COMPARISON AND ANALYSIS OF MULTI-STOREYED BUILDINGS OF VARIOUS CONFIGURATIONS IN SEISMIC ZONES V

Ameet Paul Singh[1], Pradeep Singh Sodhi[2], Ubaid Bashir[3]
[1]Alumni, Civil Engineering Department, SRMIST, Modinagar, Uttar Pradesh, India
[2]Alumni, University of California, Los Angeles, CA, United States of America
[3]Alumni, Civil Engineering Department, PES University, Karnataka, India

Abstract: Zone V falls under the category of an extremely severe zone. It covers 10.79 percent of the land area of India. Human towns and structures sustain severe damage and destruction as a result of the ground surface deformation brought on by the earth's crust's vertical and horizontal movement. The main goal of this project is to investigate the stability and structural behavior of multistory RC structures for various plan configurations, including rectangular buildings along with L-, C-, I-shaped, and T- shaped buildings using ETABS. Calculating loads and assessing the entire structure using ETABS for static analysis. The analysis is the process of predicting the behavior of the structure under specified load conditions. The use of Software to design and analyze structure helps save more time and can give results with a high level of accuracy. Comparison and analysis of commercial buildings with different shapes, i.e, C-, I-, L-, rectangular and T-shaped building is the main purpose of this work. The definition of a commercial building is based on its use, i.e, more than 50% of floor space is used for commercial purposes. The effect of seismic and wind forces on buildings with different shapes and configurations has been analyzed by utilizing ETABS software.

ETABS is an engineering software product that is utilized for the analysis and design of structures. Comparison and analysis are done as per the provisions of IS 456-2000. M30 grade of concrete and Fe-415 steel is adopted. Load combinations are taken as per IS 875-part 5 (2015). Live loads are taken as per IS 875-part 1. Earthquake zone 5 is adopted for analysis. Load combinations of 1.2(DL + LL + EQ) are considered. Several concerns affect the performance of structures from which story drift, base shear, and story displacement play a crucial role in finding the behavior of structure against seismic loads. Results are conveyed in form of tables and bar charts. Story displacement increased with story height. The result shows that a building with an L shape shows the least amount of displacement in all stories while a building with T-shape has the least amount of shear and thus both are more stable and economical in comparison to all other users in the building analysis against seismic loads.

Keywords: Etabs, Zone V, Storey Shear, Storey Drift, Storey Displacement

1. INTRODUCTION

During an earthquake, a structure's damage often starts where a structural weakness in the building systems is present. High-Rise RC structures are a unique type of construction with unique characteristics and requirements. Numerous people frequently occupy these buildings, and as a result, their collapse, destruction, or loss of functionality may have highly negative effects on both the quality of life and the local economy in the impacted areas. Each high-rise construction represents a large investment, hence high-rise structure research is typically carried out using more advanced techniques and approaches. Tall buildings are primarily made to withstand Earthquake loads since the lives of the people inside them depend more on the amount of earthquake resistance the structure provides. Therefore, assessment of wind-generated pressure is essential for these kinds of tall structures. Thus, structural engineers and academics can benefit from understanding contemporary methods for seismic and wind load analysis of different shapes of high- rise RC buildings. The majority of constructions in contemporary times are characterized by irregular vertical and planar forms. Moreover, a significant amount of work is required to design and analyze such erratic structures. In other words, structures with irregular shapes are more likely to sustain damages or losses than those with regular ones. Therefore, extensive structural analysis is required for irregular structures to maintain acceptable behavior to sustain seismic forces. Most of the time, the plot that will be used to build a structure won't have a predictable shape. Therefore, the plot configurations may have an impact on the geometry of the structure. Studying the stability of buildings with various geometrical configurations and their seismic load responses will help in curtailing economic and property losses. By increasing a structure's seismic and wind resistance, a structural engineer can create a building that is structurally stable and reliable. The zone in which the structure is located determines the proper design or shape be provided. To prevent structural failure or to overcome property loss, it is essential to verify and plan according to each stage of the building process.

A structure's response to lateral stresses, base shear, story displacement, and story drift, is a key factor in determining how stable the structure is under seismic. Storey shear is the phrase used to describe the design seismic load to be applied at each floor height. Base shear is the summation of story shear. Hazard maps that depict seismic zones are updated periodically, indicating the presence of increased base shear pressure on existing structures. At each floor height, base shear pressure contributes to both the overall dead load and the live load. The highest permissible limit is suggested in the

IS standards for buildings for story displacement, which is the entire displacement of the story concerning the base. Story drift is represented as a ratio between the displacement of two succeeding floors and their height. Determining the Storey drift is crucial for building earthquake analysis. This paper compares and analyses buildings that have various configurations and shapes.

