International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 08 | Aug 2018 www.irjet.net p-ISSN: 2395-0072

A Study on Effect of Mass Irregularity on Seismic Response of RC Structures

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Abstract - *Earthquake is a phenomenon in which large amount of elastic energy released within fraction due to sudden transition motion in the ground and this energy travels in the form of unstable waves called seismic waves. Mass irregularity in the structures is due to uneven distribution of mass, strength or stiffness or due to their structural form. The percentage difference is small of changes in mass in comparison to the total mass of the building; the effect of mass irregularity is small on the mode shapes in regular buildings. A G+8 storey building is modeled in ETABS 2016 software with three different models, viz., Structure without mass irregularity, Structure with mass irregularity at Storey 4 and Structure with mass irregularity at stilt floor, this models are analysed under response spectrum method. It was concluded that the irregularity in the building should be avoided as irregularity leads to failure of structural members during earthquake.*

Key Words: **Mass irregularuty1, Earthquake forces2, Framed structures3, Mode shapes4, Response spectrum analysis5**

1. INTRODUCTION

Earthquake is a phenomenon in which large amount of elastic energy released within fraction due to sudden transition motion in the ground and this energy travels in the form of unstable waves called seismic waves. This phenomenon occurs mainly due to moment of tectonic plates in which the stress over comes the friction that inter lock between the plates releases energy that travels on the crest in the form of waves with shaking of the ground. When structure is located on such ground it undergoes excitation. When building is acting under static load whole mass will be concentrated at center of mass. When there is action of dynamic load the column has to resist the load by concentrating mass at center of stiffness and these two points must be coincided. Otherwise eccentricity occurs in building due to interaction between the external lateral load and resisting force in the structure. This mainly leads to results in failure of structure which may lead to loose of many lives.

Because resistance of structure to the seismic load mainly depends on the structural element connection, geometry and mass etc. The structure must be designed such a way that load on the structure must be transferred to the ground in safe and short manner without any discontinuity in the load transfer path. Otherwise it may lead to poor performance of the structure. This condition arise structure when asymmetrical plan, uneven distribution of mass or irregular in stiffness of building. It may create weak points in building. To perform well under the earth quake loading structure should have sufficient lateral strength, stiffness and Ductility. The configuration of structure should be regular and simple.

2. Objectives

- The analysis of a multistoried RC building having G+8 Storey is analyzed for earthquake intensity.
- The Modelling of regular and irregular building are modelled under Etabs.
- To analyze the regular and irregular building models with Response Spectrum method of analysis for earthquake zone V.
- To compare the response between regular and irregular structure for base shear, storey drift, storey displacement and storey stiffness.
- To study the performance of structure at different storey heights.

3. Methodology

- An extensive literature review is carried out to establish the above objectives for the project work.
- G+8 storey structure is chosen for the present investigation.
- ETABS software is chosen for modelling and analysis of the selected structure.
- To understand the behaviour of structure, two models are considered with mass irregularity in different storeys.

3.1 Modelling

Table-1: Model 1 - Structure without Mass Irregularity

Number of storeys	*G+8*
C/C distance between columns in X-direction	6m
C/C distance between columns in Y-direction	4m
Foundation level to ground *level*	2m
Floor to floor height	3m
Wall thickness	230mm
Live load on all floors	3kN/m^2
Materials	M25 and Fe415
Size of column	350x500mm
Size of beam	350x500mm
Thickness of slab	150mm
Seismic zone V	0.36
Soil Type	II

Table-2: Model 2 – Structure with Mass Irregularity at Storey 4

Number of storeys	*G+8*
C/C distance between columns in X-direction	6m
C/C distance between columns in Y-direction	4m
Foundation level to ground *level*	2m
Storey 4 height	4 m
Floor to floor height	3m
Wall thickness	230mm
Live load on all floors	3kN/m^2
Materials	M25 and Fe415
Size of column	350x500mm
Size of beam	350x500mm
Thickness of slab	150mm
Seismic zone V	0.36
Soil Type	II

