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BEHAVIOR OF HIGH-RISE BUILDING WITH BOTTOM, INTERMEDIATE, TOP SOFT STOREY AND SWIMMING POOL AT TOP

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ABSTRACT-High rise reinforced concrete buildings with ground soft storey are naturally liable to collapse because of seismic load, even then their construction continues to be widespread in order to overcome the demands of parking. For this purpose a G+20 story building is considered for the present project work, modeling and analyzing of building is done by using ETABS 2015. In this project ,work is done to know the behavior of the building provided with top, intermediate and ground soft storey and swimming pool at top of the building subjected to earthquake effects. The response of the different building models are studied by comparing various parameters such as time period, storey displacement, base shear and story drift by using Equivalent-Static analysis, Response Spectrum analysis and Time History analysis. The structural action of the building is studied by providing shear walls of different shapes.

Keywords: Soft Storey, Equivalent Diagonal Strut, Shear wall, Displacement, Drift,Base shear, Equivalent static method, Response spectrum method, Time history method.

I. INTRODUCTION

The dangers caused by earthquakes are expected, under which disasters are primarily due to damage or loss of buildings. The objective of seismic analysis is accepted only when the structure is able to tolerate slight shaking intensity without causing any harm, thus the structure can be left after the event. Later forces can cause significant stress in the structure and in addition the cause of the lateral pathway is formed. Most of buildings built in present times have particular characteristic that bottom stories are left open for reception and parking purposes etc. Such reinforced concrete structures are known as open bottom story structures. The quality request on the segment in the principal story for these building is huge, upper stories move together as a solitary square and the greater part of the level uprooting of the building happens in the delicate ground story. Fortified solid building can sufficiently oppose both level and vertical load. Shear walls are engaged in working to resist lateral forces and to strengthen the gravitational load. The location of shear wall impacts the general behavior of the building. For the powerful and productive execution of the building, it is fundamental to the place the shear wall at effective location. Most of the engineers have concluded that by varying the place of the shear walls the factors like base shear, time period, storey drift, and lateral displacement can be decided. Reinforced concrete structures having open bottom storey are recognized as a bottom soft storey structures, when structures built with soft stories at various levels same effect of bottom soft storey can be seen. From the past earthquake it has been observed that a building with discontinuity in the stiffness and mass subjected to application of forces and deformations at the point of discontinuity which may leads to the failure of members at the junction and collapse of building. Most inexpensive method to remove the failure of soft storey is by adding shear walls.

II.OBJECTIVES OF STUDY

The objectives of current study are as listed/follows below:

- To know the impact of the structure with ground, top and intermediate Soft storey subjected to lateral seismic loading.
- To carry out lateral load analysis for various models as per the code.
- To study the behavior of ground, top and intermediate Soft storey of R C high rise buildings.
- To study the behavior of building by considering the water load in the form of swimming pool at top of the reinforced concrete building.
- To study the influence of shear walls of several shapes like L, C, H(Double cell wall) and Multi cell wall on the general behavior of building.
- To find out time period, displacement, base shear, storey shear and storey drifts at every storey level using Equivalent-Static method, Response-Spectra method and Time-History method.
- To examine the extent of change in storey drift and internal forces computed with bare frame model and also the completely different building models.

III. DETAILS OF MODELS

TABLE 1 MODEL DETAILS

Model No	Model description
1	Bare Frame building model with top, bottom and intermediate soft storey and swimming pool at top.
2	Reinforced concrete building model same as model 1, further an addition of L-type shear wall at corners
3	Reinforced concrete building model same as model 1, further addition of C-type shear wall at corners
4	Reinforced concrete building model same as model 1, further addition of H-type (Double cell wall) shear wall at corners.
5	Reinforced concrete building model same as model 1, further addition of Multi cell wall type shear wall at corners.
6	Reinforced concrete building model same as model 1, with full diagonal strut along all the four elevated sides of the building excluding the ground soft storey.
7	Reinforced concrete building model same as model 2, with full diagonal strut along all the four elevated sides of the building excluding the ground soft storey.
8	Reinforced concrete building model same as model 3, with full diagonal strut along all the four elevated sides of the building excluding the ground soft storey.
9	Reinforced concrete building model same as model 4, with full diagonal strut along all the four elevated sides of the building excluding the ground soft storey.
10	Reinforced concrete building model is same as model 5, with full diagonal strut along all the four elevated sides of the building excluding the ground soft storey.

