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A Study on Positioning of Different Shapes of Shear Walls in L Shaped Building Subjected to Seismic Forces

MD Afroz Patel*
*PG Student,
Department of Civil Engineering,
Khaja Banda Nawaz College of Engineering,
Gulbarga, Karnataka State, India

Prof. Shaik Abdulla**
**Assistant Professor,
Department of Civil Engineering,
Khaja Banda Nawaz College of Engineering, Gulbarga,
Karnataka State, India.

Abstract: **An investigation has been performed to study the optimum location and different shapes of shear walls in L shaped high rise building. Shear walls are the structural members used to increase the strength of RCC Structures. It is essential to find out the effective, efficient and ideal location of shear walls become essential to the building interior when the exterior walls cannot provide extra strength and stiffness to the building. In this study an L shaped high rise building with different locations of shear walls and with different shapes of shear walls is considered for the analysis. The high rise building is analyzed using the ETABS software to determine the various parameters such as Time period, Base shear, Storey drift and Storey displacement. The results of the analysis on the various parameters are presented in the tabular form and graphical form and the results of various parameters are compared using the different methods of seismic analysis such as ESA RSA and Time history analysis.**

Keywords - Time Period, Base Shear, Storey Drift, Storey Displacement, Location Of Shear Wall, Shapes Of Shear Wall, Seismic Analysis E.S.A, R.S.A, T.H.A

I. INTRODUCTION

R.C.C building can significantly resist both vertical and horizontal load. In order to resist the higher values of seismic forces in a multi storied building the shear walls which are lateral load resisters should be introduced in a building. Shear walls are defined as vertical plate like reinforced concrete wall are introduced in a building in addition to beam column and slab. The shear walls are mainly incorporated in a building to resist the lateral loads and to support the gravity loads. The overall behaviour of the building is mainly influenced by positioning of shear wall and the reinforced shear wall high in plane stiffness. It is very important to position the shear wall in an ideal location for effective and serviceable performance of building.

II. LITERATURE REVIEW

M. Santhosh, S. Pradeep, they carried out the project on "Seismic Analysis and Design of Multi Storey Building with Non Parallel Shear Wall System". The main focus of the study is to discuss the effectiveness of shear wall by considering different models. A G+5 storey building was considered which was located in the seismic zone V and the earthquake, They concluded from the analysis results that base shear for structure without shear wall was less when compared with the structures with shear walls due to reduced self weight Prof.Vishwanath.B.Patil, Sunil Kumar Kalyani, there research was on "Effect of Shear Wall Sections on Multistory Building with Satellite Bus Stop Having Floating Columns With Top Soft Storey". They performed an investigation of columns in the ground level of G+12 multistoried building with soft ground floor as satellite bus stop and floating columns in the upper stories subjected to earthquake loading, they concluded that there was no effect in drift for the building with top soft storey when subjected to seismic loading. The storey acceleration was maximum for the building with no brick masonry infill in ground and top storey, but having full brick masonry infill in rest of all stories with swastika shape shear wall at corners along x direction in response spectrum analysis and time history analysis. . Dr. E Arunakanthi, A Murali Krishna, there research was on "Optimum Location of Different Shapes of Shear Walls in Unsymmetrical High Rise Buildings". Their main work deals with a study on optimum location of shear walls in an unsymmetrical high rise building. They considered high rise building with different location of shear wall and different shapes (L, U, box, H, T, W) for analysis. There building configuration consists of 30 storeys for each model. The influence of the time period was significant on shape of shear wall and its position. The columns located away from shear wall had less shear force and high bending moments compared with columns connected with shear wall. Sanjay Sen Gupta. There research was on "Study on Shear Walls in Multi Storied Buildings with Different Thickness and Reinforcement Percentage for All Seismic Zones in India''. The effect of different thickness and corresponding reinforcement percentages required for shear walls in multi storied building was investigated in this paper. From the results the following conclusions were made. The reinforcement percentage of shear walls at different locations for a shear wall of constant thickness. Ahmed Najim Abdullah Al-Askari, Prof N. V. Ramana Rao. Their work deals with the "Study on The Optimum Location and Type of Shear Wall in U Shape Building under Different Types of Soils". A high rise building was considered for the analysis with shear wall at different locations. They concluded that the time period significantly influenced by the shear wall and its position and not by the different types of soils.

