RESEARCH ARTICLE OPEN ACCESS

Enhancing Seismic Performance of G+20 Buildings: Comparative Analysis of X-Brace Placement through Response Spectrum Evaluation

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ABSTRACT
In high-rise buildings, bracing systems are crucial for maintaining structural integrity against seismic forces, wind pressures, and gravity. Positioned strategically within the building frame, bracings resist lateral forces, minimize sway, and enhance stability and occupant comfort. They distribute lateral loads efficiently, reducing the risk of structural failure during extreme events, particularly in seismic or high-wind regions. Additionally, bracings provide vertical support and reinforcement, especially in structures with irregular configurations or complex load distributions. They transfer loads between different building levels, maintaining equilibrium and preventing excessive deflection or deformation. Integrating bracings into high-rise buildings is essential for superior performance, durability, and aesthetic appeal, ensuring occupant safety and satisfaction. This study evaluates the impact of X-brace placement on the seismic performance of G+20 buildings using response spectrum analysis. Through numerical simulations, various X-brace configurations are analyzed, comparing scenarios from bare frames without X-braces to those with X-braces in two distinct positions.

***Keywords* —** X-Brace, ETAB, Multi Storey Building, Construction.

I. INTRODUCTION

Earthquakes are highly destructive and unpredictable, causing significant loss of life and property mainly due to the collapse of structures. High-rise buildings are particularly vulnerable during strong earthquakes. Rapid urbanization, limited construction space, and high land costs drive the demand for high-rise constructions, especially in earthquake-prone regions like India. To enhance seismic resilience, incorporating steel bracing into the structural system is effective. Various configurations such as X, diagonal, V, knee, and O-grid bracing improve structural response.

Diverse-intensity earthquakes impact infrastructure and ecosystems, often causing traffic delays and structural collapses. Empirical data shows that collapses lead to injuries and property losses. Studying seismic strength and exposure features is crucial for improving the endurance of structures against varying earthquake intensities. High-rise structures need to effectively transfer gravity and lateral loads, such as those from wind and earthquakes, which induce high stresses and reduce stability. Rigidity is crucial for resisting lateral loads.

India has experienced multiple damaging earthquakes, with over 60% of its area in seismic zones III, IV, and V. Despite this, only about 3% of the built-up area is well-designed to withstand earthquakes. Structural response to seismic activity depends on deformation caused by different loading aspects, influencing internal forces and displacement behavior. Mass and stiffness of the building determine movement requirements. Shear walls and steel bracing are used to reduce displacement and enhance structural performance. Bracing systems in RC frames reduce lateral displacement by placing components under tension and compression.

Structural design must consider various loads, including lateral loads from wind and earthquakes. Center-bare frame variants are more flexible but less stiff. Bracing systems reduce shear forces and bending loads while increasing stiffness with minimal extra weight. X-braces are suitable for steel construction due to their lateral stiffness. Buildings flex under lateral loads, with displacement increasing until plastic hinges form, eventually leading to collapse. Each structure's stiffness and capacity to handle lateral stresses depend on variables such as the number of floors and span lengths.

II. PROPOSED MODEL AND METHODOLOGY

In this section examines the impact of various X-brace configurations on the seismic performance of G+20 buildings using response spectrum analysis. The study compares different scenarios, starting with a G+20 bare frame without any X-braces, followed by the implementation of X-braces at two different positions within the structure.

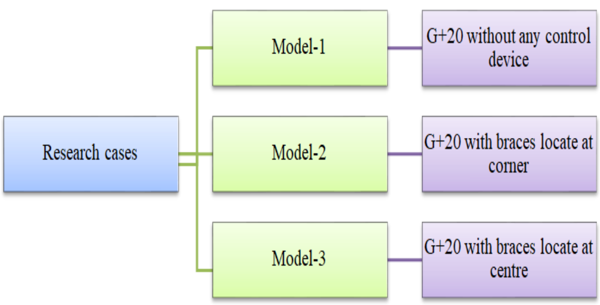
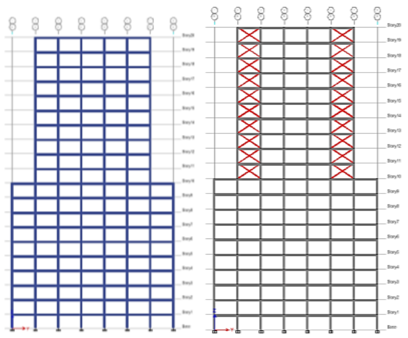
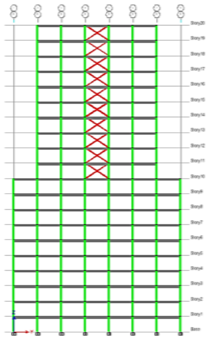


