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Seismic Analysis of Multistoried RCC Buildings Regular and Irregular in Plan

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Abstract— **This paper focuses on the study of seismic response of buildings having regular and irregular plan configurations. RC buildings (Regular and Irregular) of height G+6, G+9 & G+14 having re-entrant corners are selected for this study. FEM modelling and analysis was carried out using ETABS software. Response spectrum Analysis is carried out for seismic zones (II to V) specified in IS 1893 (Part I): 2002 with soil types II(medium stiff). Linear Static Dynamic Analysis has been performed to understand the performance characteristics of the irregular structures in comparison with regular RC structures. Further, the response obtained for each structure in different zones and heights are compared. It is observed from the results that the irregular building has maximum displacement compared to regular building maximum story shear is observed in regular building**

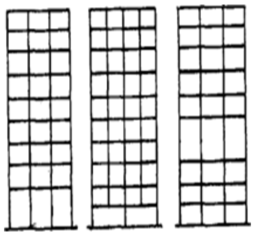
Keywords— ETABS, Seismic Analysis, Storey Shear,Storey Drift, Base shear, response spectrum

I. INTRODUCTION

A large portion of India is susceptible to damaging levels of seismic hazards. Hence, it is necessary to take in to account the seismic load for the design of structures. In buildings the lateral loads due to earthquake are a matter of concern. These lateral forces can produce critical stresses in the structure, induce undesirable stresses in the structure, induce undesirable vibrations or cause excessive lateral sway of the structure. Sway or drift is the magnitude of the lateral displacement at the top of the building relative to its base. Traditionally, seismic design approaches are stated, as the structure should be able to ensure the minor and frequent shaking intensity without sustaining any damage, thus leaving the structure serviceable after the event. The structure should withstand moderate level of earthquake ground motion without structural damage, but possibly with some structural as well as non-structural damage. This limit state may correspond to earthquake intensity equal to the strongest either experienced or forecast at the site. In present study the results are studied for response spectrum method.

A. Plan Irregularity

Asymmetric or plan irregular structures are those in which seismic response is not only translational but also tensional, and is a result of stiffness and/or mass eccentricity in the structure. Asymmetry may in fact exist in a nominally symmetric structure because of uncertainty in the evaluation of center of mass and stiffness, inaccuracy in the measurement of the dimensions of structural elements.



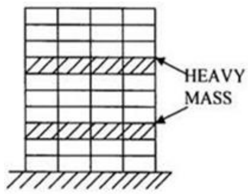


Fig No -1.1Mass irregularity Fig No -1.2: Stiffness irregularity

B. Torsion Irregularity:

To be considered when floor diaphragms are rigid in their own plan in relation to the vertical structural elements that resist the lateral forces. Tensional irregularity to be considered to exist when the maximum storey drift, computed with design eccentricity, at one end of the structures transverse to an axis is more than 1.2 times the average of the storey drifts at the two ends of the structure

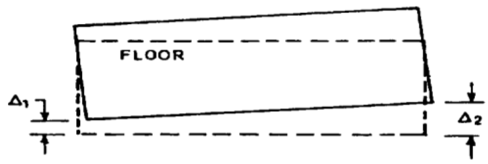


Fig No -1.3: Torsion irregularity [IS 1893:2002]

C. Re-entrant Corners

Plan configurations of a structure and its lateral force resisting system contain re-entrant corners, where both projections of the structure beyond the re-entrant corner are greater than 15 % of its plan dimension in the given direction

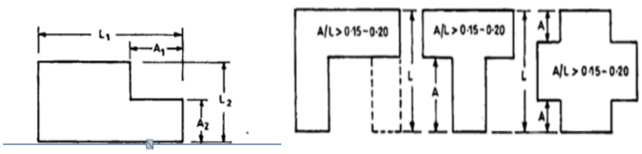


Figure No-1.3: Re-entrant corner irregularity [IS 1893:2002]

The response spectrum technique is really a simplified special case of modal analysis. The modes of vibration are determined in period and shape in the usual way and the maximum response magnitudes corresponding to each mode are found by reference to a response spectrum. The response spectrum method has the great virtues of speed and cheapness.