1.1 Classifications of buildings:

In this study, the behavior of G+7 multistory RC commercial structures with various plan configurations in seismic zone V is being investigated. IS 456-2000 is used for concrete design, and IS1893:2016 is used for building seismic analysis. The following list includes five different plan configurations that were taken into account for the seismic study of the same structure:

1. C-shape building
2. I-shape building
3. L-shape building
4. Rectangular shape building
5. T-shape building

2. LITERATURE REVIEW

- Researchers Arvindreddy and R.J. Fernandos [2015] looked into how regular and irregular buildings responded in zone V. ETABS was used for both static and dynamic approaches. It was determined that the static approach produced larger displacements than the dynamic method after comparing the displacements of both regular and irregular models for the various methods.
- Ravindra N. Shelke [2017] investigated the effects of numerous vertical irregularities on a structure's seismic response. He concluded that when seismic intensity increased from zone 2 to zone 5, base shear and lateral displacement increased with the height of the building, indicating a greater seismic demand the structure should be able to withstand.
- Milind V. Mohod [2015] has examined the impact of plan and form configuration on irregularly shaped constructions. Utilizing the structural analysis program STAAD Pro, it has been determined how irregularity (plan and form) affects structure. And he came to his conclusion after taking into account how lateral displacement affected various building and structural forms. In contrast to other basic shaped buildings (Core- rectangle, Foursquare, Regular building), he has seen that Plus-shape, L-shape, H-shape, E-shape, T-shape, and C-shape buildings have displaced more in both directions (X and Y). When gathering the software's data, story drift, which is a crucial element for understanding the drift need of the structure, is taken into account.

3. METHODOLOGY AND BUILDING SPECIFICATIONS

Here, a study of the behavior of G+7 buildings of various shapes in zone V is being conducted. The modeling was done using the standard program ETABS. It is a more flexible and user-friendly tool that provides a wide range of capabilities like static and dynamic analysis, non-linear dynamic analysis, and non-linear static pushover analysis, among others.

No. of stories	7
Concrete grade	M30 for columns and M30 for beams
Steel grade	HYSD415
Main beams size	300mm × 450mm
Plinth beams size	300mm × 450mm
Columns size	450mm × 450mm
Slab thickness	150mm
Live load	3 kN/m^2

4. OBJECTIVE

The objective of this work is as follows:

1. To Model RCC commercial buildings of different shapes using ETABS
2. To analyze the seismic load behavior of RCC Commercial buildings of different shapes using ETABS for earthquake zone V.
3. To compare the outcomes of the analysis of buildings of various shapes.

