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DESIGN AND ANALYSIS OF A HIGH-RISE BUILDING WITH AND WITHOUT HANGING COLUMN BY ETAB SOFTWARE

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ABSTRACT
Currently, the use of hanging columns is a common characteristic in contemporary high-rise structures in metropolitan India. hanging columns are often used in many projects, particularly above the bottom level. This allows for the use of transfer girders, resulting in a larger open area on the ground floor. Due to the lack of continuity in the load path, the hanging columns are more susceptible to seismic activity. Occasionally, it is necessary to fulfil certain criteria even when certain features are not deemed safe. Therefore, an attempt is made to analyse the behaviour of a G+15 multi-storey structure, with certain storeys designated for commercial use and the rest for residential use. This research examines and analyses the seismic behaviour of multistory structures with and without hanging columns. This research presented the analysis and findings of many parameters in a high-rise structure, including storey drifts, storey displacement, and Base shear. The design and analysis were conducted utilising the Extended Three Dimensional Analysis of Building Systems (ETABS) software.
KEYWORDS: *Multi-storey structure,hanging column,high-rise structure, ETABS software*

1. INTRODUCTION

Nowadays, it is common for urban multi-story structures to have an open first level as a necessary characteristic. The main purpose of this adoption is to provide space for parking or reception lobbies on the ground floor. The seismic response of a structure is significantly influenced by its general configuration, dimensions, and structural arrangement, as well as the manner in which seismic forces are transmitted to the foundation. The seismic forces generated at various levels inside a structure must be efficiently transmitted downwards to the ground via the most direct route. Poor performance of the building occurs when there is any deviation or discontinuity in the load transmission route. Buildings that include vertical setbacks, such as hotel buildings with a few floors wider than the rest, have a significant increase in earthquake pressures at the point of discontinuity. Buildings with reduced column or wall density on a specific floor or with abnormally high floors are more prone to damage or collapse, which often originates in that particular floor. Several structures using columns suspended or supported by beams at an intermediate level, rather than extending all the way to the foundation, exhibit discontinuities in the direction of load transmission. This may be achieved by the use of transfer beams. The hanging column is supported by the transfer beam, which in turn transmits the forces to the columns underneath it. This is currently a prevalent characteristic in high-rise structures.

2. OBJECTIVE AND SCOPE OF THE STUDY

A G+15 high-rise structure with and without hanging columns is examined in this thesis, with part of its storeys designated for commercial use and the rest storeys for residential use. It should be able to endure any loading scenario and perform the intended function. It need to guarantee the affordable design of the construction as well. The construction must meet safety requirements in order to function as cheaply as possible. The comparison and seismic analysis is carried out by applying all the loads and combinations in order to determine whether the structure is safe or unsafe with hanging columns. The analysis and results are presented in this study. The superstructure's analysis and design were completed using ETABS, which is acknowledged as the industry standard for Building Analysis and Design Software.

3. METHODOLOGY

3.1 Building Parameters

Utility of Building- Commercial & Residential Building
Number of Stories- G+15

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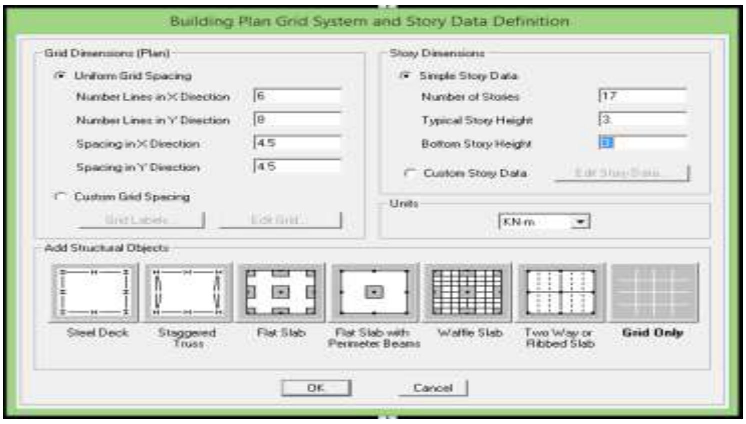
Geometry of Building- Symmetric
Type of Construction-RCC framed Type Of Walls ,Brick walls External walls 0.20m Internal walls 0.10m
Floor to floor height-3.0 m
Height of the plinth- 2.0 m above the ground Grade of Concrete M25
Grade of Steel-Fe 500

3.2 ETABS Analysis

The grid size are established as the first stage in ETABS. This involves determining the X and Y directions of the line count as well as the distance between grid lines. The number of storeys, typical storey height, and bottom storey are then specified as part of the definition of the storey data. The grid data also includes a reference of the slab type.



