

# **A Comparative Study on High Rise Buildings Constructed Under RC Framed System and Shear Wall System**

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**ABSTRACT:** Shear wall structures are one of the major developments in buildings to resist the lateral loads and provides good structural stability to high rise buildings. The present study is an attempt to develop structural models of 18 storeyed building with RC beam-column- slab framed system and shear wall-flat slab system. The performance and strength of the building are verified for both lateral and gravity loads. The models are analysed for earthquake zone II and basic wind speed of even 50 m/s. Analysis results of the two models are compared to obtain seismic performance of building in terms of displacement, storey drift and base shear. ETABS software used for analysis of the structural models.

**KEYWORDS:** ETABS, RC shear wall, RC beam column frame, performance.

## **I. INTRODUCTION**

In the design of RC high rise buildings, performance and economic considerations are prime aspects, apart from other constructability issues. The present study deals with the significance of structural configuration of high rise structures under the influence of gravity and lateral load conditions. In this context 18 storied RCC moment resisting frame structure modelled for the construction at coastal belt of Visakhapatnam city in Andhra Pradesh. Two types of structural models are developed as bare frame and shear wall structure and their relative performances are evaluated with respect to the lateral displacements, inter-storey drift and strength aspects. It is evident that the structural designer often faced design limitations about framing of structural elements such as locations of columns, shear walls beams and beams in the lower storied portions building. This is due to the provision of large column free areas for parking and other commercial establishments. In certain locations where the lighting and ventilation requirements are important, the location of shear walls are restricted. In view of the design limitations, the proposed two models are designed as column beam frame model at 1<sup>st</sup>, 11<sup>th</sup> storey and the remaining storeys designed as beam-column-slab system in first model and shear wall –flat slab system in the second model. Lateral loads such as wind and earthquake shows significant influence on performance of structure. In this context the present study concerned about the relative performance of both the models with respect to lateral displacement, inter-storey drift and strength of the structure. Rigorous analysis carried out with the help of ETAB software and the results verified with standard building codes. Both economy and performance of the structure are the key issues for designer. This study briefs about the performance of generalized multi storied structures constructed in Visakhapatnam city and the influence of shear walls compared with beam column framed structure in top storey.

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## II. LITERATURE STUDY

Khushboo K. Soniet et al.[1], developed structural models for 12 storey, 15 storey and 18 storey building with and without shear walls , to assess the comparative seismic performance of buildings in terms of displacement, storey drift, base shear, and cost. The seismic analysis proceed through static analysis method for earthquake zone II. They concluded that high rise buildings with shear wall are economical as compared to without shear wall.

Akash D.shah , conducted parametric study of multistorey tall building using composite member and conventional member. In the study ,thirty storey tall building of three different models designed based on RCC structure, steel structure and composite structure. The analysis is done by ETABS software and results such as storey drift, joint displacement and base shear are verified. He concluded that composite structures are more economical and effective than RC and steel structures in multi storied buildings

## III GEOMETRY AND DESCRIPTION

For this study, an 18 storey building with 3.5 meters height for each storey and 3 meter for base storey, regular in plan is modelled. A rectangular building consists of spans of 37 meter in X and 28 meter in Y direction. The plan of the building measures 38m x 27m. Shear wall were used in shear wall –flat slab system as a load transferring member. These building are assumed to be fixed at the base and the floor act as rigid diaphragms. The sections of structural elements are square. But their dimension is different. Each storey height of buildings is assumed to be constant excluding the ground storey. The building is modelled using software ETAB v15.2.2 software; among the two model of 18 storey (with and without shear wall) were studied in Zone II by static analysis. After this comparison is done for Lateral Displacement, Storey Drift and Base Shear.

**Table 1:** Building design data

Structure	SMRF
Plan dimension	38m x 27m
No.of storey	18
Storey height	3m
Bottom storey height	3.5m
Thickness of slab	0.15m
Thickness of shear wall	0.15m
Beam size B <sub>1</sub>	0.3m x 0.6m
Beam size B <sub>2</sub>	0.3m x 0.51m
Beam size B <sub>3</sub>	0.3m x 0.46m
Column size C <sub>1</sub>	0.3m x 1.1m
Column size C <sub>2</sub>	0.3m x 0.83m
Column size C <sub>3</sub>	0.3m x 0.69m
Seismic zone	II
Soil type	II(medium)
Importance factor	1
Response reduction factor	5
Zone factor	0.1
Live load	3 kN/m
Floor finish	1 kN/m
External wall loads	16.2 kN/m
Internal wall loads	8.1 kN/m
Grade of concrete	M25
Grade of steel	Fe 415

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Figure 1 shows the configuration of columns in model-1 and Figure 2, shows the configuration of shear walls in model-2 as detailed below.

