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Response spectrum analysis of tall building having different structural systems

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Abstract- *In this paper the response spectrum analysis of tall building having (15-25-35) stories height with two structural systems (Shear wall – S.W and shear wall combined bracing – S.W&bracing systems. The study is to be carried out to analyze the tall building under response spectrum analysis and define the better system on comparison of analysis results.*

Keywords – *Response spectrum analysis, Structural system, Shear wall and Shear wall combined bracing system.*

I. INTRODUCTION

Presently a day's particularly expanding in the population, population of rural areas draws in towards urban areas, makes an expanding interest for tall structures. The expanding population and developing financial aspects in significant urban communities of the world mean expanding urbanization comprehensively and the proceeding with ascend in population thickness in urban areas. Tall structures can suit numerous a bigger number of individuals on a littler land rather than would be the situation with low ascent structures on a similar land.

The accomplishment of basic framework for tall structures is not a simple assignment. As a structural engineer we not just need to rely on the quality of the building we like wise need to make the building economy so different frame works like edge framework, outline frame work with shear wall, shear wall joining bracing systems can be utilized to make structure solid and economy.

In this project three major systems used for the tall buildings are:

1. Shear wall system.
2. Shear wall combined bracing system.

Shear wall system

Comprise of a vertical endless solidifying components of the framework resisting the horizontal forces, the shear wall oppose the force along the length of the wall. The shear wall situated on each level of the structure. It is utilized as a part of fortified solid structures and suited to private structures. In this structure the shear wall is taken as the focal center utilizing for stairs and lift.

Shear wall combined bracing system

New framework comprising of shear wall as a focal center wall likewise the bracings are utilized encompassing the building. Arrangement of the bracings are characterize according to openings of building [window, gallery, ventilators, etc.] this framework is lean toward for making the structure light in weight.

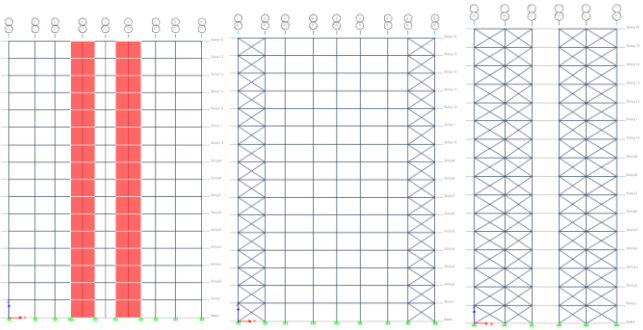


Fig 1: Shows the model elevation of 15 stories [A - S.W] and [B - S.W & Bracing]

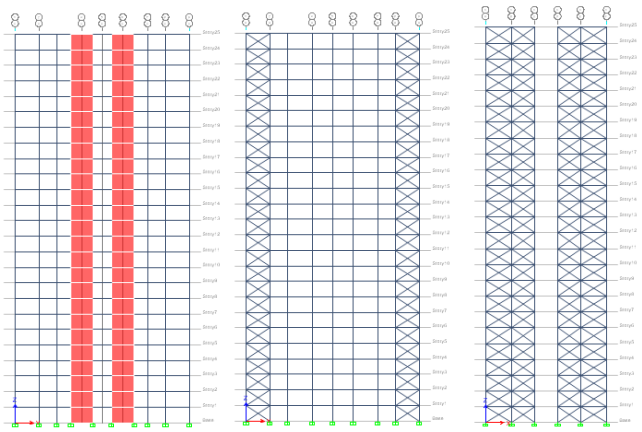


Fig 2: Shows the model elevation of 25 stories [C – S.W] and [D – S.W & Bracing]

II. AIMS OF RESEARCH

The study aims to show different basic frameworks and the analysis and outline of every one ought to be done independently and compared with each other.

Study is to be done to research the performance of shear wall and shear wall combined bracing system under response spectrum analysis and to compare the result with varying storey height.

