IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684, p-ISSN: 2320-334X
PP 63-66
www.iosrjournals.org

Seismic Analysis of Structures with Irregularities

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ABSTRACT: *Irregularities are not avoidable in construction of buildings; however the behaviour of structures with these irregularities during earthquake needs to be studied. Adequate precautions can be taken. A detailed study of structural behaviour of the buildings with irregularities is essential for design and behaviour in earthquake. The main objective of this study is to understand different irregularity and torsional response due to plan and vertical irregularity and to analyze cross shape and L shape building while earthquake forces acts and to calculate additional shear due to torsion in the columns. This study was initiated to quantify the effect of different degrees of irregularity on Structures designed for earthquake using simplified analysis. The types of irregularity Considered was (a) Horizontal Irregularity- Re entrant corner (b) Vertical Irregularity -Mass Irregularity. The main objective of this study is to understand different irregularity and torsional response due to plan and vertical irregularity and to analyze cross shape and L shape building while earthquake forces acts and to calculate additional shear due to torsion in the columns.*

The realistic structure could have been different beam span, different loading on beam & different sizes of column. As in this project it was intended to understand basically the behavior of structure as a whole or in part it was thought of choosing non-realistic structure with frames 5m x 5m. It was further thought of that the outcome of project may lead to the development of classical approach in understanding behavior of structure of reentrant corner locations. Summary of findings include, the Re-entrant corner columns are needed to be stiffened for shear force in the horizontal direction perpendicular to it as significant variation is seen in these forces. Significant variation in moments, especially for the higher floors about axis parallel to earthquake direction, care is needed in design of members near re-entrant corners. From the torsion point of view the re-entrant corner columns must be strengthen at lower floor levels and top two floor levels and from the analysis it is observed that behavior of torsion is same for all zones

Keywords: *Asymmetric Building, Cross-shape L- Shape Building, Re-entrant Corner, Removal of Diaphragm, Torsional Response.*

I. INTRODUCTION

Many buildings in the present scenario have irregular configurations both in plan and elevation, which in future may subject to devastating earthquakes. In case, it is necessary to identify the performance of the structures to withstand against disaster primarily due to earthquake. Irregularities are not avoidable in construction of buildings; however the behaviour of structures with these irregularities during earthquake needs to be studied. Adequate precautions can be taken. A detailed study of structural behaviour of the buildings with irregularities is essential for design and behaviour in earthquake.

Several related studies have focused on evaluating the response of "regular" structures. However there is a lack of understanding of the seismic response of structure with irregularities. Therefore a comprehensive evaluation of the effect of vertical and horizontal irregularities on the seismic demand of building structures is greatly needed.[1]

Regularities and Irregularities in Structures

2.1 Introduction In this chapter, a brief overview of research into the seismic behaviour of plan irregular Structures are presented. Current earthquake codes define structural configuration as either regular or irregular in terms of size and shape of the building, arrangement of the structural and non-structural elements within the structure, distribution of mass in the building etc.

2.2.1 Vertical Irregularity: Vertical irregularity results from the uneven distribution of mass, strength or stiffness along the elevation of a building structure. Mass irregularity results from a sudden change in mass between adjacent floors, such as mechanical plant on the roof of a structure. Stiffness irregularity results from a sudden change in stiffness between adjacent floors, such as setbacks in the elevation of a building.

2.2.2 Plan Irregularity Asymmetric or plan irregular structures are those in which seismic response is not only translational but also torsional, and is a result of stiffness and/or mass eccentricity in the structure. A regular structure may actually be asymmetric if the structure has masonry infill walls or stiffer lateral resisting systems on one side of the structure that has not been taken into consideration in the analysis. Asymmetry may in fact exist in a nominally symmetric structure because of uncertainty in the evaluation of centre of mass and stiffness, inaccuracy in the measurement of the dimensions of structural elements. [2]

II. ANALYSIS OF STRUCTURE

3.1 Introduction: In order to study behavior of structure with re-entrant corner as whole as well as in parts it was through initially of choosing a realistic structure wherein opening and staircases. The realistic structure could have been different beam span, different loading on beam & different sizes of column. As in this project it was intended to understand basically the behavior of structure as a whole or in part it was thought of choosing non-realistic structure with frames 5m x 5m. It was further thought of that the outcome of project may lead to the development of classical approach in understanding behavior of structure of reentrant corner locations. Thus two shapes were finalized. [3]Analysis of a building is done considering building as a whole as well as in parts as “A” block and “B” Block.Column no’s 1 & 2 is critical in these structures so forces and displacement at these two locations were only considered. It was further thought of that the beheviour may be similar or may be distinguishable for two different heights of structure. So accordingly G + 4 & G+14 storied building configurations were chosen.[4]

3.2 Building Details: The structural analysis of a fifteen storey and five story reinforced concrete building is done. The building is assumed as commercial complex. Geometry of building is "cross" shape and L Shape. Seismic analysis has been done in Staad-Pro. Regular Grid Plan of the structure and 3-D model has been shown in Fig 4.1 showing the position of re-entrant corner column. The structure is assumed to be located in seismic zone II on a site with medium soil. Building contains different irregularity like Plan irregularity and Re-entrant corner irregularity. [5]

Figures and Tables

Zone-wise comparison of Axial Force in B Block of Cross Shape Building indicates significant variation. Fig. 4.2 indicates axial force varies as the zone changes and it is especially observed in higher floor levels.

