Review Paper on Non-Linear Analysis of Multistory RC Irregular Building for Seismic Load by using Response Spectrum Method

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Abstract— A structure can be classified as irregular if it contains irregular distributions of mass, stiffness and strength or due to irregular geometrical configurations. Many buildings in the present scenario have irregular configurations both in plan and elevation. This in future may subject to devastating earthquakes. Codes suggests the different limits for these irregularities like as per IS 1893:2002, a storey in a building is said to contain mass irregularity if its mass exceeds 200% than that of the adjacent storey. In case, it is necessary to identify the performance of the structures to withstand against disaster for both new and existing one. This study is concerned with the effects of various vertical irregularities on the seismic response of a structure. The objective of the project is to carry out Response spectrum analysis (RSA) of vertically irregular RC building frame structure by the use of STAAD.PRO software of structure design. This study is limited to reinforced concrete framed structures subjected to seismic loads (dead load, live load and earthquake load). For this, RC frames of G+9 multi-story buildings are considered. All the frames are assumed to be located in zone V. The seismic parameters such as storey drift, base shear, peak story shear and top node displacement of irregular buildings are compared with that of a regular building. Result found from the response spectrum analysis that in irregular shaped building displacements are more than that of regular shaped building. The overall performance of regular building is found better than irregular building. This study may be used for designing new irregular building structures and for analyzing existing irregular building.

Keywords: Mass Irregularity, Set-back Structure, Stiffness Irregularity, Strength Irregularity, Vertical Irregularity

I. INTRODUCTION

Earthquakes are most unpredictable and devastating of all-natural disasters. Earthquakes have the potential for causing the greatest damages among all the natural hazards. Since earthquake forces are random in nature and unpredictable. They not only cause great destruction in human casualties, but also have a tremendous economic impact on the affected area. The concern about seismic hazards has led to an increasing awareness and demand for structure designed to withstand seismic forces. When a structure is subjected to ground motions in an earthquake, it responds by vibrating. Those ground motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. During an earthquake, the damage in a structure generally initiates at location of the structural weakness present in the building systems. High-Rise RC structures are a special class of structures with their own peculiar characteristics and requirements. During earth motion mostly the waves which arise effect on structures at the weak points of structure to collapse or damage the structure, in irregular structures these weakness points are define as mass irregularity, stiffness irregularity, strength irregularity in both horizontal and vertical directions, The behavior of irregular structures than regular is different during earthquake, in regular structures. The distribution of mass stiffness and strength is uniform and there is no discontinuity in mass, stiffness and strength the structure works as a one part and face much lesser damage during earthquake.

As per IS 1893:2002 (part I) vertical irregularities are classified as follows and which are portrayed from fig: 1.2 to 1.6:

A. Stiffness irregularity:

1) Soft storey: A soft storey is one in which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three storeys above.
2) b) Extreme soft storey: A extreme soft storey is one in which the lateral stiffness is less than 60 percent of that in the storey above or less than 70 percent of the average stiffness of the three storeys above.

B. Mass irregularity:

Mass irregularity shall be considered to exist where the seismic weight of any storey is more than 200 percent of that of its adjacent storeys.

C. Vertical geometric irregularity:

Vertical geometric irregularity shall be considered to exist where the horizontal dimension of the lateral force resisting system in any storey is more than 150 percent of that in its adjacent storey.

D. Discontinuity in capacity:

A weak storey is one in which the storey lateral strength is less than 80 percent of that in the storey above.

II. LITERATURE REVIEW

A. S. Varadharajan, et al [22]

In this paper, an extensive parametric study is conducted on plane RC moment resisting frames with setbacks. Firstly, a parameter called as irregularity index is proposed based on the dynamic characteristics of the frame to quantify the setback irregularity. Secondly, this paper aims to determine the effect of setback presence on inelastic deformation demands. To achieve this purpose, building frames with different arrangement of setbacks are modeled and designed in accordance with the European standard code of practice. These frames are subjected to an ensemble of 13 ground motions scaled to different intensities in order to obtain different performance levels as prescribed by SEAOC 1995 and analyzed by time history analysis.

B. Shaikh Abdul Aijaj ,et al[19]

The effect of mass and stiffness irregularity of G+10 storied vertical geometric irregular building is studied using finite element method based software. Linear static Analysis of regular structure by finite element method using ETABS in

term of story drift, displacement, peak story shear, base share. Non linear Analysis of vertical irregular building with setback finite element method using ETABS in term of story drift, displacement, peak story shear, base shear. Comparison of vertical irregular building with setback with regular building frame structure. Two methods of analysis, linear static and linear dynamic analysis are used to evaluate response of the structure in the form of story shear, story displacement and story drift. Considering the storey displacement, the frame with heavy mass on 3rd & 7th floor (frame-2) is the weakest than the (frame-1), as it suffers the considerable change in displacement in all the floors. As far as storey drift is concerned, frame-2 is weak than the frame-1, as the frame -2 having the considerable change in story drift. Story shear is maximum in frame-2. From this it is clear that the frame having mass irregularity on vertically irregular frame is susceptible to damage in earthquake lying zone The analysis proves that vertically irregular structures are harmful and the effect of mass irregularity on the vertically irregular structure is also dangerous in seismic zone.