Model 1:- Floor plan of the bare framed structure (column-beam-slab system)

Model 2:- Floor plan of the shear wall –flat slab structure. (Column-shear wall –flat slab system)

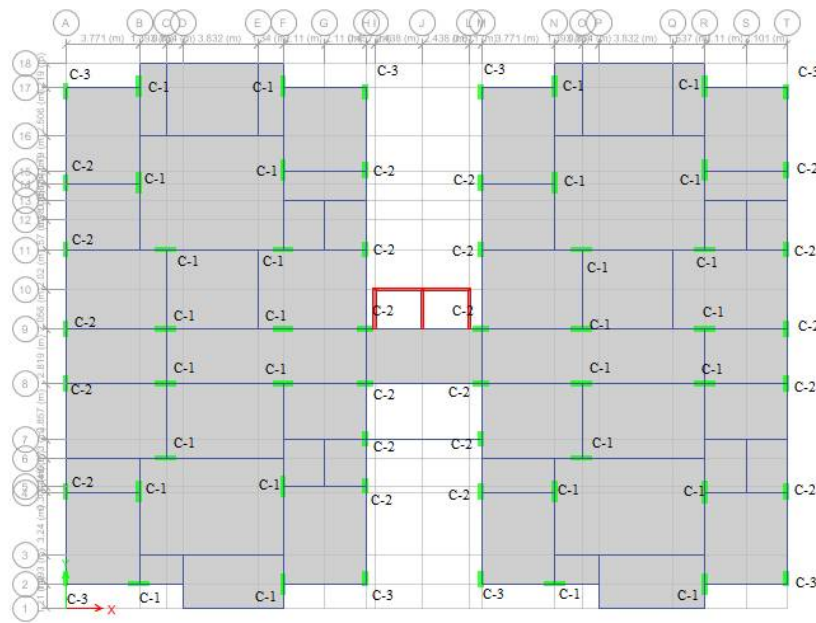


Fig 1: Typical column layout plan of 18storeyed residential building

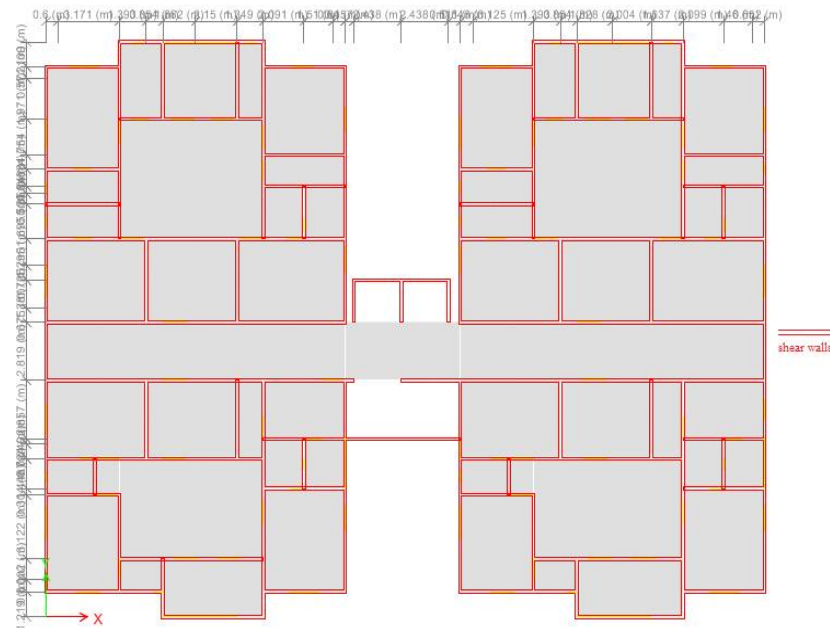


Fig 2 : Typical shear wall layout plan of 18storeyed residential building

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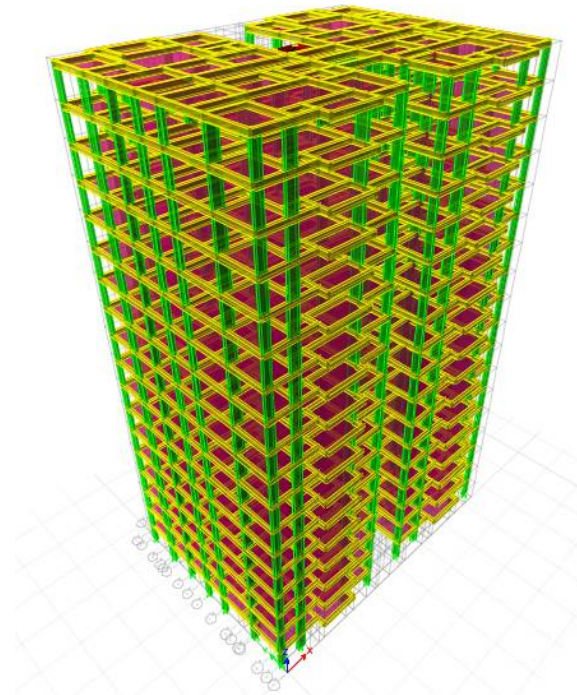


Fig 3: Framed structural model-1 with beam-column and slab system

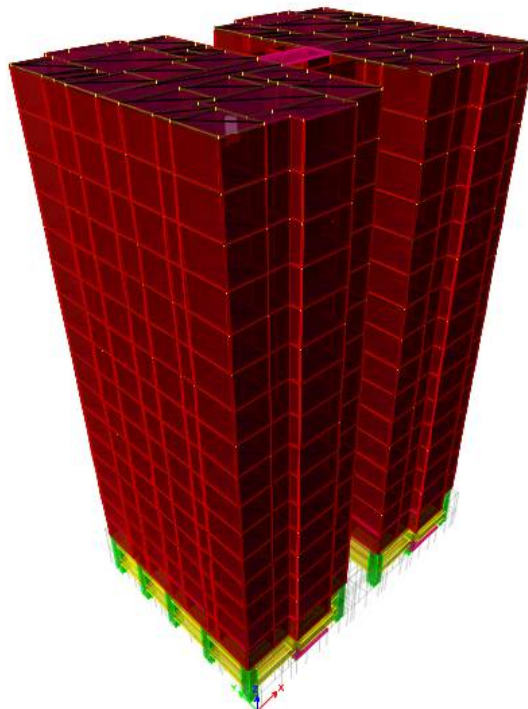


Fig 4: Shear wall structural model-2, with shear wall and flat slab system

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## IV. RESULTS AND DISCUSSIONS

During this study, the relative performance of 18 Storey building designed with and without shear wall are analysed in Zone II by Static Coefficient Method and validated through ETABS software. The studies are aimed to compare the lateral displacement, storey drift and base shear of the two structural models.

