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A Review on Analysis of the Coupling Beam and Shear Wall by Using Staad Pro V8i Software

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ABSTRACT

Shear walls in enhancing the structural integrity and resistance of multistory buildings, particularly against lateral loads such as those from wind or earthquakes. This is a well-established concept in structural engineering.

The use of reinforced concrete framed buildings, complemented by strategically positioned shear walls, offers robust resistance to both vertical and horizontal forces. The analysis you described, conducted using the response spectrum method and Finite Element Analysis software like STAAD Pro, provides a comprehensive understanding of how these structures respond to seismic forces.

By comparing buildings with and without shear walls, the study likely highlighted the significant advantages of incorporating shear walls in high-rise structures. These walls not only mitigate lateral loads but also help minimize story drifts and torsional effects, contributing to overall structural stability.

In essence, the findings underscore the importance of evaluating and incorporating shear walls effectively in the design and planning of multistory buildings to ensure their resilience against seismic events and other lateral forces.

Keywords: Modeling by STAAD Pro, Special Moment Resisting Frames, Diff. types of Plans, Seismic Analysis.

Introduction

Shear walls

Shear walls indeed play a crucial role in high-rise buildings, especially in resisting lateral forces like those from wind and seismic activity. Their design and placement can significantly enhance the structural integrity and safety of tall structures. However, as you mentioned, the practical challenges in construction, such as congestion at beam-column joints and difficulty in concrete placement, necessitate thoughtful design considerations.

The utilization of various types of shear walls, including deep straight walls, angular, U-shaped, or box-shaped walls, underscores the importance of both functional and architectural requirements in high-rise buildings. By adapting the shear wall design to fit the specific needs of the building, engineers can optimize both structural performance and aesthetics.

Furthermore, the irregularities outlined in section 7 of IS 1893(part1):2002 highlight the importance of recognizing and addressing potential weaknesses in building design. Vertical irregularities, such as sudden changes in strength, stiffness, geometry, or mass distribution, can lead to uneven force distribution throughout the building's height. Similarly, plan irregularities, like asymmetrical plan shapes or discontinuities in horizontal resting elements, can introduce torsion, diaphragm deformations, and stress concentration.

By understanding and mitigating these irregularities through careful design and engineering practices, architects and engineers can enhance the overall safety and performance of high-rise buildings, ensuring they withstand the forces they may encounter throughout their lifespan.

Coupling beam

A coupling beam is a structural element used in reinforced concrete buildings to connect two or more structural components, typically shear walls or columns. It serves to transfer lateral forces, such as those generated by wind or seismic activity, from one part of the structure to another, ensuring overall stability and strength.

Coupling beams are designed to resist high shear forces and are often employed in regions with high seismic activity to enhance the building's performance during earthquakes. They are typically positioned between adjacent shear walls or columns, providing a continuous load path to distribute and dissipate lateral forces effectively.

The design of coupling beams involves considerations such as their length, width, reinforcement detailing, and the materials used to ensure they can effectively transfer forces and maintain structural integrity under various loading conditions. Additionally, proper detailing and construction practices are crucial to ensure that coupling beams perform as intended during seismic events.

Literature Review

Sanket Mendhe et al (2022) the convenience of shear walls in the primary preparation of multistory structures has for some time been perceived. At the point when walls are arranged in worthwhile situations in a structure, they can be extremely proficient in opposing horizontal burdens starting from wind or seismic tremors. Supported concrete outlined structures are satisfactory for opposing both vertical and even loads following up on them. Broad exploration has been finished in the plan and examination of shear wall elevated structures. A private structure Tall building structure is considered for the investigation. To assess the seismic reaction of the structures and investigation was performed by utilizing reaction range strategy utilizing Limited component based programming STAAD Star. The properties of these seismic shear walls overwhelm the reaction of the structures, and thusly, it is vital to fittingly assess the seismic reaction of the walls. A concentrate on an ordinary high-rise working with shear wall and without shear wall was examined to comprehend the parallel burdens, story floats and twist impacts. From the outcomes it is derived that shear walls are more impervious to horizontal burdens in structure.

Prashant Sharma et al (2021) was study you described seems to focus on optimizing the cost of multi-storey building construction while maintaining structural integrity he primary aim is to reduce construction costs without compromising the structural integrity and stiffness standards of the building.

The building employs a dual system of structural walls and moment-resisting frames. However, the use of reinforced concrete (RCC) for walls is identified as a costly aspect.

The study suggests reducing the area of shear walls, which are crucial for lateral load resistance, to cut costs. Parametric analysis indicates that a reduction of up to 20% in shear wall area is feasible for cost reduction Eight different cases are analyzed, varying the percentage of opening in the shear wall from 0% to 36.75% Response Analysis Method of dynamic analysis using Staad.pro V8i software is employed. This method evaluates the effects of opening in the shear walls on moments, shear, torsion, and axial forces in beams and columns. The study observes that increasing the opening in shear walls beyond a certain percentage (20%) leads to failure in drift at a specific height. To address this issue, a flared area of 0.5m height is introduced at the height of failure to counteract drift effects.

