Seismic Effect in Severe Zones on Octagonal and Rectangular Shape Structures

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Abstract- An earthquake is a sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. Earthquakes are among the most powerful events on earth, and their results can be terrifying. Response of structures to earthquake depends on so many factors such as number of storeys, soil–structure interaction, stiffness and mass of the structure, vertical, plan and torsional irregularities and re–entrant corners etc. In this study a G+9 storey RCC building model with symmetric and octagonal building configuration is considered. These models are analyzed using a ETABS software. Response spectrum function is used to study the difference in behavior of the model under two seismic zones (i.e. Zone IV & V) and compression is made on base shear, storey drift, storey displacement and storey stiffness. It was concluded that symmetric building model offers a better resistance against earthquake forces.

Index Terms-Earthquake, Storey Displacement, Storey Drift, Base Shear.

1. INTRODUCTION

Earthquake is the most disastrous, unpredictable and unpreventable natural phenomenon which causes huge damage to the structures, properties and life. Earthquake loading is highly uncertain and it depends on duration, amplitude and frequency contents of the seismic waves. Response of structures to earthquake depends on so many factors such as number of storey's, soil–structure interaction, stiffness and mass of the structure, vertical, plan and torsional irregularities and re–entrant corners etc. As per Bureau of Indian standards code 1893–Part 1 (2002), Indian plateau is divided into four seismic zones as shown in Table 1.1 and Fig. 1.1. Higher the seismic zone, higher is the region for severe earthquake.

2. AIM AND OBJECTIVES

2.1. *Aim*

1. Behaviour of structure with Symmetric and Octagonal configuration.
2. Behaviour of structure with Octagonal building model subjected to dynamic analysis.
3. Effect of various parameters on the structural member of the model.

2.2. *Objectives*

This paper deals with G+9 storeyed RC building as per IS 1893:2002 provisions. Analysis and design for symmetric and octogonal building.

The objectives of this work are as follows:

1. The analysis of a multi-storeyed RC building having G+9 Storey is analysed for earthquake intensities of zone IV and V.
2. The Modelling of Symmetric and Octagonal buildings are modelled under ETABS.
3. To analyse the Symmetric and Octagonal building models for Response Spectrum.
4. To analyse the models with Symmetric and Octagonal configuration for storey displacement, storey drift, storey acceleration, storey forces, storey stiffness, base shear, time period, frequency.

3. MODELLING

The modelling of structure is done by ETABS 2016 software. G+9 storeys RC building is considered for the analysis. To understand the behaviour of structure, two models are considerd with regular and irregular configuration in different seismic zones like zone IV and zone V

Table 1. Symmetric building configuration in seismic Zone IV and V

Number of stories	G+9
C/C distance between columns in	3m

X-direction	
C/C distance between columns in Y-direction	3m
Foundation level to ground level	3m
Floor to floor height	3m
Live load on all floors	3kN/m^2
Live load on roof	1.5kN/m^2
Floor Finish	1.5kN/m^2
Materials	M25 and Fe415
Size of column	500x500mm
Size of beam	230x500mm
Depth of slab	150mm
Seismic zone IV, i.e. Z	0.24
Seismic zone V, i.e. Z	0.36
Soil type	II

Table 2. Octagonal building configuration in seismic Zone IV and V

Number of stories	G+9
Number of faces in each circle	8
Number of diagonals	8
Length of each face in inner circle	3.86m
Length of each face in middle circle	6.06m
Length of each face in outer circle	9m
Diagonal Distance between outer and middle circle	3.25m
Diagonal Distance between middle and inner circle	3.23m
Diagonal Distance between inner to centre circle	4.96m
Number of columns in outer circle	20
Number of columns in middle circle	8
Number of columns in inner circle	8
Foundation level to ground level	3m
Floor to floor height	3m
Live load on all floors	3kN/m^2
Live Load on Roof	1.5kN/m^2
Floor Finish	1.5kN/m^2
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Fig. 1. Plan of Octagonal Model

