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A STUDY ON COMPARATIVE STUDY ON FLAT SLAB STRUCTURE WITH AND WITHOUT SHEAR WALL

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Abstract - *This study presents a detailed comparative analysis of flat slab structures with and without shear walls to evaluate their seismic performance, structural behavior, and overall efficiency. Flat slab structures are widely used in modern construction due to their simplified formwork and enhanced architectural flexibility. However, their seismic performance has been a subject of concern, especially in regions prone to seismic activity. This research involved numerical simulations and analytical investigations to explore the behavior of flat slab structures under seismic loads.*

In this work, two main factors were considered namely with shear walls and without shear walls for flat slab structure. The Structure is modelled with the ETABS software and analysis according to 1893:2002. The project work is carried out for (G+10) stories of structure and analysis for different models, Flat slab with shear and without shear partitions.

Based on the assessment of various parameters, it was observed that the flat slab with shear partition exhibited decreased values of story displacement and drift, along with improved values of story stiffness and shear when compared to the flat slab with shear wall system.

Key Words: Flat Slab, Shear Wall, Seismic Loads and E-TABS.

1. INTRODUCTION

Flat slab is a widely used structural system in modern construction that offers simplicity, flexibility, and efficiency in building design. In this system, the floor slabs are directly supported by columns without the use of beams, resulting in a flat and clean soffit at each level. The absence of beams allows for increased headroom, providing more usable space and greater architectural freedom. Flat slabs are particularly advantageous in mid to high-rise buildings where the floor-to-floor height is crucial for maximizing the number of levels. This system also simplifies the construction process, reduces the need for complex formwork, and speeds up the overall construction time, leading to potential cost savings.

The lack of beams reduces the structural redundancy, making them vulnerable to lateral forces during seismic events. Overall, flat slab systems continue to be popular choices for various building types due to their inherent benefits, and with careful design and reinforcement, they can offer a safe and economical solution for a wide range of construction projects.

