

ABSTRACT

Seismic analysis of high-rise buildings with transfer structures is crucial for their safety and stability in earthquake-prone areas. Transfer structures reduce the number of support columns and increase usable space but introduce complexities in structural behavior during seismic events. Comprehensive seismic analysis is essential to ensure these structures withstand seismic forces without collapsing or suffering significant damage. Both linear and nonlinear analysis methods are used, with appropriate ground motions selected. Linear analysis determines fundamental frequency and mode shapes, while nonlinear analysis simulates behavior under seismic loads, including plastic hinge development and force redistribution due to the transfer structure. Results guide the optimization of the transfer structure and other elements to improve seismic performance. Weak points, such as areas with excessive drift or displacement during earthquakes, are identified for targeted design improvements. The study emphasizes the significance of comprehensive seismic analysis for high-rise buildings with transfer structures to ensure safety and stability. Findings inform design optimization, enhancing seismic performance and occupant safety.

LLRS, Seismic, Core wall, Modifiers, Transfer

INTRODUCTION

High-rise buildings are complex structures that require careful analysis and design considerations, especially in earthquake-prone regions. The seismic performance of such buildings is of utmost importance to ensure the safety of occupants and minimize structural damage during seismic events. One common design approach for high-rise buildings is the use of a central shear wall system, which consists of vertical walls that provide stiffness and resistance against lateral forces caused by earthquakes. In this analysis, we focus on a building with two central shear walls. The two central shear walls are strategically positioned to enhance the building's overall structural integrity and withstand seismic loads effectively. These walls act as the primary load-bearing elements, resisting lateral forces and providing stability. To enhance the connectivity and load distribution between the two shear walls, link beams are introduced. Link beams connect the top portions of the two shear walls, ensuring that forces and deformations are distributed evenly, thus reducing concentration points and potential weak areas.

Another significant feature of the analyzed building is the presence of a transfer floor at the first level. The transfer floor serves as an intermediate structural element that transfers the loads from the upper floors to the shear walls efficiently. During an earthquake, the lateral forces acting on the building induce bending moments and shear forces within the shear walls and the link beams. The seismic analysis of the

building involves evaluating the structural response under different seismic loads to ensure its overall stability and performance. Advanced computational techniques, such as finite element analysis, are commonly used to simulate the seismic behavior of high-rise buildings with central shear wall systems. These analyses provide valuable insights into the building's response, allowing engineers to optimize the design and ensure its safety. The earthquake analysis of high-rise buildings with two central shear walls connected through link beams and a transfer floor requires consideration of various factors, such as local seismic hazard, soil conditions, building materials, and design codes and regulations specific to the region.

STIFFNESS IRREGULARITY

Stiffness irregularity refers to variations in stiffness or rigidity within a structural system. These irregularities can have significant implications for the behavior and performance of buildings, particularly during seismic events. Understanding and addressing stiffness irregularities are crucial to ensure the structural integrity and safety of buildings, especially high-rise structures.

In the context of high-rise buildings, one type of stiffness irregularity arises from the presence of a transfer slab between certain floors. A transfer slab, also known as a transfer floor or transfer structure, is used to transfer the loads from upper floors to lower floors, typically to accommodate column-free spaces or to support additional loads. The introduction of a transfer slab creates a change in stiffness between the floors above and below it. The transfer slab, being stiffer than the typical floor slabs, can lead to a stiffness irregularity within the building's structural system. This irregularity affects the distribution of forces during seismic events and can potentially compromise the overall stability and performance of the structure. Stiffness irregularity due to the transfer slab can result in concentration of forces, increased structural displacements, and potential for localized damage in specific areas of the building. These irregularities can induce higher stresses in structural elements, such as columns and beams, and can lead to non-uniform distribution of seismic forces. Therefore, it is essential to conduct a thorough analysis and design consideration for buildings with transfer slabs to address the stiffness irregularity. This involves evaluating the seismic response of the structure, assessing the distribution of forces and displacements, and implementing appropriate measures to mitigate the effects of stiffness irregularity.

STRUCTURAL CONFIGURATION

The analysis and design process for high-rise structures involves a crucial step of modeling the building in ETABS software. ETABS is a widely utilized software tool that enables the creation of a precise and comprehensive 3D model. The modeling procedure encompasses defining the building's geometric

parameters, such as floor plans, column sizes, and beam dimensions. After establishing the fundamental geometry, the software enables the specification of materials and structural elements, including concrete, steel, and shear walls.

