SIESMIC ANALYSIS OF MULTI STORIED RC BUILDING HAVING VERICAL MASS IRREGULARITY WITH AND WITHOUT SHEAR WALL

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Abstract - *An earthquake is the perceptible shaking of the surface of the earth that can be violent enough to destroy major buildings and kill thousands of peoples. Earthquakes are considered as the most unpredictable and devastating of all the natural disasters. Due to this reason it is difficult to save over engineering properties and life, against it. India is considered as one of the most disaster prone country in the world. There are so many studies carried out about earthquakes but however it has not been possible to predict when and where earthquake will happen. In this study, 3d analytical model of twelve storied buildings have been generated for vertically mass irregular buildings. Models are analyzed using structural analysis tool 'ETABS". The analytical model of the buildings includes influence of the mass at different storey of the structure i.e. at 4th floor, 8th floor and 12th floor respectively. In order to resist the lateral forces on the different models, shear walls are provided at all four corners. And the results are compared for models having irregular mass at different floors with and without shear walls. Also the results of Linear Static (Equivalent static method) and Linear dynamic Analysis (Response spectrum Analysis).*

***Key Words*: Mass Irregularity, Equivalent, Response spectrum, Shear walls, Time period, Storey forces**

1.INTRODUCTION

During an earthquake, failure of structures starts at the points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structures. The structures having this discontinuity are termed as Irregular structures. Irregularities are not avoidable in construction of buildings; however the behavior of structures with these irregularities during earthquake needs to be studied. Adequate precautions can be taken. A detailed study of structural behavior of the buildings with irregularities is essential for design and behavior. Civil engineering structures are mainly designed to resist static load. Generally the effect of dynamic loads acting on structure is not considered. This feature of neglecting the dynamic forces sometimes becomes the cause of disaster. The Indian Standard code IS-1893: 2002 (Part-I) defines a number of structural irregularities. The code suggests a different approach of analysis for irregular structures.

2. OBJECTIVES OF THE STUDY

- To carryout analysis of a multi-storeyed RC building with and without vertical mass irregularity using ETABS.
- To perform lateral load analysis on different buildings models as per code.
- To analyse the structure using different methods such as Equivalent static method, and Response spectrum method.
- To study the effects of vertical irregularity in high rise buildings considering parameters like displacement, time period, storey drift and base shear.
- To study the effect of shear walls in the models in order to resist the lateral loads.
- To compare the results of models having vertical mass irregularity with and without shear walls.
- To compare the results of linear static analysis with linear dynamic analysis.

3 NEED FOR RESEARCH

Irregular buildings constitute a large portion of the modern urban infrastructures. Structures are never perfectly regular and hence the designers routinely need to evaluate the likely degree of irregularities and the effect of this irregularities on a structure during an earthquake.

To improve the understanding of the seismic behavior of building structures with vertical mass irregularities. The present study is an exertion in condition of seismic evaluation of multi-storied reinforced concrete vertical mass irregular buildings with and without shear walls.

4. DESCRIPTION OF MODELS

According to the project objective, nine models are selected which are as follows

Model 1: Regular Frame
Model 2: Frame with Heavy Mass at 4th Floor
Model 3: Frame with Heavy Mass at 4th Floor with SW
Model 4 : Frame with Heavy Mass at 8th Floor
Model 5: Frame with Heavy Mass at 8th Floor with SW
Model 6: Frame with Heavy Mass at Roof.
Model 7: Frame with Heavy Mass at Roof with SW
Model 8: Frame with Heavy Mass at 4th, 8th, and Roof
Model 9: Frame with Heavy Mass at 4th, 8th, and Roof with SW.