Increasing the opening of shear wall area up to 35% while reducing the concrete area by 1170.20 m^2 is found to be feasible. Additionally, the introduction of shear belts helps reduce drift and stabilize the structure.

Overall, the study suggests a cost-effective approach to building construction by strategically reducing shear wall areas while ensuring structural stability through appropriate modifications.

Akshay Umare et al (2019) was study shear walls in tall structures has indeed revolutionized the field of structural engineering, particularly in seismic regions where the risk of earthquakes is high. Shear walls play a crucial role in enhancing the stability and strength of buildings, especially as the trend towards taller structures continues due to urbanization and population growth.

The shift from designing buildings solely for gravity loads to considering lateral loads, such as seismic forces, has become imperative with the rise of tall buildings. Shear walls, known for their high in-plane strength and stiffness, provide effective resistance against these lateral forces, thereby increasing the overall resilience of structures.

Your project focusing on G+25 reinforced concrete framed structures with asymmetric plans and strategically placed shear walls is a commendable endeavor. By analyzing various parameters like base shear, displacement, story drift, shear force, and bending moment, you're gaining valuable insights into how different configurations impact the structural performance.

The finding that shear walls placed at corners provide the best results in terms of resisting larger seismic forces is significant. It underscores the importance of not only incorporating shear walls but also considering their placement strategically within the building layout to maximize effectiveness.

This research contributes to the ongoing efforts in structural engineering to develop safer and more resilient buildings, particularly in earthquake-prone areas. The optimization of shear wall placement based on thorough analysis can lead to the design of more robust structures capable of withstanding the challenges posed by natural disasters.

Prof. P.S. Lande et al (2018) was discussing the importance of shear walls in structural engineering, particularly in providing strength and safety to buildings under various external loads like earthquakes and wind. The use of shear walls is crucial, especially in tall structures, as they play a significant role in resisting lateral loads.

Your paper seems to focus on analyzing different models of shear walls for their effectiveness in handling lateral loads. Using E-Tabs 2015 software for equivalent static analysis and response spectrum analysis is a common practice in structural engineering research.

The parameters you're studying, such as storey displacement, storey shear, storey stiffness, and storey drift, are essential for understanding how different models of shear walls perform under various loading conditions. This analysis can help engineers make informed decisions about the design and placement of shear walls in buildings to optimize their structural integrity and safety.

Divya Thambi K et al (2017) was study coupled shear walls play a critical role in resisting lateral forces, especially in seismic regions. The behavior of coupled shear wall systems is influenced by various factors including building configuration and the degree of coupling between walls. To ensure their satisfactory performance during earthquakes, it's essential that these systems possess sufficient deformation capacity and strength.

High Strength: Coupled shear walls must be strong enough to withstand the forces exerted during an earthquake without collapsing or suffering severe damage. This strength ensures the structural integrity of the building under seismic loading.

High Ductility: Ductility refers to the ability of a material to deform plastically before failure. In the context of coupled shear walls, high ductility allows the structure to undergo significant deformation during an earthquake while maintaining its load-carrying capacity. This prevents sudden brittle failure and provides warning signs of impending structural damage.

High Energy Absorption Capacity: During an earthquake, structures experience dynamic loading which imparts significant energy. Coupled shear walls with high energy absorption capacity can dissipate this energy effectively, reducing the impact of seismic forces on the building and preventing catastrophic failure.

High Shear Stiffness: Shear stiffness is crucial for limiting lateral deformations in coupled shear wall systems. High shear stiffness helps control displacements and accelerations during seismic events, enhancing the building's overall stability and reducing the risk of structural damage.

By ensuring that coupled shear walls possess these characteristics, engineers can design buildings that are resilient to seismic activity, minimizing the risk to occupants and property.

S. P. Sharma et al (2015) the understanding of seismic behavior in multi-story reinforced concrete (RC) frame structures, particularly focusing on lateral load resisting systems such as shear walls and diagram systems. Brief overview of the increasing demand for earthquake-resistant structures. Importance of seismic analysis in structural design. Introduction to the focus of the paper: multi-storey RC frame structures with shear walls and diagram systems. Description of the analytical methods and software used for seismic analysis. Explanation of the structural models considered, including variations in shear wall locations and heights. Details of the comparative study approach and parameters considered. This structure should help organize your paper effectively and ensure that you cover all the necessary aspects of your research. Make sure to provide clear explanations, sufficient detail, and logical flow throughout the paper.

