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A Parametric study on Effect of Geometry of structures on Response of Multistorey buildings subjected to Seismic Loads

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Abstract - The main objective of this parametric study is to analyze the response of different Shapes of building by evaluating the parameters like storey shear, torsional irregularity, storey displacement, storey overturning moment, storey drift & storey stiffness. For this study, G+25 multistoried building of Box, L, H, U- Shape were used for the analysis purpose. Shear walls are placed at the corners of the structures for counteracting the lateral seismic forces and to keep the Storey displacement under limits as per the codal provision of IS 1893:2016. The building is modelled in ETABS-2018 ultimate 64-bit, version 18.0.2. Box building is having a higher value of Storey Shear and Storey overturning moment as compare to other shapes of building. H-Shape & U-shape is having a Similar value of storey stiffness.

***Key Words*: Different geometries, Response spectrum analysis, Dynamic analysis, Storey displacement, Storey drift, ETABS.

1. INTRODUCTION

Structural analysis is mainly concerned with finding out the behavior of a structure when subjected to some loading. This action can be in the form of load due to the weight of things such as people, furniture, wind, snow, etc. or some other kind of excitation such as an earthquake, shaking of the ground due to a blast nearby etc. Thus, in present study an comparative analysis has been made to investigate the seismic response of G+25 structures situated in seismic zone-III. As per IS 1893-(part 1) Structure irregularity is divided into two types namely plan irregularity and vertical irregularity. Vertical irregularity happens due to the significant changes in stiffness, strength, mass or dimension or because of in plane discontinuity in lateral force resisting system (LFRS). The plan irregularity happens because of few reasons, for example when the structure is fundamentally subjected to asymmetrical plan shapes.

2. LITERATURE REVIEW

Literature survey was conducted on the works carried out by earlier researchers whose efforts has been devoted to study comparative analysis for different geometries of structures. The summary and gap found in literature survey are discussed below

Summary of Literature review

Based on study, following conclusions could be drawn:

- Structures with irregularities produces more deformation than those with less irregularities in high seismic zone.
- Response of structure includes storey displacement, storey overturning moment, Torsional irregularity, storey shear etc.
- Seismic analysis of structure can be carried by following methods.
    - Equivalent Static Analysis
    - Push over analysis
    - Response Spectrum Analysis
    - Time History Analysis
- The analysis has to be done by using parameters for the designs as per the IS 1893-2016.

3. OBJECTIVES & SCOPE

Objectives

- The main objective of this research is to present the comparative study of effect of geometry of structures on response of multi-storey buildings having shear walls at the corners of the structure subjected to lateral seismic load.
- To suggest the best geometry of multi-storey building having shear walls at the corners and lift well under seismic action.
- To calculate the torsional irregularity of all geometries of building.

Scope

Structure with lateral supporting members like shear walls are known to be the more effective structural system for building under high lateral loads such as seismic or wind loading.

4. METHODOLOGY

Analysis of G+25 Multi-storey R.C.C structures of different shapes having shear walls at corners and lift well are analyzed in ETABs. The structures are considered to be in Zone-III having a zone factor of Z=0.16. This dynamic analysis of building is done by the Response spectrum method. The modeling and analysis of structures is done by using ETABS version 18.0.2 software.

5. MODELING AND ANALYSIS

A. Plan Details

Parameters used for analysis of G+25 Multistorey buildings of different geometries are mentioned below.

Table 1. Plan Details

Sr No.	Particulars	Dimensions/ values
1	Model	G+25
2	Building height	75m
3	Storey height	3m
4	Size of column	300mmx900mm
5	Size of beam	200mmx600mm
6	Live load on floors	2.0 KN/m²
7	Floor finishing load	1.0 KN/m²
8	Wall thickness	230mm
9	Thickness of slab	150mm
10	Shear wall thickness	200mm
11	Grade of concrete	M30
12	Grade of steel	Fe500

B. Seismic Parameters

Table 2. Seismic Parameters

Sr No.	Particulars	Values
1	Soil type	I
2	Importance factor	1.2
3	Seismic zone	III
4	Zone Factor	0.16
5	Damping Ratio	5%
6	Response Reduction Factor	4

C. Load Details

The structure is acted upon by different loads such as dead load (DL), live load (LL) and Earthquake load (EL).

- Self-weight of the structure comprises of the weight of the beams, columns and slab of the structure.
- Dead load of the structure according to (IS 875 part 1)
    - **Dead load for beam**
      = unit weight of concrete X Thickness of beam X Width of beam
      = 25 KN/m^3 x 0.2m x 0.6m
      = 3.0 KN/m
    - **Dead load for column**
      = unit weight of concrete X Thickness of column X Width of column
      = 25 KN/m^3 x 0.3m x 0.9m
      = 6.75 KN/m

- Live load on the floor is 2.0 KN/m^2
- Floor finish load on the floor is 1.0 KN/m^2
- LMR (Lift machine room load) is 5.0 KN/m^2
- Water tank load is taken as 35 KN/m^2.

