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A Comparative Study on Seismic Analysis of Vertical and Plan Irregular Multi-Storey R.C Building using ETABS

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ABSTRACT: Due to urbanization and less availability of construction land, the engineers are planning for multi-storied construction. In this study, a multi-storied (G+10) RC building is considered for earthquake analysis by using previous earthquake data i.e., the analytical method used for this work is time history analysis. When the multi-storied building constructions comes into the practice there are various possibility of failure of the structures, either it might be due to gravity loading or might be due to lateral pressures i.e., Earthquake or wind loads. If the structures are not analysed and designed for the above-mentioned loading conditions as per the IS codal specifications, a severe damage might be observed. So, in this study, the analysis is performed for gravity loadings and by using the previous earthquake analytical data, "Time History Analysis" method is used for the earthquake analysis. There is various finite element approach software are available in the market, for this study ETABS (version 21) is used for analysing the structure. In this study totally 5 models are used they are planning regular and irregular building are considered and the results for all of these are discussed in the coming chapters.

KEYWORDS: Regular building, Irregular building, Vertical irregular building, Seismic Zone, Time history Method.

I. INTRODUCTION

Earthquakes are formidable natural occurrences resulting from the sudden release of energy within the Earth's crust, generating seismic waves that cause ground tremors. They pose significant threats to both infrastructure and human life due to their destructive and unpredictable nature. Typically originating several kilometers beneath the Earth's surface, earthquakes are centered at a focal point known as the epicenter, where their impact is most severe. These seismic events vary in magnitude, measured on scales like the Richter scale, which quantifies the energy released during an earthquake, ranging from minor tremors registering below 2 to catastrophic events surpassing 9 on the scale. The Multi-Storey buildings are very commonly constructed to shelter large population in small per capita area. These multi-Storey buildings are usually irregularly shaped to give better aesthetic appearance. But irregular multi-Storey buildings are much affected when earthquake occurs and can cause damage to adjacent structures also. And for aesthetic purpose the modelling has been done in ETABS software. Time history analysis (THA) provides dynamic structural and response of structure under various past earthquake loadings which varies with respect to the specified time function. Hence the present work involves study of seismic response of a different structure by Time history analysis for a given seismic intensity and ensure the structures can resist similar earthquake loads.

II. OBJECTIVES

- To Analysis the building structure using time history analysis of dynamic structure using ETABS software.
- To determine structural response of regular building to previous earthquake data.

- To determine the behaviour of storey shear, storey displacement, storey drift and Overturning Moment of the regular structure with plan irregular and vertical irregular structure.
- To comparison between models and their behaviours on different earthquakes on regular structure with plan irregular and vertical irregular structure.

III. METHODOLOGY

A comprehensive review of existing literature and the provisions outlined in the Indian standard code is conducted to determine the methods for designing storey shear, storey drift, storey displacement and overturning moment in structures. The buildings are structured with a plan dimension of 25 meters by 35 meters, featuring 5 bays and spanning across 10 stories. The height of the floor is 3.5 meters each.

The dimensions of the column size is 300mm by 750mm, and the beam size is 300mm by 450mm. The structural models are exposed to seismic forces from three historical earthquakes, each occurring in both the X and Y directions. These earthquakes include the El Centro earthquake of 1940, the Helena Montana Corralito earthquake of 1935, and the Hollister earthquake of 1974.

Table 1: Parameters for the development of the structural models

Sl. No	Parameter	Value
1	Type of Structure	Commercial
2	No. of Stories	10
3	Total Height of Building	35 m
4	Storey Height	3.5 m
5	Plan Size	25 m x 35 m
6	Column Size	300 mm x 750mm
7	Beam Size	300 mm x 450 mm
8	Grade of Concrete	M30
9	Steel Grade	Fe500
10	Slab Thickness	150 mm
11	Bays Width in X-Direction	5 m
12	Bays Width in Y-Direction	7m
13	Concrete Density	25 kN/cum
14	Brick Density	20 kN/cum
15	Earthquake Load	As per IS 1893-2016
16	Moment Resisting Frame	OMRF
17	Types of Soil	II
18	Zone Factor	0.1
19	Importance Factor	1.2
20	Response Reduction Factor	3
21	Earth quick zone	2

