Dynamic Analysis of Multistorey RCC Building with Different Irregularities

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Abstract: **Highrise reinforced concrete building construction is increasing in big cities. As a result, the structure becomes more vulnerable to lateral loads like wind and seismic loads as it becomes taller. Therefore, it is crucial that the building be safe from dynamic loads because their intensity changes over time. The response and behaviour of a G+20-story RCC-framed building with a horizontal plan and vertical irregularities with and without shear walls is studied in this study work. The square, L, and T shapes are the shapes taken into consideration for the study. The analysis method use is linear static analysis. The Effect of plan shape are studied in this paper in terms of storey drift, roof displacement and time period.**

Keywords: **Plan irregularity, Vertical Irregularity, Seismic Analysis, ETABS, Storey shear.**

1. INTRODUCTION

With the increase in the modern architecture, different complex design of buildings has been introduced in the construction field. These architectural works sometimes create problem for the structural engineer regarding the structure's stability and safety. In most of the cases it is the vertical irregularity of the building. When the seismic forces act on this structure, it leads to the irregular distribution in their mass, stiffness and height of the buildings. High-rise structures are subjected to various static and dynamic load and their combinations during their life span. These various loads sometime affect the performance of the building due to the irregularities in their shape and geometry. Generally symmetrical shape is preferred for design of any structure as it distributes the load uniformly across the cross section of the building. In all the structures, its vertical and horizontal geometry plays an important role in transferring the load to the base. With different type of geometry building behaves differently. Some of the main components are considered while designing the structures like deflection, lateral displacement, drift capacity, moment of inertia, stiffness of building, overturning moment etc. change in the geometry of the building greatly affect these parameters. Various shapes like rectangular, L-shape, I-shape, O-shape, T-shape, and U-shape in has been analysed for seismic zone V. The findings suggest that most of the buildings exceed the permissible drift limit and the permissible displacement limit [1]. It has been also concluded that displacement in rectangular shaped building is less than C shaped Building. The base shear value from dynamic analysis is more than the base shear from static analysis for both shape of building. Overturning moment is more in rectangular shaped building than in C-shaped building. The stiffness decreases with increase in storey height of the building [2]. The objective of the study is to contribute to an understanding of the effects on plan and vertical irregular structures with and without shear wall subjected to seismic loading and comparison of their output results to understand its behaviour.

2. METHODOLOGY

The linear static analysis is performed on three complex shaped RC framed structures. Following methodology was followed in the current work: -

1. Selected complex geometry shaped square shaped, L- shaped, T-shaped (in the plan) RC Framed structures were modelled and analysed by static analysis method for zone 4.
2. The structure was analysed by static method.
3. The results so obtained in the analysis of such structure with different shapes were studied and compared to understand the extent of response of structure in both conditions.
4. With the same procedure structures of different shapes having vertical irregularities were analysed and results were obtained.

3. STRUCTURAL MODELLING

G+20 high rise building and obtain performance of different shape of structures located in Zone 4 for the following case:

1. Plan Irregular Building without Shear Wall
- WSP – S (Square shape building without shear wall)
- WSP – L (L- shape building without shear wall)
- WSP – T (T- shape building without shear wall)

2. Vertical Irregular Building without Shear Wall
- WSV – S (Vertically Irregular Square shape building without shear wall)
- WSV – L (Vertically Irregular L- shape building without shear wall)
- WSV – T (Vertically Irregular T- shape building without shear wall)

3. Plan Irregular Building with Shear Wall
- SP – S (Square shape building with shear wall)
- SP – L (L- shape building with shear wall)

- SP – T (T- shape building with shear wall)

4. Vertical Irregular Building with Shear Wall

- SV – S (Vertically Irregular Square shape building with shear wall)
- SV – L (Vertically Irregular L- shape building with shear wall)
- SV – T (Vertically Irregular T- shape building with shear wall)

Table 1. Geometrical parameters of Structures (G+20)

S. No.	Parameter	Details
1	Plan shapes	Square, L, T shaped
2	Plan Dimensions	35 X 35 sq. m.
3	Storey	20
4	Span	5 meter
5	Floor Area	1600 sq. m.
6	Height of Building	60 m
7	Storey Height	3 m
8	Beam Size	400mm X 800mm
9	Column Size	1000mm X 1200mm
10	Width of Shear Wall	500 mm
11	Grade of Concrete	M30
12	Seismic Zone	IV
13	Grade of Rebar	HYSD 500