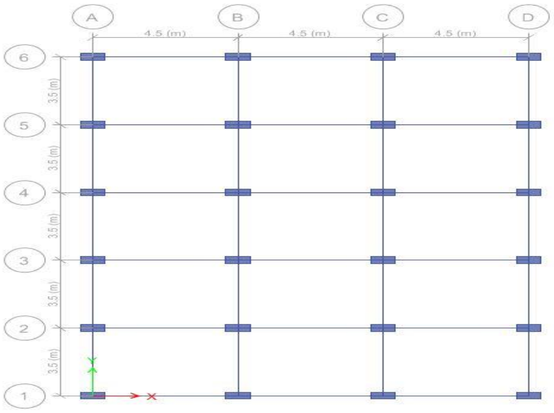


Fig-1: Plan of the Building

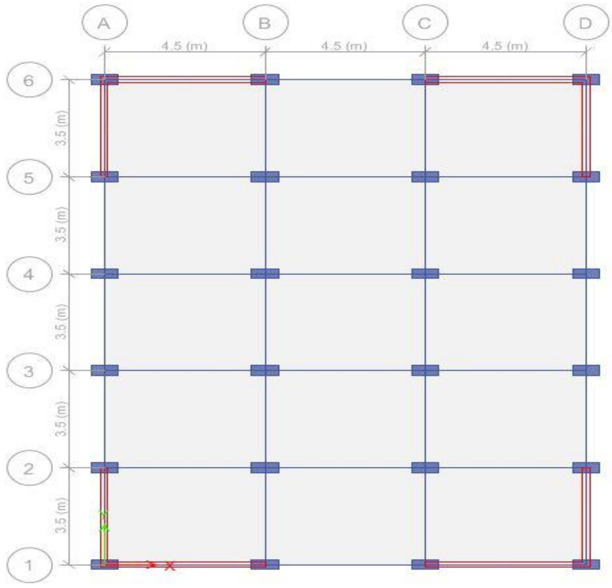


Fig-2: Plan of the Building with shear walls

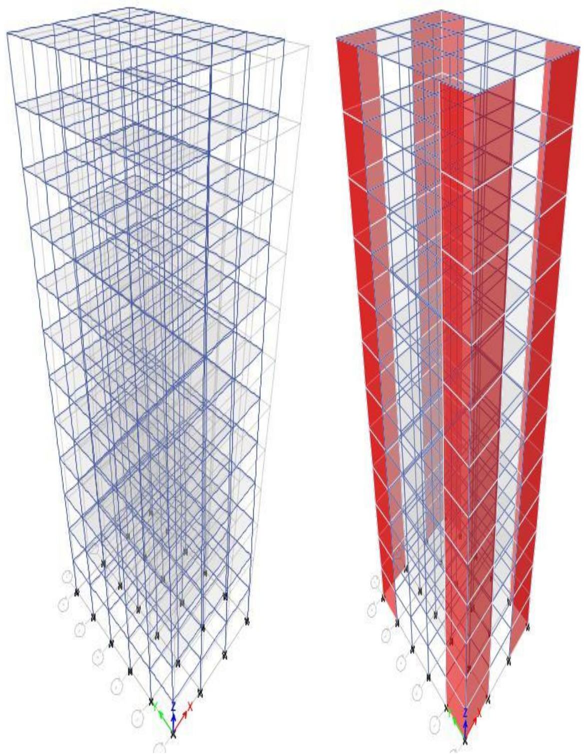


Fig-3: 3d View Of Regular frame With And Without SW

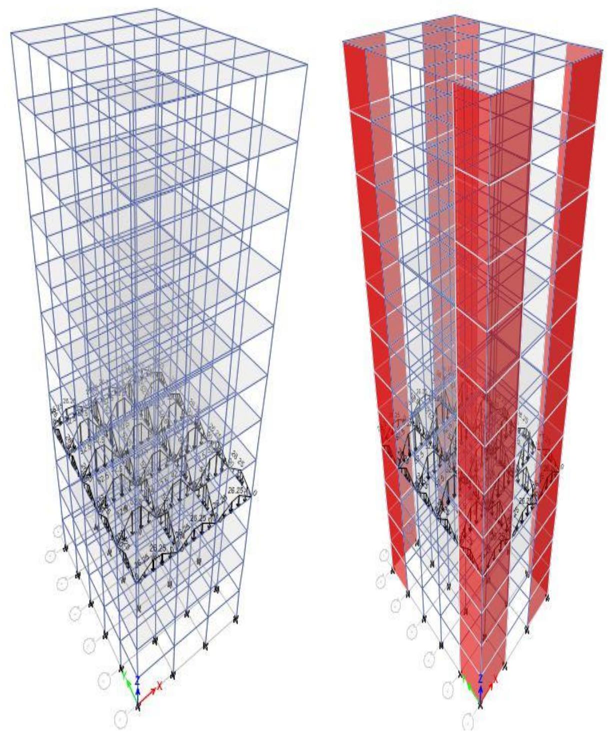


Fig-4: 3d View Of Building With **Heavy mass at 4th floor** With And Without Shear Wall

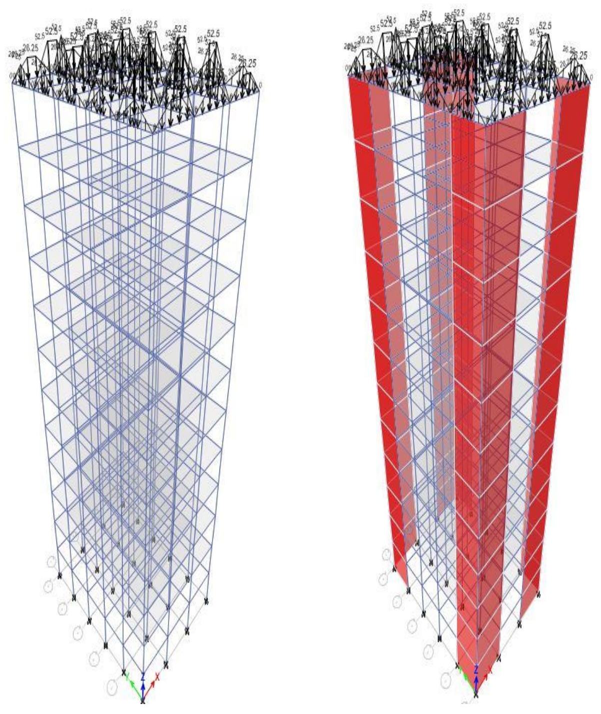


Fig-6: 3d View Of Building With **Heavy mass at 12th floor** With And Without Shear Wall

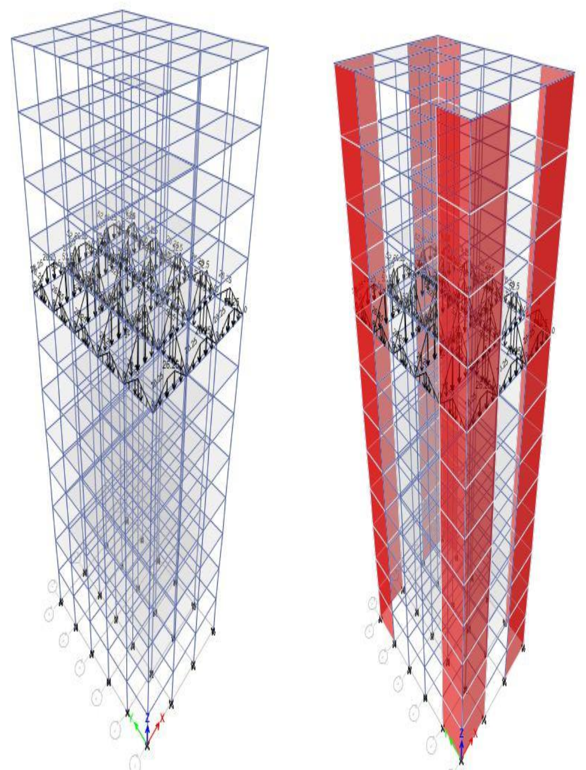


Fig-5: 3d View Of Building With **Heavy mass at 8th floor** With And Without Shear Wall

