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Parametric Evaluation of Tall Structure with Various Lateral Load Resisting Systems Subjected to Dynamic Loadings

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ABSTRACT

The high-rise buildings are majorly suffering with seismic forces, it can be found out by displacement parameter. The more the displacement the lesser will be the stiffness of the structure. The static analysis is having higher displacement value than response spectrum analysis. The increase in percentage is about 17%. This will increase the construction cost due to increase in stiffness. The base shear value increases with increase in weight of the structure. However, the diagrid structure seems to be having lesser weight than all other models. From the overall analysis it is proved that, diagrid structure is very much effective than any other structure. However, in case of constraint in providing diagrid due to its architectural features, the outrigger system with bracing will be very much effective.

KEYWORDS: *High rise building, Bracing, Seismic analysis, Response spectrum method, Equivalent static method, outrigger*

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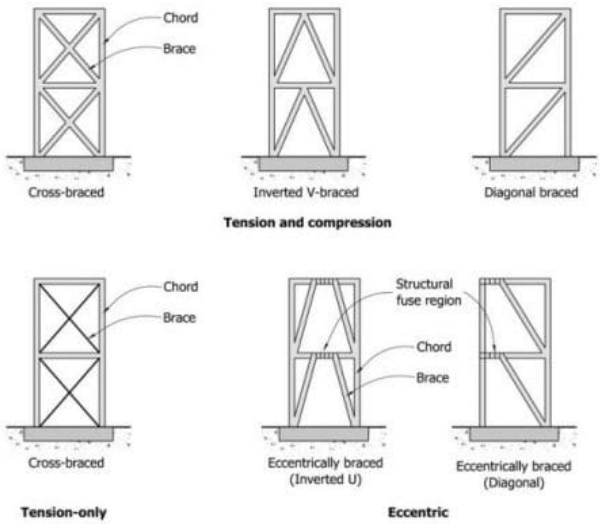
1. INTRODUCTION

It is assumed to be advancement in the world can be achieved by constructing tall structures and with advanced technology. The increase in population and the people facing towards urban life is forcing in the construction of high-rise structures. These high-rise structures are mostly used as residential and commercial purpose. Advancement of elevators, lifts are the main reason for high rise structure.

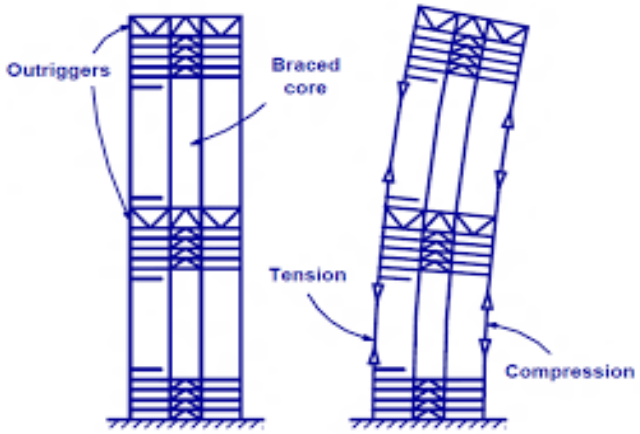
This structure provides a vast area at different levels leads to work at closer spaces with different wings of business. The structures are more affected by seismic forces; therefore, it is necessary to consider seismic effects and other critical loads causing the damages to the structures. These lateral loads can create unfavorable environment in the structure. They might produce undesirable stresses across the structure, results in lateral sway of structure.

The Term high Rise building is having its own definitions by various sector of people. Usually it is assumed to an high rise structure, if it is taller than the other surrounding structure in the vicinity. Since, in the urban areas most of the structures are multi storeyed and generally it is termed as high rise if the structure is much taller than the other surrounding structures. However, in case of rural areas, even a multi storeyed structure can be termed as a high-rise structure. The various codes and NBC specify the structures as high rise if it is having its own height. Bracings acts like truss system. This will usually provide between two columns to connect beam and column ends or Mids. Usually columns and beams carry gravity loads and bracings will resist lateral loads.

Diagrid is a type of structure where the outer most layer of the structure is having only inclined columns. The vertical columns are not provided at the periphery. The axial force action can prevent the structure by overturning and the shear forces. These are having its own advantages based on its shape.



