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Cost Comparison of a Six Storey RC Building Subjected to Earthquake Forces Using Response Spectrum Analysis

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Abstract--- ***A six storey RC framed structure was used for performing seismic analysis with shear wall placed at different locations. The analysis was carried out at different seismic zones and the results were compared. Shear wall has become the most common method in construction of structures subjected to seismic forces because it provides a greater lateral strength and stability when subjected to horizontal forces. Hence the buildings are modeled and designed using ETABS 2016 software and results are further predicted in a detailed manner by plotting various graphs as per IS1893-2002.***

Keywords— shear wall, IS1893-2002, linear case, non-linear case, ETABs2016.

I. INTRODUCTION

Seismic design of structures is essential to improve their performance against the lateral loads. Nowadays shear wall is most widely used for the building which is in seismic zone areas. It will resist the lateral loads by providing lateral stiffness and stability. The position of Shear wall is employed in both low and high rise buildings and its effects are studied a lot in the recent times. Shear walls are constructed in building to avoid damages in the whole structure and to attain the stiffness was found to be effective and economical. The location of shear walls at some critical positions in the structure was found to resist an efficient lateral force when subjected to seismic forces. Therefore in this paper three different models were created based on positioning of shear wall he results were compared and discussed in detail Non linear and linear seismic analysis can be performed by many methods. One such method is by using Response-spectrum analysis (RSA). This method explains a linear-dynamic statistical analysis whose results mainly defines the value of each natural mode vibration of the joints present in the structure after the seismic analysis has been carried out. It is mainly suitable for well designing the shear wall as it is designed to provide a greater lateral stiffness when subjected to dynamic forces. Structures designed for a short duration period is subjected to greater acceleration effects, than those of structures subjected to longer duration period. Structures having longer period acceleration has a great amount of displacement. The objectives of structural performance should be taken into account at the preliminary stage of design and while defining response-spectrum parameters.

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II. LITERATURE REVIEW

[1] Mohammed.,et al – in this paper a building with 6, 9 and 12 stories were considered for doing seismic analysis built with shear wall at different locations using ETABS and IDRAC-2D- software's used. Applied the Moderate and high seismic hazardous levels. For every 3 floor, c/s changed. Non-linear pushover analysis, incremental dynamic analysis was carried out. Construction cost and repair cost was estimated. Comparing with repairing cost, the initial construction cost is only 6-9 % increase in high seismicity levels. [2] O.cavadar, et al -After an Bingol earthquake in Turkey 2003,One collapsed building was considered. Non-linear static & dynamic analysis carried out and seismic responses were evaluated by a Turkish code (TEC 2007).8 storey shear wall building were applied with 10 % of 50 years hazard level.3 earthquake intensities were applied on the structure. Comparing the two methods, static push over shows the lower damage than NDA. [3] Al chehab, et al -14 different RC structures were considered and 5 structures designed as MRF and designed the structure as seismic resistant design with shear wall systems at different storey heights of the building such as 3, 6, and 10 stories and the variation across the bays considered were 3, 4, and 5 with symmetrical patterns. ELS (EXTREME LOADING FOR STRUCTURE) type of software was used for performing the analysis. The non linear type of analysis was carried out suing finite element based approach. After performing the analysis it was finally concluded that as the height of the building was of greater height it provides resistance to blast damage and progressive collapse. [4] W zhang.,et al – designed a 4 and 8-storey framed building for different ratio of shear and non linear analysis was performed using Open sees software and finally was concluded that there was limiting damage in the structure under DE –level when analysed by two methods of seismic shaking .

III. BUILDING MODELING

For this paper, a residential building with 6 storey with a height of each is 3.5m and as per the recommendations of IS 1893-2016 analysis and design has been performed. The structural elements were considered as square & rectangular sections in shape. The buildings were modeled in ETABS 2016 software. Three models were studied with different positioning of shear wall in building in all four zones comparing lateral displacement, cost of steel and total cost of building required in all zones for all models.

A The Different Models of Frames.

- A bare frame is initially analyzed and designed as model I structure
- A building with shear wall which is located at the central part is considered as Model 2
- A building with shear wall which is located at the corners is considered as Model 3

B. Building Details

- No of stories: 6 (G+5)
- Height of each storey: 3.5m
- Beam size: 300mm*400mm
- Column size: 400mm*600mm
- Slab thickness: 150mm, 200mm
- External wall thickness: 230mm
- Internal wall thickness: 115mm
- shear wall thickness: 250mm
- Steel and concrete grades: Fe 415 and M25
- Live load- 4kN/m^2
- Masonry load 16.1 kN/m
- Type of soil is considered as medium soil
- Importance Factor of the building is considered as 1 fro residential building
- A response reduction factor of the building is considered as 5 moment resisting framed structure.