III. STEPS OF RESEARCH

The research is to carry out on the following steps:

- Modeling of defined models of tall buildings having [15-25-35] height for the two type of structural systems [S.W system and S.W – Bracing system] by ETABS software.
- The models having focal center of the stairs and lifts as shear wall to oppose shear strengths for both S.W & S.W – Bracing models in addition bracings are provided surrounding sides for S.W – Bracing model.
- The values of frame sections are defined by using trial and error method.
- The procedure of investigation and plan for models and try to accomplish the Indian standard conditions in structures configuration to oppose seismic resistance about dimensions and ratio of reinforcement for each element. Study the models again after modification of the dimensions. Then after the process of analysis is made.
- Acquiring structural analysis program ETABS in analysis of six models with two structural systems [S.W system & S.W – Bracing system] having [15-25-35] storey height and extract the result of analysis and compare the results.
- Preparing the graphs of the results using EXCEL program and compare the graph of two systems.
- Determination of the appropriate structural systems for the different tall buildings in the number of stories.

IV. CHARACTERISATION OF PROBLEM

Tall building having [15-25-35] storied are modeled for two structural systems [S.W & S.W – Bracing]. Data taken for the model are as given below in table: 1&2 the total base area of the building is $23\times33.8m^{2.}$ Two models of same plan, both plan having shear wall core located in the center of the plan use as stairs and lifts. Difference is that in second model bracings are provided surrounding external side.

Table 1: Shows the geometric characteristic of the Problem

Sr.No	Specification	Details
1	Concrete and Steel	M30 and FY500
2	Slab	150 mm
3	Bracings	230×230mm
4	Load combination	As per IS code
5	Zone	3
6	Plan Dimension	23 × 33.8 m²
7	Storey height	3 m
8	Live load	2 Kn/m²
9	Floor finish	1 Kn/m²
10	Wind speed	44 m/s **[Vadodara city]**
11	Terrain Category	1
12	Analysis **[Dynamic Analysis]**	Response spectrum

Table 2: Shows the Beam & Column dimension storey wise

Sr.No	Storey	Beam [mm]	Column [mm]
1	15	300*650	900*450 [up to 9 storey] 900*350 [10 to 15 storey]
2	25	300*650	1100*550 [up to 9 storey] 1100*450 [10 to 25 storey]
3	35	300*650	1100*550 [up to 9 storey] 1100*450 [10 to 25 storey] 900*450 [26 to 35 storey]

As per above table 1 & 2 the models of [15-25-35] stories of specified system is modeled as shown in figure. Fig3 shows the S.W & S.W bracing combined system.