Table-3: Model 3 – Structure with Mass Irregularity at Stilt Floor

Number of storeys	*G+8*
C/C distance between columns in X-direction	6m
C/C distance between columns in Y-direction	4m
Foundation level to ground *level*	2m
Stilt floor height	4 m
Floor to floor height	3m
Wall thickness	230mm
Live load on all floors	3kN/m^2
Materials	M25 and Fe415
Size of column	350x500mm
Size of beam	350x500mm
Thickness of slab	150mm
Seismic zone V	0.36
Soil Type	II

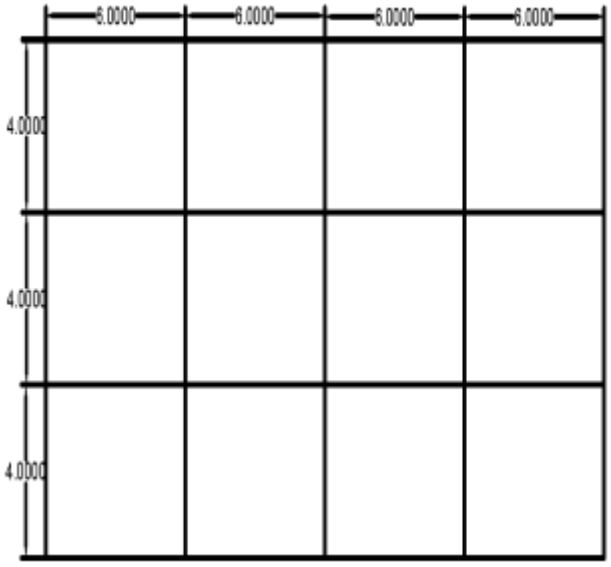

Fig-1: Plan of RC Structure

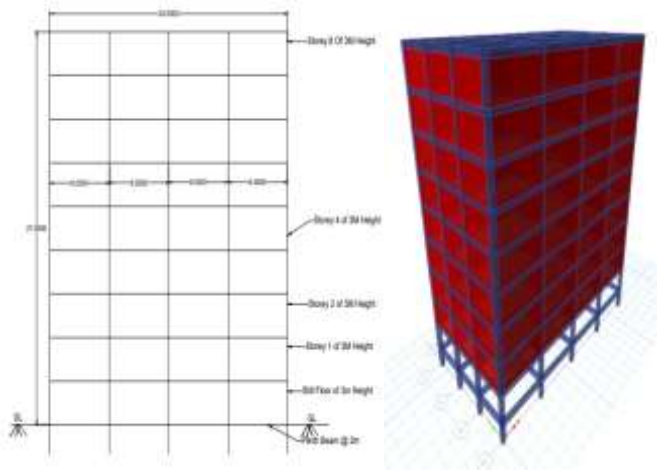

Fig-2: 2D and 3D Elevation of Structure without Mass Irregularity

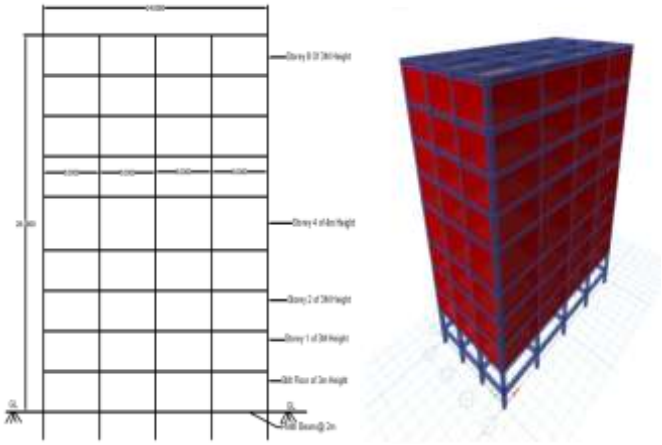

Fig-3: 2D and 3D Elevation of Structure with Mass Irregularity at Storey 4

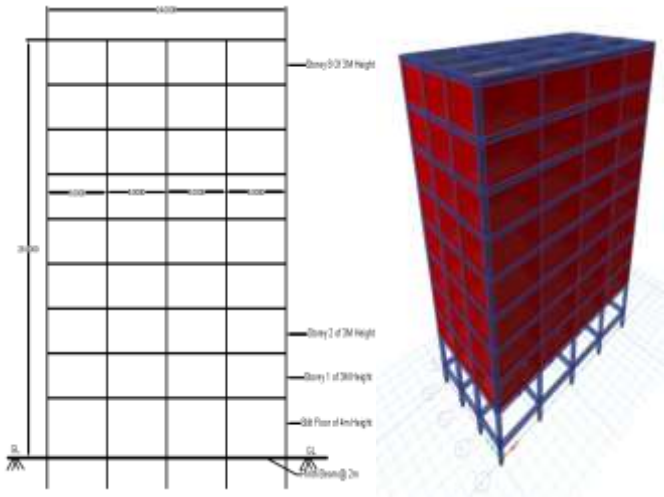

Fig-4: 2D and 3D Elevation of Structure with Mass Irregularity at Stilt Floor

4. Analysis Results

This chapter deals with analysis results of RC building with mass irregularity in different storeys.

- Model 1- Structure without mass irregularity
- Model 2- Structure with mass irregularity at storey 4
- Model 3- Structure with mass irregularity at stilt floor

