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EARTHQUAKE BEHAVIOUR OF BUILDINGS WITH AND WITHOUT SHEAR WALLS

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ABSTRACT: *Shear walls are specially designed structural walls which are incorporated in buildings to resist lateral forces that are produced in the plane of wall due to earthquake, wind and flexural members. This paper presents the study and comparison of the difference between the earthquake behavior of buildings with and without shear wall using STAAD.pro.*
Keywords: *Analysis and comparison, Earthquake behavior, Shear wall, STAAD.pro.*

I. INTRODUCTION

The race towards new heights and architecture has not been without challenges. When the building increases in height, the stiffness of the structure becomes more important. Tall structures have continued to climb higher and higher facing strange loading effects and very high loading values due to dominating lateral loads. The design criteria for tall buildings are strength, serviceability, stability and human comfort. Thus the effects of lateral loads like wind loads, earthquake forces are attaining increasing importance and almost every designer is faced with the problem of providing adequate strength and stability against lateral loads.

Alpa Sheth, (2008) conducted a research on three concrete towers having concrete flat slabs with shear walls, with and without a perimeter framing beam and one of the models was also analyzed with addition of outrigger system. Anshuman. S et al., (2011) conducted a research on solution of shear wall location in multi storey building. An earthquake load was calculated and applied to a fifteen storied building located in zone IV. It was observed that the top deflection was reduced and reached within the permissible deflection after providing the shear wall. Dr. B. Kameshwari et al., (2011) analyzed the effect of various configurations of shear walls on high-rise structure. The drift and inter-storey drift of the structure in the following configurations of shear wall panels was studied and was compared with that of bare frame. Diagonal shear wall configuration was found to be effective for structures in the earthquake prone areas. T. Fatima et al., (2011) studied on Lateral movements in composite high-rise buildings under Seismic Action. This study provides an insight into the behaviour of building under seismic load.

Wakchaure M.R et al., (2012) conducted a study on Earthquake Analysis of High Rise Building with and Without In filled Walls. The main objective of this work was to carry out the effect of masonry infill walls on the seismic behavior of R.C.C. High-Rise building with linear dynamic analysis method. Due to infill walls in the High Rise Building top storey displacement was reduced. A. Rahman et al., (2012) studied on drift analysis due to earthquake load on tall structures. In this study regular shaped structures have been considered. Estimation of drift was carried out for rigid frame structure, coupled shear wall structure and wall frame structure.

P. P. Chandurkar et al., (2013) conducted a study on seismic analysis of RCC building with and without shear walls. They have selected a ten storied building located in zone II, zone III, zone IV and zone V. Parameters like Lateral displacement, story drift and total cost required for ground floor were calculated in both the cases. Alfa Rasikan et al., (2013) conducted the study and comparison of the difference between the wind behavior of buildings with and without shear wall using Staad pro. The staad model of 15 and 20 storied buildings without shear wall and with shear wall have been considered to carry out the study. Displacements of the buildings were compared.

II. BUILDING MODELLING

For this study, a 50-story building with a 3.5-meters height for each story, regular in plan was modeled. These buildings were designed in compliance to the Indian Code of Practice for Seismic Resistant Design of Buildings .The buildings were assumed to be fixed at the base. The buildings were modeled using software STAAD Pro. Models were studied in all four zones comparing lateral displacement and base shear for all structural models under consideration.

Model 1 – Framed structure.
Model 2– The building with shear walls one on each side.
Model 3– The building with shear walls on corner.
Model 4– The building with shear walls at centre.

2.1 Preliminary data for the building.

No. of stories	50
Floor to Floor Height	3.5 m
Beam size	450x900 mm^2
Column size	900x2000 mm^2
Thickness of slab	200 mm
Thickness of Wall	230 mm
Shear wall	450mm
Grade of Concrete and steel	M40 and Fe500

