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Investigation of the Opening Area Effect of Core Type Shear Wall in Hospital Buildings with Highest Importance Factor.

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ABSTRACT

Throughout history, mankind has been fascinated by multi-story buildings, initially constructed for defensive and later religious purposes. However, the height of tall buildings makes them more susceptible to lateral forces from wind or seismic movements, which can lead to collapse or bending. Stability, stiffness, lateral deflection resistance, and overturning moment resistance become critical factors in such structures. Shear walls, as structural elements, play a significant role in providing ductility, lateral stiffness, strength, and energy dissipation capacity.

In many cases, structural walls need to have openings to accommodate various functional needs such as doors, windows, and service ducts. However, these openings can reduce the rigidity of the shear wall, depending on their size and shape.

The objective of the current parametric study is to investigate and critically evaluate the impact of different opening sizes in shear walls on the behavior and reactions of multi-story buildings, specifically focusing on the Opening Area Effect of Core Type Shear Wall in Hospital Buildings with the Highest Importance Factor. The analysis is conducted using the Staad-Pro software and the Response Spectrum method (1893–2016) on various G+20 storey prototype structures with different types of shear wall openings, some of which reduce the volume of shear wall in the border elements.

The comprehensive investigation reveals that the case of HIF5 has been the most effective in the study. According to IS 1893:2016, the hospital building can be preserved with the highest importance factor of I = 1.5 for the opening area effect of core type shear walls. Additionally, it is suggested that seismic harm will not occur as long as the openings are limited to 25%.

Key Words: Opening Area, Core Type Shear Wall, Shear Wall, Highest Importance Factor

INTRODUCTION

A shear wall, also known as a shear panel, is a structural system utilized in structural engineering to counteract the effects of lateral loads on a building, such as wind and earthquake loads. These walls are designed to withstand loads imposed in planes along their height, and the applied load is typically transmitted to the wall through a diaphragm, collector, or drag element. Shear walls are commonly constructed using materials like brick, concrete, and wood.

The appropriate lateral strength of shear walls is essential to resist horizontal earthquake stresses effectively. If shear walls are adequately strong, they can transmit these horizontal forces to the components below them in the load path, which may include additional floors, slabs, foundation walls, or other shear walls. Moreover, shear walls offer lateral rigidity, preventing excessive side-sway of the roof or floor above and minimizing nonstructural damage in suitably rigid buildings.

The overall strength of a shear wall is determined by the combined strengths of its three main components: wood, sheathing, and fasteners. The Uniform Building Code (UBC) allows the use of various materials for shear wall sheathing, including oriented strand board, gypsum wallboard, cement plaster, fiberboard, and wood particleboard, each offering different strengths. Fasteners like screws or nails are commonly used in shear wall construction, and their strength is influenced by the density of the lumber species.

The stiffness and strength of a shear wall depend on the total stiffness of its three components: wood, sheathing, and fasteners. The flexibility of a wood shear wall is influenced by factors such as the size and grade of the end studs, the thickness and grade of the sheathing, and the diameter of the sheathing fasteners. Hold down devices also contribute to the shear wall's rigidity, preventing horizontal movement at the top of the wall, which could reduce its stiffness.

The height to width ratio of shear walls significantly affects their rigidity, with tall narrow walls being stiffer than long short ones. The UBC specifies minimum wall lengths for particular wall heights to control stiffness. The permissible dimension ratio varies depending on the sheathing material's construction and type.

Overall, shear walls are crucial structural elements designed to enhance a building's stability and resistance to lateral forces. Proper design and construction, considering the materials and dimensions, play a vital role in achieving effective shear wall performance.

OBJECTIVE OF THEWORK

The research studies mentioned above lead to the following conclusions:

• The main objective of the presented studies is to enhance the performance of high-rise structures by modifying the proportion of openings in shear walls and analyze how these changes impact the building's seismic response.

• The evaluation of shear wall performance considers different seismic zones' behavior.

• Various researchers have observed an increase in the structural stability of the utilized structures as the primary goal of their investigations.

• The key aspects explored in these studies include the ideal height, shear wall location, various opening area percentages and heights, variations in shear wall location, among others. These factors form the basis of the extensive inquiry.

