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SEISMIC EVALUATION OF VERTICAL IRREGULARITY IN HIGH-RISE BUILDINGS WITH AND WITHOUT HANGING COLUMN

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ABSTRACT

Various regions throughout the globe have had detrimental consequences in tall multi-story buildings as a result of earthquakes, mostly owing to the presence of various abnormalities and badly planned constructions. A structure is said to be vertically irregular when there is an uneven distribution of stiffness, strength, and mass across the height of the building. The presence of hanging columns in an uneven structure significantly increases its irregularity, resulting in a discontinuous load path and a higher likelihood of collapse during an earthquake. The presence of a hanging column, caused by a discontinuity in the load path, compromises the structural integrity of the structure, resulting in reduced performance. The current research examines and analyses high-rise buildings with a regular construction and irregularities, both with and without a hanging column. An analysis has been conducted to examine the crucial placement of a hanging column in various positions around the peripheral columns of both regular and irregular buildings in zone V. The research examines the behaviour of high-rise buildings, namely those with regular and irregular vertical structures, that are ten stories tall and include hanging columns. The buildings are tested under earthquake stresses to observe their reaction. The different reaction parameters, including base shear, storey drift, node displacement, shear pressures, and bending moments, are analysed in the different models. The findings are compared to assess the impact of the presence of a hanging column in a structure.

KEYWORDS: *Multi-storey, Irregularity,Hanging column, High-rise buildings, seismic analysis*

1. INTRODUCTION

Around the world, earthquakes have shown the dangerous effects and susceptibility of high-rise buildings. An earthquake's impacts are greatly magnified in irregularly planned buildings. Strong earthquakes provide a significant danger of high-rise building frames with hanging columns at one or more locations collapsing. Buildings now have to have fewer columns and more open space because of both practical and aesthetic requirements. The general geometry, size, and form of the structure, as well as the way the forces are transmitted to the ground, have a significant impact on its behaviour. The forces generated in a building at various floor levels during an earthquake must be sent to the ground using the quickest route possible. The load transfer route becomes discontinuous due to hanging columns, which impairs the structure's performance. Architects are increasingly interested in these structures because of the advantage of having more open space due to fewer columns without any obstacles. hanging columns are an inevitable feature of many multi-story buildings and may be disadvantageous if built in seismically prone areas. The hanging column is a vertical component that rests, at its lowest point, on a beam, a horizontal component. As a result, the beam shifts the weight to the column next to it or below it.Because the hanging column creates an uneven distribution of mass, stiffness, and strength over the building's height, the structure may exhibit vertical irregularities.

2. METHODOLOGY

2.1 Modelling And Analysis

The G+10 story frame has been modelled in this research. A total of sixteen models—two with and without hanging columns and two with standard and asymmetrical vertical frames—have been created and examined. Position on the hanging column at the base of the structure has been adjusted at the building's outside, middle and inner peripheries. By using Staad-Pro for equivalent static analysis, the model is examined for Zone V, which corresponds to medium soil Type II.

Model 1: The model-1 is a rectangular building model devoid of any hanging columns or vertical irregularities. Model 2: The model-2 is a rectangular building model with hanging columns around the perimeter and no vertical irregularities.

Model 3: The model-3 is a rectangular building model with a hanging column in the centre of its perimeter and no vertical irregularities.

Model 4: The model-4 is a rectangular building model with a hanging column on the inner perimeter and no vertical irregularities.

type 5: There is no hanging column in this rectangular building type, which has Type-1 vertical irregularity.

Model 6: The model-6 is a rectangular structure with hanging columns around the perimeter and a Type-1 vertical irregularity.

Model 7: The Model-7 is a rectangular building model with a hanging column on the central perimeter and a Type-1 vertical

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irregularity.

Model 8: The model-8 is a rectangular building with an inner periphery hanging column and a Type-1 vertical irregularity.

Model 9: There is no hanging column in this rectangular building model, which has Type-2 vertical irregularity. Model 10: The model-10 is a rectangular building model with a hanging column around the perimeter and a Type-2 vertical irregularity.