There are two major disadvantages of using this approach First, the method produces a large amount of output information that can require an enormous amount of computational effort to conduct all possible design checks as a function of time. Second, the analysis must be repeated for several different earthquake motions in order to assure that all the significant modes are excited, since a response spectrum for one earthquake, in a specified direction, is not a smooth function. According to the code, dynamic analysis may be performed using either response spectrum method or the time history method. In either method, the assure that all the significant modes are excited, since a response spectrum for one earthquake, in a specified direction, is not a smooth function. According to the code, dynamic analysis may be performed using either response spectrum method or the time history method

II. LITERATURE REVIEW

Milind V. Mohod[1](2015), has studied the effects of plan and shape configuration on irregular shaped structures. The effect of irregularity (plan and shape) on structure has been carried out by using structural analysis software STAAD Pro. V8i. And he concluded that considering the effect of lateral displacement on different shapes of the building of the structure. He has been observed that, Plus-shape, L-shape ,H-shape, Eshape, T-shape and C-shape building have displaced more in both direction (X and Y) in comparison to other remaining simple shaped building (Core-rectangle, Core-square, Regular building).The storey drift being the important parameter to understand the drift demand of the structure is considered while collecting the results from the software.

Mohammed yousuf et al. (2013) [2]They made a study on dynamic analysis of reinforced concrete building with plan irregularity for Four models of G+5 building with one symmetric plan and remaining irregular plan have been taken for the investigation. The analysis of R.C.C. building is carried out with the FE based software ETABS 9.5. Estimation of response such as; lateral forces, base shear, storey drift, storey shear is carried out. Four cross sectional variation in columns section are considered for studying effectiveness in resisting lateral forces.

Arvindreddy and R.J.Fernandes [2015 [4]: investigated the response of regular and plan irregular structures under zone V. Static and dynamic methods were conducted using ETABS. The displacements of both regular and irregular models were compared for the different methods and it was concluded that static method gave higher displacements compared to dynamic method.

Mohammed Rizwan Sultan ,D. Gouse Peera(2015)[3] in this paper they have made dynamic analysis on multi storied structure for different shaped this study is to grasp the behavior of the structure in high seismic zone and also to evaluate Storey overturning moment, Storey Drift, Displacement, Design lateral forces. They have consider different shapes like Rectangular, L-shape, H-shape, and C-shape The complete models were analyzed with the assistance of ETABS 9.7.1 version The results indicates that, building
with severe irregularity produces more deformation than those with less irregularity particularly in high seismic zones. And conjointly the storey overturning moment varies inversely with height of the storey. The storey base shear for regular building is highest compare to irregular shape buildings.

III. BUILDING DETAILS

Here the study is carried out for the behavior of G+14,G+19,G+6 and building with different shapes in all zones. The general software ETABS has been used for the modeling. It is more user friendly and versatile program that offers the wide scope of the features like static and dynamic analysis, non- linear dynamic analysis and non-linear static pushover analysis, etc

Table No 1.1 Building Plan and Dimension Details

Table below shows the details of building.

Total height of the building	45m,30m,21m
No. of stories	15,10,7
Height of each storey	3m
Grade of concrete	M30
Grade of steel	Fe 415
Depth of slab	150mm
Size of beams	300 X 600 mm
Size of columns	600 X 600 mm

IV. OBJECTIVES

The objective of this work are as follows based on the conclusion of the literature review

a. To Model RCC buildings of different heights Regular and Irregular plans using ETABS

b. To analyses the seismic behavior of regular and irregular RCC buildings using ETABS for different zones and different heights

c. To compare the results obtained from the analysis for each type of building with different zones and heights.

V. BUILDING DIMENSIONS AND MODELS WITH DIFFERENT SHAPES

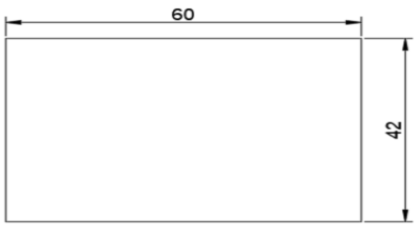


Fig No: 5.1Regular Building Dimensions

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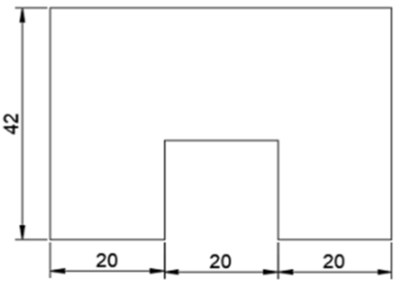


