Seismic analysis of Multistoreyed buildings with and without Floating columns

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Abstract. Because of the expanding population, the idea of towering construction comes to mind. The idea is now proving to be effective as a result of advancements in civil technology. Engineers are in charge of determining the height of the construction as well as the number of levels. When it comes to structural damage, earthquakes are the most common phenomenon to be encountered. As the structure's height grows, it becomes more capable of withstanding strong seismic forces. In this thesis, the response of tubular systems to seismic forces is discussed in detail. The advancements in three-dimensional structural analysis and computational power have made it possible to build higher structures that are both efficient and safe. Recently, tubular construction has become an increasingly popular structural technique for tall buildings. Tubular constructions are available in a variety of configurations, with tube in tube designs being the most ideal for high-rise buildings. The use of braced frames and structural walls alone (even if made of appropriately sized elements) may not be enough to manage the total lateral displacement of tall structures, as well as the force demands placed on different structural parts by wind and earthquake.As a result, depending on the size and weight of the structure, more rigid structural systems, such as tube systems, tube-in-tube systems, and bundle tube systems, are needed. Tube systems are the most common kind of rigid structural system used in commercial buildings. Based on the performance of a 30-story structure with a bundled tube system and base shear values and displacements, this thesis does a static and dynamic (Response Spectrum) study in accordance with IS 1893-2002 on the performance of the building.

1. Introduction

As an inescapable aspect of many urban multistory structures in India, open first floors are becoming more popular. This is especially true in metropolitan areas, where open first floors are widespread. In most cases, this is used to construct parking lots or reception lobbies on the ground floor of a building's first floor.[2] A building's seismic force distribution is different from the total seismic base shear experienced by the structure during an earthquake, which is based on the earthquake's natural period. The seismic force distribution is determined by the structure's stiffness and mass distribution over the structure's entire height.[1]

In order to understand how a structure will behave during earthquakes, it is important to consider its general form, size, and geometry, as well as how seismic forces are transported to the ground underneath it. For a structure to perform properly during an earthquake, the earthquake forces generated at the various floors must be transferred down the height of the structure to the ground using the shortest route possible. Any deviation or discontinuity in this load transfer path results in the structure performing poorly during the earthquake.[3] If the load transfer path is not properly designed, the structure will perform poorly during an earthquake. When earthquake pressures are applied to a structure with vertical setbacks (for example, a hotel building that is a few floors wider than the rest of the building), the seismic forces at the level of discontinuity rapidly increase at the level of discontinuity.[6] Damage or collapse is more likely to occur at a particular level or storey in structures that have fewer columns or walls at that level or storey or that have an unusually tall storey if the damage or collapse occurs at that level or storey in structures that have fewer columns or walls at that level or storey.[4] Following the earthquake that hit Bhuj in 2001, many buildings in Gujarat with an open ground floor designed for parking fell down or were badly damaged, and many more were severely damaged as a consequence. Structures with columns that hang or float on beams at an intermediate level but do not reach all the way to the foundation have discontinuities in their load transmission paths because of the way the columns are designed.[8]

1.1 Floating column

According to the plans, a column will be a vertical component that will begin at the foundation level and will be responsible for transmitting the weight to the ground. According to another definition, a floating column is a vertical structural element that, due to the architectural design or the site conditions, rests at its lower level (termination level) on a beam, which is a horizontal structural element that supports the column. As a consequence of this weight transfer, extra columns underneath the beams bear the brunt of the load.[5,6]

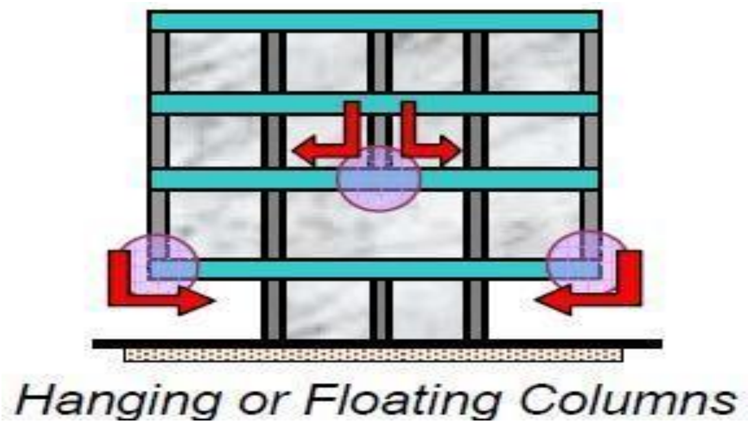


Figure1. Hanging or floating column

1.2 Objectives of theStudy

The objective of the present work is

- to investigate the behavior of multistory structures with floating columns when subjected to seismic excitations
- In order to analyses the impacts of seismic analysis on a structure with a floating column, the software Staad pro was utilized.
- Investigation of base shear and storey displacements between floating columns situated at various places across a G+9 residential multi-story structure.