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III. BUILDING DESCRIPTION

The plan of the RC SMRF building is as shown in the Fig 4.1. The plans of the various models are as shown in the Figures from fig 4.2 to 4.9 below. In this study the plan configuration is same for all the models. Each model is of 20 storeys with a depth of the foundation equal to 2m. Each storey height is kept equal to 3.3m for all the various building models. An irregular building in zone V is considered for the study. Floor live load is taken exactly half (50%) for the calculation of the seismic weight. The design data applied for all the different building models is given below in Table3.1

Table 3.1 Salient Features of the Building

Sl.No.	Specifications	Details
1.	Type Of Structure	SMRF
2.	Zone	V
3.	Layout	as Shown in the fig.1
4.	Number Of Stories	(G+20)
5.	Ground Storey Height	3.3m
6.	Floor-To-Floor Height	3.3m
7.	Wall Thickness	0.23m
8.	Live Load	4.0 KN/m^2
9.	Materials	M20, Fe500 and Fe 415
10.	Seismic Analysis	ESA, RSA And Time history
11.	Design Philosophy	Limit State Method Conforming To IS 456 : 2000
12.	Size of Column	(0.8x0.8)m and (1mx1m)
13.	Size of Beams in Longitudinal and Transverse Direction	(0.3x0.6) m
14.	Total Thickness of Slab	0.150 m

IV. MODELLING AND ANALYSIS

Here in this study we have considered eight models for the study. First model consist of Bare Frame, Second Model consist of infill masonry ,in the remaining models shear walls of different shapes are provided by replacing the infill masonry at the required location. The layout of the plan for all the models is same as shown in figure 4.1 below

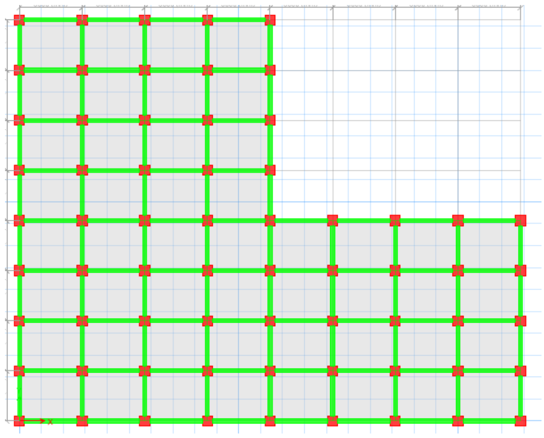

Fig4.1 Plan Layout

Model 1: In this model, a bare frame with mass of infill as uniformly distributed load on all the beams is considered. Model 2: In this model, the brick infill masonry wall is provided throughout the height of the building. Model 3: This model has five box type shear wall one at top and one at bottom and three at the middle of edges. Model 4: This model has five L shape shear wall all the shear walls are located at the outer edges of the plan of building. Model 5: This model has 3 U shaped shear walls one at Top middle, one at right middle bottom and one at bottom middle of the plan of building. Model 6: This model has three T shaped shear wall one at top middle, one at right middle bottom, and one at bottom middle of the plan of building. Model7: This model has two W shaped shear wall located at middle right corner of the plan of building. Model 8: This model has two I shaped shear wall located at middle right corner of the plan of building**.**

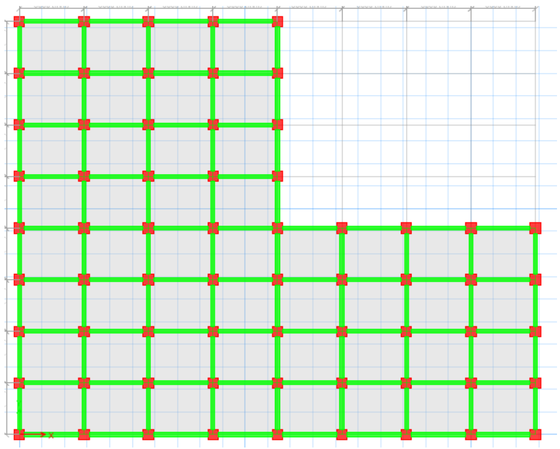

Fig 4.2

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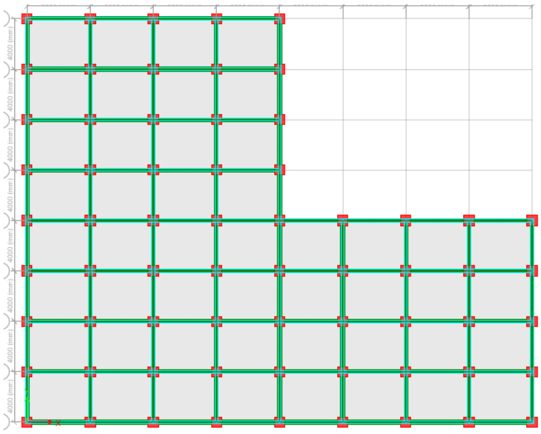

