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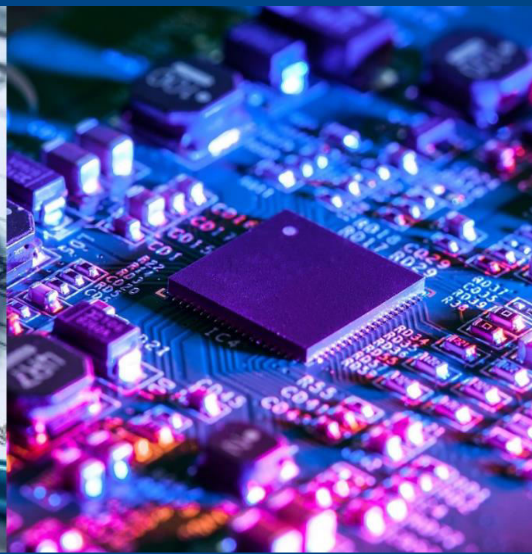

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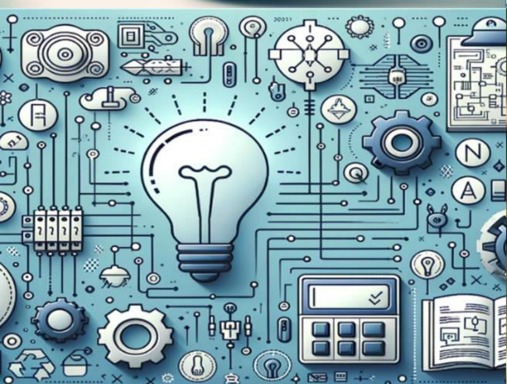

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A Comparative Study of RC Column and Composite Column with Flat Slab System using Linear Static Analysis and Push Over Analysis by STAAD Pro

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ABSTRACT: This research investigates the structural behavior of Reinforced Concrete (RC) columns and Composite columns within a flat slab system under static and seismic loading conditions. Utilizing STAAD PRO, Linear Static Analysis (LSA) and Push Over Analysis (POA) are applied to simulate the response of a 10-story building subjected to a range of forces. The study comprehensively compares the two column systems in terms of their load-carrying capacity, displacement, stress distribution, and seismic resistance. Results indicate that composite columns outperform RC columns in seismic scenarios, providing superior ductility, energy dissipation, and overall stability. While composite columns come at a higher material cost, their enhanced seismic performance makes them a viable option for buildings located in high seismic zones. This research offers recommendations for the design of column systems in modern construction and highlights the importance of considering seismic performance in structural design.

KEY WORDS: RC column, composite column, push over analysis, linear static analysis, Staad pro v8i

I. INTRODUCTION

The role of columns in structural design is crucial as they bear vertical loads and transfer them to the foundation. RC columns, the most widely used in buildings, provide a reliable and economical solution for load-bearing, but they may struggle under seismic conditions, especially in high-rise structures. The composite column system, on the other hand, uses a combination of concrete and steel to leverage the strengths of both materials.

Flat slab systems, which simplify the floor layout by eliminating beams, are gaining traction in modern building designs. However, these systems place additional stress on columns, especially during lateral loading, which necessitates the selection of columns that can withstand both vertical and horizontal forces effectively. The combination of composite columns with flat slab systems can potentially address these challenges.

Basic definition of flat slab: In general normal frame construction utilizes columns, slabs & Beams. However it may be possible to undertake construction without providing beams, in such a case the frame system would consist of slab and column without beams. These types of Slabs are called flat slab, since their behavior resembles the bending of flat plates. In modern high-rise construction, the selection of an efficient structural system plays a vital role in ensuring safety, performance, and cost-effectiveness. Among the various framing options, flat slab systems have gained popularity due to their architectural flexibility, reduced floor-to-floor height, and ease of construction. However, the structural efficiency of a flat slab system largely depends on the type of column used. Reinforced Concrete (RC) columns are widely adopted for their simplicity and compatibility with concrete construction, while Composite columns, which combine the properties of steel and concrete, offer enhanced load-bearing capacity and ductility. This study aims to investigate and compare the performance of RC columns and Composite columns when used with flat slab systems. The comparison is carried out through two primary analytical methods: Linear Static Analysis and

Nonlinear Pushover Analysis, both implemented using STAAD Pro software. These methods help in evaluating the structural behaviour under lateral and gravity loads, with a focus on parameters such as displacement, base shear, and overall structural response.