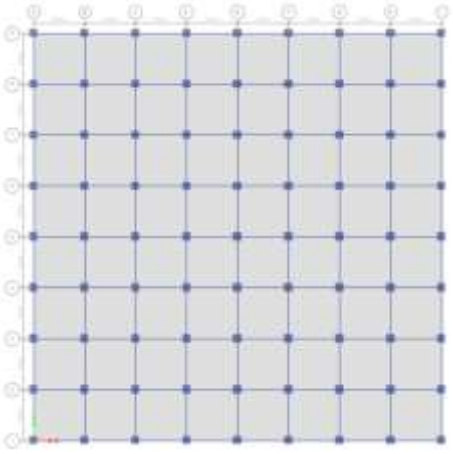

Fig. 1 Plan Square Shaped

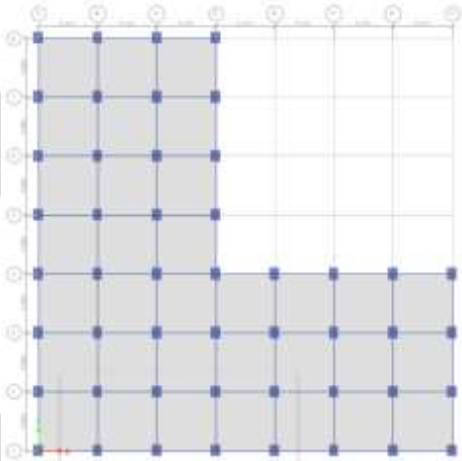

Fig. 2 Plan L-Shaped

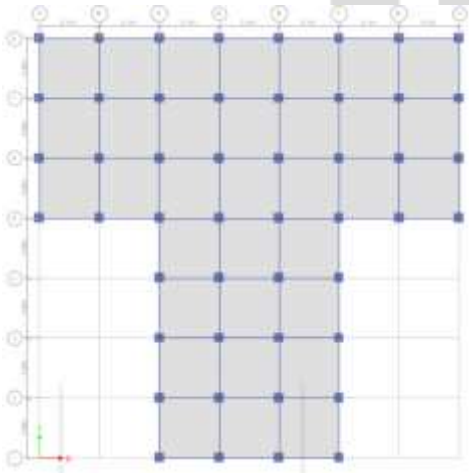

Fig. 3 Plan T- Shaped geometry

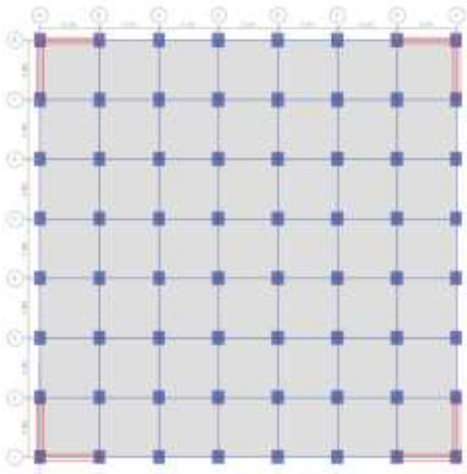

Fig. 4 Plan Square shaped with Shear Walls

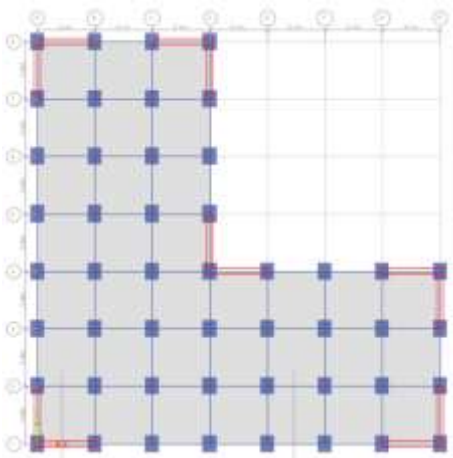

Fig. 5 Plan L shaped with Shear Walls

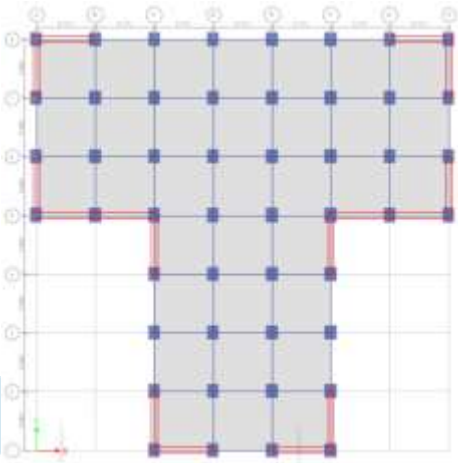

Fig. 6 Plan T shaped with Shear Walls

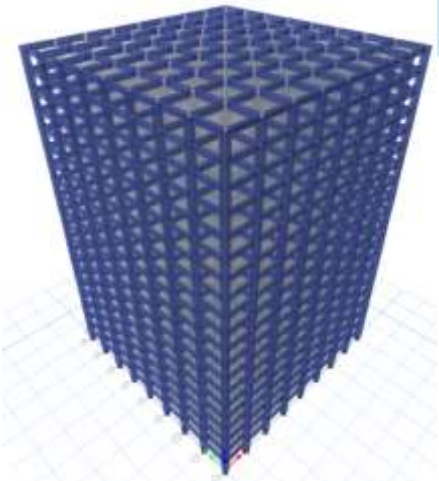

Fig. 7 3D View Square Shaped

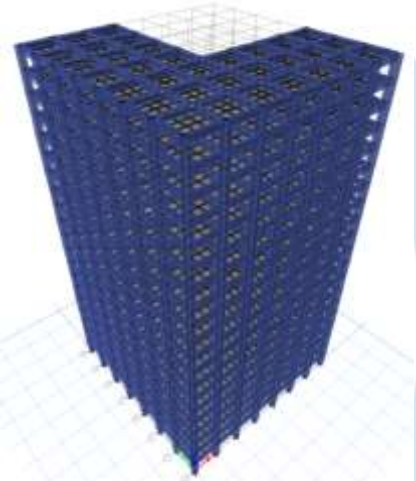

Fig. 8 3D View L-Shaped

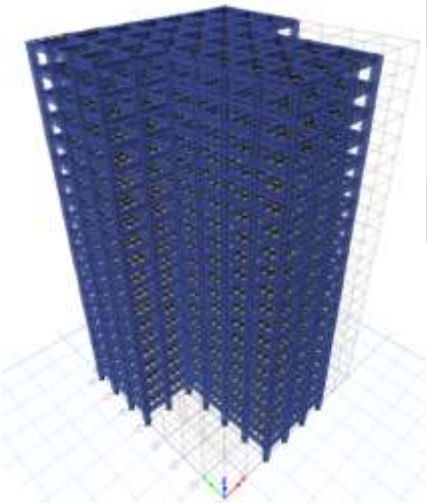

Fig. 9 3D View T-Shaped

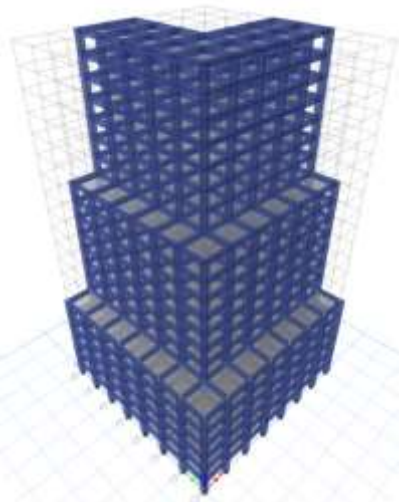

Fig. 10 3D View L-Shaped Vertical Irregular