Result:-

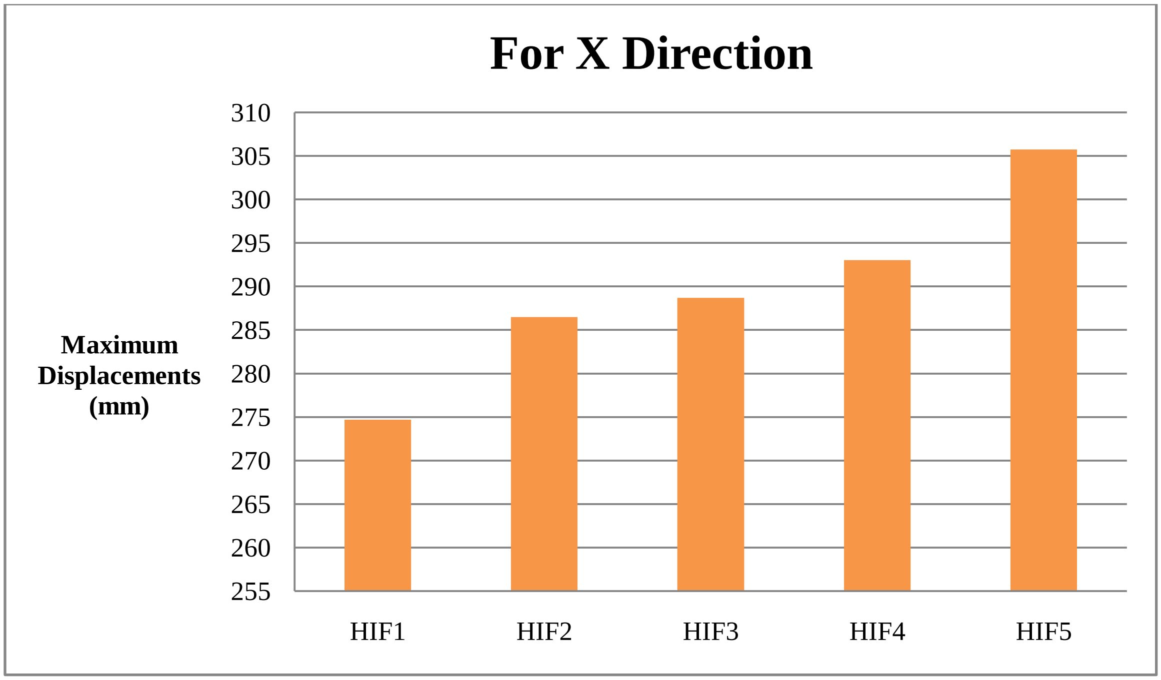

Fig. 1: Maximum Displacement in X direction for all Buildings in Zone III

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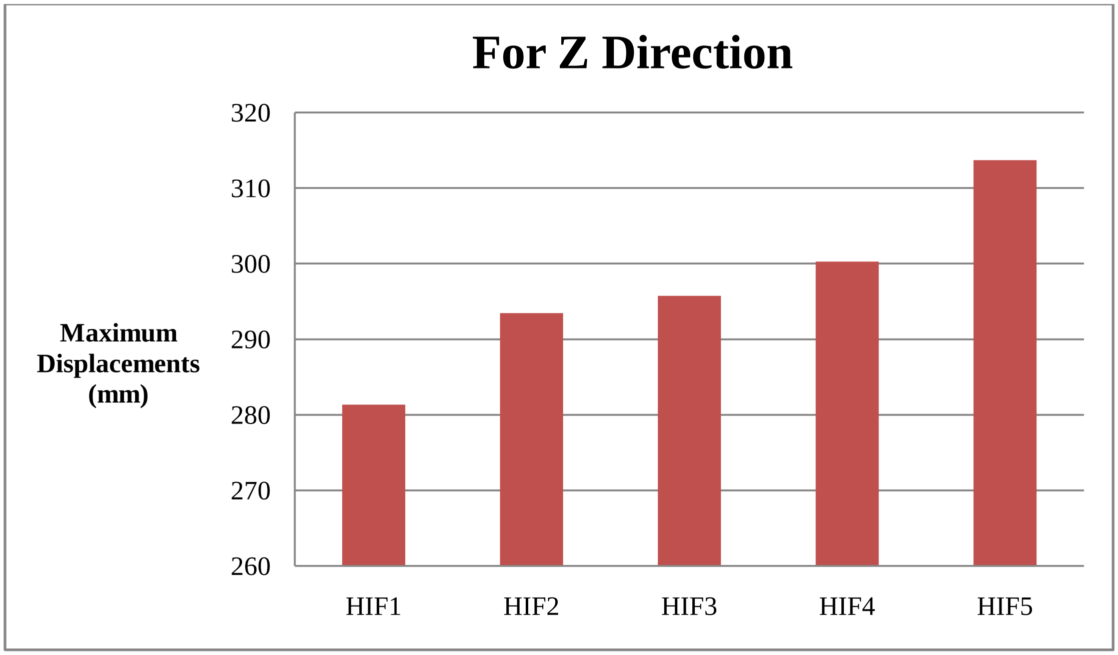

Fig. 2: Maximum Displacement in Z direction for all Buildings in Zone III

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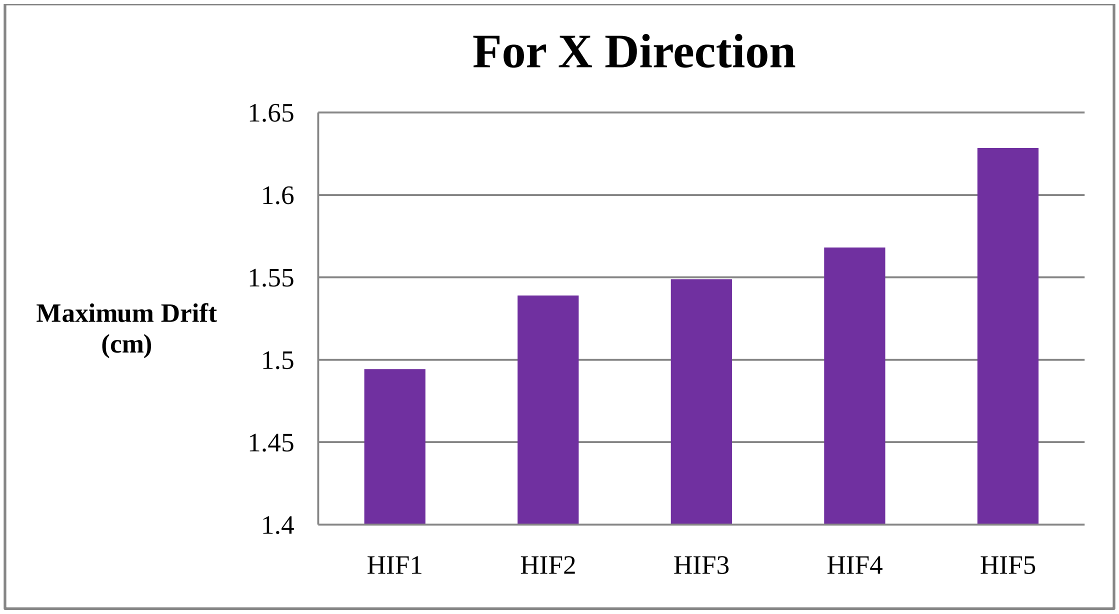

