Seismic analysis of a multi- storied building for different plan configurations using E-tabs

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Abstract : This paper consists of the work made on the study of seismic analysis on the multi- storied building by maintaining same floor area for all four different plan configurations. To make the analysis of these different four plan configurations, the modelling is done prior in the ETABS:2016 (Extended Three-Dimensional analysis of building system). An effort is made by providing all the load combinations and the performance of each plan is analysed individually and the comparison is made between symmetrically and asymmetrically plan configurations by keeping the floor area constant. After completion of the analysis, the comparison of storey displacement, base shear and storey drift is made and conclude that the symmetrical plans are superior when compared to asymmetrical plans in the view of the resistance against the seismic forces. Further the expansions joints are to be provided in the asymmetrical plans to ensure the safety against the seismic forces.

1 Introduction

In the field of structural engineering the asymmetric structures cause severe damage due to seismic waves caused during the earthquake than that of symmetric counterparts. The consideration such as the plan irregularity one among the common types of irregularities found in the conventional structures. The scarcity of land, improper urban planning, the variation in the functionality of the structure and the aesthetic requirement of the structure leads to design asymmetric building even in high elevation regions of India. The seismic analysis is mandatory to perform the designing of such structures but it is not a common practice and lack of knowledge[1] about earthquake design in that region.

The multi storeyed buildings have become very much common in the urban areas due to scarcity of land that leads to increase in the cost of land. This scarcity of land is due to rapid urbanization that leads to construction of multi storeyed building[1]. Many of the structures are irregular either in stiffness, mass distribution or shape. In order to meet all the codal requirements the structure may be constructed with irregular configurations, but when compared to regular configuration this structure performance will not be as good as irregular[2] In civil engineering seismic analysis plays an important role in structural engineering and makes the structure safe, economic, aesthetic, stable and the values such as base shear and the displacement are to be considered and taken into account to check the stability of the structure with even seismic forces[3] The standard process for the analysis of multi-storied building is done by ETABS by following [4]. E-Tabs can design and check for the concrete and steel frames, composite columns, composite beams, masonry and concrete shear walls and steel joists. The comprehensive and customizable reports will be available foe the analysis and design outputs [5]. The pushover analysis gives the perfect than remaining analysis [6]

2 Different plan configurations considered for the study

In this study, 4 different plan configurations are considered by maintaining the same floor area for each plan. The plans considered for the study are as shown in fig 1,2,3 and 4.

(I) L – Shaped
(II) T - Shaped
(III) U – Shaped
(IV) Rectangular Shaped

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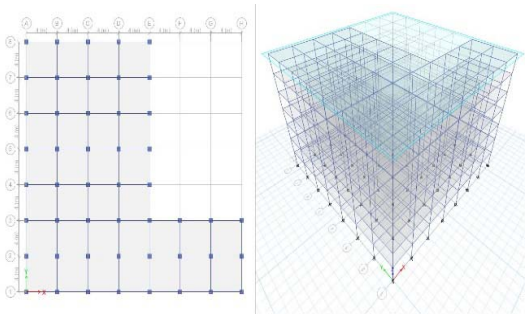

Fig.1. L-Shaped Plan and elevation of 8 storied building

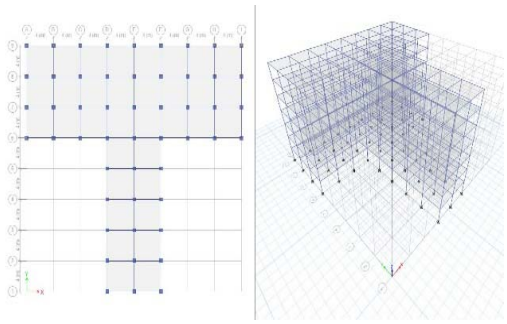

Fig.2. T-Shaped Plan and elevation of 8 storied building

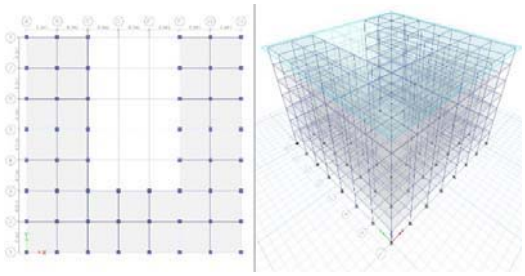

Fig.3. U- Shaped plan and elevation of 8 storied building

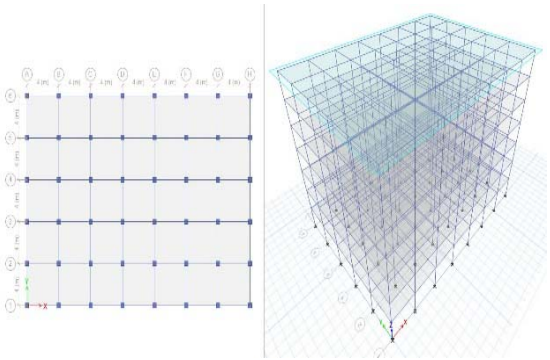

Fig.4. Rectangular Shaped Plan and elevation of 8 storied building

3 Specifications of material and building description

A 8 storied building of different plan configurations with same floor area is considered in the study of seismic analysis. A multi- storied building with fixed conditions, the size of the column being 450mm x 450mm, the size of the beam being 300mm x 350mm, the thickness of the main wall being 230mm, density of the concrete being 25KN/m^3, the density of the bricks being 20KN/m^2. The grade of concrete used in this analysis is M30 and the grade of steel for the study is Fe-415.

