ANALYSIS ON SEISMIC PERFORMANCE OF HIGH RISE BUILDING BY CHANGING THE LOCATION OF SHEAR WALL FOR DIFFERENT SOIL CONDITION

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ABSTRACT

Shear wall is one of the most commonly used lateral load resisting in high rise building. Shear wall has high in plane stiffness and strength which can be used to simultaneously resist large horizontal load and support gravity load and masonry infill forms a small role in resisting the lateral loads. Incorporation of shear wall has become inevitable in multi-storey building to resist lateral forces .It is very necessary to determine effective, efficient and ideal location of shear wall.

In this paper, study of 15 storeys building in zone V is presented with some preliminary investigation which is analysed by changing various position of shear wall with different shapes in different soil conditions, according to the IS code 1893 (Part 1): 2002 for determining parameters like storey drift, storey shear, lateral displacement and performance point of building by adopting a pushover analysis. This analysis is done by using standard package ETAB v9.7.4.

Key words: Lateral Displacement, Storey Drift, Storey Shear, Performance Point, Shear wall (SW), Masonry infill.

INTRODUCTION

Earthquakes are the most unpredictable and devastating of all natural disasters, which are very difficult to save over engineering properties and life, against it. Hence in order to overcome these issues we need to identify the seismic performance of the built environment through the development of various analytical procedures, which ensure the structures to withstand during frequent minor earthquakes and produce enough caution whenever subjected to major earthquake events. So that can save as many lives as possible. The behaviour of a building during an earthquake depends on several factors, stiffness, adequate lateral strength, ductility, simple, regular configurations and buildings with shear wall or without shear wall. The buildings with shear and greater lateral load resisting capacity, uniformly distributed mass and stiffness in plan as well as in elevation suffer much less damage compared to building without shear wall or any lateral load resisting system. But nowadays need and demand of the latest generation and growing population has made the architects or engineers inevitable towards planning of different type of buildings on different type of soil. Hence earthquake engineering has developed the key issues in understanding the role of behaviour of different type of buildings on different type of soil conditions.

MODELING

For this study, a 15-story building with a 3-meters height for each story, regular in plan is modeled. These buildings were designed in compliance to the Indian Code of Practice for Seismic Resistant Design of Buildings IS 1893-2002. The buildings are assumed to be fixed at the base and the floors acts as rigid diaphragms. The sections of structural elements are square and rectangular. Storey heights of buildings are assumed to be constant including the ground storey. The buildings are modeled using software ETAB Nonlinear v 9.7.4.Four different models were studied with different positioning of shear wall in building and Three different type of models were analysed by considering the masonry infill. Models are studied in all zone-V and in different soil conditions, comparing lateral displacement, story drift, storey shear and performance point.

PLAN OF ALL MODELS

Shear wall models

The regular building with a 15^{tn} number of stories is considered for the purpose of studying the seismic behavior of high rise building for different shear wall locations and for different soil conditions. The plan view of the different shear walled building is shown below.

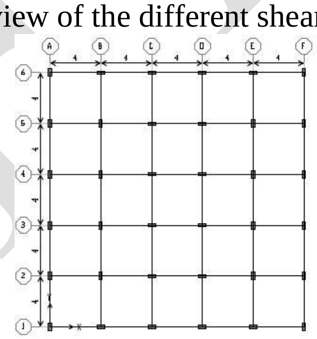


Fig 1: Model I (Bare Frame)

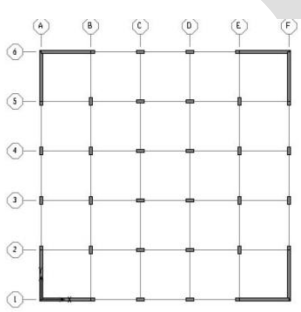


Fig 2: Model II (Corner SW)

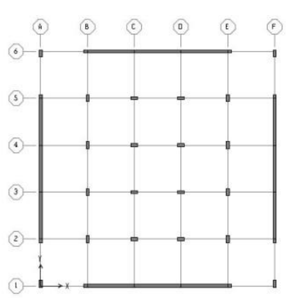


Fig3: Model III (Side SW)

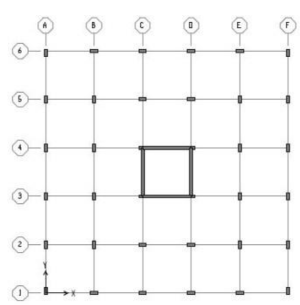


Fig4: Model IV (Core SW)

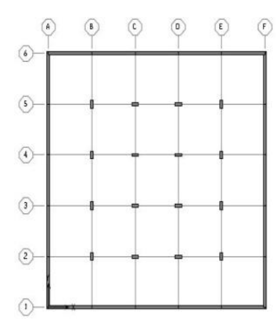


Fig5: Model V (Periphery SW)

Masonry Infill models:

Similarly as mentioned above, three different infill models are considered for the present work to study the seismic behaviour of the infilled high rise buildings, which are given below.