Various Bracing systems



Outriggers structure system

2. OBJECTIVES

A. To understand the seismic resistant behaviour of following structures.

Model 1- High rise structure with Bare frame system.
Model 2- High rise structure with Bracing system
Model 3- High rise structure with Outrigger system
Model 4- High rise structure with both Bracing and outrigger
Model 5- High rise structure with both Outrigger system and Belt truss
Model 6- High Rise Diagrid System

B. To understand the structure is subjected to static and dynamic behaviour of structures.

C. The analysis is carried out for the particular seismic zones to check the variations in the response.

D. The results in terms of base shear, displacement, storey drift, and time period are compared and discussed.

3. METHODOLOGY

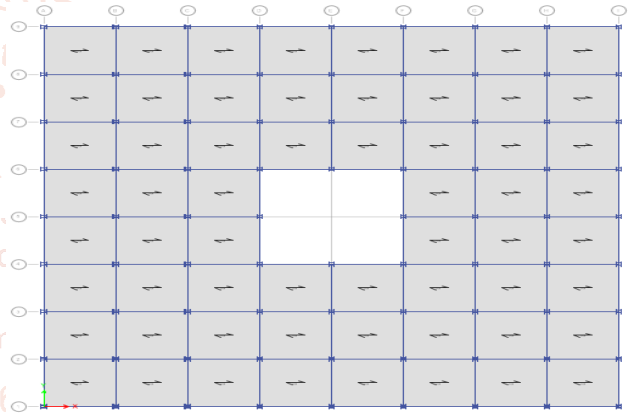
To carryout expensive literature review, to establish the objective of the study.Etabs software is used for the modeling and analysis of different building configurations. Analyse the model using all major Static (Equivalent static analysis) and Dynamic analysis using IS1893-2016. Concrete mix of M35 grade, reinforcing steel of Fe500 and structural steel of Fe450 will be consider for the analysis of the structural system. Preliminary member sizes are assumed for beams and columns , later member sizes are economized and based on the system adopted. Conclusions are made based on the performance of each system under study.

4. MODELING

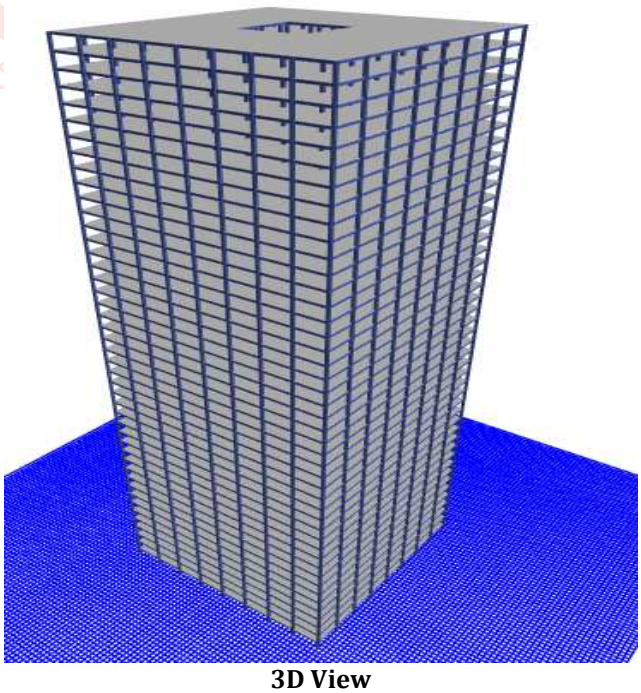
The proposed models are structural steel. The model is 45 storey height with regular shaped structure. The below Table 4-1 shows material properties and design parameters used in this project.

Sl. No.	Description	Data
1.	Seismic Zone	III
2.	Seismic Zone Factor (Z)	0.16
3.	Importance Factor (I)	1.2
4.	Response Reduction Factor (R)	5
5.	Damping Ratio	0.05
6.	Soil Type	Medium Soil (Type II)
7.	Height of the building	135m (45 Storey)
8.	Story to story Height	3.0 m
9.	Span Length	6m
10.	Column used	Built Up column
11.	Thickness of Slab	Deck 150mm
12.	Floor Finish	1.5 KN/m^2
13.	Live Load	4.0 KN/m^2
14.	Grade of Concrete (f_{ck})	M35
15.	Grade of Structural Steel (f_{ys})	Fe 450
16.	Grade of Reinforcing Steel (f_{yr})	Fe 500