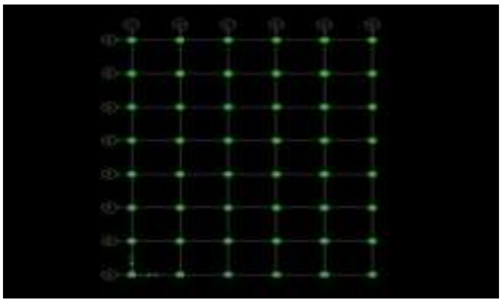


Figure 1: Plan and Elevation Model of Building

3.3 Types of Models Analysis by ETABS

The types of models used for this proposed study are as follows:
Case -1: 20% of Commercial space and 80% of Residential space of hanging columns over the height of building

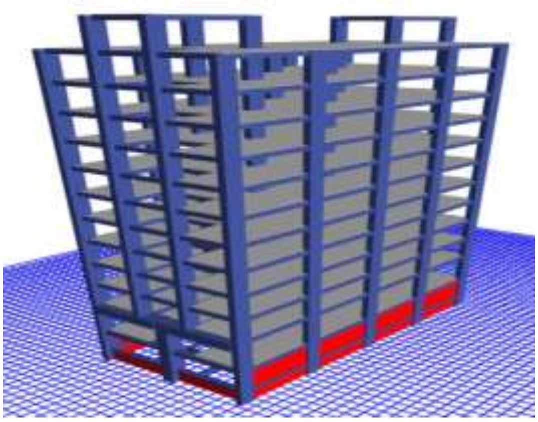


Figure 2: 3D model of Case-1

Case -2: 50% of Commercial space and 50% of Residential space of hanging columns over the height of building.

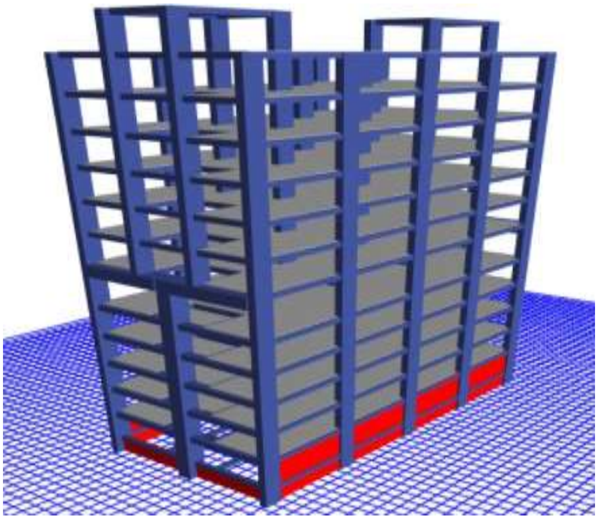


Figure 3: 3D model of Case-2

Case -3: 80% of Commercial space and 20% of Residential space of hanging columns over the height of building.

