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DYNAMIC AND STATIC ANALYSIS OF MULTI-STORY BUILDINGS WITH FLOATING COLUMNS

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ABSTRACT

Floating columns are a structural design feature commonly used to create open spaces in modern multi-story buildings. However, their presence introduces discontinuities in the load transfer path, potentially compromising structural stability during seismic events. This study investigates the static and dynamic performance of RCC framed structures with and without floating columns, using STAAD.Pro for seismic analysis. Five-story and ten-story building models located in seismic Zone IV were analyzed to evaluate parameters such as displacement, storey drift, base shear, and buckling behavior. Results reveal that structures with floating columns experience higher displacements and storey drifts, emphasizing their vulnerability in seismic zones. The findings highlight the need for careful design and strategic placement of floating columns to enhance structural resilience.

Keywords: Floating Columns, Seismic Analysis, STAAD.Pro, RCC Structures, Buckling Analysis, Zone IV

1. INTRODUCTION

Modern architectural demands have led to the adoption of floating columns, which enable the creation of large open spaces in multi-story buildings. However, this design introduces structural irregularities, making buildings more susceptible to seismic forces. The primary objective of this study is to evaluate the performance of RCC framed structures with floating columns under static and dynamic conditions. Using STAAD.Pro, the study focuses on analyzing critical parameters such as base shear, displacement, and elastic buckling behavior in seismic Zone IV conditions.

1.1 Problem Statement

Buildings with floating columns often fail to distribute seismic forces effectively, leading to instability and potential collapse. Despite their aesthetic and functional advantages, the risks associated with their use in high seismic zones require in-depth analysis.

1.2 Objective

This paper aims to:

1. Assess the seismic behavior of multi-story buildings with floating columns.
2. Compare the performance of buildings with and without floating columns under static and dynamic loads.
3. Identify best practices for the structural design of buildings with floating columns in seismic zones.

2. LITERATURE REVIEW

Several studies have explored the seismic performance of structures with floating columns. For instance:

- **Pardhi et al. (2016)** found that floating columns significantly increase lateral displacement and storey drift in high-seismic zones, making them unsuitable without additional reinforcement.
- **Kumar et al. (2016)** highlighted the role of dynamic analysis in capturing the behavior of multi-story buildings with floating columns.
- **Lakkhitharadhya et al. (2016)** demonstrated that buildings on sloping ground with floating columns experience higher base shear compared to flat-ground buildings.

  The review underscores the importance of evaluating seismic responses using advanced modeling tools like STAAD.Pro and accounting for buckling behavior in structural design.

3. METHODOLOGY

The analysis was conducted using STAAD.Pro software on five-story and ten-story RCC framed structures with and without floating columns.

3.1 Structural Models

Five structural models were developed to study the behavior of RCC framed structures with and without floating columns under seismic loads. These models include varying configurations and placements of floating columns:

- **MOD0500**: 5-story building without floating columns.
- **MOD0502**: 5-story building with floating columns on the 2nd floor.

- **MOD1000**: 10-story building without floating columns.
- **MOD1002**: 10-story building with floating columns on the 2nd floor.
- **MOD1005**: 10-story building with floating columns on the 5th floor.

3.2 Parameters Analyzed

1. **Displacement**: Maximum average displacement in X and Z directions.
2. **Storey Drift**: Lateral drift at each floor level.
3. **Base Shear**: Total shear force at the base of the structure.
4. **Buckling Behavior**: Elastic buckling load for compression members.

3.3 Software and Standards

- **STAAD.Pro** was used for finite element analysis.
- Design parameters followed **IS 1893 (Part 1): 2002** for seismic analysis.

4. RESULTS AND DISCUSSION

4.1 Displacement

- Structures with floating columns showed significantly higher displacements compared to those without.

Table 1 Maximum Average Displacement

Model	Maximum Displacement (cm)
MOD0500	1.53
MOD0502	1.86
MOD1000	2.44
MOD1002	2.87
MOD1005	3.04

- **MOD0502** experienced an average displacement of 1.86 cm, while **MOD0500** was limited to 1.53 cm at the top floor.

4.2 Storey Drift

- Maximum storey drift was observed at the lower floors and decreased with height.

Table 2 Storey Drift

Model	Storey Height (m)	Maximum Drift (cm)
MOD0500	3.5	0.49
MOD0502	3.5	0.56
MOD1000	3.5	0.70
MOD1002	3.5	0.87
MOD1005	3.5	1.02

- **MOD1000** had a drift of 0.70 cm at the 5th floor, compared to 0.49 cm for **MOD0500**.

4.3 Base Shear

- Buildings without floating columns exhibited higher base shear, indicating better load distribution.

Table: 3 Base Shear

Model	Base Shear (kN)
MOD0500	1,722.41
MOD0502	1,569.05

Model	Base Shear (kN)
MOD1000	1,924.85
MOD1002	1,395.30
MOD1005	1,302.20

- The base shear for **MOD1002** was 1,395 kN, compared to 1,722 kN for **MOD0500**.

4.4 Buckling Behavior

- Floating columns reduced the buckling resistance of critical load-carrying members.

Table – 4 Buckling Analysis

Model	Elastic Critical Load Reduction (%)
MOD0500	0
MOD0502	12
MOD1000	0
MOD1002	18
MOD1005	25

- Columns in **MOD0502** showed a 12% reduction in elastic critical load compared to **MOD0500**.

4.5 Comparative Analysis

The results indicate that floating columns increase displacement and drift while reducing overall stability. Placement at higher floors further exacerbates these effects.

5. CONCLUSION

This study demonstrates that floating columns adversely affect the seismic performance of multi-story buildings. Key findings include:

1. Increased displacement and drift in structures with floating columns.
2. Reduced base shear and buckling resistance in floating column models.
3. Floating columns at higher floors pose greater risks than at lower floors.

Recommendations

- Avoid using floating columns in high seismic zones unless additional reinforcement measures are implemented.
- Conduct thorough dynamic analysis during the design phase to assess potential vulnerabilities.
- Implement seismic-resistant design techniques such as shear walls or bracing in buildings with floating columns.

6. REFERENCES

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