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LINEAR ANALYSIS OF REINFORCED CONCRETE FRAME BUILDING HAVING MASS IRREGULARITY WITH AND WITHOUT SHEAR WALL UNDER SIESMIC EFFECT

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Abstract — *The report comes up with the procedure for seismic analysis of vertically irregular reinforced concrete frame structures using linear static and dynamic methods. Various reinforced concrete structures in metropolitan regions lying in active seismic zone may undergo moderate to severe damages during potential ground movements. Therefore it is essential to minimize offensive risks to property and life.*

The irregularities in a structures is mainly due allocation of lumped mass in a storey and by stiffing the storey all over the altitude of the structure. These changes make the structure irregular in plan or irregular in its elevation. Hence the engineers have being investigating the various asymmetrical plan structure to come up with perfect and accurate designs so that structure be safe or get less effected by seismic wave or earthquake.

In this project a fifteen storey model is prepared with vertical mass irregularity using ETABS software. To know the influence of shear walls at the corners of the structures during cause of seismic waves using linear static analysis. The displacements, storey drifts, storey force for each storey and base shear for different models is being compared by analyzing the models with linear static and linear dynamic analysis.

Keywords*-Mass Irregularity, Linear Static Analysis. Linear Dynamic Analysis, Shear Wall, Time Period, Storey Forces*

I. INTRODUCTION

An earthquake is sensible shaking of the surface of a earth that can be furious enough to destroy major structures and cause the life of thousands of people. 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 countries 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.

During the earthquake, failing of building elements starts at point of weakness. This collapse is because of discontinuous or change in mass, firmness and geometry of structure or building. The structures having this intermittence are called as Irregular structures. The behavior of structures with these irregularities due to earthquake needs to be studied. Satisfactory precautions can be taken. A careful study of structural behavior of the buildings with an irregularities is essential for the design and action. Structures are mainly designed to resist static load. Mainly the effect of dynamic loads acting on structure is not focus. The neglecting of the dynamic forces sometimes result 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 irregularities in buildings.

II. OBJECTIVES OF THE STUDY

2.1 OBJECTIVES

- To carryout analysis of multi-storeyed RC building with and without vertical mass irregularity using ETABS.
- To carry out lateral load analysis on different 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 Types in order to resist the lateral loads.
- To compare the results of Types having vertical mass irregularity with and without shear walls.
- To compare the results of linear static analysis with linear dynamic analysis.

III. NEED FOR RESEARCH

Asymmetrical structures represent a huge segment of the current built-up infrastructure. Constructions of building are never completely symmetrical therefore engineers consistently in need to evaluate the unsymmetrical structure with different plans to minimize the cause of seismic effect on structure.

Need for research is required to get inexpensive & efficient lateral stiffness structure for high earthquake areas. To optimise and design of tall structures with different seismic loads. To improve the understanding of the seismic behavior of building structures with vertical 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.

IV. DESCRIPTION OF TYPES

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

- Type 1: Regular Frame
- Type 2: Heavy Mass at 5th Floor
- Type 3 Heavy Mass at 5th Floor with SW
- Type 4 Heavy Mass at 10th Floor
- Type 5 Heavy Mass at 10th Floor with SW
- Type 6: Heavy Mass at Roof.
- Type 7: Heavy Mass at Roof with SW
- Type 8 Heavy Mass at 5th,10th,and Roof
- Type 9: Heavy Mass at 5th,10th,and Roof with SW

