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Behaviour of Symmetrical and Asymmetrical Structure in High Seismic Zone

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Abstract – *Structural designs of buildings for seismic load is very important for structural safety during major motions; most of the hilly regions of India are massively seismic.*
Hilly regions of India fall under the high seismic zones. Behaviour of building differs in hilly slope from the other buildings on planes 3-D Analytical model of building are analyze the use of structural evolution tool "SAP 2000 Non linear." Structural analysis is mainly used for finding out the behaviour of a structural and this action can be done in the form of load due to the weight of things such as people, furniture, snow etc. The aim of this paper is to study the behaviour of symmetrical and asymmetrical building in high seismic zone using SAP 2000. To study the effect of seismic analysis is done using linear dynamic i.e. response spectrum method.

Key Words: **- Symmetric and Asymmetric building, Response spectrum method, SAP 2000, Story drift, Base shear, Time period, History Analysis.**

1. INTRODUCTION

At present people are facing problems of land scarcity, cost of land. The pollution, explosion and introduction of industrial revolution led to the exodus of people from village to urban. Loading on buildings can vary from normal commercial loads to heavy loads for special buildings used for special purpose. The high rised structure is not properly design for the resistance of lateral forces. It may cause to the complete failure of structures. The earthquake resistance structures are design based on some factors. The factors are natural frequency of the structures, type of forced action. Importance of the building etc. The structure design for ductility needs to be designed for less lateral loads as it has better moment distribution qualities.

In earthquake design the construction is subjected to random motion of the floor at its base which induces inertia forces in the building.

1.1 Objectives

i) To study the element forces and response base reactions for analysis of symmetric and asymmetric structure.
ii) To study the effect of time period, history analysis for symmetric and asymmetric multistory building.
iii) To compare the base reactions element forces, story drift of buildings.

1.2 Methodology

There is different type of earthquake analysis methods but response spectrum method being time consuming and tedious process.

Most of the time it resorts to computer applications. Now adays modelling the structure, usually we model the space frame, neglecting the in-fill wall stiffness. The seismic coefficient method should not be applied to anything other than mass concrete because today with the availability of powerful computers and software's.

The peak members force displacement, story forces, story shears and base reactions for each mode of response shall be combined by recognized methods to estimate to total response. The representation of the max. Response of idealized single degree freedom system having certain time period.

2. LITERATURE REVIEW

In 2017, A. Sampath & G. Srikanth studied the behaviour of symmetrical and asymmetrical structure in high seismic zone. For this a 3-D analytical model of 4 and 9 storied building had been generated for symmetrical and uneven building models and analyze with the structural evaluation tool "SAP 2000 '' The analysis is done to study the effect of time period, frequency, response base reactions and joint reactions, element forces, section cut forces of symmetrical and asymmetrical multistoried building in high seismic zone. From the analysis we conclude that the performance of asymmetrical building is better than symmetrical building

for given loading and soil condition and base shear of symmetrical structure is more as compare to asymmetrical structure. Also, the tensional moment is asymmetrical structure is more than symmetrical structure.

In 2017, Prof. Shindey Ganesh & Birari Vipul studied seismic behaviour of building of symmetrical and asymmetrical structure using STAAD Pro. Seismic analysis is a major tool in earthquake engineering which is used to understand the response of building due to seismic excitations in a simpler manner. Seismic analysis method is used in this study are: - Equivalent Static analysis and response spectrum Analysis &Time history analysis. The plan dimensions of symmetric structure are 15mx10m and symmetric structure is 10mx10m and a floor height of 3m. Each in all the floors. Static analysis gives higher values for max. Displacement of the stories in both X and Z direction. Base shear values obtained by manual analysis are slightly higher than software analysis. The lower base shear is getting in symmetrical shape building and the higher base shear is getting is asymmetrical shape building. The irregular shape building undergoes more deformation and hence regular shape building must be preferred. Equivalent Static analysis gives higher values as Compared to Spectrum Method.

In 2016, Burugula Subrahmanyam Prasanth and J. Simon presented to find variation of parameter displacement, story drift, time period, base shear with respect to geometry of building. Response spectrum analysis was done for all the models using ETABS software and all the above parameters are extracted from all the models including one reference model with rectangular geometry. All the models generated are compared with that of the base for reference models and the results are stated. It was found that the story drift was maximum at the bottom of the structure when compared to the above stories so as the displacement. Circular column is found to have increase base shear when compared with remaining models' masonry in fills induces stiffness which reduces the stiffness of the structure.