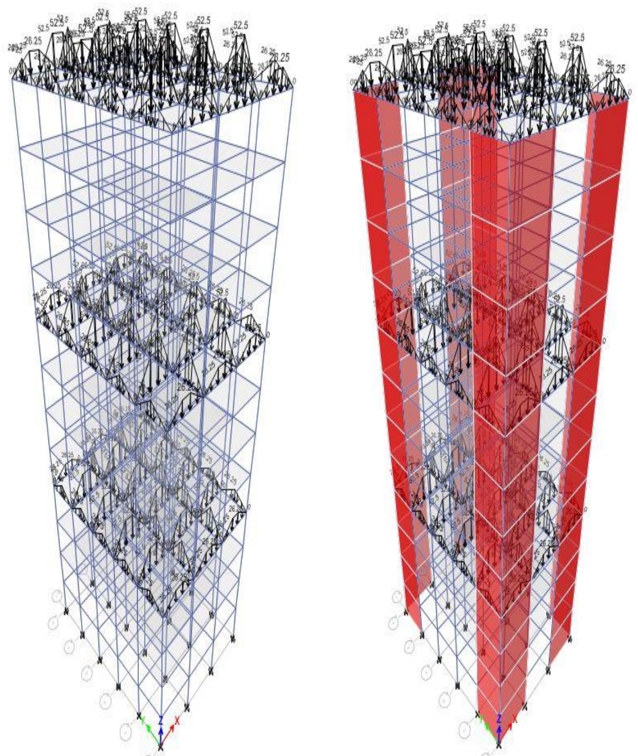


Fig-7: 3d View Of Building With **Heavy mass at 4th,8th &12th floor** With And Without Shear Wall

5 METHODS OF SEISMIC ANALYSIS

Seismic analysis is a major tool in earthquake engineering which is used to understand the response of structures due to the seismic excitations in simpler a manner. In the past buildings were designed just for gravity loads and seismic analysis is a recent development. It is a part of structural analysis and a part of structural design where earthquake is prevalent. The various seismic analysis methods which used in this study are as follows

1) Linear static analysis (Equivalent static method)
2) Linear dynamic analysis(Response spectrum metho

5.1 LINEAR STATIC (Equivalent Static Analysis)

This method is perhaps the simplest procedure at disposal for a structural engineer to perform an earthquake analysis and achieve the reasonable results. It is prescribed in any relevant code for earthquake analysis and is broadly used especially for buildings and other common structures meeting certain regularity conditions. The method is also called "The Lateral Forces Method" as the effects of an earthquake are assumed to be the same as the ones resulting from the statical transverse loadings. If the structural reaction is not substantially affect by assistance from higher mode of vibrations it is quite effective to assume that with a suitable set of inertia forces one may achieve a good approximation for the response. This is the basic concept of the "Equivalent Static Method".

5.2 LINEAR DYNAMIC(Response Spectrum Analysis)

The linear dynamic analysis is recognized as most consistent designing tool. Indeed, dynamic analysis be specified as ideal method for structural analysis. When the linear dynamic analysis is opted, an experimental consideration of inelastic response is prepared. Due to simplicity and association the engineers prefer elastic-dynamic analysis. Whereas every mode have its individual pattern of deformation, in multistoried structure it is essential to acquire assistance from more than one mode.

6. STRUCTUARAL SPECIFICATION

Table -1: SPECIFICATIONS

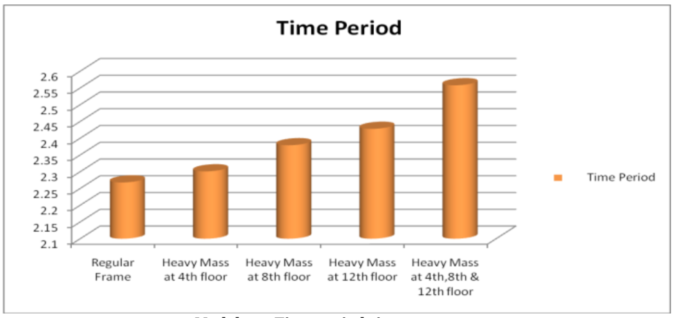
General Specification	
Number of storey	12
Storey height	3.5m
Size of Beam	300X500mm
Size of Column	350X750
Thickness of Slab	150mm
Lumped Mass	15kN/m^2
Width of Wall	230mm
Density of masonry	20 kN/m^3
Wall load	20x0.23x(3.5-0.3) = 14.72 kN/m^2
Shear wall	200mm
Grade of concrete & Steel	M25 & Fe500
Live load	3 kN/m^2
Floor Finish	1 kN/m^2
Earthquake Parameters	
Zone Factor (Z)	V
Importance Factor (I)	1
Soil type	Rock I
Response reduction factor (R)	5

7. RESULTS

Results of the selected buildings studied are presented and discussed in detail. The results are included for building models and the response results are computed using the equivalent static and response spectrum method. ETABS software tool is used to perform the analysis of building models.

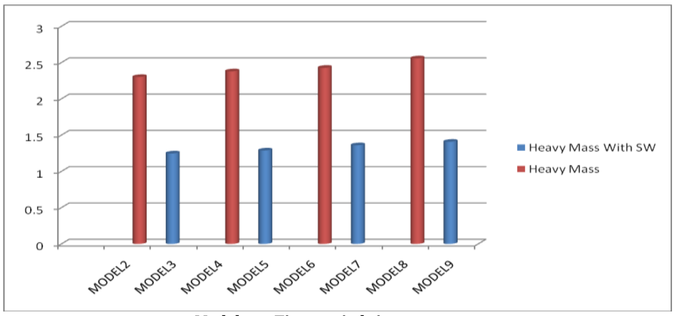
The results of natural period of vibration, lateral displacements and storey drifts for the different building models for each of the above analysis are presented and compared. An effort has been made to study the effect of vertical mass irregularity with and without shear walls at corners.