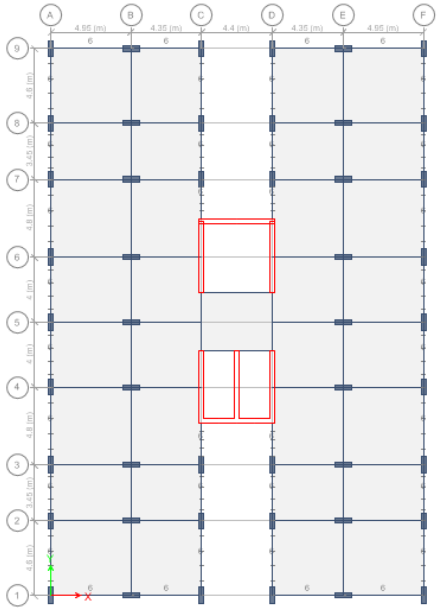


Fig3: Plan of S.W, S.W & Bracing

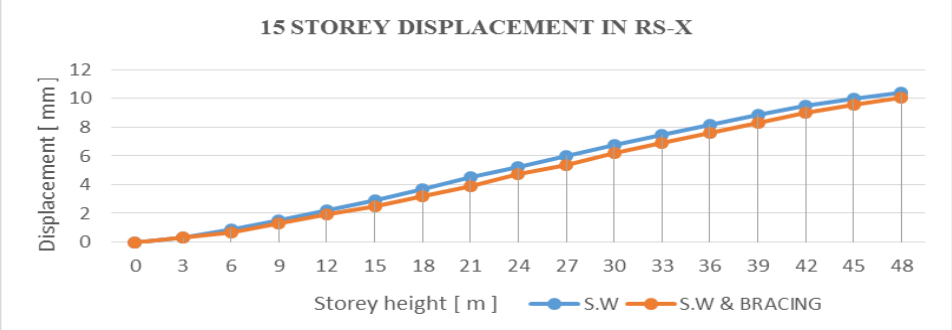
V. ANALYSIS

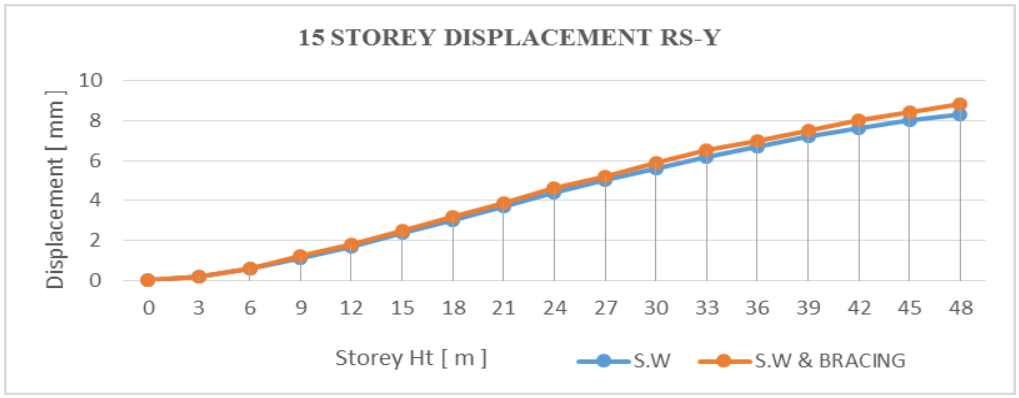
- **Response spectrum analysis**

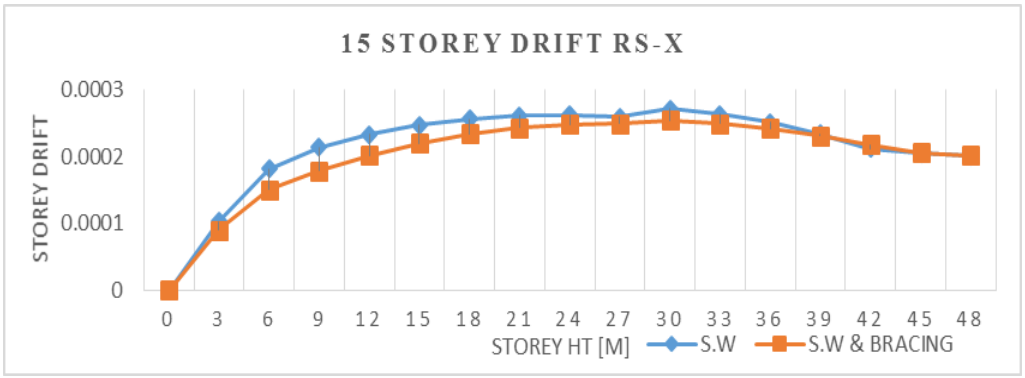
The response spectrum shows how building response characteristics vary with building frequency and period. As building period lengthens, accelerations decrease and displacement increases. On the other hand building with shorter periods undergo higher accelerations but smaller displacements.
Advantages in using the response spectrum method of seismic analysis for prediction of displacements and member forces in structural systems. The analysis involves the calculation of only maximum values top displacements and member forces in each mode of vibration using smooth design spectra that are the average of several earthquake motions **[1]**.