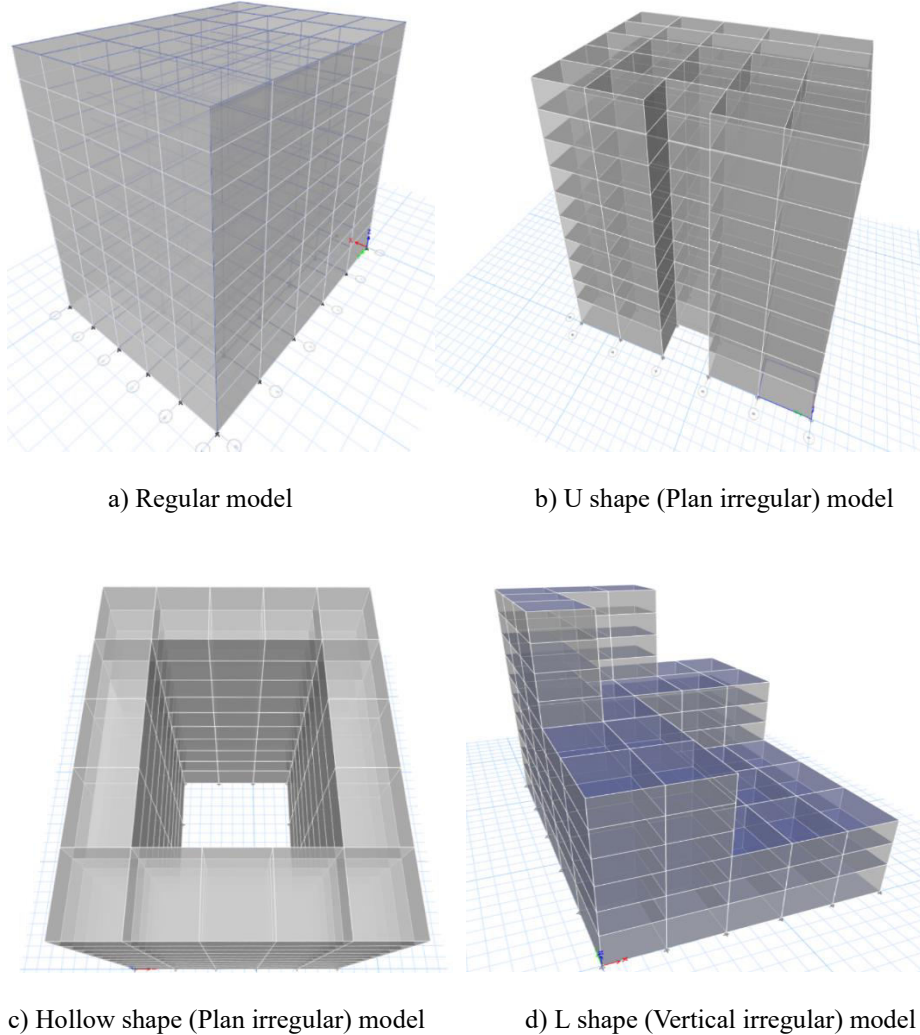


Figure 1: 3D models of four different regular and irregular structures.

IV. RESULTS AND DISCUSSIONS

Time history analysis is performed on all the models. Earthquake data used in time history analysis are as mentioned in clause 4.2. The behaviour of models is studied by extracting the results from the analysis in the form of Storey Drift, Storey Shear, Storey Displacement and Storey Overturning Moment. The results are plotted in a graphical form as shown in following figure below.