In the case of the seismic evaluation, a residential project with G+32 configuration is being considered. The building has plan dimensions of 82m x 35m and a floor-to-floor height of 3.6m. Detailed information regarding the building's characteristics can be found in Table, while a visual representation of its layout can be observed in Figure.



Plan and Isometric View for a Building

SEISMIC ANALYSIS

The seismic analysis is a crucial aspect of ensuring the safety and structural integrity of high-rise buildings. This study focuses on analyzing the response of a high-rise building that incorporates a unique lateral load resisting system (LLRS). The LLRS consists of two central core walls, a peripheral core wall system, and a transfer structure located at the first floor. The main objective of the seismic analysis is to evaluate how the building behaves under seismic forces and identify potential failure modes. By understanding the building's dynamic behavior during seismic events, engineers can ensure its stability and minimize the risk of damage to protect the occupants. The utilization of two central core walls as the primary LLRS enhances the building's stiffness and strength, effectively countering the lateral loads induced by seismic activity. The precise placement and configuration of these core walls play a critical role in distributing the seismic forces throughout the structure, reducing deformations, and ensuring overall stability. The peripheral core wall system complements the central core walls by providing additional resistance against lateral

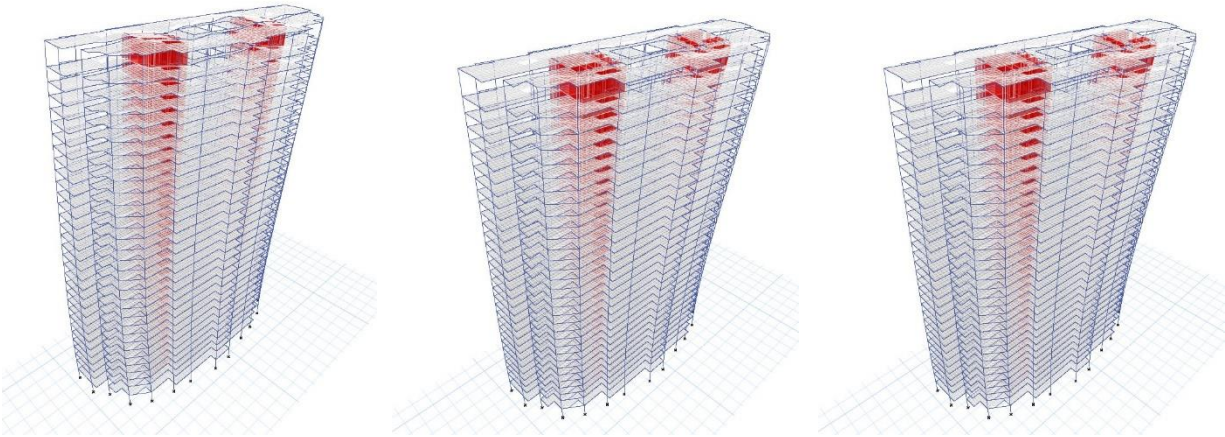
forces, thus enhancing the overall structural performance. The combination of the central and peripheral core walls creates a robust system that effectively absorbs and dissipates seismic energy, thereby minimizing the impact on the building's structural elements.

Additionally, the inclusion of a transfer structure at the first floor facilitates the smooth transfer of loads between different sections of the building. This transfer structure redistributes the forces, ensuring efficient transmission of vertical and lateral loads to the foundation, thereby reducing localized stress concentrations and potential weak points. During the seismic analysis, engineers consider various parameters, including ground motion characteristics, building mass, stiffness, and the behavior of individual structural elements. Advanced numerical modeling techniques, such as finite element analysis, are employed to simulate the building's dynamic response and assess its performance under different seismic scenarios. The analysis involves evaluating critical factors such as inter-story drift, floor accelerations, base shear, and modal properties of the structure. These parameters provide valuable insights into the building's behavior, enabling engineers to optimize the design, identify potential deficiencies, and make necessary adjustments to enhance its seismic resistance.