Model 11: The Model-11 is a rectangular building model with a hanging column on the central perimeter and a Type-2 vertical irregularity.

Model 12: The model-12 is a rectangular structure with an inner perimeter hanging column and a Type-2 vertical irregularity.

Model 13: The Model-13 is a rectangular building model that lacks a hanging column and has Type-3 vertical irregularity.

Model 14: The Model-14 is a rectangular building model with a hanging column around the perimeter and a Type-3 vertical irregularity.

Model 15: The Model-15 is a rectangular building model with a hanging column on the central perimeter and a Type-3 vertical irregularity.

Model 16: The model-16 is a rectangular structure with an inner perimeter hanging column and a Type-3 vertical irregularity.

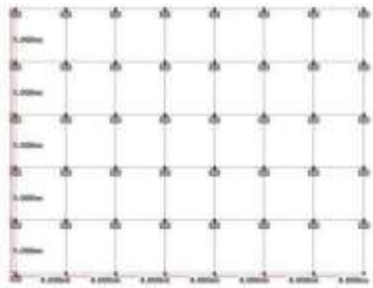
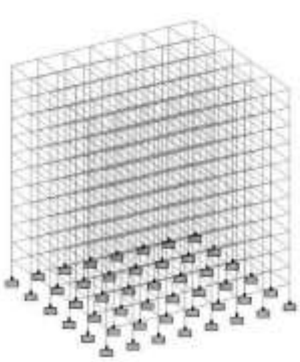
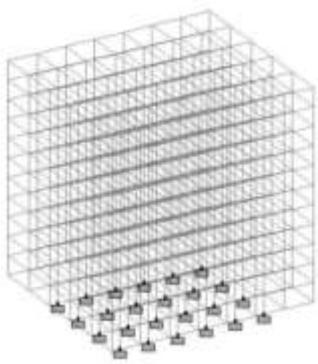
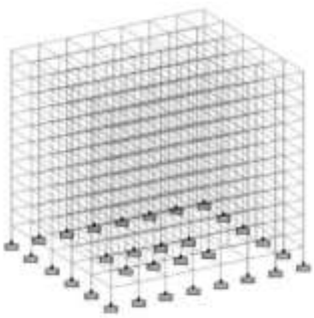
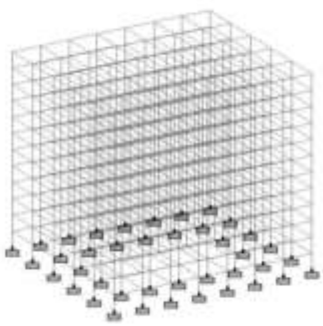


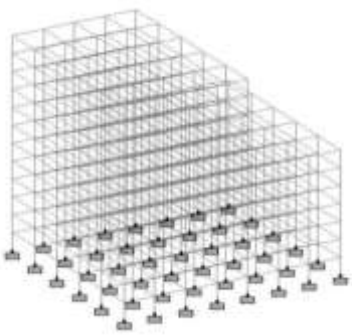
Fig.1. Plan Model











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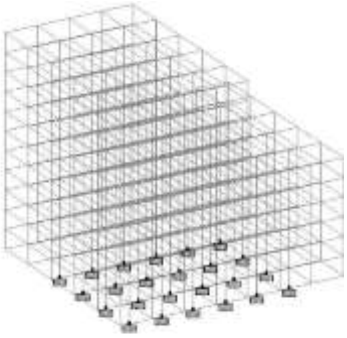