In 2013, Ganesh Baravkar and Vijaya Sarathy presented "Parametric study of response of an as symmetric building for various earthquake resistance factors." In this paper earthquake is major concern in high seismic prone areas. The structure which lies in seismic zone are to be specially designed. The goal of earthquake resistant design is to construct structures that fare better during seismic activity and their conventional counterparts. In this paper a study is conducted on the performance of an asymmetric structure, with plan irregularity, strength and stiffness irregularities. A time history analysis is performed using relevant software, a comparative discussion is made on the response of structure between normal building and building which is designed for earthquake resistant. The results showed that it was important to select a suitable parameter, for the type of resistance that the building must offer. This parametric study clears the importance of each earthquake resistance factors.

3. MODELLING OF STRUCTURE-

For this study, two types of buildings are taken, one is symmetric and other is F- shaped asymmetric model. All the buildings are modelled using SAP2000v20.2.0. Each building is an 8 -storey building and the height of each storey is 3.3m.

The plan of building models is given below: -

1. Model 1 – symmetric building model is taken as shown in fig -1.
2. Model 2 – An F-shaped building model is taken as shown in fig -2.

Table- 1 Design details

S. No.	Particulars	Dimension/Value
1.	No. of Stories	G+7
2.	Floor to Floor height	3.3m
3.	Beam Size	350mmX450mm
4.	Column Size	500mmX500mm
5.	Thickness of Slab	150mm
6.	Height of Building	26.4m
7.	Wall Thickness	230 mm
8.	Grades of Concrete	M20, M25, M30
9.	Grade of Steel	Fe415
10.	Response Reduction Factor	5
11.	Importance Factor	1.2
12.	Soil Condition	Medium (II)
13.	Seismic Zone	IV (0.24)
14.	Damping	5%
15.	Live Load	$2KN/m^2$
16.	Floor Finish	$1.8KN/m^2$
17.	Earthquake Load	As per IS-1893-2016(Part-I)
18.	Analysis Method	Response Spectrum Analysis
19.	Software Used	SAP2000v20.2.0

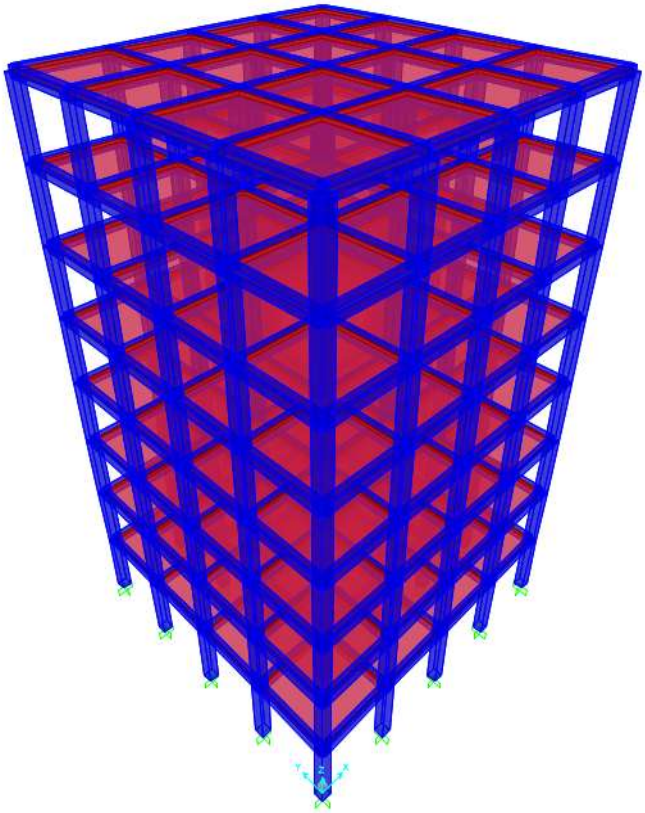


Figure -1: Symmetric model (3d)