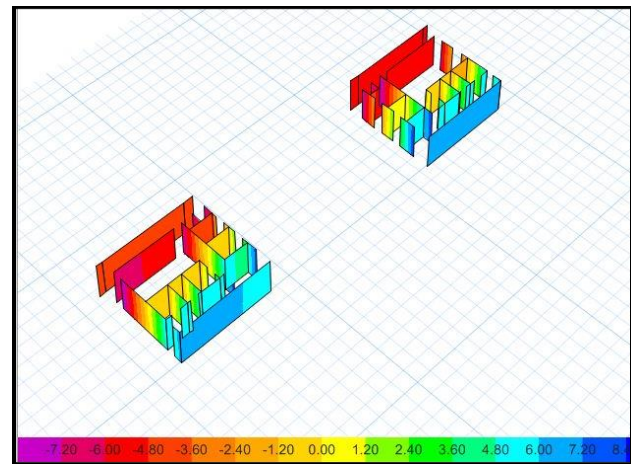
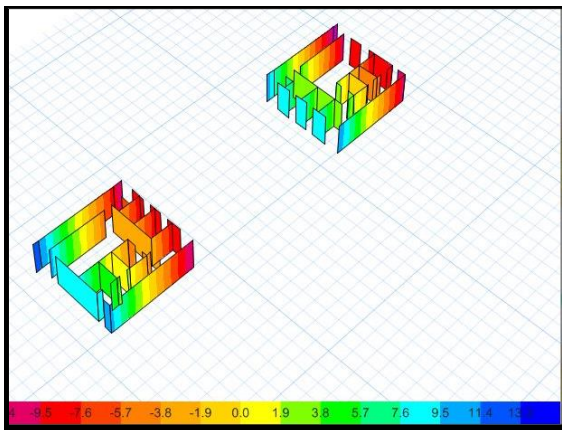
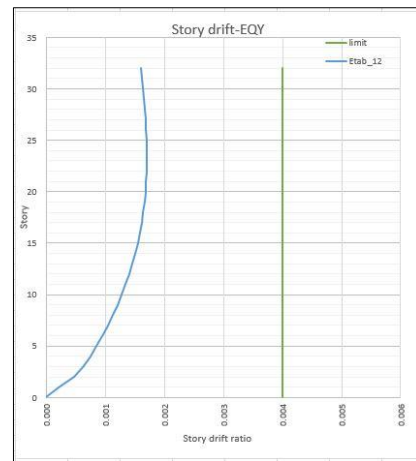
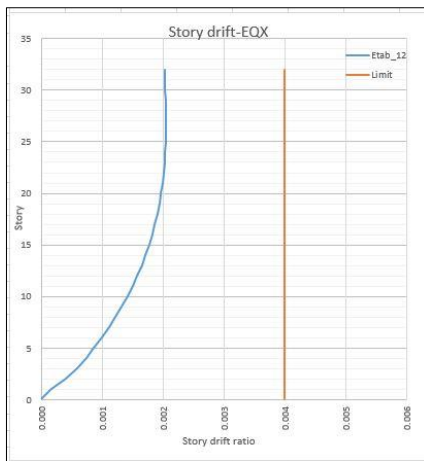
By conducting a comprehensive seismic analysis of the high-rise building with the two central core walls system as the LLRS, peripheral core wall system, and the transfer structure, engineers can ensure that the structure is capable of withstanding anticipated seismic forces. The knowledge gained from this analysis contributes to the development of effective design strategies for seismic-resistant high-rise buildings, ultimately enhancing the safety and resilience of urban infrastructure.

