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Optimization of Floating Column Configuration for Enhanced Seismic Safety

SUMAN SHARMA[1], SANKICHA BODHI[2]

Research Scholar[1],Assistant Professor[2]

Millennium Institute Of Technology & Science,Bhopal

Abstract

Floating columns are widely used in modern multi-story buildings for architectural and functional benefits. However, their presence leads to load transfer irregularities, making buildings vulnerable in seismic conditions. This study investigates the seismic performance of reinforced concrete (RC) buildings with and without floating columns on both sloping and plain terrains. Using STAAD Pro V8i software, G+4 models were analyzed under seismic conditions. The study evaluates parameters such as natural frequency, time period, base shear, storey drift, displacement, and forces. The findings emphasize the importance of proper design considerations for floating columns, especially in seismic zones, to ensure structural safety.

Keywords

Seismic performance, Floating column, STAAD Pro, Sloping ground, Storey drift, Base shear, Time period

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1. Introduction

The rapid urbanization and increasing demand for open spaces have led to the use of floating columns in modern buildings. These columns do not transfer loads directly to the foundation but rest on beams, causing structural irregularities. Their seismic vulnerability necessitates detailed investigation to optimize configurations for improved safety.

2. Methodology

The study involves modeling and analyzing a G+4 RC building under seismic conditions using STAAD Pro V8i software. The research compares different configurations of floating columns on sloping and plain grounds. The primary parameters considered include:

- Natural frequency
- Time period
- Peak storey shear
- Maximum displacement of nodes
- Storey drift
- Axial force
- Shear force

Ten models were analyzed, with floating columns positioned at various levels to observe variations in seismic response.

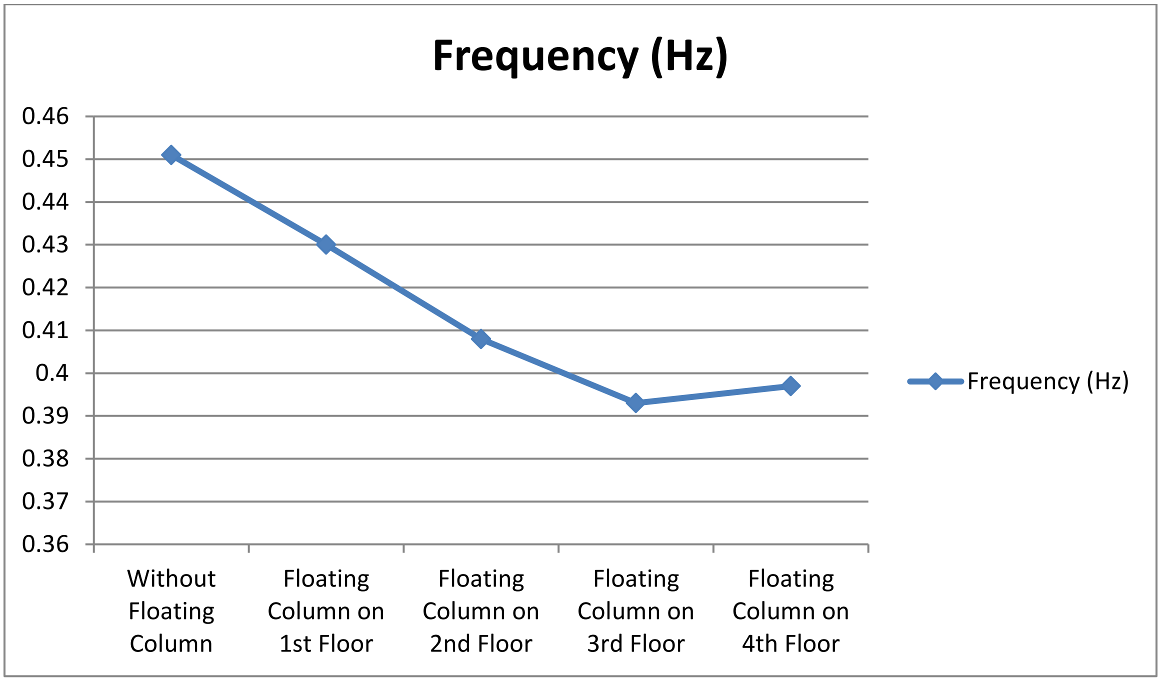
3. Results and Discussion

3.1 Natural Frequency

Natural frequency decreases with the introduction of floating columns, making buildings more susceptible to resonance effects.