1) Below charts represents the fundamental natural time periods for different models with heavy mass at different floors



Models vs. Time periods in sec

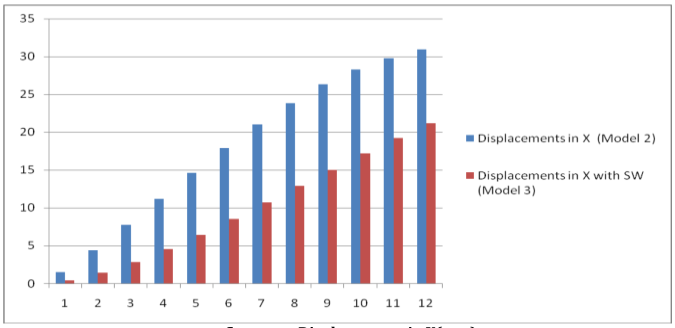
Chart 1 : Time periods for different models



Models vs. Time periods in sec

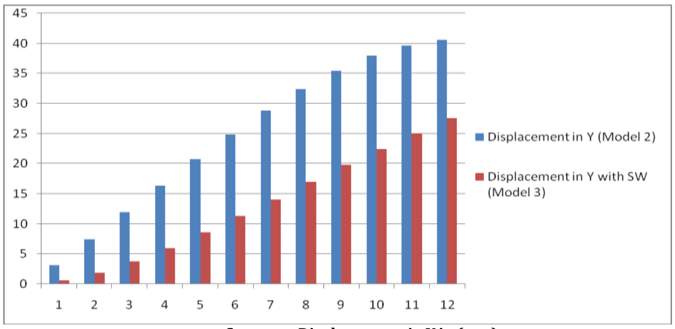
Chart 2 : Time periods for different models with shear walls

2) Below charts referents the storey displacements for models with and without shear walls



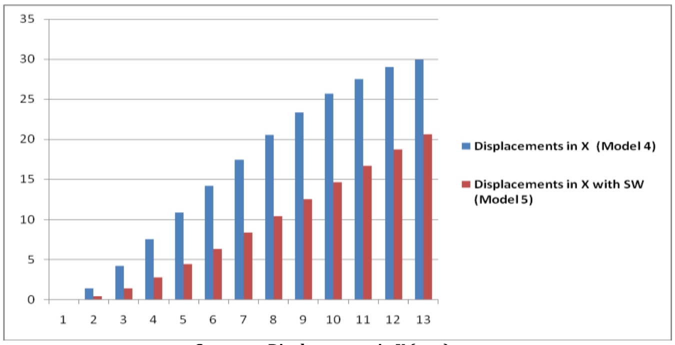
Storey vs. Displacements in X(mm)

Chart -3 Displacements comparisons



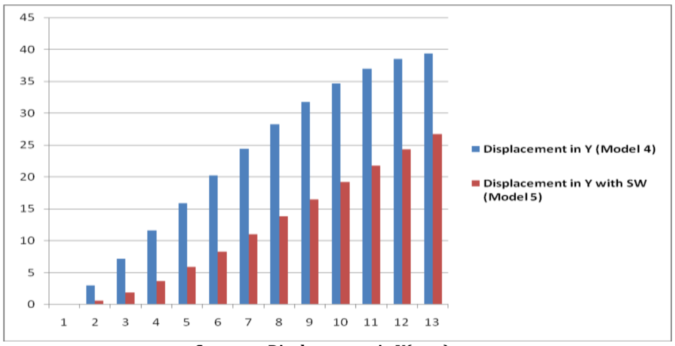
Storey vs. Displacements in Y in (mm)

Chart -4 Displacements comparisons



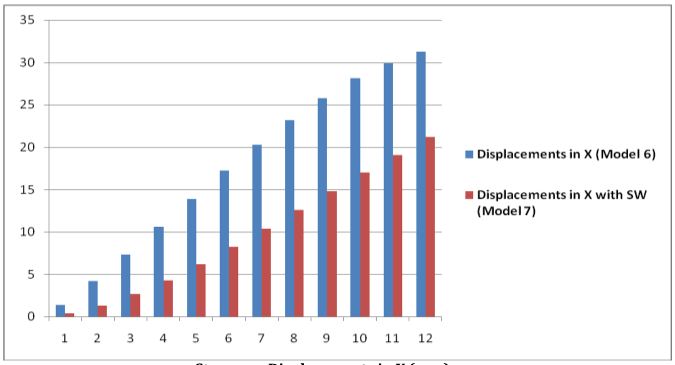
Storey vs. Displacements in X (mm)

Chart -5 Displacements comparisons



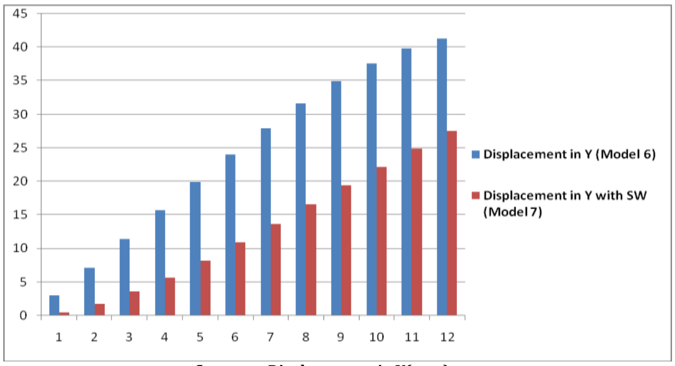
Storey vs. Displacements in Y(mm)

Chart -6 Displacements comparisons



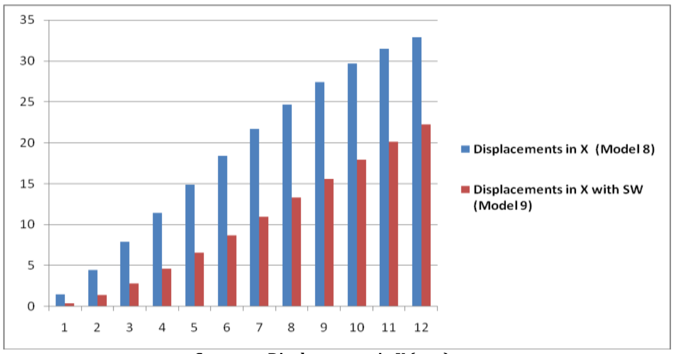
Storey vs. Displacements in X (mm)