VI. RESULTS AND DISCUSSION

After response spectrum for all three models the critical results showing displacement & storey drift comparison graphs are listed below:
RS-X – Response spectrum analysis in X direction, RS-Y – Response spectrum analysis in Y direction







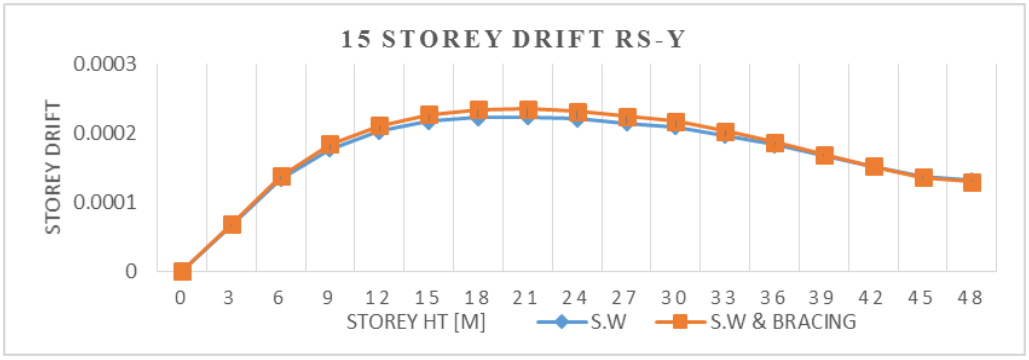
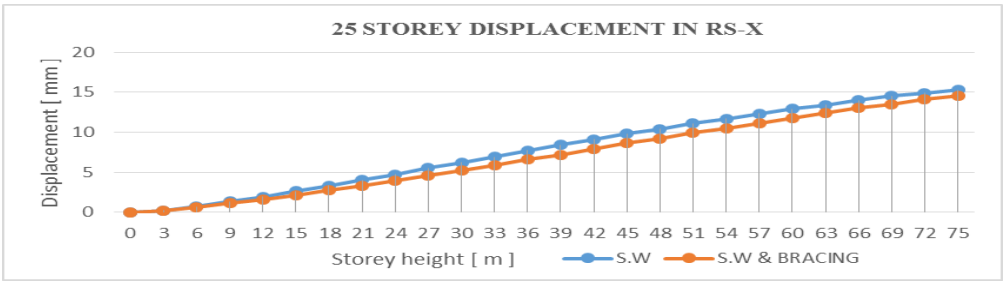


Fig4: Shows the comparison result of displacement and storey drift of two models 15 storey

As per above results shown in fig 4 for 15 storey building RS-X & RS-Y **[RS – Response spectrum]** there is not so much difference in the values of Displacement and Storey drift between S.W & S.W – bracing combined system models. By this we can say that at the height of 45m [15 storey] both the systems either S.W system or S.W – Bracing system preferred, but if we think on economic base than S.W system should be economy.