5. BUILDING DIMENSIONS AND MODELS WITH DIFFERENT SHAPES

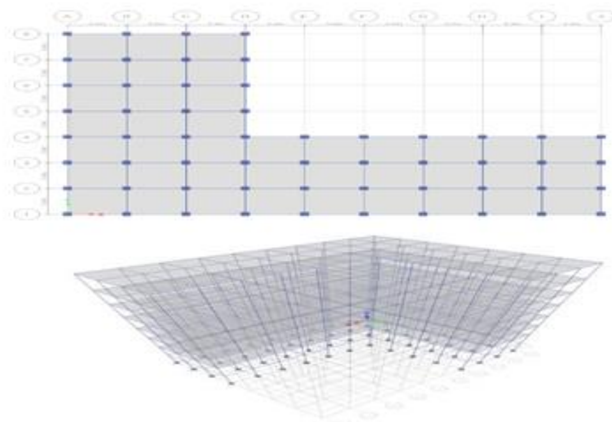

Figure 5.1 plan and 3D Elevation of L-Shaped Building

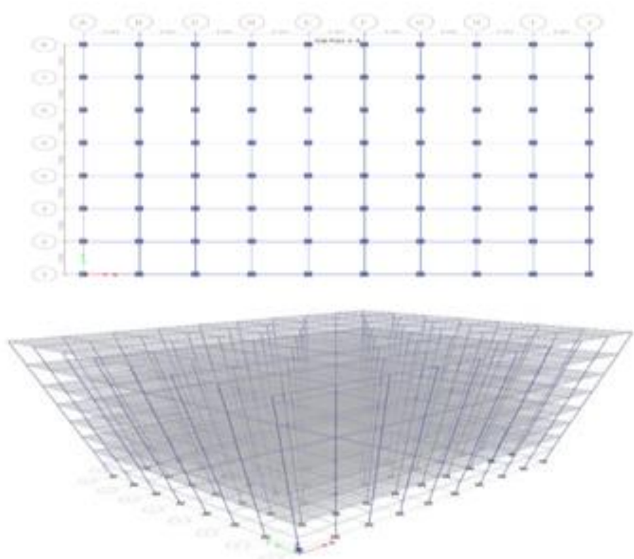

Figure 5.2 plan and 3D Elevation of Rectangular Building

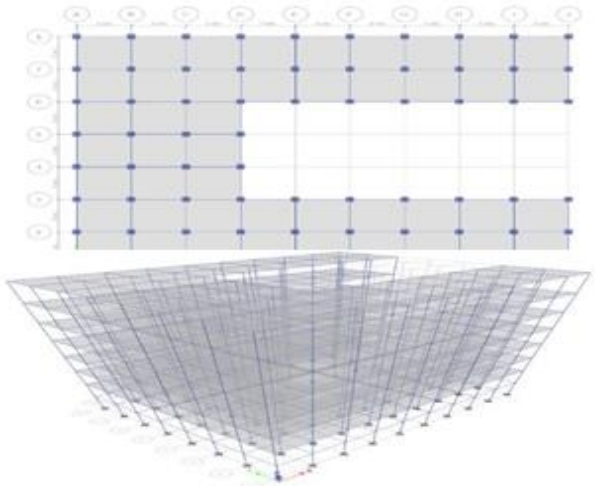

Figure 5.3 plan and 3D Elevation of C-Shaped Building

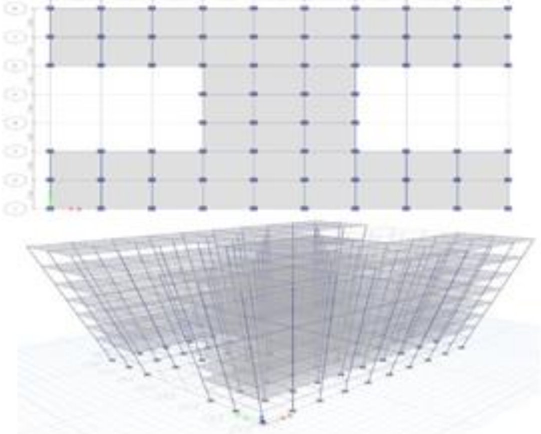

Figure 5.4 Plan and 3D Elevation of I-Shaped Building

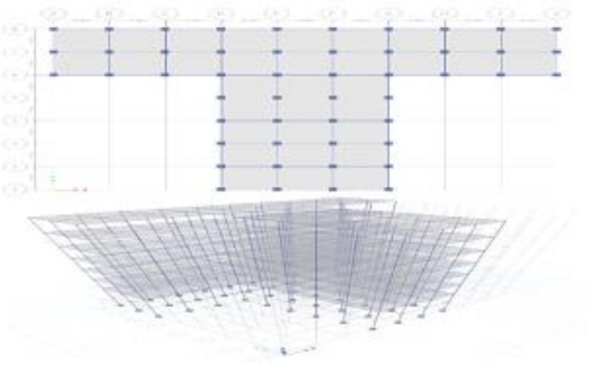

Figure 5.5 plan and 3D Elevation of T-Shaped Building

6. RESULTS AND DISCUSSIONS OF BUILDING OF ALL SHAPES

The five different types of RCC building frames analyzed are C-shaped, I-shaped, L-shaped, Rect-shaped, and T-shaped. The findings from the analysis of each building's structural behavior are tabulated and discussed in the manner as follows.

Table 6.1 Comparison of Maximum Displacement of Buildings of various shapes

Elev.	Displacement				
	C shaped	I shaped	L shaped	Rect. Shaped	T shaped
m		mm	mm	mm	mm
1.5	0	0	0	0	0
5	4.319	4.205	4.434	4.568	4.26
8.5	10.369	10.096	10.655	10.939	10.273
12	16.416	15.983	16.854	17.25	16.281
15.5	22.232	21.642	22.895	23.309	22.066
19	27.584	26.847	28.53	28.877	27.396
22.5	32.185	31.318	33.424	33.657	31.985
26	35.697	34.726	37.228	37.295	35.496
29.5	37.809	36.77	39.634	39.463	37.624

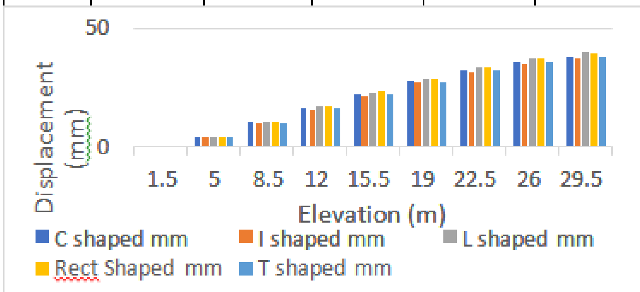

Figure 6.1 Showing results of Comparison of Maximum Displacement for all Buildings

Fig. No. 6.1 Shows that maximum story displacement increases with the height of the story. Table 6.1 shows that on the 7th floor of each building, the L-shaped building has the greatest displacement, while the I-shaped building has the least displacement.