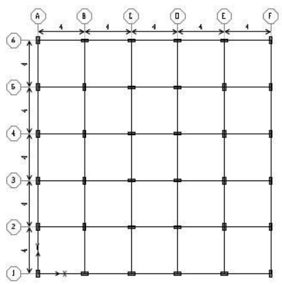


Fig 6: Model I (Bare Frame)

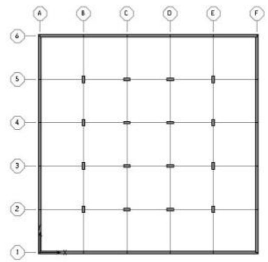


Fig 7: MODEL II (Infill at outer periphery)

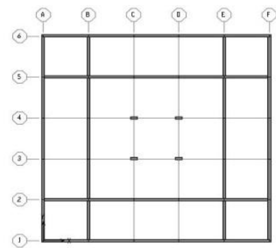


Fig 8:MODEL III (partially filled infill)

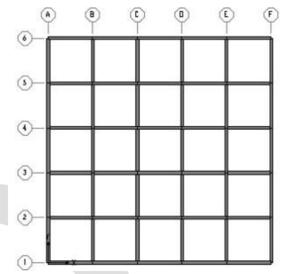


Fig 9: MODEL IV (Completely filled infill)

BUILDING DATA

A multi-storey building is considered with 15^{th} (G+14) number of stories with 4 bay in X and Y direction. The dimensions of the building elements are given below.

Table 1: building data

PARAMETERS	SOIL (Hard, Medium & Soft soil)
Seismic Zone	V
Seismic Zone Factor	0.36
R	5
H	45 m
h	3 m
Thickness of Shear Wall	0.25 m
Thickness of infill Wall	0.25 m
Thickness of Slab	0.125 m
Beam Size	0.25 X 0.35 m^2
Column Size	0.25 X 0.6 m^2
Material Properties	M25 Grade of Concrete (f_{ck})
	Fe 415 Grade of Steel(fy)

Building is modeled using standerd package ETAB. Beams and columns are modeled as two noded beam elements with six DOF at each node. Shear wall are modeled using shell element. Equivalent static analysis or linear static analysis is performed on models. Based on analysis result parameters such as storey shear, displacement, storey drift and performance point compared for each model.

Equivalent Static Analysis

The natural period of the building is calculated by the expressions $T=(0.09xh)/\sqrt{d}$ for bare frame as given in IS 1893 (Part 1): 2002, where *h* is the height and *d* is the base dimension of the building in the considered direction of vibration. The lateral load calculation and its distribution along the height are done as per IS 1893 (Part 1): 2002. The seismic weight is calculated using full dead load plus *25%* of live load. For the equivalent static load analysis the earthquake load is considered in both X and Y directions.

Pushover Analysis

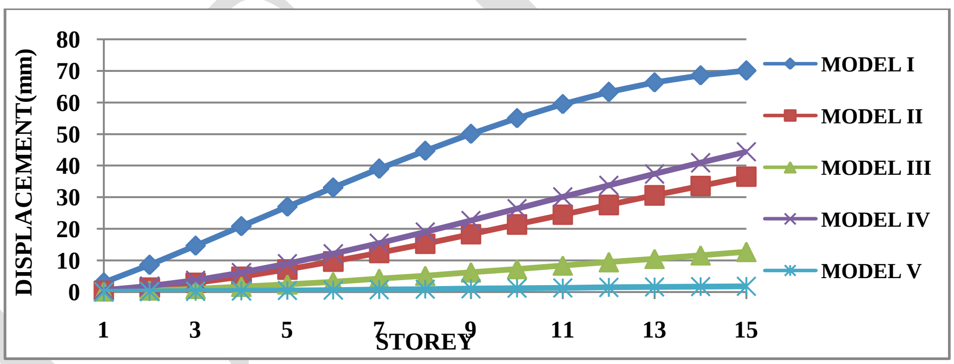
After the linear static analysis the designing of 3D Building model for gravity load combinations as per IS 456-2000 has done. Later assign the default hinge properties available in ETABS Nonlinear as per ATC-40 to the frame elements. For the beam default hinge that yields based upon the flexure (M3) and shear (V2) is assigned, for the column default hinge that yields based upon the interaction of the axial force and bending moment (P M2 M3) is assigned.