These parameters are taken into account while modeling and analyzing the model in ETABS software

Geometry of buildings

1. Box Shape Buildings

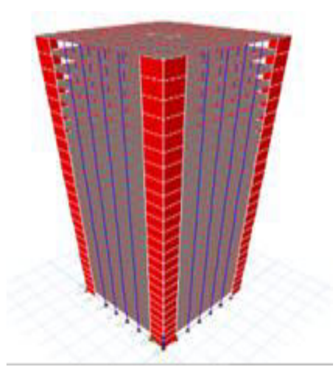


Fig 1. Box Shape building

2. L-Shape Buildings

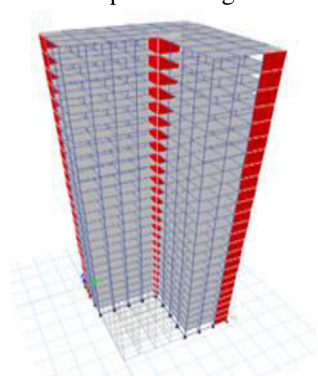
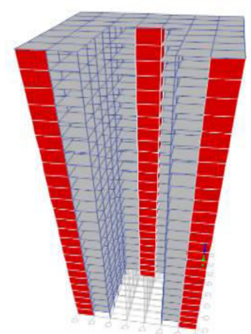


