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Assessment of High-Rise Buildings with Different Core Wall Configurations on Various Regular Plans

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Abstract: The design of tall buildings is based on three criteria that is strength, durability, stability. The effect of oscillatory movement results in an extensive response in the structure when lateral loads are applied to a tall building. The most important dynamic characteristics of an earthquake are the peak ground acceleration, frequency and duration. These properties serve as the dominant rule in studying the behavior of structures under seismic motion. When an earthquake occurs, it reduces the safety margin provided by non-structural components. The behavior of core wall is influenced by its proportion and support condition. The present study outlines the seismic design concepts in which different geometry of cores are applied to a building. The dynamic analysis of building is carried out with ETABS 2019.

***Index Terms* – acceleration, seismic motion, dynamic analysis**

INTRODUCTION

High-rise constructions employ a variety of techniques to resist lateral forces, the shear wall being the most popular. Since the seismograph was developed, it has been used to record different earthquakes and estimate the seismic forces that have been applied to structures; it has been noted that these values are significantly higher than those that the various codes prescribe. In addition to high strength concrete and steel reinforcement, modern structures also feature lightweight flexible partitions and curtain walls. As a result, non-structural components safety margins are reduced.

These days, it is possible to combine shear walls with bending frames so that the structure behaves in a ductile, resilient, and soft manner. The placement of a shear wall in steel constructions with concrete shear walls greatly minimizes the lateral displacement of the structure and allows for a greater contribution from the lateral force to be absorbed.

One of the lateral load resisting systems most frequently utilized in high rise buildings is the shear wall system. A shear wall is a structural system that offers stability against wind, earthquakes, and blasts. It gets its stiffness from the structural forms that are already there. Around elevator and stair cores, the shear wall can be either planar, open parts, or closed sections.

LITERATURE REVIEW

Hajiyev Mukhlis Ahmad, Hasan Dabbaghasadollahi Poor (2018), focused on the study of steel structures with RC shear wall. Seven models of plan dimension 48m X 48m is considered. All models are of 42-storey and having a storey height of 3.3m. Models are subjected to El Centro, BAM, Kobe earthquake ground motion. Non-linear time history analysis was performed. The paper concludes that the performance of structure in fifth model in terms of base shear is best. It is observed that in structure with shear wall, displacements increase by 50%. Drift difference was found as 37%.

Rupali Goud, Sumit Pahwa (2016), have conducted on research to study the behaviour of building with different location of core wall. The model used for analysis is of 10-storey and height of each storey of 3m. Plan dimensions are 35m X 30m. Four models are considered in which cores are provided at the centre, edge and at the corner. Models are assumed in zone V and analyzed by equivalent static method in STAAD PRO software. The paper concludes that core provided at the corner and edge has better drift reduction percentage when compared to structure without core.

Mayur N Prajapati, Vishal V. Patel (2016), research focus on study of various effect of various structural systems. Plan dimension is taken as 20m X 18m. Thickness of shear wall is 230mm and height of each storey is 3.5m. Structure with shear wall is of 35-storey and then increased to 47-storey. Structure having both shear wall and X-bracings system is of 47-storey. All the models are located in zone III of India and analyzed by equivalent static method in ETABS software. The paper concluded that the storey displacements of the structure with shear wall and X-type bracing is reduced by 40%. Model with shear wall has a displacement of 10% when compared to dual system.

The main topic of Shaik Kamal Mohammed Azam 2013 was the assessment of the seismic performance of multi-story Reinforced Concrete framed buildings with Shear walls. In this investigation, strength, stiffness, and damping parameters are being compared. When compared to the lateral stiffness of tall buildings, the use of core walls has a bigger impact on lateral strength. Additionally, for buildings with lesser heights, shear wall has a smaller impact on lateral strength than lateral stiffness.

METHODOLOGY

A 32-storey Circular plan building of 42m diameter is considered for the analysis. Floor height is taken as 3.2m.
Four models were considered.
The plan view of all the models is shown below.

Circular Plan without core – Model M1
Circular Plan with rectangular core 1 – Model M2
Circular Plan with rectangular core 2 – Model M3
Circular Plan with circular core – Model M4

Time history analysis was performed in ETABS 2019 software. For the purpose of analysis, ground motion data are required. In the present study, KASHMIR earthquake is considered. The magnitude of 7.6 was recorded on Mercalli intensity scale. It is considered as the deadliest earthquake in South Asia.

