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Comparative Study on Seismic Behavior of G+20 Building

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ABSTRACT

This study conducts a comparative analysis of GFRG (Glass Fiber Reinforced Gypsum) panels and Reinforced Concrete (RCC) regarding their structural performance in multi-storey buildings, employing ETABS software. GFRG panels are increasingly recognized as a sustainable and cost-effective substitute for traditional RCC construction materials. The analysis evaluates critical structural parameters including load-bearing capacity, seismic resilience, and overall stability across diverse design scenarios. Through simulations in ETABS, the study contrasts the behavior of buildings constructed with GFRG panels versus RCC, highlighting respective advantages and limitations. The findings provide insights into the feasibility and performance characteristics of GFRG panels in contemporary construction methods, with implications for sustainable building design and structural engineering practices.

Keywords: - ETAB, Multi Storey Building, Construction.

I. INTRODUCTION

Multistory buildings, due to their height and structural complexity, are particularly susceptible to the forces generated by earthquakes. Understanding the seismic behavior of these structures is crucial for ensuring their safety and integrity during seismic events. Earthquakes can impose significant lateral forces on buildings, leading to various forms of damage, ranging from minor cracks to catastrophic collapse.

Seismic behavior in multistory buildings refers to how these structures respond to earthquake-induced forces. Understanding this behavior is crucial for designing buildings that ensure occupant safety and structural integrity during seismic events. Key factors influencing seismic behavior include the structural configuration, material properties, foundation and soil conditions, and the building's dynamic characteristics. Proper seismic design and detailing, such as using shear walls and braced frames, as well as incorporating damping mechanisms, are essential for distributing and absorbing seismic forces. Ensuring a clear load path and redundancy in the structural system, considering P-Delta effects, and securing non-structural components further enhance seismic resilience. This holistic approach helps engineers create buildings that withstand seismic events, minimizing damage and ensuring safety.

The seismic behavior of G+20 multistory buildings is a critical area of study in structural engineering, particularly in regions prone to earthquakes. These tall structures, with their considerable height and mass, face unique challenges when subjected to seismic forces. Understanding how a G+20 building responds to an earthquake involves examining the interplay of various factors, including structural configuration, material properties, and the implementation of advanced seismic protection systems such as base isolators and dampers. This study aims to explore these dynamics, providing insights into effective design and construction practices that enhance the resilience and safety of high-rise buildings during seismic events. By analyzing the performance of a G+20 building under simulated seismic conditions, this research contributes to the development of more robust and reliable construction methodologies for high-seismic regions.

II. SEISMIC BEHAVIOR OF MULTISTORY BUILDINGS

Multistory buildings, due to their height and structural complexity, are particularly susceptible to the forces generated by earthquakes. Understanding the seismic behavior of these structures is crucial for ensuring their safety and integrity during seismic events. Earthquakes can impose significant lateral forces on buildings, leading to various forms of damage, ranging from minor cracks to catastrophic collapse.

A. *Key Aspects of Seismic Behavior:*

Dynamic Response: Unlike static loads, seismic forces induce dynamic responses in buildings. This involves complex interactions between the structure's mass, stiffness, and damping properties. The dynamic response determines how the building will vibrate during an earthquake, influencing factors like natural frequency and mode shapes.

Structural Configuration: The configuration of a multistory building, including its geometry, height, and the distribution of mass and stiffness, plays a pivotal role in its seismic behavior. Regular configurations tend to perform better under seismic loads compared to irregular ones, which can experience stress concentrations and torsional effects.

Load Path and Redundancy: The ability of a structure to efficiently transfer seismic loads to the foundation is crucial. Buildings with well-defined load paths and redundancy are better equipped to handle unexpected load distributions and potential structural failures.

Material Properties: The materials used in construction, such as concrete, steel, and composite materials, affect the building's ability to absorb and dissipate seismic energy. Material properties like strength, ductility, and damping capacity are critical in determining the overall seismic performance.

Seismic Design Codes: Modern seismic design codes and standards provide guidelines for designing buildings to withstand earthquake forces. These codes are based on extensive research and empirical data, incorporating factors such as building occupancy, importance, and local seismicity.