Fig 2. L-Shape building

3. U-Shape building



4. H-Shape building

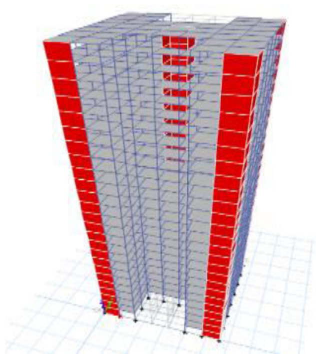


Fig 3. U-Shape building

Fig 4. H-Shape building

6. RESULTS

Storey shear in x-direction

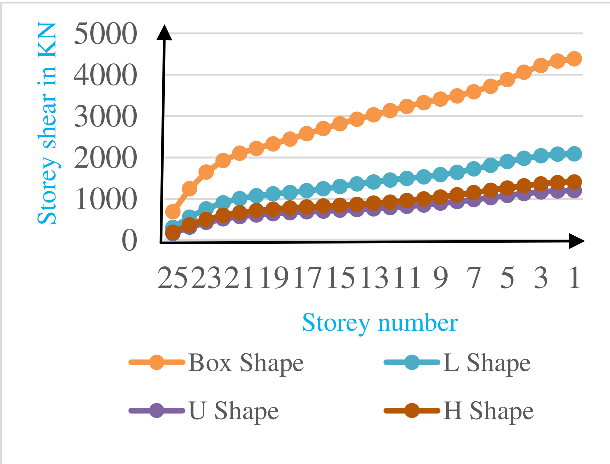


Fig 5. Storey shear in x-direction

Storey shear in y-direction

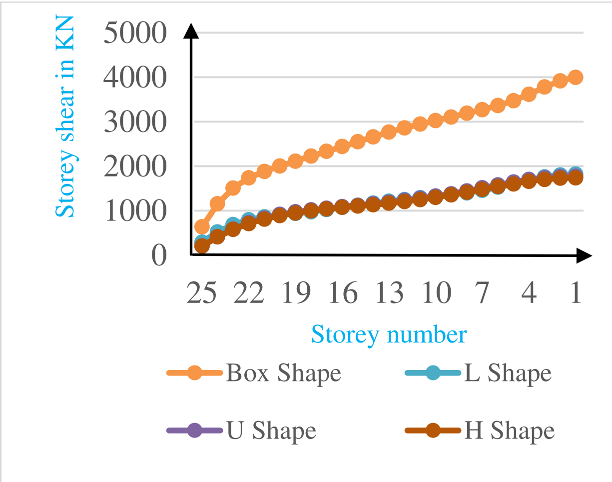


Fig 6. Storey shear in y-direction

Storey overturning moment in x-direction

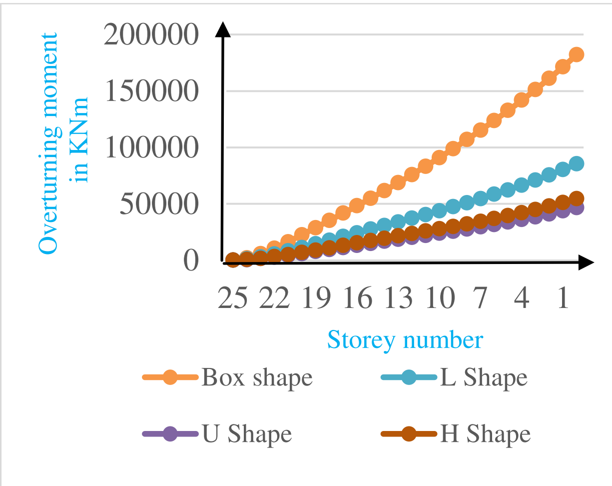


Fig 7. Storey overturning moment in x-direction

Storey overturning moment in y-direction

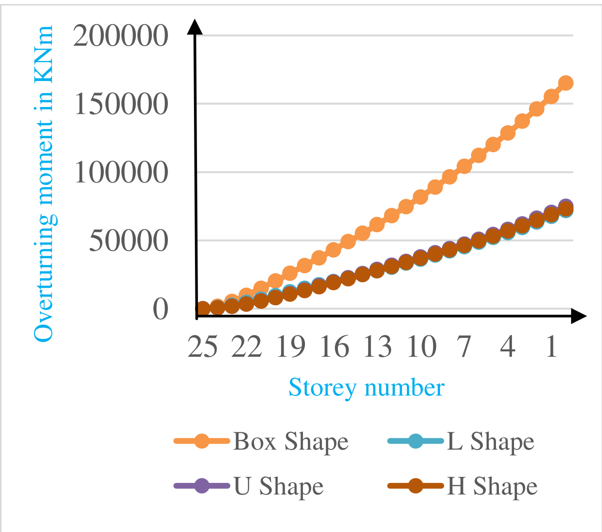


Fig 8. Storey overturning moment in y-direction

Storey displacement in x-direction

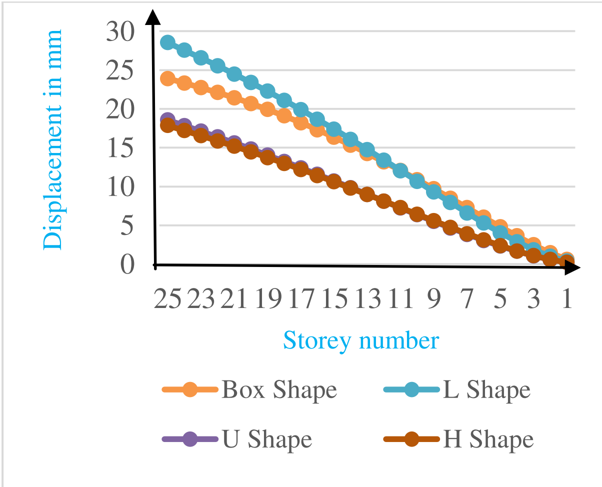


Fig 9. Storey displacement in x-direction

Storey displacement in y-direction

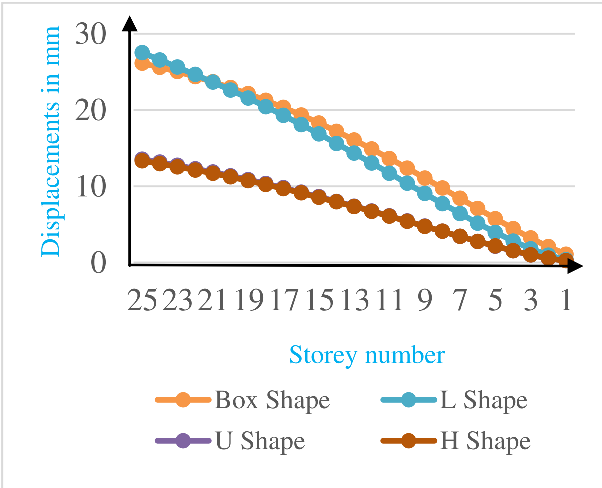


Fig 10. Storey displacement in y-direction

Storey drift in x-direction

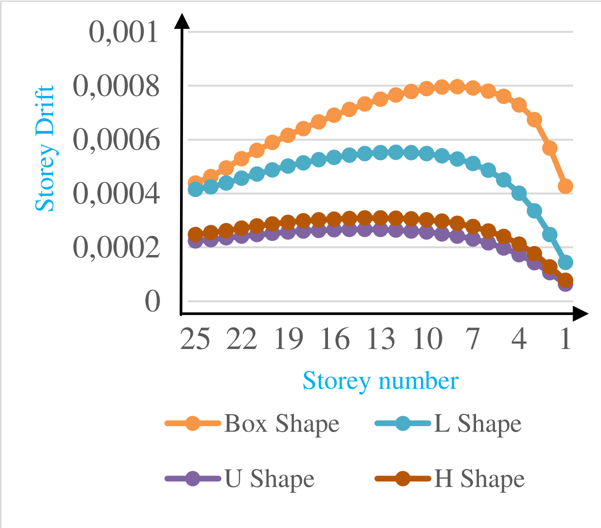


Fig 11. Storey drift in x-direction

Storey drift in y-direction

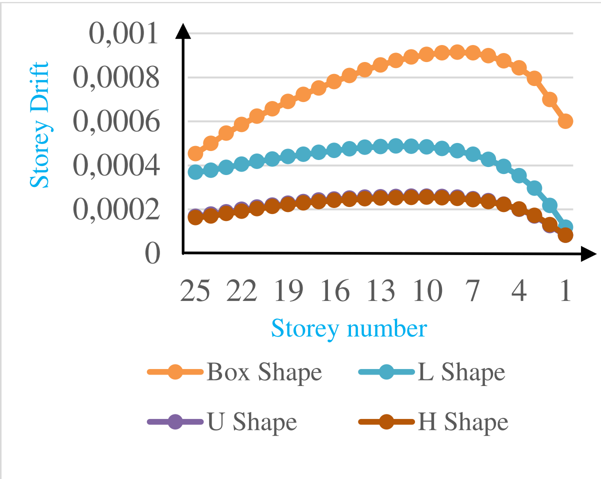


Fig 12. Storey drift in y-direction

Storey stiffness in x-direction

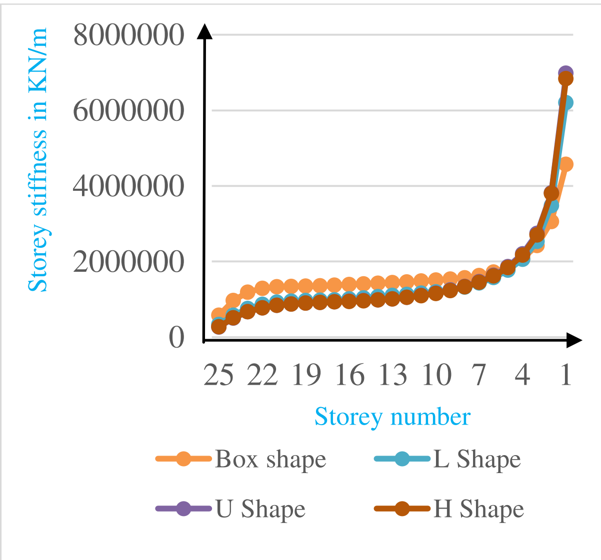


Fig 13. Storey stiffness in x-direction

Storey stiffness in y-direction

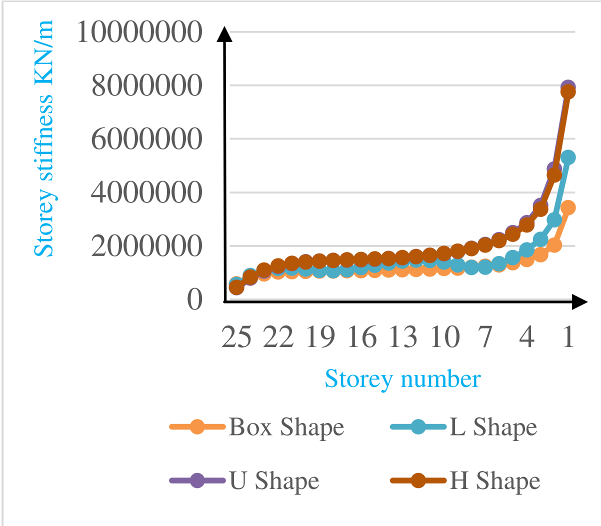


Fig 14. Storey stiffness in y-direction

7. CONCLUSION

1. Irregularity in shapes affects the response of the structure. Generally, non-symmetric structure gives more displacements values as compare to symmetric structures.
2. Box-shaped structure was having a higher value of storey overturning moment as compared to other geometry of buildings.
3. L-Shape building is irregular in shape and having a maximum displacement of 28.534mm and H-Shape building is a regular i.e., symmetric in shape and has a minimum displacement of 17.861mm in x- direction.
4. In x-direction, Storey drift is maximum for Box Shape building which is 0.0008 & minimum for U-Shape building which is 0.000063.
5. In y-direction, L-Shape structure has a displacement of 27.487mm and H-Shape structure has a displacement of 13.327mm. Therefore, w.r.t displacement H-shape building has a better performance than other geometry.
6. Storey stiffness is maximum for U-Shape building which is 6979521.22 KN/m & minimum for box Shaped building which is 4571063.17 KN/m for x-direction.
7. From overall comparison it can be stated that, H-Shape building having shear walls at the corner is more vulnerable than the other shapes of building.

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IS Codes-

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