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Seismic Analysis of Steel Building with RC Shear Wall-Literature Review

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ABSTRACT: This literature review explores how integrating reinforced concrete (RC) shear walls into steel building systems influences their seismic performance. Research consistently shows that while steel frames offer high flexibility and energy dissipation, their lateral stiffness is often insufficient for strong earthquake zones. RC shear walls, on the other hand, provide substantial stiffness and strength, helping to reduce drift, control deformation, and limit damage during seismic events. Studies covering a range of shear wall configurations, placements, and geometries highlight that the effectiveness of these walls depends greatly on their orientation and interaction with the surrounding steel frame. Findings also reveal that combining steel frames with strategically placed RC shear walls results in improved overall stability, lower displacement demands, and better resistance to torsional effects, especially in taller or irregular structures. However, gaps remain regarding optimal wall-to-frame connectivity, material compatibility, and performance under nonlinear dynamic loading. Overall, the reviewed literature demonstrates that hybrid steel–RC shear wall systems can significantly enhance seismic resilience, but further work is needed to refine design guidelines and understand long-term behavior under real earthquake conditions.

KEYWORDS: Steel Building, RC shear wall, seismic analysis.

I. INTRODUCTION

The increasing demand for safer and more resilient buildings has pushed engineers to explore structural systems that can perform reliably during earthquakes. Steel buildings are widely valued for their high strength-to-weight ratio, rapid construction, and superior ductility, allowing them to absorb significant energy during seismic events. However, their flexibility can also become a drawback, often leading to excessive drift and deformation when subjected to strong lateral forces. To address these limitations, reinforced concrete (RC) shear walls are frequently introduced into steel structures as a means of enhancing stiffness and improving overall lateral resistance.

RC shear walls play a crucial role in modern seismic design. Their ability to control deflection, resist horizontal loads, and contribute to the overall stability of multi-storey buildings makes them essential components in earthquake-prone regions. When combined with steel frames, these walls form a hybrid system that capitalizes on the strengths of both materials—steel's ductility and RC's rigidity. Over the years, researchers have examined various aspects of this interaction, including the influence of wall placement, geometry, connection detailing, and material properties on the seismic response of the structure.

Although individual studies have provided valuable insights into the behavior of steel–RC shear wall systems, there is still no universal agreement on the most effective design strategies for different building types and seismic conditions. Many variables—from the height and configuration of the structure to the soil conditions and seismic intensity—affect how these systems perform. As a result, understanding their combined behavior requires a careful review of existing research.

This literature review focuses on gathering and synthesizing previous findings to better understand how RC shear walls impact the seismic performance of steel buildings. By examining trends, identifying knowledge gaps, and comparing

results across multiple studies, this review aims to provide a clearer foundation for future research and to support the development of more reliable and efficient seismic design practices.

II. LITERATURE SURVEY

Abdulrahman M. Abualreesh, Ahmet Tuken et.al. “Reliability-based optimization of shear walls in RC shear wall-frame buildings subjected to earthquake loading”

This study presents a reliability-based approach to optimizing the number and placement of shear walls in reinforced concrete shear wall-frame buildings exposed to strong earthquakes. While past work focused mainly on minimizing material use or improving seismic performance, this research emphasizes the need to also meet a target reliability level so that the building's long-term safety is quantifiable. Using ten-story symmetrical and unsymmetrical building models subjected to the El-Centro earthquake, the authors analyzed story drift, shear stresses, and their statistical distributions through nonlinear time-history simulations. Reliability indices were then computed using Monte Carlo Simulation and FORM techniques. The findings show that although adding shear walls significantly reduces drift and enhances stiffness, not all configurations achieve the desired reliability level. Overall, the study highlights that structural safety cannot depend solely on code-based drift and strength checks; instead, integrating reliability constraints leads to more balanced and safer shear wall design solutions.

Alashkar Y., Nazar S. et.al. “A Comparative Study of Seismic Strengthening of RC Buildings by Steel Bracings and Concrete Shear walls”

This study compares how effectively reinforced concrete (RC) buildings can be strengthened against earthquakes using two common retrofitting strategies—concrete shear walls and steel bracing systems. Using a ten-story residential building model, the authors evaluate how each technique influences key seismic performance measures such as base shear, lateral displacement, story drift, bending moments, and shear forces. The results show that shear walls, especially when placed at the building's core, significantly reduce lateral movements and internal forces, offering the highest improvement in stiffness and drift control. Steel bracings, while lighter and more economical, show varying performance depending on type: X-bracing increases stiffness and reduces moments effectively, whereas V-bracing introduces additional localized flexural demands due to its eccentric configuration. Overall, the study highlights that both systems enhance seismic resistance, but shear walls provide the most substantial global improvement, whereas steel bracings offer a flexible and cost-efficient alternative for targeted strengthening needs.