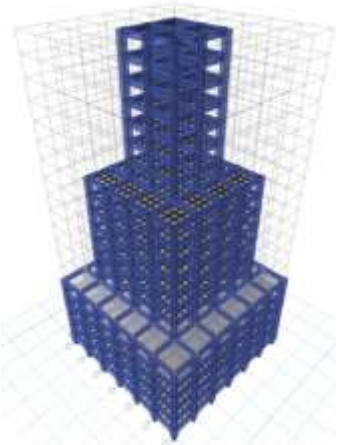

Fig. 11 3D View Square Vertical Irregular

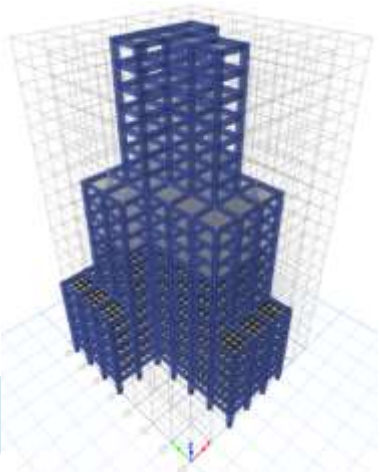

Fig. 12 3D View T-Shaped Vertical Irregular

5. RESULTS AND DISCUSSIONS

The results are so obtained that were influenced by seismic load are discussed & compared to understand the effects of specially shaped structure on different seismic parameters of structures and its performance.

5.1 Roof Displacement

For plan irregular shaped building, it has been found that in T- shaped building has observed about 86% more roof displacement as compare to square and L – Shaped buildings. On incorporating shear wall, it has been found that in T- shape building has observed about 65% more roof displacement as compare to square and L – Shape building.