2. Methodology

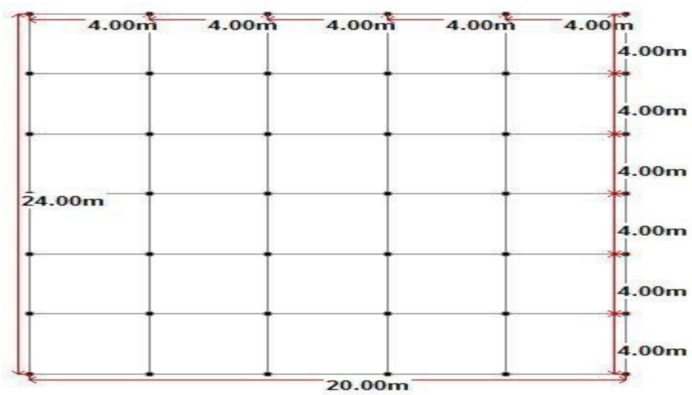
It is the systematic, theoretical examination of the techniques that are used in a particular area of study that is known as methodology. In this context, theoretical examination of the collection of techniques and concepts connected with a particular area of knowledge is included.

Dead loads
Imposed loads
Wind loads

Design of Wind Pressure
Design Wind Speed (V_z)
Seismic loads

2.1 Analysis of Models

The steel frame that was utilized for this research has a total height of 10 (G+9) stories. The average floor height is 3 m, and the building has a total height of 30 m. As shown in figure4.1, the sides stretch 24 metres by 20 metres and are split into four bays of four



meters square each.

Figure 2. plan layout

Following models are considered for analysis

- Rectangular Building without any floating column
- Rectangular Building with floating column at ground floor
- Rectangular Building with floating column at third floor
- Rectangular Building with floating column at fifth floor

MODEL 1 - Rectangular Building without any floating column

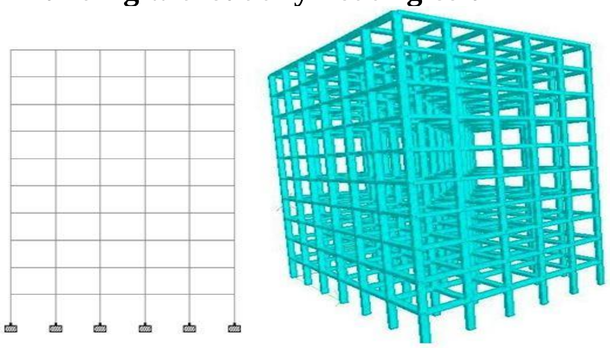


Figure 3. Elevation and 3d view of the model building without floating columns

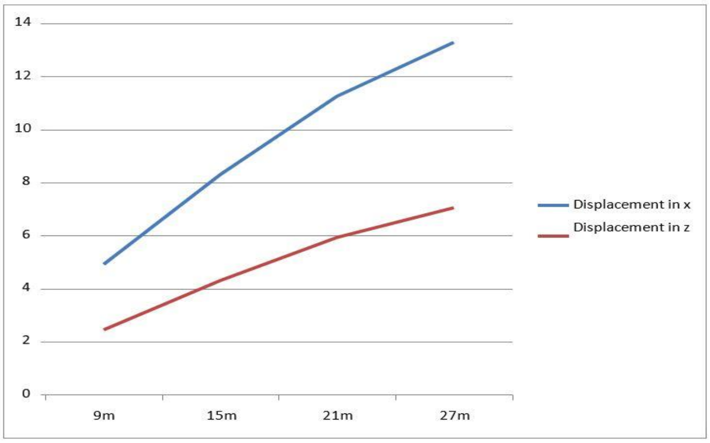


Figure 4. Displacements in x and z directions

It is observed from figure. 4 that as the height of building increases displacement is increasing from bottom to the top floor.