Fig No 5.2 C Shape Building Dimensions

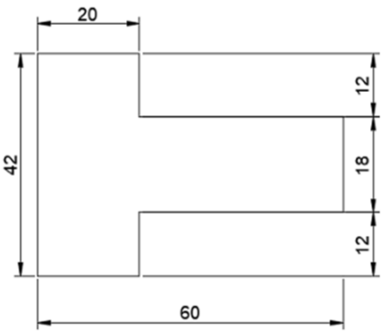


Fig No: 5.3 T Shape Building Dimensions

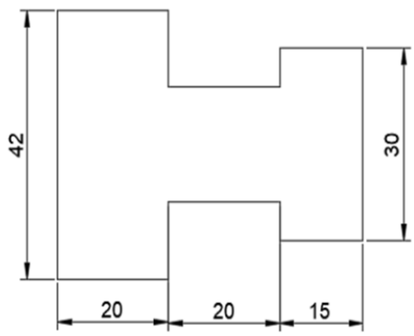
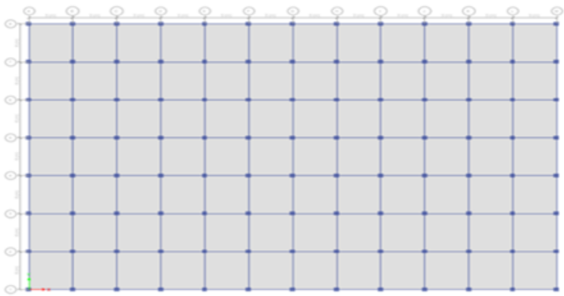


Fig No: 5.4 I Shape Building Dimensions



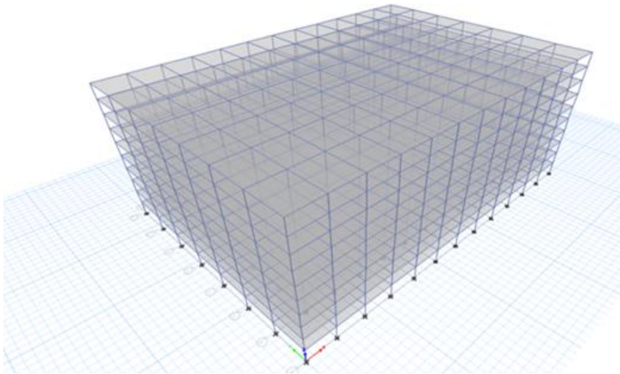
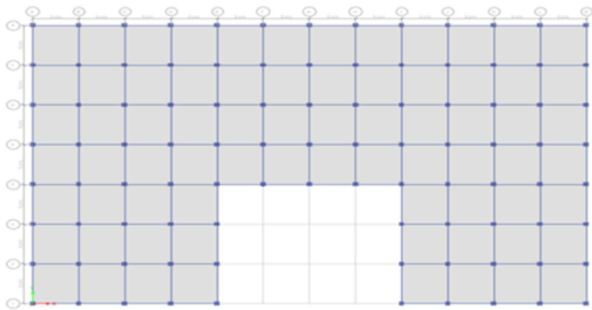


Figure no: 4.5: Plan and 3d view of regular shape RCC Building



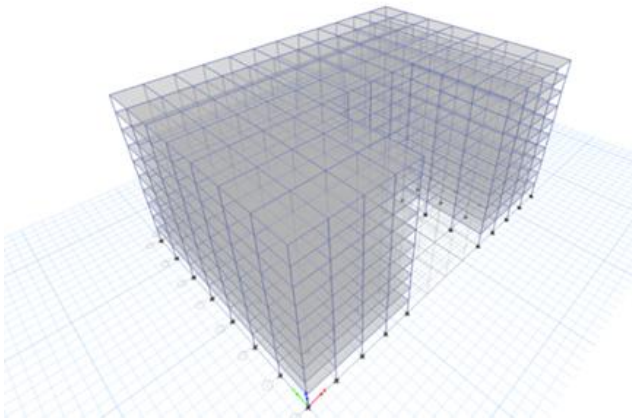
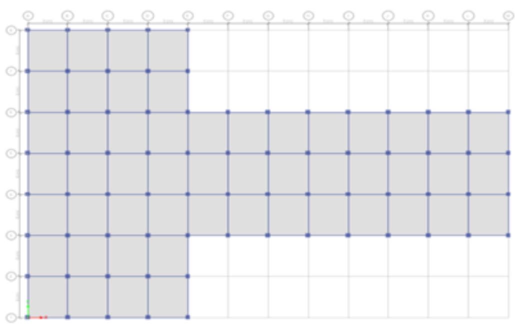


