Assessment of Different Types of Bracing System in Commercial Building Under Seismic Response

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Abstract - Tall buildings are susceptible to lateral movements and torsional deflections when subjected to earthquake loads. To counteract these effects and ensure structural stability, it's essential to enhance the building's lateral stiffness. Bracing the frame members is a widely employed method to achieve this goal. Bracing systems are designed to minimize lateral deflection by subjecting the frame members to tension and compression forces, akin to a truss system. This project focuses on a comprehensive review of literature concerning the behavior and analysis of various bracing structural systems. The reviewed articles explore different types of bracing systems, including K- bracing, V-bracing, inverted V-bracing, X-bracing, and single diagonal bracing. The consensus from the literature review indicates that implementing bracing systems effectively reduces the adverse effects of lateral loads on tall structures. The proposed project aims to build upon the insights gleaned from the literature review by investigating a mixed bracing system. By combining elements from different bracing configurations, the project seeks to optimize lateral stiffness and stability further. This approach acknowledges the diverse challenges posed by lateral loads in tall buildings and aims to address them comprehensively. Through rigorous analysis and experimentation, the proposed project endeavors to contribute to the body of knowledge surrounding bracing systems in tall buildings. By exploring the efficacy of a mixed bracing system, the project aims to offer practical insights and recommendations for enhancing the structural performance and resilience of tall buildings against lateral forces.

Keywords: K, V, inverted V, X, Single Diagonal Bracing.

1. INTRODUCTION

In simple terms, using bracing elements in tall buildings is a smart and cost-effective way to resist sideways forces. These bracing elements, also known as stiffeners, are made up of standard columns and supports primarily meant to handle the building's weight. They include diagonal members connected within the structure to withstand horizontal forces. Think of them like a lattice mesh, with columns acting as the main support beams. This bracing works well because the diagonal pieces handle stress in a way that requires less material to stay strong against sideways pressure.

Tall buildings, officially defined as those over 50 meters by the Council for Tall Buildings and Urban Habitat, come in various categories. Skyscrapers, for example, are over 100 meters tall, while super tall buildings reach heights of 300 meters or more, and mega tall buildings exceed 600 meters. The demand for such towering structures stems from several factors, including limited land availability, increased need for commercial and residential space, economic growth, technological advancements, innovative building designs, cultural significance, and the desire for prestige associated with building tall.

These frames typically utilize structural steel components, capable of efficiently handling both tension and compression. The beams and columns within the frame bear the vertical load, while the stiffening system handles lateral forces.

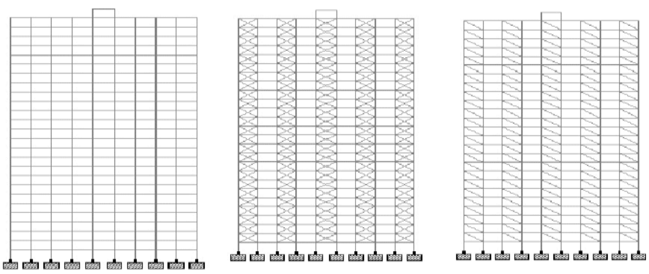
By effectively resisting lateral forces, these stiffening systems enhance structural efficiency compared to rigid frames alone.

2. Objective

- Model 1: BE1 – Regular Building (No Bracing Element)
- Model 2: BE2 – Building with X- Bracing Element & Single Diagonal Bracing Element
- Model 3: BE3 – Building with K- Bracing Element & Single Diagonal Bracing Element Model 4: BE4 – Building V- Bracing & Inverted Diagonal Bracing Element
- Model 5: BE5 – Building with V- Bracing Element & X- Bracing Element Model 6: BE6 –V- Bracing Element & K-Bracing Element
- Model 7: BE7 – Building with Inverted V Bracing Element & X- Bracing Element.

S. No.	Combination of Bracing	
1	Normal Structural	Moment Resisting Frame
2	X	Single Diagonal
3	K	Single Diagonal
4	V	Inverted Diagonal Bracing
5	V	X
6	V	K
7	Inverted V	X