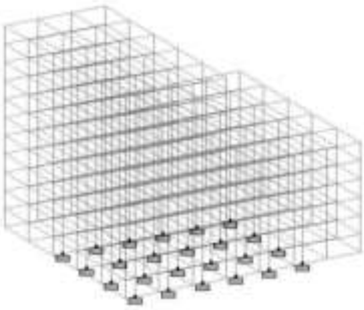

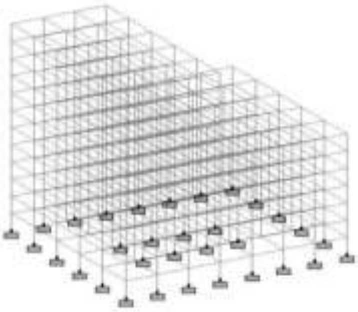

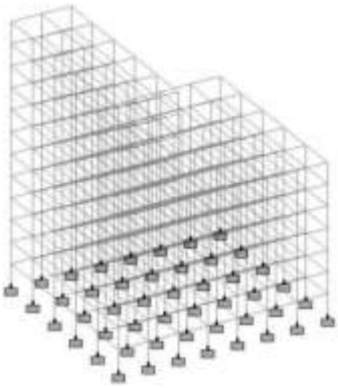

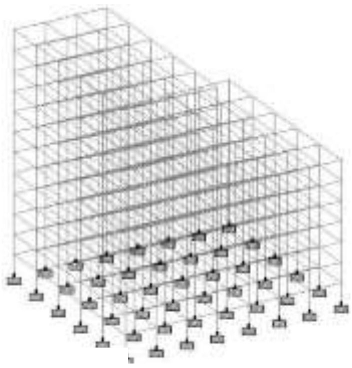

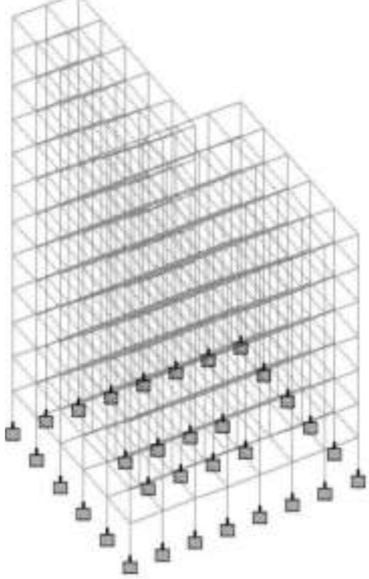

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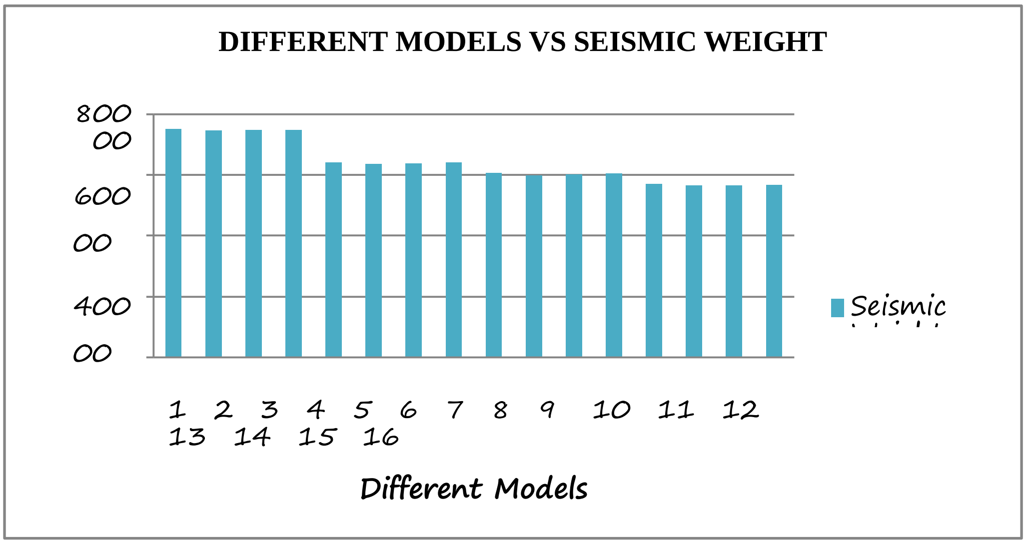
2.2 Load Analysis

In the present work, for the analysis of the structure, the loads such as the dead load (IS-875 PART 1), live load IS-875 (PART 2), and the seismic load are taken for analysis as per IS 1893 (Part 1):2002. The load combinations are also applied as per the IS code.