Figure no - 4.6: Plan and 3d view of C shape RCC Building



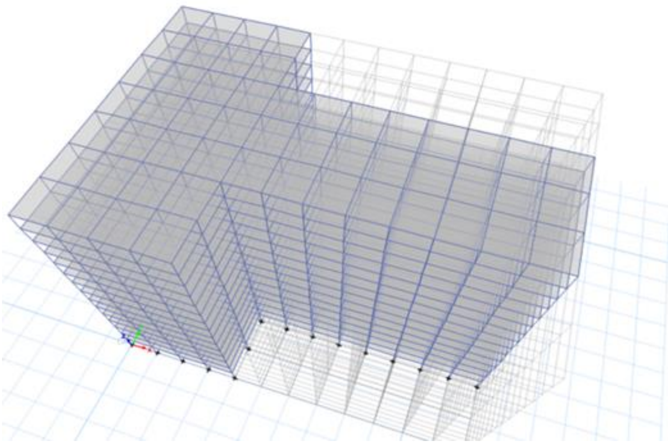
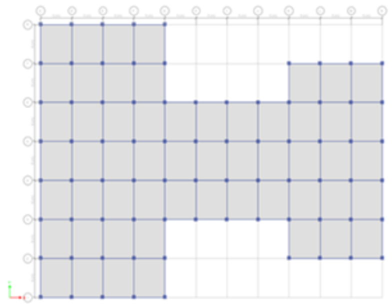


Figure no - 4.3: Plan and 3d view of T shape Building



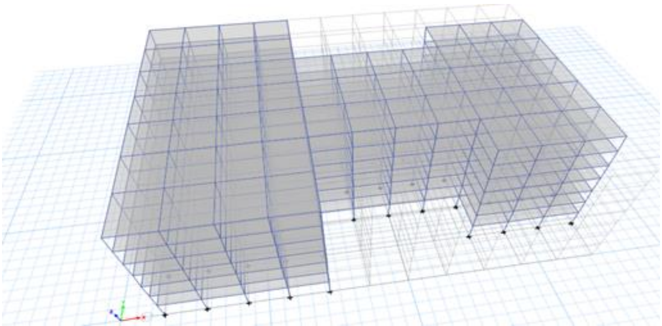
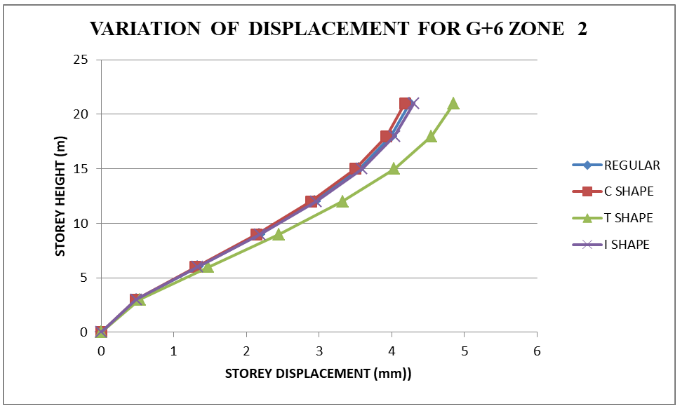
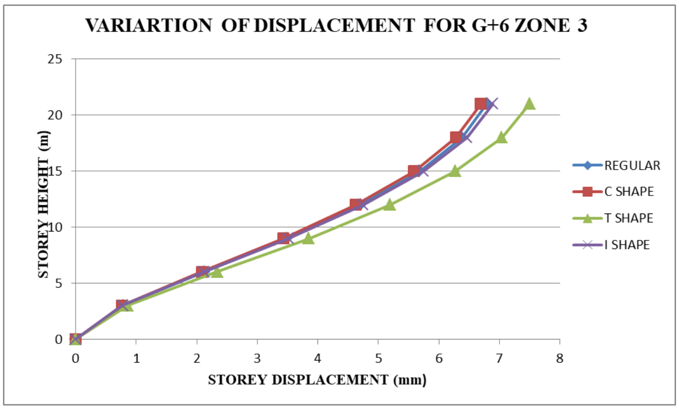