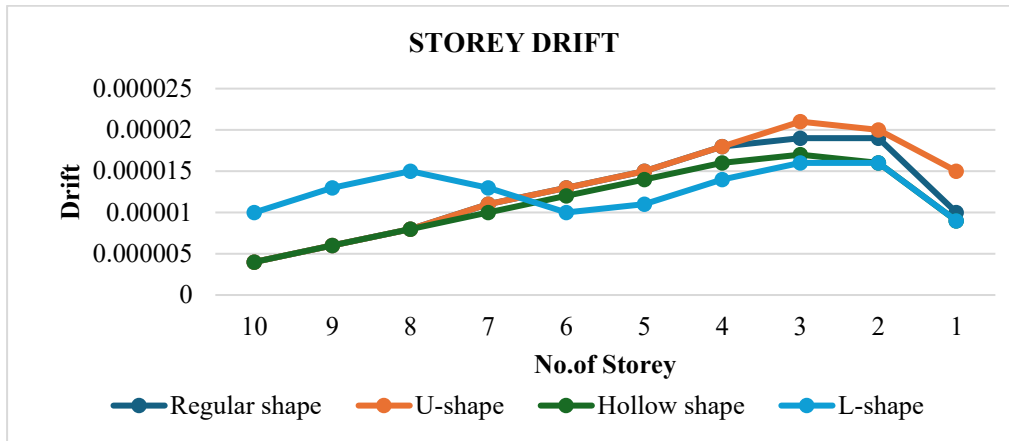


Figure 2: Storey Drift of structures due to El Centro 1940 in X direction

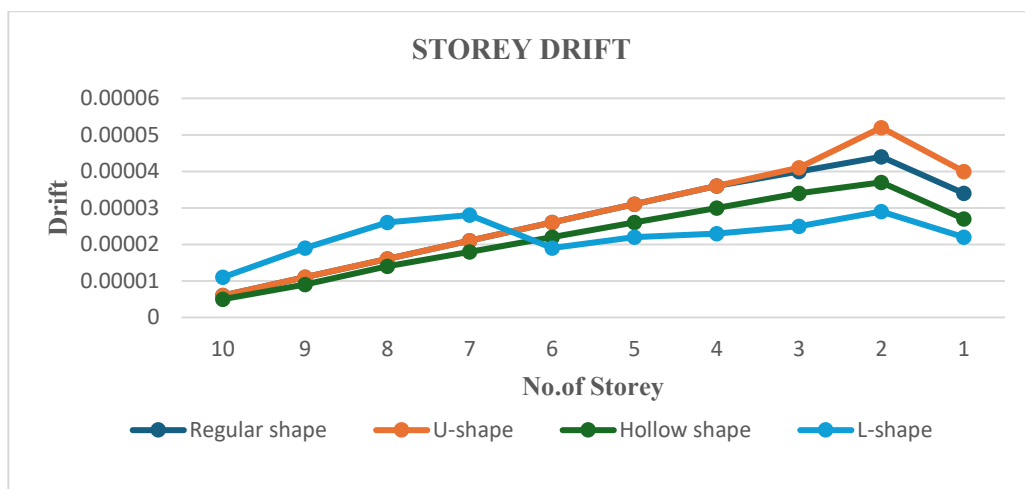


Figure 3: Storey Drift of structures due to El Centro 1940 in Y direction

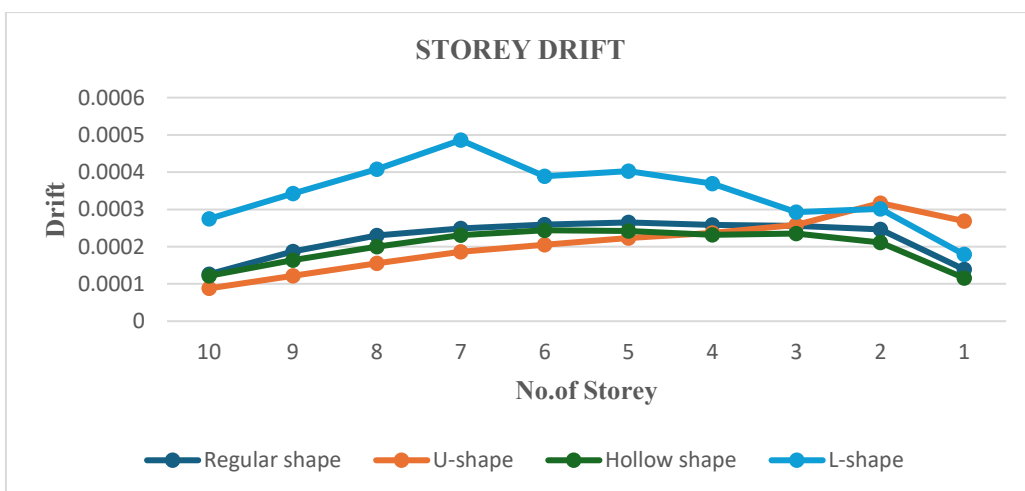


Figure 4: Storey Drift of structures due to Helena Montana 1935 in X direction

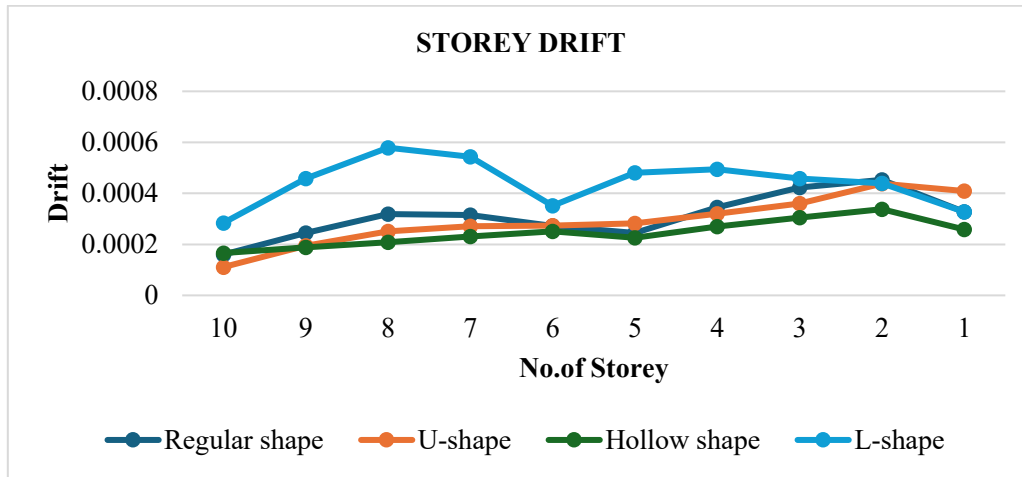


Figure 5: Storey Drift of structures due to Helena Montana 1935 in Y direction

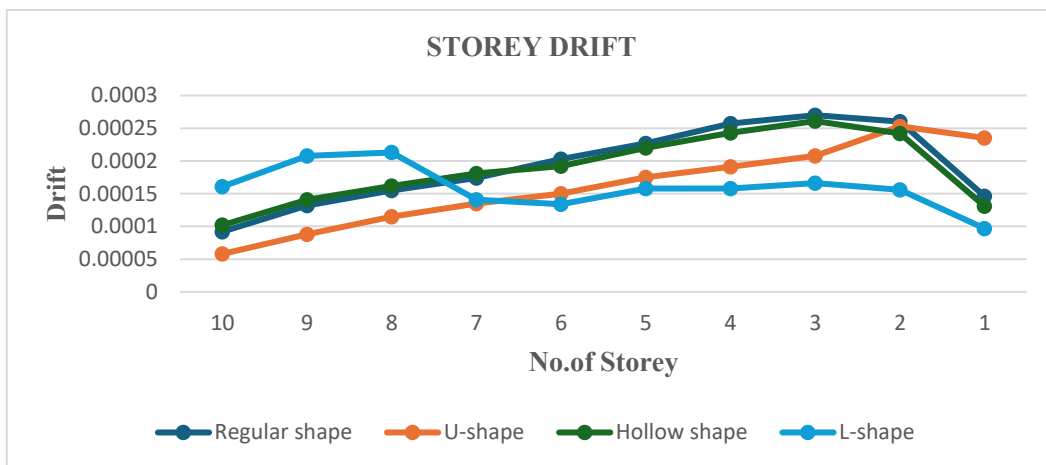