Table 1. Parameters considered in the seismic analysis of the Ordinary Moment Resisting Frame

Type of building	SMRF
No. of storeys	8
Plan configuration	L-shaped, T-shaped, U-shaped, Rectangular shaped
Seismic zone	V
Soil type	Medium soil
Importance Factor	1.5
Response Reduction Factor	5

4 Results

The responses such as Base shear, maximum storey displacement and Maximum storey drift of the models considered in the study are tabulated below

4.1 Base Shear

Table 2. Base shear values with respect to plan of the building

Plan of the Building	**Base Shear Values (KN)**
L-shaped	3095.58
T-Shaped	3125.73
U-Shaped	3320.92
Rectangular shaped	3067.10

4.2 Maximum storey displacement

Table 3. Maximum storey displacements in X and Y direction with respect to plan of the building

Plan of the Building	Maximum Storey Displacement (mm)	
	X-direction	Y-direction
L-shaped	54.21	2.5000
T-Shaped	56.39	3.6000
U-Shaped	57.43	2.9000
Rectangular shaped	67.64	0.0217

Fig.5. Comparison of maximum storey displacements for symmetric and asymmetric plans in seismic X direction

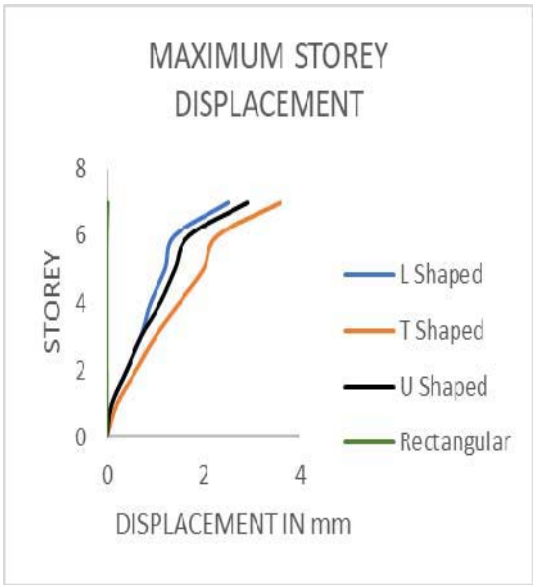

Fig.6. Comparison of maximum storey displacements for symmetric and asymmetric plans in seismic Y direction

4.3 Maximum storey drift

Table 4. Maximum storey shear in X and Y direction with respect to plan of the building

Plan of the Building	Maximum Storey Drift (unitless)	
	X-direction	Y-direction
L-shaped	0.002922	0.002938
T-Shaped	0.003071	0.002836
U-Shaped	0.003134	0.002712
Rectangle shaped	0.005475	0.005655

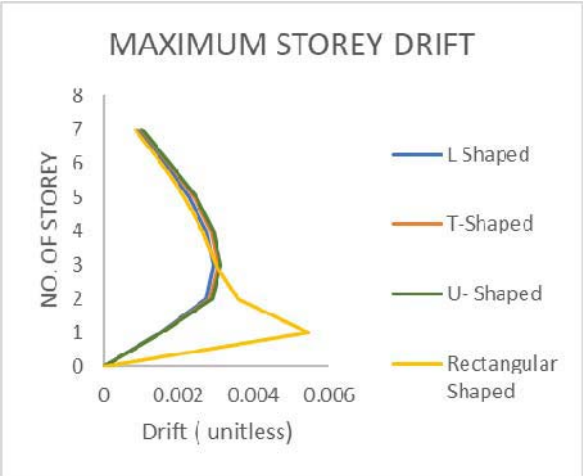

Fig .7. Comparison of maximum storey drifts for symmetric and asymmetric plans in seismic X direction

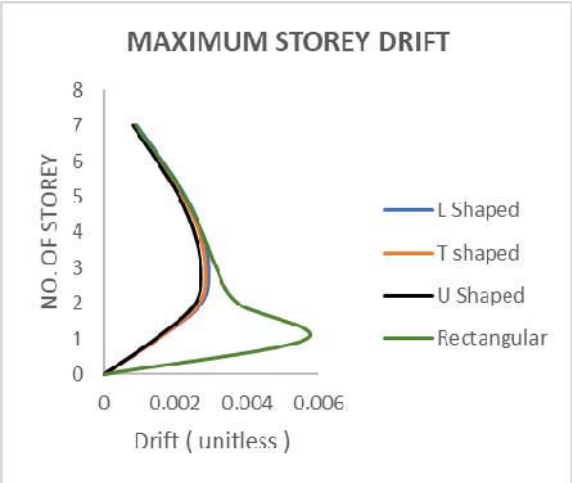

Fig .8. Comparison of maximum storey drifts for symmetric and asymmetric plans in seismic Y direction

5 Conclusions

From the design and analysis of Buildings, following conclusions have been drawn :

1. The base shear of the rectangular shaped building is found to be 3067.13 KN.
2. The base shear value of the L-Shaped ,U-shaped and T-shaped building is found to be increased by 9.12 %, 18.9 % and 8.20% respectively.
3. The maximum storey displacement for rectangular shaped building in X and Y direction for static load case is 67.64 and 0.0217 respectively.
4. The maximum storey displacement for L-shaped, U-shaped and T-shaped building when compared to rectangular shaped building was found to be increased by 23.09 %,&26.33 %, 19.51 % & 28.86 % and 17.71 % & 32.09 % in X and Y direction respectively.
5. The maximum storey drift for Rectangular shaped building is found to be 0.005475 and 0.0000004 in X and Y direction respectively.
6. The maximum storey drift for L- Shaped, T-shaped, U-shaped building is found to be decreased by 46.63%& 48.04 %, 43.90% & 49.84 % and 42.75 % & 52.04 % in X and Y direction respectively.
7. The maximum storey displacement and maximum storey drift for symmetric building is found to be higher than the asymmetric building.

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