Table 1 Loads

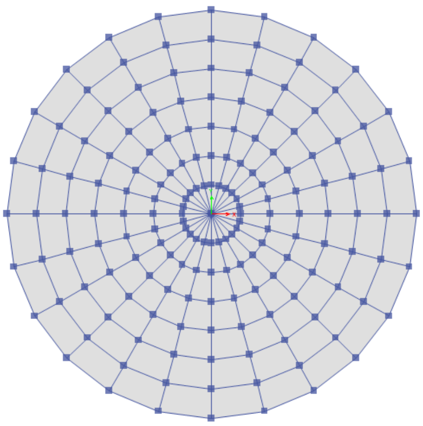
Loads considered	Load intensity
Live Load	3 KN/m^2
Floor Finish Load	1.2 KN/m^2
Wall Load	8 KN/m

Table 2 Frame specifications

Section Type	Size
Beams	300mm x 450mm
Columns	800mm x 800mm
Slabs	150mm
Thickness Of Core Wall	250mm
Grade of concrete	M30
Grade of steel	Fe550

Table 3 Seismic properties

Seismic Zone	V
Zone Factor	0.36
Importance Factor	1.5
Soil Type	II
Response Reduction Factor	5



RESULTS AND DISCUSSION

Fig. 1 Plan view of Model M1

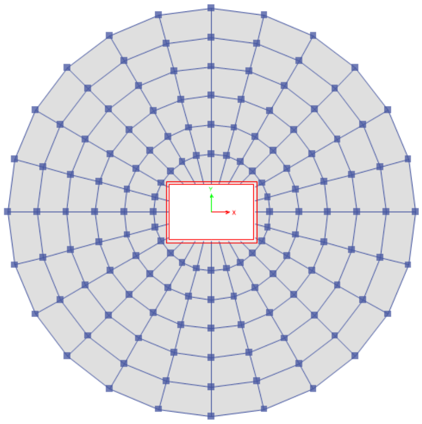


Fig. 2 Plan view of Model M2

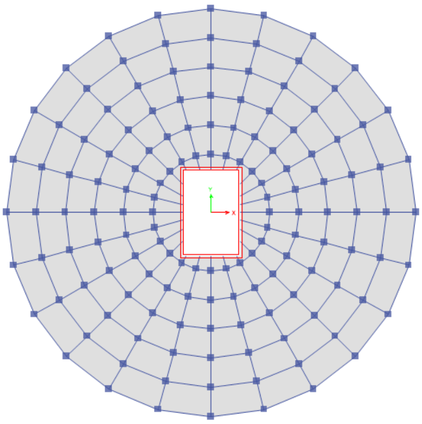


Fig. 3 Plan view of Model M3