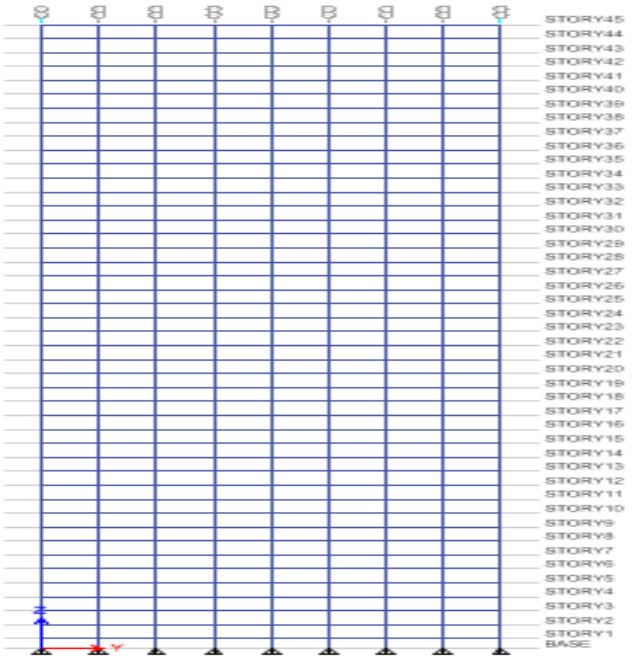
Seismic and Model Parameters



Plan View



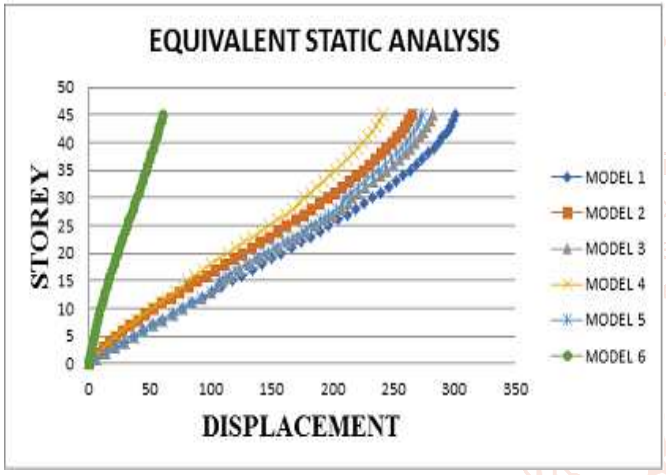
3D View



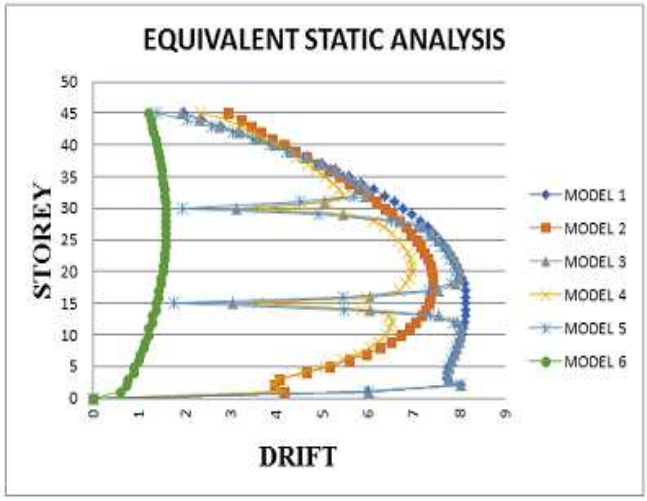
Elevation View

5. RESULT

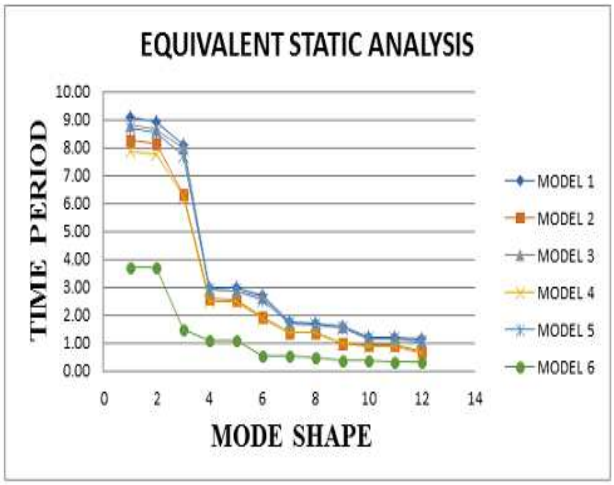
A. Equivalent Static Analysis:(ESA)