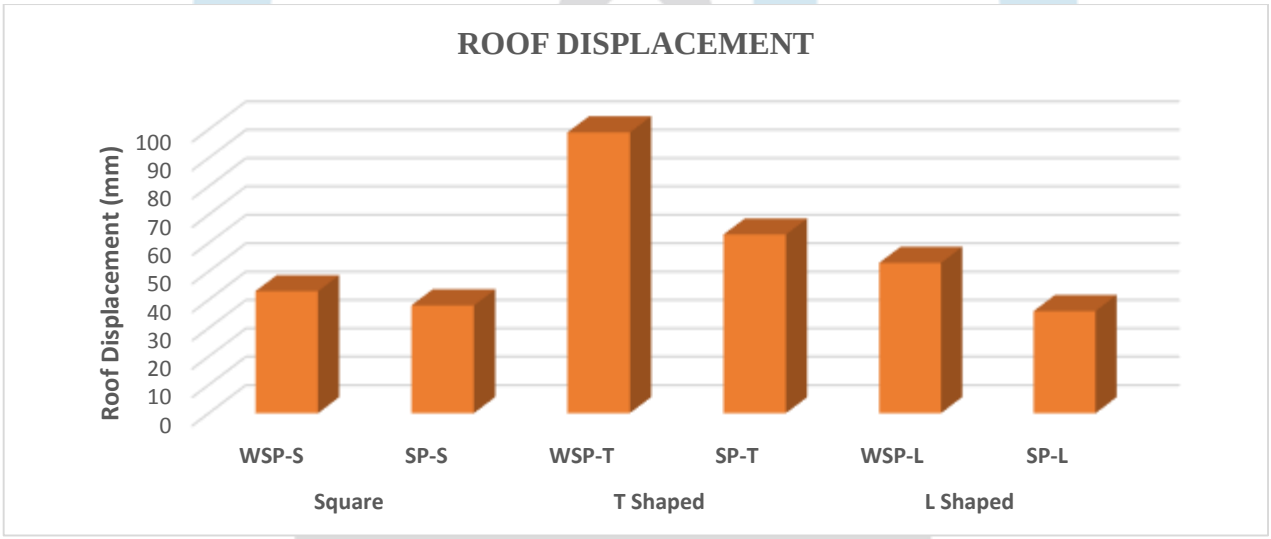

Fig. 13 Roof Displacement for Plan Irregular Building

For vertical irregular shaped building, it has been found that in all three buildings have similar roof displacement. On incorporating shear wall, it has been found that in square shaped building has observed about 46% more roof displacement as compare to L and T – Shaped building. Since due to vertical irregularity T and L shaped buildings have a greater number of shear walls due to which roof displacement decreases.

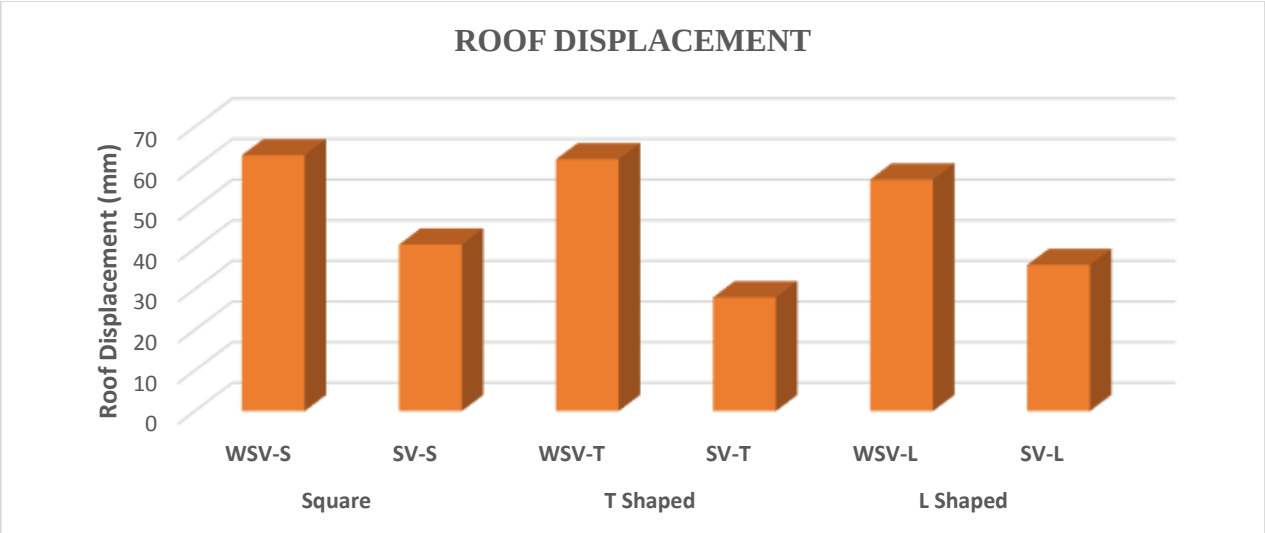

Fig. 14 Roof Displacement for Vertical Irregular Building

5.2 Time Period

For plan irregular shaped building, it has been found that in L and T- shaped building has observed about 17% more time period as compare to square shaped buildings. On incorporating shear wall, it has been found that in T - shaped building has observed about 20% less time period as compare to square and L – Shape building.