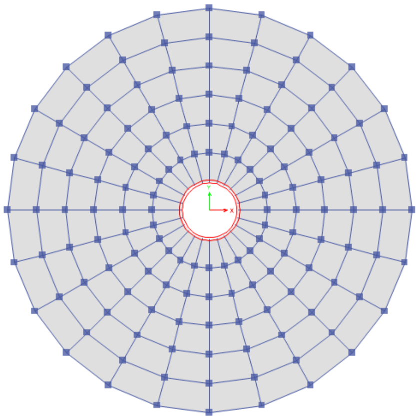


Fig. 4 Plan view of Model M4

BASE SHEAR

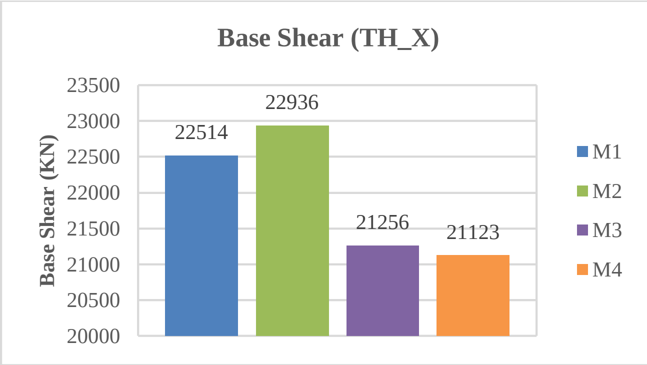


Fig. 5 Base shear in X-direction

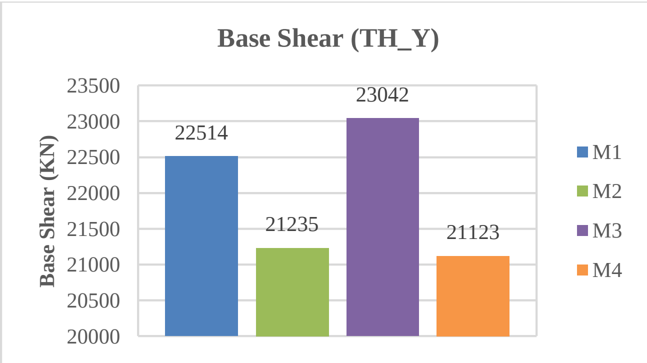


Fig. 6 Base shear in Y-direction

TIME PERIOD

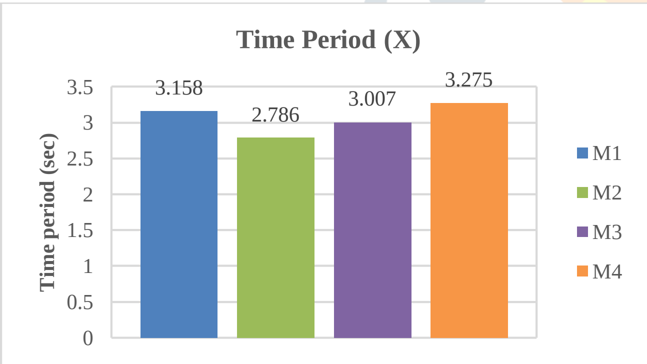


Fig. 7 Time period in X-direction

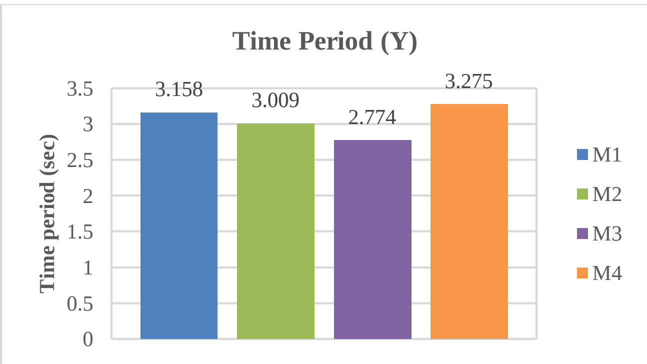


Fig. 8 Time period in Y-direction

STOREY DISPLACEMENT

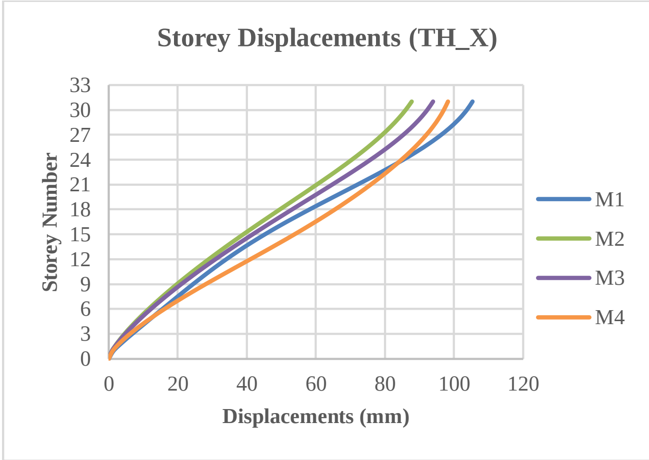


Fig. 9 Storey displacement in X-direction

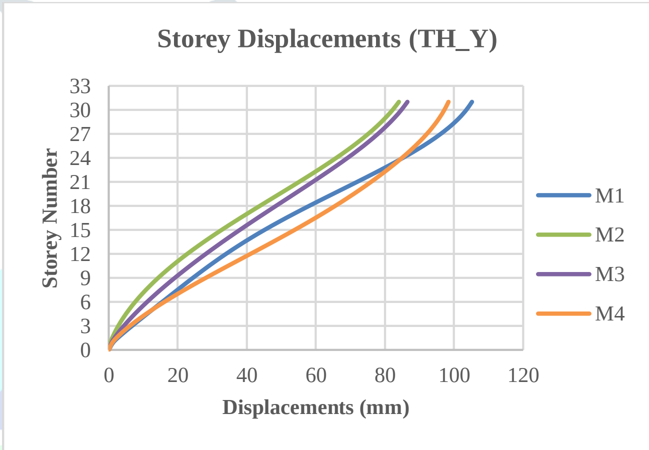


Fig. 10 Storey displacement in Y-direction

Model	Displacement (mm)	
	X-direction	Y-direction
M1	105	105
M2	88	84
M3	94	86
M4	98	98