### A. LATERAL DISPLACEMENT

The lateral displacement (shown in fig: 5) for 18 storey building with and without shear wall for zone II were determined from the analysis on ETABS Software. The lateral displacement of 18 Storey building with shear walls was then compared to the lateral displacement of 18 storey building without shear wall in Zone II and corresponding graphs were plotted.

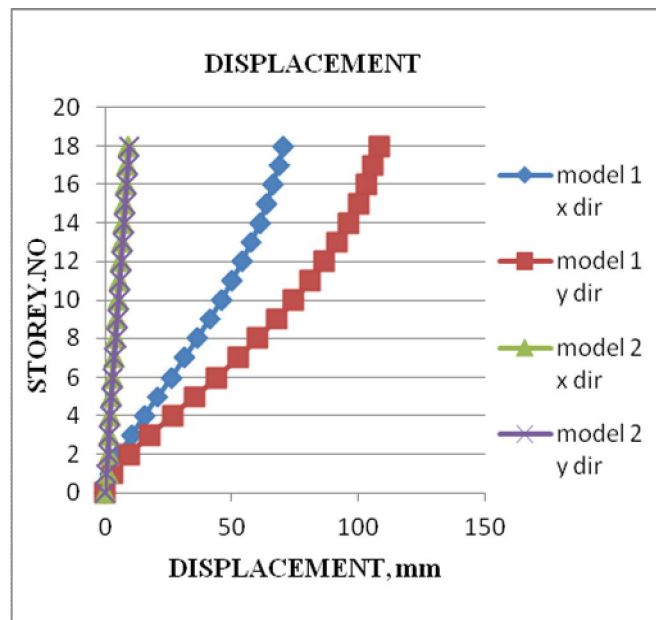


Figure 5

It is observed that, the displacement of model-2 (with shear walls) is less than the displacement of model-1 (without shear walls) in Zone II. In no case the values of displacements is more than the permissible values. The values of Displacement of model 1 i.e. with shear walls decreases by 75%-80% then the values of model 1 i.e. without shear walls in Zone II

### B. STOREY DRIFT

The Storey Drift for 18 storey building (shown in fig: 6) with and without shear wall for zone II determined from the analysis of ETABS Software. As per IS 1893 (Part 1):2002, clause 7.11.1, the displacement shall not exceed 0.004 times the storey height. The storey drift of 18 Storey building with shear walls was then compared to the storey drift of 18 storey building without shear wall in Zone II and corresponding graphs were plotted.