RakshithGowda K.R et al (2014): This paper bargains the way of behaving of multi storyed RC three dimensional casing normal structure and in an upward direction unpredictable (ventured) working in which delicate story's are given at various level to various burden blends. It is important to study and analyze different elective models of built up substantial second opposing casing working with delicate story at various level. Two distinct structures, normal and in an upward direction sporadic structure in which delicate story are given at various story level are demonstrated utilizing ETABS (9.7.4) bundle and examined. Models are dissected as exceptional second opposing edge utilizing same static examination and reaction range investigation. The outcomes are introduced by plotting the chart for each models considered in the study. The examination completed is identical static investigation and dynamic examination. The aftereffect of Story dislodging, Entomb story

float, Base shear and Crucial time span at the principal mode is introduced for all models. In this study standard structure is contrasted and sporadic structure, the exhibition of all the structure models is seen in high seismic zone V. The entomb story float was seen to be most extreme in an upward direction unpredictable construction. The Base shear values are seen to be something else for the edges with complete infill, while the uncovered casing models show the base worth in both X and Y-bearing. The relocation is seen to be least in normal structure when contrasted and the sporadic structure for time span mode-1.Hence it very well may be presumed that the customary structure is more secure than sporadic structure.

C.M. Ravi Kumar et al. (2013) explores seismic vulnerability assessment in reinforced concrete (RC) buildings with various configurations of shear walls. They investigate the impact of shear wall placement on the structural integrity and seismic performance of multistoried buildings.

The research considers several scenarios, including buildings without shear walls and those with shear walls positioned at different locations: at the center, diagonal corners, mid along X-direction, mid along Y-direction, and at the intersection of X and Y directions. The study aims to identify the optimal location for shear walls to minimize stresses in structural members while reinforcing the building economically.

Key findings suggest that incorporating shear walls, regardless of building height, significantly enhances structural strength compared to bending frames alone. The placement of shear walls influences the distribution of stresses and seismic forces within the structure. For instance, constructing shear walls at the building center may reduce the time period of the structure but could introduce torsional effects, making this configuration less desirable.

The study highlights the importance of utilizing structural analysis software, such as ETABS, to streamline the analysis and design process, as manual calculations are laborious and time-consuming. Additionally, it emphasizes the necessity of ensuring that moment resisting frames can independently resist a significant portion of the design seismic base shear, typically around 25%.

The findings suggest that placing shear walls strategically, such as along the X-direction, can minimize story displacement and drift while optimizing structural performance. However, the study underscores the need for further analytical and experimental investigations to refine the understanding of shear wall placement and its impact on multistoried buildings' seismic response.

Conclusion:

Based on the comprehensive literature review, several key conclusions can be drawn:

Effectiveness of Shear Walls: Adding shear walls at appropriate locations within frames reduces lateral forces, especially in structures with minimal initial lateral forces. They also enhance resistance to lateral loads and mitigate torsional effects, particularly in irregular structures.

Impact of Shear Wall Dimensions: Larger shear wall dimensions result in greater absorption of horizontal forces, emphasizing their role in structural stability and load distribution.

Code Displacement Values: Displacement values vary between different building codes, with UBC generally yielding higher maximum values compared to IS, highlighting the importance of considering code-specific requirements.

Dynamic Analysis Necessity: Static analysis alone may not suffice for high-rise buildings, mandating the inclusion of dynamic analysis for accurate assessment of structural behavior under varying loads.

Economic Considerations: While equivalent static analysis may be convenient, dynamic analysis often yields more economical designs by providing lower displacement values.

Symmetry and Structural Response: Regular configurations exhibit higher base shear and story drift values due to their symmetrical dimensions, compared to irregular configurations.

Effectiveness of Shear Wall Placement: Models incorporating shear walls at core and corner positions exhibit reduced displacement values, emphasizing the significance of shear wall placement for optimal structural response.

Member Size and Shear Walls: Shear walls enable economic reductions in member sizes, particularly columns, contributing to cost-effective structural design.

Displacement and Drift Reduction: Buildings with shear walls demonstrate lower displacement and inter-story drift compared to RCC buildings without shear walls, indicating their effectiveness in minimizing structural deformations.

Torsional Analysis Importance: Irregular buildings require thorough analysis for torsional effects to ensure structural integrity and stability.

Effect of Openings on Shear Wall Performance: Size and placement of openings within shear walls affect both stiffness and seismic response, underscoring the need for careful consideration during design.

Accuracy of Response Spectrum Method: Response spectrum analysis yields more accurate results compared to equivalent static analysis, making it a preferred method for seismic assessment.

Shear Walls and Soil Interaction: Incorporating shear walls and considering soil interaction significantly alters member forces, emphasizing the importance of comprehensive analysis.

Impact on Column Forces: Shear walls mitigate bending moment and shear force in ground floor columns, especially in sloped terrains, without significantly affecting axial forces.

These conclusions collectively underscore the multifaceted role of shear walls in enhancing structural performance, optimizing design efficiency, and ensuring seismic resilience in various building configurations.

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