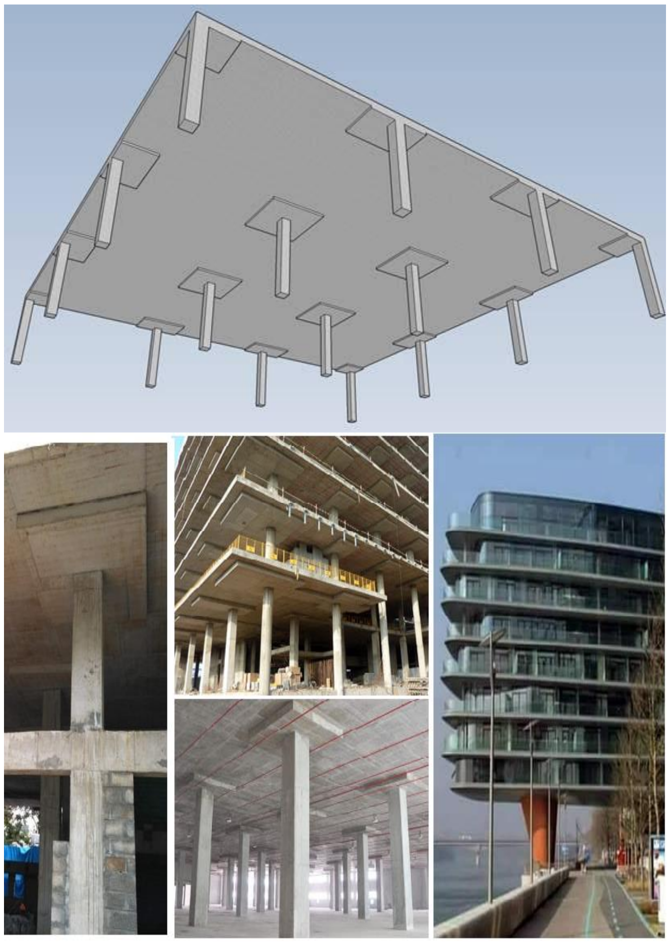

FIG 1.1 FLAT SLAB WITH DROP PANEL

A flat slab with drop panel is a modified version of the conventional flat slab system, designed to enhance its load-carrying capacity and stiffness. In this system, the floor slab has thicker sections, known as drop panels, directly below the columns. These drop panels increase the effective depth of the slab at critical points, improving its flexural and punching shear resistance. The drop panels redistribute the load from the columns to a wider area, reducing the stress concentrations around the column heads. This reinforcement also helps to control deflections and minimize cracking in the slab. The combination of the flat slab's simplicity and the added strength provided by the drop panels makes this system a popular choice for mid to high-rise building structural performance.

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2. LITERATURE REVIEW

Ms. Naik Ashwini Shankara and Dr. P.B. Ullagaddi (Dec 2021): The research assesses the structural behavior of a flat slab featuring shear walls and bracing systems, employing E-TABS software for Response Spectrum Analysis. Several models of varying stories were studied, revealing that the flat slab with shear walls outperformed the bracing system in terms of reducing Story Displacement and Drift while enhancing Story Stiffness and Shear. The flat plate with shear walls proved to be the most efficient, closely followed by the flat slab with bracings.

Raghda Halima, Mohamed Madawy, And Youssef Agag The (2019): In this research, the performance of shear walls in seismic analysis was examined using equivalent static load approach and response spectrum analysis at various stages. The seismic parameters, such as base shear, story drift, and story displacement, were thoroughly evaluated for a 20-story reinforced concrete multi-story building. The findings indicated that response spectrum analysis better captured the structure's realistic behavior compared to the equivalent static load approach. The study underscored the crucial role of shear walls in influencing the building's seismic performance.

Sk. Jain Shahab and A.P. Nagendra Babu (2017):

The research compares seismic analysis of G+10 buildings fortified with bracings and shear walls in Zones 2, 3, 4, and 5. Analyzing and contrasting the seismic response of multistory buildings with various shear wall positions is crucial for selecting the optimal construction alternative in earthquake-prone regions. The study shows that placing shear walls on the perimeter, rather than the center area, exacerbates the buildings' story drift.

Mr Santhosh (2014): Shear wall systems are widely used in high-rise buildings for exceptional lateral-load resistance, providing stiffness and strength. They counteract gravity loads and shears from wind or earthquakes, making them advantageous in structural engineering. However, limited research explores non-parallel shear walls in multi-storey buildings. This study analyzes three models: a bare frame system and two with parallel and non-parallel shear walls. Response spectrum analysis on a five-story building in Zone V using ETABS v9.6 and SAFE v12.1.1 software determines the optimal shear wall location based on various factors.

3.OBJECTIVES

- To study the behaviour of G+10 Flat slab structure
- To perform Equivalent static analysis and Dynamic (Response spectrum and time history analysis) as per IS 1893-2016.
- To analyse and design a multistory building with different types of shear walls at different locations and compare it for seismic zone 2
- To fully understand the various parameters such as displacement, base shear, Time period, story shear to various structure configuration.

4.METHODOLOGY

Modeling in ETABS is the process of creating a digital representation of a structure. It involves inputting the building's geometry, material properties, and load conditions to perform structural analysis and **e**valuate its behavior under various loads and conditions.