Base Isolation and Energy Dissipation Systems: Advanced seismic protection techniques, such as base isolation and energy dissipation systems, have been developed to enhance the seismic performance of multistory buildings. These systems help in reducing the seismic forces transmitted to the structure, thereby minimizing damage.

B. Challenges and Considerations

Soil-Structure Interaction: The interaction between the building foundation and the underlying soil can significantly influence seismic behavior. Soft soils can amplify seismic waves, increasing the demand on the structure.

Torsional Effects: Irregularities in the building plan or elevation can lead to torsional movements during an earthquake, causing uneven stress distribution and potential localized failures.

Progressive Collapse: Inadequate design or construction can result in progressive collapse, where the failure of a primary structural component leads to the subsequent failure of other parts of the building.

III. LITERATURE REVIEW

Rodriguez et al. 2024 [1]: This study offers a detailed comparative analysis of various methods for assessing seismic response in structures, focusing on maximum displacements and collapse evaluation. Modal spectral analysis, non-linear dynamic analysis, and incremental pushover analysis were applied to a specific structure, with results compared. The study highlights the importance of time step selection and ductility inclusion for accurate predictions. Non-linear dynamic analysis showed that an earthquake similar to the 2011 Lorca event would severely impact the structure under study, emphasizing the significance of finite element method modeling for predicting plastic hinge formation and assessing structural safety. The findings stress the need for multiple analytical approaches and detailed modeling to understand seismic behavior comprehensively and ensure structural resilience during extreme events.

Campiche et al. 2024 [2]: This research presents findings from the Ecclissa project, which introduced an innovative wall system designed to withstand severe seismic events. The system features a CFS (Cold-Formed Steel) frame with pre-installed UHS (Ultra-High-Strength) bars in a "V" configuration for enhanced horizontal resistance. Extensive design and experimental procedures, including monotonic and cyclic tests, evaluated the system's overall and local performance. Results indicate that a well-designed Light Frame-Reinforced Structure (LFRS) system can effectively withstand seismic loads by preventing plastic deformations in UHS members and maintaining elastic behavior in other elements.

Gao et al. 2024 [3]: This paper proposes a simplified simulation method for scaffold design, summarizing column placement rules for design and optimization. The scaffold, consisting of horizontal, vertical, and diagonal members, was analyzed for stiffness in different braced designs: concentric, eccentric, and knee braced. The study, based on finite element simulations and theoretical formulas, found that the overall support arrangement showed greater stiffness compared to other arrangements. Guidelines for scaffold design and optimization were provided, emphasizing the importance of consistent connection between levels and the need for lower weak layers.

Kamble et al. 2023 [4]: This review evaluates the seismic performance of diagrid structures with different secondary bracing arrangements. Using ETABS software and seismic loads per IS 1893:2016, the study finds that secondary bracing, especially in an X-arrangement, significantly enhances seismic resistance by reducing storey displacement and drift while increasing base shear. Other bracing arrangements, such as V-arrangement, inverted V-arrangement, and diagonal arrangement, also showed improvements in seismic performance, underscoring the effectiveness of secondary bracing in improving diagrid building stiffness and resilience against seismic forces.

Li et al. 2022 [5]: This study provides empirical data on earthquake damage evaluation in industrial structures, enhancing the understanding of seismic hazards at industrial sites. Based on field research from the 2008 Wenchuan earthquake, the study highlights common seismic damages in industrial buildings, such as local and overall collapse, column cracking, and wall failure. Recommendations for improving earthquake resistance in industrial buildings were provided, contributing valuable information for updating China's seismic intensity scale and seismic code for industrial plants.

Asgar et al. 2022 [6]: This study focuses on the structural performance of a G+13 RC frame structure in three seismic zones (III, IV, and V) using various bracing systems. Analyzed with STAAD Pro software and following IS 1893:2016 (Part I), the study compared braced and unbraced frame models in terms of interstory displacement, axial force, foundation shear force, and structural weight. Findings indicate that braced systems reduce lateral displacement and story drift compared to unbraced frames, with x-bracing significantly increasing structural stiffness across all seismic zones.

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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