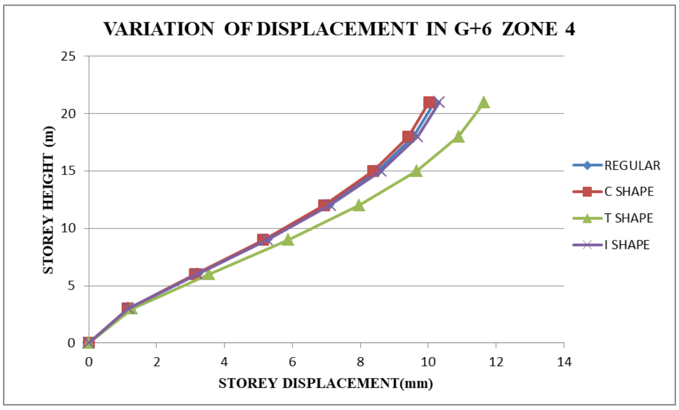
Figure no - 4.3: Plan and 3d view of I shape Building

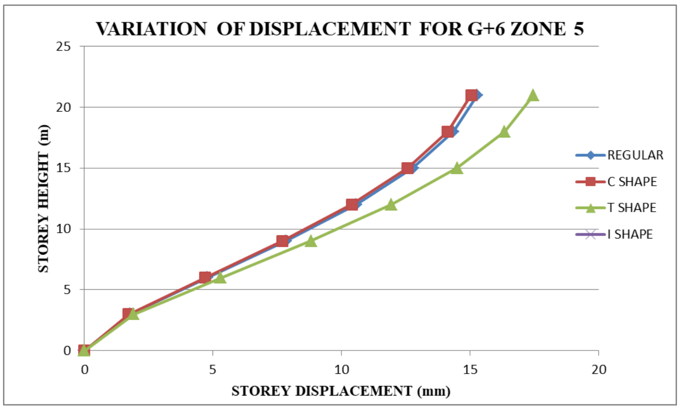
VI. RESULTS

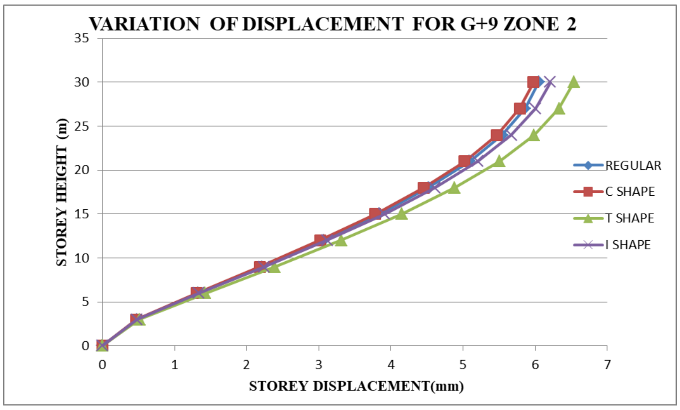
a) Variation of storey displacement