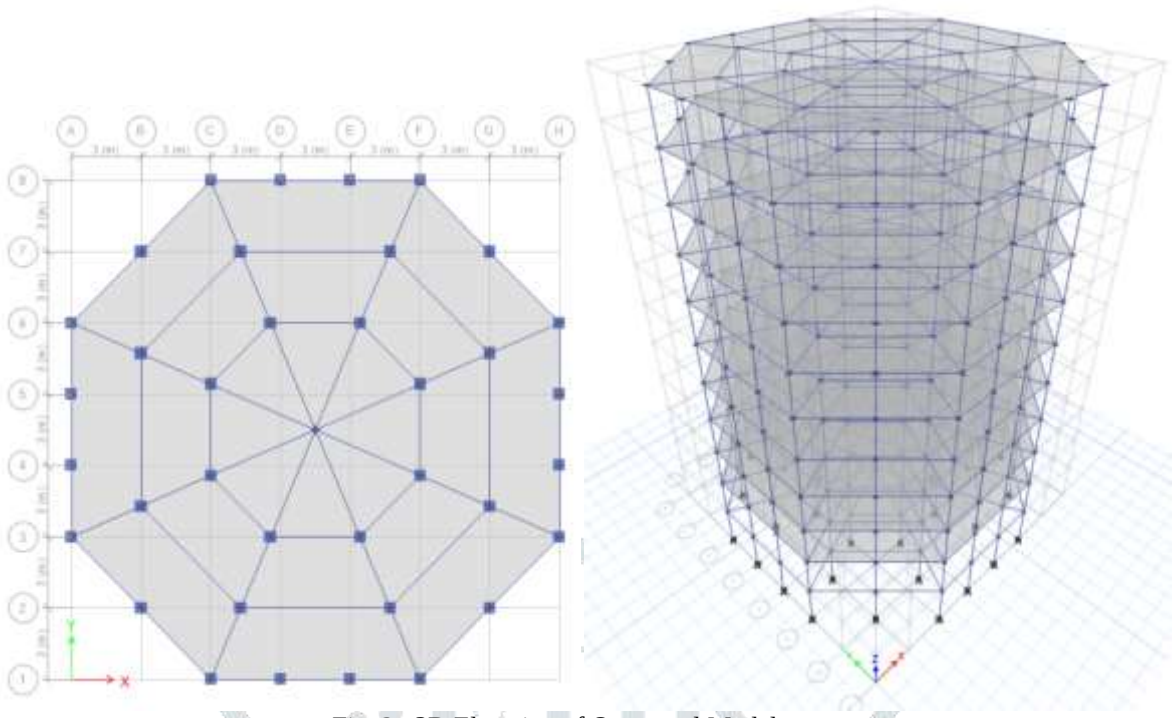


Fig. 2. 3D Elevation of Octagonal Model

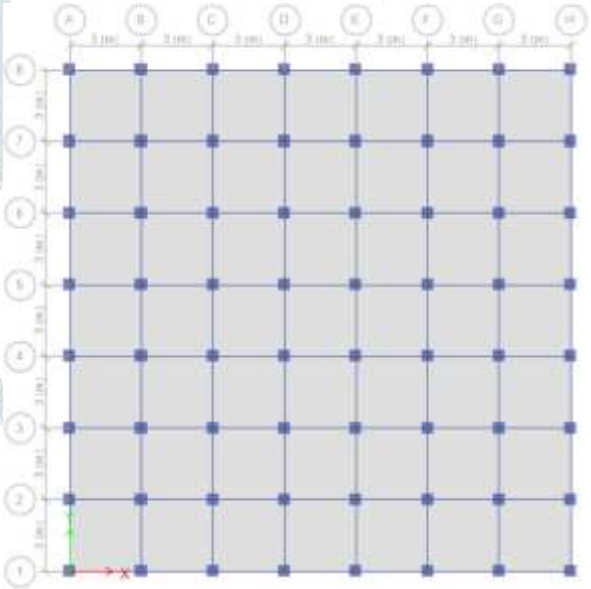


Fig. 3 Plan of Symmetrical Model

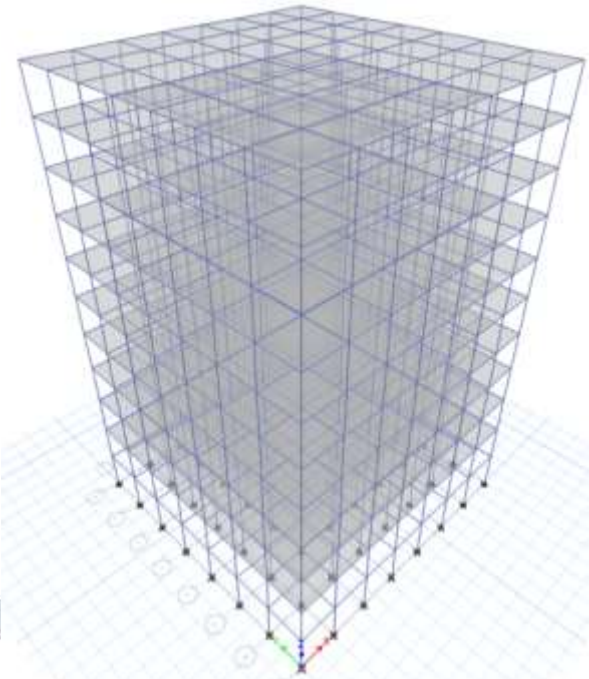


Fig. 4. 3D Elevation of Symmetrical Model

4. RESULTS AND DISCUSSION

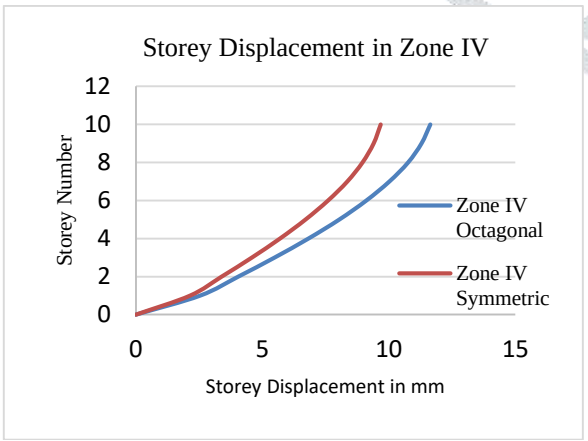
This chapter deals with results and discussion of multi storey building with Octagonal and Symmetric Plan Structure.

1. Model 1- Octagonal Structure
2. Model 2- Symmetric Structure

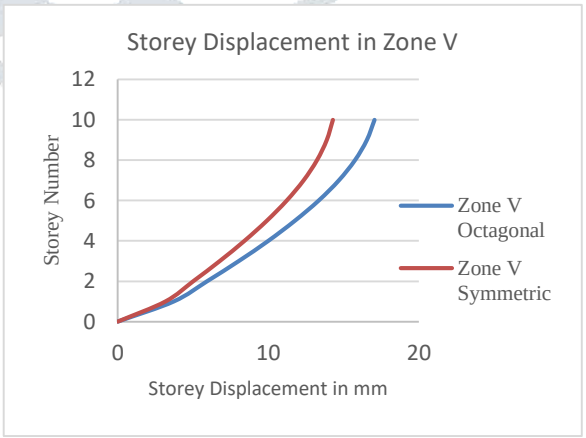