IV. PLAN USED IN ANALYSIS

Structure Data

The top storey plan and bottom storey plan of the structure are shown in figure 1 and 2. For the project, the plan layout is kept unchanged for all the models. Each building model is of 21 storeys. The typical storey height is 3.2m except 21st storey, 12th storey and ground storey. The height of 21st storey is 3m, 12th storey is 2.2m and the height of ground storey is kept 5m for all the different building models. The analysis of the building is done in Zone 5.

Material Properties:

Youngs modulus of M40 = 31622.77 N/mm2

Concrete density = 25 kN/m3

Brick masonry density = 20 kN/m3

Dead load intensities:

Floor finish = 1 kN/m2

Imposed load intensity :

Imposed load = 3.5 kN/m2

Member properties:

Thickness of Slabs

S1=150mm (1stto 21stfloor except the some portion of slab of 20thstorey, which is covered by swimming pool.)

S2 =300mm (some portion of 20thstorey, which is covered by swimming pool.

Column sizes

C1=750x1500mm (1st to 4th storey and also the corner columns of 5th storey.)

C2 = 600x1200mm (5th storey (except the corner columns) to 21st storey.)

Beam sizes

Beam 1=600X1200 mm (1st to 2nd storey.) Beam 2=400X800 mm (5th to 10th storey.)

Beam 3=400X600 mm (3rd, 4th, 11thto 21thstorey.)

Thickness of wall =230 mm

Swimming pool size=32X24X3 m

Hydraulic pressure on slab =19.62 KN /m2.

Hydraulic pressure on walls =16.67KN/m2

Seismic Data:

Zone factor as per (table 2 of IS: 1893-2002)=0.36 (Zone 5)

Importance factor I from (Table 6 of IS: 1893-2002) = 1.0

Response reduction factor R from (Table 7 of IS: 1893-2002) =5.0(SMRF)

Soil type (Figure 2 of IS1893-2002) =Type II (Medium soil)

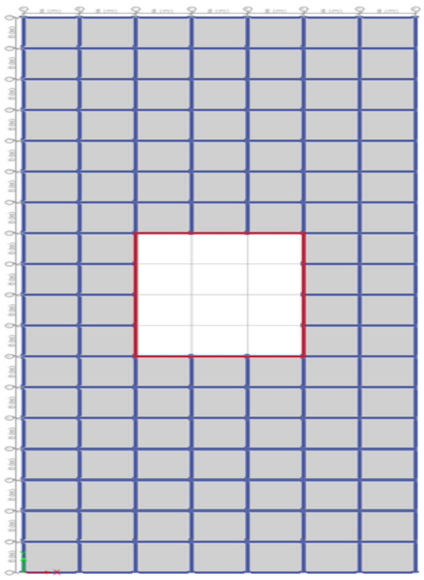

Figure.1 Top Plan Layout

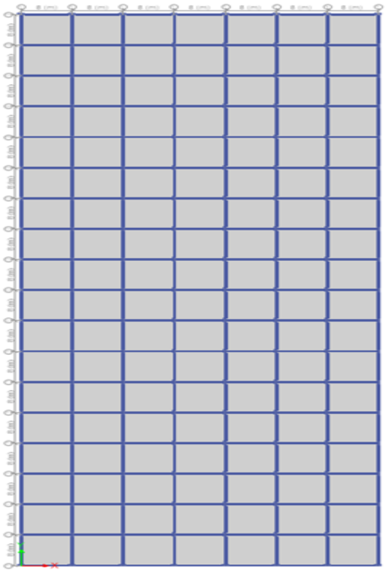

Figure.2 Bottom Plan Layout

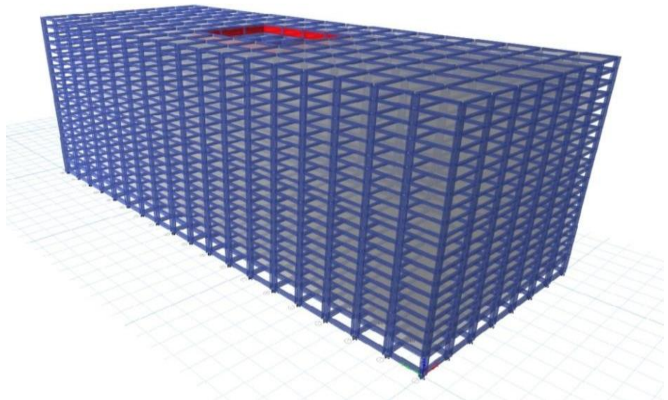

Figure.3 .3D view

V. RESULTS

1. Time period

TABLE 2 : TIME PERIOD

Fundamental time period(Sec)	
MODEL NO.	Time Period
01	2.981
02	2.415
03	2.635
04	2.322
05	2.356
06	0.799
07	0.743
08	1.153
09	0.765
10	0.780

