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Fragility and Vulnerability Assessment of Monolithic Building Construction

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***Abstract*- The thesis aims to study the modeling and analysis of monolithic building using ETABS modeling of normal framed building and regular monolithic building have to be conducted and analysis and modeling of different plan irregular building, vertically irregular building which includes set back and step back structures using equivalent static analysis, modal analysis, response spectrum analysis and fragility analysis. The earthquake response of the building and damage assessment and are found out by comparing the analysis result. Using HAZUS manual damage indices due to the earthquake should be worked out and fragility curves should be generated using percentage of damage on Y axis and peak ground acceleration on X axis.**

Keywords—ETABS,Monolithic building construction Fragility analysis,HAZUS, ground acceleration

I. INTRODUCTION

Monolithic structure means the whole structure along with the slab is casted at a time. In order to construct a monolithic structure we required formwork for construction. In this project we discuss about the importance of use of monolithic construction work for high rise building. In accordance with the importance of time, it is feasible method for construction of the repetitive construction work as compared to conventionally applied method of construction. In this work we use aluminum formwork. Monolithic construction work is able to deliver good quality and durable structure in cost effective manner. It has been used in development of silos, residential building, schools, stadium, and roof of industries, nuclear reactors, pressure vessel, and auditorium. In monolithic structure we used formwork which provides proper alignment, smooth surface and good quality work. Due to use of formwork it increases the speed of construction as compare to conventional method. The progress of any country can be only judged by the progress of the construction industry of the country. Cost and time are the two important entities which plays vital role in any construction activity. Hence it has become necessary to estimate cost and time required to complete the construction. Indian construction industry has started using a number of the arena elegance technology. At same time, progressive rise in stock of construction industry in India and rapid growth of population and urbanization has led to shortage of accommodation and situation has become critical in urban and metropolitan areas. For construction of mass building works, it's far important to have progressive technology that are capable of fast construction and are able to construct best quality and durable construction in cost intended manner.

1.1. FRAGILITY AND VULNERABILITY ASSESSMENT

Recent studies shows that structural performance of Reinforced Concrete (RC) buildings always play crucial roles in terms of earthquake losses. Structures already built are vulnerable to future earthquakes. Damage to structures cause deaths, injuries, economic losses. Earthquake risk is associated with seismic hazard, vulnerability of building, exposure. Seismic risk measures the likely ground movement that can happen at site. Tools specifically defined for crisis administration and seismic danger moderation arrangements must be defined. Vulnerability assessment reveals the damageability of a structure under varying ground motion intensities. The aim of a vulnerability assessment is to obtain the probability of a given level of damage for a given building type due to scenario earthquake. Vulnerability of structures to ground motion effects is usually expressed in terms of fragility curves or damage functions that take into account the uncertainties in the seismic demand and structures capacity. Fragility curve is a statistical tool developed for the vulnerability assessment in different field. The outcome of this assessment can be used in loss estimation which is essential in disaster mitigation emergency preparedness.

II. OBJECTIVES

- To find out the effectiveness of monolithic building construction technique in various types of buildings
- Comparison of Monolithic building with normal framed building.
- Analysis of various types of Monolithic building using different analysis method
- Comparison of different Monolithic building
  - ✓ Regular building
  - ✓ Plan irregular building
  - ✓ Vertically irregular building which includes set back and step back buildings

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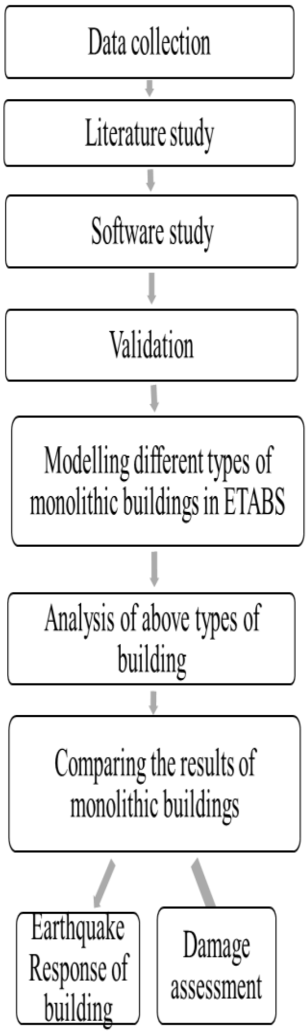
- Building response and damage assessment of different types of monolithic structures
  - ✓ Storey drift
  - ✓ Storey stiffness
  - ✓ Storey shear
  - ✓ Wall axial load
  - ✓ Wall shear force

III.METHODOLOGY

Sl no.	Component	Values
1	Model	G+10
2	Storey height	3m
3	Beam	300mm X380 mm
4	Column	450mm x450mm
5	Wall thickness	150mm
6	Material	M25
7	Grade of steel	Fe415
9	Slab thickness	200mm
10	Seismic zone	5
11	Importance factor	1
12	Type of soil	Soft soil
13	Type of structure	Concrete
14	Response reduction factor	5
15	Live load	3kN/m^2
16	Floor finish	1kN/m^2



IV . MODELING

In the first phase of my project a regular G+10 storey framed building and a regular G+10 storey monolithic building was considered to study the behaviour of both the building and hence compare the results.in the second phase of my project several monolithic buildings were considered which includes plan irregular building ,vertically irregular building .