Define three static pushover cases. In the first case gravity load is applied to the structure, in the second case lateral load is applied to the structure along X-direction and in the third case lateral load is applied to the structure along Y-direction.
The buildings are pushed to a displacement of 4% of height of the building to reach collapse point as per ATC 40 (Applied Technology Council). Tabulate the nonlinear results in order to obtain the inelastic behaviour.

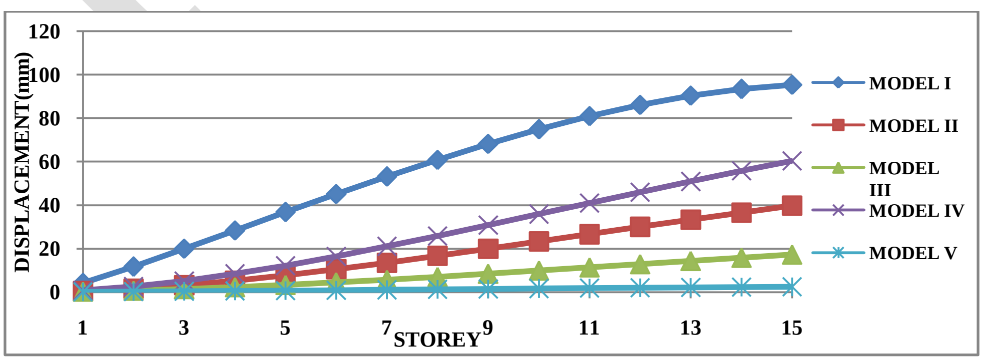
RESULTS of SHEAR WALL MODELS

Lateral Displacement

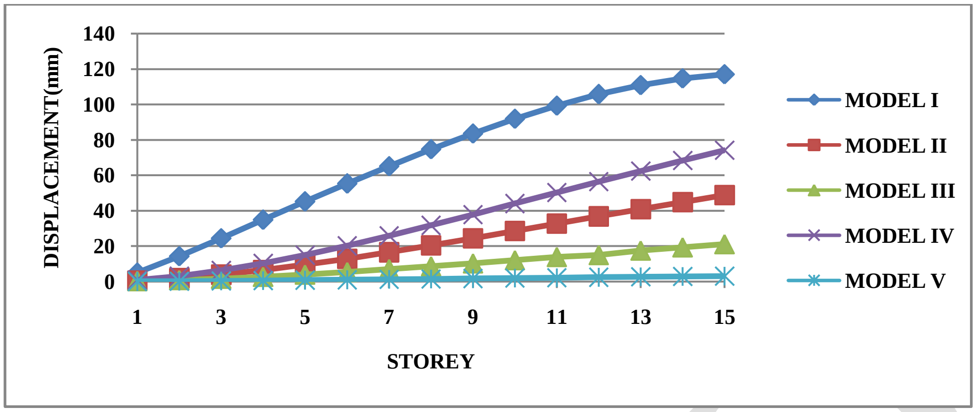
The lateral displacement of all shear wall models at each storey levels for different soil conditions are shown below. From Graph 1 to Graph 3.



Graph 1: Lateral Displacement profile of all shear wall models for soil 1



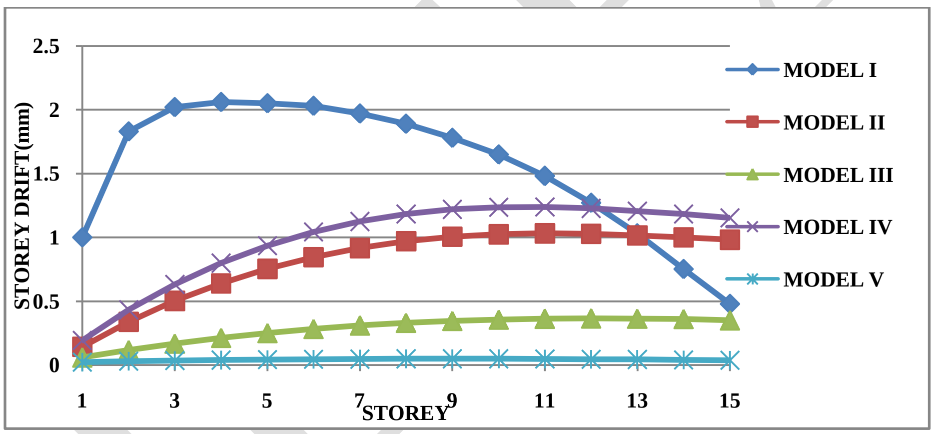
Graph 2: Lateral Displacement profile of all shear wall models for soil 2