Fig 4.3

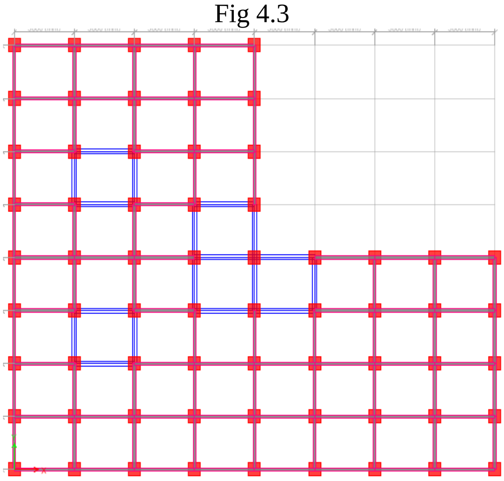

Fig 4.4

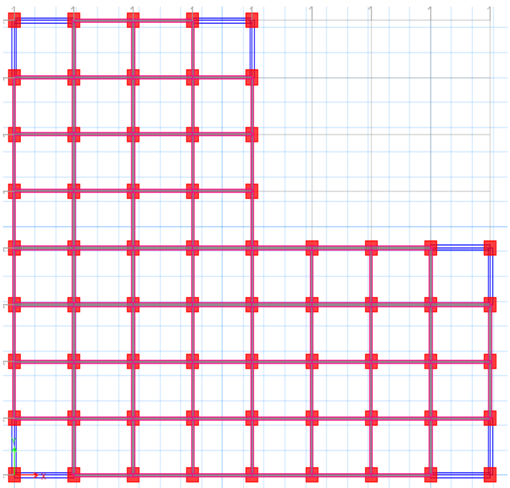

Fig 4.5

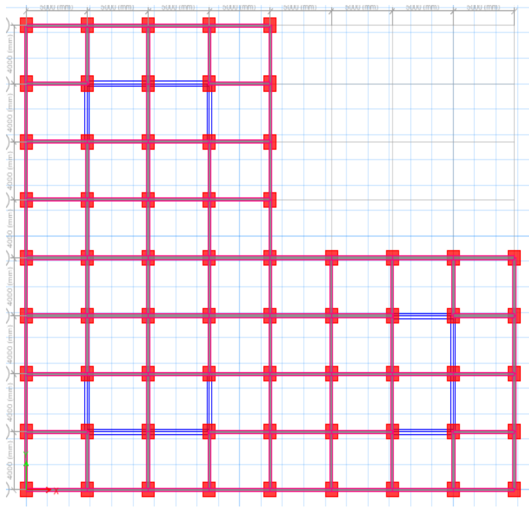

Fig 4.6

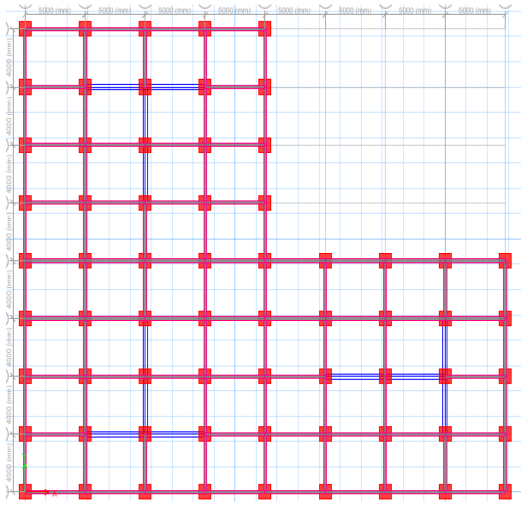

Fig 4.7

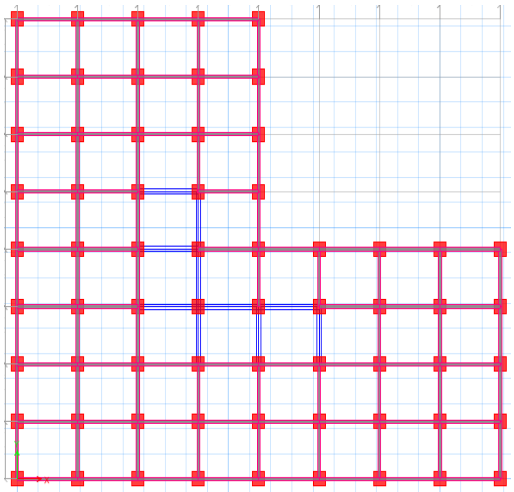

Fig 4.8

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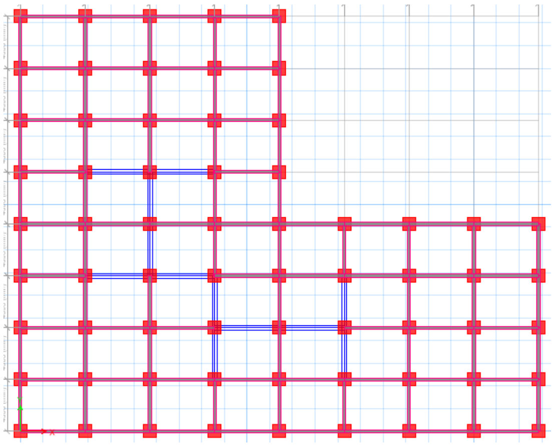

Fig 4.9.

V. RESULTS AND DISCUSSION

5.1 Fundamental Time Period

The graph (chart 1) represents the values of time period obtained from IS: code method and the ETABS analysis. The graph shows that the value of time period obtained from the ETABS analysis is more than the IS: code method for the bare frame model. It is observed from the graph that the values of time period obtained from IS: code in X and Y direction is more than the ETABS analysis for different models. It is also observed that model 2 has the highest value of time period obtained from ETABS analysis compared to the other models and the same value of Time period is obtained for various models in IS: code method.