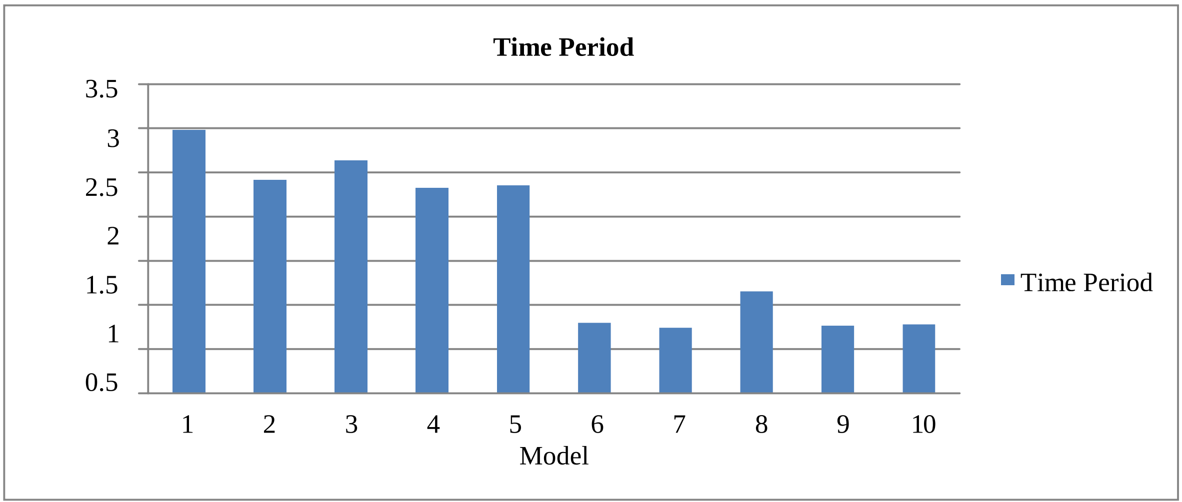

Chart 1: Model Vs Time period for Different models.

2. Base Shear

TABLE 3. BASE SHEAR

Number of Models	Base shear in kN	
	Base shear by RSA	Base shear by THA
	RS x	TH x
1	118061.00	68530.00
2	162699.48	105033.26
3	140540.60	99708.06
4	172849.90	104122.20
5	166381.90	109365.99
6	498166.40	453638.49
7	521999.67	367975.17
8	325324.01	243986.50
9	499423.87	388830.50
10	489933.65	387478.15