Discussions are made based on following parameters

4.1. *Storey Displacement*

The floor level versus displacement graph is been plotted for the models with Octagonal and Symmetric structure in Zone IV and Zone V.



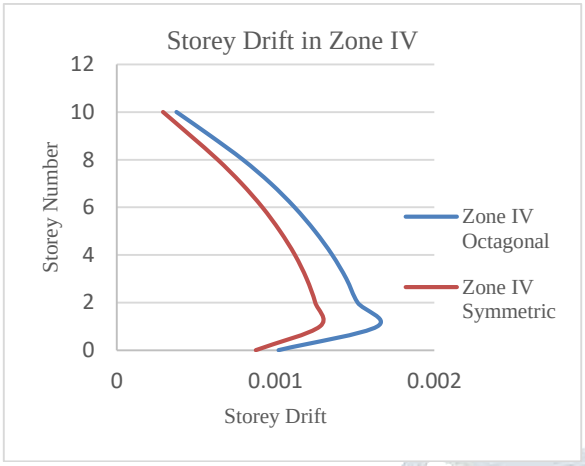
Graph 1. Storey Displacement in Zone IV



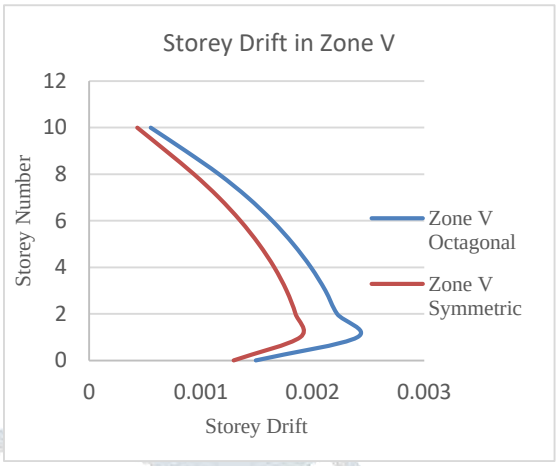
Graph 2. Storey Displacement in Zone V

4.2. *Storey Drift*

The floor level versus drift graph is been plotted for the models with Octagonal and Symmetric structure in Zone IV and Zone V.