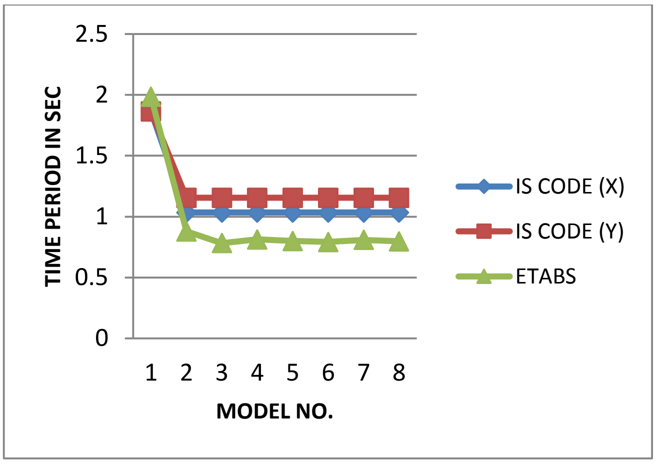

Chart 1. Time period Vs Model

5.2. Design Seismic Base Shear

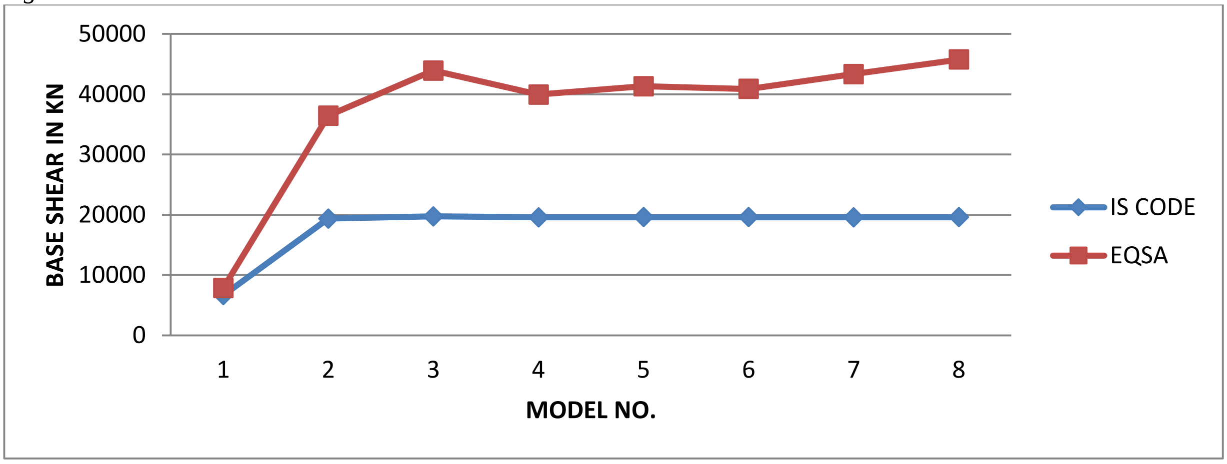

Chart 2 Base Shear Vs Models of IS Code Vs ESA along Longitudinal Direction

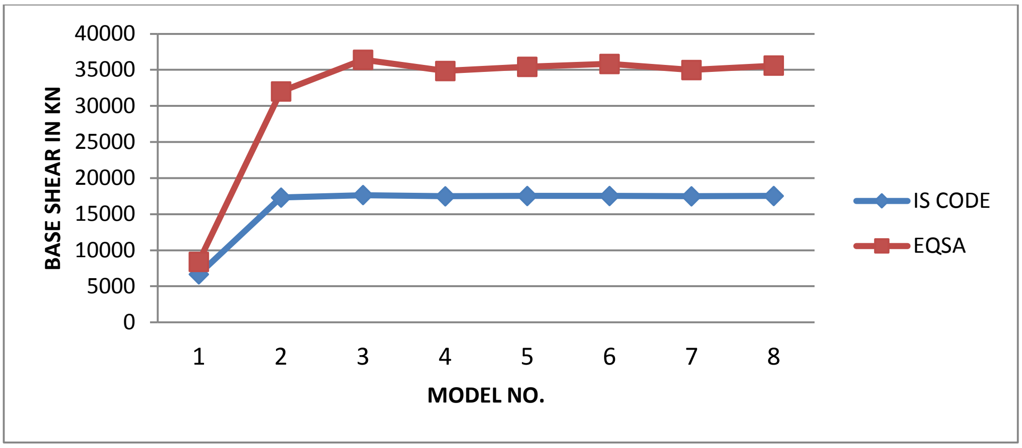

Chart 3. Base Shear Vs Models of IS Code Vs ESA along Transverse Direction

The graphs (Chart 2and Chart 3) shows the values of seismic base shear for various models obtained from the ESA and from the IS code method. From the graphs it is observed that the values of seismic base shear obtained from the IS code method are the least as compared to the ESA. The