C. Ground Floor Plan In Autocad

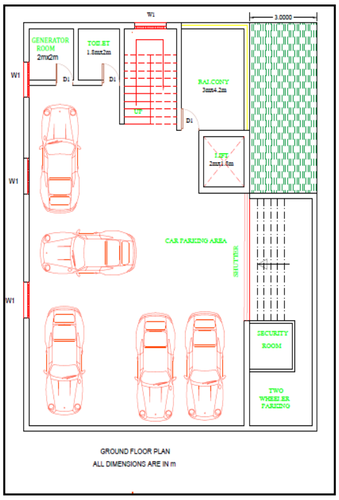

FIGURE 1- GF

D. Typical Floor Plan In Autocad

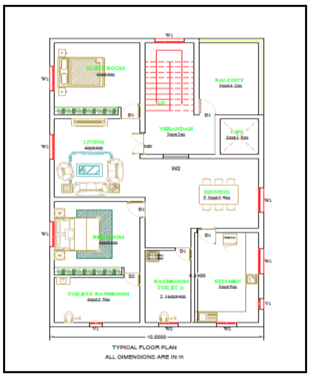

FIGURE 2- TYPICAL

E. Plan In Etabs Of Ground Floor

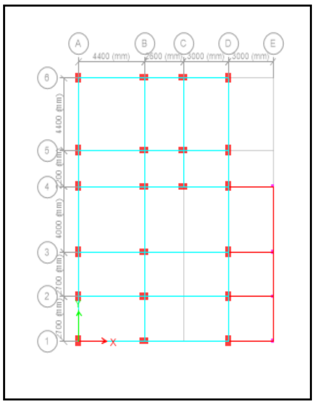

FIGURE 3-BARE FRAME

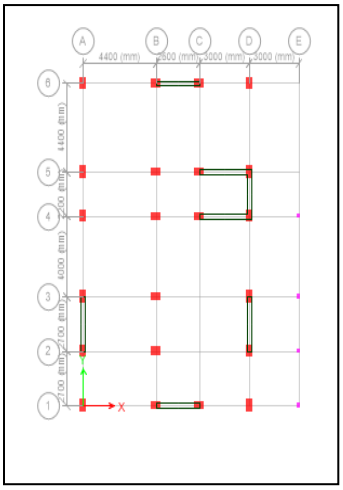

FIGURE 4-SHEAR WALL IN CENTER

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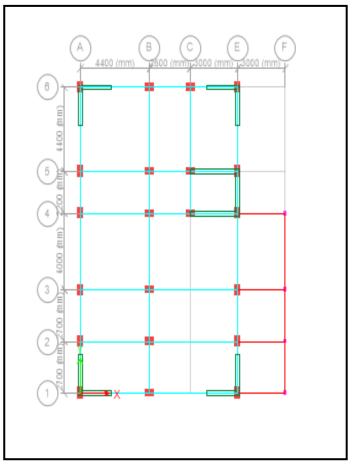