MODEL 2: Square Building with floating column at first floor

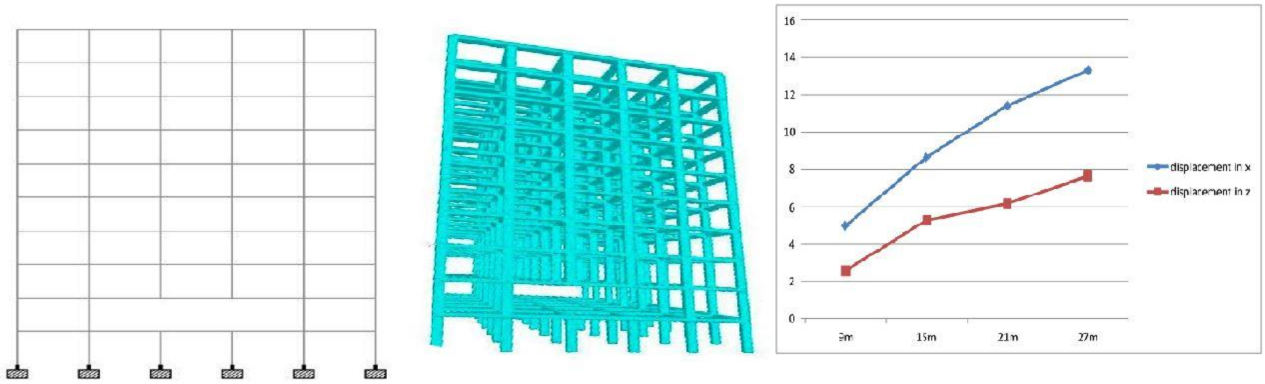


Figure 5. Elevation of building with floating column at first floor, 3d view of building having floating column at first floor , Displacement in x and z directions

MODEL 3: Square Building with floating column at Third floor

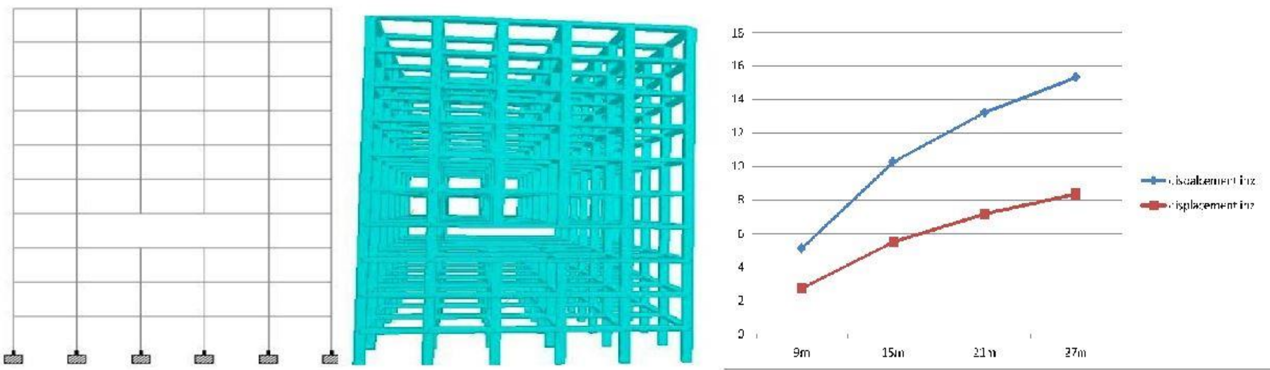


Figure 6. Elevation of building with floating column at third floor, 3d model of building with floating column at 3^{rd}floor, Displacements in x and z direction

MODEL 4: Square Building with floating column at fifth floor

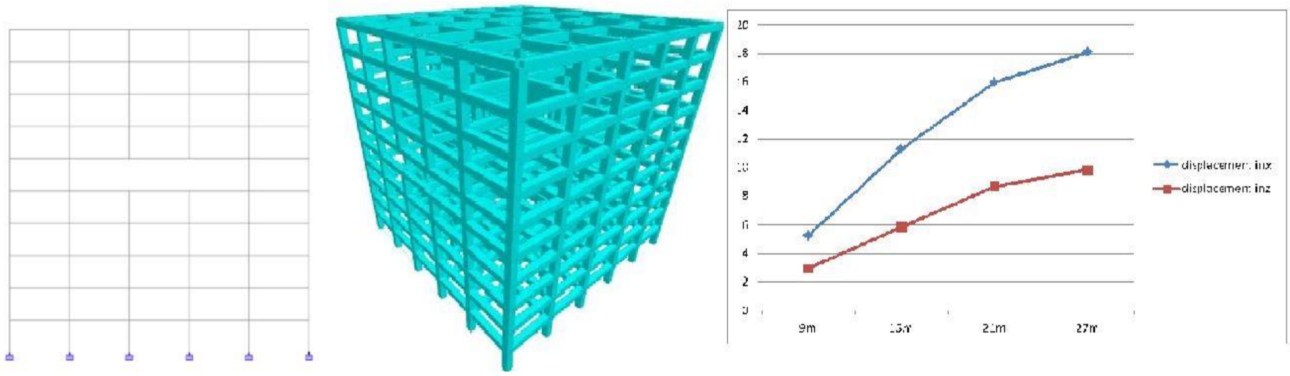


Figure 7. Elevation of building having floating column at 5th floor, 3d view of building with floating column at 5th floor, Displacements in x and z directions

3. Results and Discussions

The results of the comparative analysis between a building without floating column and with floating column will be carried on the basis of base shear and storey displacements.