Chart -7 Displacements comparisons



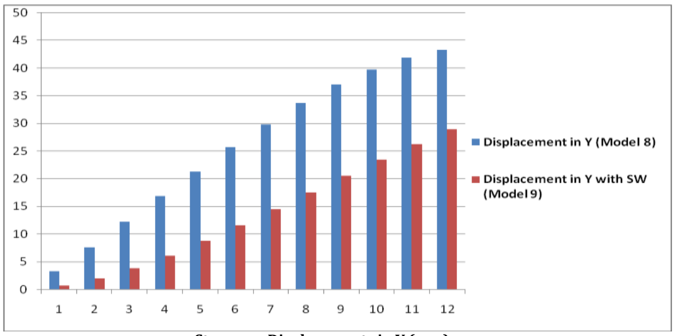
Storey vs. Displacements in Y(mm)

Chart -8 Displacements comparisons



Storey vs. Displacements in X (mm)

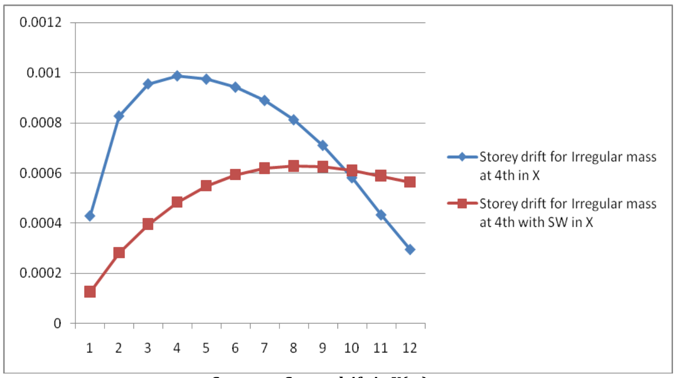
Chart -9 Displacements comparisons



Storey vs. Displacements in Y (mm)

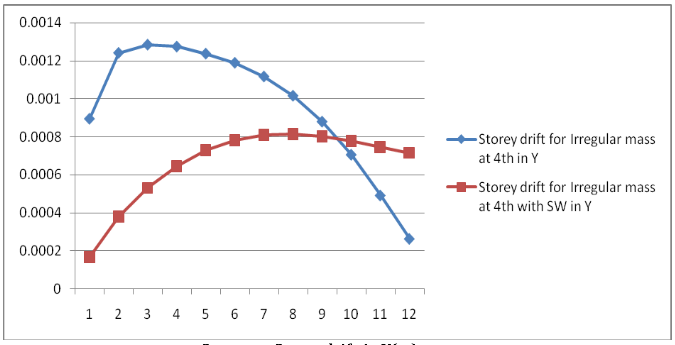
Chart -10 Displacements comparisons

3) Below charts referents the storey Drifts for models with and without shear walls



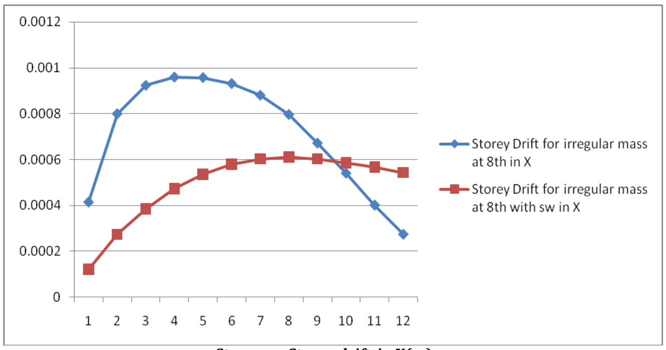
Storey vs. Storey drift in X(m)

Chart -11 Storey Drift comparisons



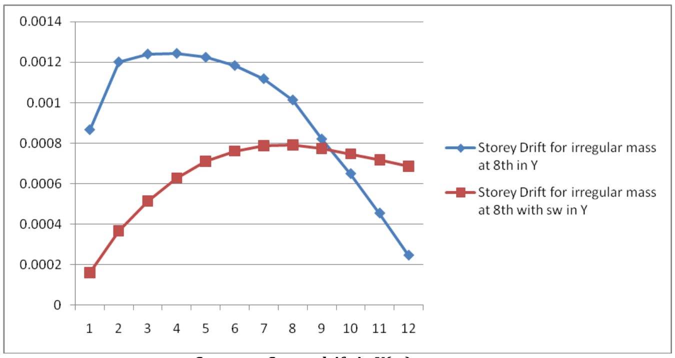
Storey vs. Storey drift in Y(m)

Chart -12 Storey Drift comparisons



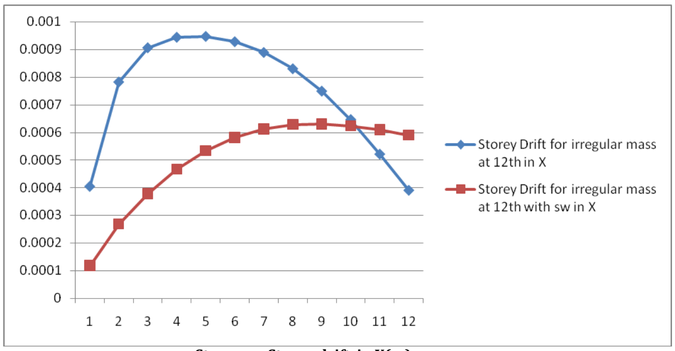
Storey vs. Storey drift in X(m)

Chart -13 Storey Drift comparisons



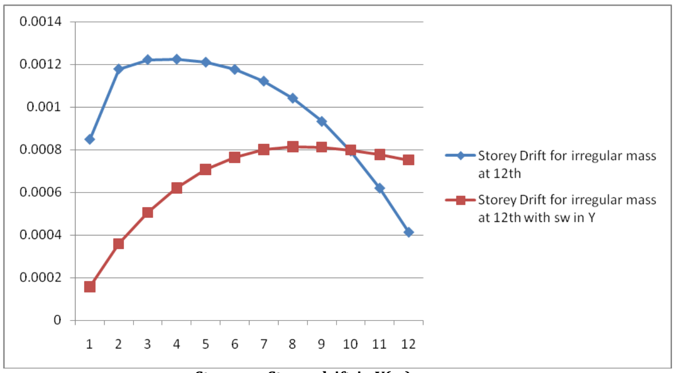
Storey vs. Storey drift in Y(m)