FIGURE 5- SHEAR WALL IN CORNER

F. 3d-View In Etabs

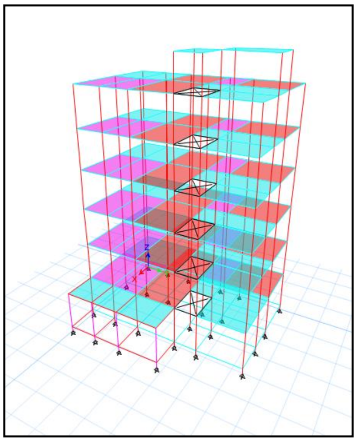

FIGURE 6-3D BARE FRAME

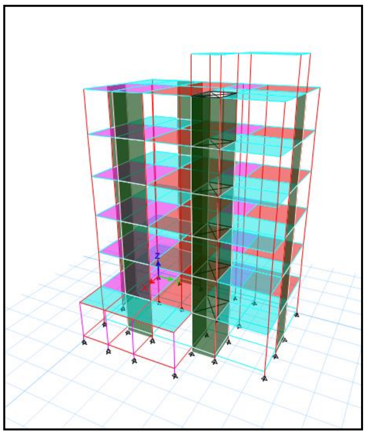

FIGURE 7- 3D SHEAR WALL IN CENTER

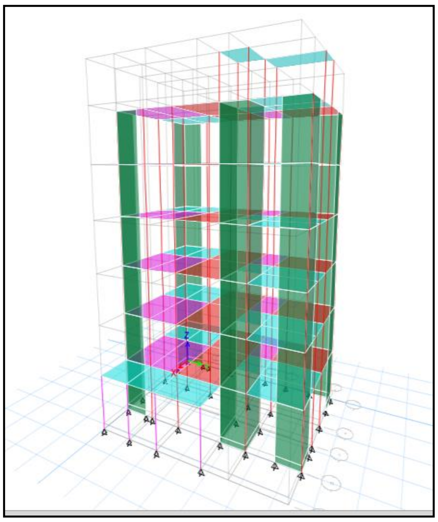

FIGURE 8- 3D SHEAR WALL IN CORNER

As per the recommendations of IS 1893-2016, the load the Standard load combinations were given as input and response spectrum analysis was carried out and the results were presented in graphical format.

IV. RESULTS AND DISCUSSION

A. Displacements Of Models

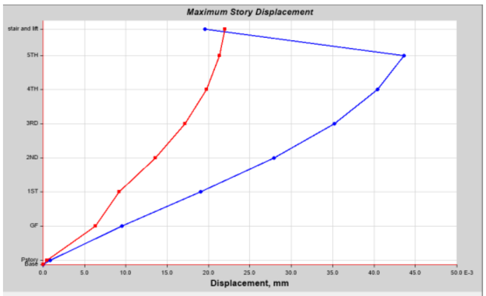

FIGURE 9- DISPLACEMENT OF A BARE FRAME

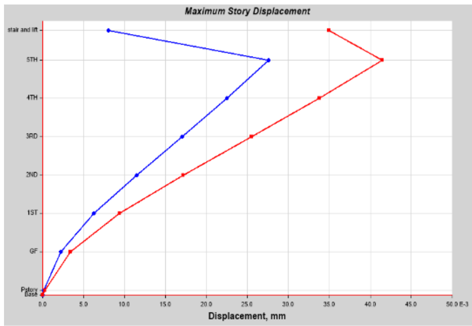

FIGURE 10- DISPLACEMENT OF SHEAR WALL IN CENTER

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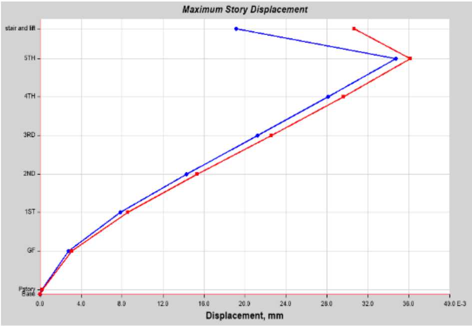

FIGURE 11- DISPLACEMENT OF SHEAR WALL IN CORNER

After the analysis, the shear wall located in center gives the economic value compared to other two frames from the displacement graphs.

B. Cost Of Steel

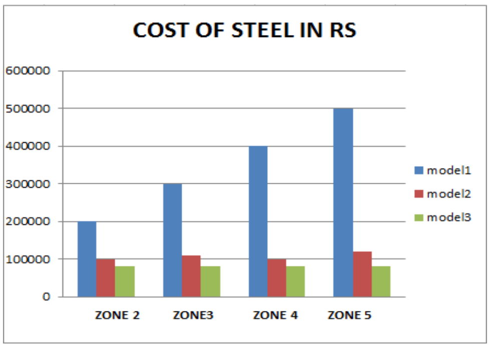

FIGURE 12- COST of STEEL VS DIFFERENT ZONES

From this graph, model 3 gives an economic value compared to other models in different seismic zone.

C. Total Cost Of Different Model

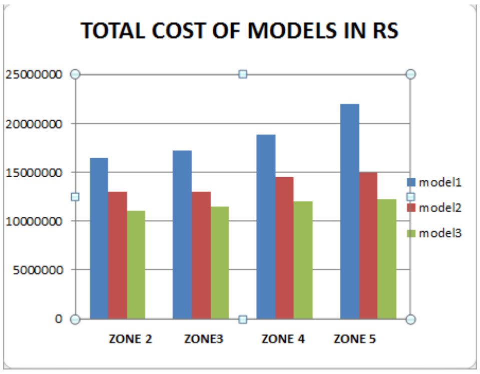

FIGURE 13- TOTAL COST VS DIFFERENT ZONES

From this graph, model 3 gives an economic value compared to other models in different seismic zone.

V. CONCLUSION

From the analysis it was finally concluded that the building with shear wall allocated at the corners was found to provide more stiffness in the building and restricts more damage to the structures when subjected to seismic forces

Also observed that,

1. Location of shear wall wiil also play an important role for attracting mor seimsic forces, so the the wall must be placed at proper position.
2. Providing shear wall in sufficient locaton substancially reduces the the displacements duringearthquake.

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