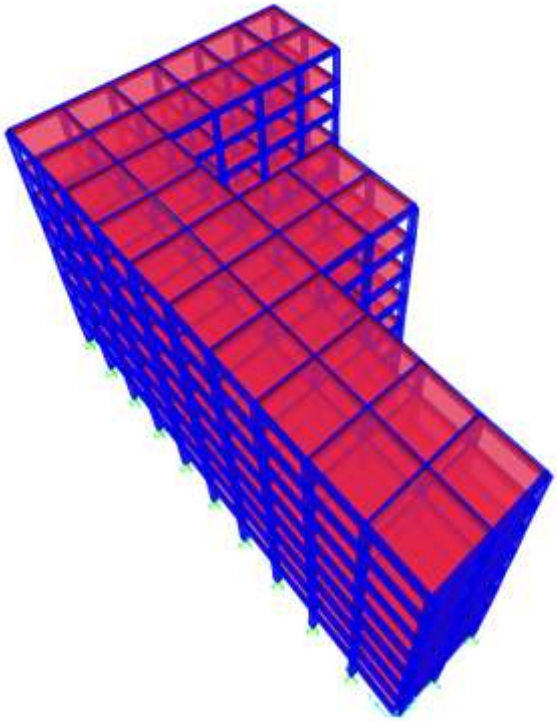
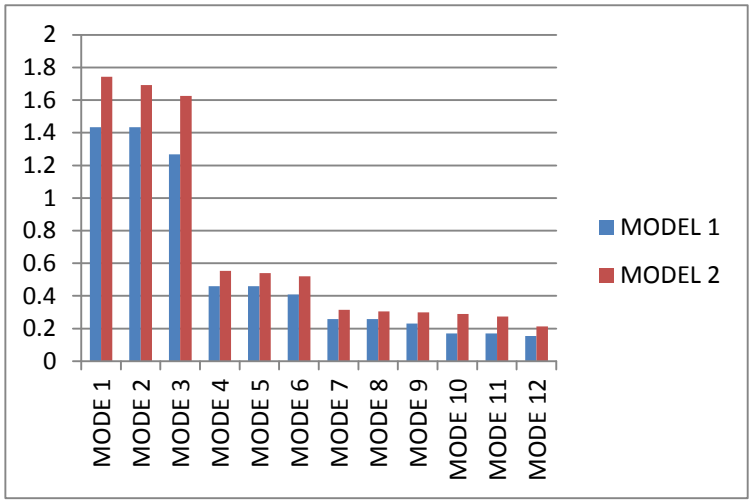
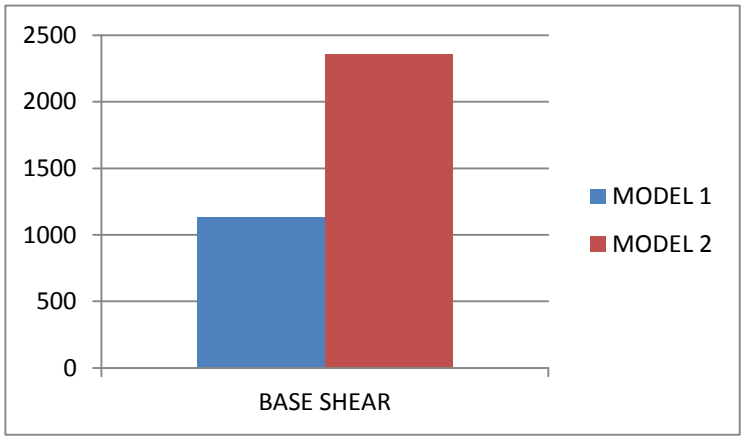


Figure-2 Asymmetric F- shaped model.