Fig. 3: Storey Drift in X direction for all Buildings in Zone III

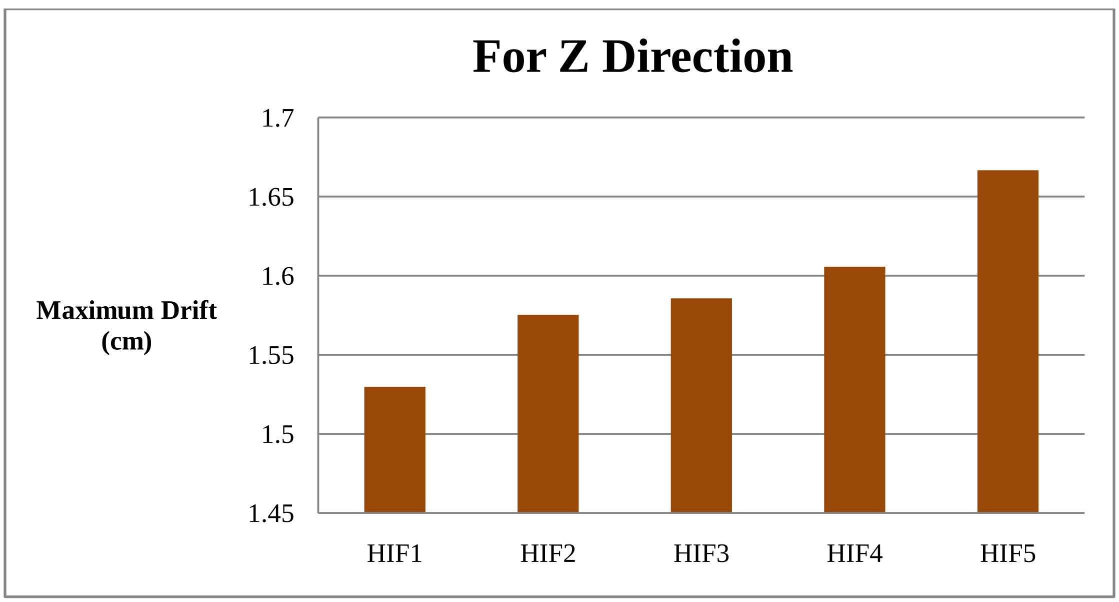

Fig. 4: Storey Drift in Z direction for all Buildings in Zone III

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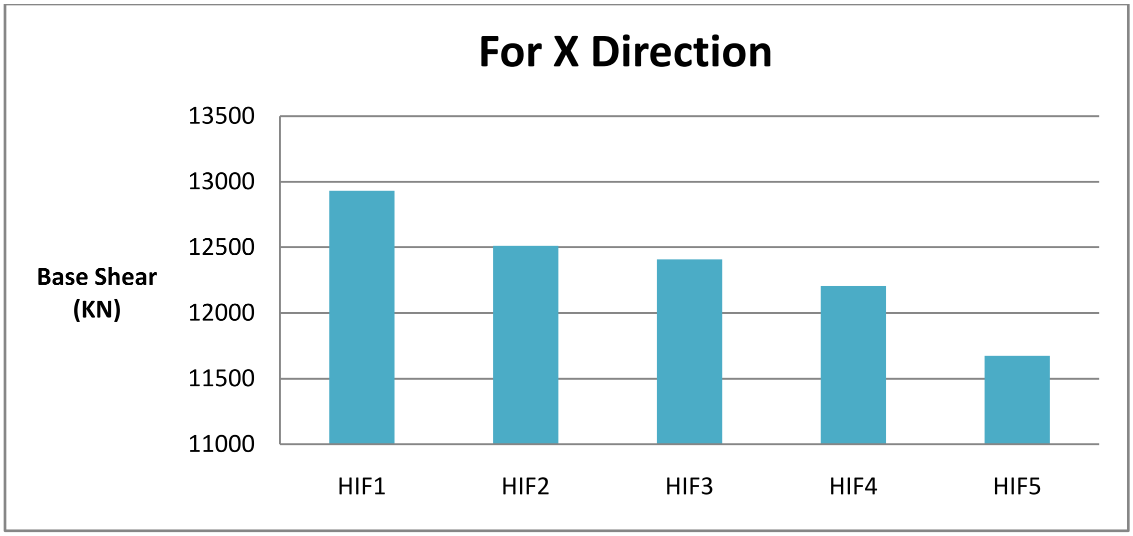

Fig. 5: Base Shear in X direction for all Buildings in Zone III

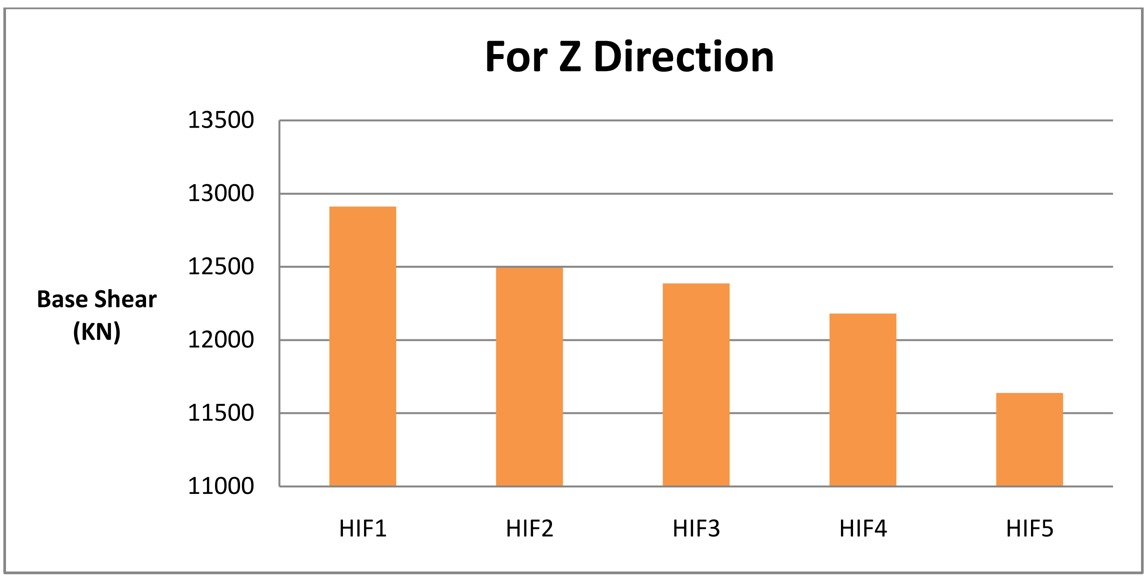

Fig. 6: Base Shear in Z direction for all Buildings in Zone III

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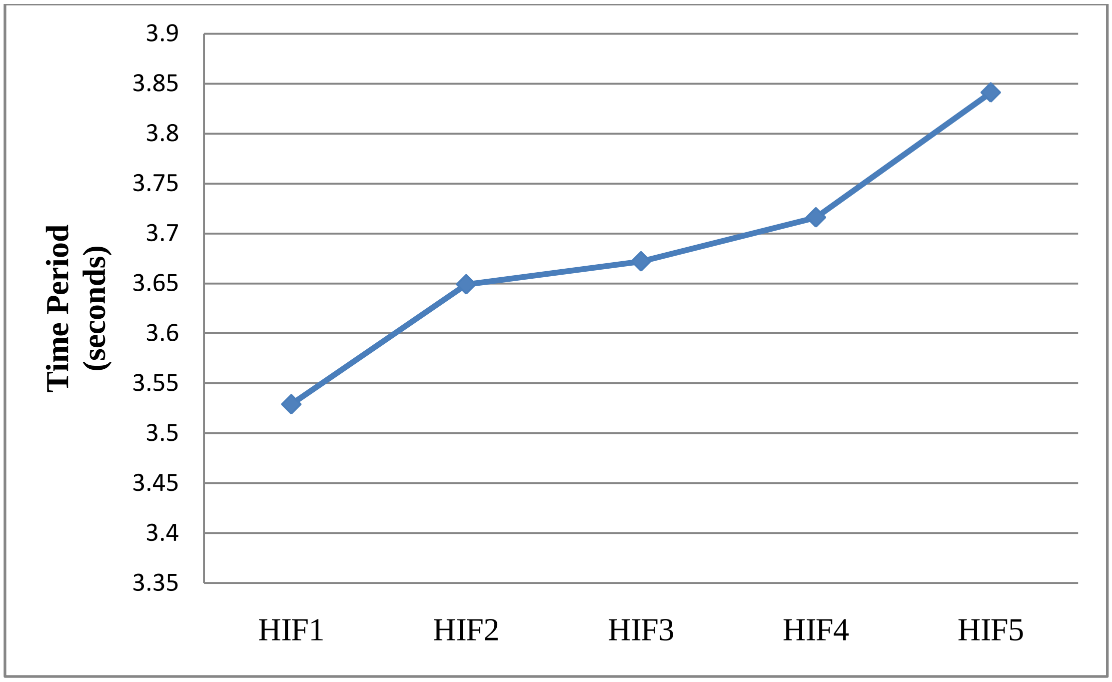

