"EFFECT OF STIFFNESS IRREGULARITY ON THE SEISMIC PERFORMANCE OF MULTISTORY VERTICALLY REGULAR AND IRREGULAR BUILDING FRAME-A REVIEW"

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ABSTRACT: *The aim of this project is to review the effect of stiffness irregularity by providing soft storey at different floor level on the seismic performance of multistory G+ 15 vertically regular and irregular building frames. In these paper literatures of various researches were studied on the effect of stiffness irregularity on the seismic performance of R.C. frame building. Those paper gives more information about failure of model considering the presence of stiffness irregularity at different floor levels and for different load combinations .The Indian standard code of practice IS1893(part 1):2002,IS 875 guidelines and methodology are used to analysis and designed the building .Seismic characteristics in terms of storey drift, displacement, base shear, time period have been compared with the seismic characteristics of models without stiffness irregularity i.e. without soft storey. The effect of stiffness irregularity by providing soft storey at different floor levels for regular as well as irregular building has been observed .It was found that providing infill improves earthquake behavior of structure when compared to soft storey provided structure.*

Keywords: soft storey, stiffness irregularity, storey drift, storey displacement, base shear, Response spectrum method.

1. INTRODUCTION

In the past, several major earthquakes have exposed the shortcomings in buildings, which leads to damage or collapse. It has been found that regular shaped buildings perform better during earthquakes. The structural irregularities cause non-uniform load distribution in various members of a building. There must be a continuous path for these inertial forces to be carried from the ground to the building weight locations. A gap in this transmission path results in failure of the structure at that location. There have been several studies on the irregularities, viz., (Jack P. Moehle, A. M. ASCE 2002), Seismic Response of Vertically Irregular Structures, seismic response of vertically irregular frames with pushover analysis (Chintanapakdee, Chopra, 2004) and evaluation of mass, strength and stiffness limits for regular buildings specified by UBC (Valmundsson and Nau, 1997), Seismic Response of RC Frame Buildings with Soft First Storeys (Arlekar Jaswant N, Jain Sudhir K. and Murty C.V.R, 1997) etc. In the present review paper, response of a multi-storeyed vertically irregular and regular frame is studied for stiffness irregularity at different floor levels in the elevation. These irregularities are introduced by changing the positions of soft storey under the gudlines of I.S 1893:2002(part1). Stiffness irregularities include soft storey provided at different floor levels which is applied on vertically irregular & regular building frame. Effects on storey-shear forces, storey drifts and displacement is studied.

2. BRIEF LITERATURE REVIEW

Following chapter provides the brief survey of existing literature in various paragraphs listed below. This study is to determine the scope of work and to understand the present status of such project undertaken.

P. B. Lamb and Dr R. S. Londhe[1] Studied "Seismic Behavior of Soft First Storey". In this paper a building with the help of different mathematical models considering various methods for improving the seismic performance of the building with soft first storey. Analytical models represent all existing components that influence the mass, strength, stiffness and deformability of structure. The equivalent static and multimodal dynamic analysis is carried out on the entire mathematical 3d model using the software SAP2000 and the comparisons of these models are presented. Finally, the performance of all the building models is observed in high seismic zone v.

The use of masonry infill is found to be not effective in reducing the strength demand on the first storey columns, though they considerably reduce the stiffness irregularity. In this case the stiffness of first storey is 45% of second storey stiffness. The use of cross bracings significantly increases the first storey stiffness. Light weight infill is found to be quite effective in increasing the stiffness of first storey, storey drift and marginally reduces the strength demand in first storey columns. When the results from equivalent static analysis are compared with response spectrum analysis, it is observed that the lateral displacements and inter storey drift comes out to be 5-25% less.

M.R. Amin, P. Hasan. B. K. and M.A. Islam[2] have been investigated the effect of soft storey for multistoried reinforced concrete building frame, four building models (3, 6, 9 and 12 storey) with identical building plan were analyzed. Equivalent diagonal struts were provided, as suggested in , in place of masonry to generate infill effect. Earthquake load was provided at each diaphragm's mass centre as a source of lateral load as set forth by the provision (1993). Soft storey level was altered from ground floor to top floor for each model and equivalent static analysis was carried away using ETABS 9.6.0 analysis package. Results show a general changing pattern in lateral drift irrespective to building height and location of soft storey. Inter-storey drift ratio was found increasing below the mid storey level and maximum ratio was obtained where the soft storey was located. The rate of increase in drift ratio at any particular floor (kept soft) for different building height increases linearly from bottom to top floor. As the building height increases, location of soft storey goes downwards from mid storey level to produce maximum lateral drift.

Shaikh Abdul Aijaj Abdul Rahman [3], Studied Seismic response of Vertically Irregular RC Frame with Stiffness Irregularity at Ground Floor. In this paper, two frames having different irregularities but with same dimensions have been analyzed to study their behavior when subjected to lateral loads. All the frames were analyzed with the same method as stated in IS 1893-part-1:2002.The frame-1 (vertically irregular) develops least storey drifts while the building with stiffness irregularity on vertically irregular building (frame-1) shows maximum storey drift on the respective storey levels. Hence, this is the most vulnerable to damages under this kind of loading and the same frame with excess height of story develops slightly more storey shears, which should be accounted for in design of columns suitably.
The analysis proves that vertically irregular structures are harmful and the effect of stiffness irregularity on the vertically irregular structure is also dangerous in seismic zone. Therefore, as far as possible irregularities in a building must be avoided. But, if irregularities have to be introduced for any reason, they must be designed properly following the conditions of IS 1893-part-1: 2002 and IS- 456: 2000, and joints should be made ductile as per IS 13920:1993. 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.