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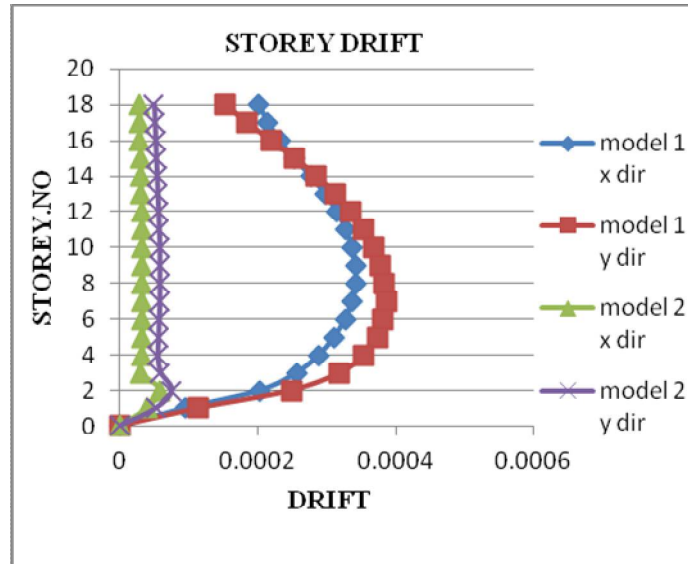


Figure 6

It is observed that the storey drift of model-2 i.e. with shear walls is less than the storey drift of model 1 i.e. without shear walls in all Zone II. In no case the values of displacement is more than the permissible values. The values of storey drift of model 2 i.e. with shear walls decreases by (60-70) % at 6<sup>th</sup> storey and by 18% for 18<sup>th</sup> storey.

### C. BASE SHEAR

The Base Shear of 18 storey building (shown in fig: 7) with and without shear wall for zone II were determined from the analysis on ETABS Software. The Base Shear of 18 storey building without shear walls was then compared to the Base Shear of 18 storey building with shear wall in Zone II and corresponding graphs were plotted.

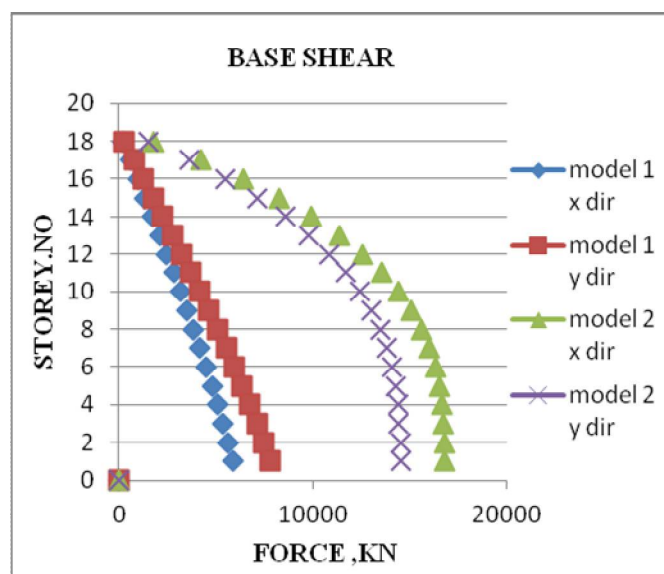


Figure 7

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From above fig.8 and it is observed that the Base Shear of model 2 i.e. with shear walls is less than the Base Shear of model 1 i.e. without shear walls in Zone II. The values of Base shear of model 2 i.e. with shear walls increases by 46% then the values of model 1 i.e. without shear walls in Zone II

## v. CONCLUSIONS

From the observations, the following conclusions are made about the performance of structure:

- [1] The shear wall system gives low displacement [75-80% less] compared with beam-column framed system.
- [2] Maximum inters story drift observed in beam- column framed system than shear wall system. The maximum drift is occurred at sixth storey and gradually reduced in further storeys. In shear wall system, low and constant drift values are observed.
- [3] Base shear resistance in shear wall system is 46% more than the framed system.
- [4] For lateral resistance load system, shear walls are more efficient than beam-column framed structures in multi-storeyed buildings.
- [5] Load transfer mechanism is more compatible in shear wall system than beam-column frame system. It is one of the major influential factors for progressive collapse of the structure.

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