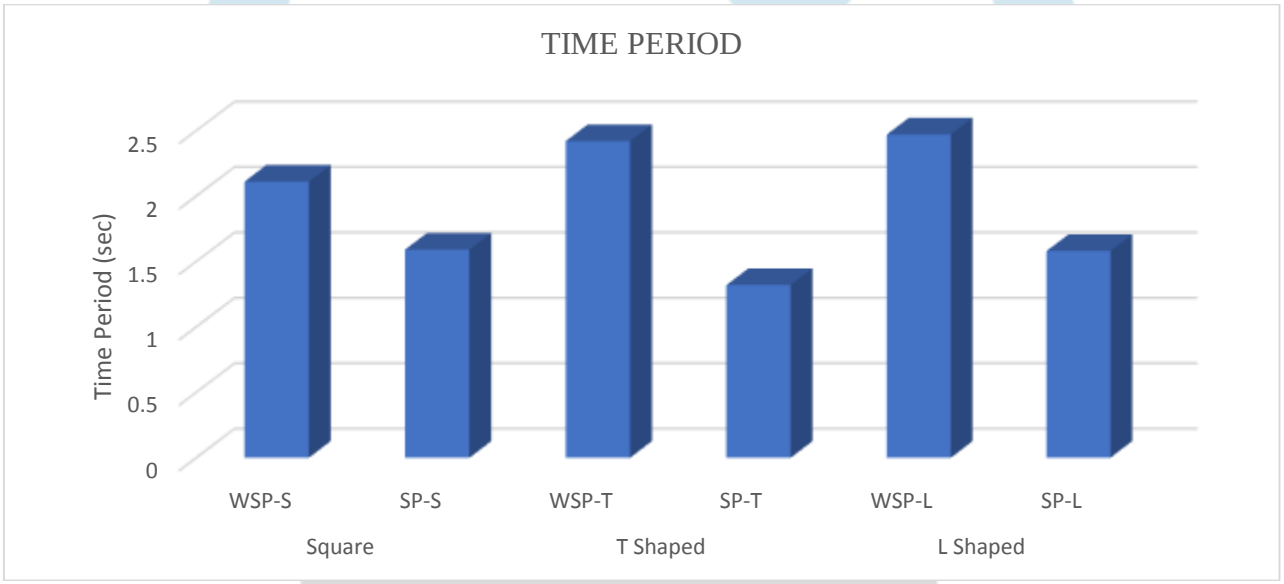

Fig. 15 Time Period for Plan Irregular Building

For vertical irregular shaped building, it has been found that in L and T- shaped building has observed about 10% more time period as compare to square shaped buildings. On incorporating shear wall, it has been found that in T - shaped building has observed about 50% less time period and L – shaped building has 18% as compare to square shaped building.