2.2 Building plans.

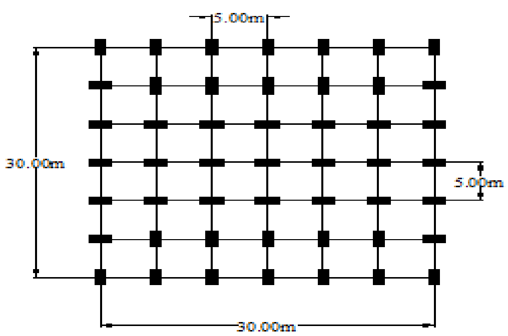


Fig .1.Model- 1

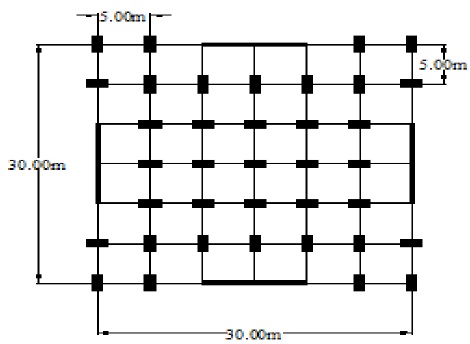
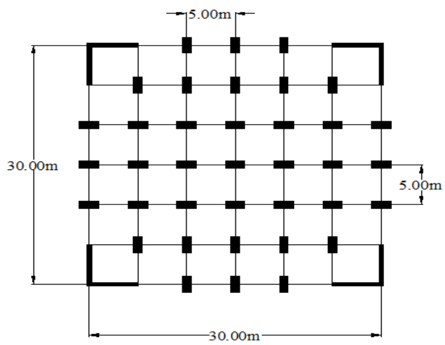


Fig.2.Model -2



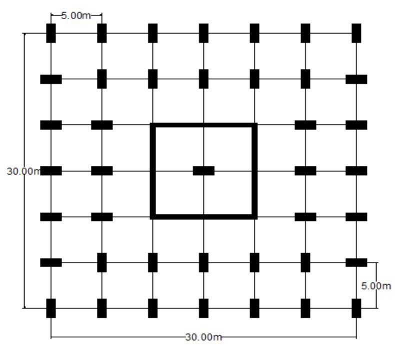


Fig.3.Model -3 Fig.4.Model -4

2.3 3-D Models of the buildings.

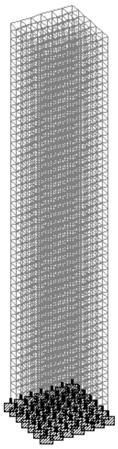


Fig.5. model 1

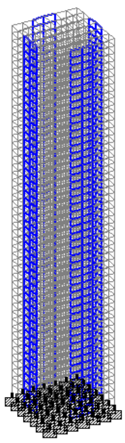


Fig.6. model-2.

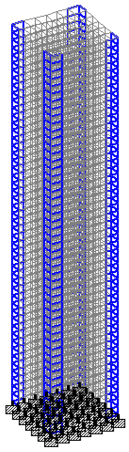


Fig.7. model-3

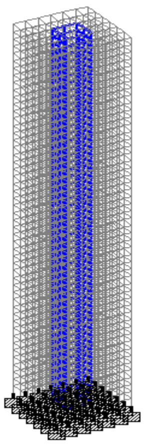


Fig.8. model-4

III. LOAD CONSIDERATION

While designing any building, different loads acting on it play a major role. An error in estimation of these loads can lead to the failure of the structure. Therefore, a careful study of loads that are acting on the structure becomes necessary. The loads in particular area must be selected properly and the worst combination of these loads must be evaluated.

The dead load in a building should be comprised of the weight of all walls, partitions, floors, roof and should include the weight of all other permanent constructions in that building. Dead load for the design purpose is assessed from the code, IS 875:1987(Part I).

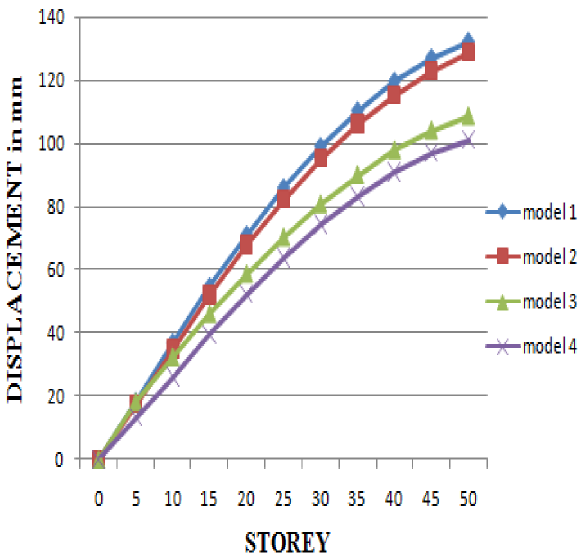
Imposed load on floor should be comprised of all loads other than dead load. Imposed load for the design purpose is assessed from the code, IS 875:1987(Part II).