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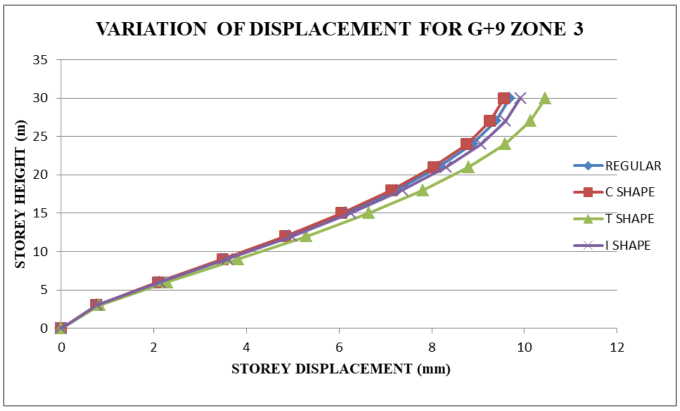
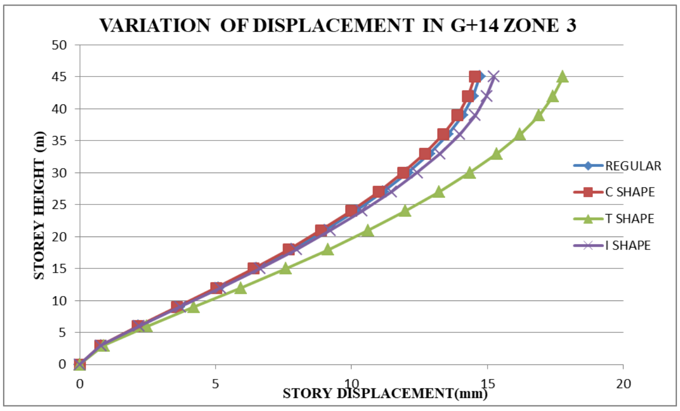
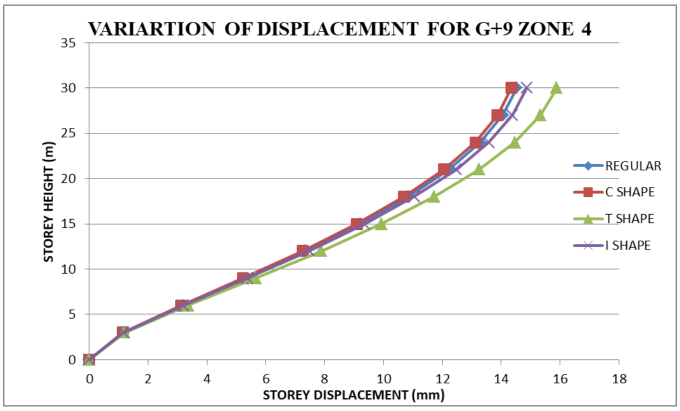
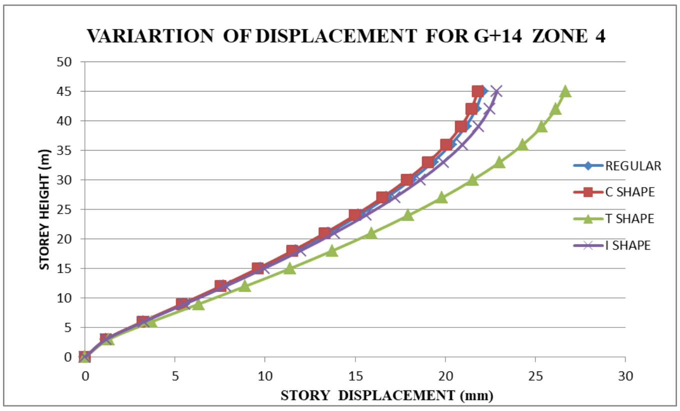
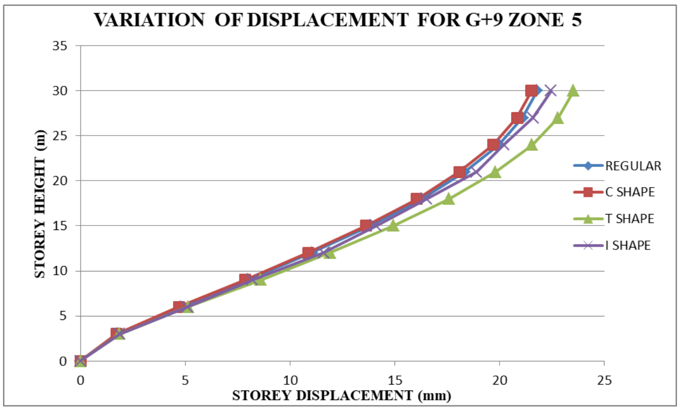
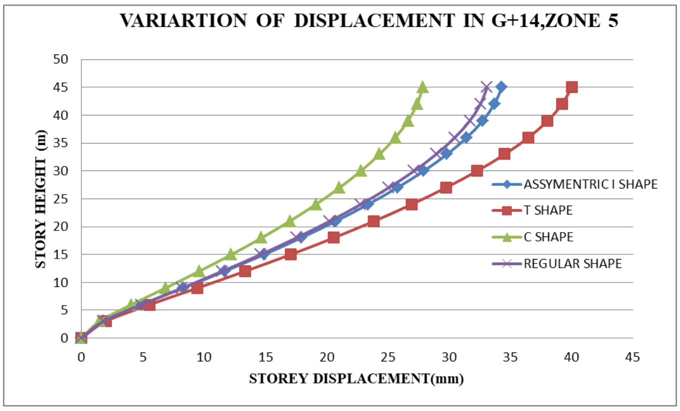