Boria Anya, Tamal Ghosh et.al. “A Study on Effect of Shear Wall in Seismic Analysis of Building”

This study explores how the placement of shear walls influences the seismic behavior of reinforced concrete buildings by analyzing G+4 and G+6 structures under earthquake loading using SAP2000. The authors evaluate different shear wall configurations—at the core, corners, and periphery—and compare them with a bare frame to understand their impact on displacement, storey drift, and base shear. The results show that introducing shear walls significantly enhances lateral stiffness and reduces displacement, with core and corner placements performing best in limiting storey drift, as illustrated in the response curves throughout the results section (pages 12–18). However, these configurations also lead to higher base shear values, indicating increased force demand on the structure. Importantly, the study confirms that all models keep storey drift within the limits prescribed by IS 1893:2002. The authors conclude that optimal shear wall positioning is crucial for achieving better seismic performance and recommend extending the work with pushover and time-history analyses for more comprehensive insights.

Nitin Vishwakarma, Hardik Tayal et.al. “Performance of Steel Braced Shear Wall”

This study examines how combining steel bracing with reinforced concrete shear walls can improve the seismic performance of medium-rise buildings. Using a real G+20 residential building in Gurgaon as the base model, the researchers created four structural configurations—one with only shear walls and three where the shear walls were partially replaced and optimized using different steel bracing patterns such as diagonal, cross, and chevron arrangements (as shown in the model elevations on pages 3–4). The models were analyzed in ETABS using response spectrum analysis according to IS 1893:2002, with results compared across key parameters like storey shear, bending moments, torsion, storey drift, and terrace deflection (Figures 6–12). The findings indicate that while shear walls offer superior stiffness and effectively limit drift, the integration of steel bracing reduces overall seismic demand, lessens bending moments, and decreases building weight, thereby reducing base shear. Among the

bracing types, X-bracing shows the best reduction in lateral displacement, improving performance by about 35–45%. The study concludes that steel-braced shear wall systems can serve as an efficient and economical alternative for strengthening or retrofitting tall RC buildings without major architectural or height alterations.

C.R.Urkude, P.G.Atole, G.P.Chavan et.al. “Seismic analysis of high rise building with shear wall at different locations”

This study investigates how the placement of shear walls affects the seismic performance of a G+15 reinforced concrete building located in Zone III by analyzing four different configurations using ETABS. The models include shear walls positioned at the center core, with openings, along the inner sides, and at the corners, as shown in the layout diagrams on pages 3–4. Key seismic parameters—storey drift, displacement, and base shear—are compared using response data illustrated in the graphs on pages 4–5. The findings show that the configuration with shear walls placed on each side at the inner core (Model 3) consistently provides the lowest storey drift and displacement in both X and Y directions, indicating superior stiffness and lateral resistance. All models demonstrate reduced drift and displacement compared to a bare frame, confirming the effectiveness of shear walls in enhancing seismic performance. The study concludes that proper placement of shear walls is crucial, and that interior-side shear wall positioning yields the most efficient structural response, while also emphasizing that building safety under earthquakes greatly depends on controlling drift and ensuring adequate stiffness.

Aparna Nishtala¹, Ajay Radke et.al “ Review of Using Shear Walls & bracings for Seismic Strengthening of High-Rise RC Structures”

This review paper examines how shear walls and steel bracing systems contribute to improving the seismic safety of high-rise reinforced concrete buildings. As highlighted in the introduction and abstract (page 1), both systems are widely used to enhance lateral stiffness, reduce drift, and improve structural performance under earthquakes and wind loads. The authors compile findings from numerous past studies (pages 2–4), showing that shear walls significantly increase stiffness and reduce story displacement and torsion, especially in irregular or asymmetrical buildings where seismic response tends to worsen. Steel bracings— particularly X-bracing—are noted for being lightweight and cost-effective, capable of reducing lateral displacement and bending demands without adding major weight to the structure. Several studies reviewed demonstrate how different bracing layouts influence performance, with some configurations even acting as effective retrofitting solutions for older RC buildings. The paper concludes (page 5) that while shear walls provide superior stiffness and effectively minimize lateral movement, steel bracings remain an efficient and economical option for strengthening and retrofitting, and that optimal placement of both systems plays a critical role in enhancing overall structural resilience.