Seismic design is done in accordance with IS: 1893:2002. This RC framed building is located in all Seismic Zones. The parameters to be used for analysis and design are given below as per IS: 1893. (Part I)

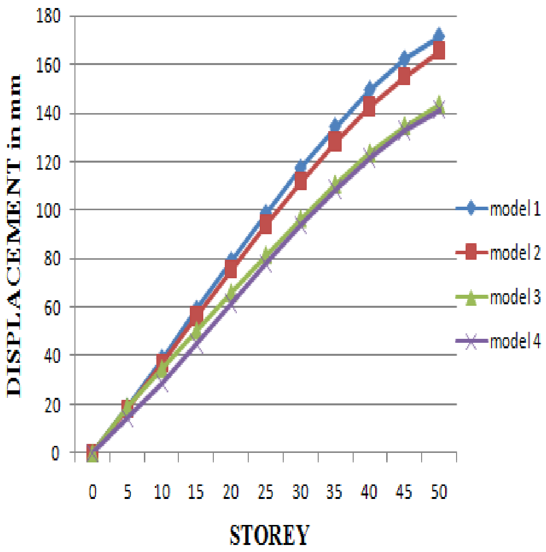
Zone factor, Z	0.1,0.16,0.24,0.36 (Refer Table 2)
Importance factor, I	1.0 (Refer Table 6)
Response reduction factor, R	3.0 (Refer Table 7)
Fundamental Natural Period of vibration, T_a	$= 0.09 \text{ X } h/(d)^{0.5}$
Soil type	Medium Soil

IV. RESULT AND DISCUSSION

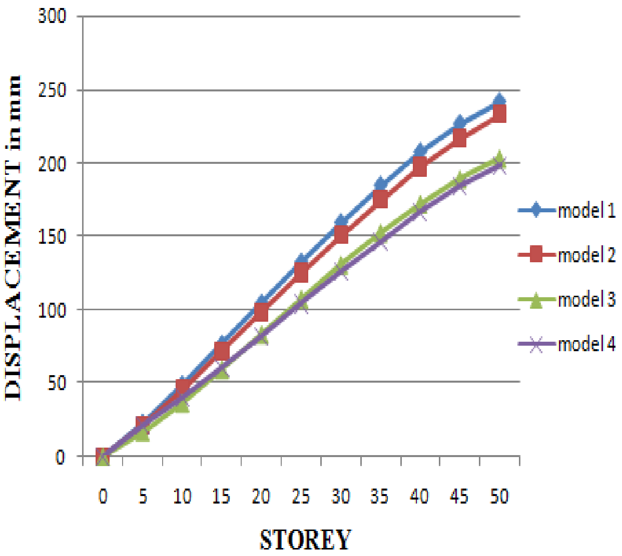
4.1 Lateral Displacements



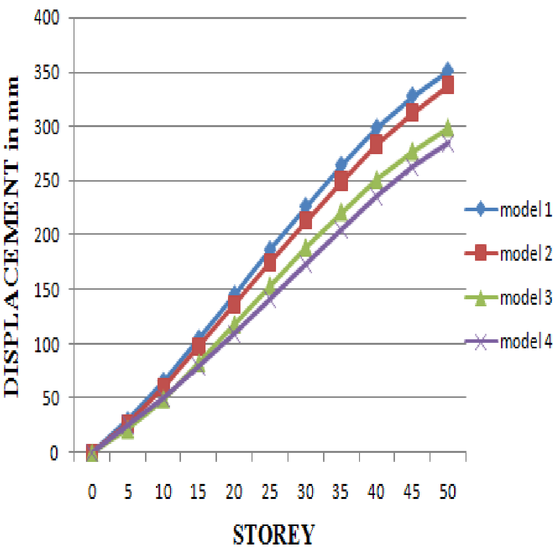
zone II



zone III



zone IV



zone V

4.2 Displacement reduction.

The top displacement of the model 1 is high compared to all other models. Percentage reduction in the top displacement of model 2, model 3 and model 4 with respect to model 1 is as shown in the following graphs.