Fig 1. Proposed Model

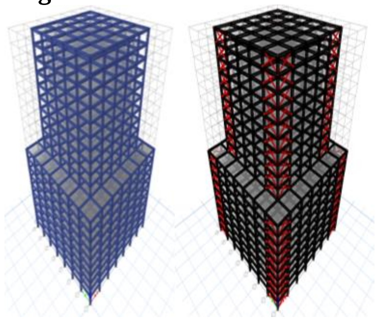


i) Case-1 ii) Case-2



iii) Case-3

Fig 2. Elevation View of Model



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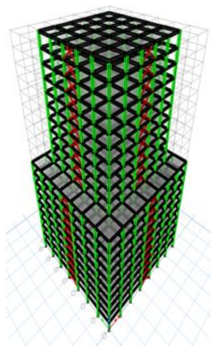

iii) Case-3

Fig 3. Three-dimensional view of Model

Table 1: Geometrical Data

S. No.	Data	Value
1	Rebar	HYSD 500
2	Grade of concrete	M40
3	No. of stories	G+20
4	No. of bay along X-direction	8
5	No. of bay along Y-direction	8
6	Span along X-direction	5m
7	Span along Y-direction	5m
8	Floor height	3m
9	Column size	500*500 mm
10	Beam size	500*400 mm
11	Depth of Slab	200mm
12	wall load	13.8 kN/m
13	Live load	3kN/m^2
14	Software	CSI ETABS
15	seismic load	IS 1893-2016
16	Seismic zone	5
17	Site type	2
18	Importance factor	1
19	Response Reduction	5
20	Analysis Method	Response Spectrum Method
21	Bracing	ISNB 250 H

