STUDY OF LITERATURE ON SEISMIC RESPONSE OF RC IRREGULAR STRUCTURE

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Abstract - *In multi-storeyed framed building damage occurring from earthquake ground motion generally initiates at locations of structural weaknesses present in the lateral load resisting frames. In some cases these weaknesses may be created by discontinuities in stiffness, mass between adjacent storeys. Such discontinuities between storeys are often associated with sudden variations in the vertical geometric irregularity. Vertical irregularity are structures with soft stories which can further be broken down into the different types of irregularities as well as their severity for a more refined assessment tool pushover analysis which is one of the method available for evaluating building against earthquake loads. A structure is induced incrementally with a lateral loading pattern until the structure lateral loading pattern until the structure reaches a limit state. The model is then modified to account for the reduced stiffness of the building and is once again applied with a lateral load unit additional member's yield. A base shear vs. displacement capacity curve and a plastic hinging model is produced as the end product of analysis which gives a general idea of the behavior of the building. In the building frame is designed as per Indian standard i.e. IS-456: 2000, IS-1893: 2002 and IS-1893: 2016. The main objective of this study the irregularities which we need to consider while analyzing it for the seismic loading given in IS- 1893: 2002 (Part-I) and to compare seismic behavior of RC structure by using IS code 1893: 2016 (Part-I). The structural guideline on things such as the computation of the target displacement and the things to consider for a proper analysis such as the modelling rules. The ATC-40 document is followed in this study. Using structural analysis design SAP2000 software. The present study is to evaluate the behavior of two typical new R.C.C building were taken for analysis G+6 and G+11 floor reinforced concrete frame structure subject to earthquake force in zone V. The paper gives the study of different literature investigation taken on pushover analysis.*

1. INTRODUCTION

Earthquakes pose multiple hazards to a community, failure of structure starts at points of weakness. This weakness increases due to discontinuity in mass, stiffness and geometry of structure. The structures having this discontinuity are called as Irregular structures. Vertical irregularities are one of the main reasons of failures of structures during earthquakes. Vertical irregularity are buildings with soft stories. This can be further broken down into the different type of irregularities as well as their severity for a more refined assessment tool.

Pushover analysis is one of the methods available for evaluating building against earthquake loads. A structure is induced incrementally with a lateral loading pattern until the structure reaches a limit state. The structure is subjected to the load until some structure members yield. The model is then modified to account for the reduced stiffness of the building and is once again applied with a lateral load until additional members yield. A base shear vs. displacement capacity curve are produced the plastic hinging model after complete the analysis which gives a general idea of the behavior of the building.

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Figure 1. Manhattan city showing different irregular buildings

2. REVIEW OF PREVIOUS STUDIES ON VERTICAL IRREGULARITY

1. Lee and Ko (2007) Investigated the seismic response characteristic of three 1:12 scale 17-story RC wall building models was studied different types of irregularity at the bottom two stories were subjected to the same series of imitation of a situation earthquake excitations. The study evaluated the first model has a symmetrical moment-resisting frame (Model 1), the second has an infilled shear wall in the central frame (Model 2), and the third has an infilled shear wall in only one of the exterior frames (Model 3) at the bottom two stories. Based on the test results, which are analyzed and compared. They estimated fundamental periods for other structures than moment frames and bearing wall structures in UBC 97 and AIK 2000 appear to be reasonable. The large amounts of energy absorption by damage are similar regardless of the existence and location of the infilled shear wall. The largest energy absorption is due to overturning, followed by that due to shear deformation. It was also observed that rigid upper system renders rocking behavior in the lower frame, and its self-weight contributes up to about 23% of the resistance against the total overturning moment.

2. Athanassiadou (2008) illustrated the influence of irregular in elevation on the response of multistorey reinforced concrete (R/C) frame buildings under the seismic loading by considering Two ten-storey two-dimensional plane frames with two and four large setbacks in the upper floors respectively, as well as a third one regular in elevation, have been designed to the provisions of the 2004 Eurocode 8 (EC8) for the high (DCH) and medium (DCM) ductility classes, and the same peak ground acceleration (PGA) and material characteristics. All frames have been subjected to both inelastic static pushover analysis and inelastic dynamic time-history analysis for selected input motions. They found that the assessment of the seismic performance is based on both global and local criteria. The report concluded that the effect of the ductility class on the cost of buildings is negligible, while the seismic performance of all irregular frames appears to be equally satisfactory, not inferior to that of the regular ones, even for motions twice as strong as the design earthquake. They describe the DCM frames are found to be stronger and less ductile than the corresponding DCH ones. The over strength of the irregular frames is found to be similar to that of the regular ones, while DCH frames are found to dispose higher over strength than DCM ones. They stated that the pushover analysis seems to underestimate the response quantities in the upper floors of the irregular frames.

3. Wibowoa et al (2010) studied the effects of field test insight into the push-over load deflection and collapse behaviour of a soft storey building. They analyze the five storey building as being particularly vulnerable to earthquake excitation due to the particularly weak connections at each end of the ground floor precast columns that constituted the soft storey. Evaluated four field tests were undertaken to investigate the actual lateral force deflection behaviour of the soft storey columns. They analyzed model advanced to predict the overall force displacement relationship that was influenced by the three component mechanisms of (a) connection strength at column ends, (b) gravity rocking strength and (c) ground slab interaction, was establish to be in excellent agreement with the experimental test results. The study reported that the precast soft storey system was establish to been sufficient displacement capacity for lower seismic regions, but the performance was considered marginal for higher seismic regions.