Chart-1: Storey Displacement in X-Direction

Chart-2: Storey Displacement in Y-Direction

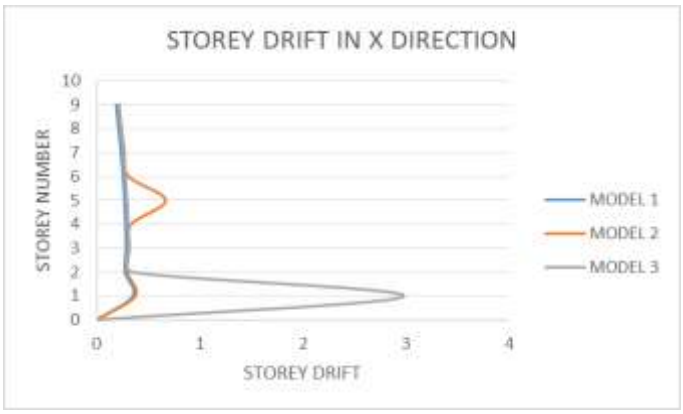

Chart-3: Storey Drift in X-Direction

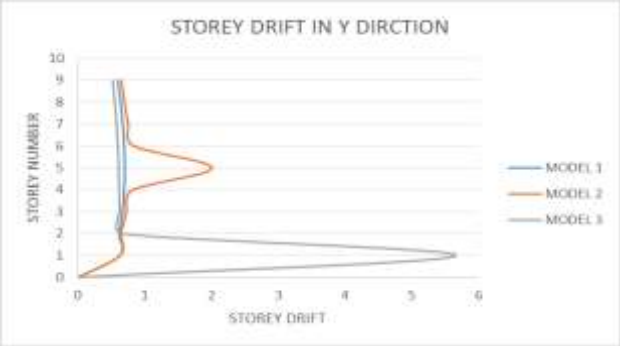

Chart-4: Storey Drift in Y-Direction

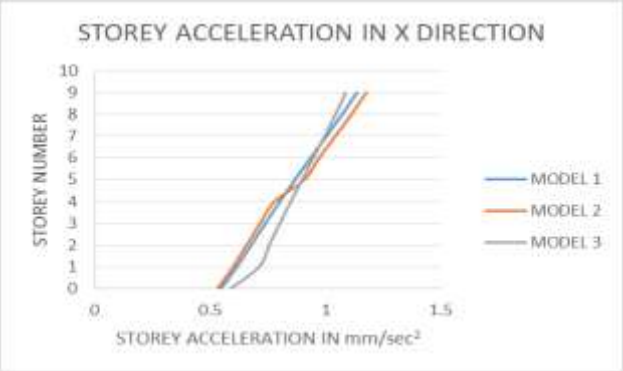

Chart-5: Storey Acceleration in X-Direction

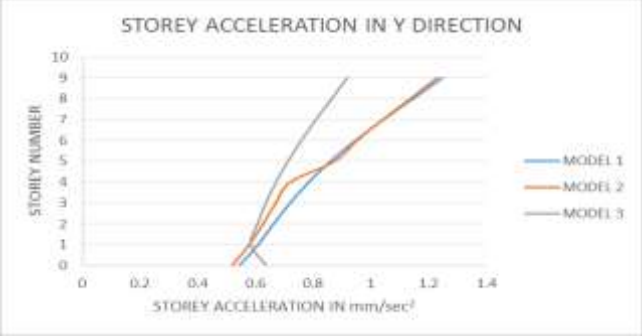

Chart-6: Storey Acceleration in Y-Direction

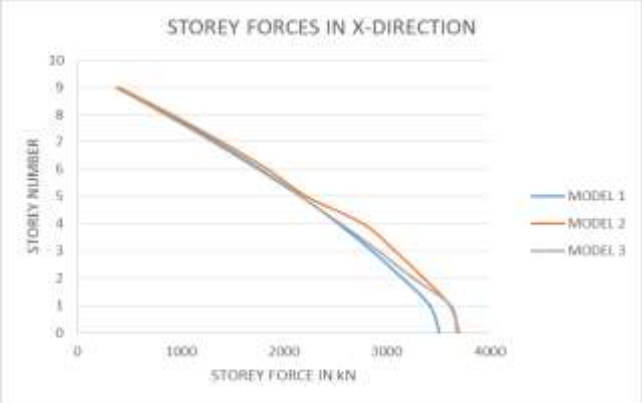

Chart-7: Storey Forces in X-Direction

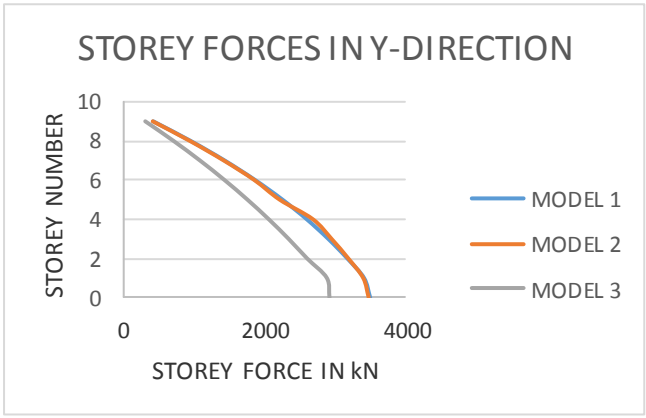

Chart-8: Storey Forces in Y-Direction

Chart-9: Storey Stiffness in X-Direction

Chart-10: Storey Stiffness in Y-Direction

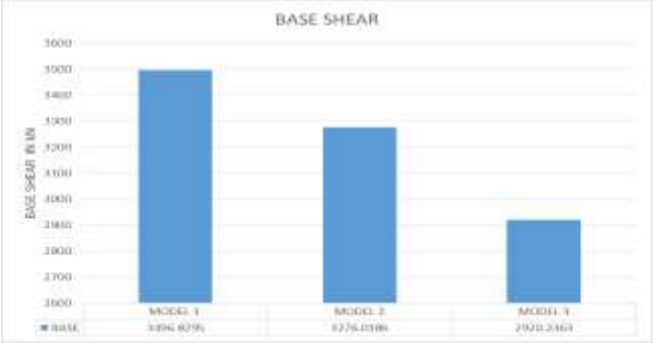

Chart-11: Base Shear

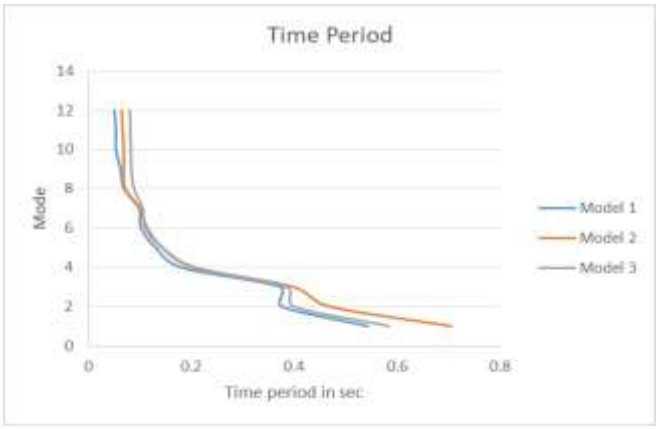

Chart-12: Time Period

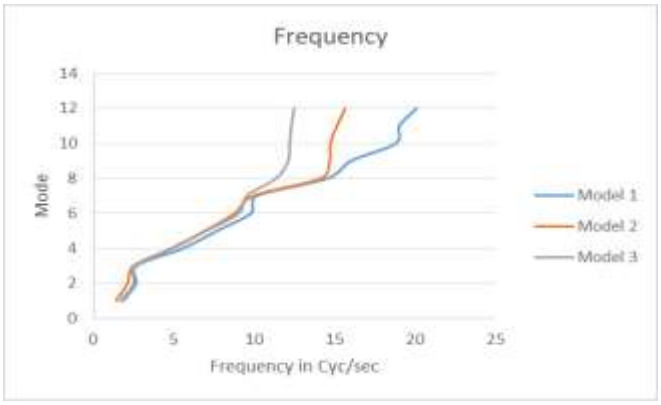

