

ANALYSIS OF MULTI-STOREY BUILDINGS WITH HYBRID SHEAR WALL- STEEL BRACING STRUCTURAL SYSTEM: A REVIEW

Shubham Bhalchandra Ajmire¹, Dr. B. H. Shinde²

¹PG student, Department of Civil Engineering, G.H. Rasoni University, School of Engineering and Technology, Amravati, India.

²Assistant Professor, Department of Civil Engineering, G.H. Rasoni University, School of Engineering and Technology, Amravati, India.

ABSTARCT

This study conducts a thorough examination of the strategic placement of shear walls and bracing systems in multistorey buildings, emphasizing their pivotal roles in mitigating lateral forces. The research is driven by the increasing importance of these structural components in bolstering the stability and resilience of tall buildings amidst urban growth. Central to this investigation is a comprehensive literature review, which synthesizes existing research on shear walls and bracing systems. Beyond delving into historical and theoretical contexts, the review identifies gaps and obstacles within the current scholarly landscape.

Keywords: shear walls, bracing systems, multistorey buildings, lateral forces, structural stability

1. INTRODUCTION

1.1 General:

In the modern urban landscape, multistorey buildings stand as iconic structures, demanding robust structural designs capable of withstanding lateral forces such as wind and seismic activities. Among the various structural systems employed, shear walls and bracing systems play pivotal roles in enhancing the stability and resilience of tall structures. This comparative study aims to explore optimal configurations for shear walls and bracing across different locations within multistorey buildings.

Context and Significance:

As urbanization continues to rise, the construction of tall buildings becomes increasingly prevalent. These structures face heightened vulnerability to lateral forces due to their height and exposure. Selecting an effective lateral load-resisting system is crucial for ensuring the safety, functionality, and longevity of multistorey buildings. Shear walls and bracing systems emerge as key contenders, each offering unique advantages in mitigating lateral loads.

Shear Walls and Bracing: A Structural Imperative:

Shear Walls: Foundation of Stability:

Shear walls represent essential components in the structural arsenal of multistorey buildings, providing robust defense against lateral forces like wind and seismic activities. These vertical structures, integral to the building's framework, are strategically placed to counteract lateral forces acting parallel to their planes. The fundamental purpose of shear walls is to enhance the overall stability of the structure by redistributing lateral forces, mitigating sway, and bolstering resistance to deformation.

Perimeter Shear Walls:

Perimeter shear walls, often located along the building's exterior, serve as shields against external lateral forces, particularly those induced by wind. Their placement maximizes the effectiveness of the building envelope in withstanding external pressures.

Core Shear Walls:

Positioned at the core of the building, core shear walls contribute to the overall stiffness of the structure. They play a critical role in reducing torsional effects and enhancing the lateral load-resisting capacity, particularly in tall buildings.

2. REVIEW OF LITERATURE

2.1 General:

Re-written Passage with Expanded Analysis:

This section delves into the existing body of research on shear walls and bracing systems, their role in multistorey buildings, and how to optimize their placement for superior lateral load resistance. As high-rise structures become a defining feature of urban landscapes, understanding the intricacies of these systems becomes paramount. This review aims to not only provide a historical and theoretical foundation but also identify knowledge gaps and pave the way for

further exploration. By synthesizing diverse perspectives and methodologies, it establishes a framework for subsequent comparative analysis. This analysis will ultimately yield a contextualized understanding of the factors influencing the efficacy of shear walls and bracing systems in multistorey buildings.

Key Findings from Reviewed Literature:

- **Shear Walls as Seismic Safeguards:** Reinforced concrete shear walls are widely recognized as crucial components in earthquake-resistant building design (Studies by [1, 2, 3]). Their inherent rigidity enables them to effectively resist lateral loads induced by seismic events. Research by Karthick et al. [1] emphasizes this point, highlighting the substantial contribution of shear walls to a building's seismic response. Studies by Chandurkar et al. [2] further underscore this by analyzing the impact of shear wall placement on a building's performance in varying seismic zones.
- **Optimizing Shear Wall Placement:** The literature emphasizes the significant influence of shear wall placement on a building's seismic performance. Chandurkar et al. [2] investigate this concept by employing four different models, including a bare frame structure and models incorporating shear walls in strategic locations. Their analysis across various seismic zones demonstrates the effectiveness of well-positioned shear walls in mitigating seismic impact.
- **Beyond Earthquakes: Addressing Wind Loads:** The reviewed literature acknowledges that both shear walls and bracing systems offer effective solutions for resisting not only earthquake-induced lateral loads but also wind loads. Rizwan et al. [3] support this notion, highlighting the practical application of these systems in multistorey buildings for enhanced performance during seismic and wind events.
- **Evaluation Through Analytical Tools:** The studies employ various parameters to assess the effectiveness of these systems. Story displacement, story drift, and base shear are some of the common metrics used. Rizwan et al. [3] exemplify this practice by evaluating building performance based on these parameters in a G+14 storey structure with different bracing and shear wall configurations. Software like ETABS is frequently used to perform these analyses, as demonstrated by Limda et al. [5] in their seismic behavior study of shear-walled and braced frames.
- **Addressing Challenges of High-Rise Irregularities:** The literature acknowledges the growing demand for high-rise buildings with complex configurations. These irregular structures pose unique challenges in terms of seismic resistance. Studies by Patel et al. [7] address this by exploring outrigger systems as a potential solution for high-rise buildings with irregular configurations.
- **Knowledge Gaps and Future Directions:** The review also identifies areas where further research is necessary. Studies by Gupta et al. [8] point to the need for a deeper understanding of optimal shear wall placement for various building configurations and seismic zones. Additionally, the ever-increasing demand for high-rise buildings, as discussed by Sharma et al. [9] and Naik et al. [10], necessitates continuous advancements in structural design, particularly regarding strategies to manage lateral loads effectively.
- **Shubam Sharma et al [11]** investigated the use of finite element analysis to optimize seismic performance in structures. They employed a linear dynamic method and finite element software to evaluate numerous configurations of a hybrid structural system. This system combined shear walls and bracings to achieve superior seismic resistance. The study aimed to identify an optimal configuration that minimized negative structural responses under earthquake conditions. The researchers compared factors like time period, base shear, overturning moment, story drift ratio, and story displacement for different models. By analyzing these comparisons, they were able to determine the optimal structural configuration. The results indicated that the hybrid system exhibited a reduction in fundamental time period and story displacement, while maintaining negligible increases in base shear and overturning moment compared to traditional structural models.
- **Dharanya A et al [12]** focused on the impact of seismic forces on high-rise buildings. Their research emphasized the importance of lateral stiffness in multistorey structures. During earthquakes, lateral or torsional deflections can cause significant discomfort for occupants. To address this issue, the study compared the effectiveness of shear walls and cross bracings in enhancing the lateral resistance of a G+4 storey residential RC building with a soft story (a weaker ground floor compared to upper floors). The analysis was conducted using ETABS software and adhered to the IS 1893:2002 codal provisions, a set of standards for earthquake-resistant building design in India.
- **Md. Samdani Azad et al [13]** conducted a comparative study on the use of shear walls and steel bracings in mitigating seismic loads for reinforced concrete (RC) and steel structures, respectively. Both systems are prevalent methods for minimizing earthquake damage in buildings. However, the study revealed that while both approaches are effective, they exhibit varying effects on structural behavior under seismic loads. This is attributed to differences

in response factors for various structural systems. The research presented a numerical approach to illustrate these dissimilarities and proposed a novel method using steel bracing to strengthen the lateral force resisting system, a crucial component for resisting earthquake forces.

- Mohd Atif et al [14] compared the seismic performance of a G+15 building with various bracing and shear wall configurations across different earthquake zones (II-V) in India. They aimed to understand the key factors that contribute to poor seismic performance and identify strategies to improve structural behavior during future earthquakes. The analysis focused on a symmetrical G+15 ordinary RC moment-resisting frame (OMRF) building modeled using STAAD Pro. V8i software. The study retrieved the time period of the structure in both directions from the software and performed seismic analysis according to IS 1893(part 1):2002 standards. The researchers employed the linear static method as outlined in the code to determine the lateral seismic forces acting on the RC frame for each earthquake zone.
- K.V.G.M.Sreeram et al [15] investigated the effectiveness of shear walls and bracings in enhancing the lateral stiffness, ductility (deformation capacity), and overall safety of structures subjected to earthquakes and wind loads. They analyzed a G+9 multi-story building using two different frame models and time history analysis conducted with STAAD-Pro software. The study compared the performance of the building with shear walls at the corners and braced frames. They evaluated and compared factors such as story drifts, maximum bending moments, maximum shear forces, and deflections.
- Islam, M. R., et al [16] explored the concept of shear walls as structural components that provide stability against lateral loads like wind and seismic forces. They discussed various materials used in shear wall construction, including reinforced concrete, plywood/timber, unreinforced masonry, and reinforced masonry. Additionally, they categorized shear walls into different sub-types such as coupled shear walls, shear wall frames, shear panels, and staggered walls.
- Priyanka Soni et al [17] reviewed research on enhancing the performance of shear walls under lateral loads. Their focus was on high-rise buildings with soft stories, where shear walls resist a significant portion of the lateral loads in the lower levels, while the frame supports the loads in the upper stories. This configuration is particularly relevant for buildings in India, where base floors are often used for parking or offices, and upper floors serve residential purposes.
- Pujari, Aishwarya et al [18] investigated the behavior of RC structures incorporating either shear walls or steel bracings for seismic resistance. They compared the effectiveness of these systems in an asymmetrical plus-shaped G+7 RC frame structure. The analysis employed the Response Spectrum Method (RSM) and was conducted using ETABS software. The researchers placed shear walls and bracings at various locations within the model. They compared parameters like base shear, displacement, story drift, time period, and story acceleration to assess the relative stiffness and strength provided by each system.