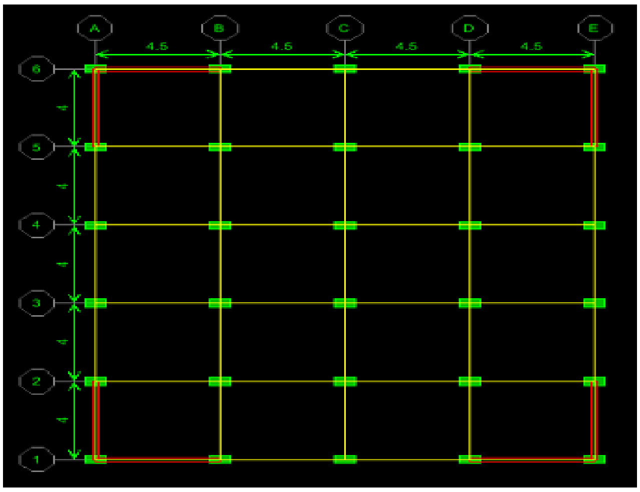

Fig 1: Plan view with SW

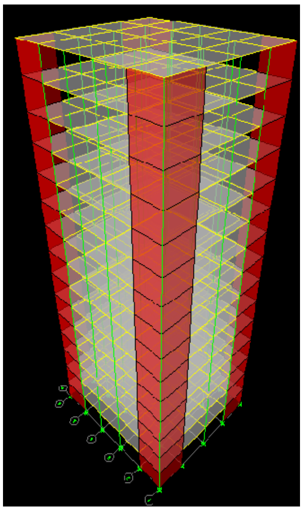

Fig 2: 3D view of types with SW

V. METHODS OF SIESMIC ANALYSIS

5.1 GENERAL

The intention of performing seismic analysis is to evaluate the force and deformation demands and capacities of the structural components. The analysis procedures is divided into linear procedures which include linear static & linear dynamic (Equivalent static analysis & Response spectrum analysis) & non-linear procedures which include non-linear static and non-linear dynamic (NLSPA & NLTHA).

5.2 LINEAR STATIC ANALYSIS (Equivalent Static Method)

This method is perhaps the simplest procedure at disposal for a structural engineer to perform an earthquake analysis and achieve 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".

The structure to be analyzed by the equivalent static method should respect certain criteria regarding its geometrical regularity and stiffness distribution such as:

- All lateral load resisting elements (such as columns or walls) should run from the base to the top without any disruption.
- Mass and lateral stiffness should not change abruptly from the base to the top.
- Geometrical asymmetries in height or in plan due to setbacks should not exceed certain values.

5.3 LINEAR DYNAMIC ANALYSIS (Response Spectrum Analysis)

The invention in computers programs and the successive improvement in technologies, together with widespread investigate in typesing, additional consistent tools are presented for use in building design. 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.

Use footnotes sparingly (or not at all) and place them at the bottom of the column on the page on which they are referenced. Use Times 8-point type, single-spaced. To help your readers, avoid using footnotes altogether and include necessary peripheral observations in the text (within parentheses, if you prefer, as in this sentence).

VI. STRUCTUARAL SPECIFICATION

Number of storey	15
Storey height	3.2m
Size of Beam	300X500mm
Size of Column	400X750
Thickness of Slab	150mm
Lumped Mass	15kN/m^2
Width of Wall	230mm
Density of masonry	20 kN/m^3
Wall load	20x0.23x(3.2-0.3) = 13.34 kN/m^2
Shear wall	200mm
Liveload	3kN/m^2
Floor Finish	1kN/m^2
EARTHQUAKE PARAMETERS	
Zone Factor (Z)	V
Importance Factor (I)	1
Soil type	II
Response reduction factor (R)	5

VII. RESULTS

6.1 INTRODUCTION

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

The results of natural period of vibration, lateral displacements and storey drifts for the different building Types 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.

Below Chart Represents the fundamental natural time periods for different models with heavy mass at different floors