Chart -14 Storey Drift comparisons



Storey vs. Storey drift in X(m)

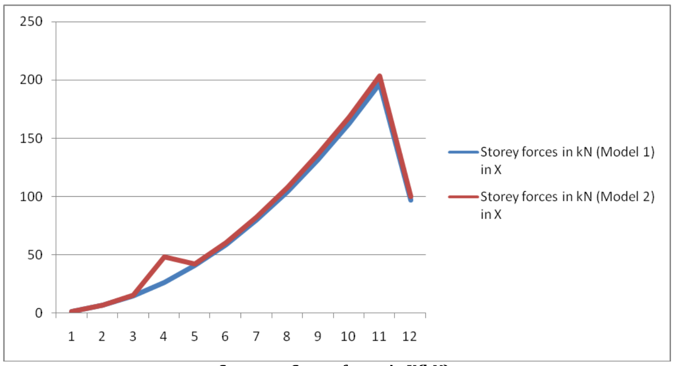
Chart -15 Storey Drift comparisons



Storey vs. Storey drift in Y(m)

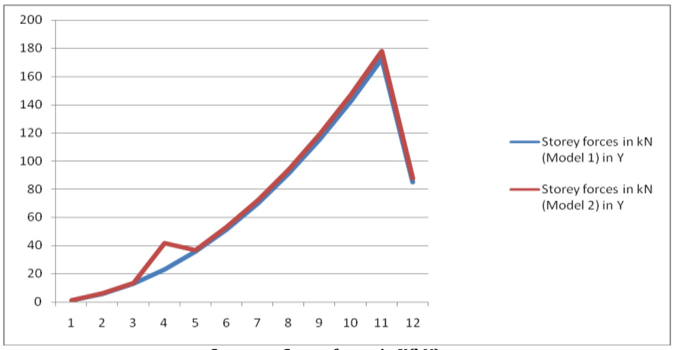
Chart -16 Storey Drift comparisons

4) Below charts referents the storey Forces comparison for regular and irregular frame



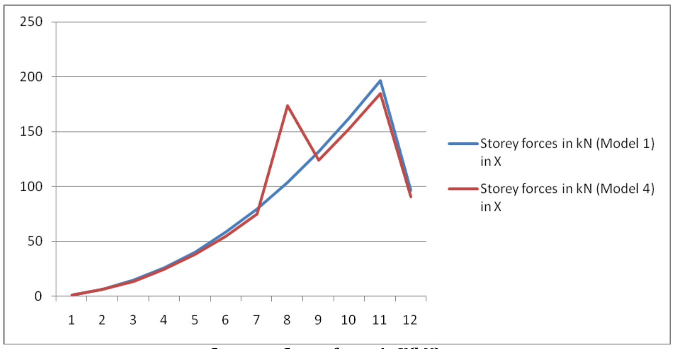
Storey vs. Storey forces in X(kN)

Chart -17 Storey forces comparisons



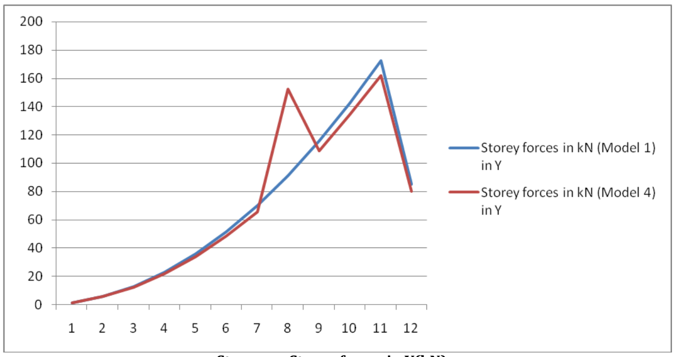
Storey vs. Storey forces in X(kN)

Chart -18 Storey forces comparisons



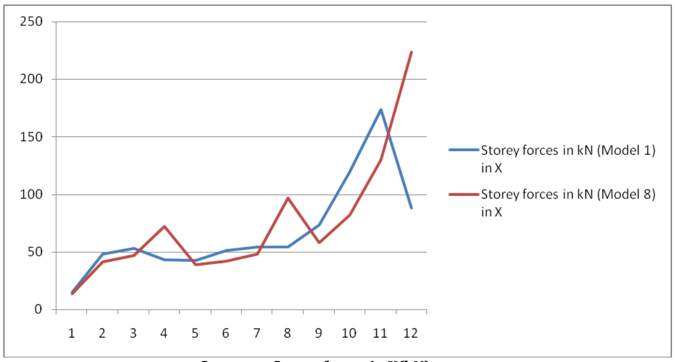
Storey vs. Storey forces in X(kN)

Chart -19 Storey forces comparisons



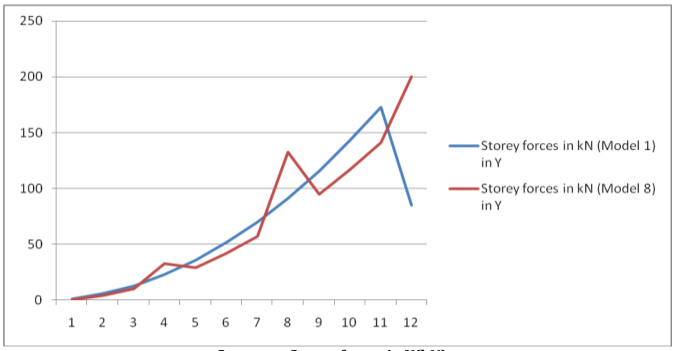
Storey vs. Storey forces in Y(kN)

Chart -20 Storey forces comparisons



Storey vs. Storey forces in X(kN)