4. Sarkar et al. (2010) suggested a new method of quantifying irregularity in vertically irregular building frames, accounting for dynamic characteristics (mass and stiffness). The salient conclusions were as follows:

(1)A part of vertical irregularity, suitable for stepped buildings, called regularity index‘, is proposed, accounting for the changes in mass and stiffness along the height of the building.

(2) An empirical formula is proposed to calculate the fundamental time period of stepped building, as a function of regularity index.

5. Hejazi1 et al (2011) Studied the effect of serious structural damage suffered by several modern buildings during recent earthquakes emphasize the importance of avoiding immediate changes in lateral stiffness and strength. Although damage and collapse due to soft story are most often observed in buildings, they can also be refined in other types of structures. The lower level accommodate the concrete columns act as a soft story in that the columns were inadequate to provide adequate shear resistance during the earthquake. They can be provided most economical way of retrofitting such as a building is by adding proper bracing to soft stories. They has been approved to investigate on adding of bracing in various arrangements to structure in order to decreased soft story effect on seismic response of building. It is advantage to assess the vulnerability level of existing multi-storied buildings so that they can be retrofitted to possess the minimum requirements. This will help in minimizing the impending damages and catastrophes.

6. Kirac et al (2011) discussed the importance of base floors of the existing buildings are generally arranged as garages or offices. No walls are built in at these floors due to its recommended management and comfort problems. But upper floors do have walls divide rooms from each other for the residential usage. In these preparation, the upper floors of most buildings are stiffer than their base floors. This phenomenon is called as the weak-storey irregularity. They described the weak stories are subjected to larger lateral loads during earthquakes and under lateral loads their lateral deformations are greater than those of other floors so the design of structural members of weak stories is demanding and it should be particular from the upper floors. The study analyzed the building models which are consisting of various stories, storey heights and spans. They compared the result with the current earthquake code. The ratio of buildings which acquire weak-storey irregularity is resolved for both Ankara and Eskisehir regions. It is observed that negative effects of this irregularity can be decreased by some precautions during the construction stage. They stated that some recommendations are presented for the existing buildings with weak-storey irregularity.

7. Misir (2015) investigated the effects of a new type of infill called locked brick infill adopting horizontal sliding Joints in reducing the soft-story formation in reinforced concrete (RC) frames with code-conforming seismic detailing. He performed nonlinear static time-history analyses on multistory planar frames with only the upper stories infilled in order to force the soft-story irregularity. The parameters of frame and infill elements that was used in numerical simulations was obtained from half-scale RC infilled frame tests that had been performed by the author covering single storey single bay frames infilled with standard and locked bricks. He stated that the numerical reproduction showed that the use of locked bricks to form infill walls has the potential to decrease the soft-story/weak-story formation in comparison to standard bricks due to its shear drift mechanism and decreased upper-story/first-story stiffness, even in buildings that have noninfilled first stories.

8. Arlekar *et al.* analyzed the seismic response of four storey RC frame building with open ground storeys using equivalent static analysis and response spectrum analysis to find the resultant forces and displacements. They argued for immediate measures to prevent the haphazard 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. Some alternate measures involving stiffness balance of the open first storey and the stiffness above, were proposed to reduce the irregularity introduced by the open first storey.

9. Negro and Verzeletti studied the effects of the infills on the global behavior of the structure by performing series of pseudo-dynamic tests on the full-scaled four-storey reinforced concrete frame. The response of structure in three configuration i.e. bare frame, uniform infilled frame and partial infilled frames has been compared. They plotted time history curve and base shear for all three structures and concluded that the presence non-structural masonry infills can change the response of structure to a large extent. Irregularities in the panels were found to result in unacceptably larger damage to the frame as a result of high ductility demands. They also found that masonry infill increases stiffness, strength and energy dissipation capacity.

10. Sahoo & Rai (2013) analyzed the evaluation of two strengthening techniques to improve the seismic performance of the existing non-ductile RC frames with soft-story at the ground story level. The first technique, termed as column retrofit, uses only partial steel jacketing to build up the lateral strength and plastic rotational capacities of the defective columns at the ground story level. The next technique, termed as full retrofit, acknowledge the aluminum shear links as enhanced energy dissipation devices in extension to the strengthened ground story columns. Steel collector beams and chevron braces are used to relocation the lateral load from the RC frame to these dissipating devices. They analyzed the Non-linear static and dynamic analyses to evaluate the performance of the existing and the strengthened frames. The essential parameters investigated are (a) interstory drift, (b) residual drift, (c) yield mechanism, (d) energy dissipation, and (e) lateral strength. They used the full retrofit frame effectively controlled the drift response by avoiding the soft-story collapse because of the significant energy dissipation in the shear links. Furthermore, the FR frame achieved the desired yield mechanism without exceeding the design target drift level.

3. CONCLUSION

Structure which is designed for seismic forces gives more ductility as compare to gravity designed structure. Some behavior is observed in both case regular and irregular structure. Due to different behavior of structure the nonlinear performance of structure will be affects. Irregular structure cannot sustain more force as compared to regular structure hence structure becomes damage. Irregularities are harmful for the structures so it is important to have simpler and regular shapes of frames as well as uniform load distribution around the building. As far as possible irregularities in a building must be avoided.

But, if Irregularities have to be introducing for any reason, they must be designed properly.

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