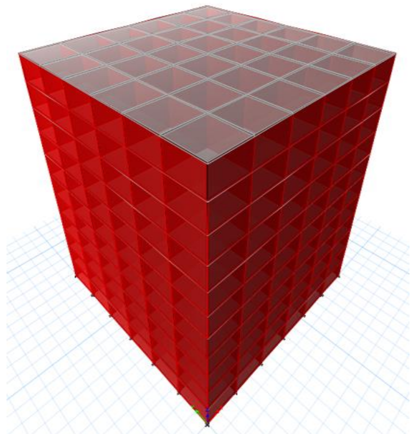


Figure 1: 3 D View of square building

Asymmetric or plan irregular structures are those in which seismic response is not only translational but also tensional and is a result of stiffness and or mass eccentricity in the structure. From the dynamic point of view a plan irregular building is that for which one or more rotational modes have a significant participating mass ratio.

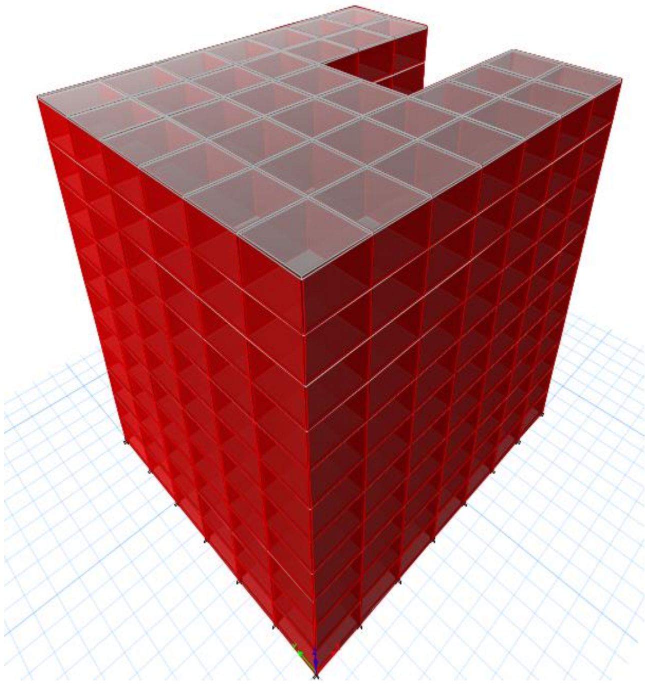


Figure 2: C shaped building 3 D View

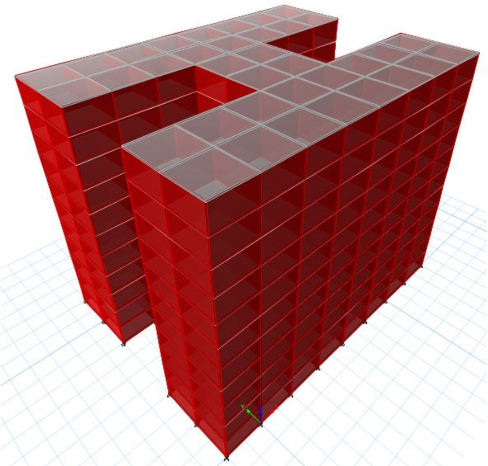


Figure 3: I shaped building 3 D View

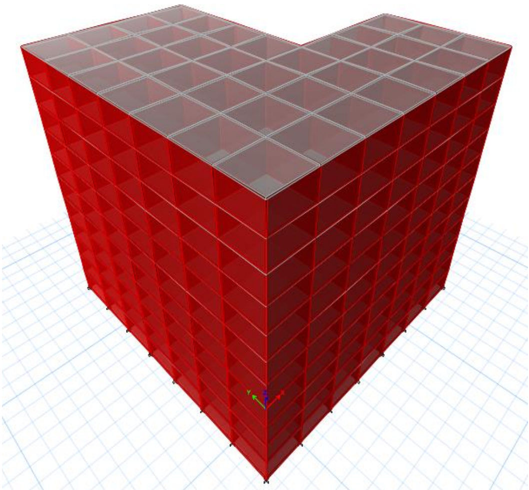


Figure 4: L shaped building 3 D View

Different types of plan irregular buildings were modelled which includes C shape, L shape, Plus shape, I Shape, Building with opening , Step shape, T shaped building.