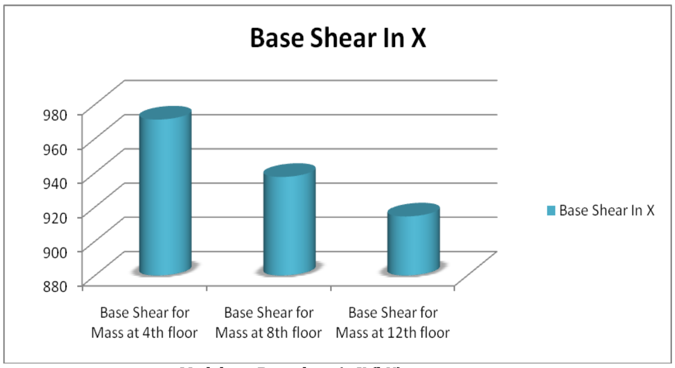
Chart -21 Storey forces comparisons



Storey vs. Storey forces in Y(kN)

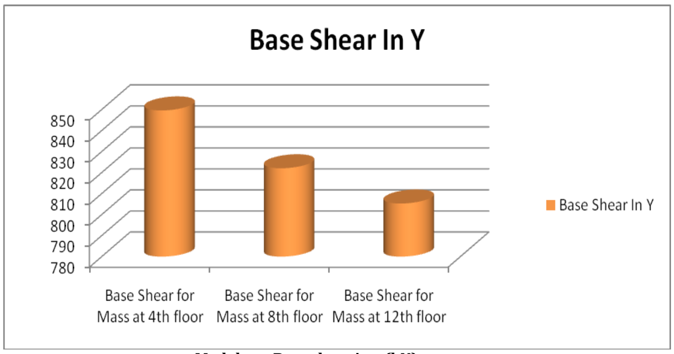
Chart -22 Storey forces comparisons

4) Below charts represents the seismic base shear for different irregular frames



Models vs. Base shear in X (kN)

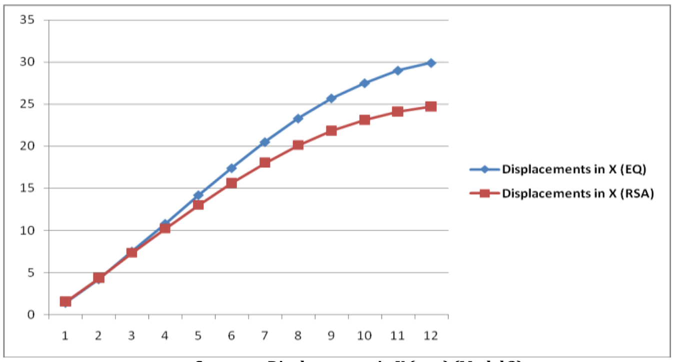
Chart -23 Base shear comparisons



Models vs. Base shear in y (kN)

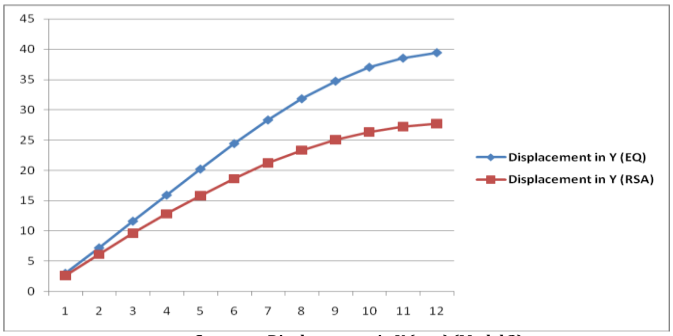
Chart -24 Base shear comparisons

5) Below charts represents the comparison between equivalent static and Response spectrum analysis results



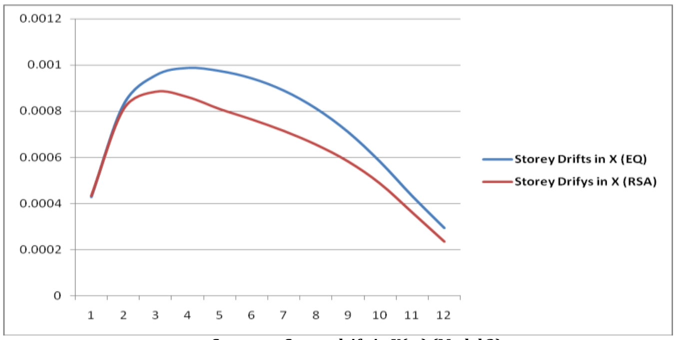
Storey vs. Displacements in X (mm) (Model 2)

Chart -25 Displacements comparisons



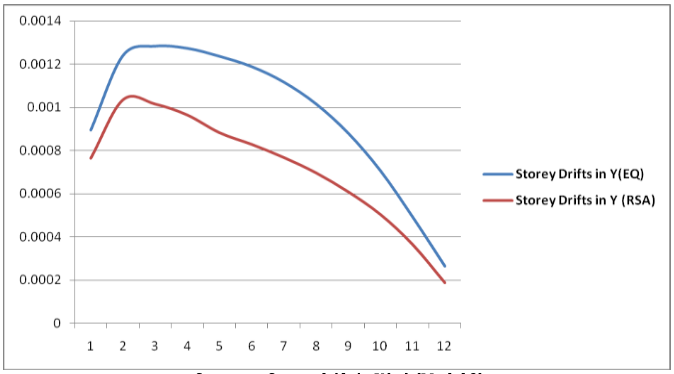
Storey vs. Displacements in Y (mm) (Model 2)

Chart -26 Displacements comparisons



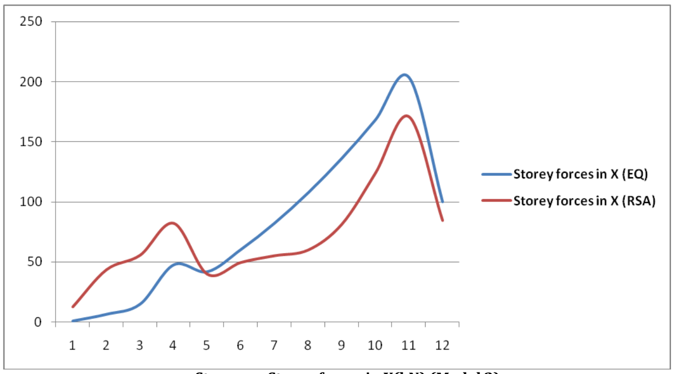
Storey vs. Storey drift in X(m) (Model 2)