value of seismic base shear obtained from IS code method and ESA for the bare frame or model 1 is very less compared to the other models. It is observed that the values of seismic base shear obtained from ESA in X direction for model no 8 has the highest value as compared to the other models. From the graph it is observed that the values of seismic base shear is slightly varying for IS code method and the values of seismic base shear is gradually increasing for ESA.

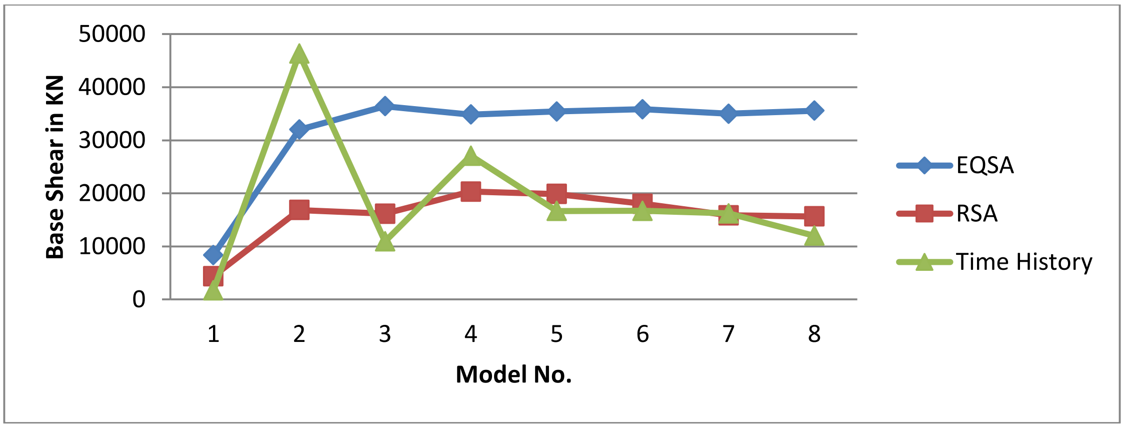

Chart 4.Comparison of Base shear by ESA, RSA, and Time history for various Models along Longitudinal direction