III. RESULTS AND DISCUSSION

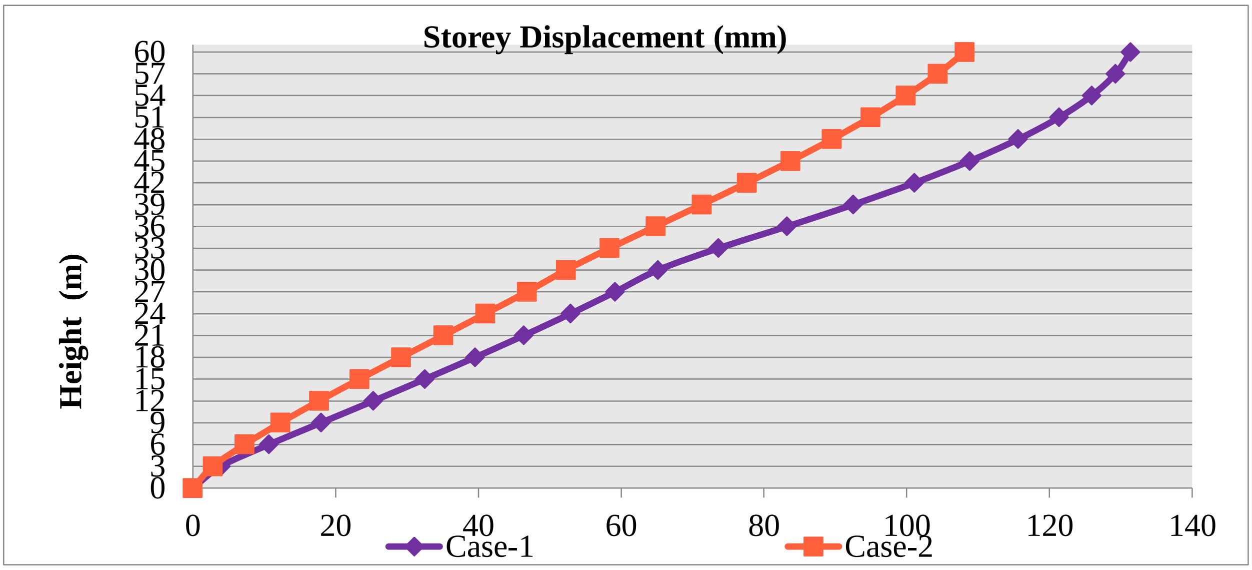

Fig 4. Effect on storey displacement of bare frame with and without braces at corners

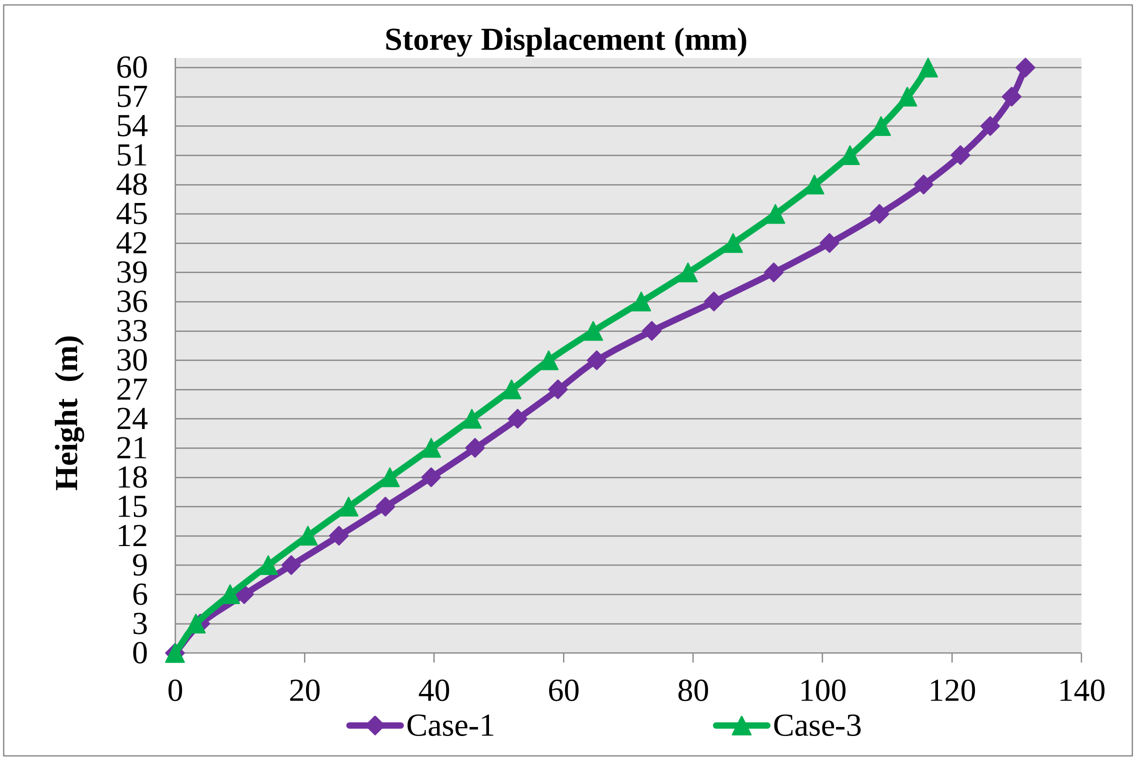

Fig 5. Effect on storey displacement of bare frame with and without braces at centre