Chart -27 Storey Drift comparisons



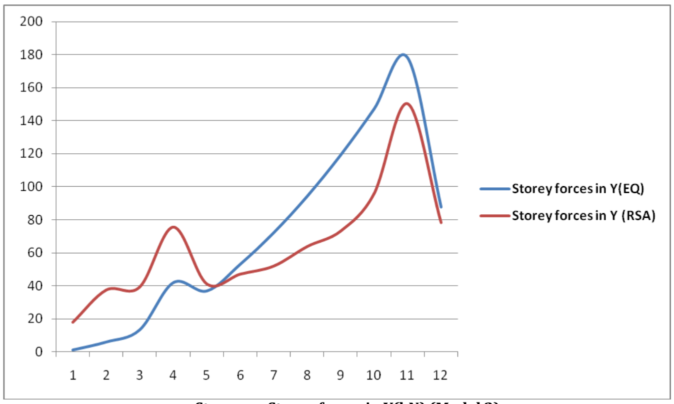
Storey vs. Storey drift in Y(m) (Model 2)

Chart -28 Storey Drift comparisons



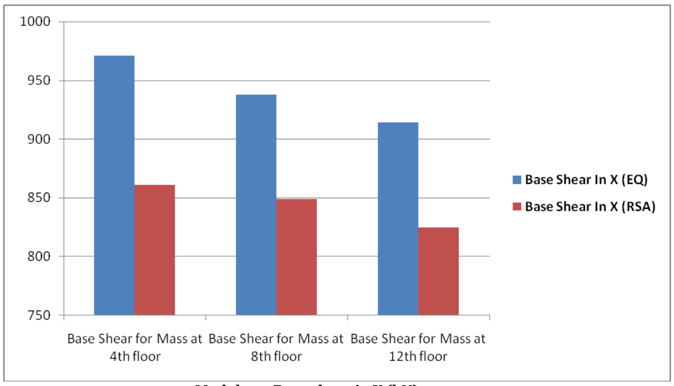
Storey vs. Storey forces in X(kN) (Model 2)

Chart -29 Storey forces comparisons



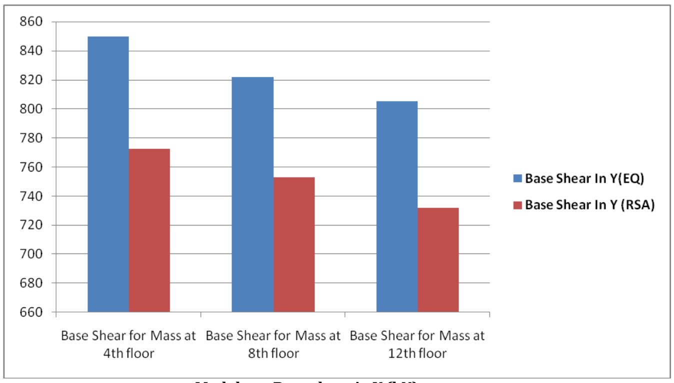
Storey vs. Storey forces in Y(kN) (Model 2)

Chart -30 Storey forces comparisons



Models vs. Base shear in X (kN)

Chart -31 Base shear comparisons



Models vs. Base shear in Y (kN)

Chart -31 Base shear comparisons

8. CONCLUSIONS

1) According to the results, it has found that the fundamental natural time period increases as the heavy mass shifted toward top, i.e. the time period of the frame with heavy mass at top floor will be more than the frame with heavy mass at 4th floor

2) It has also found that , while shear walls are placed at the corners of the irregular mass frame the time period reducing nearly 45%.

3) According to the results, it has found that the displacements will be higher as the irregular mass shifts toward top. Also the inclusion of shear wall reducing the displacements up to 35% in linear static analysis and up to 40% in linear dynamic analysis.

4) According to the results, it has found that the storey drift is reducing in the mass irregular building when shear wall are provided.

5) According to the results, it has found that the storey forces are high for floors which are subjected to heavy mass.

6) According to the results, it has found that the results of Response Spectrum Analysis are less as compare to the equivalent static analysis.

7) According to the results, it has found that the storey force was found to be more for the first storey in case of Response Spectrum Analysis as compared with the equivalent static analysis.

8) According to the results, it has found that the base shear is decreases as the heavy mass shifting toward top of the frame. Therefore the base shear is maximum for the frame having heavy mass at 4th floor.

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REFERENCES

[1] N.Anvesh, Dr. Shaik Yajdani, K. Pavan kumar, "Effect of Mass Irregularity on Reinforced Concrete Structure Using Etabs" International Journal of Innovative Research in Science,Engineering and Technology(IJIRSET), Vol. 4, Issue 10, October 2015.

[2] S Monish, S Karuna, "Effect of Vertical Irregularity in RC Framed Buildings in Severe Seismic Zone" International Journal of Emerging Technology and Advanced Engineering, Volume 5, Issue 6, June 2015).

[3] Himanshu Bansal, Gagandeep,"Seismic Analysis and Design of Vertically Irregular RC Building Frames" International Journal of Science and Research (IJSR), Volume 3 Issue 8, August 2014.

[4] Arvindreddy, R.J.Fernandes, "Seismic analysis of RC regular and irregular frame structures", International Research Journal of Engineering and Technology (IRJET), Volume: 02 Issue: 05 | Aug-2015.

[5] Sharma and Biswobhanu Bhadra, "Seismic Analysis And Design Of Vertically Irregular Rc Building Frame", National Institute of Technology Rourkela

[6] IS 1893 (Part 1): 2002 Indian Standard Criteria for Earthquake Resistant Design of Structures, Part 1 General Provisions and Buildings, (Fifth Revision)

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