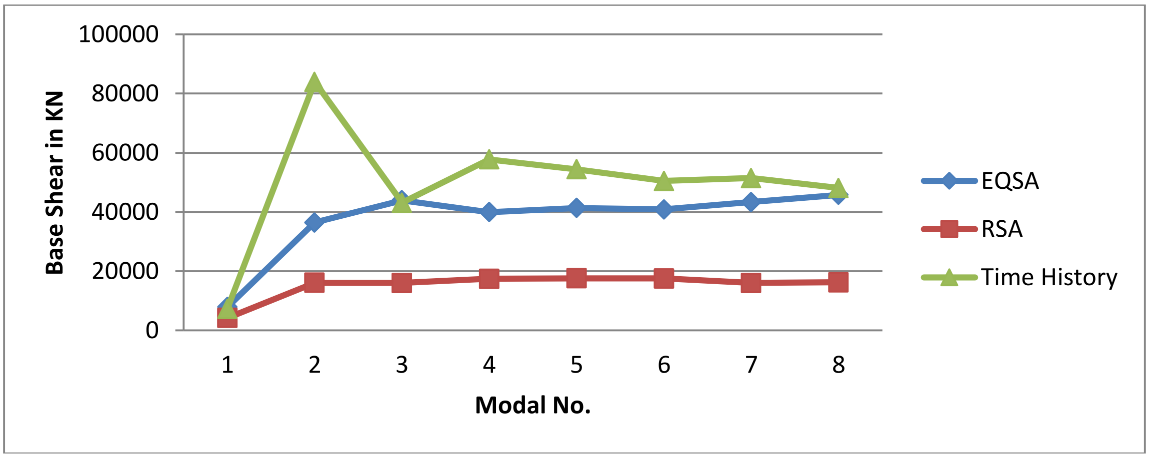

Chart 5.Comparison of Base shear by ESA, RSA, and Time history for various Models along Transverse direction

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The Chart 4 shows the comparison of seismic base shear values obtained from ESA, RSA and time history analysis. From the graphs it is observed that the time history analysis yields the highest value of seismic base shear compared to the other methods. It is observed that the seismic base shear values for bare frame model in longitudinal direction obtained from time history analysis is less as compared to the other models. The graph of RSA lies in between the ESA and Time history analysis. It is also observed that there is sudden decrease in base shear values obtained from time history analysis.

From the Chart 5 It is observed that there is a highest variation in base shear for model 2 in transverse direction from time history analysis compared to the other methods. Apart from the model 1 all the other values of seismic base shear lies in a horizontal line obtained from ESA and time history analysis. The graph of RSA lies below that of ESA and time history analysis. It is also observed that least values of seismic base shear is obtained from time history analysis.

