and irregular configuration structure for base shear, storey drift, storey displacement and storey stiffness.
- 5. To compare the performance of the structures that varies in plan dimensions and with different quake zones.

2.2. Scope

- 1. Behaviour of structure with regular and irregular configuration in various seismic zones.
- 2. Behaviour of structure with irregularity under dynamic analysis.
- 3. Effect of various parameters on the structural members.

2.3. Methodology

The step by step procedure followed to achieve the above objectives is;

- 1. An extensive literature review is carried out to establish the above objectives for the project work.
- 2. G+9 storey structure is chosen for the present investigation.
- 3. ETABS software is chosen for modelling and analysis of the selected structure.
- 4. To understand the behaviour of structure, two models are considered with regular and irregular configuration in different seismic zones

3. MODELLING

The modelling and the analysis of the structure is carried out using ETABS software. Response Spectrum Method is used for the analysis of structure.

Table 1. Building Details of Structures with Regular and Irregular Configuration in Seismic Zone IV.

Number of stories	G+9
C/C distance between columns in	5m
X-direction	
C/C distance between columns in	5m
Y-direction	
Foundation level to ground level	3m
Floor to floor height	3m
Live load on all floors	3kN/m ²
Live Load on Roof	1.5kN/m ²
Floor Finish	1.5kN/m ²
Materials	M25 &Fe415
Size of column	500x500mm
Size of beam	230x500mm
Depth of slab	150mm
Seismic zone IV	0.24
Soil Type	II

Table 2. Building Details of Structures with Regular and Irregular Configuration in Seismic Zone V.

Number of stories	G+9
C/C distance between columns in	5m
X-direction	
C/C distance between columns in	5m
Y-direction	Asses
Foundation level to ground level	3m
Floor to floor height	3m
Live load on all floors	3kN/m ²
Live Load on Roof	1.5kN/m ²
Floor Finish	1.5kN/m ²
Materials	M25 &Fe415
Size of column	500x500mm
Size of beam	230x500mm
Depth of slab	150mm
Seismic zone V	0.36
Soil Type	II



Fig. 2. 3D Elevation of Regular Structure

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Fig. 4. 3D Elevation of Irregular Structure

4. RESULTS AND DISCUSSION

This chapter deals with results and discussion of multi storey building with regular and irregular configuration in various seismic zones.

- 1. Model 1- Structure with regular and irregular configuration in Zone IV
- 2. Model 2- Structure with regular and irregular configuration in Zone V

4.1. Storey Displacement

The floor level versus displacement graph has been plotted for both models, and from the graph it is clear that the building with regular configuration has a lesser displacement than that of the building with irregular configuration.



Graph 2. Storey Displacement in Zone V

4.2. Storey Drift

The floor level versus drift graph has been plotted for both models, and from the graph it is clear that the building with regular configuration has a lesser drift than that of the building with irregular configuration.



Graph 3. Storey Drift in Zone IV



4.3. Storey Acceleration

The floor level versus acceleration graph has been plotted for both models, and from the graph it is clear that the building with regular configuration has a lesser acceleration than that of the building with irregular configuration.



Graph 5. Storey Acceleration in Zone IV



Graph 6. Storey Acceleration in Zone V

4.4. Storey Forces

The floor level versus force graph has been plotted for both models, and from the graph it is clear that the building with irregular configuration has a lesser storey force values than that of the building with regular configuration.



Graph 8. Storey Forces in Zone V

4.5. Storey Stiffness

The floor level versus stiffness graph has been plotted for both models, and from the graph it is clear that the building with irregular configuration has a lesser storey stiffness values than that of the building with regular configuration.

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Graph 9. Storey Stiffness in Zone IV



4.6. Base Shear

From the graph it is clear that the building with irregular configuration has a lesser base shearvalue than that of the building with regular configuration.



Graph 11. Base Shear in Zone IV



Graph 12. Base Shear in Zone V

5. CONCLUSION

Effects on models have been shown in the form of graph in successive part of results and discussions, by comparing various parameters such as displacements, storey drifts, storey acceleration, storey force, storey Stiffness, and base shear. Hence from the obtained results the following conclusions are made,

- 1. Considering the effect of lateral displacement on structure. It has been observed that, building with L-shape have displaced more in comparison to regular simple shaped building.
- 2. The storey drifts being the important parameter to understand the drift demand of the structure. L-shaped models showed larger drift than regular simple shaped models.
- 3. The storey force in both the zones i.e., for IV and V showed that regular building model has a lower force than that for the building with irregular configuration.
- 4. The storey stiffness in both the zones i.e., for IV and V showed that regular building model has high stiffness than that for the building with irregular configuration.
- 5. The graphs of base shear for zone IV and V, has a higher shear values for the regular simple building than that for irregular configured building.
- 6. As the storey force decreased and an increase in storey stiffness and base shear for the regular simple shaped building, which give a clear indication that regular configured building perform better then that the irregular structure.
- 7. It is observed that, there are no torsional effects in the frame because of symmetry that is the center of mass that coincides with the center of rigidity, hence symmetric structure perform better in resisting earthquake force.
- 8. From the above results so obtained from all the graphs is clear that building with regular configuration give a better resistance against earthquake forces and offer a stable structure.

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