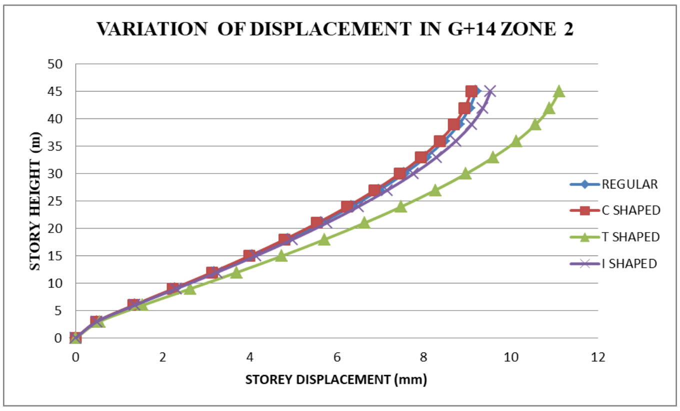






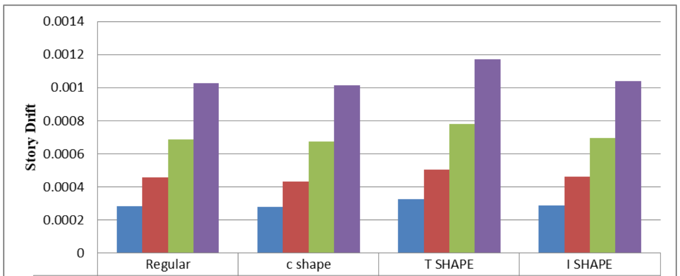






From the above graphs it can be observe that the T shaped building structure has the maximum storey displacement whereas the C shaped building has the minimum storey displacement for G+6,G+9,G+14 structures in all zones i.e, II, III, IV and V respectively.

b) Storey Drift



	Regular	c shape	T SHAPE	I SHAPE
ZONE 2	0.000285	0.000279	0.000325	0.000289
ZONE 3	0.000456	0.00043	0.000505	0.000462
ZONE 4	0.000685	0.000674	0.00078	0.000694
ZONE5	0.001027	0.001014	0.001171	0.001041

Fig No 6.1: Storey Drift in different zones in G+6

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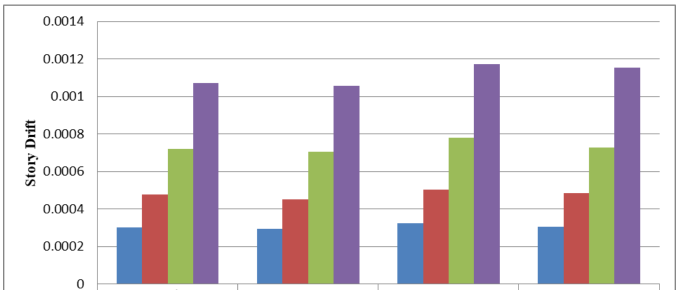
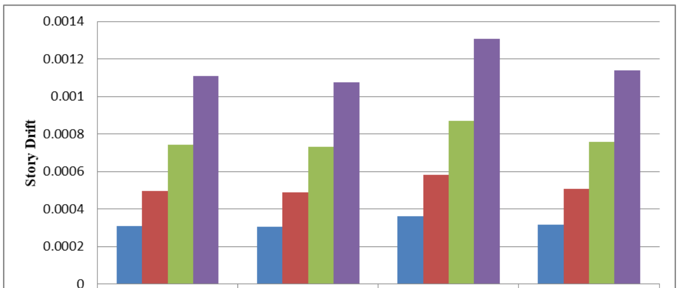


	Regular	C SHAPE	T SHAPE	I SHAPE
ZONE 2	0.000301	0.000294	0.000325	0.000304
ZONE 3	0.000476	0.00045	0.000505	0.000485
ZONE 4	0.00072	0.000705	0.00078	0.000728
ZONE 5	0.001072	0.001057	0.001171	0.001154

Fig No 6.2: Storey Drift in different zones in G+9

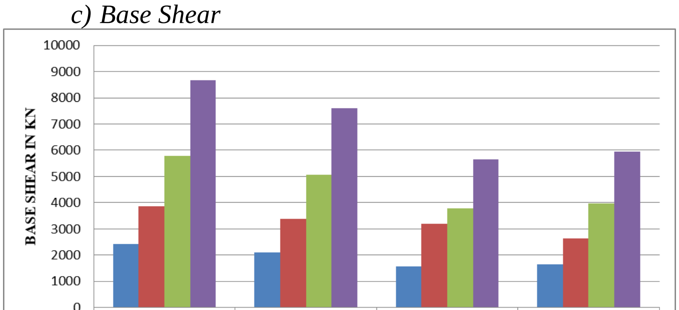


	Regular	C SHAPE	T SHAPE	I SHAPE
ZONE 2	0.000309	0.000305	0.000363	0.000316
ZONE 3	0.000496	0.000488	0.000581	0.000506
ZONE 4	0.000744	0.000732	0.000871	0.000759
ZONE 5	0.00111	0.001077	0.001307	0.001139