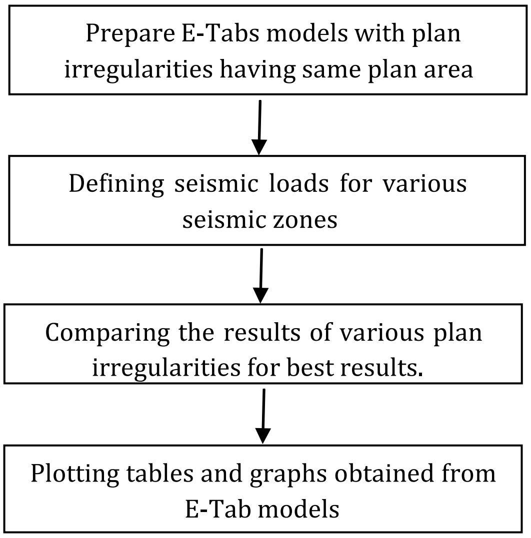


Figure 4.1 Flow Chart of methodology

4.1 STRUCTURAL DATA USED:

PARTICULARS	RCC STRUCTURE
Plan dimensions	58m*30m
Height of each story	3.5m
No. of story	G+10
Type of building	Commercial building
Grade of Concrete Column & Slab	M45 M25
Grade of Steel	Fe-550
Size of Column	C 750*750mm
Size of Beam	B 400*750mm
Size of Slab	250 mm
Size of Drop	500 mm
Deck slab	150 mm
Shear wall	250 mm

4.2 MODELING

MODEL 1: Flat slab without shear wall.

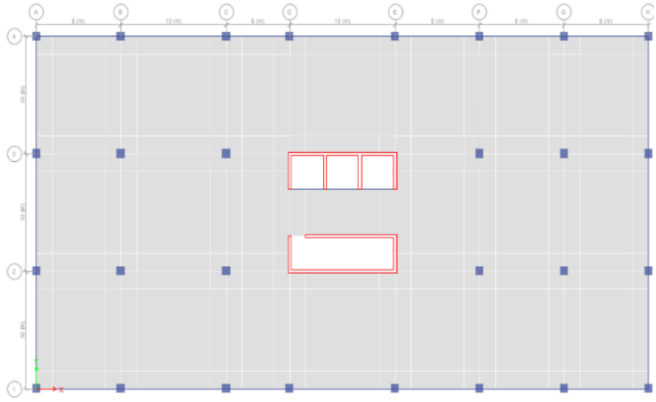


Fig -1: Flat slab without shear wall having (G+10) story building (Plan View)

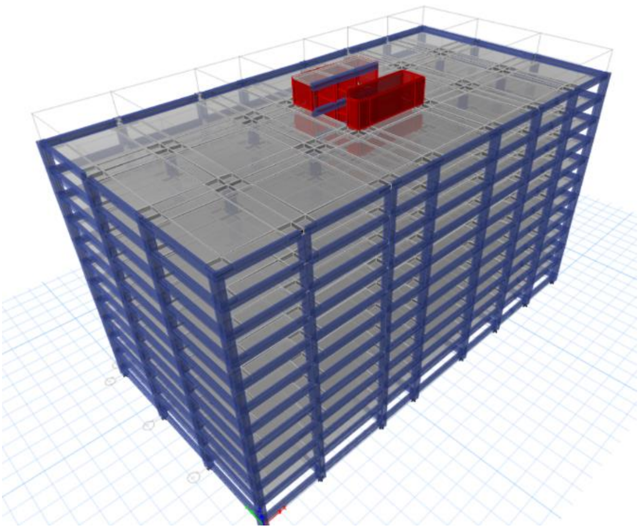


Fig -2: Flat slab without shear wall having (G+10) story building (3D View)

MODEL 2: Flat slab with shear wall at the corners.

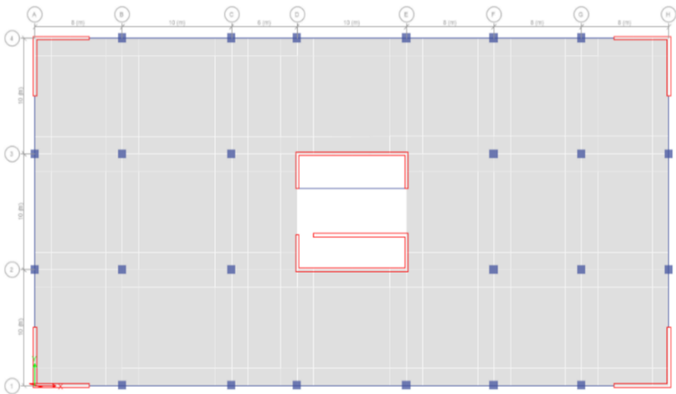


Fig -3: Flat slab with shear wall at corners having (G+10) story building (Plan View)