Fig. 7: Time Period for all Buildings in Zone III

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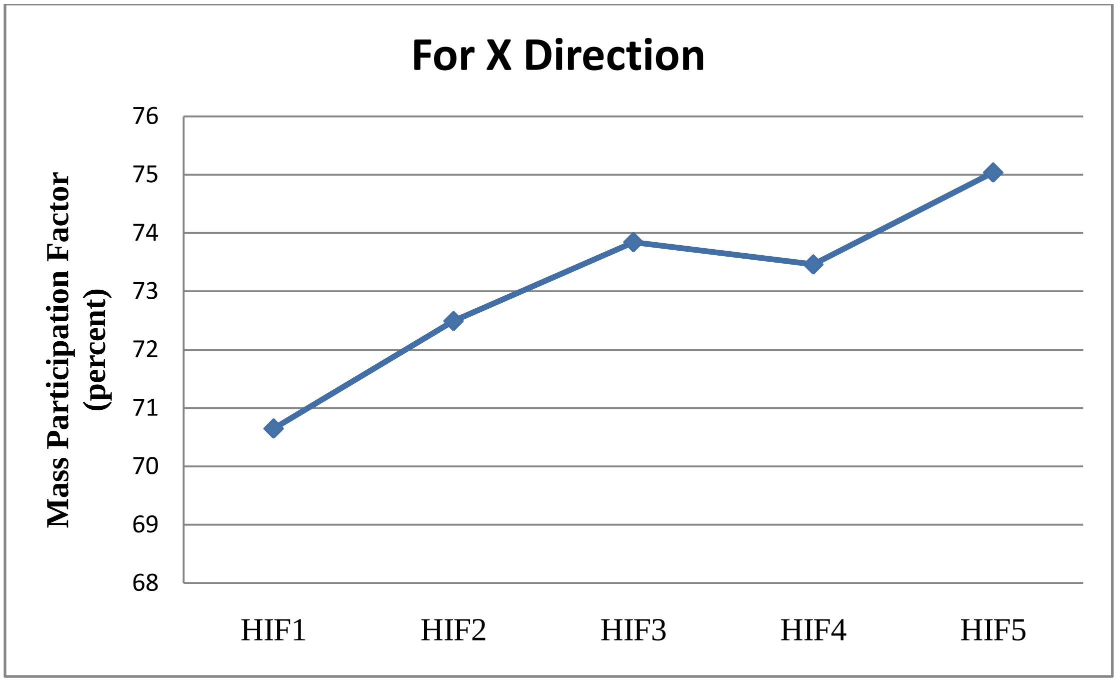