Table 1: Natural Frequency on Plane Ground

Model	Frequency (Hz)
Without Floating Column	0.451
Floating Column on 1st Floor	0.43
Floating Column on 2nd Floor	0.408
Floating Column on 3rd Floor	0.393
Floating Column on 4th Floor	0.397

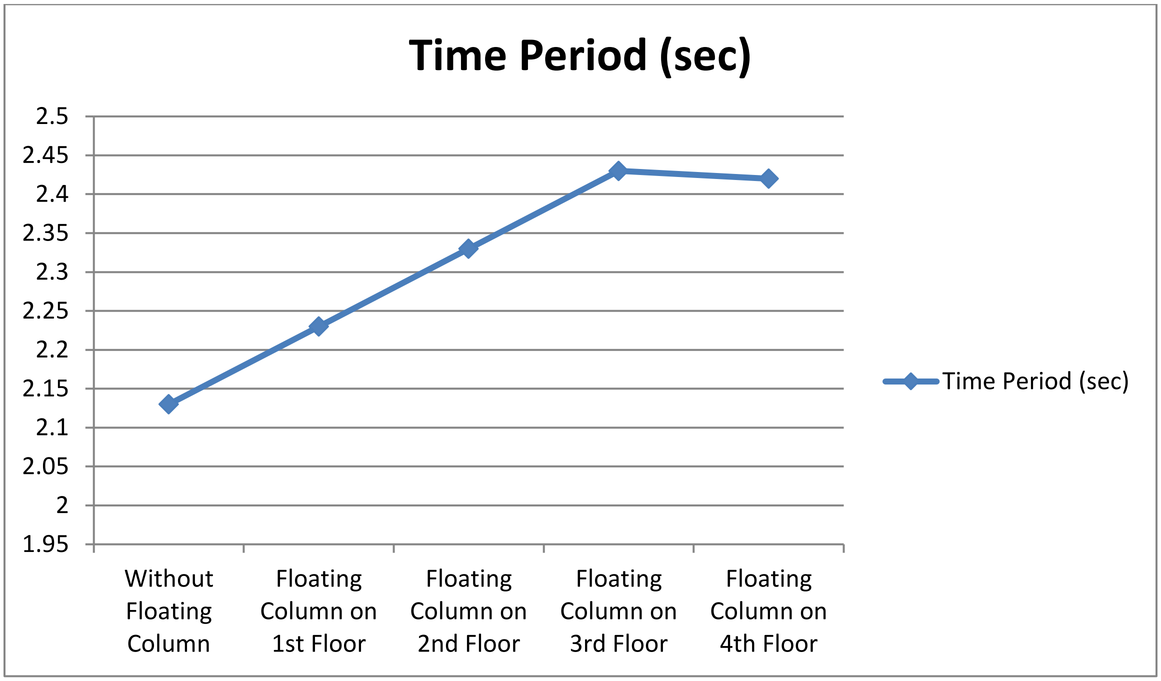


3.2 Time Period

Time period increases as floating columns are introduced, indicating a more flexible structure, which is critical in seismic conditions.

Table 2: Time Period on Sloping Ground

Model	Time Period (sec)
Without Floating Column	2.13
Floating Column on 1st Floor	2.23
Floating Column on 2nd Floor	2.33
Floating Column on 3rd Floor	2.43
Floating Column on 4th Floor	2.42