Bhakti N. Harne, R. R. Shinde[4] Studied "Review on seismic performance of multi-storied RC building with soft storey". This paper highlight open ground storey is vulnerable to collapse during earthquake. Soft storey in a building causes stiffness irregularity in a structure. Due to this the structures undergoes unequal storey drift, formation of plastic hinges and finally collapse. The presence of infill wall improves the performance of building under the lateral forces. These researches focus on the combination of measures adopted on the structure to reduce the effect of soft storey through static and dynamic analysis. The parameters studied in these researches are storey drift, axial and shear forces bending moment, displacement, time period, base shear. Also, it focuses on the equivalent strut approach to consider the effect of infill wall on the performance on building.

Vipin V Halde, Aditi H. Deshmukh[5] Studied "Effect of soft storey on Structural Response of High Rise Building". In this paper highlight the investigate the effect of a soft storey for multi-storeyed high rise building with different models having identical building plan. Equivalent diagonal struts are provided as suggested in FEMA-273 in the place of masonry to generate infill effect. Soft storey level is altered at different floors in different models & equivalent static analysis is carried out using SAP 2000 analysis package RC frame buildings with open first storeys are known to perform poorly during in strong earthquake shaking. In this paper, the seismic vulnerability of buildings with soft first storey is shown through an example building. The drift and the strength demands in the first storey columns are large for buildings with soft ground storeys and hence necessary measures should taken to improve capacities of the columns in the soft first storey.

Devesh P. Soni and Bharat B. Mistry[6] Studied "Qualitative Review Of Seismic Response Of Vertically Irregular Building Frames"This study summarizes state-of-the-art knowledge in the seismic response of vertically irregular building frames. Criteria defining vertical irregularity as per the current building codes have been discussed. A review of studies on the seismic behavior of vertically irregular structures along with their findings has been presented. It is observed that building codes provide criteria to classify the vertically irregular structures and suggest dynamic analysis to arrive at design lateral forces. Most of the studies agree on the increase in drift demand in the tower portion of set-back structures and on the increase in seismic demand for buildings with discontinuous distributions in mass, stiffness, and strength. The larges seismic demand is found for the combined-stiffness-and-strength irregularity.

Jaswant N. Arlekar, Sudhir K. Jain and C.V.R. Murty[7],Studied"seismic response of RC frame buildings with soft first storeys". This paper highlights the importance of explicitly recognizing the presence of the open first storey in the analysis of the building. The error involved in modeling such buildings as complete bare frames, neglecting the presence of infills in the upper storey's, is brought out through the study of an example building with different analytical models. This paper argues for immediate measures to prevent the indiscriminate use of soft first storeys in buildings, which are designed without regard to the increased displacement, Ductility and force demands in the first storey columns. Alternate measures, involving stiffness balance of the open

first storey and the storey above, are proposed to reduce the irregularity introduced by the open first storey. The effect of soil flexibility on the above is also discussed in this paper.

Rakshith Gowda and Bhavani Shankar[8] Studied "Seismic analysis Comparison of Regular and vertically irregular RC building with soft storey at Different Level" This paper present the investigation is to study the behavior of multi storyed RC 3-d frame regular building and vertically irregular (stepped) building in which soft storey's are provided at different level for different load combinations. Stad pro is used for modeling and analysis RC buildings. It is necessary to study and to examine various alternative models of reinforced concrete moment resisting frame building with soft storey at different level, the performance of all the building models is observed in high seismic zone v. In an investigation has been made to study the behavior of RC frames when subjected to static and dynamic earthquake loading. The result of bare frame, frame with infill, and different location of soft storey provided are compared and conclusion are made in view of is code. It is observed that, providing infill improves earthquake resistant behavior of the structure when compared to soft storey provided. If the frame cannot be provided with complete infill, the soft storey can be provided in the 5th floor as the this model exhibits comparatively less displacement and inter storey drift and 10th floor shall be avoided as this model had maximum displacement and inter storey drift in comparison with the models with soft storey in other locations. The displacement is observed to be minimum in regular building when compared with the irregular building for time period mode-1. Hence it can be concluded that the regular building is safer than irregular building.

3. CONCLUSIONS

The paper presents a review on "Effect of Stiffness irregularity on the seismic performance of multistory vertically regular and irregular building frame". It was found that due to stiffness irregularity by introducing soft story shows poor performance during earthquake as the stiffness of soft storey is less than 70% of the storey above.

Previous investigation on the seismic analysis on multi-storied building with soft storey shows that, provision of shear wall, bracing, stiffened column provides lateral strength and stiffness to the building and improves performance of building under earthquake shaking. It is observed that providing soft storey reduces story shear, storey drift, lateral displacement of building .It is also observed that regular building gives better performance than irregular buildings. It is also observed that soft storey at higher level reduces base reaction. So this study has been made to study the seismic behavior of such buildings subjected to earthquake loads.

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