5.3. Storey Drifts

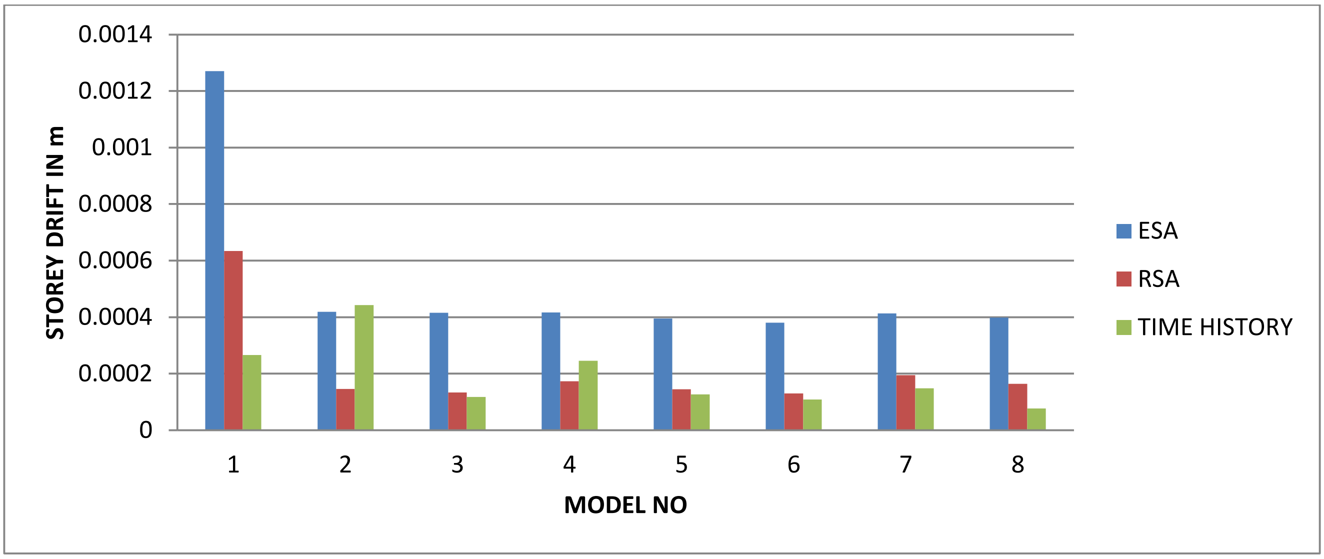

Chart 6. Comparison of Storey Drift, Models and Methods of Analysis along longitudinal direction

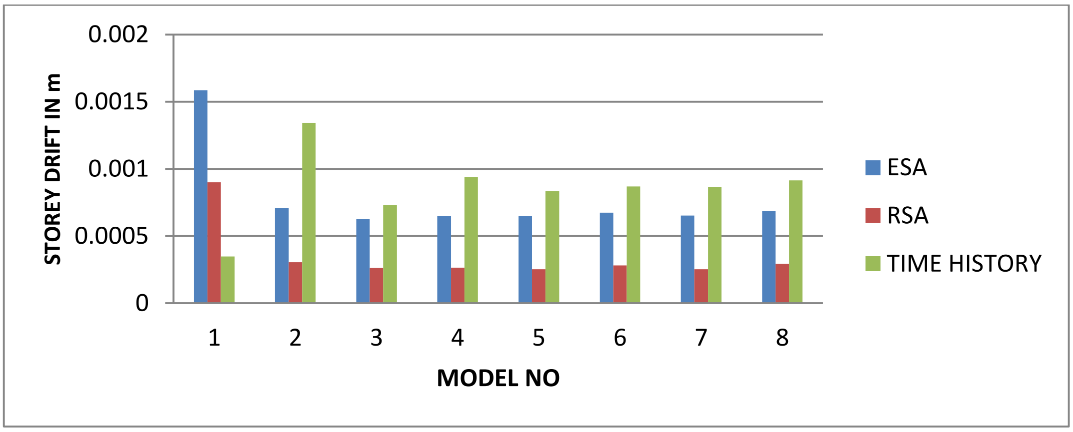

Chart 7. Comparison of Storey Drift, Models and Methods of Analysis along Transverse direction

The graph (chart 6 and 7)represents the comparison of storey drift values of different models along longitudinal and transverse direction obtained using ESA ,RSA and Time history analysis. From the Chart 6 it is observed that the maximum value of storey drift is obtained for bare frame model using ESA and RSA and a least value of storey drift is obtained from time history analysis for the Model 8 along the longitudinal direction.

From the chart 7 it is observed that maximum value of storey drift is obtained for bare frame model using ESA, and RSA. Model 2 showed maximum value of storey drift obtained from time history analysis compared to other methods of analysis along the transverse direction. Model 5 showed least value of storey drift obtained from RSA.

5.4. Storey Displacement

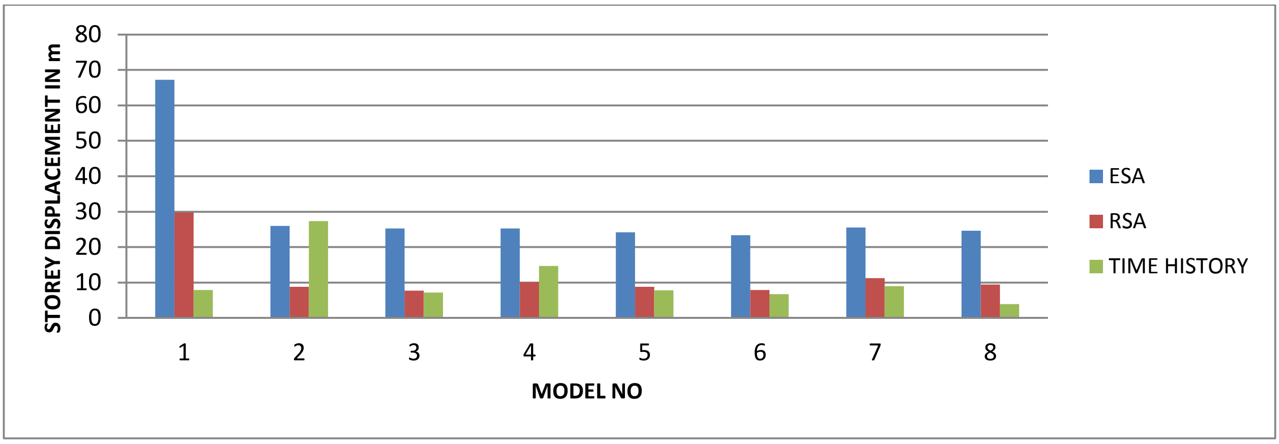

Chart 8.Comparison of Storey Displacement, Models and Methods of Analysis along longitudinal direction