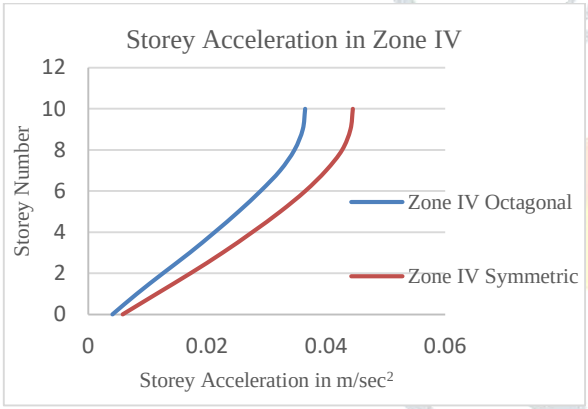
Graph 3. Storey Drift in Zone IV



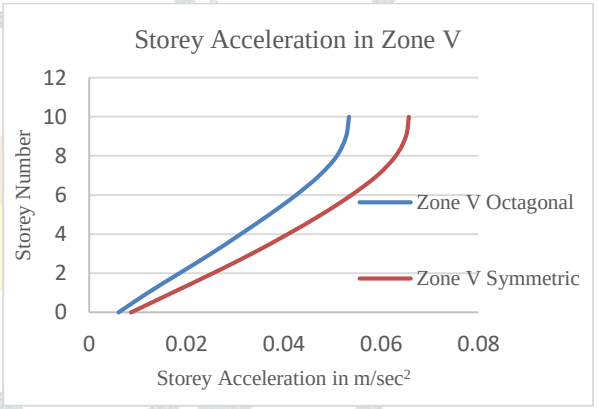
Graph 4. Storey Drift in Zone V

4.3. *Storey Acceleration*

The floor level versus acceleration graph is been plotted for the models with Octagonal and Symmetric structure in Zone IV and Zone V.



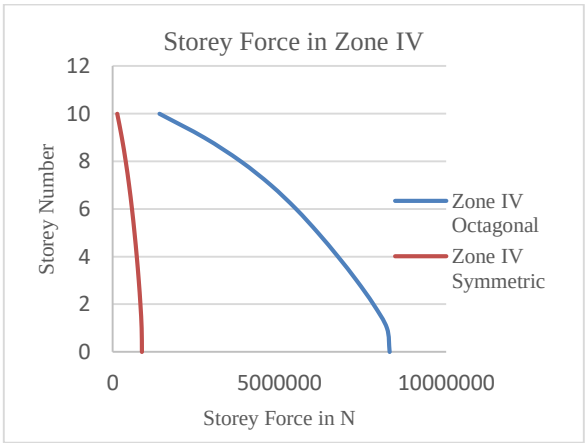
Graph 5. Storey Acceleration in Zone IV

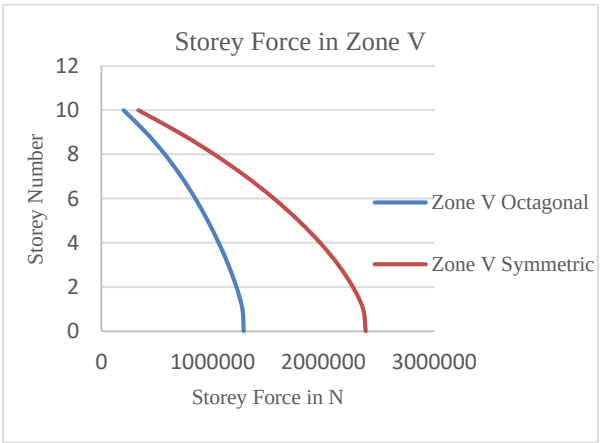


Graph 6. Storey Acceleration in Zone V

4.4. *Storey Forces*

The floor level versus forces graph is been plotted for the models with Octagonal and Symmetric structure in Zone IV and Zone V.