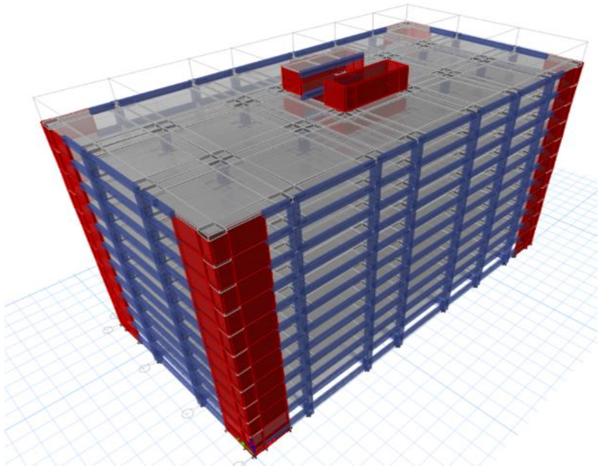


Fig -4: Flat slab with shear wall at corners having (G+10) story building (3D View)

MODEL 3: Flat slab with shear wall near to corners.

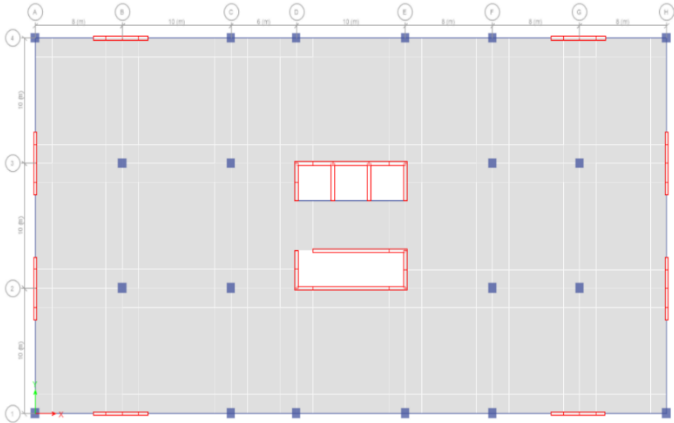


Fig -5: Flat slab with shear walls near to the corner of sides having (G+10) story building

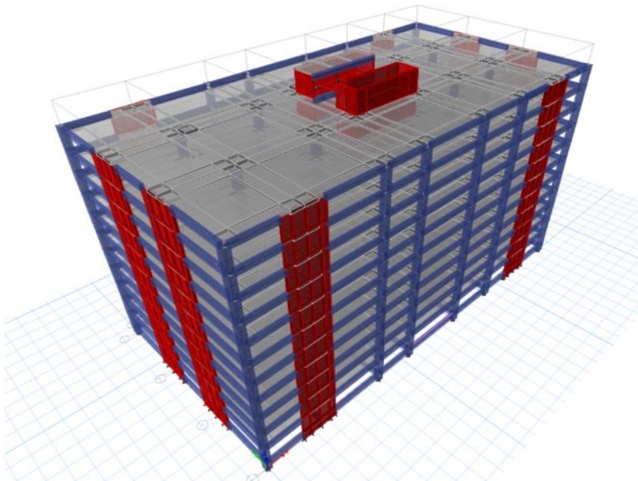
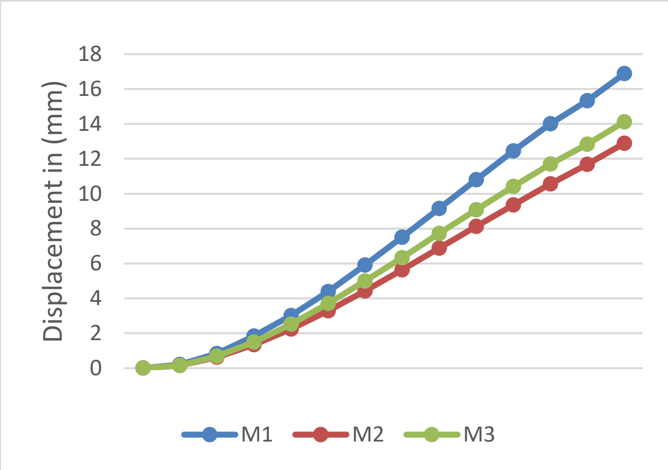