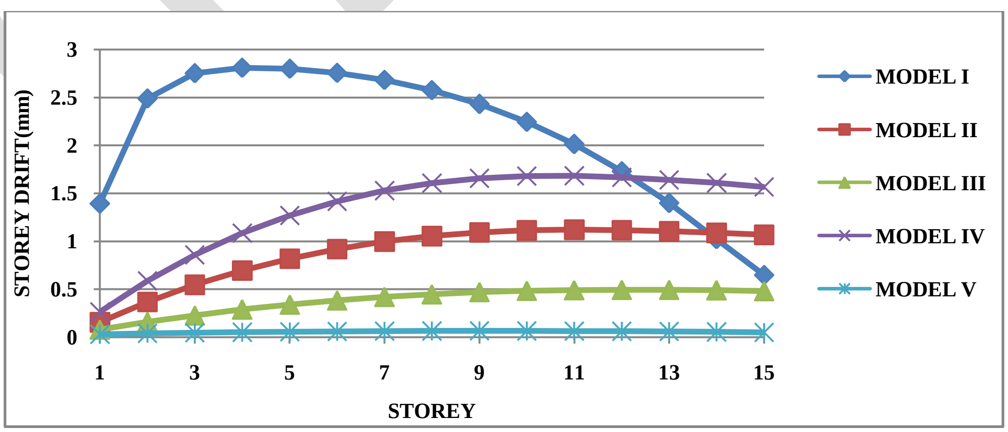
Graph 3: Lateral Displacement profile of all models for soil 3

Storey Drift

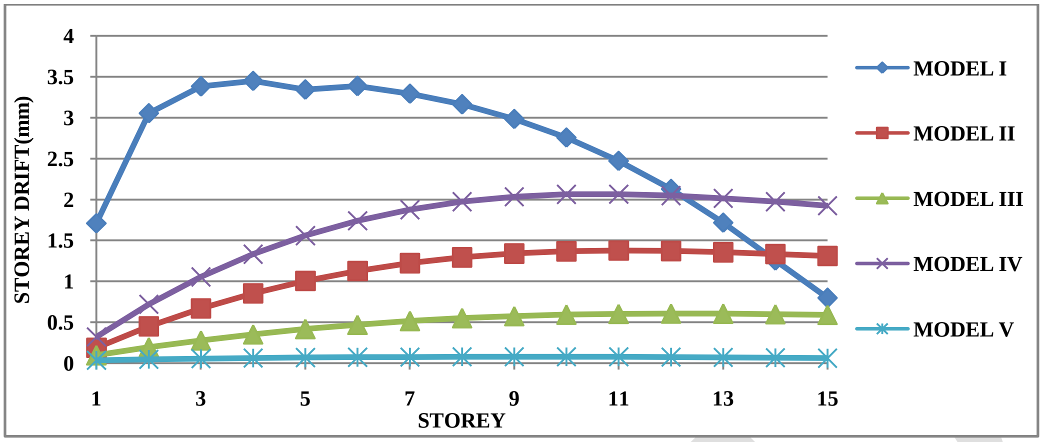
The Storey Drift of all shear wall models at each storey levels for different soil conditions are shown below. From Graph 4 to Graph 6.



Graph 4: Storey Drift profile of all Shear wall models for soil 1



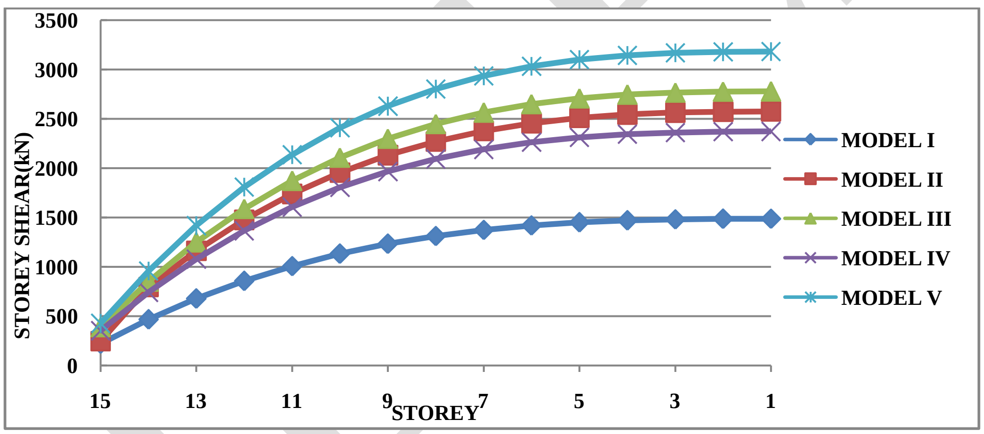
Graph 5: Storey Drift profile of all Shear wall models for soil 2