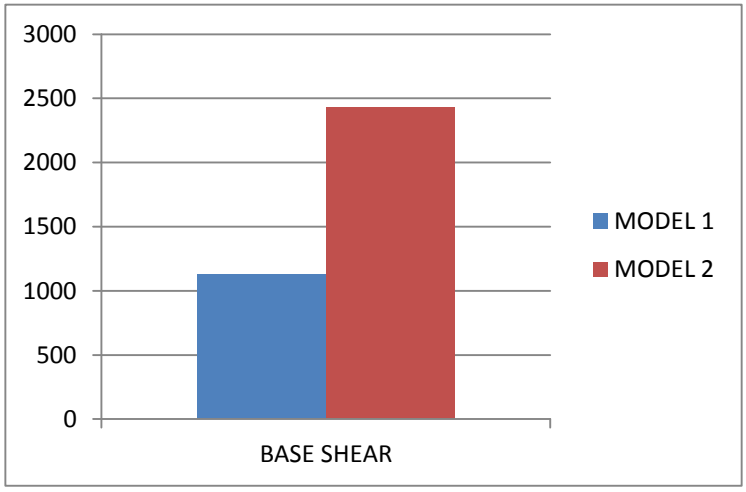
4. RESULTS



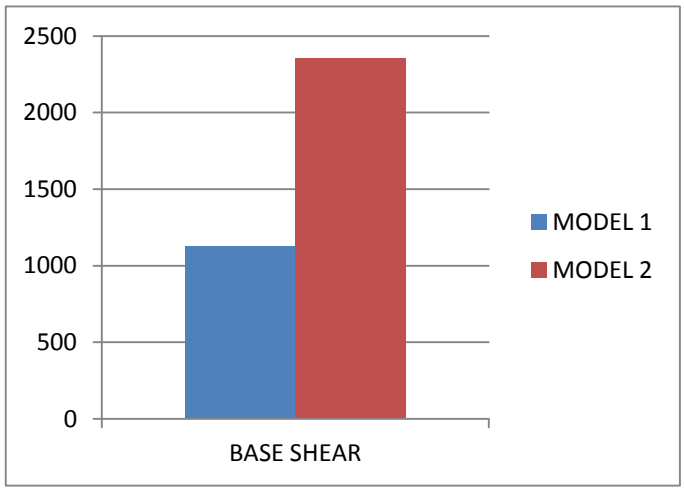
TIME PERIOD (SEC)



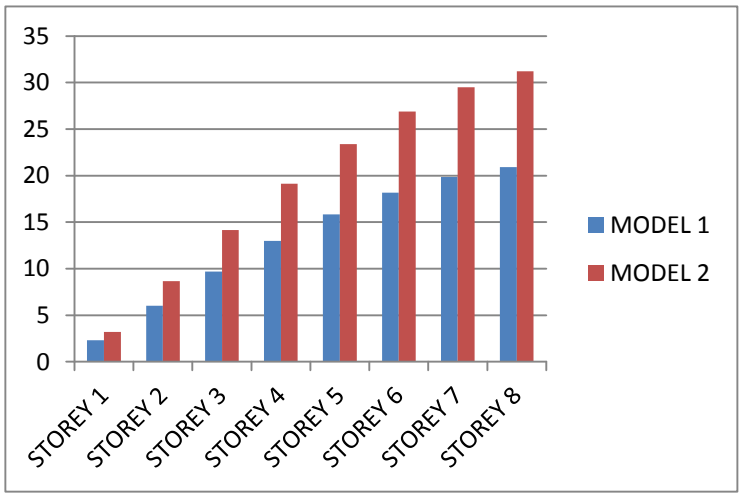
BASE SHEAR FOR EQX (KN)



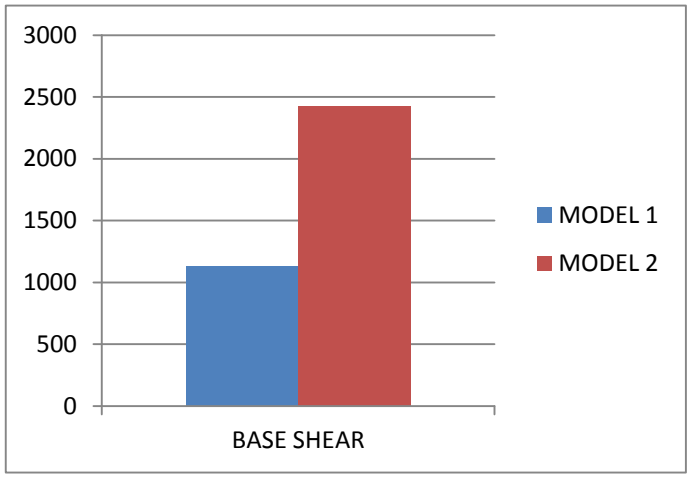
BASE SHEAR FOR EQY (KN)