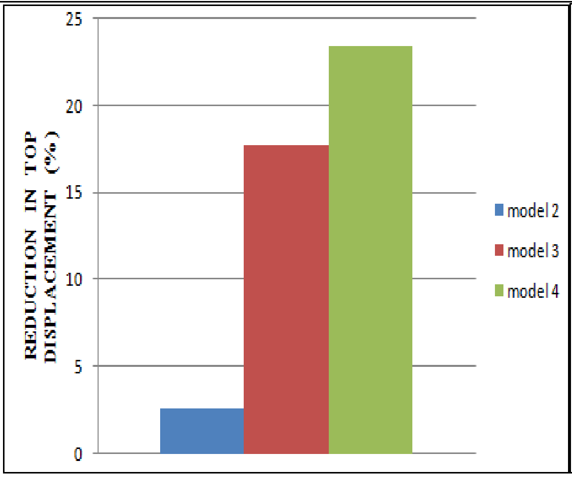


Fig .9. When the models are at zone II.

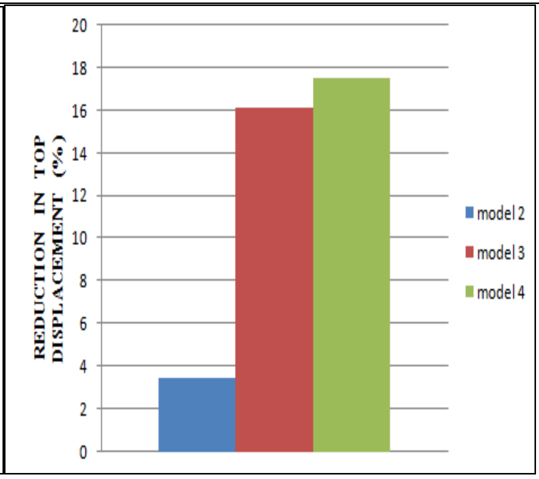


Fig .10. When the models are at zone III.

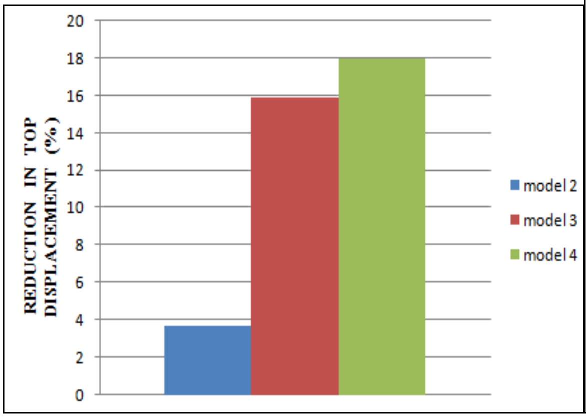


Fig.11. When the models are at zone IV.

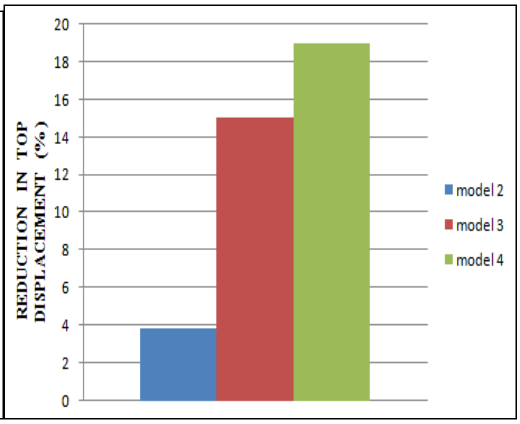


Fig.12. When the models are at zone V.

4.3 Base shear of the models.

Base shear of the building mainly depends on the value of zone factors. Base shear of the models in different zones are as shown in the following graphs.