C. PritamC.et al

Comparison and analysis of regular and irregular configuration of multistorey building in various seismic zones and various type of soil. parameters are storey displacement, maximum storey drift, storey shear and maximum overturning moment. The objective of this project is to study the structural behavior of multistory RC Structure for different plan configuration such as rectangular building along with L- shape and C- shape and H-shape in accordance with the seismic provisions suggested in IS: 1893-2002 using STAAD Pro V8i. The analysis involves load calculation and analyzing the whole structure on the STAAD Pro V8iversion for dynamic analysis i.e. Response Spectrum Analysis & Time History Analysis confirming to Indian Standard Code of Practice. These analyses are carried out by considering different seismic zones (II, III, IV and V) and for each zone the behavior is assessed by taking hard, medium and soft soil. Irregular shapes are severely affected during earthquakes especially in high seismic zones. Maximum storey drift is occurring on top storey of L-shape building while the minimum storey drift occur on Rectangular shape of building. Maximum bending moment is occur on H-shape of building.

D. Rachit Seth1 and Himanshu Pandey2

Seismic analysis of regular and irregular buildings having fixed base and base isolator using time history analysis.
This paper describes comparative study of regular and irregular reinforced concrete structures with fixed base and base isolator by using linear dynamic time history analysis. Seismic time history response is studied to understand the seismic behavior of the building.

When seismic load is applied on a fixed base building the structure tries to move in the direction of the earthquake which separates the superstructure from the substructure and thus the building collapses. Whereas, in a base isolated building the decoupling effect is created by separating the superstructure from the substructure by using rubber base isolation units which makes the building more resistant to seismic activity. This analysis includes the modelling of G+9 RCC multi-storey regular and irregular (L-shape &T-shape) building considering ground motion data for Kozani, 1995 and Jiashi, 1997 earthquakes.

The results of the analysis show variations in displacements, moment and axial force for due to seismic loading by time history analysis method using SAP2000 V14. The Storey displacement for the T-shape building with base isolator along Y-direction is similar for the all stories. All the fixed base buildings show zero displacements at the base whereas, the base isolated buildings show increase in amount of Storey displacements at base for all the three buildings. The base isolated building has more Storey displacement as compared to the fixed base building for all the three buildings.

E. Kovvuri Naga Raju [20]

This paper summarizes various aspect of the motion of the ground during earthquake do no damage the building by impact or by any external force, rather it impacts the building by creating an internal inertial force which is due to vibration of building mass.

F. Akhil R, Aswathy Kumar [21]

This analysis aims to the seismic response of various vertical irregularity structures. This project is done by response spectrum analysis of vertically irregular RC building. This study includes the modeling of regular and H shape plan irregular building, the performance of this framed building during study earthquake motions depends on the distribution of stiffness, strength, and mass in both the horizontal and vertical planes of the building. Main aims of this study is comparative study of the stiffness of the structure by considering the three models in regular structure and three models in plan irregular structure with different vertical irregular structure. All models are analyzed dynamically analysis in zone 5.

G. Juned Raheem et al [12]

Studied seismic analysis of regular and vertical geometric irregular RCC framed building. Performed a comparative study of various seismic parameters of different types of reinforced concrete moment resisting frame with varying number of stories, bending moment, story drift and node displacement etc. they performed static analysis for 40 building models.

H. Oman sayyed, et al

Studied seismic analysis of vertical irregular RC building with stiffness and setback irregularities. Two types of vertical irregularities namely stiffness and setback are considered in this study. The present study focuses on the performance and behavior of regular and vertical irregular G+10 reinforced concrete (RC) buildings under seismic loading Total eight regular and irregular buildings are modeled and seismic analysis is carried out using response spectrum analysis (RSA) method. Different seismic responses like storey displacement, storey drift, overturning moment, storey shear force, and storey stiffness are obtained.

By using these responses, a comparative study has been made between regular and irregular buildings. The storey displacement in case of stiffness irregular buildings is more than that of the regular building. Considering storey displacement, ground soft storey (S1) is the most critical case

because its displacement is 1.5 times more than that of regular building (B1) in the ground storey. The result shows that the top node displacement in case of setback irregular buildings is more than that of the regular building, except in case of model G1.

III. CONCLUSION

Based on thesis word done following conclusions can be express according seismic evaluation of building with setback.

- Response spectrum method allows a clear understanding of the contributions of different modes of vibration. It is also useful for approximate evaluation of seismic reliability of structures.
- For all vertical irregular frames with setback considered, displacement value for IR1, IR2, IR3, IR4, IR5, IR6, IR7, IR8 and IR9 at the level of setback increases, and the result shows that the top node displacement in case of irregular frames in more than that of the RB, except for IR5, IR6, IR7, IR8 and IR9.
- Comparing the maximum base shear for both regular building and irregular building the maximum shear is obtained for regular building.
- In case of setback irregular frames, a sudden extreme change in story drift due to setback has been observed, it indicates that in setback floor the story drift value extremely goes higher, while story drift for RB is normal.
- Peak story shear for irregular structures is less than regular structure but for IR 9 its higher than regular building.
- The analysis shows that the vertical irregularities widely effect the performance of RCC buildings under seismic loading, as for as possible these irregularities must be avoided, but if it introduced they must be properly designed.

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