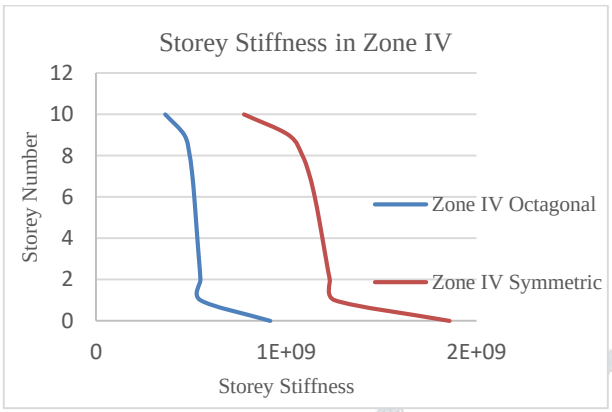


Graph 7. Storey Forces in Zone IV

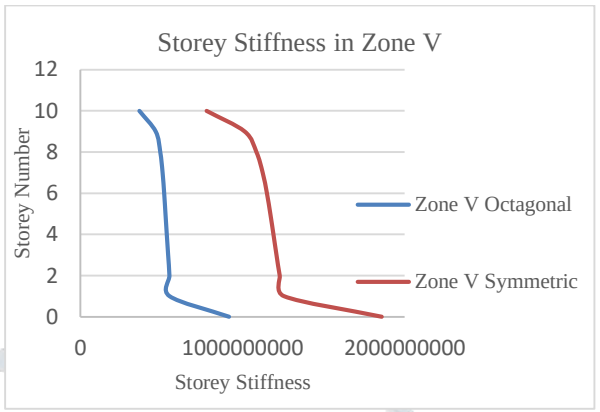
Graph 8. Storey Forces in Zone V

4.5. *Storey Stiffness*

The floor level versus stiffness graph is been plotted for the models with Octagonal and Symmetric structure in Zone IV and Zone V.