Fig. 8: Mass Participation Factor in X direction for all Buildings in Zone III

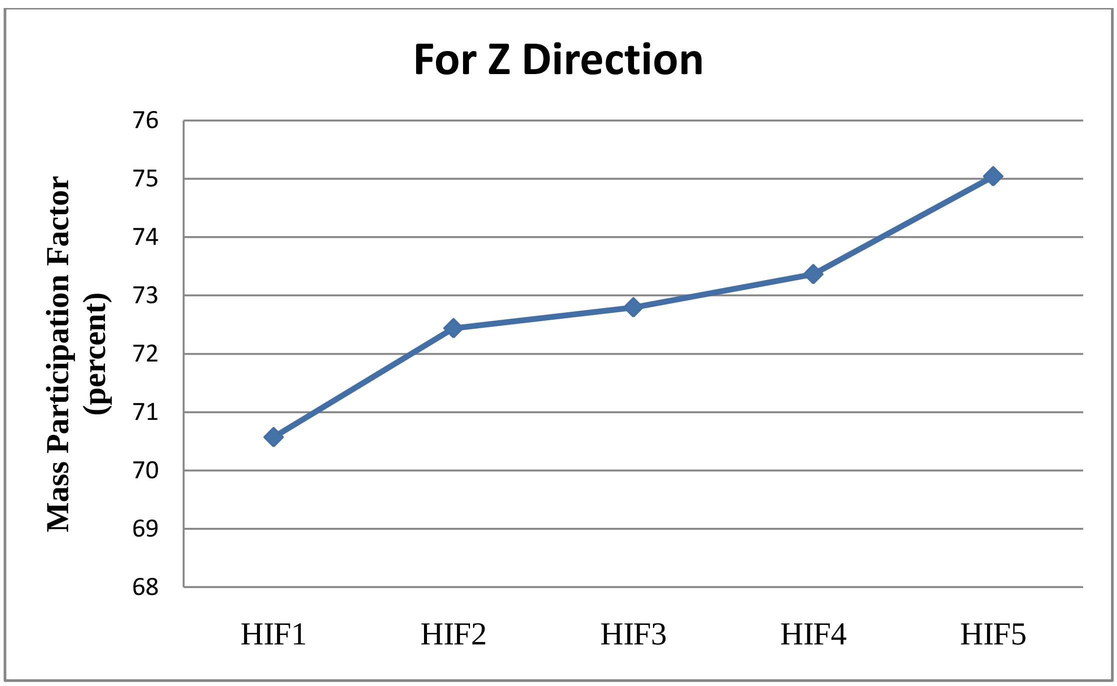

Fig. 9: Mass Participation Factor in Z direction for all Buildings in Zone III

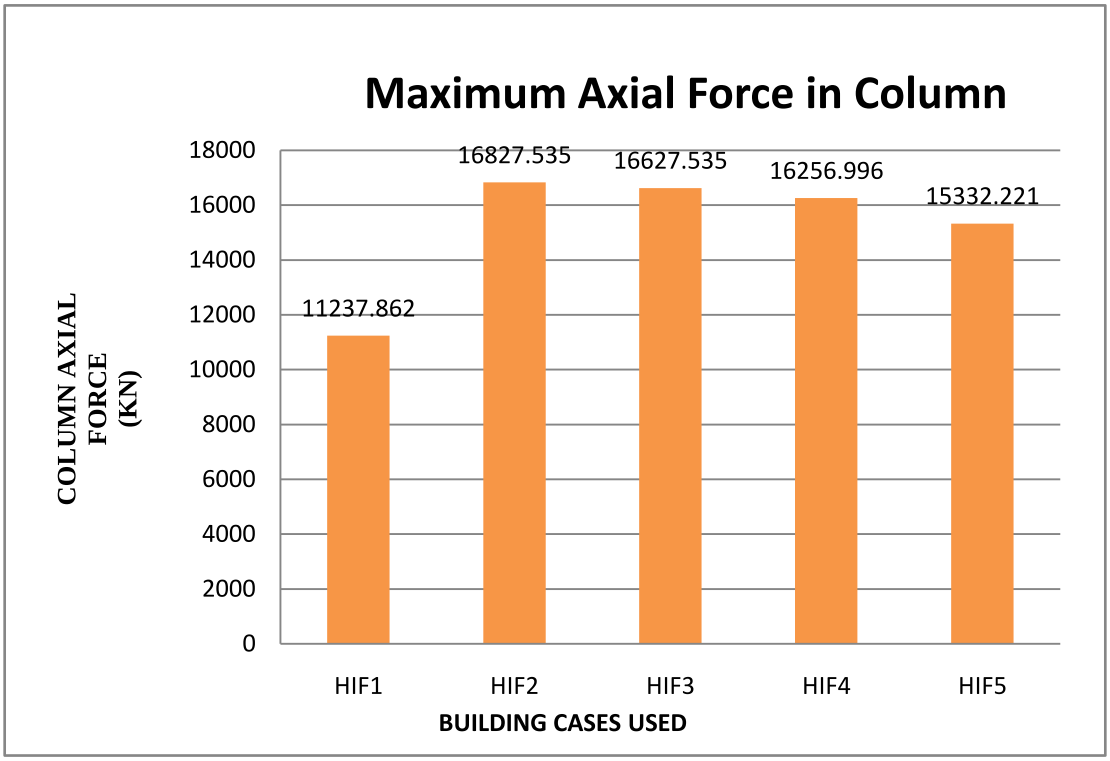

Fig. 10: Maximum Axial Forces in Column direction for all Buildings in Zone III

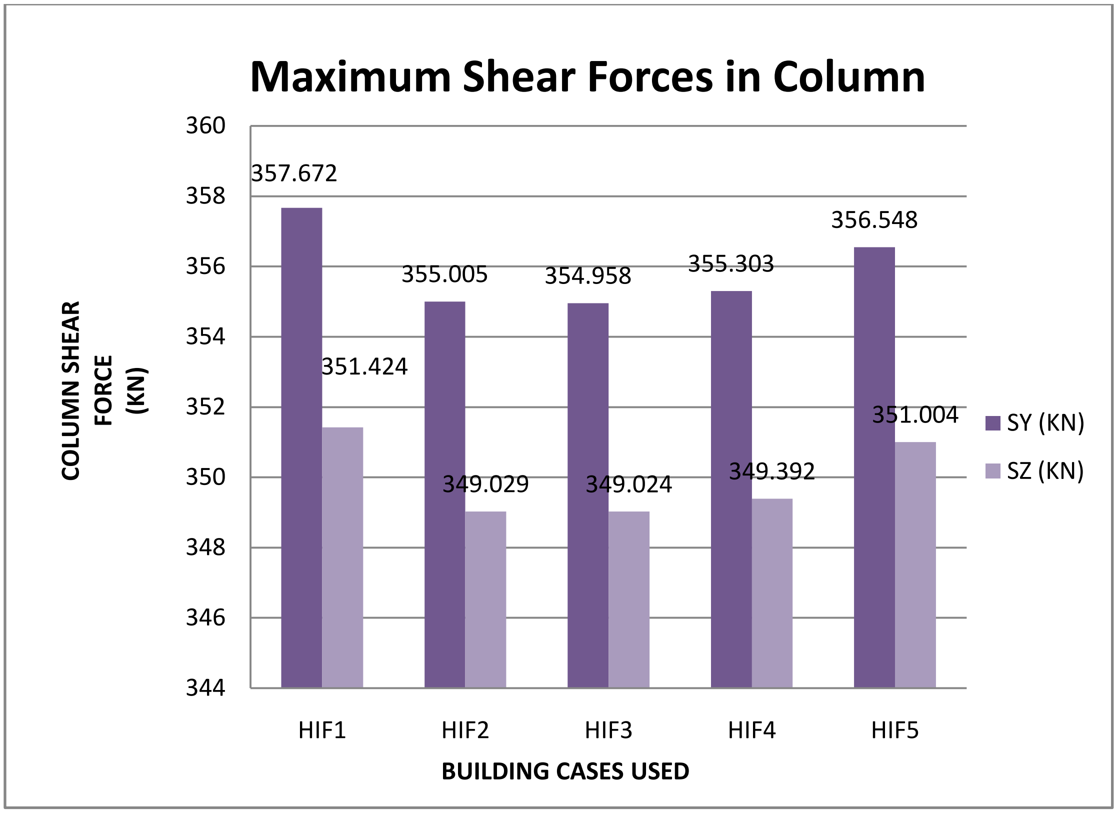