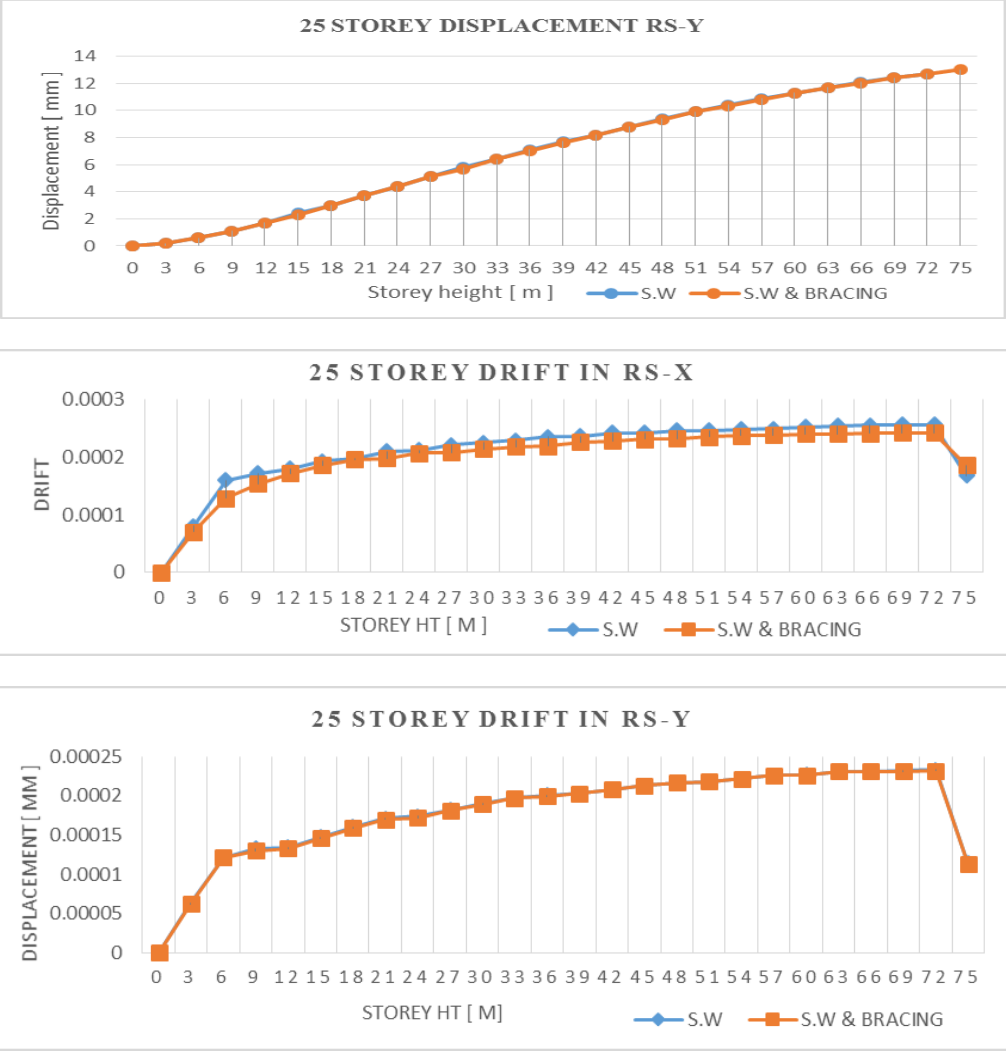
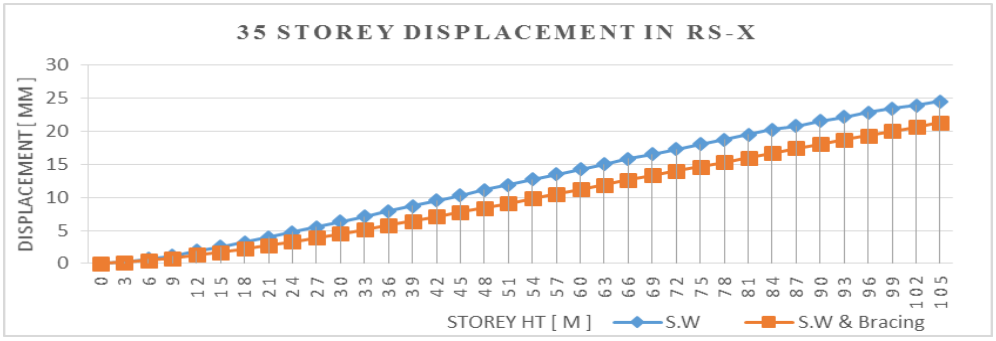


Fig5: Shows the comparison result of displacement & storey drift 25 storey

As per above fig 5 there is a little bit difference in the values of displacement and storey drift between S.W & S.W – bracing system models. As per the difference is small the both systems are applicable for 75 m [25 storey] height structure.