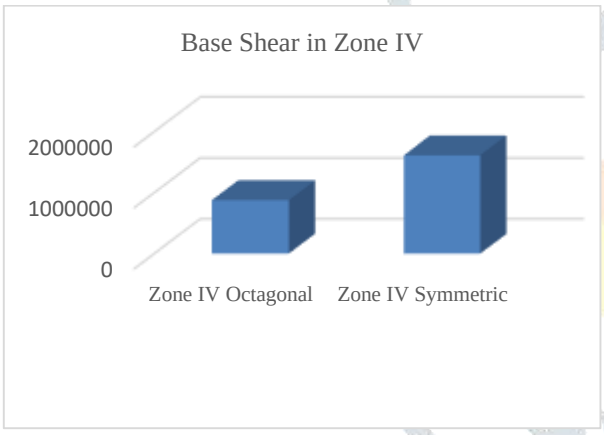


Graph 9. Storey Stiffness in Zone IV

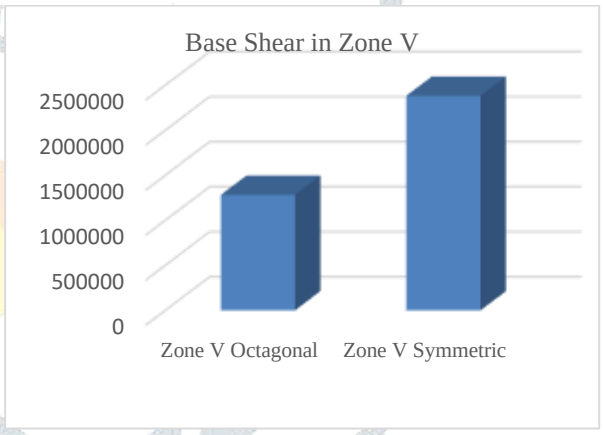


Graph 10. Storey Stiffness in Zone V

4.6. *Base Shear*

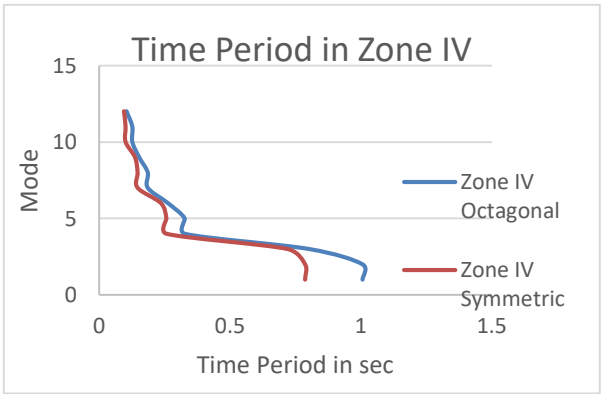


Graph 11. Base Shear in Zone IV

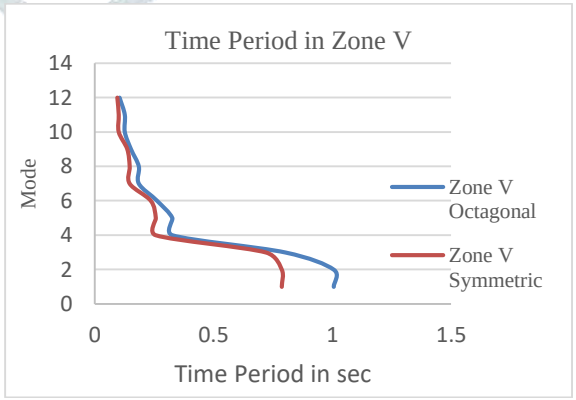


Graph 12. Base Shear in Zone V

4.7. *Time Period*

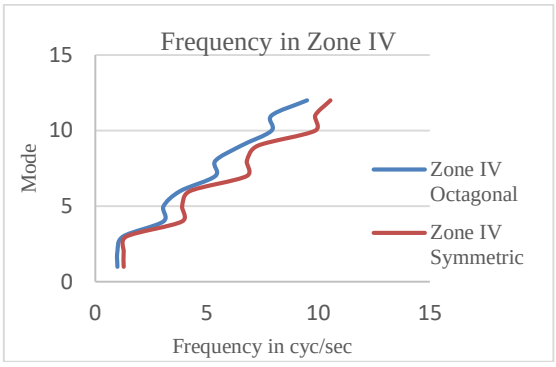


Graph 13. Time Period in Zone IV

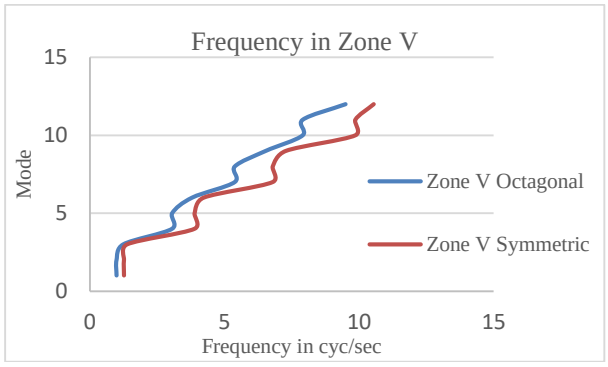


Graph 14. Time Period in Zone V

4.8. *Frequency*



Graph 15. Frequency in Zone IV



Graph 16. Frequency in Zone V

5. CONCLUSION

Effects on models have been shown in the form of graph in successive part of results by comparing various parameters such as displacements, storey drifts, storey acceleration, storey force, storey Stiffness, and base shear. Hence from the obtained results the following conclusions are made,

1. Considering the effect of lateral displacement on structure. It has been observed that, building with Octagonal-shape have displaced more in comparison to regular symmetric shape building.
2. The storey drifts being the important parameter to understand the drift demand of the structure. Octagonal-shaped models showed larger drift than symmetric shaped models.
3. The storey force in both the zones i.e., for IV and V showed that symmetric building model has a lower force than that for the building with octagonal shape.
4. The storey stiffness in both the zones i.e., for IV and V showed that symmetric building model has high stiffness than that for the building with octagonal configuration.
5. The graphs of base shear for zone IV and V, has a higher shear values for the symmetric building than that for octagonal configured building. The increase in base shear prove grater resistance against lateral forces.
6. As the storey force decreased and an increase in storey stiffness and base shear for the symmetric building, which give a clear indication that symmetric configured building perform better then that the octagonal structure.
7. It is observed that, there are no torsional effects in the frame because of symmetry that is the centre of mass that coincides with the centre of rigidity, hence symmetric structure perform better in resisting earthquake force.
8. Sites are rectangular in shape; building with octagonal shape would lead to wastage of land and money.
9. From the above results so obtained from all the graphs is clear that building with symmetric configuration give a better resistance against earthquake forces and offer a steady structure.

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