Enhancing Structural Performance and Design Flexibility in Multi-Story Buildings through Floating Column Integration: A Comprehensive Analysis

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Abstract — The study aims to utilize STAAD Software to conduct a comprehensive analysis of the seismic behavior of the buildings. This software enables the examination of various aspects related to the response of the structures under seismic forces. Secondly, the study analyzes and understands how seismic forces are distributed and modified within multi-story buildings. Specifically, it investigates the behavior of structures with floating columns in comparison to those without floating columns, aiming to identify the effects of floating columns on the seismic response. Thirdly, the study examines different positions of floating columns within the buildings and assesses their impact on the flow and distribution of forces during seismic events. By investigating the behavior of forces in relation to floating columns, the study aims to gain insights into the structural response and potential benefits of incorporating floating columns in seismic-resistant design. Additionally, the study evaluates the seismic result-story buildings with floating columns to ensure their safe and dependable behavior. Through rigorous analyses using STAAD Software, the study aims to identify any vulnerabilities, potential failures, or structural deficiencies in buildings with floating columns, with the ultimate goal of optimizing their seismic performance. Lastly, the study conducts a comparative analysis between structures with and without floating columns. By subjecting both types of structures to seismic analysis using STAAD Software, it aims to identify and evaluate the differences in their performance, highlighting the advantages and disadvantages of incorporating floating columns in seismic-resistant design. In summary, this study aims to enhance our understanding of the seismic behavior and structural performance of multi-story buildings in zone IV. By considering structures with and without floating columns, it seeks to improve seismic-resistant design practices and promote the development of safe and dependable structures in high-seismicity areas.

Keywords: Floating Column, Seismic Analysis, Multistorey Building

I. Introduction

The presence of floating columns in multi-story buildings poses challenges to their structural integrity, particularly in seismic regions. Floating columns are unsupported vertical components that transfer loads to the columns beneath them through a point load on a beam. However, the structural behavior of buildings with such discontinuous sections can be risky during seismic events. Instead of resorting to demolition, it is worthwhile to conduct studies that explore ways to enhance the structural integrity of these buildings or propose corrective measures.

One approach to improving the seismic performance of buildings with floating columns is to strengthen the columns on the first floor. By reinforcing these columns, their capacity to withstand seismic forces can be increased, thereby reducing the vulnerability of the structure as a whole. Retrofitting techniques, such as adding additional reinforcement or using high-strength materials, can be employed to enhance the stiffness and load-carrying capacity of the columns.

Another strategy for improving the structural behavior of buildings with floating columns is to increase their overall stiffness. Lateral deformation during seismic events is a significant concern, as it can lead to structural damage and compromise the safety of occupants. By introducing additional bracing elements, such as shear walls or cross-bracing systems, the lateral stiffness of the building can be improved, thereby reducing the potential for excessive deformation and enhancing its seismic performance.

These proposed measures aim to address the challenges associated with floating columns in multi-story buildings located in seismic regions. The goal is to enhance the seismic performance of these structures and mitigate the risks posed by the presence of floating columns. By conducting detailed analyses and evaluations, it is possible to identify the most effective retrofitting strategies or corrective measures that can be implemented to ensure the safe and dependable behavior of the buildings during seismic events.

II. Objective of the Work

1) Utilize STAAD Software to conduct a comprehensive analysis of the seismic behavior and structural performance of multi-story buildings in seismic zone IV.
2) Analyze and understand the distribution and modification of forces generated by seismic activity within multi-story buildings, comparing structures with and without floating columns using STAAD Software.
3) Study different positions of floating columns within multi-story buildings and assess their impact on force flow and distribution during seismic events, gaining insights into the structural response and potential benefits of incorporating floating columns in seismic-resistant design.
4) Evaluate the seismic response of multi-story buildings with floating columns, identifying vulnerabilities, potential failures, or structural deficiencies using rigorous analyses with STAAD Software. The goal is to optimize their seismic performance and ensure they exhibit a safe and dependable behavior.
5) Conduct a comparative analysis by subjecting both structures with and without floating columns to seismic analysis using STAAD Software. This analysis aims to

identify and evaluate the differences in their performance, highlighting the advantages and disadvantages of incorporating floating columns in seismic-resistant design.

III. METHODOLOGY

Consider a multi-story building consisting of 15 floors (G+15) that has undergone seismic analysis utilizing the Staad software and adhering to the Indian Standard Code IS 1893 (Part-1) 2002. The study aims to determine essential parameters such as storey displacements, storey shear, storey drift, and time period through the following seismic analysis method. The building structures are modeled in the Staad software following the guidelines outlined in IS 456-2000 (Part 1, 2) and IS 1893-2002 (Part 1). Response Spectrum Method consider for seismic analysis in this study.