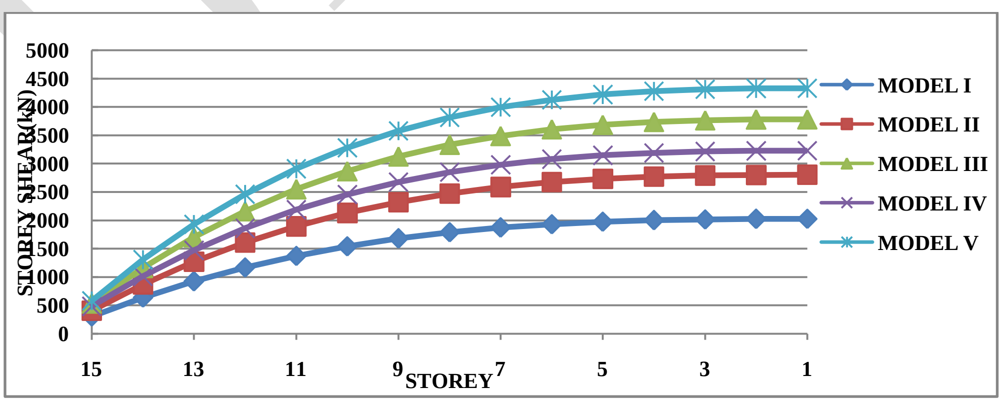
Graph 6: Storey Drift profile of all Shear wall models for soil 3

Storey Shear

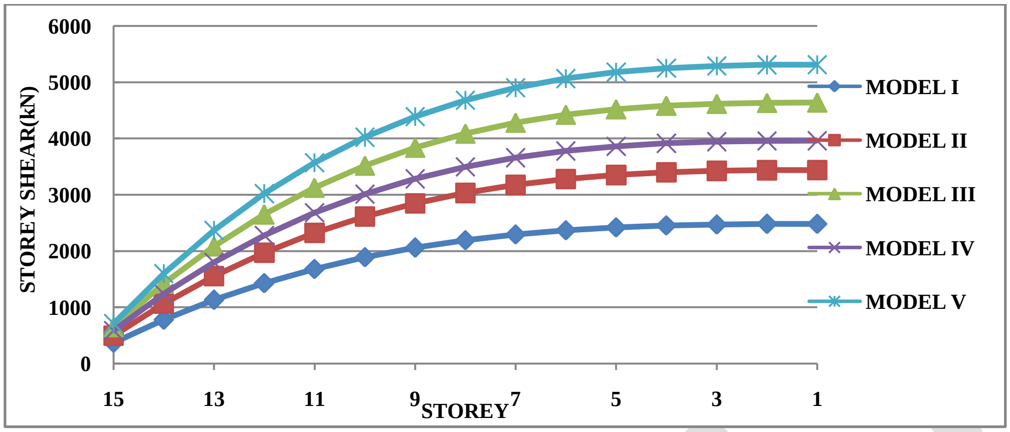
The Storey Drift of all shear wall models at each storey levels for different soil conditions are shown below. From Graph 7 to Graph 9.



Graph 7: Storey shear profile of all models for soil 1



Graph 8: Storey Shear profile of all models for soil 2



Graph 9: Storey Shear profile of all models for soil 3

Pushover Result

The results of pushover analysis can be obtained in the form of performance point of the building. Therefore, the performance point of different type of models is tabulated below. Table 1 shows the performance point of different type of shear models.

Table 2: Performance Point of all shear wall models

MODEL TYPE	PERFORMANCE POINT (V, D)	
	BASE SHEAR (kN)	DISPLACEMENT (in m)
BARE FRAME (MODEL I)	1167.652	0.383
MODEL II	6839.609	0.222
MODEL III	14568.94	0.125
MODEL IV	5281.145	0.244
MODEL V	44365.643	0.038

The masonry infill models have been analysed and tabulated similar to that of shear wall building to compare the results of considered parameters, such as storey shear, lateral displacement, storey drift and performance point of building.