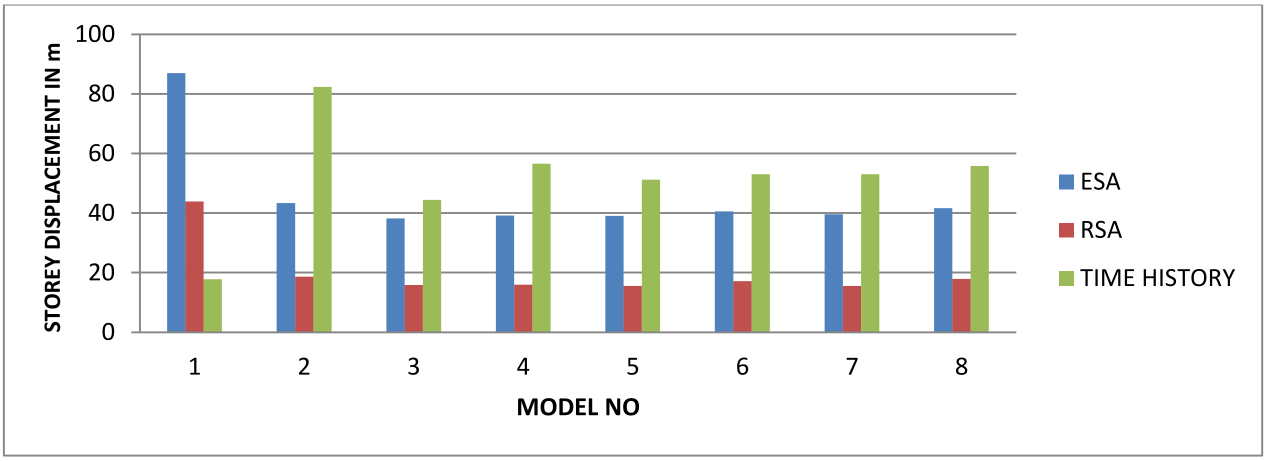

Chart 9.Comparison of Storey Displacement, Models and Methods of Analysis along Transverse direction.

The graph (Chart No 8 And 9) shows the comparison of storey displacement values of different models along longitudinal and transverse direction using ESA , RSA and time history analysis. From the chart 8 it is seen that model 1 showed maximum value of storey displacement in ESA and RSA and model 8 showed minimum value of storey displacement in Time history analysis along longitudinal direction.

From the chart 9 it is observed that model 1 showed maximum value of storey displacement in ESA and RSA and model 2 showed maximum value of storey displacement in Time history analysis. Model 5 and model 7 showed least value of storey displacement in RSA along the transverse direction.

VI. CONCLUSION

1) The shape of shear wall and its position have a significant influence on the time period. From the ETABS analysis model 3 showed significant difference in time period compared to the other models due to the presence of box type shear wall.

2) It was found that seismic base shear values are much varied by the addition of shear walls since the seismic weight increases.

3) There was a much difference in seismic base shear values obtained from ETABS analysis compared to the IS: Code method.

4) Time history analysis gives the higher value of seismic base shear for all the models compared to the other methods of analysis.

5) Storey drift values are within the limits recommended by the code IS: 1893:2002 (Part 1)

6) Storey drift has significantly influenced by the addition of shear walls and the shapes of shear wall. In the model 8 storey drift values are decreased due to the presence of I shaped shear wall when analysed by the time history analysis.

7) Storey displacements are generally reduced by the provision of shear wall the reason behind this is the shear wall increases the stiffness of the structure.

8) On comparison of storey displacements values of different models along the longitudinal and transverse directions using the ESA, RSA and time history analysis. Model 1 showed highest value of storey displacements due to the absence of shear wall. By the addition of I shaped shear wall model 8 showed a least value of storey displacement obtained by time history analysis.

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