



Seismic Analysis of Vertical Irregular Buildings Using Response Spectrum Method

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Abstract

Researchers studied for earthquakes since long time and still they earthquakes are unpredicted. It is impossible to predict time and place of earthquake. To design and construct the structure which can withstand against earthquake is research interest since last many years, also researchers required to measure the frequency and intensity of earthquake for future structural design. Safety, strength and performance are the parameters which are to be considered while designing structure in seismic zones specially. However codes and guidelines are prepared by engineering societies in world which can be used to design buildings. Present paper explores existing research for RSM seismic analysis.

Keywords: Seismic analysis, vertical irregularity, ETABS, RSM, Building design

Introduction

Earthquakes of Killari 1993, Bhuj 2001, Kashmir 2005 and Haiti 2010 proved that specially designed buildings also fails due to ineffective and wrong design for seismic performance. It causes loss of life, loss of infrastructure, loss of economy and society. These parameters force the designer to design the structures considering failure parameters and factors responsible to structure fall under seismic action.

Factors responsible to failure of structure under seismic are:

- (i) Wrong and weak structure configuration and irregularities in planning phase.
- (ii) Lesser strength and ductility considerations in design phase.



Unplanned and non-scientific construction activities and sequences.

Literature Survey

Poncet and Tremblay (2004) proposed the impact and effect of mass irregularity considering case of an eight-storey concentrically braced steel frame structure with different setback configurations. Researchers considered number of locations for mass irregularity and two different ratios of seismic weight. One regular structure is also analysed which is taken into account for comparison purpose. Methods used in present paper are equivalent static load method and the response spectrum analysis method.

Soni (2006) The research paper considered several vertical irregular buildings for analysis. Various criteria's and codes have been discussed and reviewed in this paper. Vertical irregular structure performance and response is reviewed and presented. The studies suggested that for combined-stiffness-and-strength irregularity large seismic demands are found.

Patil and Kumbhar (2013) Ten story building is considered and tested against nonlinear dynamic response under seismic effect. SAP 2000 is used as a software application tool in this paper. Five number of seismic time histories are used to compare results of considered cases. Similar variation patterns are for displacement and base shear values are noted with different intensities and it is suggested and concluded that the high-rise RCC buildings must be tested using time history method confirm safety against seismic effects..

Aijaj and Rahman (2013) researchers in this paper tried to analyse the proportional distribution of lateral forces involved in earthquake for individual storey due to changes in stiffness of vertically irregular structure. A G+10 structure with vertically irregularity is modeled to analyse stiffness irregularity at floors. Drift, deflection and shear under seismic force through linear static & dynamic analysis is analysed.

Varadharajan et al. (2013) Paper review existing works regarding plan irregularities and justified the preference of multistorey building models over single storey building models. Regarding the vertical irregularities it was found that strength irregularity had the maximum impact and mass



irregularity had the minimum impact on seismic response. It is also found that dynamic analysis is more accurate than pushover analysis for seismic cases.

Ramesh Konakalla et al. (2014) Research focused to study “Linear Behavior of the Buildings with Plan Irregularities under Earthquake and Wind Loads”. Linear Static Analysis method is used. Results for four different frames are observed and it was concluded that there is no torsional effect in the frame because of symmetry means due to the center of mass coincides with the center of rigidity and also the lateral displacements are same in the direction of earthquake force. It is suggested in the last that because of variations in responses, it is better to study the response for each and every irregular building instead of taking a broad view.

Bansal (2014) Vertical irregular building is analysed with Response spectrum analysis and Time history Analysis. Irregularities considered are mass irregularity, stiffness irregularity and vertical geometry irregularity. The storey shear force was found maximum for the first storey and it decreases to minimum in the top storey in all cases.

Harshitha (2014) Dynamic behavior of high-rise building is studied using IS1893-2002 code recommended response spectrum method and time history method. Base shear, Response Spectra at different story levels, Bending Moment Diagram and Shear Force Diagram variations are considered to study and analyses in present study. STAAD Pro software is used to analyse the building models and it is found that the base shear obtained from Time history analysis is higher than Response Spectrum analysis. This is because of variation in amplitude and frequency content of the ground motions.

Bansal and Gagandeep (2014) Ductility based design is carried considering vertical irregular building and methods used are RSA and THA. Three types of irregularities namely mass irregularity, stiffness irregularity and vertical geometry irregularity were considered. According to our observation, the storey shear force was found to be maximum for the first storey and it decreases to minimum in the top storey in all cases. The mass irregular structures were observed to experience larger base shear than similar regular structures. The stiffness irregular structure experienced lesser base shear and has larger inter-storey drifts.

Konakalla (2014) Four different 20 story building are analysed for effect of vertical irregularity under Dynamic Loads Using Linear Static Analysis. Response of all cases is compared and

concluded that in regular structure there is no torsional effect in the frame because of symmetry. The response for vertically irregular buildings is different for the columns which are located in the plane perpendicular to the action of force. This is due to the torsional rotation in the structure.

Reddy and Fernandes (2015) Analytical study is conducted for regular and irregular buildings to analyze response of buildings in seismic zone V. 15 storey building is considered and ETABS software is used to model and simulate building response. Analysis is performed for static and dynamic methods of analysis. Paper concluded behavior of irregular structures as compared to regular structure.

Mukundan (2015) Shear wall provision in building has been found effective and economical. A 10 storey building in Zone IV is tested to reduce the effect of earthquake using reinforced concrete shear walls in the building. The results are presented after analyzing model using ETABS software and RSA method is used. Researchers also studied results varying thickness of shear walls. It is concluded that shear walls are more resistant to lateral loads in regular/Irregular structure and for safer design, the thickness of the shear wall should range between 150mm to 400mm.

Sagar et al. (2015) analysed the performance on various type of irregularity Considered i.e. (a) Horizontal Irregularity-plan irregularity (b) Vertical Irregularity -Mass Irregularity. To achieve objective of the project Time history Analysis & Response spectrum analysis method were carried out.

Khan & Dhamge (2016) highlighted the effect of mass irregularity on different floor in RCC buildings with as Response Spectrum analysis using STAAD-Pro V8i software. In the project work seismic analysis of RCC buildings with mass irregularity at different floor level were carried out. Models are compared with each other for response in terms of drift and deflection.

Salunkhe and Kanase (2017) investigated that response of mass irregular structure need to be studied for the earthquake scenario. In this paper researcher deal with RCC framed structure in both regular and mass irregular manner with different analysis methods.

Sayyed (2017) focused his study on the effect of infill and mass irregularity on different floor in RC buildings. The results were concluded that the brick infill enhances the seismic performance of the RC buildings and poor seismic responses were shown by the mass irregular building, therefore it should be avoided in the seismic vulnerable regions.



Literature Conclusion

- This is not sufficient to study the nonlinear behavior of the structure. A great amount of research in nonlinear static analysis i.e., push over analysis is in progress and at the same time a great focus is also in the direction of nonlinear dynamic analysis. To know the complete behavior of the structure with irregularity from linear stage to the collapse stage, nonlinear dynamic analysis study is done.
- Now a day, complex shaped buildings are getting popular, but they carry a risk of sustaining damages during earthquakes. Therefore, such buildings should be designed properly taking care of their dynamic behavior.
- As **Response Spectrum** Method, used for seismic analysis, it provides a better check to the safety of structures analyzed and designed by method specified by IS code

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