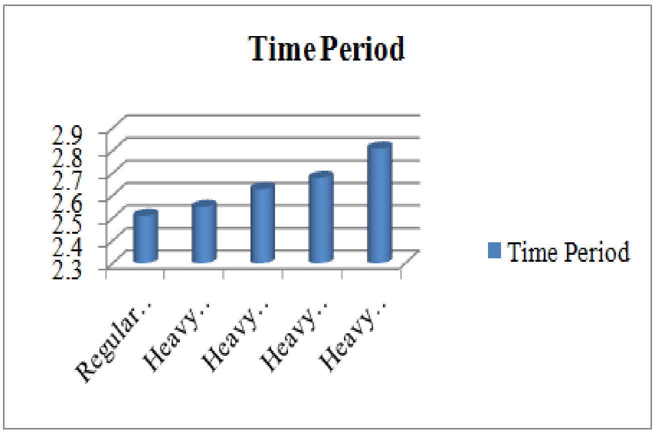

Chart 7.1 Time periods v/s Types

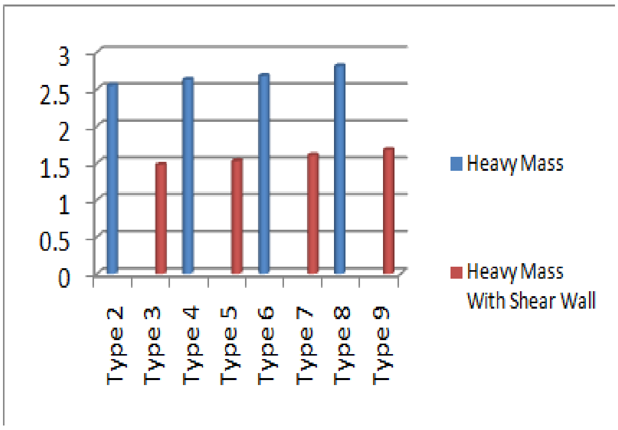

Chart 7.2 Time periods v/s Types with and without shear walls

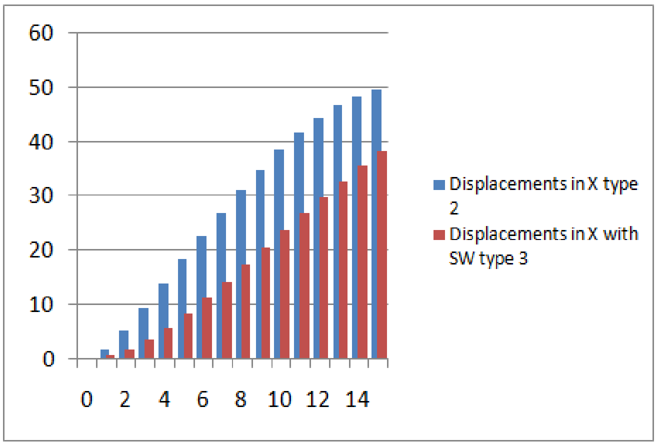

Chart 7.3 :Storey v/s. Displacements

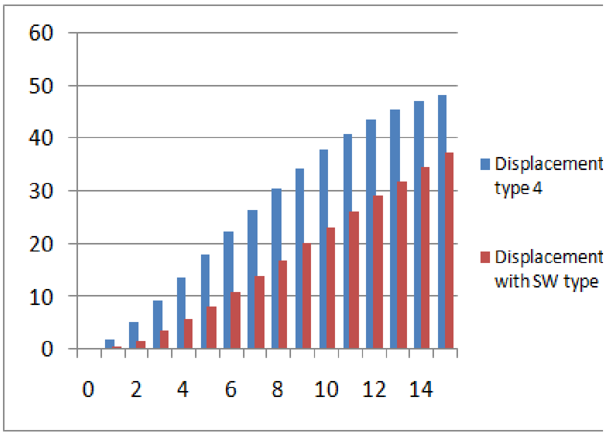

Chart 7.4 Storey v/s. Displacements

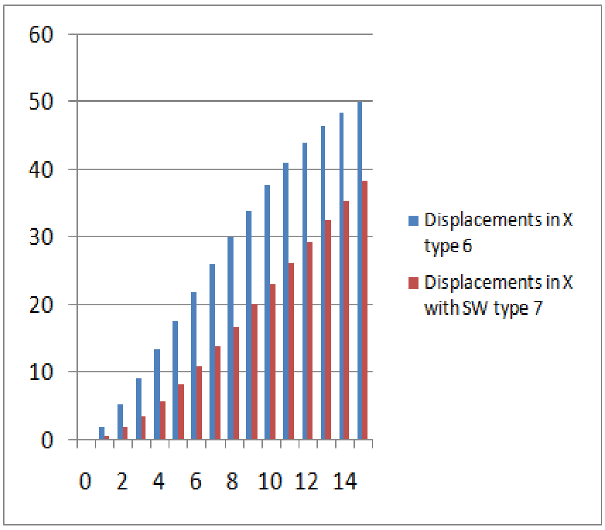