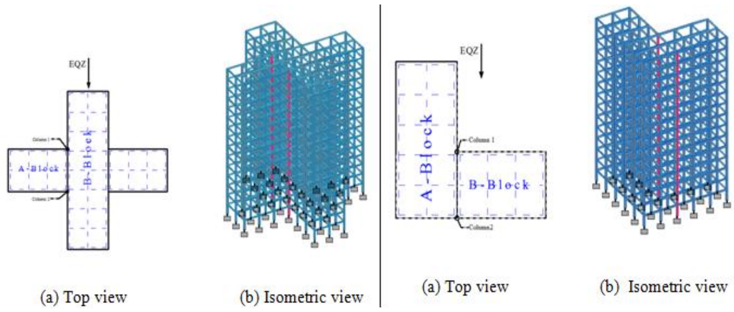

Fig. 4.1 Model of cross shape and L shape building.

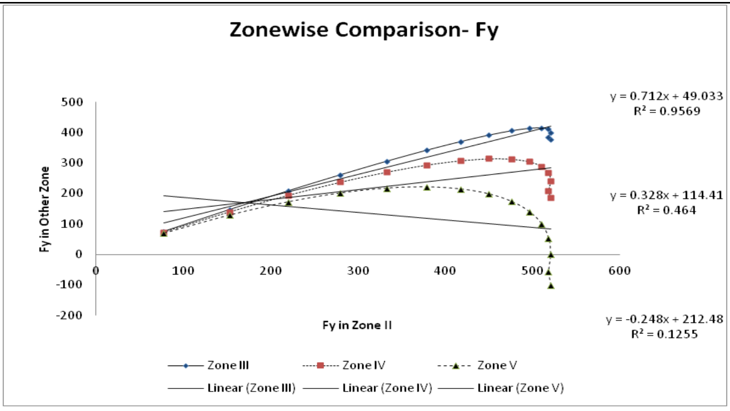

Fig. 4.2 Zone-wise comparison of Axial Force (B 15 L shape)

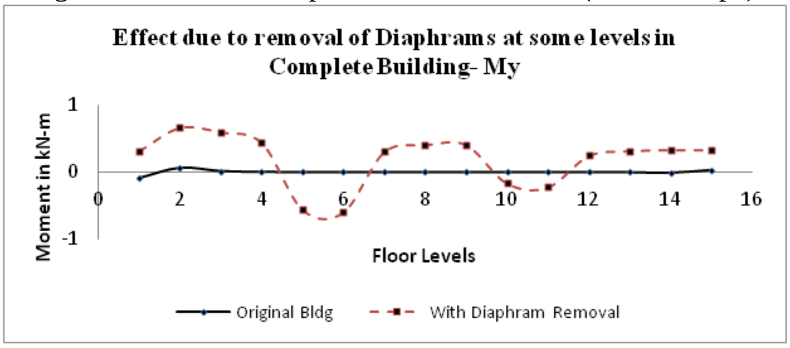

Fig. 4.3Effect of Torsion on due to removal of diaphragm

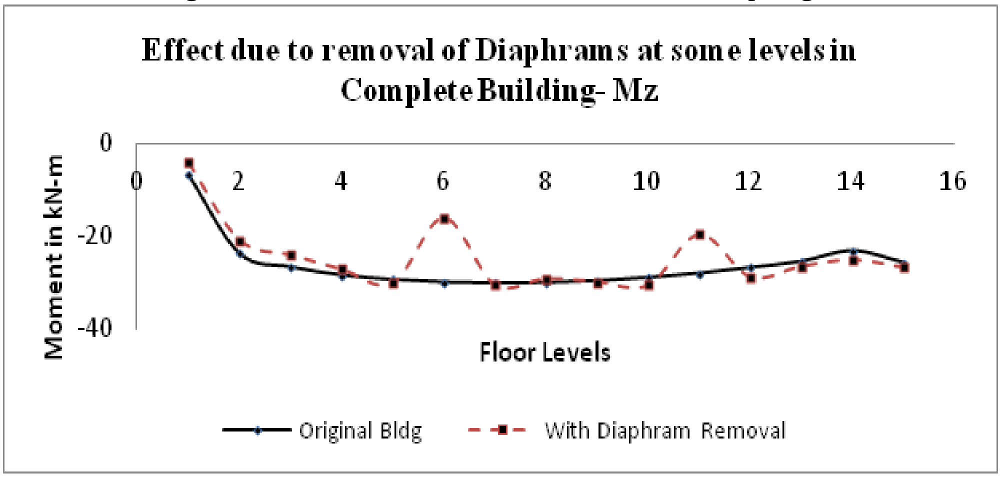

Fig. 4.4 Effect of moment in z-direction due to removal of diaphragm

Fig. 4.3 indicates that torsional effect is much more when diaphragms at some levels are removed. When diaphragms at some levels are removed effect of moment in x-direction is much more in lower floor levels than higher floor levels. It is predicted from fig. 4.4 that effect of moment in the direction of earthquake force is very significant. It is especially observed at the levels from where the diaphragms are removed.

III. CONCLUSION

The Re-entrant corner columns are needed to be stiffened for shear force in the horizontal direction perpendicular to it as significant variation is seen in these forces

From the torsion point of view the re-entrant corner columns must be strengthen at lower floor levels and top two floor levels and from the analysis it is observed that behavior of torsion is same for all zones.

Equation generated from the graph shall be used for calculating values of shear forces, moments and displacements in various zones.

Effect of torsion is much more when diaphragms at some level are removed, so in re-entrant corner building it is better to avoid irregularity in diaphragm.

IV. ACKNOWLEDGEMENTS

It gives me great pleasure in submitting this paper entitled “SEISMIC ANALYSIS OF STRUCTURES WITH IRREGULARITIES”. I express my deep sense of gratitude and sincere regards to all those who directly or indirectly helped me during my work. I owe my success to them. Most likely I would like to express my sincere gratitude towards my family and friend, for always being with me.

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