Chart-13: Frequency

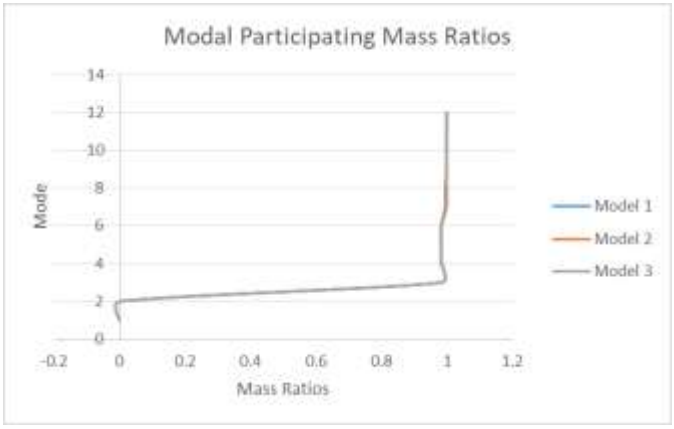

Chart-13: Modal Participating Mass Ratios

5. CONCLUSIONS

Based on analysis and study on previous chapters will draw some conclusions which are presented below.

1. In this study the effect of Mass irregularity on the structure at stilt and at middle of structure for a G+8 Storey building is been investigated.
2. The storey displacements in both X and Y directions were found to be less for regular structure but for the structure with mass irregularity at storey 4 deviated from the straight line at that storey indicating a clear sign of instability.
3. The storey drift values in both X and Y directions were found less for regular structure but for the structure with mass irregularity at storey 4 deviated from the straight line at that storey, and for mass irregularity at stilt floor the graph showed a higher deviation at stilt floor.
4. The storey stiffness in both X and Y values in the graphs show that regular structure has a higher stiffness values but for the structure with irregularity at Storey 4 showed a deviation in towards a lesser side indicating weakness of that storey.
5. The storey stiffness in both directions X and Y showed that building is having a lesser stiffness in comparison to that of regular building
6. In the case of base shear for regular structure is having a higher shear force than that for the structures with mass irregularity at Storey 4 and at Stilt floor.
7. As the base shear increases, Stiffness of the structure increases which in turn offer better resistance towards earthquake force.

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