Chart 7.5 Storey v/s. Displacements

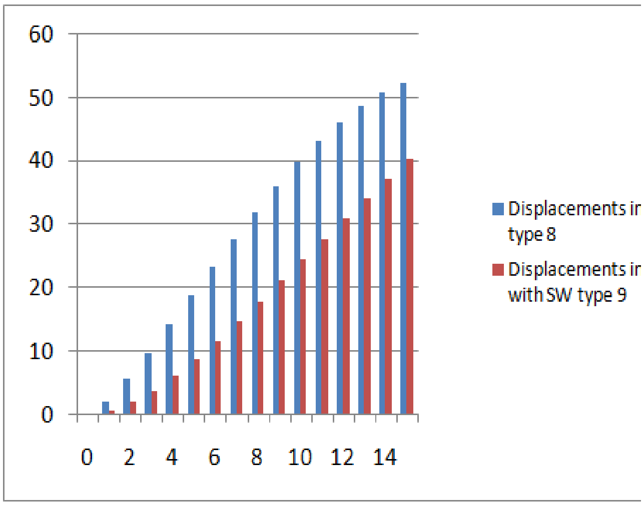

Chart 7.4 Storey v/s. Displacements

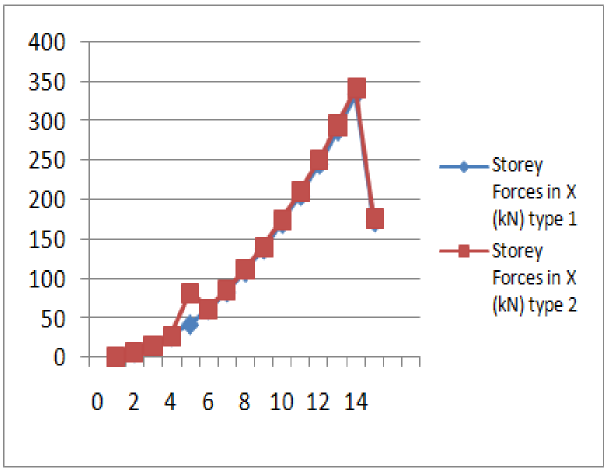

Chart 7.5 Storey v/s. Storey forces

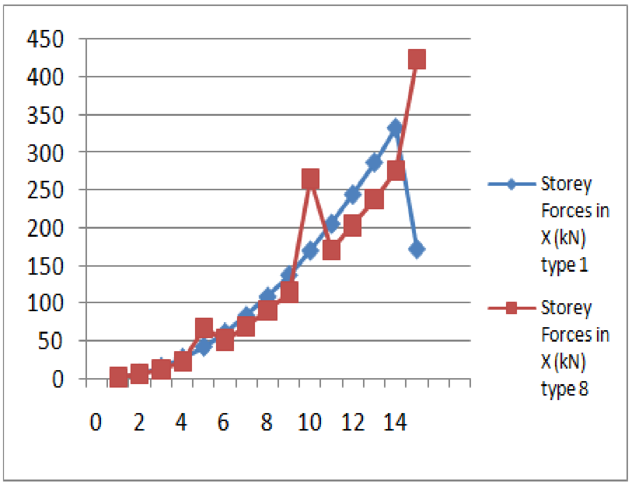

Chart 7.6 Storey v/s. Storey forces

Below Chart Represent Comparison Between Linear Static & Linear Dynamic Analysis Results