With increasing emphasis on earthquake-resistant design, understanding the performance differences between these two column types is essential for optimizing structural safety and material efficiency. This study not only highlights the strengths and limitations of each column system but also provides guidance for engineers and designers in selecting suitable construction practices for high-rise buildings.

II. LITERATURE REVIEW

Subramanian N. (2013) – In "Design of Reinforced Concrete Structures", the author outlines the behavior of RC columns and the design methodology for flat slabs, emphasizing their direct load transfer mechanism and structural simplicity in multi-storey buildings.

IS 456:2000 – The Indian Standard for RC design provides guidelines for structural design and serviceability. It includes design considerations for both flat slabs and RC columns under static loads.

Eurocode 4 (EN 1994) – Offers comprehensive design rules for composite structures, highlighting the benefits of composite columns over RC ones, such as improved strength-to-weight ratios and faster construction.

M. R. Shiyekar & V. V. Suryawanshi (2015) – Studied comparative behavior of RC and composite columns and concluded that composite columns provide better performance under axial loads and buckling resistance.

R. Natarajan & S. Muthuraj (2017) – Conducted a performance analysis of RC and composite columns using ETABS. They found that composite columns showed lesser displacement and better performance during pushover analysis.

P. G. Kakade & P. S. Pajgade (2014) – In their study on flat slab systems using STAAD Pro, they concluded that the flat slab system reduces storey height and construction time but requires careful punching shear design.

IS 11384:1985 – Standard code for composite construction in structural steel and concrete, gives theoretical background for design and analysis of composite columns.

Murali Krishnan & M. Kalyani (2018) – In their research on static and pushover analysis of RC structures using STAAD Pro, they revealed that linear static analysis is insufficient for seismic zones, and pushover analysis provides a better understanding of performance limits.

Kiran S. & Dr. B. Ramesh Babu (2020) – Carried out a comparative analysis of RC and steel-concrete composite frames and concluded that composite systems offer significant material savings and reduced seismic demands.

Gajalakshmi & I. Pandiyan (2016) – Investigated the behavior of flat slab buildings with different column types under seismic loading and showed that composite columns enhance lateral resistance.

III. METHODOLOGY OF PROPOSED SURVEY

The methodology adopted in this study involves the development and analysis of two structural models using STAAD Pro software to evaluate and compare the performance of RC columns and Composite columns within a flat slab system. Both models are designed with identical structural dimensions, story heights, and slab configurations to ensure an accurate comparative assessment. RC columns are modelled using standard concrete and steel properties, while composite columns are modelled with a combination of structural steel encased in concrete. The material properties and section sizes are chosen in accordance with relevant IS codes. Each structure is subjected to similar loading conditions, including dead load, live load, and seismic load, as defined by IS 875 and IS 1893 standards. Initially, Linear Static Analysis is performed to assess the structural behaviour under elastic conditions, focusing on displacements, base shear, and internal forces. Subsequently, Nonlinear Pushover Analysis is conducted to evaluate the response of the structures under increasing lateral loads, identifying plastic hinge formations and ductility

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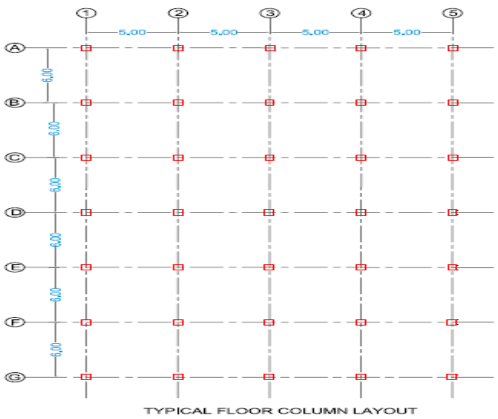
characteristics. The analytical results from both models are compared to determine which column system offers better structural performance and seismic resilience when used with a flat slab system. This methodological approach provides a clear understanding of the practical differences in using RC versus Composite columns in multistorey building design.