A. Building Specifications

The analysis focuses on a symmetrical building measuring 19.9 meters by 22 meters located in seismic zone IV of India.

B. Load Combinations

The analysis must consider the following load combinations as per IS Code 1893 (Part 1): 2002 Clause no. 6.3.1.2:

– 1.55 times the sum of the imposed load (IL) and dead load (DL).
– 1.25 times the sum of the imposed load (IL), dead load (DL), and either upward or downward live load (EL).
– 1.55 times the sum of either upward or downward imposed load (EL) and dead load (DL).
– 0.95 times dead load (DL) plus or minus 1.55 times either upward or downward imposed load (EL).

C. Model Details

There are four different models considered for analysis:
Model 1: A reinforced concrete (RCC) structure without floating columns, representing a typical building.
Model 2: A version of the model featuring floating columns at the ground floor.
Model 3: A version of the model featuring floating columns at the fifth floor.
Model 4: A version of the model featuring floating columns at the tenth floor.

These model variations allow for a comprehensive analysis of the effects of floating columns at different levels of the building, providing insights into their influence on the overall structural behavior and response.

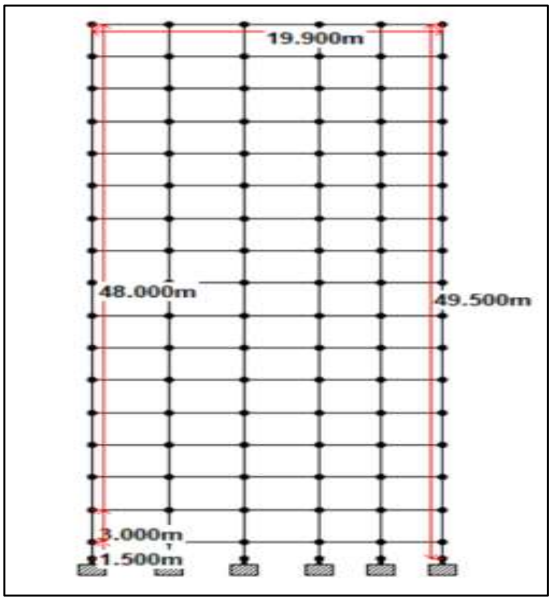

Fig. 1: Convention Building Frame

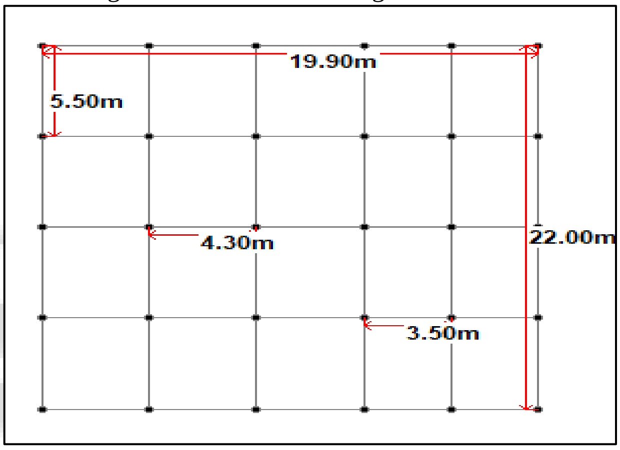

Fig. 2: Convention Building Plan

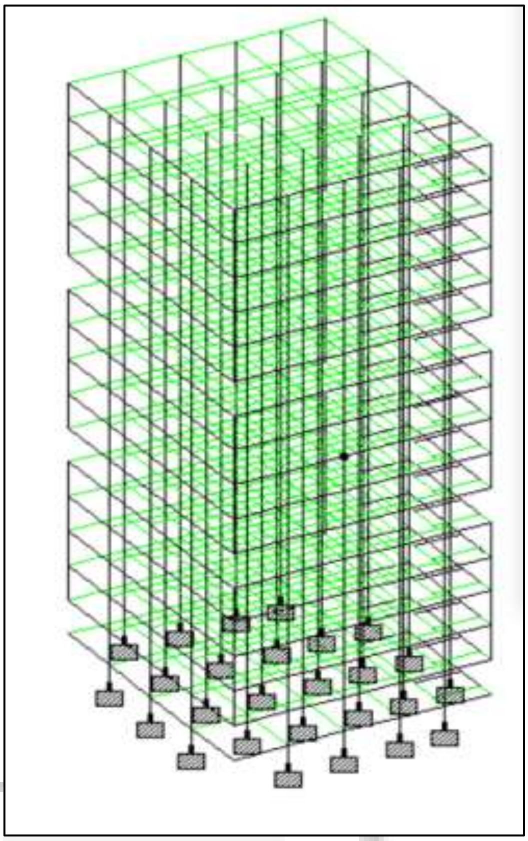

Fig. 3: Building Frame with floating Column

IV. RESULTS AND DISCUSSION

Fig. 4: shear Force Vs all Model

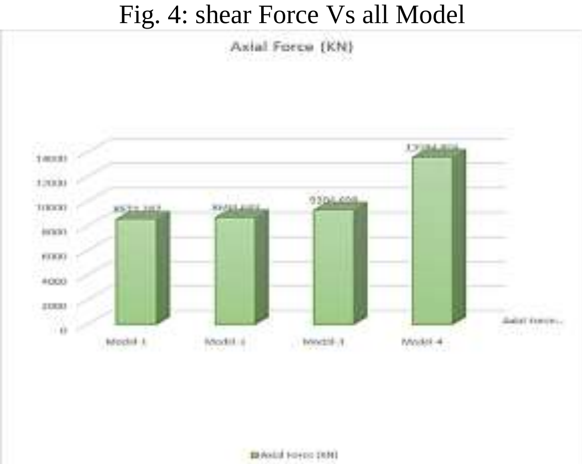

Fig. 5: Axial Force Vs all Model

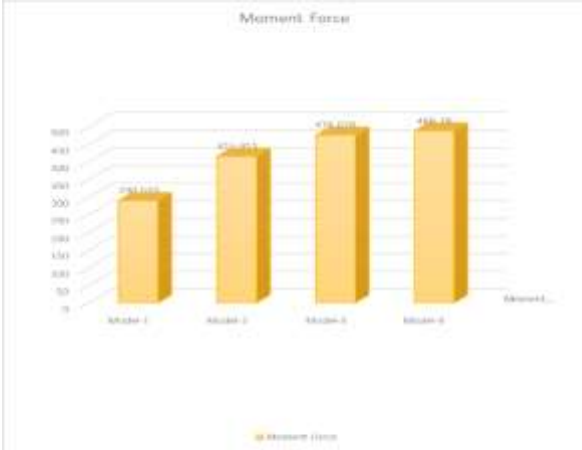