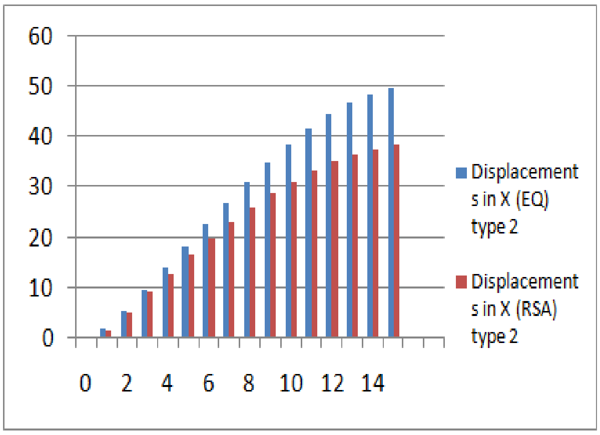

Chart 7.7 Storey v/s. Displacements

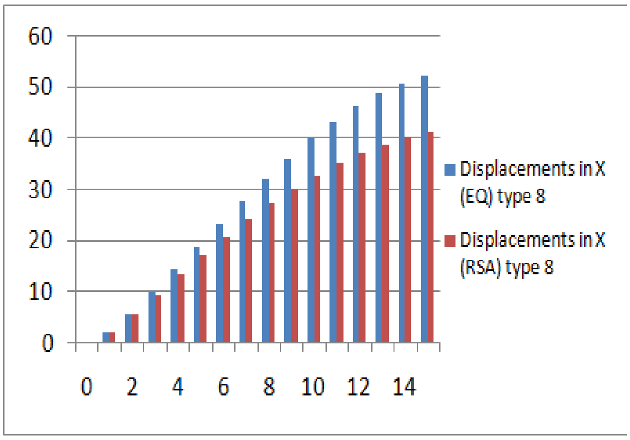

Chart 7.8 Storey v/s. Displacements

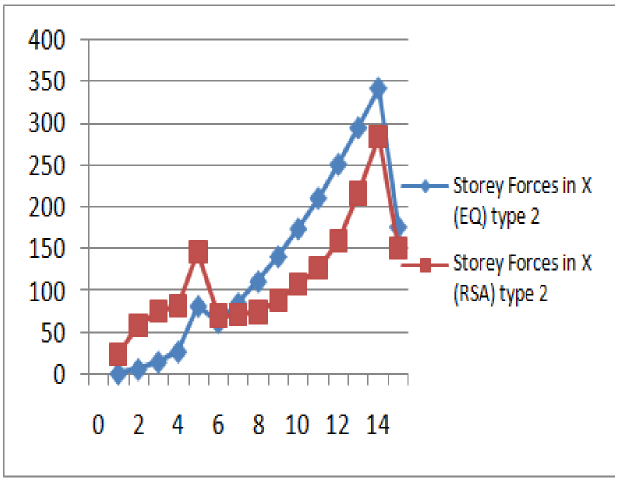

Chart 7.9 Storey v/s. Storey Forces

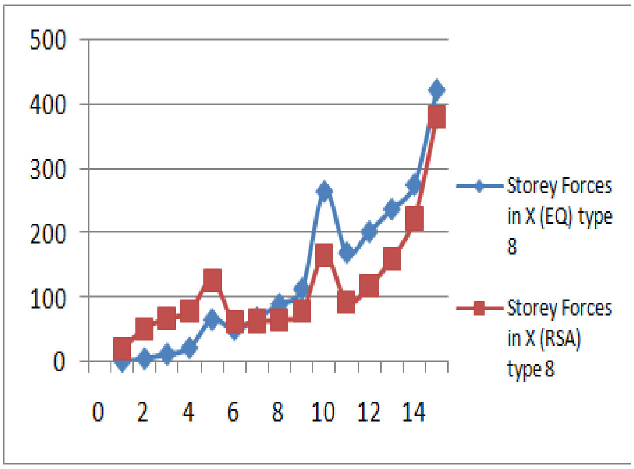

Chart 7.10 Storey v/s. Storey Forces

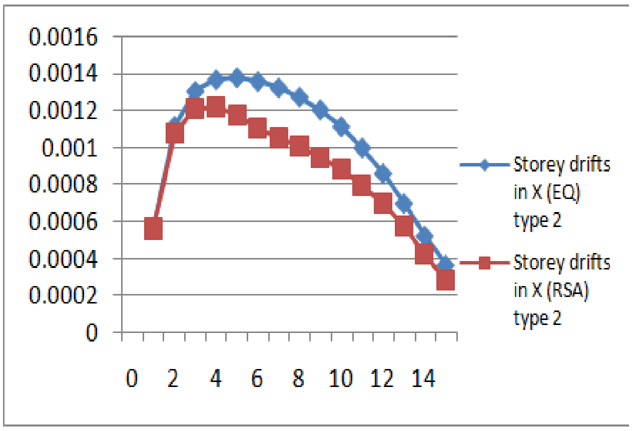

Chart 7.11 Storey v/s. Storey Drift

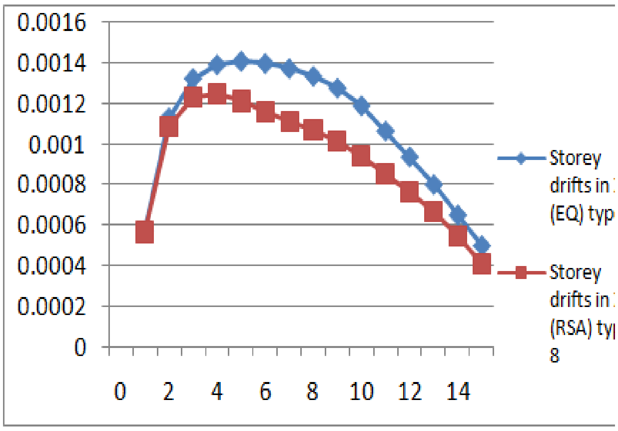

Chart 7.12 Storey v/s. Storey Drift

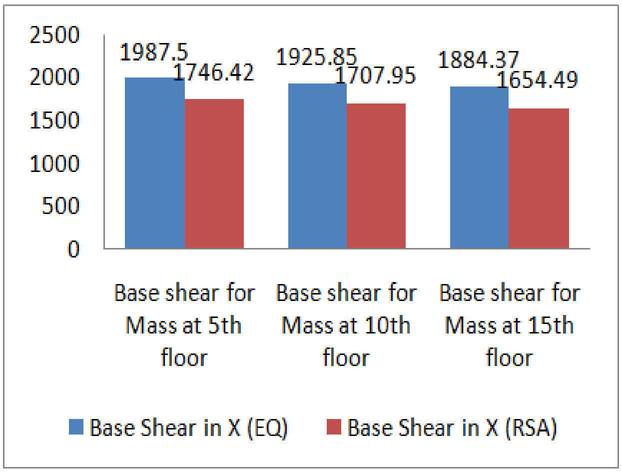

Chart 7.13 Types v/s. Base Shear

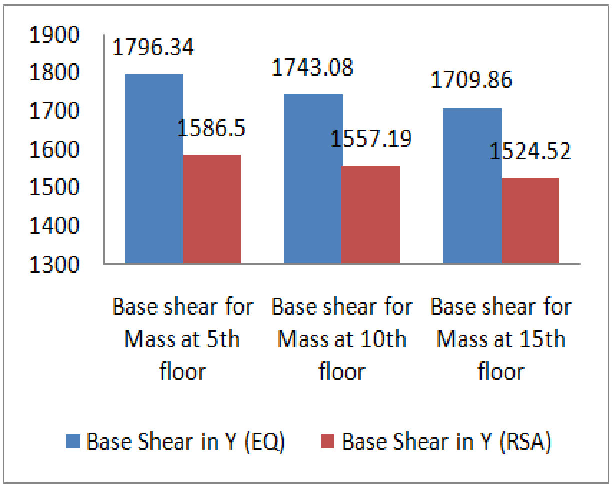

Chart 7.14 Types v/s. Base Shear

VIII. 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 lower floor
2 It has also found that, while shear walls are placed at the corners of the irregular mass frame the time period reducing considerably.
3 According to the results, it has found that the shear force and bending moments are very high in the beams of the heavy loaded floors, which may results in increase in the steel.
4 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 considerably in linear static analysis and much more in linear dynamic analysis.
5 According to the results, it has found that the storey drift is reducing in the mass irregular building when shear wall are provided.
6 According to the results, it has found that the storey forces are high for floors which are subjected to heavy mass.
7 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 lower floor.
8 According to the results, it has found that the results of Response Spectrum Analysis are less as compare to the equivalent static analysis.
9 According to the results, it has found the storey shear force was found to be more for the first storey in case of Response Spectrum Analysis as compared with equivalent static analysis.
10 Finally it can conclude that, the effect of vertical mass irregularity has local as well as global effects on the various floors of a building.

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