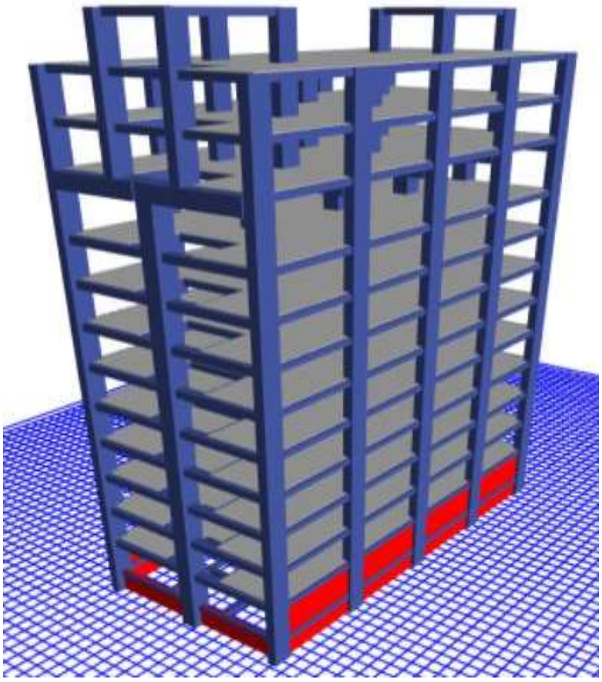


Figure 4: 3D model of Case-3

4. RESULTS AND DISCUSSIONS

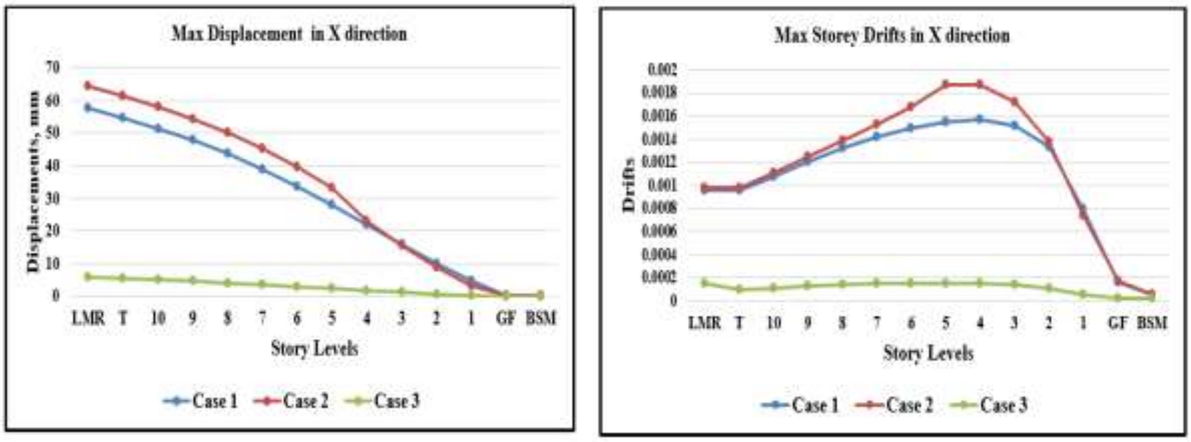


Figure 5: Displacement & Drift Graph in X directions

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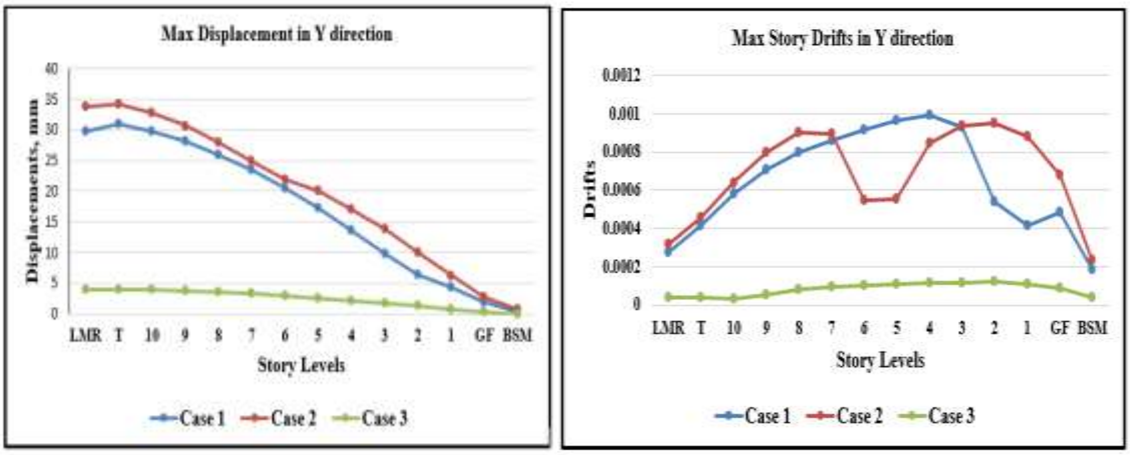

Figure 6: Displacement & Drift Graph in Y directions

5. CONCLUSIONS

The research that is discussed in the article contrasts a typical structure with one that is supported by hanging columns. The research led to the following findings.

1. The lateral displacements of hanging column buildings in X and Y directions are greater than those of a typical building due to the application of lateral loads in X and Y direction at each level.
2. In light of this, creating a hanging column building is riskier than erecting a conventional structure. It is found that hanging column buildings would experience more severe storey drift than regular buildings based on the computation of storey drift at each level for the structures. In all scenarios, the storey Drift reaches its maximum at the fifth and sixth story levels.
3. Compared to the regular structure, the hanging column building had higher story shear. This is because more materials were used than would be used in a typical structure. Therefore, compared to a regular structure, the hanging column construction is not cost-effective.
4. The ultimate conclusion is that hanging columns should not be built into structures unless they provide a valid purpose and meet functional requirements. If they are to be supplied, then careful consideration should be given to the structure's design.
5. The current study examines the seismic analysis of a multi-story structure with hanging columns at various storey levels, including the lower, middle, and higher storey levels over the building's height. An investigation of the response spectrum was carried out for each of the three construction scenarios.
6. The ETABS programme uses both the static and dynamic methods to analyse the seismic and wind behaviour of hanging columns.
7. Determining the best places for hanging columns in each of the three scenarios when the structure extends over the building's height. Here, the Case-3 holds firm, ensuring the safety of the structure.
8. The main and parapet walls are constructed of hollow, lightweight concrete blocks to reduce the structure's weight. In contrast, we may lessen the weight of the blocks on the framework by over 50%.
9. The parametric research of Time Period, Frequency, Displacement, Storey Drift, and Storey Shear reveals that the building's more hanging column floors (Case-1 & Case-2) would perform marginally worse when subjected to seismic excitation.
10. On the other hand, the Case-3 type works better during building. When all of the aforementioned factors are taken into account, Case-3 operates well and has a resistance of 86% to 92% when subjected to seismic excitation.
11. Having hanging columns in multi-story structures not only creates more open spaces but also offers a pleasing visual aspect.

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