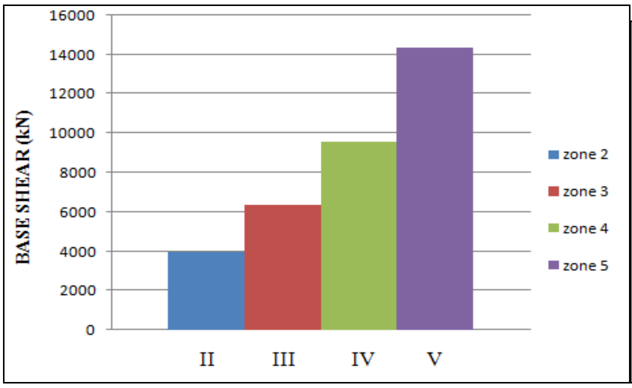


Fig.13. Base shear for model 1

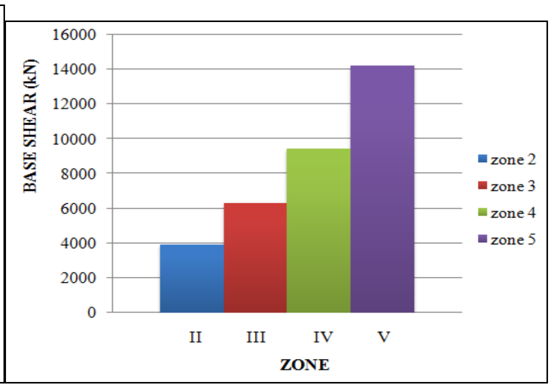


Fig.14. Base shear for model 2

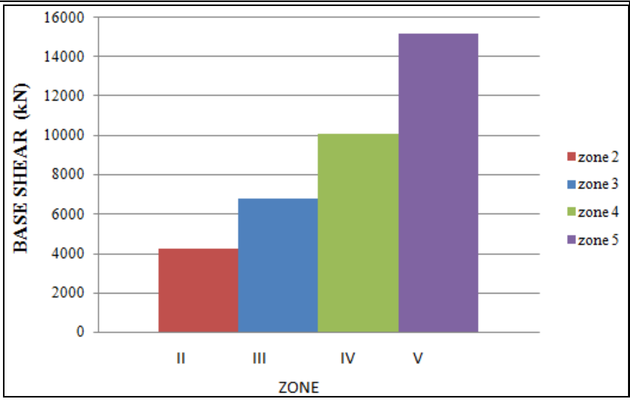


Fig.15. Base shear for model 3

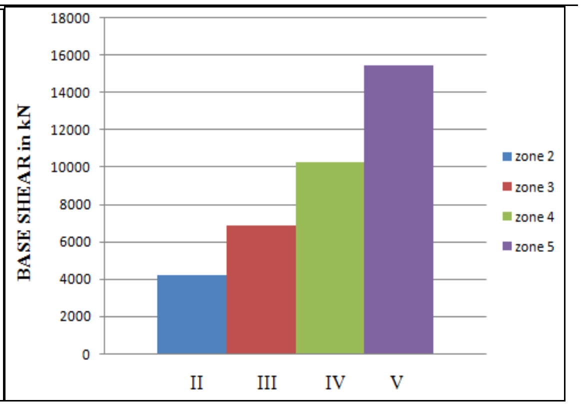


Fig.16. Base shear for model 4

V. CONCLUSION

A 50 storey building without shear wall, a 50 storey building with shear walls at different positions were analyzed. From the above result it is seen that top displacement of model 1 is high compared to other models. Top displacement can be reduced by providing shear walls. Top displacement of model 2 is 3% less compared to model 1, model 3 is 18% less compared to model 1, model 4 is 24% less compared to model 1 in earthquake zone 2.

Top displacement of model 2 is 3.5% less compared to model 1, model 3 is 16% less compared to model 1, and model 4 is 17.5% less compared to model 1 in earthquake zone 3.

Top displacement of model 2 is 3.8% less compared to model 1, model 3 is 15.7% less compared to model 1, and model 4 is 18% less compared to model 1 in earthquake zone 4.

Top displacement of model 2 is 3.7% less compared to model 1, model 3 is 15% less compared to model 1, and model 4 is 19% less compared to model 1 in earthquake zone 5.

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