Table -1: Combination of Bracing



Different Bracing Modes

Table 2 Data of the Model

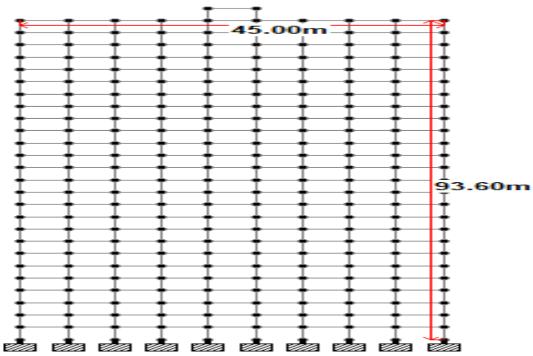


Fig -1 Elevation Regular Building

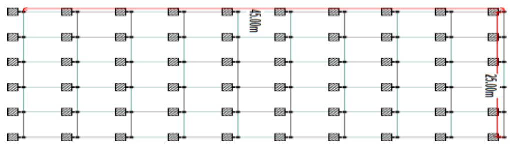


Fig -2: Plan Regular Building

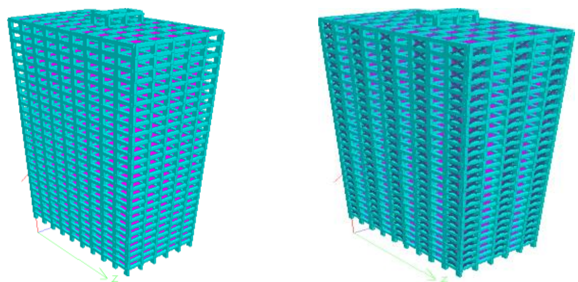


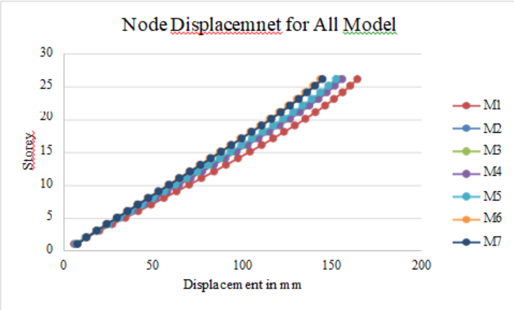
Fig -3 3d rendering Regular Building & with X- Bracing

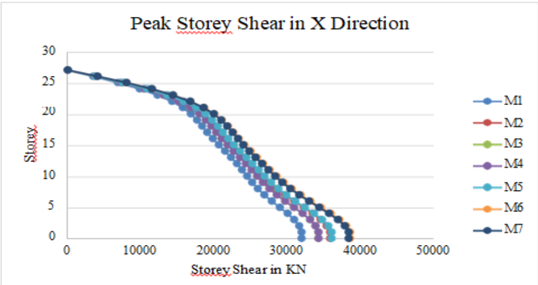
3. RESULTS

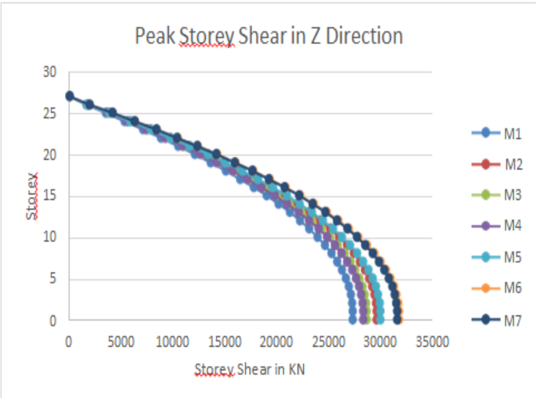
This chapter utilizes the Response Spectrum Method to compare the results of a 7-story conventional model with bracing structural models and shear wall systems in terms of Node displacement, &

S.no	Model ID	Value
1	No. of Story	G + 26 Stories
2	Plan Area	45Meters X 25 Meters
3	Story Height	3.6 Meters
4	Beam Size	800 millimeters X 1200 millimeter
5	Colum Size	1200 millimeters X 600 millimeters
	Bracing size	ISMB 500
6	Slab Thickness	160 millimeters
7	Grade of Concrete	M-25
8	Grade of Steel	Fe-550
9	Zone	Zone III

peak storey shear. The analysis aims to evaluate the performance of these different Bracing systems and assess their effectiveness in mitigating structural responses to seismic forces.







4. CONCLUSIONS

- Models M2 to M7 generally demonstrate lower node displacement compared to M1, indicating enhanced structural stiffness and reduced deformation.
- Specific bracing configurations, such as M3 and M4, tend to show slightly lower displacement values, suggesting their effectiveness in minimizing building movement and reducing node displacement compared to other bracing configurations.

In summary, the inclusion of bracing elements contributes to reduced node displacement in structural models. demonstrate improved structural stiffness and reduced deformation compared to models without bracing.

Further analysis and optimization strategies can help refine the performance of these models in minimizing node displacement and enhancing overall structural stability.

Peak Storey Shear

- Model M1 exhibits moderate to high shear forces across storeys but slightly higher than Model M1, suggesting adequate lateral load resistance with room for improvement in optimizing shear force distribution.
- Models M3, M4, M5, M6, and M7 generally show comparable shear forces to M2, indicating moderate to high lateral load resistance but similar performance in this comparison.
- Each model may benefit from further analysis and optimization strategies to enhance overall stability and reduce shear forces.

In conclusion, while the inclusion of bracing elements generally enhances structural stiffness and reduces deformation, specific configurations may offer varying degrees of effectiveness in minimizing building movement. Model M1 stands out for its relatively lower peak storey shear values, indicating higher stability compared to the other models. Further analysis and optimization strategies are recommended for all models to improve their structural performance under lateral loads.

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