Fig. 11: Maximum Shear Forces in all direction for all Buildings in Zone III

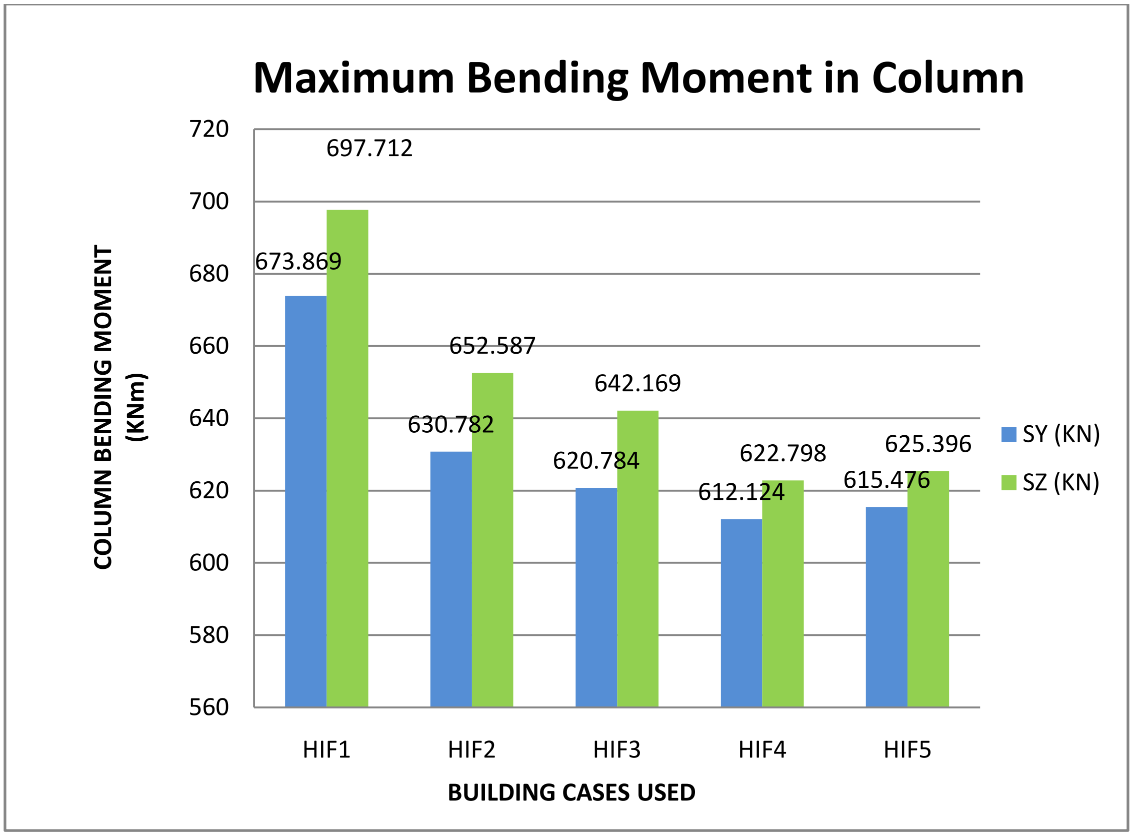

Fig. 12: Maximum Bending Moment direction for all Buildings in Zone III

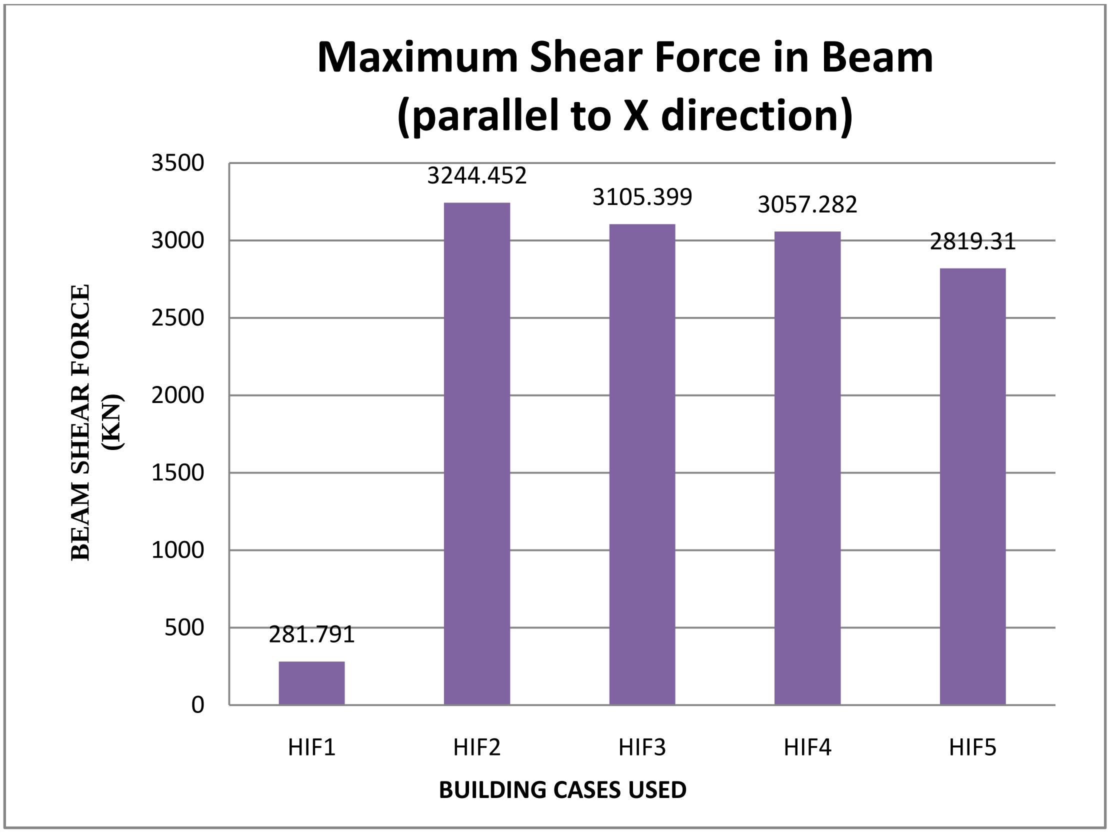

Fig. 13: Maximum Shear Forces in beams parallel to X direction for all Buildings in Zone III