Figure 6: Storey Drift of structures due to Hollister 1974 in X direction

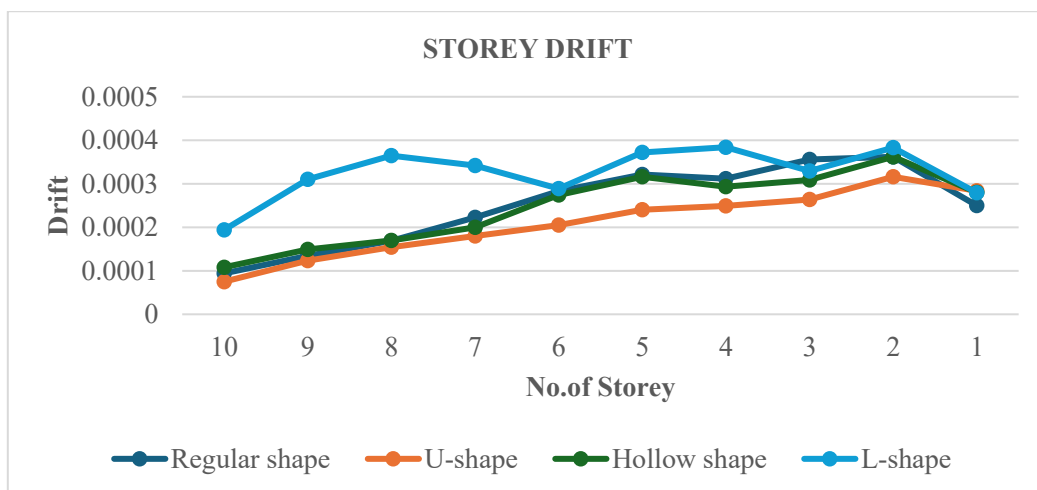


Figure 7: Storey Drift of structures due to Hollister 1974 in Y direction

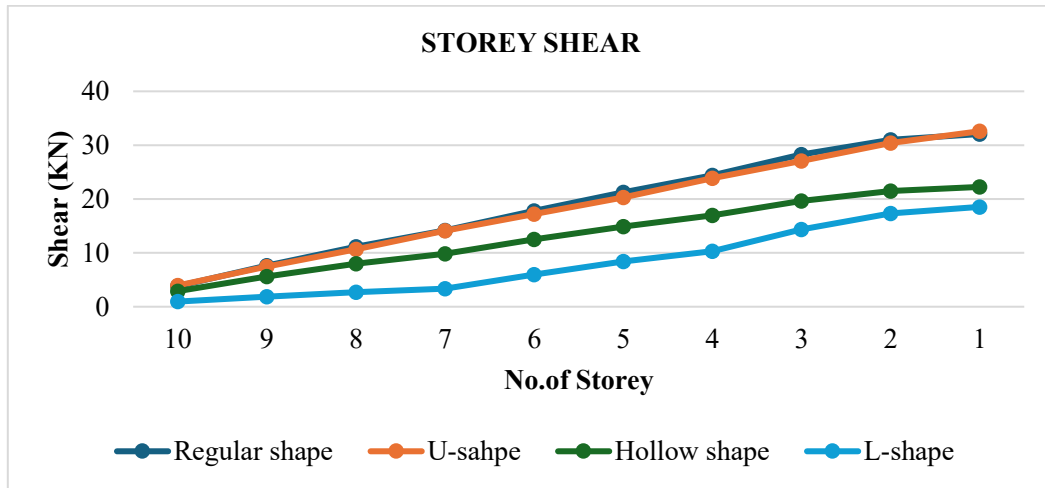


Figure 8: Storey Shear of structures due to El Centro 1940 in X direction

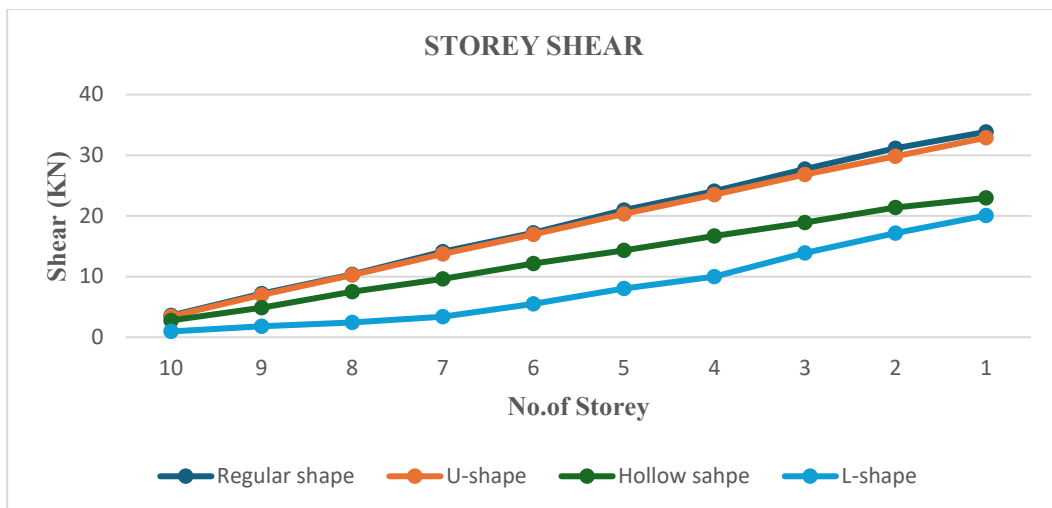


Figure 9: Storey Shear of structures due to El Centro 1940 in Y direction

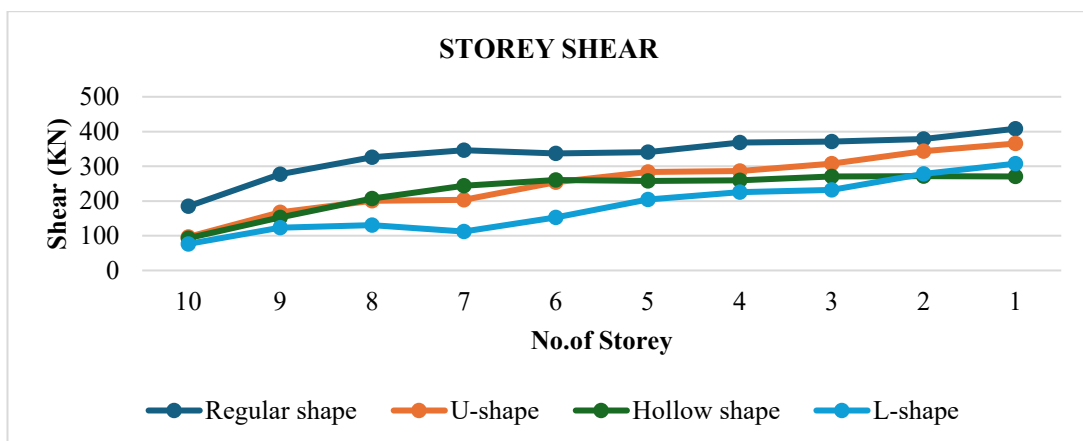


Figure 10: Storey Shear of structures due to Helena Montana 1935 in X direction