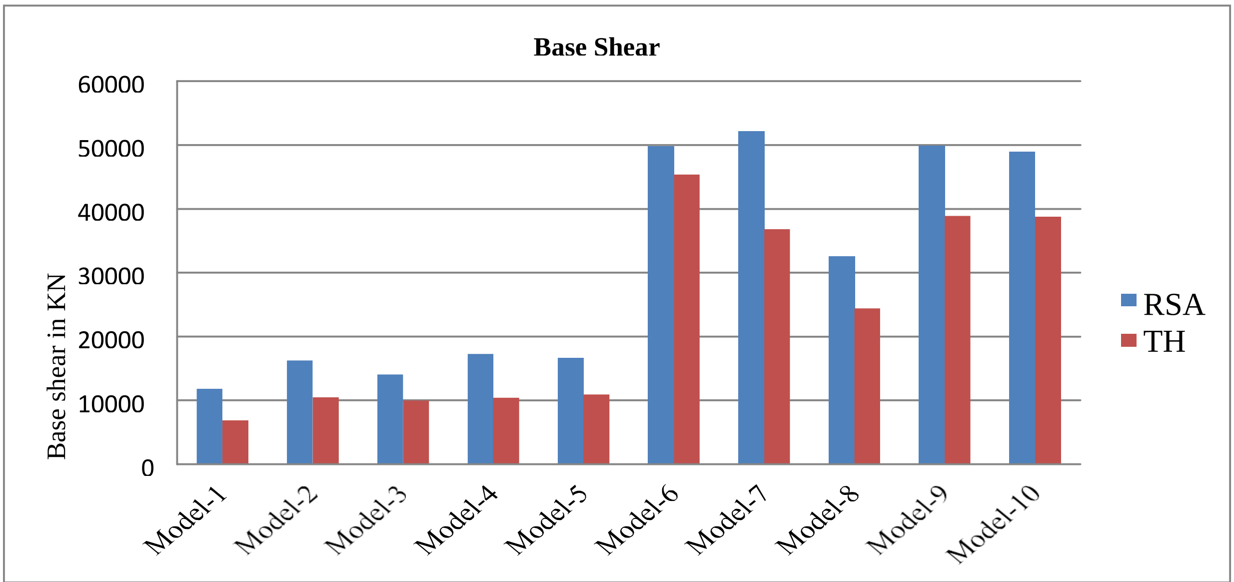

Chart 2 Comparison of base shear X by RSA and THA

3. Storey Displacement

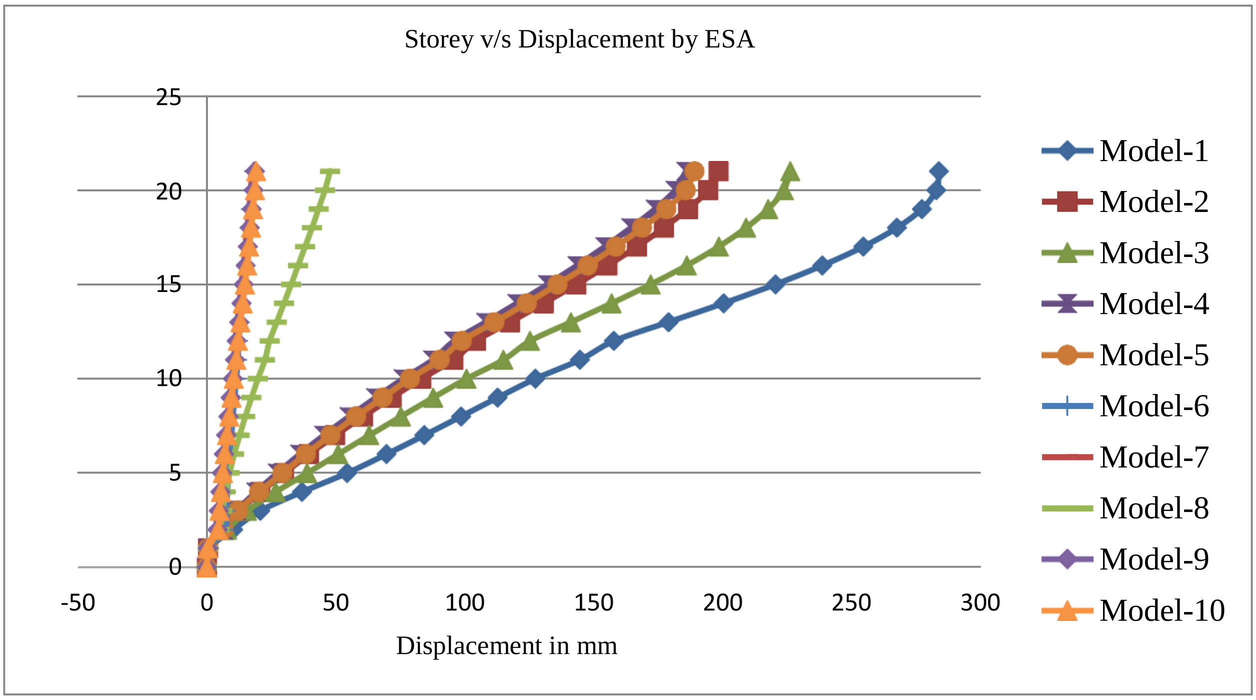

Chart 3. showing the displacement X values for all models by ESA

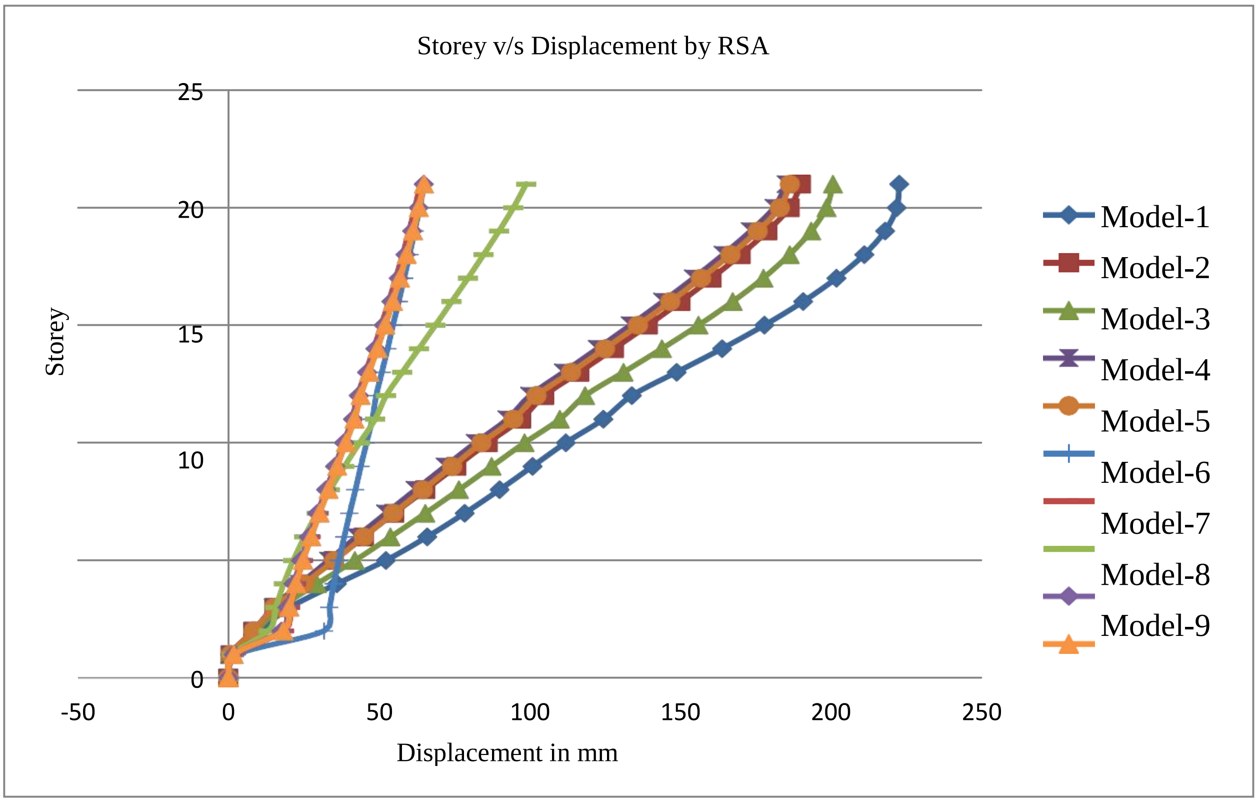

Chart 4 showing the displacement X values for all models by RSA

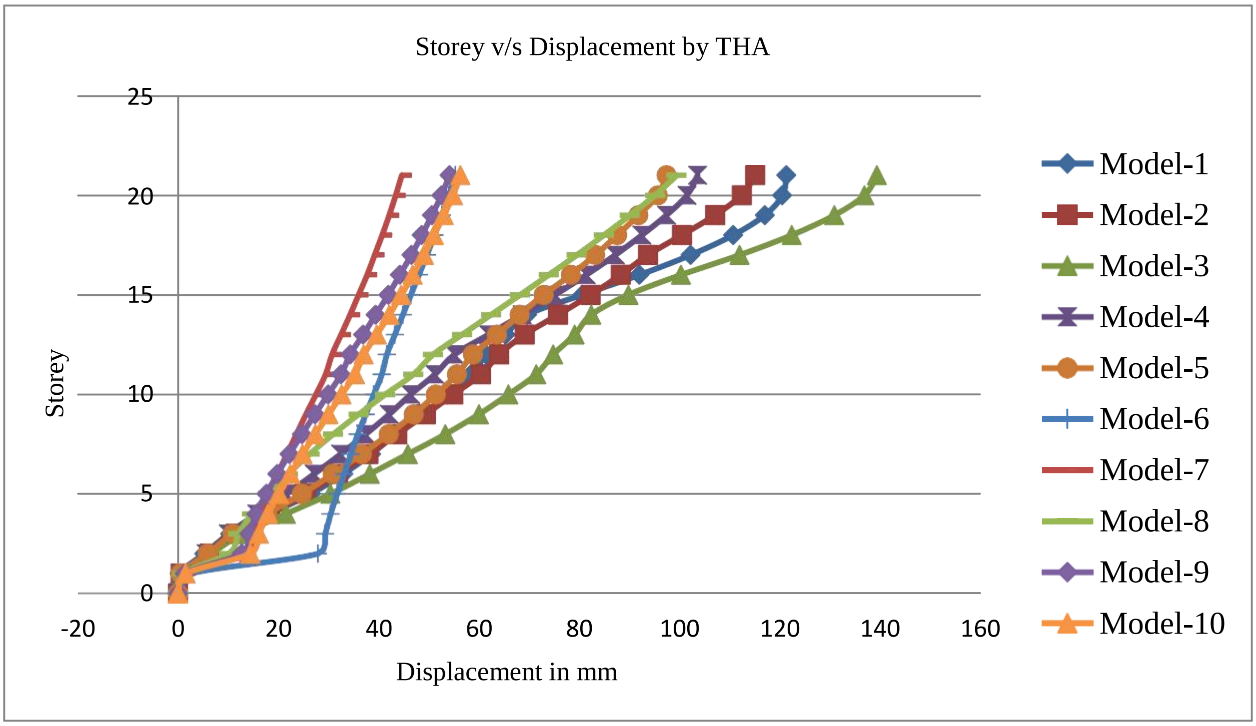

Chart 5 showing the displacement X values for all models by THA

4. Storey Drift

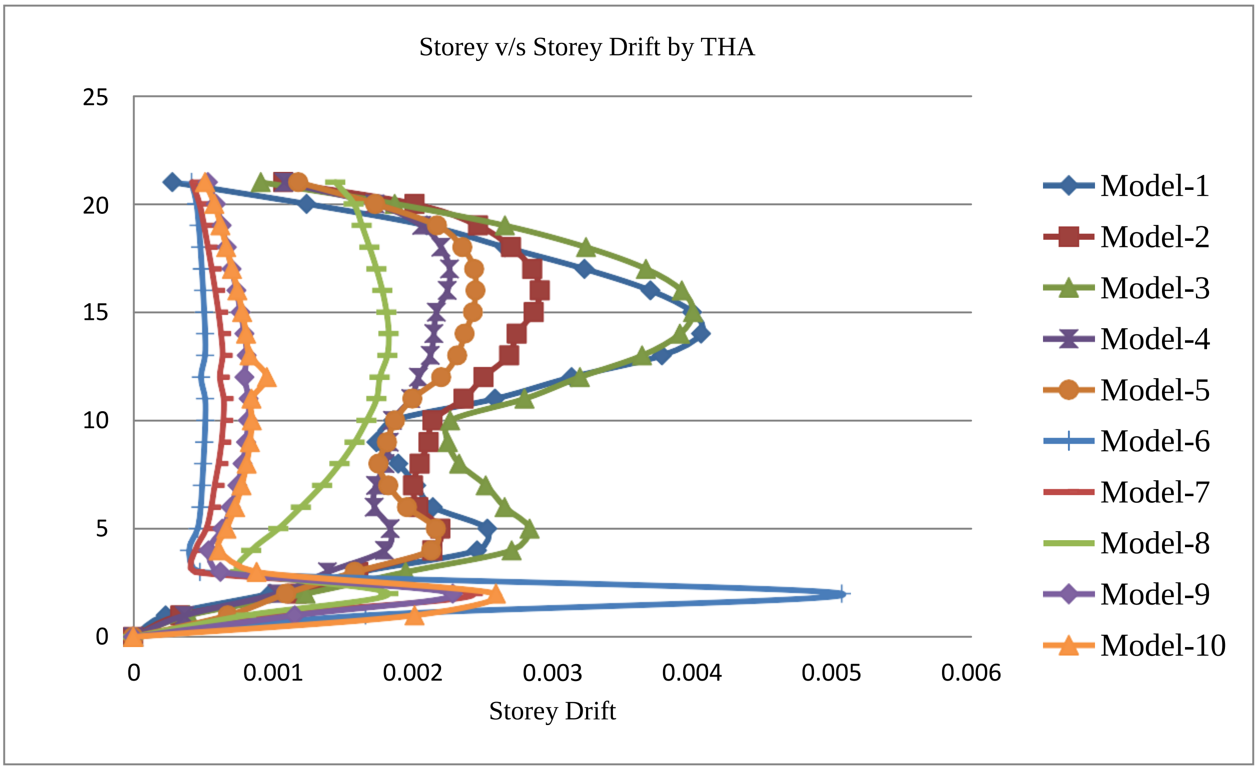