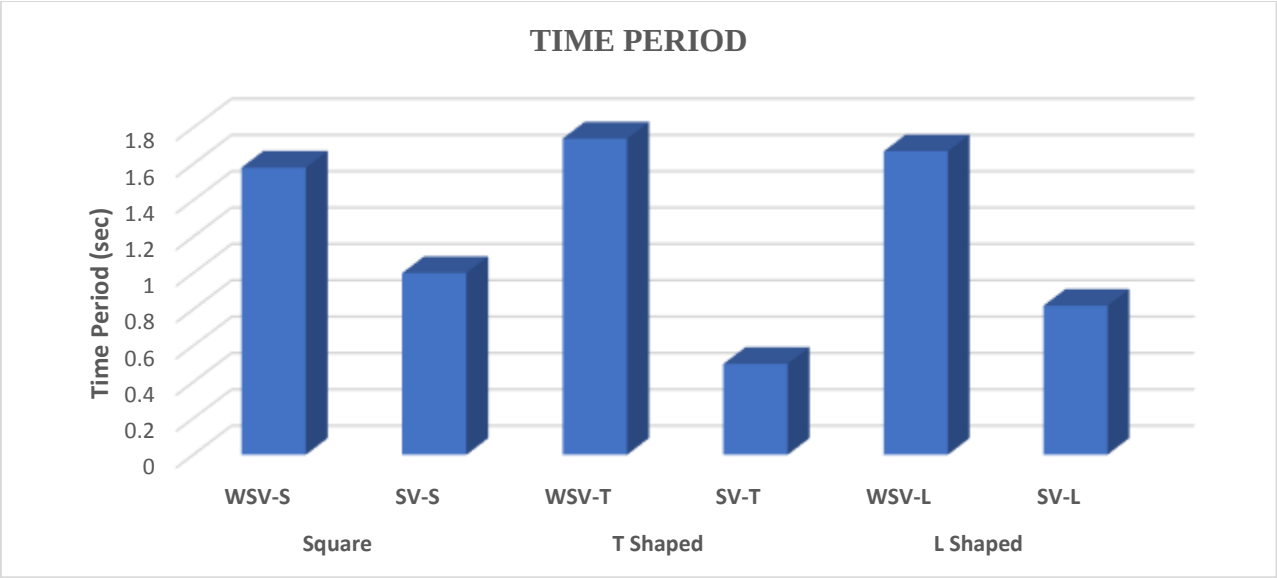

Fig. 16 Time Period for Vertical Irregular Building

5.3 Storey Drift

For plan irregular building without shear wall the maximum storey drift of T-shaped RC structure are more than the drift in Square and L-shaped structure while incorporating shear wall in plan irregular structure the maximum storey drift of RC buildings first increases till storey 15 and then gradually decreases in all shaped structure. The maximum value for drift is attained by T-shaped structure on 15th storey as compared to Square and L shaped structure.