3. CONCLUSIONS

This literature review highlights studies that employ finite element software (e.g., ETABS) to compare the effectiveness of these two systems. Researchers have investigated the influence of factors such as shear wall thickness, bracing type, and various structural configurations. These studies aim to improve our understanding of how seismic behavior and structural performance are affected by different earthquake zones and soil conditions.

This study on where to put shear walls and braces in tall buildings is important for several reasons:

- **Building codes might change:** The study results could be used to improve building codes, making buildings stronger.
 - **Better building practices:** Engineers can learn from this study to design buildings that resist earthquakes better.
 - **Saving money on construction:** The study might show ways to place shear walls and braces that cost less.
 - **Teaching future engineers:** This information can be used to teach future engineers how to design safer buildings.
- In short, this study can make buildings stronger, cheaper, and teach future engineers how to do their jobs better.

4. REFERENCES

- [1] Karthick, S., Kumar, U. S., & Geetha, G. (2016). Study on lateral resistance behaviour of high rise building with shear wall and bracings. The International Journal of Science and Technoledge, 4(2), 65.
- [2] Chandurkar, P. P., & Pajgade, D. P. (2013). Seismic analysis of RCC building with and without shear wall. International journal of modern engineering research, 3(3), 1805-1810.

- [3] Rizwan, M. (2020). Study on optimum location of bracing and shear wall on multistory building with different type of soil condition.
- [4] Martinez Martinez, J. (2007). Seismic performance assessment of multi-storey buildings with cold formed steel shear wall systems.
- [5] Limda, P. O. SEISMIC BEHAVIOUR OF MULTI STORY SHEAR WALL FRAME VERSUS BRACED FRAME.
- [6] JOSHI, K. C. (2022). SEISMIC RESPONSE OF MULTI-STOREY SHEAR WALL FRAMED STRUCTURE WITH SOFT STORY (Doctoral dissertation).
- [7] Patel, N., & Jamle, S. (2019). Use of Shear Wall Belt at Optimum Height to Increase Lateral Load Handling Capacity in Multistory Building: A Review. International Journal of Advanced Engineering Research and Science, 6(4).
- [8] Gupta, S., Gaikar, S., Patil, K., Shelar, S., Thakare, H., Wagholi, M. S., ... & India Maharashtra, I. M. (2021). Dynamic Analysis of Multi Storey Building With and Without Shear Wall. Int. J. Eng. Appl. Sci. Technol, 6(1), 227-230.
- [9] Sharma, S. P., & Bhandari, J. P. (2017). Literature Review on the Seismic Performance of Multi-Storey Building with Different Locations of Shear Wall and Diagrid. International Journal of Science and Research (IJSR), 6(6), 2319-7064.
- [10] Naik, A., & Maru, S. REVIEW PAPER ON SEISMIC ANALYSIS OF MULTI STOREY BUILDING USING SHEAR WALL, BRACING AND BASE ISOLATION.
- [11] Sharma, S., & Tiwary, A. K. (2021). Analysis of multi-story buildings with hybrid shear wall: steel bracing structural system. Innovative Infrastructure Solutions, 6, 1-12.
- [12] Dharanya, A., Gayathri, S., & Deepika, M. (2017). Comparison Study of Shear Wall and Bracings under Seismic Loading in Multi-Storey Residential Building. International Journal of ChemTech Research, 10(8), 417-424.
- [13] Azad, M. S., & Abd Gani, S. H. (2016). Comparative study of seismic analysis of multistory buildings with shear walls and bracing systems. International Journal of Advanced Structures and Geotechnical Engineering (IJASGE), 5(03), 72-77.
- [14] Atif, M., Vairagade, L., & Nair, V. (2015). Comparative Study on Seismic Analysis of Multistorey Building Stiffened With Bracing and Shear Wall. International Research Journal of Engineering and Technology (IRJET), 2(05), 1158-1170.
- [15] Sreeram, K. V. G. M., Singh, R. P., & KUMAR, S. S. B. S. (2017). Effective location of shear walls and bracings for multistoried building. International Research Journal of Engineering and Technology. www. irjet. net.
- [16] Islam, M. R., Chakraborty, S., & Kim, D. (2022). Effects of Material Nonlinearity on Seismic Responses of Multistoried Buildings with Shear Walls and Bracing Systems. ARCHITECTURAL RESEARCH, 24(3), 75-84.
- [17] Soni, P., Tamrakar, P. L., & Kumhar, V. (2016). Structural analysis of multistory building of different shear walls location and heights. International Journal of Engineering Trends and Technology (IJETT), 32(1), 50-57.
- [18] Pujari, A., & Doshi, T. D. (2022). Seismic Analysis of Multi-Storey Irregular Building, Including Effect of Shear Wall and Bracing System. IUP Journal of Structural Engineering, 15(1).