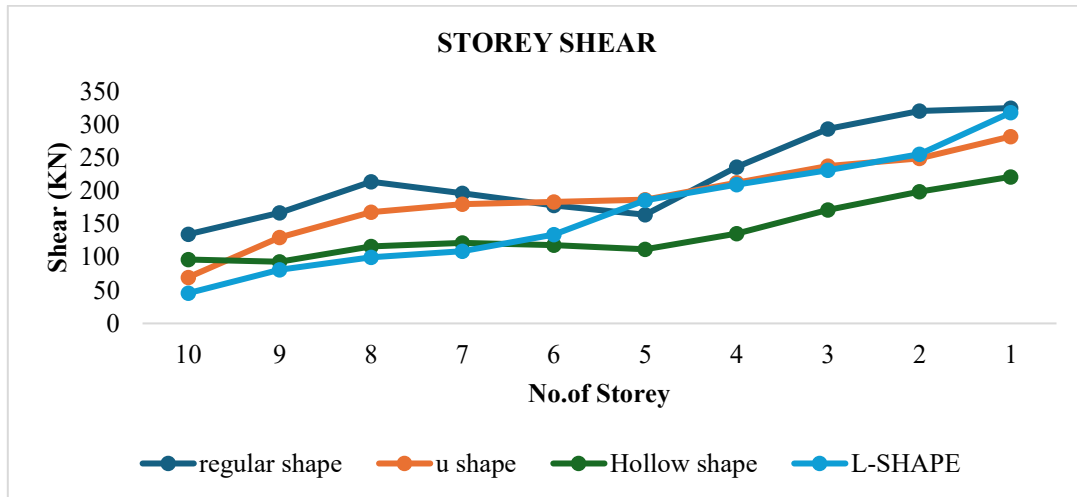


Figure 11: Storey Shear of structures due to Helena Montana 1935 in Y direction

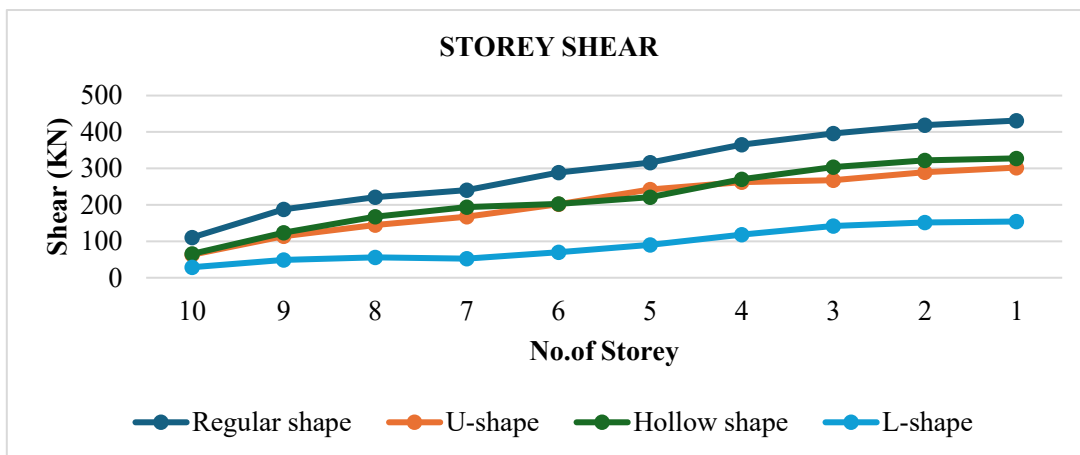


Figure 12: Storey Shear of structures due to Hollister 1974 in X direction

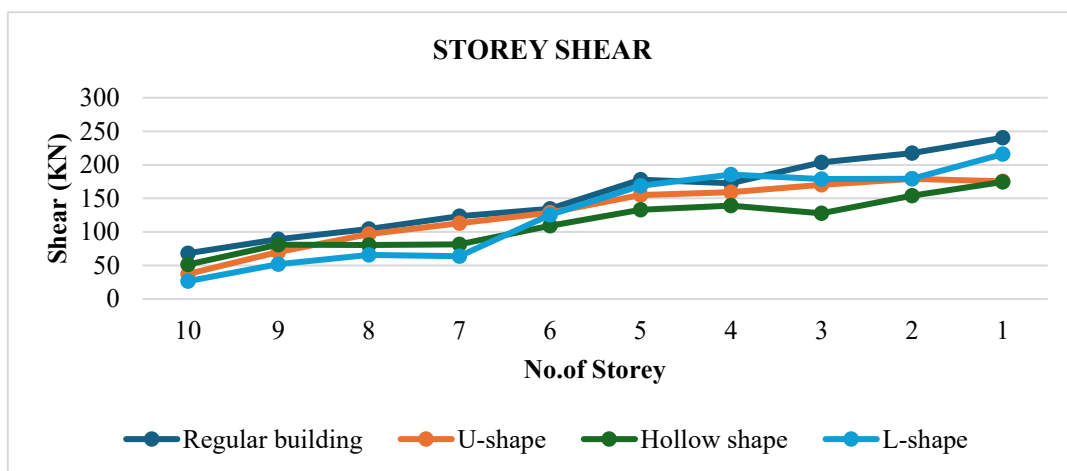


Figure 13: Storey Shear of structures due to Hollister 1974 in Y direction

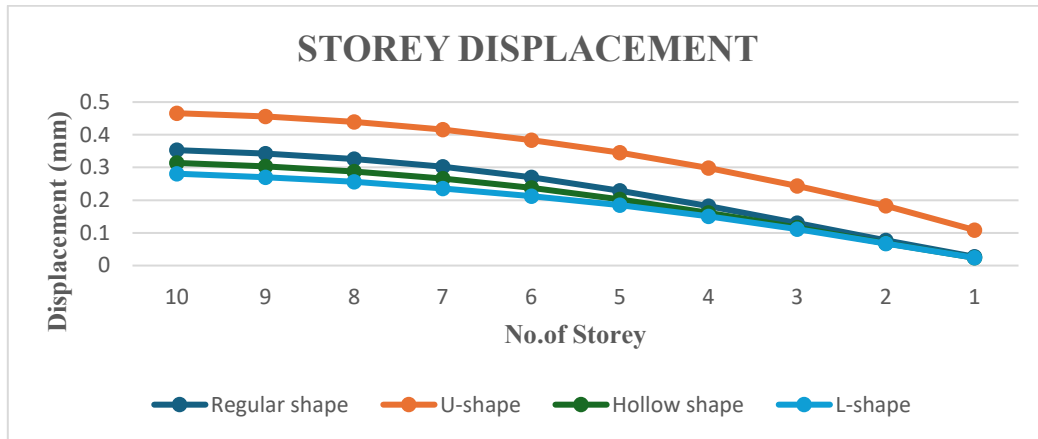


Figure 14: Storey Displacement of structures due to El Centro 1940 in X direction