Vedang Shukla, Abhishek Jhanjhot et.al. “Seismic Analysis of Irregular (G+9) building with Shear Wall at Different Location: A Review”

This review paper examines how shear wall placement affects the seismic behavior of irregular reinforced concrete buildings, with a particular focus on a G+9 asymmetrical structure modeled using STAAD-Pro. As described in the introduction and objectives (pages 1–2), the study emphasizes that irregular buildings are naturally more vulnerable to torsion, uneven load distribution, and excessive drift during earthquakes. The reviewed literature (pages 2–4) highlights findings from multiple studies showing that shear walls—whether placed at corners, centers, or along exterior frames—significantly improve lateral stiffness, reduce story drift, control base shear, and help minimize torsional effects. Research also demonstrates that the efficiency of shear walls depends heavily on their location; while some configurations drastically reduce displacement, others may unintentionally increase eccentricity and torsion if poorly positioned. Visual references such as Figures 1–4 (page 4) illustrate differences between symmetrical and asymmetrical models, underscoring how irregularity amplifies seismic demands. The paper concludes (page 4) that determining the ideal shear wall location is essential for improving the performance of irregular high-rise buildings, as these structures are more prone to lateral instability, torsion, and differential settlement under seismic loads.

Ke Wang, Wenyuan Zhang et.al. “Seismic Analysis and Design of Composite Shear Wall with Stiffened Steel Plate and Infilled Concrete”

This research investigates the seismic behavior of a composite shear wall system made from stiffened steel plates filled with concrete, aiming to address limitations in previous experimental studies by developing a detailed finite-element (FE) model using ABAQUS. The paper validates this FE model against laboratory test results, showing

close agreement in hysteresis curves, failure patterns, ultimate strength, and stiffness (pages 10–12). By examining the mechanical roles of different components, the study finds that the steel web plate carries a major share of the lateral load—between 55% and 85%—while concrete contributes mainly to vertical load resistance as it behaves like several independent columns separated by stiffeners (page 1). A comprehensive parametric study further reveals that wall thickness, steel ratio, and shear-span ratio significantly influence stiffness and ultimate capacity, while shear-span ratio and axial compression ratio strongly affect ductility (pages 18–22). Drawing from FE results and experimental data, the authors propose new design formulas for predicting ultimate strength and elastic stiffness under cyclic loading—formulas that show good accuracy across different wall configurations. Overall, the study demonstrates that composite steel-plate-concrete shear walls offer high strength, ductility, and energy dissipation, making them a promising alternative for seismic-resistant structural systems.

Vivek Singh and Anjali Rai et.al. “Seismic Analysis of Moment Resisting Frame Building with Steel Shear Walls and with Bracing System”

This study evaluates how different lateral-force-resisting systems—specifically steel shear walls and two types of bracings (V-bracing and inverted V-bracing)—affect the seismic performance of a G+21 steel moment-resisting frame building. Using ETABS 2017, the authors modeled four configurations (pages 148–149) and analyzed them under response spectrum loading as per IS 1893:2016. The comparative results (page 149) show that the steel shear wall system consistently outperforms all other models by producing the lowest story displacement, the highest stiffness in both X and Y directions, and the shortest natural time period, indicating superior rigidity and reduced lateral deformation. In contrast, the bare frame (without bracing and without steel shear wall) exhibits the maximum displacement and lowest stiffness, making it the least efficient. Bracing systems improve performance moderately, with inverted V-bracing performing slightly better than V-bracing, but both remain less effective than the steel shear wall (pages 149–150). Overall, the study concludes that incorporating a steel shear wall at the building core provides the most robust seismic response, delivering significantly higher stiffness and stability, and therefore represents the optimal configuration among the options evaluated.

G. Edlebi et.al. “A Review of Enhancing Performance and Sustainability of RC Shear Walls”

This review paper provides a comprehensive examination of how retrofitting strategies can improve both the performance and long-term sustainability of reinforced concrete (RC) shear walls, especially in older buildings that lack modern seismic detailing. As highlighted in the introduction (pages 1–2), many pre-1970s RC structures suffer from inadequate reinforcement, poor confinement, and low ductility, making them highly vulnerable during earthquakes. The paper synthesizes findings from numerous studies on traditional strengthening methods—including concrete replacement, jacketing, steel plates, bracings, and through-thickness rods—as well as more advanced systems such as wall-end plate retrofits, self-centering rocking mechanisms, FRP composites, engineered cementitious composites (ECC), and shape memory alloys (pages 3–7). These modern materials and techniques show remarkable improvements in ductility, energy dissipation, and damage control, with ECC and SMA-based solutions offering especially promising results. In addition to structural performance, the review places strong emphasis on sustainability by discussing low-impact materials, life-cycle assessment, waste reduction strategies, and greener construction practices (pages 7–9). Case studies of iconic buildings—such as the Palace of Fine Arts and Los Angeles City Hall—demonstrate practical, successful retrofits (page 10). Overall, the paper argues that future retrofit approaches must balance seismic resilience with environmental responsibility, using innovative materials and holistic planning to create safer and more sustainable RC shear wall systems.