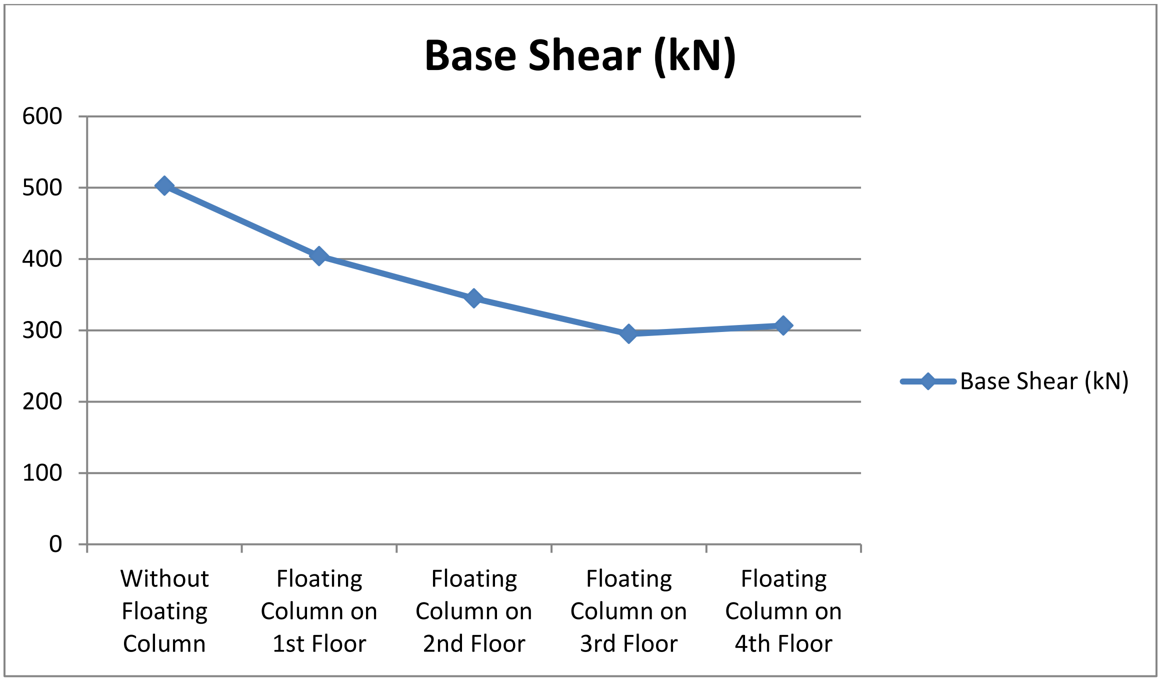


3.3 Peak Storey Shear

Floating columns reduce peak storey shear, affecting load resistance and structural integrity.

Table 3: Peak Storey Shear on Plane Ground

Model	Base Shear (kN)
Without Floating Column	502.68
Floating Column on 1st Floor	403.95
Floating Column on 2nd Floor	344.64
Floating Column on 3rd Floor	294.84
Floating Column on 4th Floor	306.8

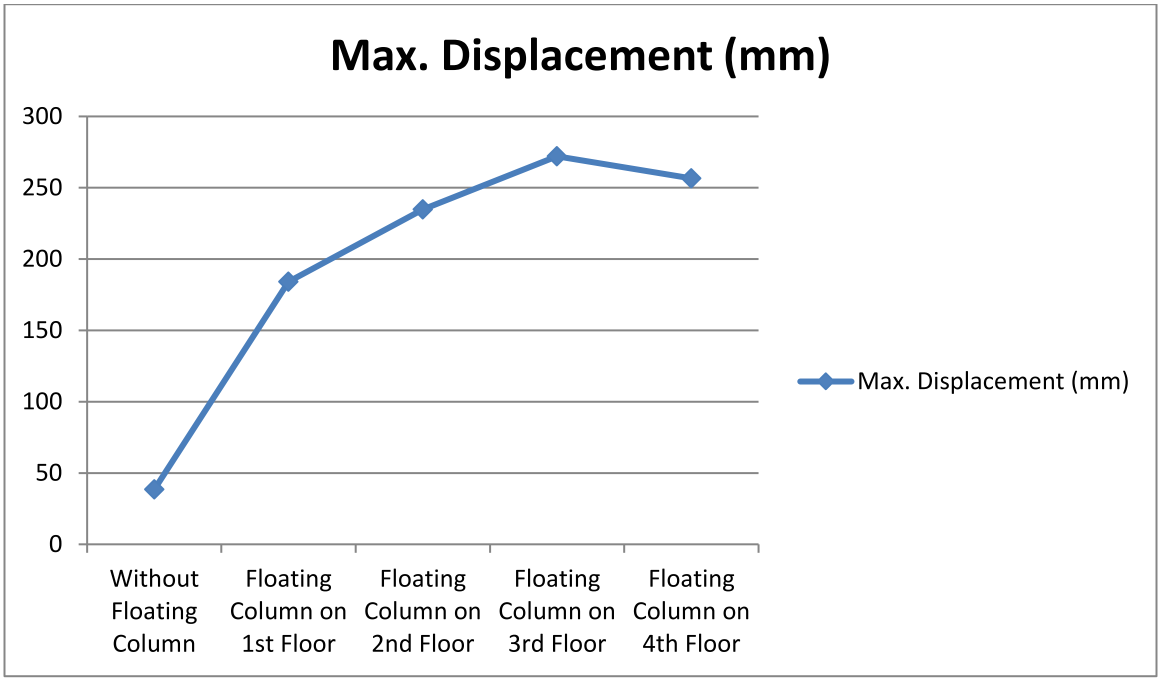


3.4 Maximum Displacement of Nodes

Displacement increases as floating columns are introduced at higher storeys, reducing building stability.