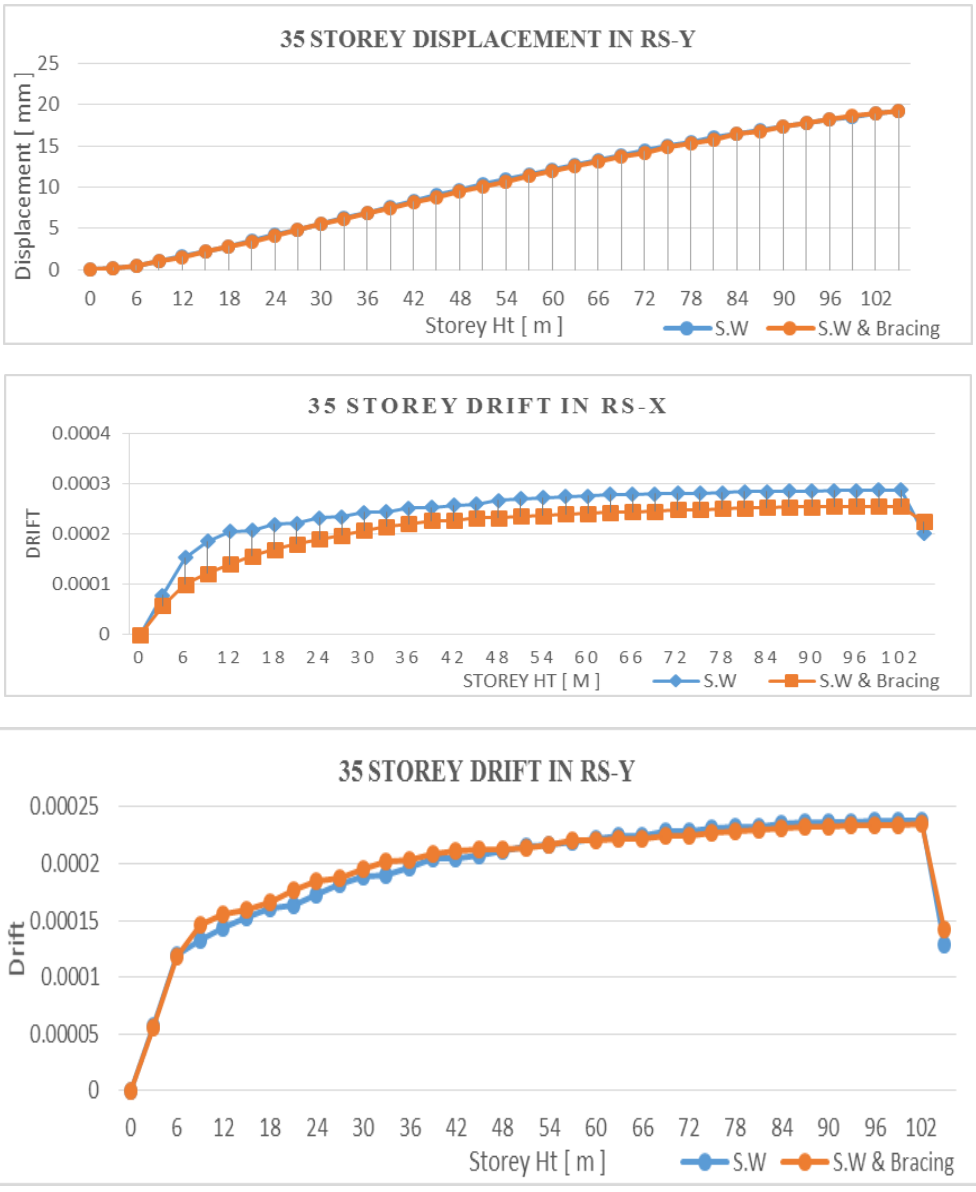


Fig6: Shows the comparison result of displacement & storey drift of two models 35 storey

According to the above fig 6 there is a difference in the values of displacement and storey drift for the 35 storey model. By this we can say that at the height of 105 m [35 storey] the dual system of S.W – Bracing system is better to be preferable.

VII. CONCLUSION

Tall building quite often require extra basic material keeping in mind the end goal to confine the relocation and storey tallness. The consequences of two models of investigation are looked at between two arrangements of models. Aimed the review realized that the response spectrum analysis investigation predicts the auxiliary reaction precisely.

Table 3 defined the recommended structural systems for different heights. The determination of framework in table is composed according to the structural efficiency in limiting the displacement and storey drift as well as economy related to cost of the structure.

Table 3: Structural systems for different heights

Height	Suggested system
15 stories [45 m]	Shear wall
25 stories [75 m]	Shear wall/S.W & Bracing combined
35 stories [105 m]	Shear

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