IV. CONCLUSION AND FUTURE WORK

This comparative study has analysed the structural performance of RC columns and Composite columns integrated with flat slab systems using Linear Static and Pushover Analysis in STAAD Pro. The results clearly indicate that composite columns exhibit superior performance in terms of strength, stiffness, and energy dissipation capacity, particularly under lateral seismic loading conditions. While RC columns are effective and commonly used due to their simplicity and availability, composite columns provide enhanced load-bearing capacity and reduced lateral displacements, making them more suitable for high-rise and earthquake-prone structures. The use of flat slab systems with composite columns also contributes to material optimization and construction efficiency. Overall, the study concludes that composite columns, when used with flat slabs, offer a more resilient and efficient structural system compared to conventional RC columns. These findings can assist structural engineers in making informed design decisions for safer and more economical building construction.



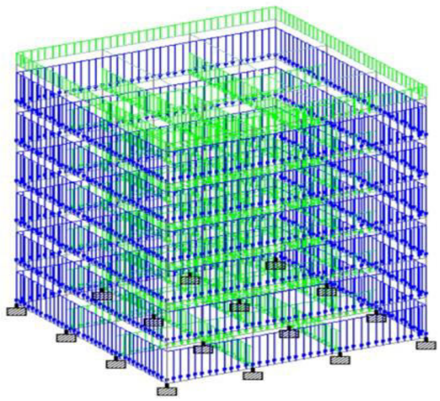


Fig:2 Dead Load on G+6 Commercial Building

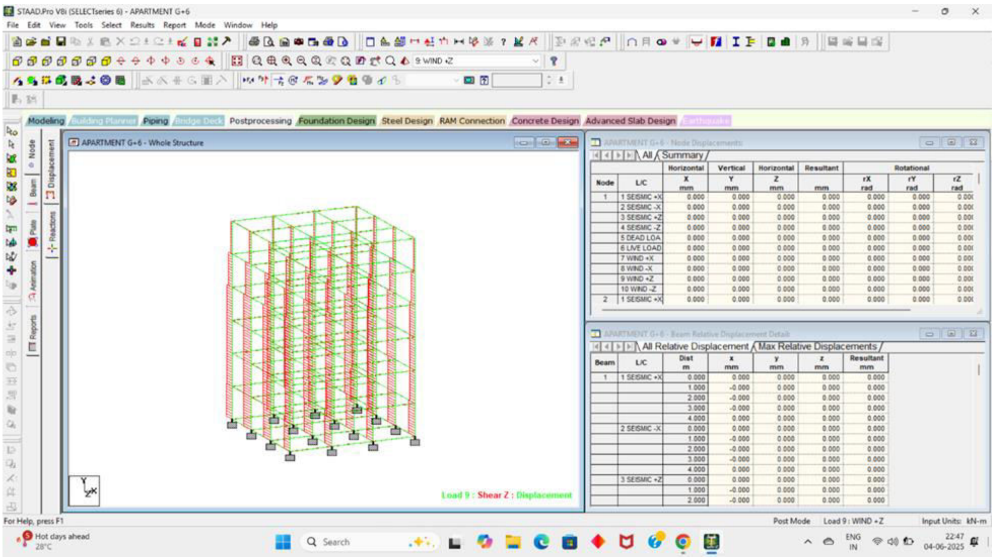


Fig: 3Shear Force and Displacement

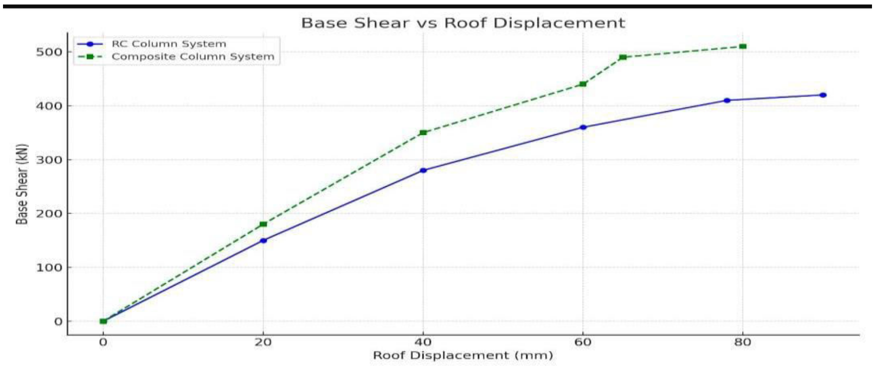


Fig: 4 Competition of RC Column vs Displacements

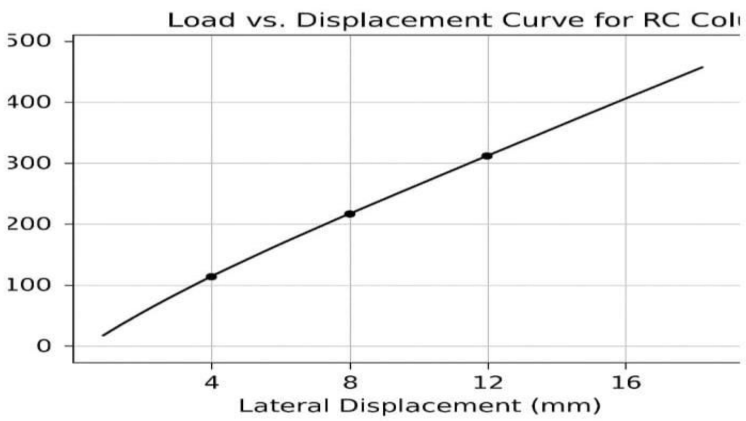


Fig: 5 Capacity Curve of RC Column

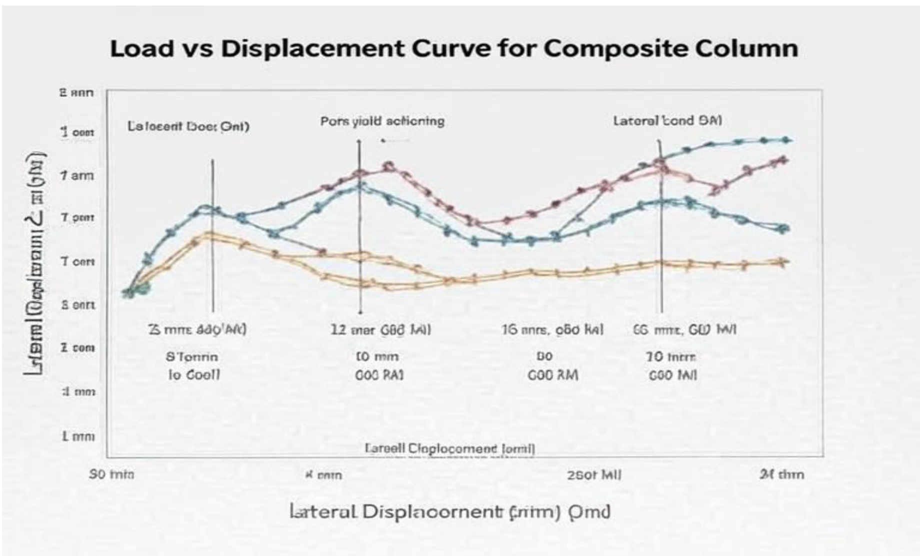


Fig: 6 Capacity Curve of Composite Column

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