Table 4: Maximum Node Displacement on Plane Ground

Model	Max. Displacement (mm)
Without Floating Column	38.4
Floating Column on 1st Floor	184.15
Floating Column on 2nd Floor	234.69
Floating Column on 3rd Floor	272.03
Floating Column on 4th Floor	256.54



3.5 Storey Drift

Storey drift is critical for seismic design. It increases significantly in floating column buildings, making them vulnerable to lateral deformations.

Table 5: Storey Drift at Various Storeys

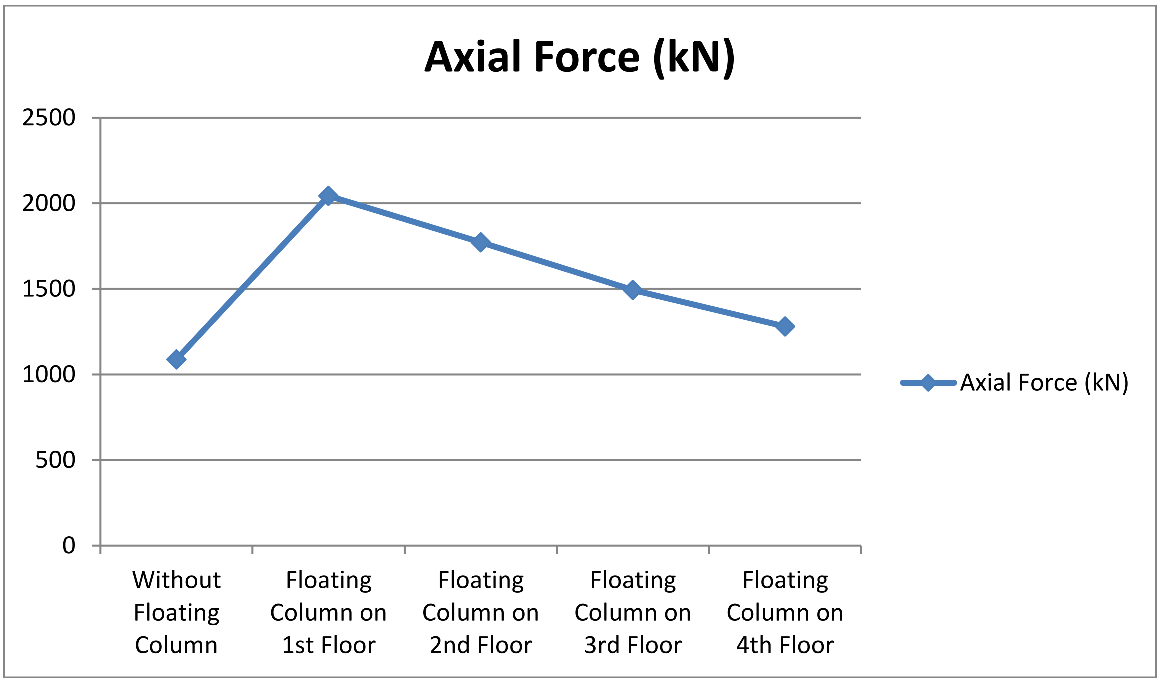
Floor	Model 1 (mm)	Model 9 (mm)
Ground	0.539	1.592
1st	1.152	5.629
2nd	1.220	7.027
3rd	1.017	4.160
4th	0.672	2.611

3.6 Axial Force

Axial forces are significantly higher in floating column buildings, requiring larger beams and supports.

Table 6: Maximum Axial Force on Plane Ground

Model	Axial Force (kN)
Without Floating Column	1088.07
Floating Column on 1st Floor	2043.25
Floating Column on 2nd Floor	1772.5
Floating Column on 3rd Floor	1492.53
Floating Column on 4th Floor	1280.4



4. Conclusion

The study highlights that floating columns negatively impact seismic performance by increasing displacement, storey drift, and reducing peak storey shear. Buildings with floating columns should be designed with larger support beams and enhanced lateral resistance mechanisms.

Future Scope

Further research can explore:

- Influence of material variations on floating column behavior
- Effect of different seismic zones on optimized configurations
- Advanced retrofitting techniques to improve floating column safety

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