Table 6.2 Comparison of story shear for Buildings of different Shapes

Elev.	Story shear				
	C Shaped	I Shaped	L Shap ed	Rect. Shap ed	T Shaped
m	kN	kN	kN	kN	kN
1.5	0	0	0	0	0
5	4309.37	4197.59	3563.97	5439.266	2964.74
8.5	4296.87	4185.63	3553.98	5424.734	2956.51
12	4209.62	4100.57	3481.83	5314.82	2896.36
15.5	4013.29	3909.19	3319.48	5067.512	2761.01
19	3664.27	3568.94	3030.86	4627.854	2520.39
22.5	3118.93	3037.31	2579.89	3940.888	2144.42
26	2333.63	2271.76	1930.5	2951.657	1603.03
29.5	1264.75	1229.77	1046.6	1605.204	866.128

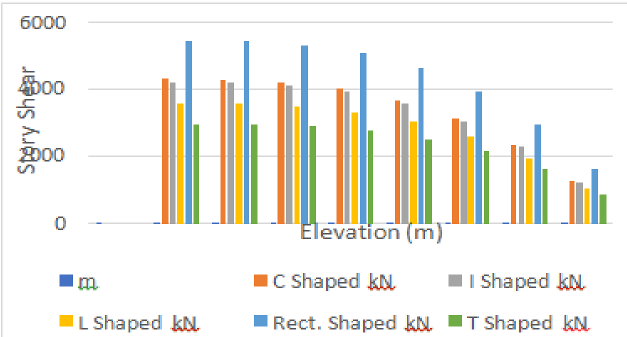

Figure 6.2 shows the comparison of Story shear for buildings of different shape

Figure No.6.2 Shows the result of the Story Shear of each building in X Direction when the Earthquake occurs in X-Direction.

Table 6.3 Comparison of Maximum Lateral/Storey Drift for Buildings of different Shapes

Elev.	Max Story Drift				
	C Shaped	I Shaped	L Shaped	Rect. Shaped	T Shaped
m					
1.5	0	0	0	0	0
5	0.001234	0.001202	0.00126	0.00130	0.0012
8.5	0.001757	0.00171	0.00180	0.00183	0.0017
12	0.001728	0.001682	0.00179	0.00180	0.0017
15.5	0.001662	0.001617	0.00173	0.00173	0.0016
19	0.001529	0.001487	0.00161	0.00159	0.0015
22.5	0.001315	0.001278	0.00139	0.00136	0.0013
26	0.001003	0.000974	0.00108	0.00103	0.0010
29.5	0.000604	0.000584	0.00068	0.00061	0.0006

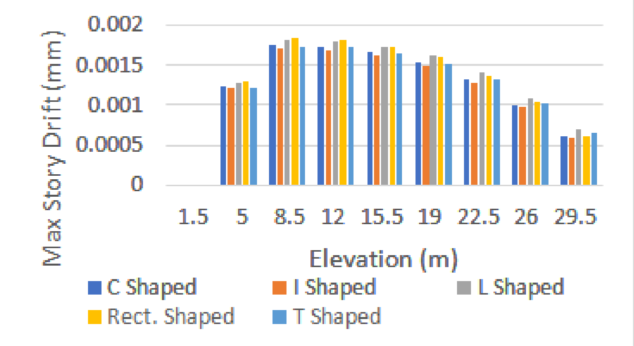

Figure 6.3 Showing results of Maximum Lateral/Storey Drift for Buildings of different Shapes

Table No.6.3 shows that in a rectangular-shaped building, the story drift is maximum on the 1st floor among all while it is least in I-Shaped at the top floor. The trend is such that Storey drift increases till the first floor and then decreases till the top floor for all different shapes of buildings.

7. CONCLUSIONS

- The Maximum displacement increases with an increase in elevation
- The top floor of the Building experiences the most displacement regardless of its shape.
- The maximum displacement is occurring on the rectangular shape of the building on all floors, except for the 7th floor, which shows the maximum displacement on the L-shaped building.
- The maximum amount of story shear occurs when the building has a rectangular shape
- The first floor of a rectangular shaped Building has the greatest story drift overall, whereas the top floor of an I- shaped building has the least story drift
- Buildings of all five shapes experience maximum story drift on the first floor.
- The maximum story shear occurs at the ground level for all shapes of Buildings
- The rectangular building has a story shear that far exceeds that of any of the building shapes.
- The results have shown that I-Shape buildings are much more stable than all other shapes.

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