DISCUSSION AND CONCLUSION

The present work focuses on study of seismic performance evaluation of multi storey RC buildings, which are located in seismic zone-V for the different soil conditions such as, hard soil, medium soil and soft soil. These conditions are considered as per IS 1893-2002 (part-1). The analysis has been carried out using standard package ETABs software. The analysis outputs were noted in terms of Lateral Displacements, Storey Drifts, and Storey Shear and the Performance Point of the buildings were tabulated on the basis of pushover analysis. The following are the conclusions are drawn from the present investigation, which are as follows.

- The multi-storey building without any infill or lateral load resisting system will undergo large displacement.

- In all type of models the displacement values are less for hard soil and it goes on increasing for the medium type of soil and soft soil.
- Storey Drift is a function of Lateral Displacement. Therefore the drift also more for soft soil than the hard soil.
- The values of storey shear are more for soft soil and less in hard soil.
- Same variation has occurred in the masonry infill models. i.e., Storey Shear, Storey Drift and Lateral Displacement values are less in Hard soil and magnitude will increase in Soft soil.
- Shear models have greater lateral load resistance than the masonry infill models.
- Performance point of shear wall model III and V is more than the other type of models, if the performance point is more for a building, then behaviour such type of buildings are good than the other type of models.
- In the masonry infill model the performance point of model III is more than the other infill model.
- The observation of results will gives that Shear wall Model V and Model III are effective in resisting the seismic force.
- In the case of infill model, completely filled model has a good and greater resisting capacity than the other type of infill models.

REFERENCE

1) Anand, N. Mightraj, C. Prince Arulraj, G (2010) "*Seismic Behavior of RCC Shear Wall Under Different Soil Conditions*", Indian Geotechnical Conference – 2010, IGS Mumbai Chapter & IIT Bombay, pp.119-122.
2) Anshuman. S, Dipendu Bhunia, Bhavin Ramjiyani (2011)"*Solution of Shear Wall Location in Multi-Storey Building*", Research article, international journal of civil and structural engineering Volume 2, pp.493-506.
3) Ashish.S. Agrawal, & S.D.Charkha (2012) "*Effect of change in shear wall location on storey drift of multi-storey building subjected to lateral loads*", International Journal of Engineering Research and Applications (IJERA), Vol. 2, pp.1786-1793.
4) Biju V & Rahul Leslie (2009) "*Effect of Lateral Load Patterns in Pushover Analysis*", 10th National Conference on Technological Trends (NCTT09) 6-7 Nov 2009, Vol- 29, pp. 305-316.
5) Chandurkar. P. P. & Pajgade. P.S(2013) "*Seismic Analysis of RCC Building with and Without Shear Wall*", International Journal of Modern Engineering Research (IJMER), Vol. 3, pp-1805-1810.
6) Kadid. A and A. Boumrkik (2008) "*Pushover Analysis of Reinforced Concrete Frame Structures*", Asian journal of civil engineering (building and housing) Vol. 9, pp 75-83.
7) Kumbhare. P. S, & Saoji. A. C. (2012) "*Effectiveness of Changing Reinforced Concrete Shear Wall Location on Multi-storeyed Building*", International Journal of Engineering Research and Applications (IJERA), Vol. 2, pp.1072-1076.

8) Nivedita N. Raut & Swati D. Ambadkar (2013) "*Pushover Analysis of Multi-storeyed Building*", Double Blind Peer Reviewed International Research Journal, Global Journals Inc, Online, Vol 13.
9) Oni. P. B & S. B. Vanakudre (2013) "*Performance Based Evaluation of Shear Walled RCC Building by Pushover Analysis*", International Journal of Modern Engineering Research (IJMER), Vol. 3,pp-2522-2525.
10) Patil. S.S, C.G. Konapure, & S.A. Ghadge (2013) "*Seismic Analysis of High-Rise Building by Response Spectrum Method*", International Journal of Computational Engineering Research (Ijceronline.Com) Vol. 3,pp.272-279.
11) Patil. S.S, C.G. Konapure, & S.A. Ghadge (2013) "*Equivalent Static Analysis of High-Rise Building with Different Lateral Load Resisting Systems*", International Journal of Engineering Research & Technology (IJERT),Vol. 2, pp.01-09

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