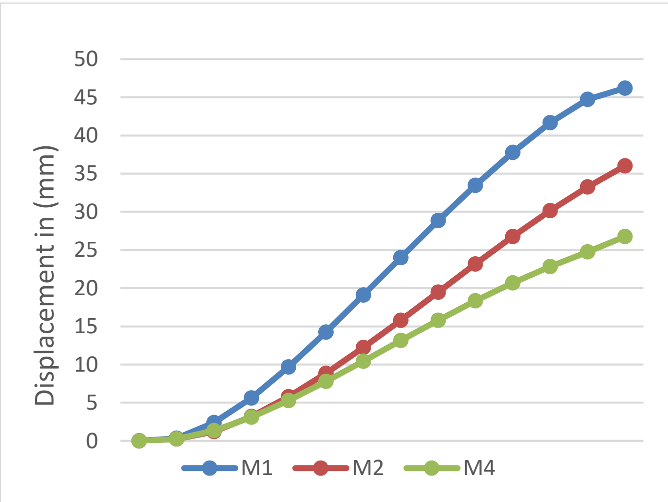
Fig -6: Flat slab with shear walls near to corner of sides having (G+10) story building (3D View)

5. ANALYSIS RESULTS

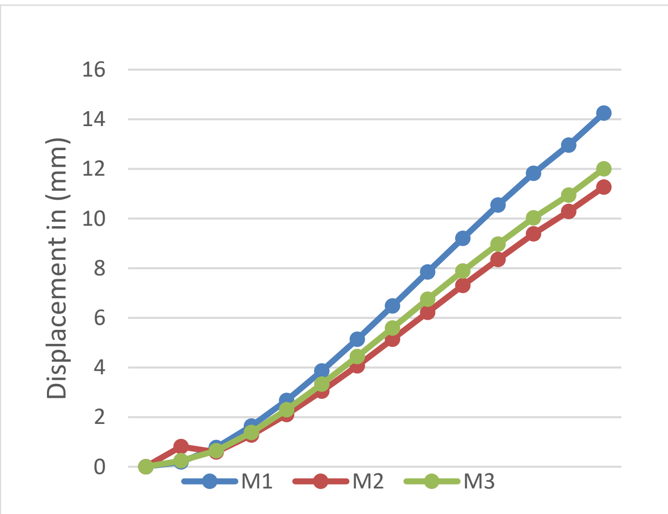
5.1 STORY DISPLACEMENT



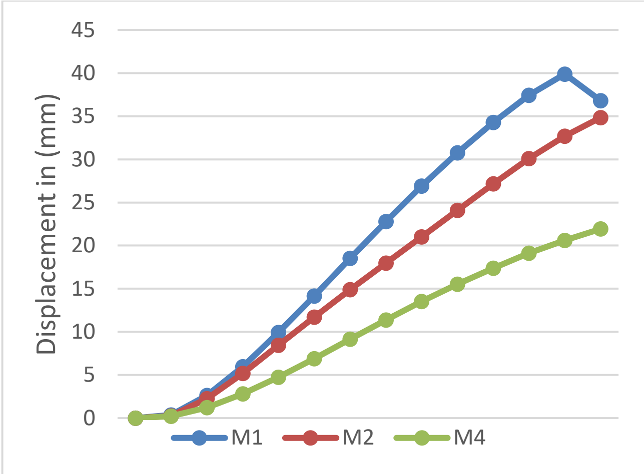
Displacement (EQX)