3. RESULT AND DISCUSSION

The research is conducted to assess seismic characteristics such as seismic weight, base shear, node displacement, storey drift, shear pressures, and bending moments. The findings for these parameters are shown in graphical form.



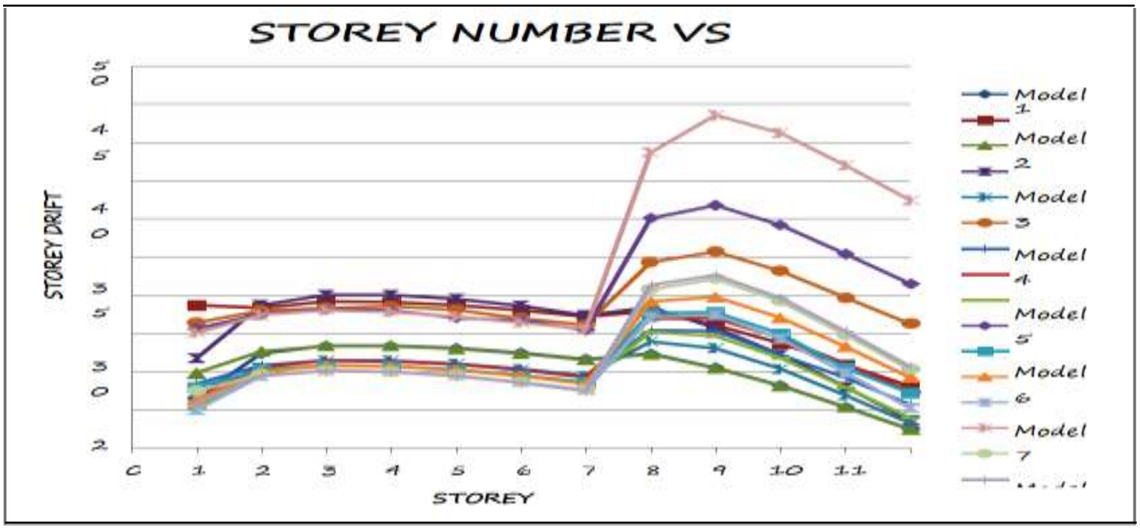


Fig.4. Graph For Storey Drift

4. CONCLUSION

- It has been noted that regular buildings have greater seismic weight and foundation shear compared to irregular ones.
- It is noted that the forces and moments in the beam members of the structure grow and are greater in models with a hanging column.
- It is clear that the drift is largest for the model with the greatest irregularity and when a hanging column is located at the outside edge of the structure (specifically, model 14). The drift is amplified in models that include a hanging column and a vertically uneven structure.
- The analysis of the storey drift response throughout the height of a building reveals that the middle storeys of the structure are more significantly impacted compared to the higher and lower stories.
- From the research, it is seen that placing a hanging column at various positions inside a building leads to variations in the reaction to earthquake forces. The most important scenario occurs when the hanging column is positioned at the outer perimeter

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of the structure.

- The node displacement findings for buildings with hanging columns are quite high. It is inadvisable to include a hanging column ill an area with a high risk of earthquakes, such as Zone V.
- Based on the analysis of different parameters and the observed results, it is evident that regular frame structures exhibit superior seismic performance compared to irregular frames in all scenarios. Therefore, it is recommended to construct regular frame structures in order to minimise the impact of earthquake forces.
- Furthermore, the displacement of the nodes, shear pressures, bending moments, and drift are much greater in structures with hanging columns. Therefore, it can be inferred that incorporating hanging columns in high-rise buildings located in high seismic zones is precarious and should be abstained from. Irregular buildings with hanging columns are much more prone to damage in areas with strong seismic activity. Therefore, it is advisable to prioritise and construct regular buildings without hanging columns.

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