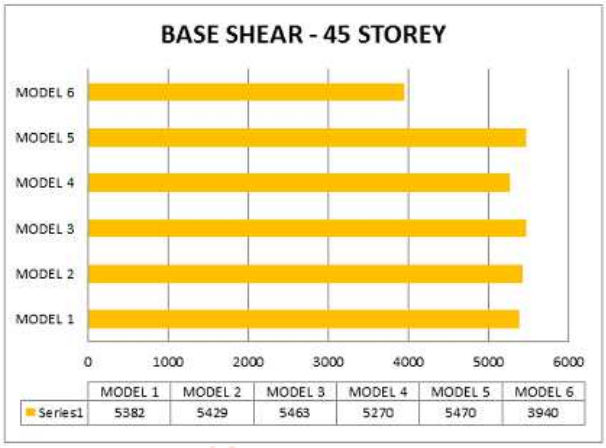
Storey v/s displacement _ Static Analysis



Storey v/s storey drifts _ Static Analysis

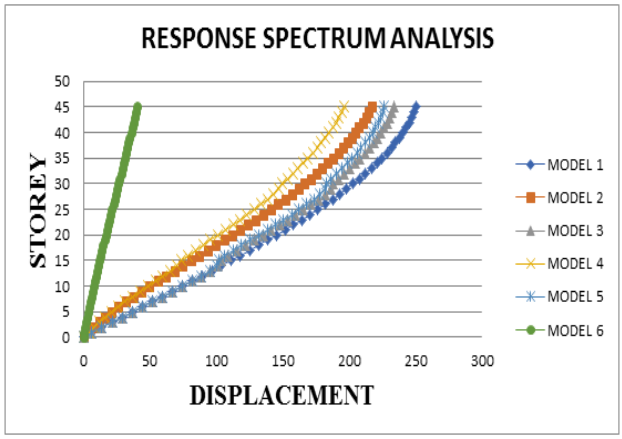


Mode numbers v/s time period _ Modal Analysis

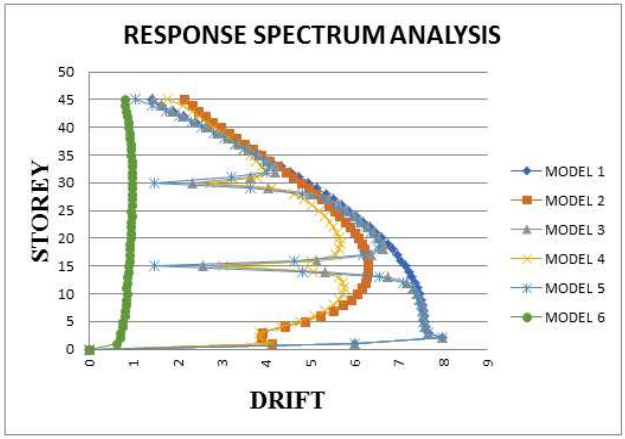


Comparison of base shear v/s models of 45 storeys

B. Response Spectrum Analysis: (SPECX)



Storey v/s displacement _ Dynamic Analysis



Storey v/s storey drifts _ Dynamic Analysis

6. CONCLUSION

A. The high-rise buildings are majorly suffering with seismic forces, it can be found out by displacement parameter. The more the displacement the lesser will be the stiffness of the structure.

B. The static analysis is having higher displacement value than response spectrum analysis. The increase in percentage is about 17%. This will increase the construction cost due to increase in stiffness.

C. The drift values are found satisfactory, since the values are lesser than limiting i.e., h/250 = 3000/250 = 12. Hence, these models are preferred in zone 3 as considered.

D. The drift values are lesser in case of dynamic analysis than static analysis.

E. From the modal analysis, it is clear that, the models 1 is more flexible than all other models. However, the Model M6 with diagrid section is brittle compared to all other models.

F. The time period in model M6 is greatly reduces than all other models. However, the decease in percentage is 9%, 3%, 13%, 4% and 59% for models M2, M3, M4, M5 and M6 when compared with model M1.

G. The base shear values of model M6 is very much lesser compared to other models. The model Model M5 is having more base shear value than other models.

H. The base shear value increases with increase in weight of the structure. However, the diagrid structure seems to be having lesser weight than all other models.

I. The time period and base shear values of models depends only on building dimensions and weight and hence it does not vary for type of analysis.

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