Displacement (EQY)



Displacement (SPEC X)



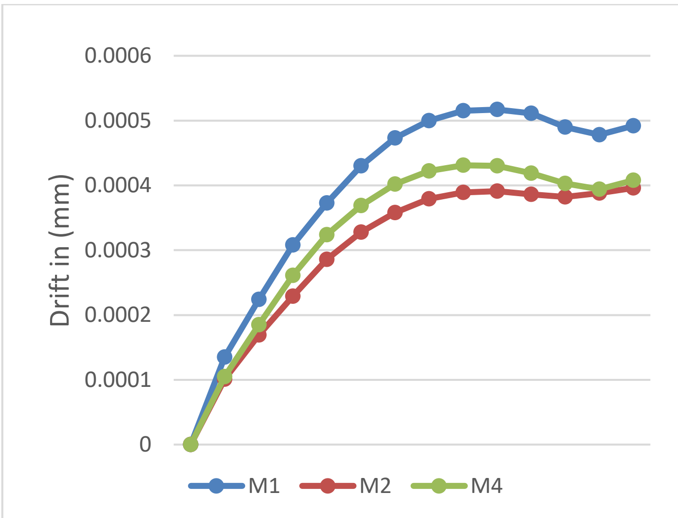
Displacement (SPEC Y)

The above graphs provides a conclusion that a flat slab with a shear partition structure proves to be more desirable than one without a shear wall since it exhibits lower story displacement

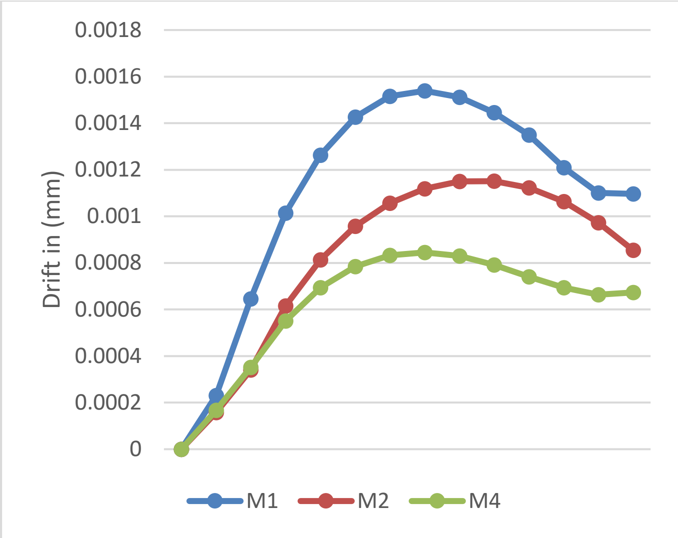
TABLE 5.1MAXIMUM DISPLACEMENT:

SL NO	MODEL RESULTS	MAX DISPL WITHOUT SHEAR WALL (M1)	MAX DISPL WITH SHEAR WALL AT CORNER (M2)	MAX DISPL WITH SHEAR WALL AT SIDES (M3)
1	EQX	16.878	12.889	14.118
2	EQY	46.192	35.995	26.742
3	SPEC X	14.243	11.269	12.006
4	SPEC Y	36.821	34.852	21.931