Chart 6 Showing the Storey Drift values for different models by THA

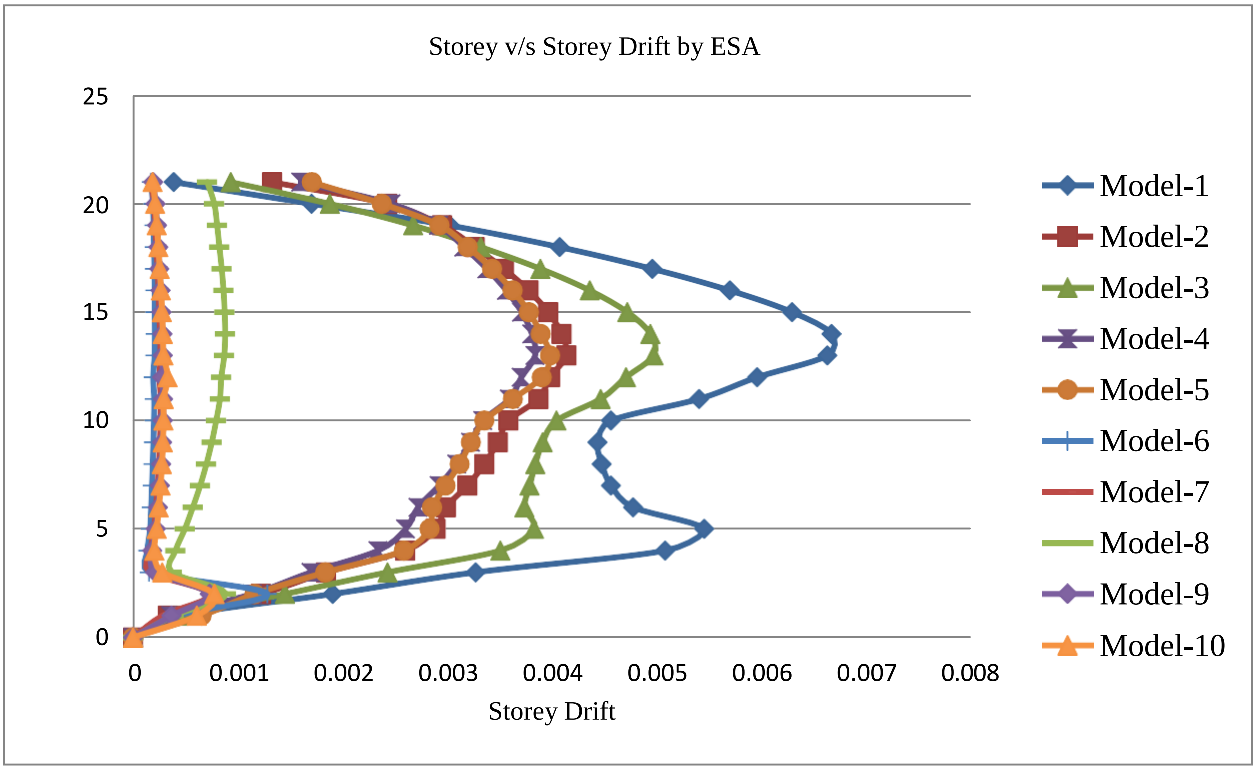

Chart 7 Showing the Storey Drift values for different models by ESA

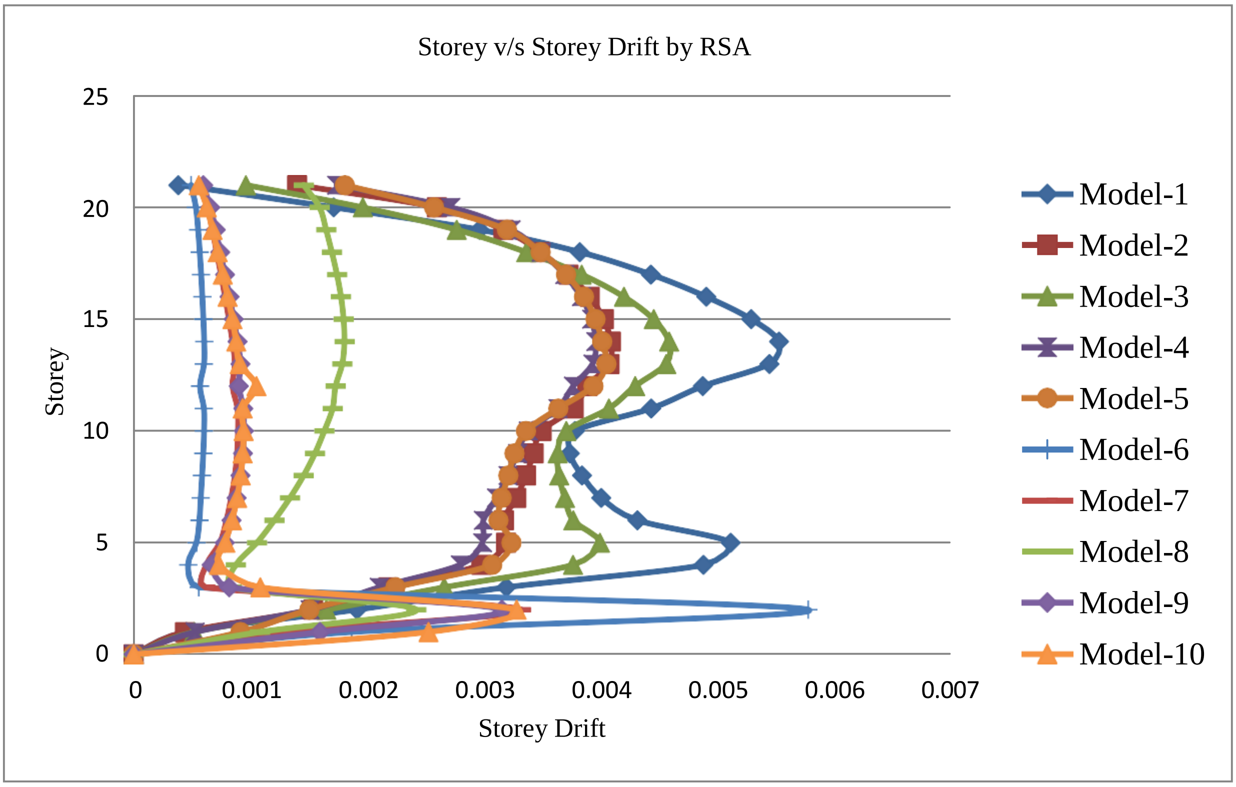

Chart 8 Showing the Storey Drift values for different models by RSA

VI. CONCLUSIONS

- Model 1 (Bare frame model) is having highest fundamental time period value as compared to the model with shear wall and diagonal strut.
- The Time period reduces with the inclusion of Diagonal strut and Shear wall.
- Model with L-type shear wall and full diagonal strut is giving less time period due to more stiffness at corners.
- If stiffness is more than displacement is less.
- Model with L -shaped shear wall and full diagonal strut shows considerably lesser storey displacement by ESA and RSA.
- Maximum reduction in storey displacement is observed in models with Diagonal strut and Shear wall.
- Storey drifts are found to be within the specified limits.
- Model with L-type shear wall shows considerably less storey drift values by Time History analysis.
- Maximum storey drift is observed at soft storey levels, which may lead to severe sway mechanism. Therefore, providing shear wall is necessary so as to keep away the structure from soft storey failure.
- All corners of the building provided with shear wall in x-direction and y-direction, significantly improves all parameters in the analysis.
- Seismic base shear is significantly more in case of shear wall building models as compared with bare frame model.
- Maximum base shear is observed in model -7(i.e. model with Diagonal strut and L-shape shear wall) by Response spectra analysis.
- The effect of soft story is less at intermediate location of the reinforced concrete building compared to soft story at the top.
- Providing top soft storey with swimming pool has significantly increased storey displacement.
- All models with different shear wall and models with both shear wall and diagonal strut are giving good results compared to bare frame model.
- Hence it is suggested to use L-shape shear wall with diagonal strut.

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