STOREY DRIFT

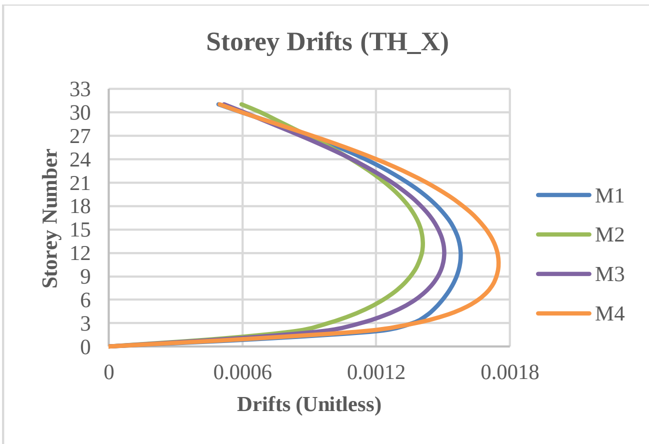


Fig. 11 Storey drifts in X-direction

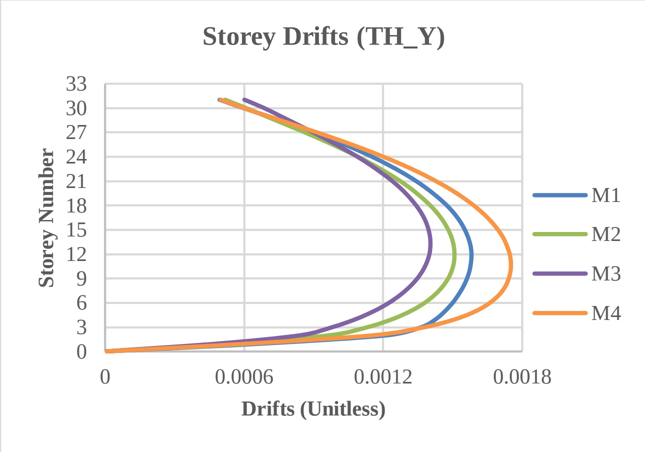


Fig. 12 Storey drifts in Y-direction

Model	Drift (Unitless)	
	X-direction	Y-direction
M1	0.001581	0.00158
M2	0.00141	0.001508
M3	0.001507	0.001403
M4	0.00175	0.001742

STOREY STIFFNESS

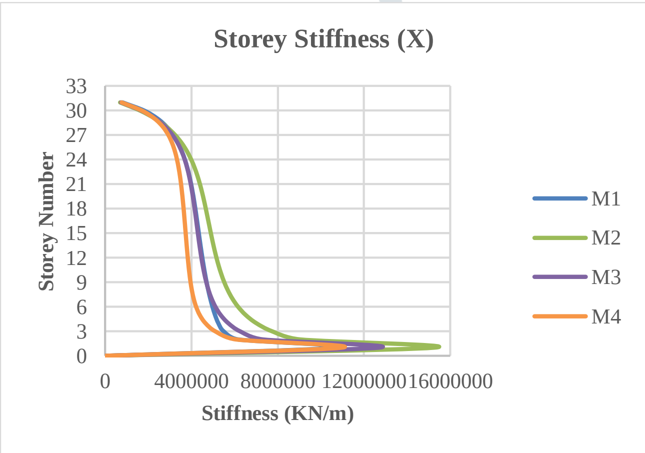


Fig. 13 Storey stiffness in X-direction

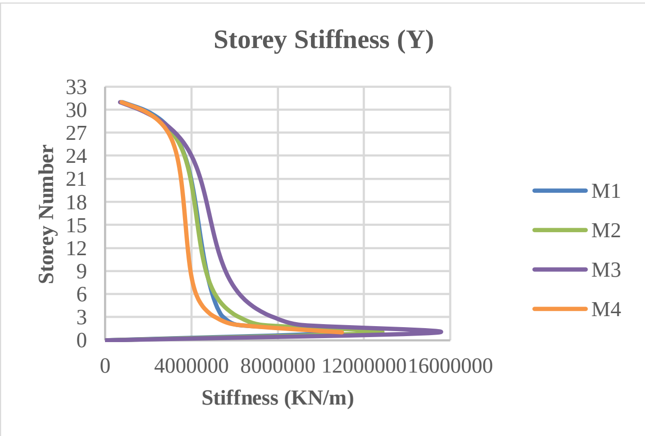


Fig. 14 Storey stiffness in Y-direction

CONCLUSIONS

The following conclusions are obtained in this paper

1. Base shear is maximum for Model M2 and minimum for Model M4 in X-direction.
2. Base shear is maximum for Model M3 and minimum for Model M4 in Y-direction.
3. The displacements of the building with the cores are less than that of without core.
4. The percentage decrease of displacements for the building with core when compared to without core (Model M1) in X-direction are as follows:

   6.89% for Model M4
   11% for Model M3
   17.6% for Model M2

5. The percentage decrease of displacements for the building with core when compared to without core (Model M1) in Y-direction are as follows:

   6.89% for Model M4
   19.8% for Model M3
   22% for Model M2

6. Storey drifts for the building with Model M2 and Model M3 are minimum in x and y directions respectively.
7. Seismic load resisting capacity of the frame building is significantly improved in the presence of core shear walls.

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