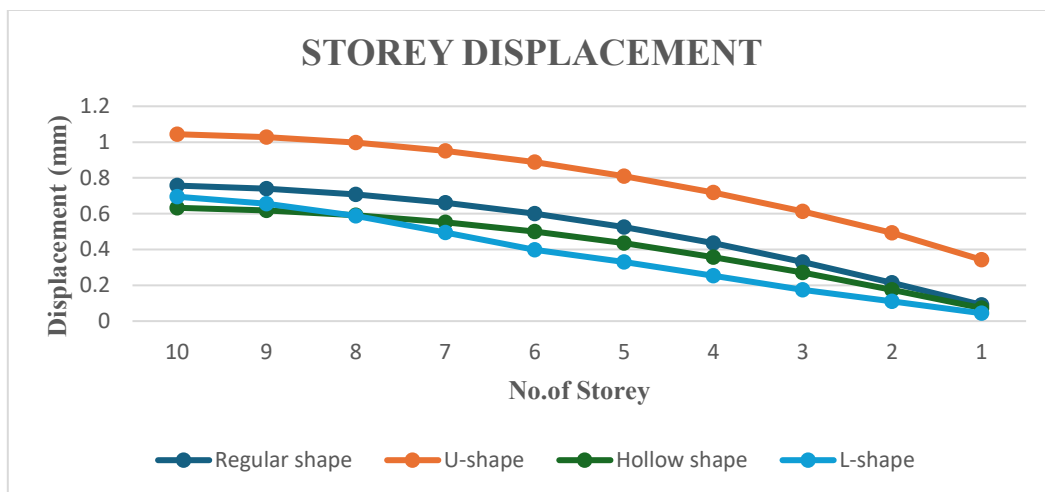


Figure 15: Storey Displacement of structures due to El Centro 1940 in Y direction

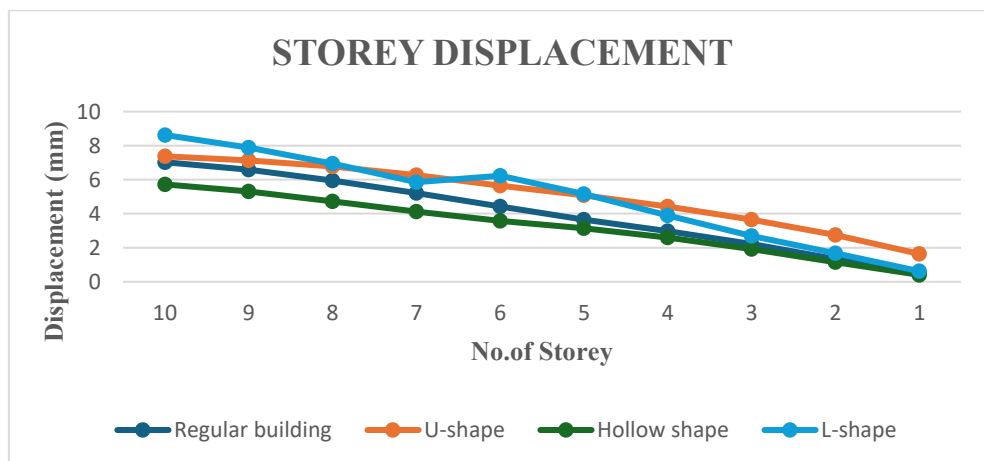


Figure 16: Storey Displacement of structures due to Helena Montana 1935 in X direction

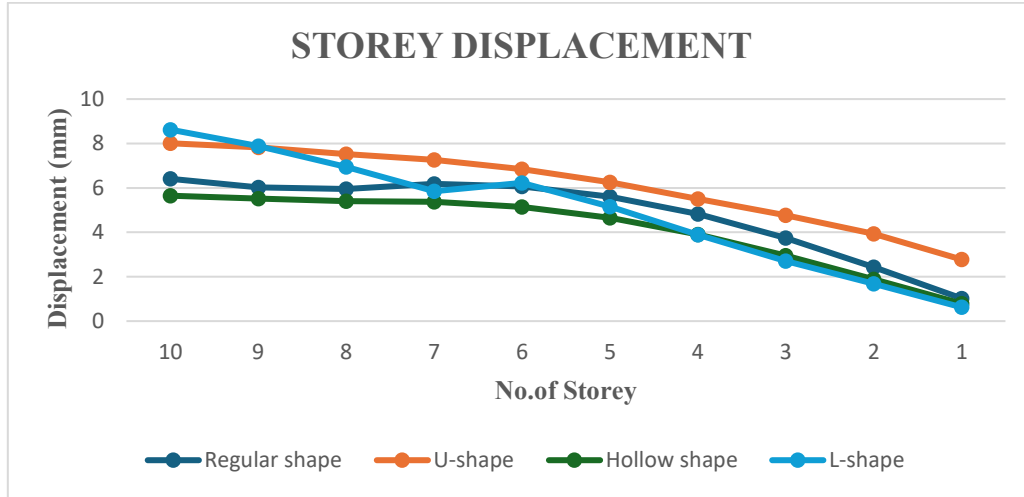


Figure 17: Storey Displacement of structures due to Helena Montana 1935 in Y direction

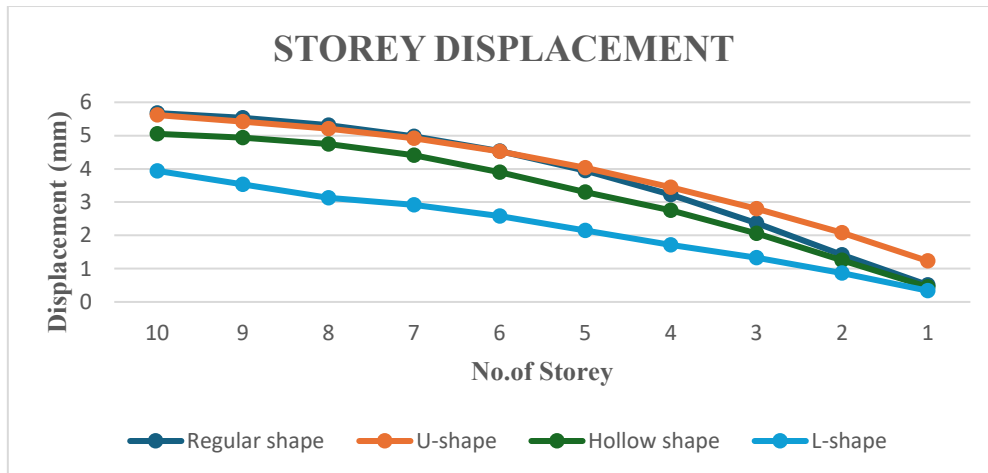


Figure 18: Storey Displacement of structures due to Hollister 1974 in X direction