Base shear

Table 1. variation of base shear

S.No	SEISMIC WEIGHT	BASE SHEAR	TIME PERIOD
MODEL 1	52959.43	2206.64	0.96
MODEL 2	52590.00	2205.50	0.96
MODEL 3	52844.92	2201.87	0.96
MODEL 4	52755.85	2198.16	0.96

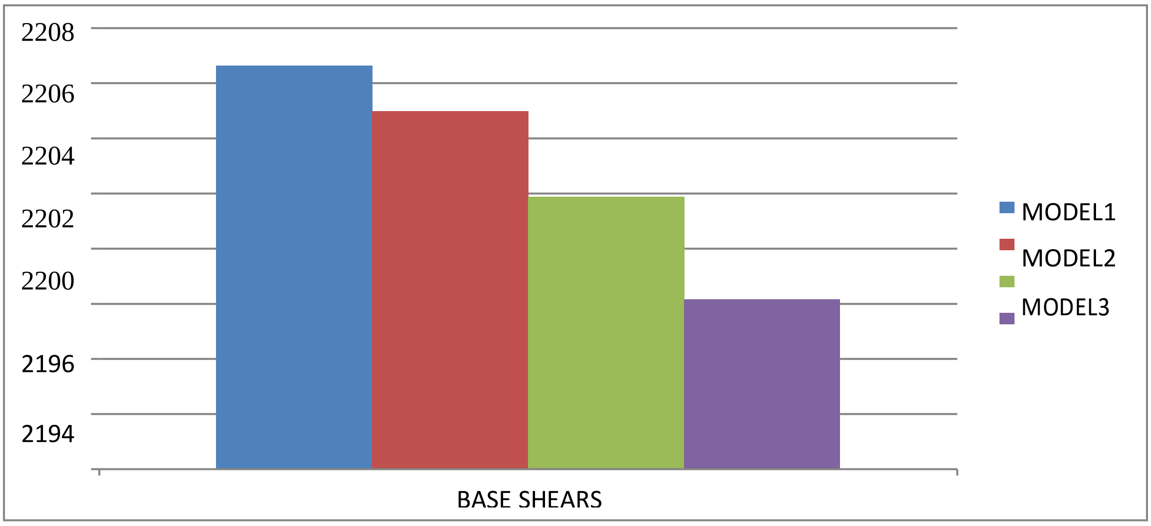


Figure 8. variation of base shear

Displacements at different heights in x-directions (in mm)

Table 2. Displacements at different heights

S. No	9m	15m	21m	27m
Model 1	4.9035	8.2946	11.2413	13.2791
Model 2	5.0020	8.6681	11.4293	13.3431
Model 3	5.1114	10.2266	13.2287	15.3226
Model 4	5.2360	11.3086	15.9596	18.0762

Displacements at different heights in z-directions (in mm)

Table 3. In z-directions (in mm)

S. No	9m	15m	21m	27m
Model 1	2.4376	4.3017	5.9274	7.0523
Model 2	2.5844	5.2896	6.1786	7.6567
Model 3	2.7399	5.5090	7.1862	8.3620
Model 4	2.9386	5.8180	8.6700	9.8753

4. Conclusions

The purpose of this article was to provide a basic overview of structural systems for high-rise structures. It has been suggested to use a system-based wide categorization rather than the height-based classifications previously used. Various structural systems within each category of the new categorization have been outlined, with a particular focus on the importance of innovation in each system.

On the basis of present study, the following conclusions can be drawn:

- Observations have been made that the base shear of a building with floating column is smaller than that of the same structure without floating column.
- It was also discovered that the value of the base sheard diminishes as the floating column moves from the bottom to the top floors of the building.
- As well as this, it has been discovered that when comparing a floating column building with an unsupported structure, the floating column building has a greater displacement.
- Moreover, it was discovered that moving a floating column from the bottom to the top floors enhances the values of the displacements.
- Specifically, it was discovered that the storey drift of buildings with floating columns is much greater than the storey drift of buildings without floating columns.
- Also noticed was that moving a floating column from the bottom to the top storeys causes the values of storey drifts to rise significantly.

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