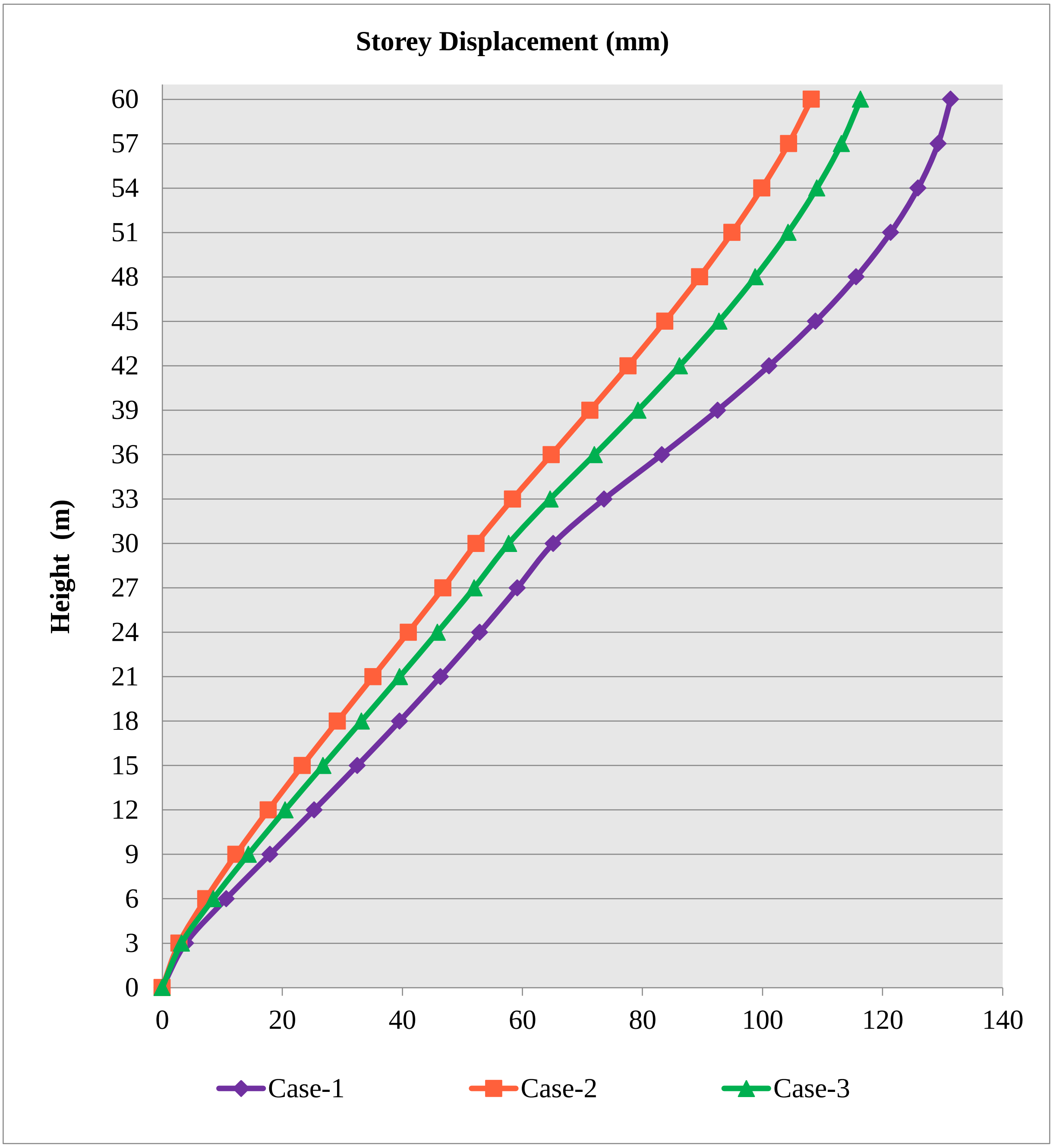

Fig 6. Storey Displacement of model in varying cases

IV. CONCLUSIONS

The seismic behavior of multistory buildings is a complex interplay of various factors including structural design, material properties, and seismic protection systems. Ensuring the resilience and safety of these structures requires a comprehensive understanding of their dynamic response to seismic events. Ongoing research and advancements in seismic design practices continue to improve the ability of multistory buildings to withstand earthquakes, safeguarding lives and reducing economic losses.

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