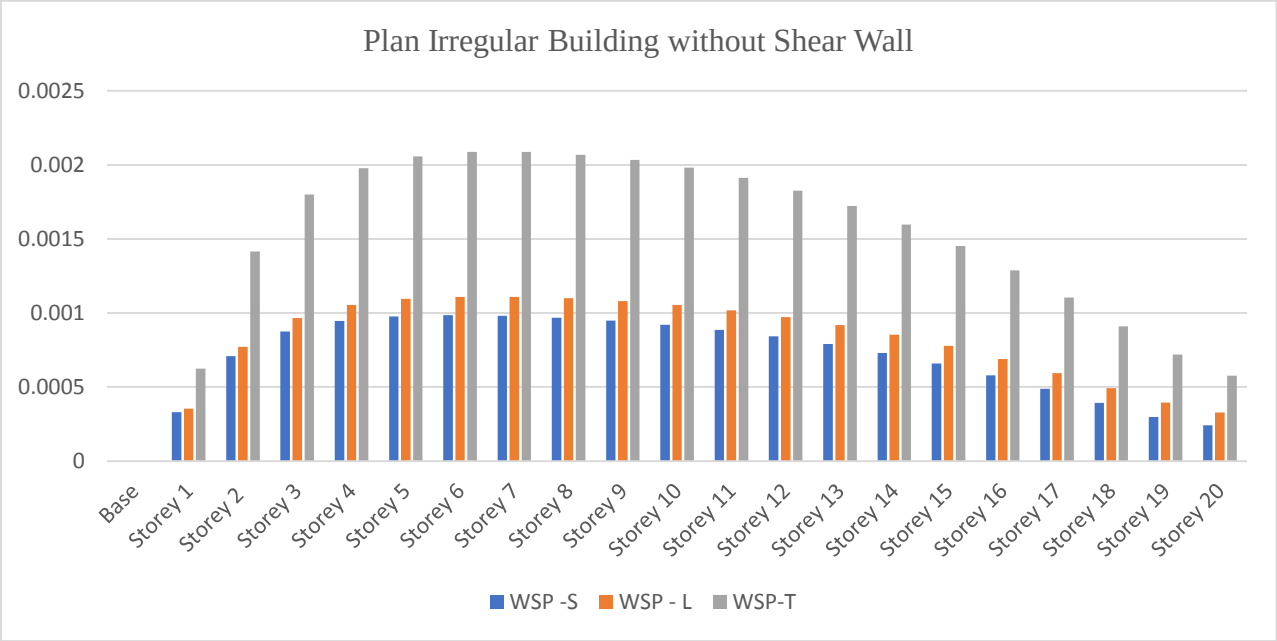

Fig. 17 Storey Drift for Plan Irregular Building without Shear Wall

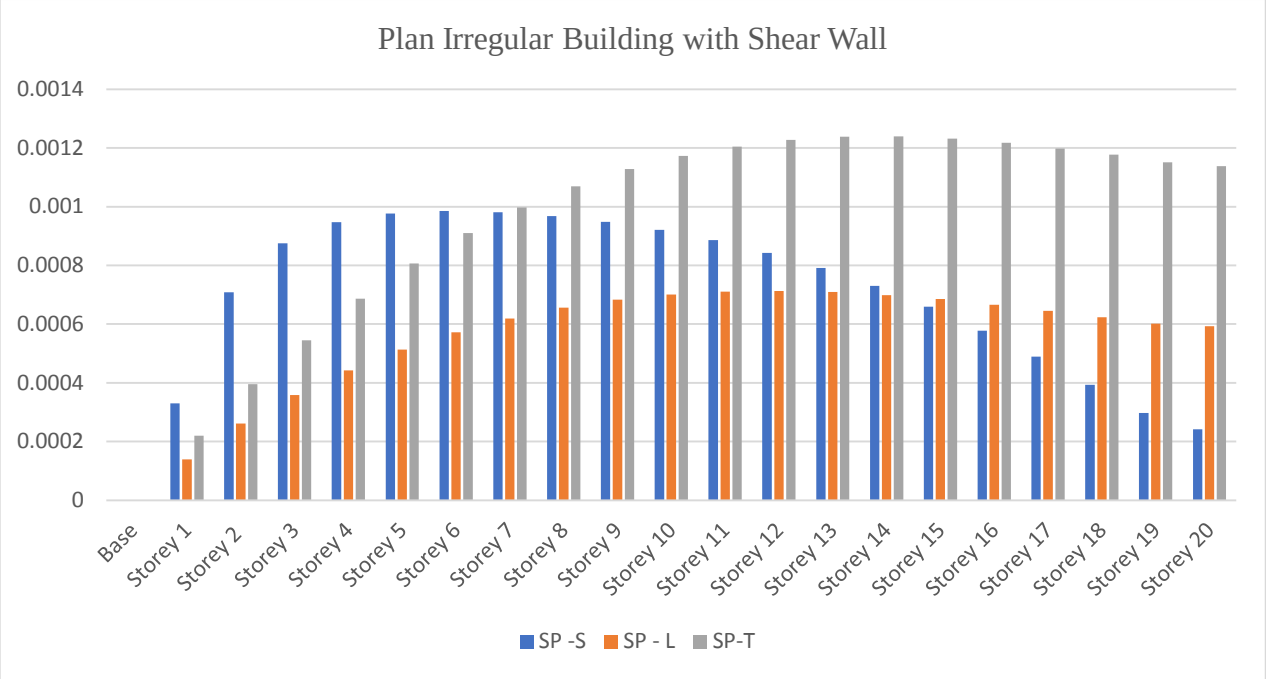

Fig. 18 Storey Drift for Plan Irregular Building with Shear Wall

For vertical irregular building without shear wall the maximum storey drift of RC structure first increases till storey 15 and then gradually decreases in all shaped structure in both (x & y directions). The maximum value for drift is attained by Square shaped structure on 15th storey as compared to L and T shaped structure. For vertical irregular building with shear wall the maximum storey drift of RC structure first increases till storey 15 and then gradually decreases in all shaped structure in both (x & y directions). The maximum value for drift is attained by L-shaped structure on 17th storey as compared to Square and T shaped structure.