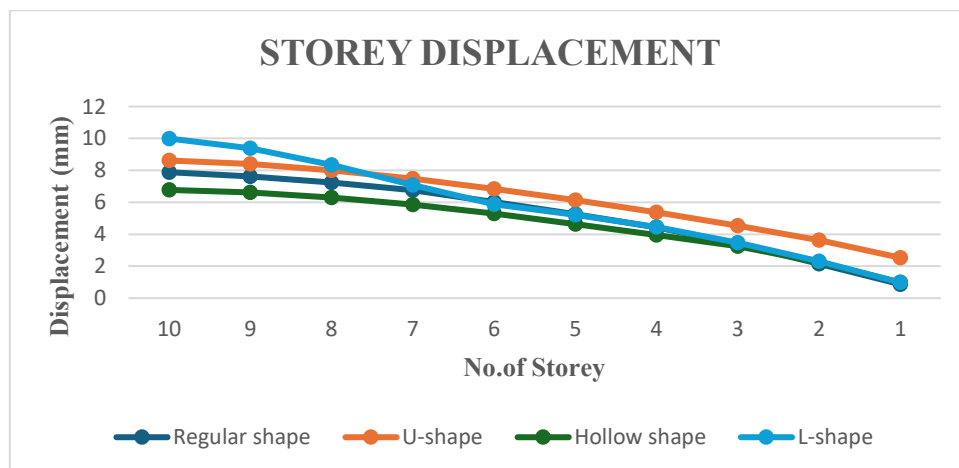


Figure 19: Storey Displacement of structures due to Hollister 1974 in Y direction

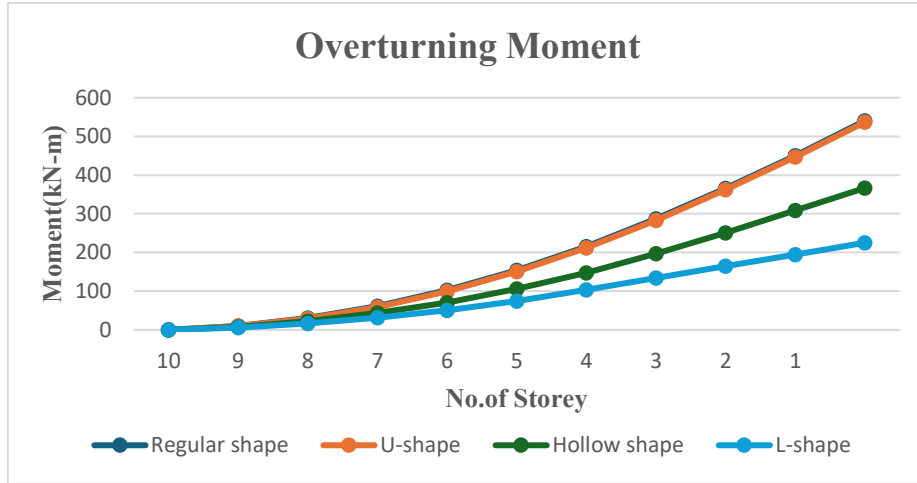


Figure 20: Storey Overturning Moment of structures due to El Centro 1940 in X direction

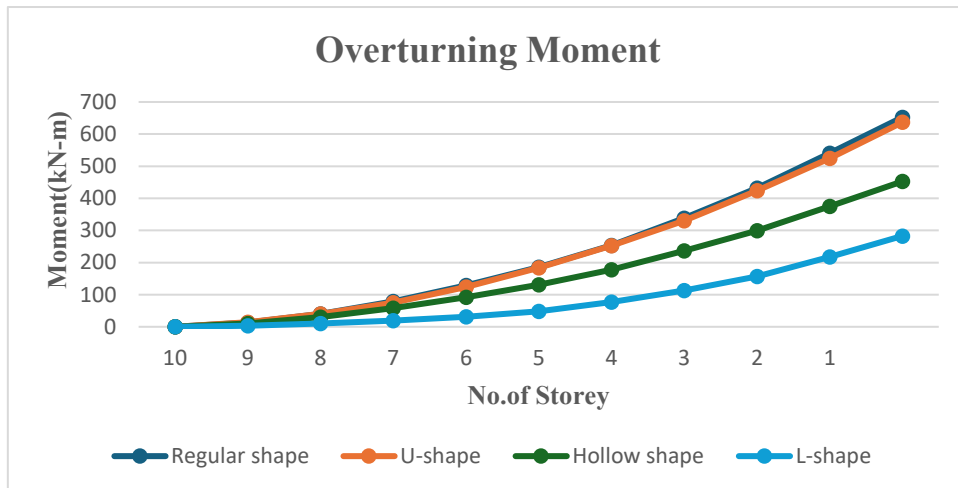


Figure 21: Storey Overturning Moment of structures due to El Centro 1940 in Y direction

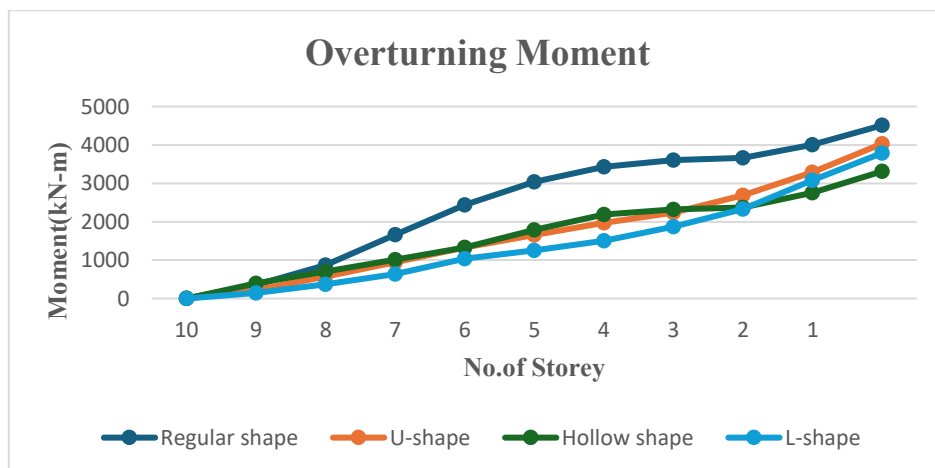


Figure 22: Storey Overturning Moment of structures due to Helana Montana in X direction

