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Seismic Demand of Framed Structure with Mass Irregularity

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ABSTRACT - The behavior of a building during an earthquake depends on several factors, stiffness, and adequate lateral strength, and ductility, simple and regular configuration. The buildings with regular geometry and uniformly distributed mass and stiffness in plan as well as in elevation suffer much less damage compared to irregular configurations.

Mass irregularity has different definition in different codes. According to IBC 2003, NZS (New Zealand Standard) and NBCC (National Building Code of Canada) criteria for structural irregularity Mass Irregularity shall be considered to exist where the effective mass of any storey is more than 150 percent of the effective mass of an adjacent storey. A roof that is lighter than the floor below need not to consider.

Discontinuity due to mass irregularity causes weakness in structure. Response of mass irregular structure needs to be study for the earthquake scenario. This dissertation deals with RCC framed structure in both regular and mass irregular manner with different analysis methods.

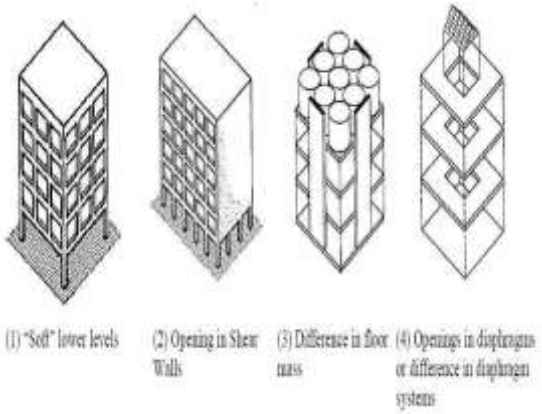
KEYWORDS - Multi-storey building, Seismic Analysis, Vertical Irregularity, Mass Irregularity, Storey drift, Storey Shear, Story Displacement.

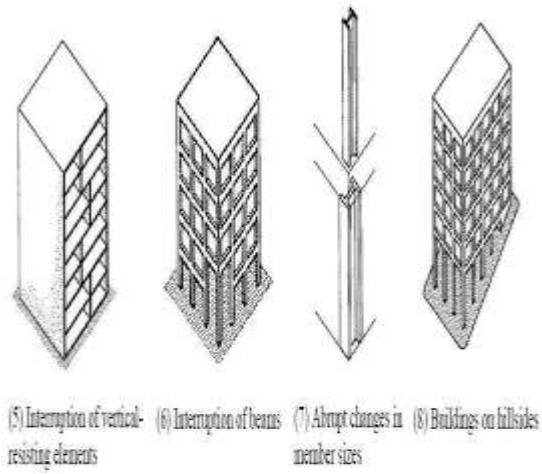
I. INTRODUCTION

During an earthquake, failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. The structures having this discontinuity are termed as irregular structures. Irregular structures are largely seen in urban infrastructure. Vertical irregularities are one of the major reasons of failures of structures during earthquakes. For example structures with soft storey which are liable to collapse due to large stress and drift. Hence, the effect of vertically irregularities in the seismic performance of structures becomes very important. Height-wise changes in stiffness and mass render the dynamic characteristics of these buildings different from the regular building.

Many buildings in the present scenario have irregular configurations both in plan and elevation. They may subject to devastating earthquakes in future. Therefore, it is necessary to identify the performance of the structures to withstand against disaster for both new and existing one. The irregularities in the buildings namely plan irregularity with geometric and diaphragm discontinuity and vertical irregularity with setback and sloping ground. In order to identify the most vulnerable model among the above mentioned building therefore various analytical approaches.

II. TYPES OF IRREGULAR BUILDING





III. OBJECTIVES

1. To study seismic demand of framed structure with mass irregularity.
2. To compare between linear static analyses, dynamic response spectrum analysis and non-linear time history analysis for mass irregular structure.
3. Study the effect of location and magnitude of mass irregularity on actual structural response.

IV. SUMMARY OF LITERATURE

1. Al-Ali AAK, Krawinkler H (1998). concluded that mass discontinuities have small effects on the elastic and inelastic response and A mass increases at the top was found to produce a relatively larger effects on roof and storey drifts than an increase at mid height or at base of the building.
2. Magliulo concluded that even very large variations of the mass distribution in elevation cause negligible modifications of the seismic response of building frames.
3. Das S, Nau JM (2003).designed building with vertical mass irregularities by employing equivalent lateral force method of elastic analysis and found that most of the structures considered performed well when subjected to the design earthquake.

V. METHODOLOGY

4. The methodology to be worked out to achieve the above-mentioned objectives is as follows:
5. Review the existing literature and Indian design code, International building code provision for mass irregular structure.
6. Select a problem statement with geometrical and structural details.
7. Model and analyze the same problem with software based on Finite 5.Element Analysis (FEA) using ETABS software.
8. Analyze the selected problem by using Equivalent Static Analysis, Response Spectrum Analysis and Nonlinear Time History Analysis with changing conditions. Also analyses with pushover method for plastic hinge location.
9. Comparison of the results obtained from the analyses. Observe the results and discuss them.

VI. CONCLUSION

In this study, seismic behaviour of RCC framed structure with mass irregularity is investigated. The structural models are 3D and symmetric in plan. Mass irregularity is considered on the different locations in the elevation of structure. This study has two parts. First part is comparison of linear static analysis and dynamic response spectrum analysis for irregular buildings and the second part is investigation of the response of irregular buildings by nonlinear time-history analysis.

In the second part of this study, nonlinear time history analysis is applied on the models subjected to El-Centro earthquake ground motions. By comparison the behaviour of regular and irregular buildings in linear static, dynamic response spectra and nonlinear time history analyses the following conclusions are drawn.

1. As the RSA method is more accurate than the ESA, however it gives lesser values for storey drift. Hence it is recommended to use ESA for calculation of story drift.
2. For high storey buildings, the storey shear obtained by NLTA is greater than the storey shear by ESA for top storeys only irrespective of location and intensities of mass irregularity.
3. Location of heavier floors does not affect the storey shear considerably.
4. In 10-storey building drifts by NLTA are less than ESA except when mass irregularity is on middle floors where the drift is 2.02 times that of the regular building.
5. The amount of irregularity has not shown considerable effect on the storey shear.

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