Fig No 6.3: Storey Drift in different zones in G+14

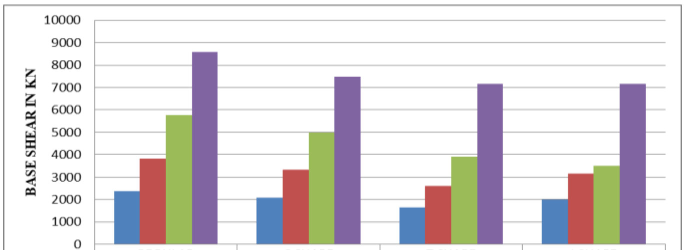
From the above graphs it can be observe that the T shaped building has the highest storey drift values whereas the C shaped building has the least values of storey drift when compared with other Regular shaped and I shaped for G+ 6,G+9,G+14 building structures.

c) Base Shear



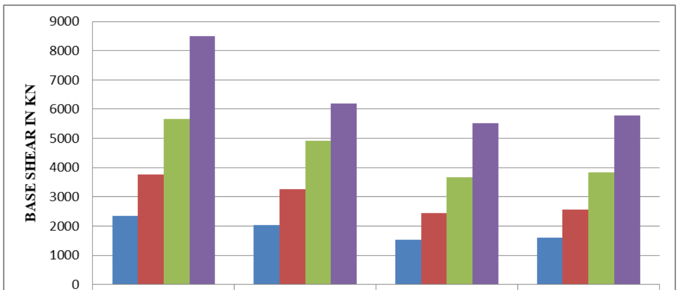
	REGULAR	C SHAPE	T SHAPE	I SHAPE
ZONE 2	2409	2110	1573	1651
ZONE 3	3855	3376	3207	2641
ZONE 4	5783	5064	3776	3962
ZONE 5	8674	7596	5664	5943

Fig No 6.4: Base shear for different zones in G+6



	REGULAR	C SHAPE	T SHAPE	I SHAPE
ZONE 2	2384	2080	1632	1989
ZONE 3	3817	3328	2607	3152
ZONE 4	5753	4992	3910	3502
ZONE 5	8581	7489	7174	7160

Fig No 6.5: Base shear for different zones in G+9



	REGULAR	C SHAPE	T SHAPE	I SHAPE
ZONE 2	2359	2027	1533	1603
ZONE 3	3775	3272	2453	2566
ZONE 4	5663	4907	3680	3849
ZONE 5	8495	6193	5521	5773

Fig No 6.6: Base shear for different zones in G+14

From the above graphs it can be observe that the regular building has the highest base shear values whereas the T shaped building has the least values of base shear when compared with other C shaped and I shaped for G+6.G+9.G+14 building structures.

VII. CONCLUSIONS

From the graphical representations we conclude that the story shear variation decreases when compared to the regular building. The average range for the G+6 structure when compared to the regular building decreases by 12% and in asymmetrical decreases by 34%.The average range for the G+9 structure when compared to the regular building decreases by 13% and in asymmetrical decreases by 35%.The average range for the G+14 structure when compared to the regular building decreases by 18% and in asymmetrical decreases by 36%.

From the graphical representations we conclude that the story drift variation for irregular case decreases and increases for the asymmetrical case when compared to the regular building. The average range for the G+6 structure when compared to the regular building decreases by 3% and in asymmetrical increases by 13%.The average range for the G+9 structure when compared to the regular building decreases by 3% and in asymmetrical increases by 14%.The average range for the G+6 structure when compared to the regular building decreases by 3% and in asymmetrical increases by 17%.

From the graphical representations we conclude that the story displacement variation for irregular case decreases and increases for the asymmetrical case when compared to the regular building. The average range for the G+6 structure when compared to the regular building decreases by 2% and in asymmetrical increases by 14%.The average range for the G+9 structure when compared to the regular building decreases by 2% and in asymmetrical increases by 17%.The average range for the G+6 structure when compared to the regular building decreases by 3% and in asymmetrical increases by 20%.

After comparison of all the cases it can be conclude that the asymmetrical building has max drift and displacement values where as max story shear is observed in regular building.

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