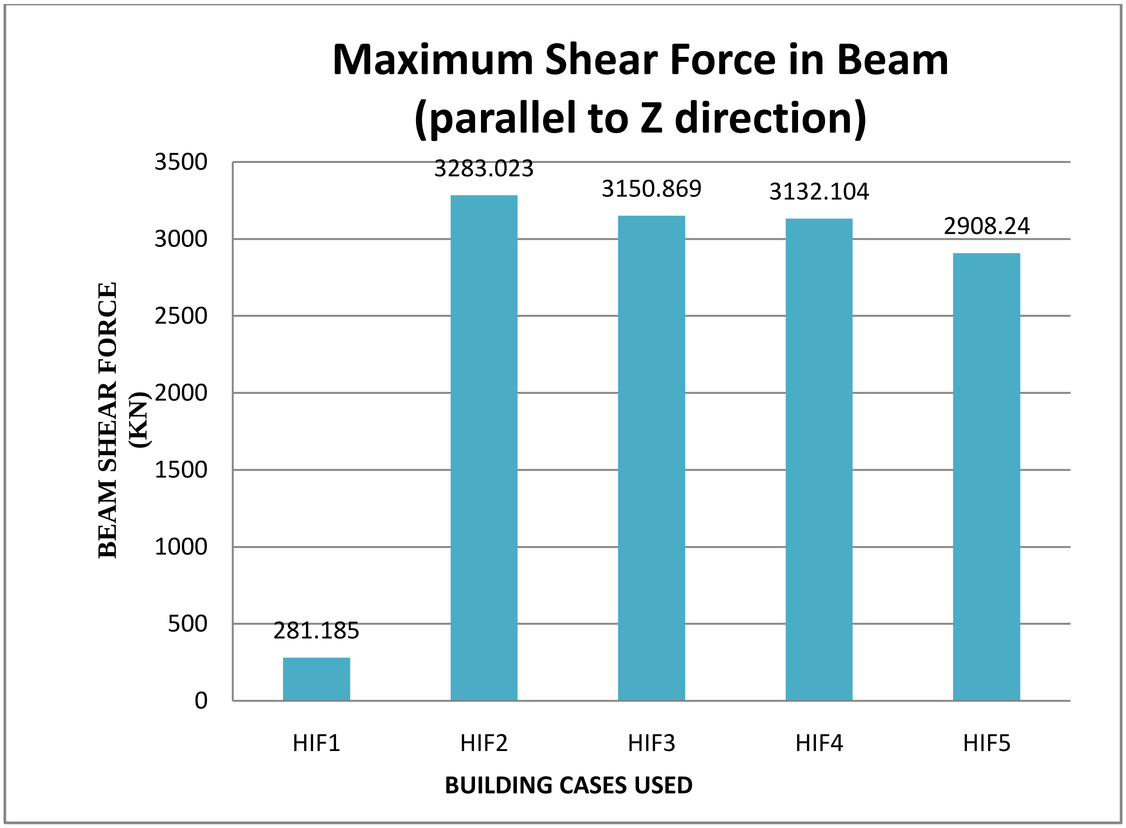

Fig. 14: Maximum Shear Forces in beams parallel to Z direction for all Buildings in Zone III

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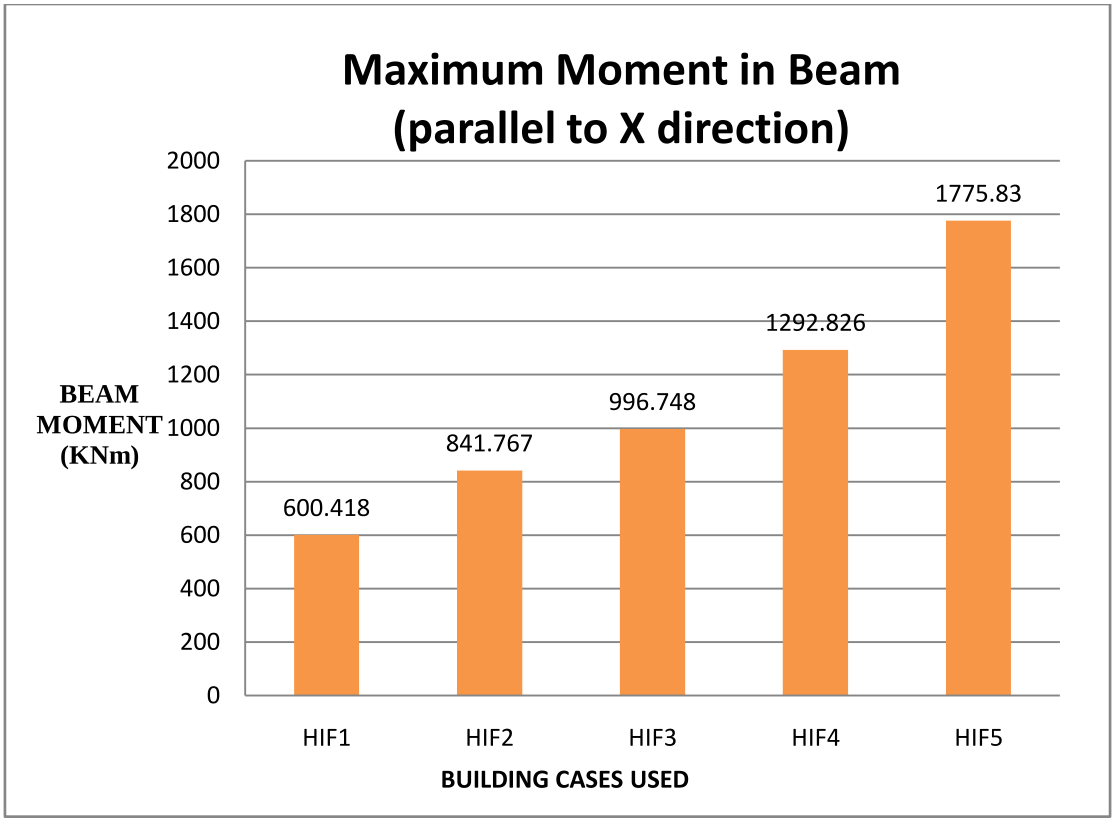

Fig. 15: Maximum Bending Moment in beams parallel to X direction for all Buildings in Zone III