V.ANALYSIS

A. *Equivalent Static Analysis*

The natural period of building is calculated by the empirical expression prescribed in the code. The total design seismic base shear calculation and its distribution along the height are done as per IS 1893(part-I)-2002. The seismic weight is calculated using full dead load plus 25% of live load.

B. Modal analysis

Modal analysis or mode super position method, is a linear dynamic response procedure which evaluates and super imposes free vibration mode shapes to characterize displacement patterns .mode shapes describes the configuration into which a structure will naturally displace

C. Response spectrum analysis

For response spectrum analyses, earthquake ground acceleration in each direction is given as a digitized response spectrum curve of pseudo spectral acceleration response versus period of the structure.

On comparing the normal framed building with monolithic building construction on conducting several analysis method it is clear that the monolithic building offers much more rigid or offers less vibration

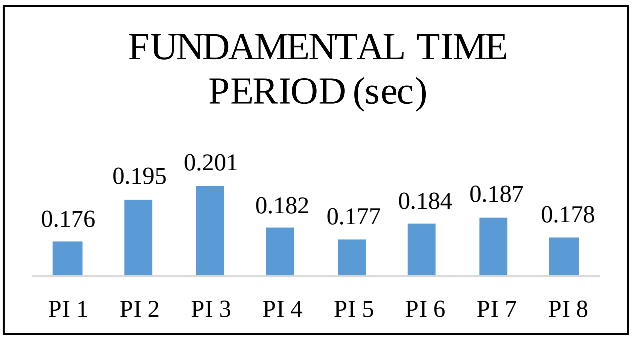


Figure 5: Comparison of time period of monolithic plan irregular buildings

PI 1- Square shape
PI 2- C shaped
PI 3- I Shaped
PI 4- L Shaped
PI 5- Opening
PI 6- plus shaped
PI 7- step shaped
PI 8- T shaped

I-Shaped building shows highest time period due to longer length of projections and more re-entrant corners .Square shape shows least time period

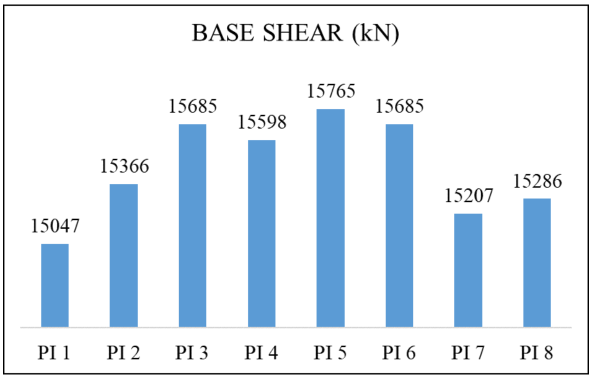


Figure 6: Comparison of base shear of monolithic plan irregular buildings

Base shear is highest for building with opening since mass and stiffness is null at the center.Base shear is least for square plan.This is due to the pattern of mass and stiffness distribution

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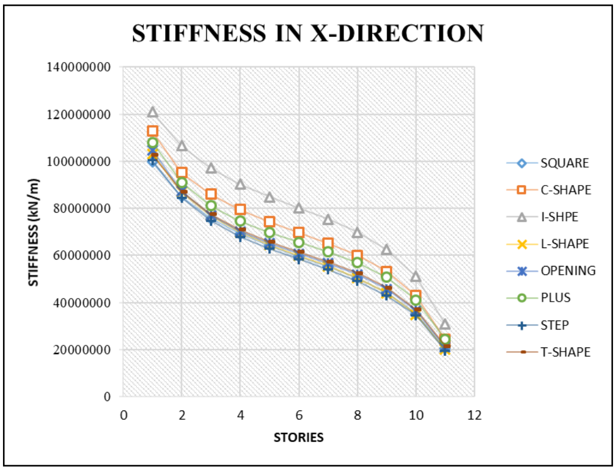

Figure 7: Comparative results of stiffness in X direction

In x-direction stiffness is maximum for I-shaped building due to its symmetry. For plan irregular building, stiffness depends on symmetry of the building