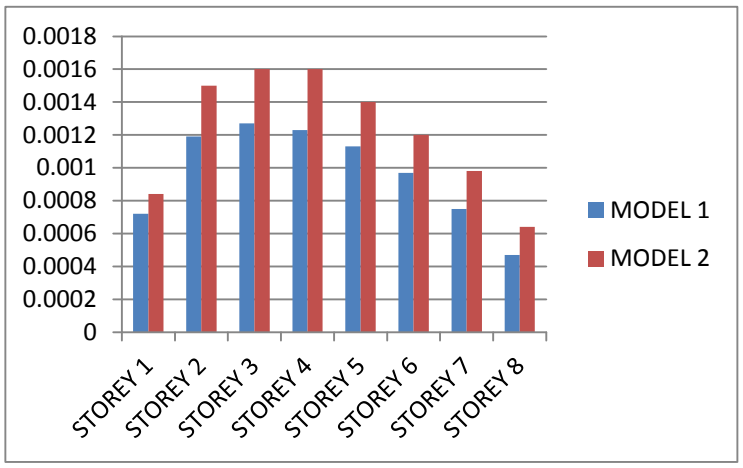
BASE SHEAR FOR RSX (KN)



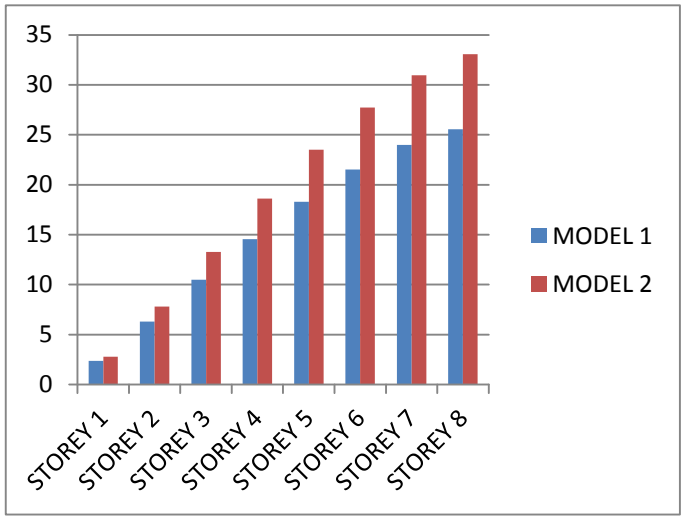
LATERAL DISPLACEMENT IN X- DIRECTION FOR RSX (mm)



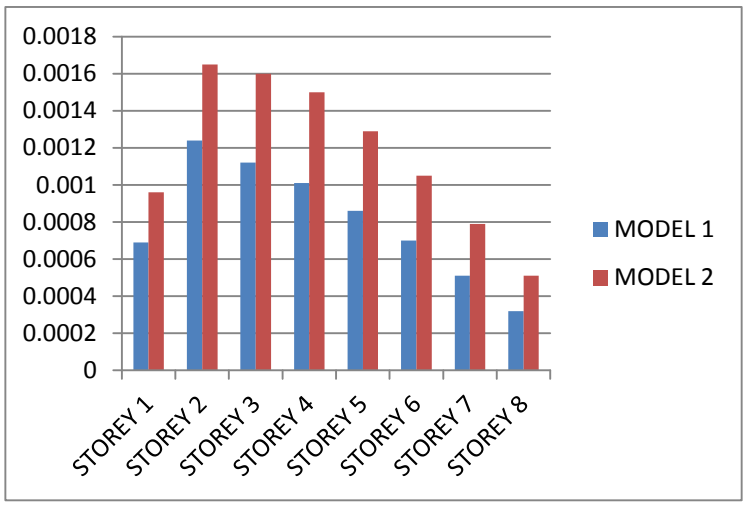
BASE SHEAR FOR RSY (KN)



STORY DRIFT IN X- DIRECTION FOR EQX (mm)



LATERAL DISPLACEMENT IN X-DIRECTION FOR EQX (mm)



STORY DRIFT IN X- DIRECTION FOR RSX (mm)

5. CONCLUSIONS

The following conclusions are drawn from the results: -

1. The value of Base shear is greater for F-shaped model than for symmetrical model in case of EQX, EQY. RSX and RSY.
2. The value of Lateral Displacement is greater for F-shaped model than for symmetrical model in case of EQX, EQY, RSX and RSY.
3. The value of Storey Drift is greater for F-shaped model than for symmetrical model in case of EQX, EQY, RSX and RSY.
4. The value of Time Period is greater for F-shaped model than for symmetrical model.
5. The value of Time Period is increasing as the mode number increasing.

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7. BIOGRAPHIES

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