Fig. 6: Bending Moment Vs all Model

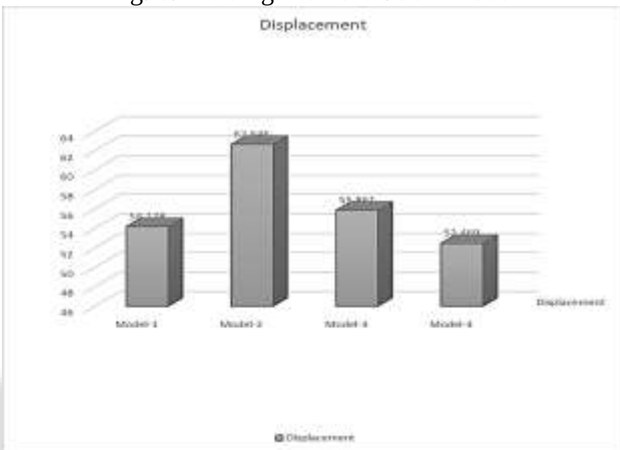

Fig. 7: Displacement Vs All Model

V. CONCLUSIONS

1) The presence of a floating column in a multi-story building leads to larger displacements, higher shear forces, reactions, and maximum bending moments compared to a model without a floating column. This indicates that the floating column has a significant influence on the structural response.
2) Upon comparing the data from each model, it becomes evident that Model 2 exhibits higher shear forces and displacements than the other models. This suggests that the placement of the floating column in Model 2 results in a more pronounced impact on the structural behavior.
3) Model 4 demonstrates a stronger response and higher bending moments compared to the other models. This can be observed when analyzing the data for each model, indicating that the specific configuration and characteristics of Model 4 contribute to its enhanced structural performance under dynamic loads.
4) Among all the models, the structure in Model 1 showcases better performance and greater strength. This implies that the absence of a floating column in Model 1 results in favorable structural behavior, indicating its reliability and stability in dynamic conditions.

These conclusions provide valuable insights into the impact of floating columns on the structural response and performance of multi-story buildings. The findings highlight the importance of careful design considerations and structural configuration to ensure optimal performance and mitigate potential risks associated with floating columns.

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