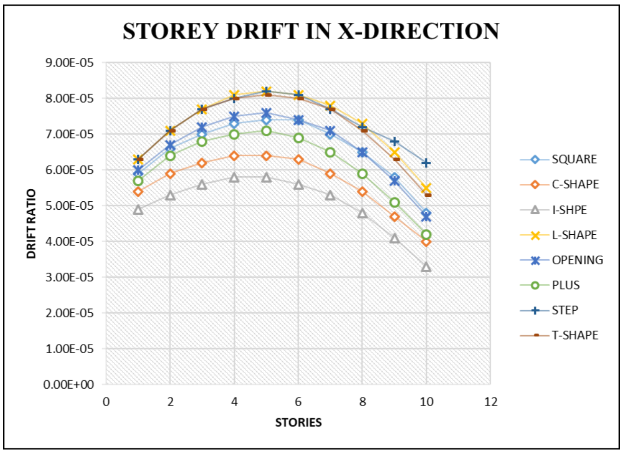

Figure 8: Comparitive results of storey drift in X direction

In x-direction the drift is maximum for step shape, L shape and T-shape. For plan irregular building, storey drift is maximum at the middle storeys.

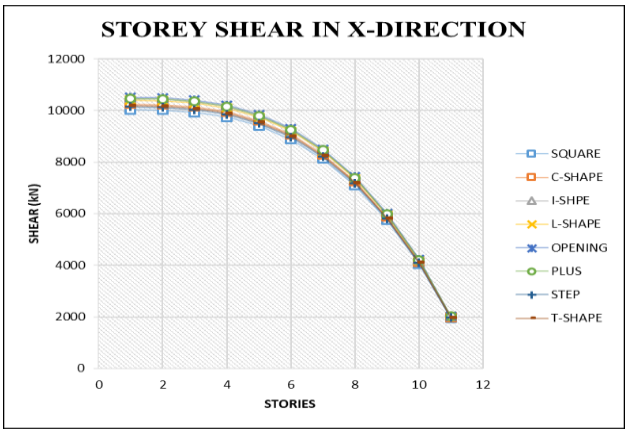

Figure 9: Comparative results of shear in X direction

Here Plan irregularity is irrespective of story shear

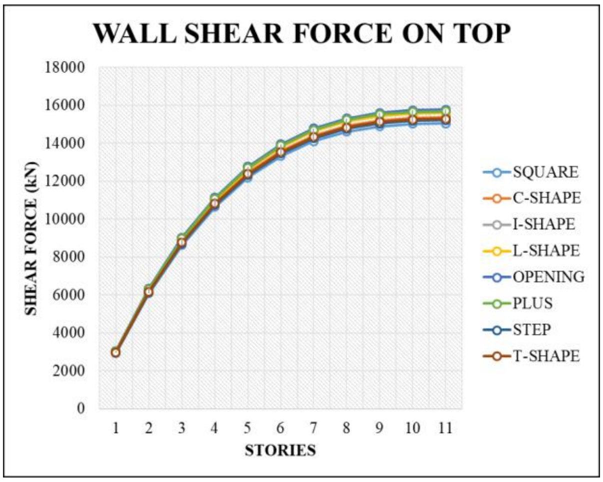

Figure 10: Comparative results of wall shear on top

Here also Plan irregularity is irrespective of wall shear force

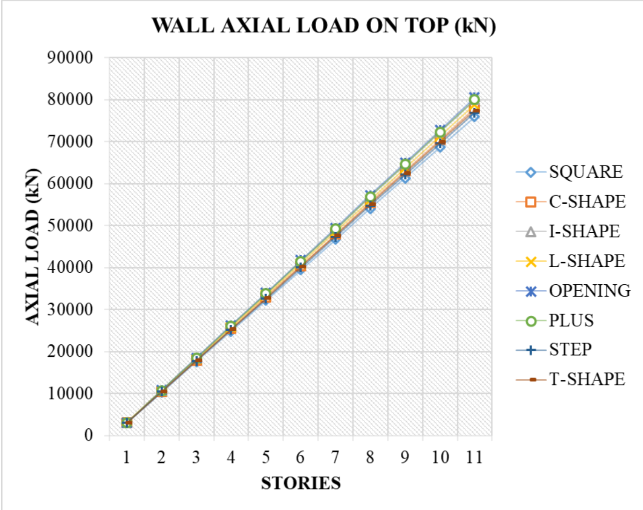

Figure 7: Comparitive results of axial load on top

Plan irregularity is irrespective of wall axial load

VI CONCLUSION

Monolithic building has less time period, high base shear, more stiffer and heavier than normal framed building hence vibrates less. Since the amount of drift is constant throughout height, there is less chance for sudden damage in monolithic building. The response of the monolithic building with plan irregularity .Time period is highest for I shaped building due to length of projections and number of re-entrant corners. Base shear is highest for building with opening due to null mass and stiffness at the centre. Storey stiffness depends on symmetry of the building. Top storeys of the monolithic building has less stiffness and storey shear. Storey drift is maximum at the middle storeys
Plan irregularity is irrespective of story shear, wall axial load, wall shear force.

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