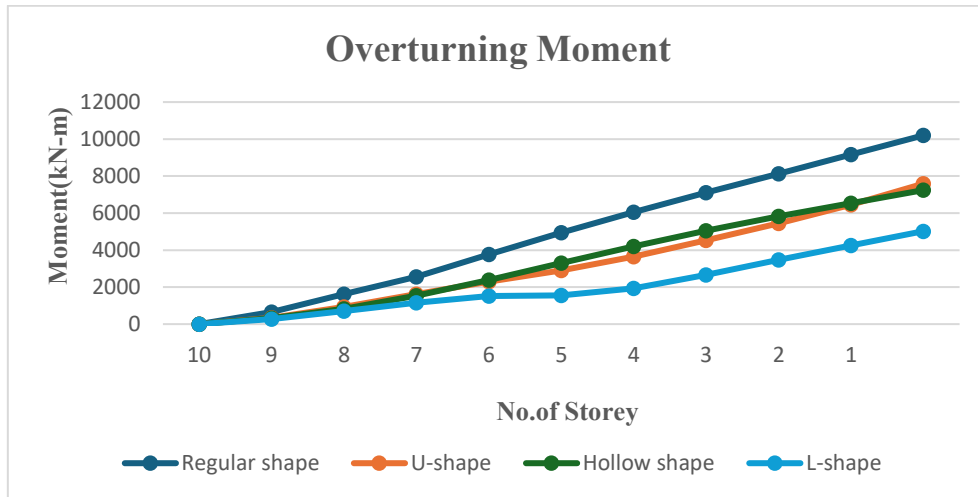


Figure 23: Storey Overturning Moment of structures due to Helana Montana in Y direction

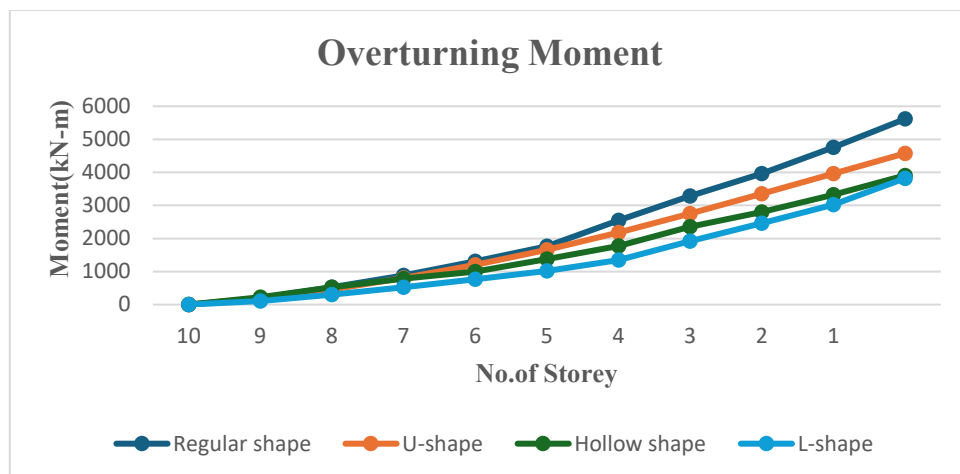


Figure 24: Storey Overturning Moment of structures due to Hollister in X direction

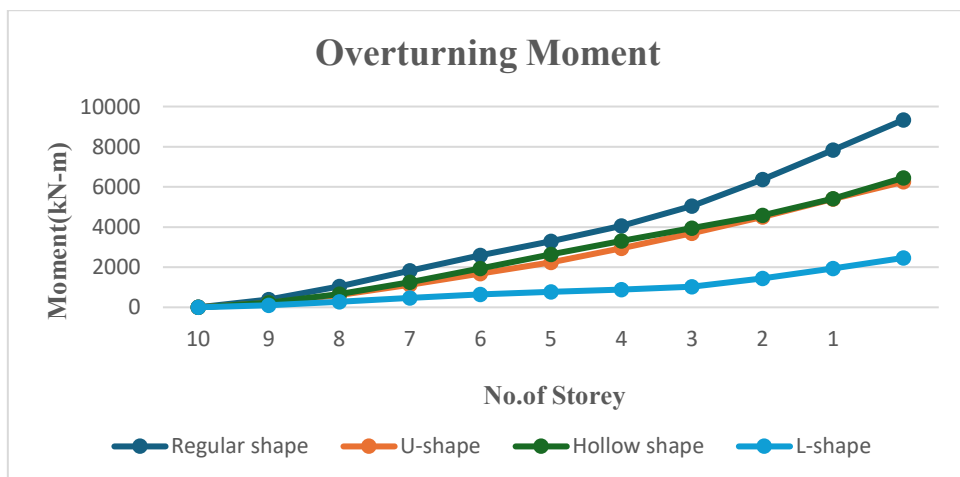


Figure 25: Storey Overturning Moment of structures due to Hollister in Y direction

V. CONCLUSION

The comparative analysis for plan regular, plan irregular, vertical irregular structure are made and discussion, regarding's to results attained from the storey shear, storey drift, storey displacement, overturning moment are being discussed in the chapter 4 and the conclusions for those results and discussions are derived here:-

1. The time history analysis using ETABS has provided a comprehensive understanding of the building's response to dynamic loads, particularly during seismic events.
2. As per the analysis storey drift, the values are comparison with vertical irregular building, regular building and hollow shape building has obtained 62.06% results, similarly u-shape building has attained 75.51%, in this above result we can analysis we can go with the u-shape structure.
3. In comparison to regular buildings, the U-shaped building has achieved 84% results. The hollow shape building has attained 75%, and the L-shaped building has reached 73%. Based on this analysis, the U-shaped structure appears to be the most favourable option.
4. In comparison with plan irregular building(U-shape), regular building has obtained 36% results, similarly hollow-shape building has attained 35.47% and L-shape building has attained 35.23%, in this above result we can analysis we can go with the regular shape structure.
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