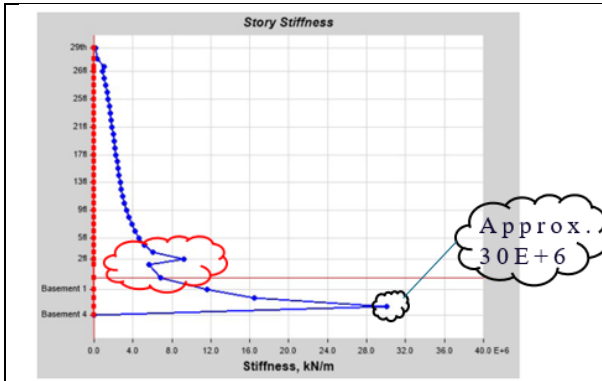
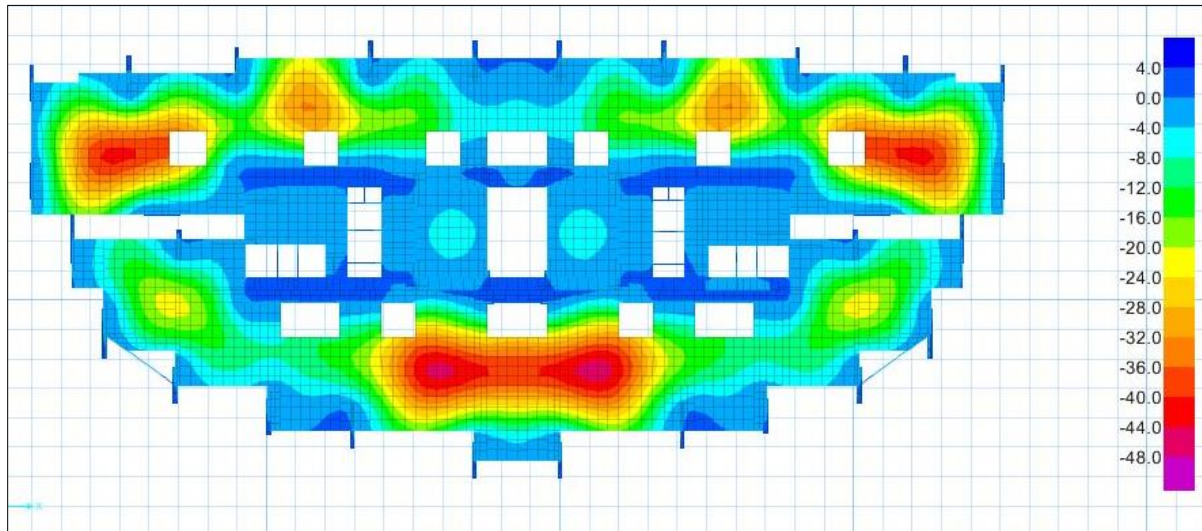
ANALYSIS RESULTS

The analysis of a complex structure, such as a high-rise building, involves extensive investigations and simulations to understand its behavior and performance under various load conditions. This chapter presents the results obtained from the comprehensive analysis conducted on the studied high-rise building, incorporating a unique lateral load resisting system (LLRS) and other structural elements.

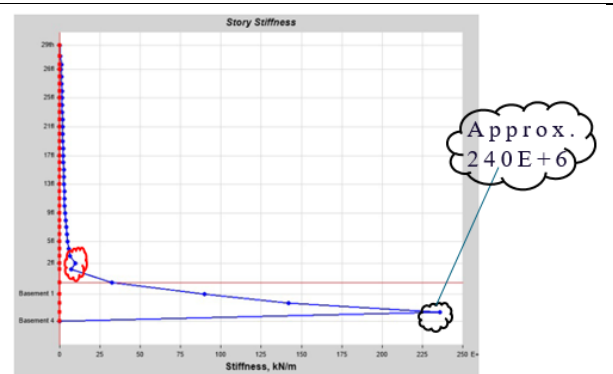


Mode Shapes





No Stiffness Irregularity With RW



Stiffness Irregularity Without RW

CONCLUSION

1. The seismic analysis of the high-rise building with a two central core walls system as the LLRS, peripheral core wall system, and a transfer structure at the first floor has provided valuable insights into its behavior and performance under seismic forces.
2. The use of two central core walls as the primary LLRS, in combination with the peripheral core wall system, has effectively enhanced the stiffness, strength, and overall stability of the building, enabling it to withstand lateral loads induced by seismic activity.

3. The location and configuration of the central core walls have played a critical role in distributing seismic forces throughout the structure, minimizing deformations, and ensuring the overall structural integrity of the building.
4. The peripheral core wall system has complemented the central core walls by providing additional resistance to lateral forces, further enhancing the overall structural performance of the building during seismic events.
5. The inclusion of a transfer structure at the first floor has facilitated the smooth transfer of loads between different sections of the building, reducing localized stress concentrations and potential weak points.
6. The comprehensive analysis considered various parameters, including ground motion characteristics, building mass and stiffness, and the behavior of individual structural elements, to accurately simulate the dynamic response of the building under seismic scenarios.
7. The analysis results, such as inter-story drift, floor accelerations, base shear, and modal properties, have provided critical information on the building's behavior, allowing for the optimization of the design, identification of potential deficiencies, and necessary adjustments to enhance its seismic resistance.
8. The findings from the seismic analysis indicate that the studied high-rise building with the proposed LLRS configuration is capable of withstanding expected seismic forces, ensuring the safety and resilience of the structure and its occupants.
9. The insights gained from this study contribute to the development of effective design strategies for seismic-resistant high-rise buildings, providing guidance to structural engineers and architects involved in the design and construction of similar structures.
10. Future research and development in this field could further refine the design and performance of high-rise buildings with similar LLRS configurations, considering additional factors such as advanced material properties, advanced analytical techniques, and new design codes and guidelines.

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