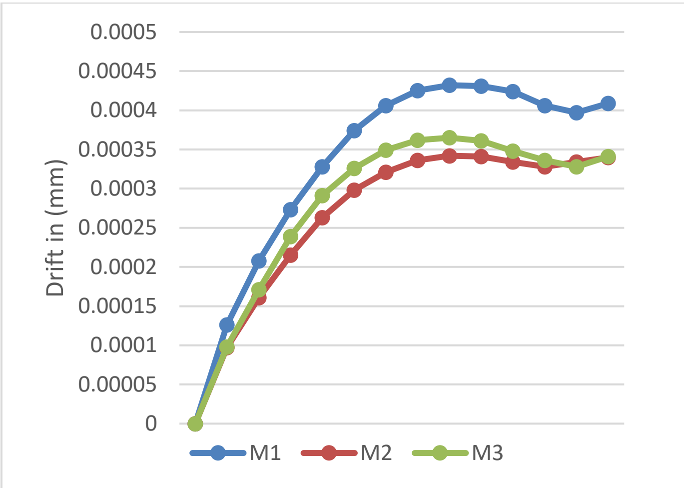
5.2 STORY DRIFT



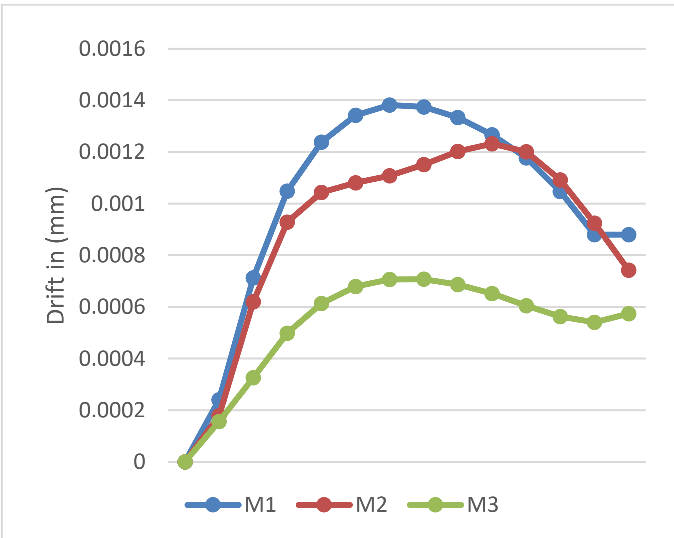
Drift (EQX)



Drift (EQY)



Drift (SPEC X)



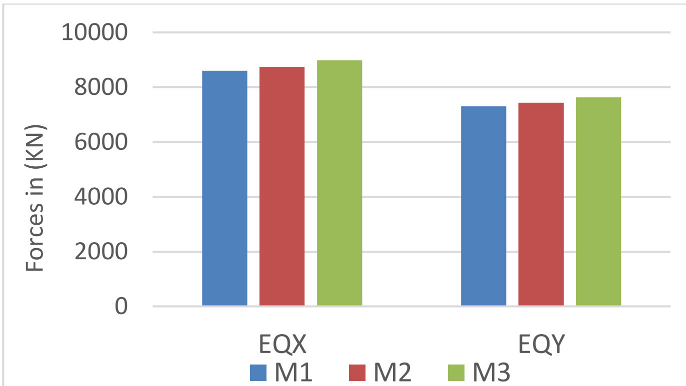
Drift (SPEC Y)

TABLE 5.2 MAXIMUM STORY DRIFT:

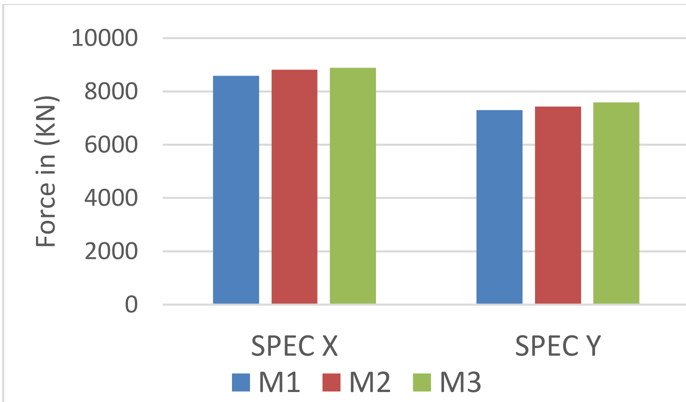
SL NO	MODEL RESULTS	MAX DRIFT WITHOUT SHEAR WALL (M1)	MAX DRIFT WITH SHEAR WALL AT CORNER (M2)	MAX DRIFT WITH SHEAR WALL AT SIDES (M3)
1	EQX	0.000517	0.000396	0.000431
2	EQY	0.001539	0.001151	0.000845
3	SPEC X	0.000432	0.000342	0.000365
4	SPEC Y	0.001382	0.001232	0.000707

The depicted graph reveals a parabolic pattern in the story drift, which correlates with the story height, reaching its peak near the central story. Analyzing the graphs, it is evident that the story drift of a flat slab with a shear partition building is lower compared to a flat slab without a shear wall.

5.3 BASE REACTIONS



BASE REACTIONS (EQX AND EQY)



BASE REACTIONS (SPECX AND SPECY)

Estimated seismic base lateral force the highest expected sideways force caused by ground motions on the structure's foundation. The graph in figure is nearly 90% similar and complies with the relevant building code regulations

TABLE 5.3 MAXIMUM BASE REACTIONS:

SL NO	MODEL RESULTS	BASE SHEAR WITHOUT SHEAR WALL (M1)	BASE SHEAR WITH SHEAR WALL AT CORNER (M2)	BASE SHEAR WITH SHEAR WALL AT SIDES (M3)
1	EQX	8593.41	8737.85	8982.35
2	EQY	7304.43	7427.17	7635.01
3	SPEC X	8583.41	8813.85	8884.87
4	SPEC Y	7304.29	7432.19	7587.37

6. CONCLUSION

After conducting an analysis of a flat slab with ten floors (Ground floor + 10 floors), using both a flat ceiling system with shear partitions and without shear partitions, the following conclusions have been drawn from the study:

1) The incorporation of shear walls in an RC Flat Structure leads to a substantial reduction in Story Drift, making it a safer option when compared to an RC Frame Structure without such walls. Shear walls play a crucial role in minimizing Story Drift, particularly in multi-story buildings.

2) The proper placement of shear walls has a significant impact on decreasing the maximum drift of a structure. Thus, the provision of well-designed shear walls becomes indispensable for RC Framed structures located in regions susceptible to higher seismic activity.

3) After analyzing different models in seismic zone 2 using response spectrum and equivalent static analysis methods, it was determined that Model 2-without a shear wall (in zone 2) produced the most favorable outcomes. This model exhibited a considerable reduction in base reactions.

7. SCOPE OF WORK

1) This study focused on four major parameters: story displacement, story drift, and base shear. The scope was limited to comparing seismic response in a building with various shear wall placements using dynamic analysis.

2) Future extensions of this examination may involve considering additional parameters such as torsion effects and soft story effects in the building to gain a more comprehensive understanding of its seismic behaviour.

3) Flat slabs with drop panels provides the higher shear strength and also increases the negative moment capacity of the structure.

8. REFERENCES

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6) Anshuman Nimade, Niraj Soni2, "Dynamic Analysis of Flat Slab System in Vertical Irregular Building with & without Shear Wall" International Journal of Research and Scientific Innovation (IJRSI) | Volume V, Issue I, January 2018

Standard Codes:

1) BIS, IS456: 2000, - Plain and Reinforced concrete code of practices, Bureau of Indian standards, Fourth Revision.

2) BIS, IS875: 1987 (Part III), - Code of Practice for Wind loads bureau of Indian standards.

3) BIS, IS 1893 (part 1) (2002)" Indian Standard Criteria for Practice for Earthquake Resistant Design of Structures General Provisions and Buildings (Fifth Revision)"