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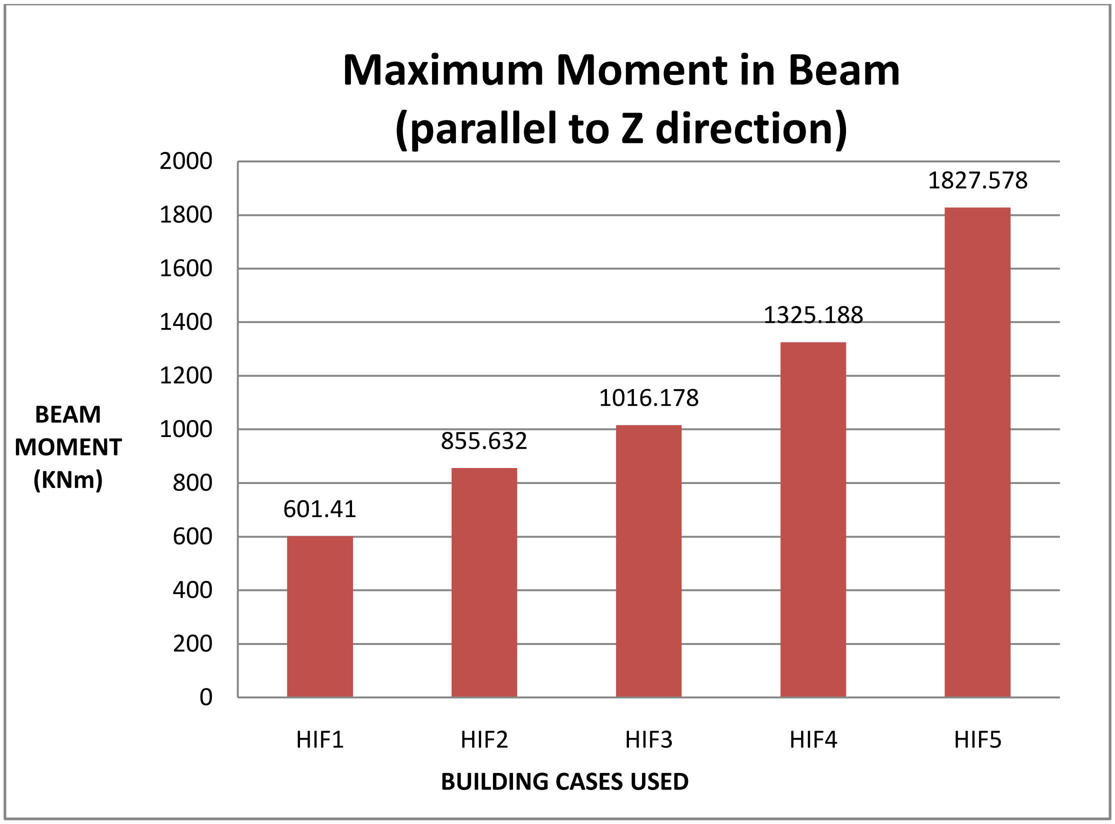

Fig. 16: Maximum Bending Moment in beams parallel to Z direction for all Buildings in Zone III

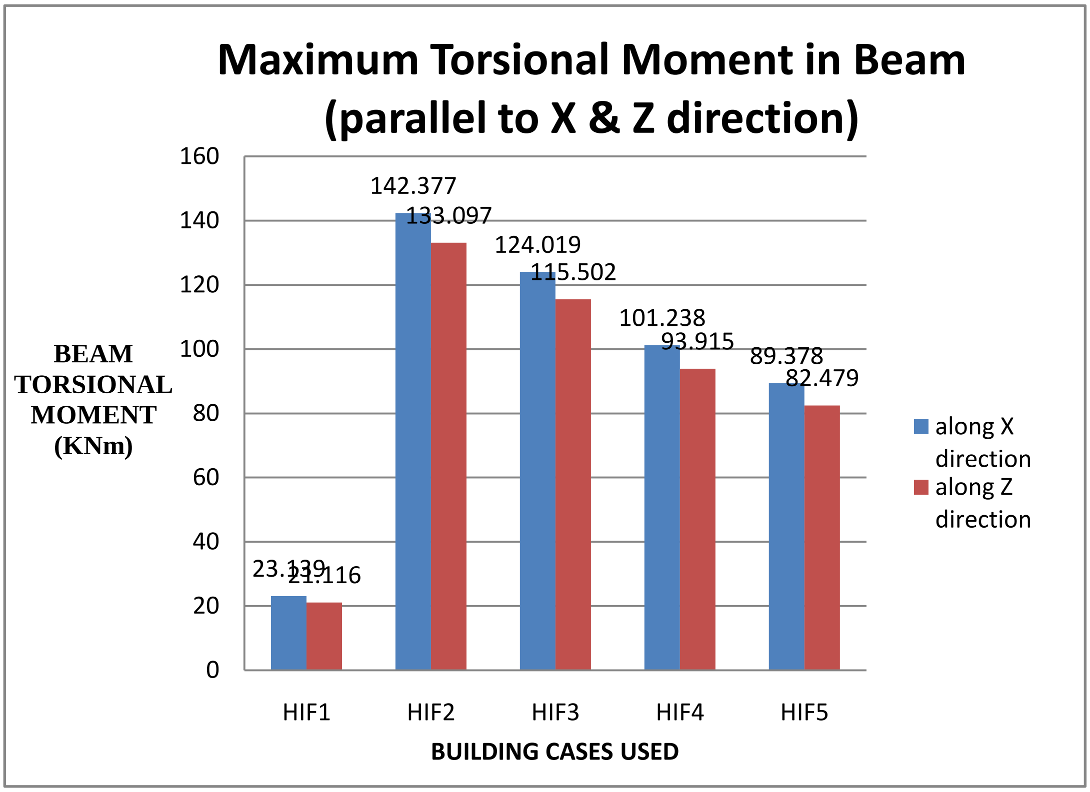

Fig. 4.17: Graphical Representation of Maximum Torsional Moment in beams along X and Z direction for all Buildings in Zone III

Conclusion-

As we examine five different cases related to the Opening Area Effect of Core Type Shear Wall in Hospital Building with the Highest Importance Factor, each case in the structure leads to different conclusions. The comparison study yields the following results for the cases given:

After comparison, it was found that HIF1 had the lowest maximum displacement in the X and Z directions because the stiffness decreased when the shear wall area was reduced.

HIF1 also had the lowest maximum drift in the X and Z directions due to the decrease in stiffness as displacement increased with a reduction in the shear wall area.

Case HIF5 had the lowest base shear forces in both the X and Z directions as the structure's weight was reduced by decreasing the shear wall area.

When examining the time period and mass participation factor for both the X and Z directions, HIF1 had the lowest values, and HIF5 emerged as the most effective case.

HIF5 shows higher efficiency in axial force compared to other cases, except HIF1, as reducing the shear wall area decreases the overall weight.

For column shear forces, HIF5 is the efficient case after comparing all cases except HIF1, due to the reduced shear wall area.

According to comparative results in column bending moment, HIF4 and HIF5 are the effective cases as the structure's weight decreases with an increase in shear wall area.

HIF5 is the best example for beam shear force in the X and Z directions, except for HIF1.

The bending moment in beams parallel to the X and Z directions increases as the shear wall area decreases, resulting in HIF4 and HIF5 as the effective cases.

HIF5 shows effectiveness in assessing the Torsional Moment in beams along the X and Z directions, compared to HIF1.

Overall analysis reveals that HIF5 is the most effective example in the study. According to IS 1893:2016, the hospital building can be protected with the highest importance factor (I = 1.5) for the opening area effect of core type shear walls. Additionally, it is advised that seismic harm will not occur with openings up to 25%.

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