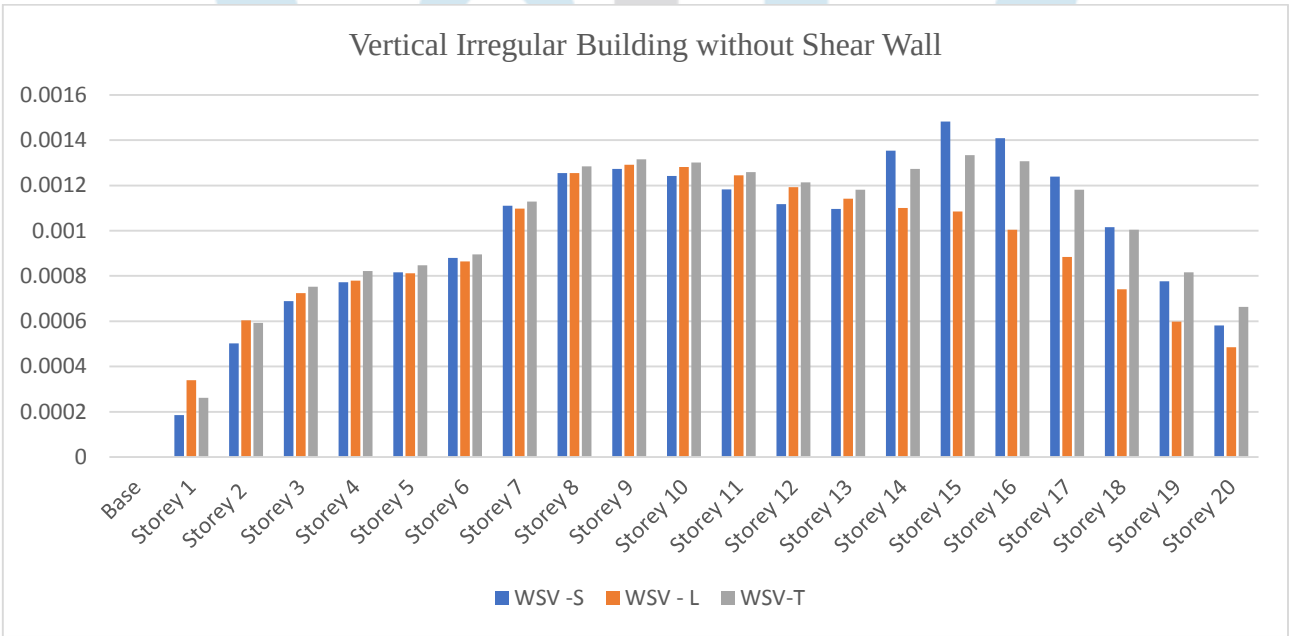

Fig. 19 Storey Drift for Vertical Irregular Building without Shear Wall

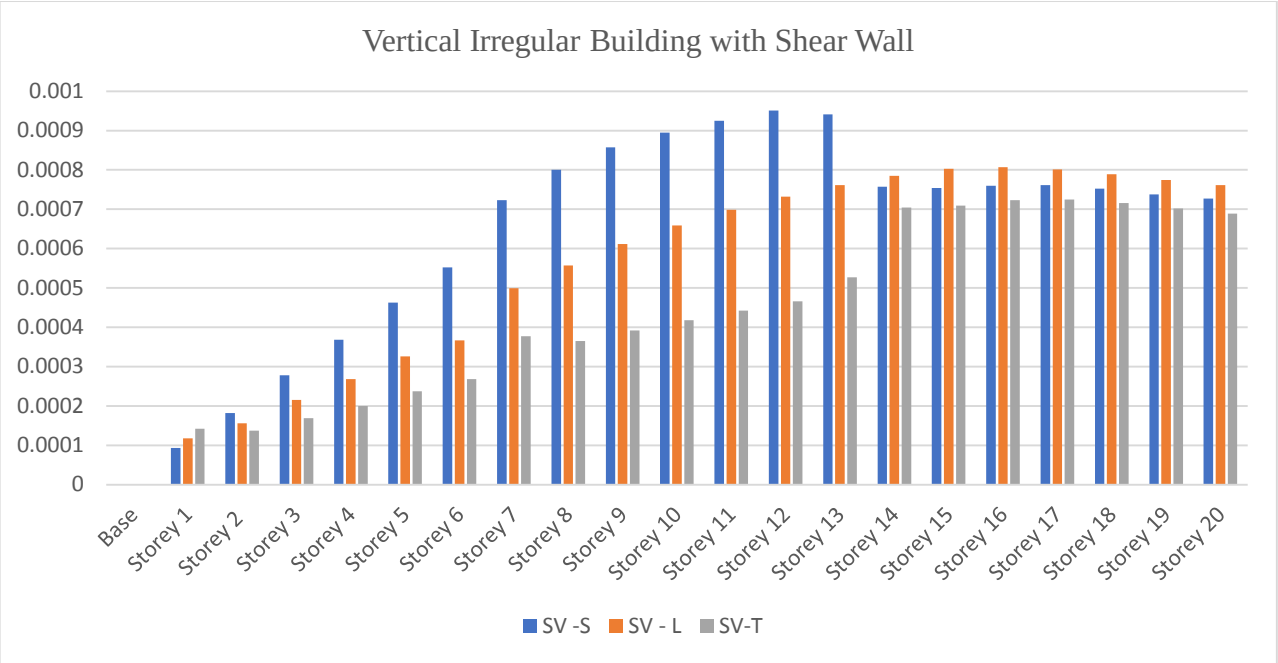

Fig. 20 Storey Drift for Vertical Irregular Building with Shear Wall

6. CONCLUSIONS

Following conclusion has been drawn from the study-

1. T- shaped plan irregular building is more vulnerable for roof displacement but for vertical irregular building L and T shaped building perform better as compare to square building these buildings have a greater number of shear walls due to which roof displacement decreases.
2. On comparing buildings behaviour on the basis of time period it has been found that L shaped building have greater value but for vertical irregular building square and L shaped building have larger values of time period.
3. Storey drift results shows that for plan irregular building, T- shaped building have the largest values of storey drift.
4. For vertical irregular building without shear wall shows that storey drift for square and T shaped building increases in upper stories while on analysing the same buildings with shear wall T and L shaped buildings performs well as compare to square shaped building.

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