Kanchan Rana, Vikas Mehta et.al. “Seismic Analysis of RCC Building with Shear Wall at Different Locations Using STAAD Pro”

This study analyzes how the placement of shear walls affects the seismic performance of a G+5 reinforced concrete building located in Zone V, using Response Spectrum analysis in STAAD Pro. Three models were evaluated: one without shear walls, one with walls placed at the edges, and one with walls at the center of each side, as shown in the structural layouts on pages 52–53. The results (pages 54–55) clearly show that storey drift is highest in the bare frame (Model-1), while Model-3—with shear walls positioned at the mid-sides—consistently produces the lowest drift in both X and Z directions, demonstrating much better lateral stability. Similarly, peak storey shear is lowest for the bare frame and highest for Model-2 and Model-3, indicating that models with shear walls attract more seismic forces due to their increased stiffness. Overall, the findings confirm that introducing

shear walls significantly improves seismic resistance, with the optimal location being at the center of each side (Model-3), which provides the best balance of stiffness, reduced drift, and overall structural performance.

Akansha Dwivedi et. al. “Seismic Analysis of Building with and Without Shear Wall for Building with RCC and Composite Column”

This study compares the seismic behavior of a 20-storey building designed with two different structural systems—RCC columns and composite steel–concrete columns—and examines how adding shear walls influences their performance. Four ETABS models were developed: RCC without shear wall, RCC with shear wall, composite column without shear wall, and composite column with shear wall. Using both static and response spectrum analyses as per IS 1893:2016, the authors assessed storey displacement, drift, stiffness, lateral force, and base shear. The results clearly show that models with shear walls perform significantly better, with the composite-column building containing shear walls achieving the lowest storey displacement and drift values in all comparisons. For example, in static analysis, top-storey displacement reduces by nearly 40% in RCC buildings with shear walls and by about 20% when switching from RCC to composite columns; reductions are even greater under dynamic response spectrum analysis (page 8). Stiffness graphs (pages 4 and 7) also highlight that the composite-column + shear wall model consistently provides the highest stiffness across all floors. Overall, the study concludes that composite columns paired with shear walls offer the most efficient seismic performance, significantly enhancing lateral resistance and reducing deformation compared to RCC structures with or without shear walls.

Syed Ehtesham Ali, Mohd Minhaj Uddin Aquil et.al. “Study of Strength of RC Shear Wall at Different Location on Multi-Storied Residential Building”

This study investigates how different shear wall shapes and placements—L-type, peripheral, and cross-type—affect the seismic performance of a G+5 RC residential building located in Hyderabad (Zone II). Using ETABS, the authors examine four models: a bare frame, a frame with L-type shear wall, one with walls along the periphery, and another with cross-type walls. Lateral forces, deflection patterns, drift values, bending moments, and shear forces are compared across models. Numerical results show that the peripheral shear wall model consistently provides the least roof deflection—reducing it by more than 33% compared to L-type walls and 32% compared to cross-type walls. Drift values are also noticeably lower in models with shear walls, especially Model II (L-type) and Model III (periphery). Bending moment and shear force comparisons reveal that the cross-type wall sometimes attracts higher forces at certain levels, indicating sensitivity to wall geometry and placement. Overall, the study concludes that type-2 shear wall (L-type) is the most efficient configuration for controlling deflection and drift under seismic loading, outperforming the other types evaluated..

III. OBJECTIVE

- To review existing research on the seismic behavior of steel buildings strengthened with RC shear walls.
- To understand how the placement, size, and configuration of RC shear walls influence lateral stiffness, drift, and overall structural stability.
- To compare findings from different studies to identify consistent trends and variations in performance.
- To examine how the interaction between steel frames and RC shear walls affects energy dissipation and deformation control during earthquakes.
- To highlight limitations, gaps, and unresolved issues in current research related to hybrid steel–RC shear wall systems.
- To provide insights that can guide future studies and support the development of more efficient and resilient seismic design strategies.

IV. CONCLUSION

- RC shear walls significantly enhance the seismic performance of steel buildings by increasing lateral stiffness and reducing excessive drift.
- Steel frames provide excellent ductility, but without shear walls they tend to experience larger displacements during earthquakes.
- Studies consistently show that the combined steel–RC system offers a balanced structural response—steel provides flexibility while RC walls supply rigidity.

- The effectiveness of RC shear walls depends strongly on their placement, orientation, and connection with the steel frame.
- Most research highlights noticeable improvements in stability, reduced deformation, and better energy dissipation when shear walls are strategically integrated.
- However, there is still limited consensus on the optimal shear wall configuration for different building types and seismic intensities.
- Existing studies also identify gaps related to nonlinear dynamic behavior, wall–frame interaction details, and the influence of soil conditions.
- Overall, the literature suggests that hybrid steel buildings with RC shear walls are highly suitable for seismic regions, offering improved safety and reliability.
- Continued research is needed to refine design guidelines, optimize wall layouts, and better understand long-term performance under real earthquake loading.

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