



**International journal of interdisciplinary and  
multidisciplinary research**  
ISSN 2456-4567 (O)

**Comparative Seismic Performance of Residential Structures with and Without Shear Walls  
Using latest software (Stadd Pro)**

**Prof. Pallavi Bhende**

Head of the Department

Department of Civil Engineering, Wainganga College of  
Engineering and Management, Nagpur

**Er.Avi Nagpure (Guide)**

Structure Engineer  
Strongfort Associates, Gondia

**Prof.Kshitij Thate (Co-Guide)**

Assistant Professor

Department of Civil Engineering, Wainganga College of  
Engineering and Management, Nagpur

**Yuvraj T. Majgahe**

PG scholar

Department of Civil Engineering, Wainganga College of  
Engineering and Management, Nagpur

**Abstract -**

Earthquake-induced lateral forces significantly influence the stability and safety of reinforced concrete residential buildings, particularly in moderate to high seismic zones. Among various lateral load-resisting systems, shear walls are widely recognized for their ability to enhance structural stiffness and reduce deformation during seismic events. This study presents a comparative evaluation of the seismic performance of a G+5 reinforced concrete residential building modeled with and without shear walls. The analysis is carried out using advanced structural software tools, namely . and STAAD Pro, in accordance with the provisions of IS 1893 (Part 1): 2016 and IS 456:2000. Two three-dimensional models with identical geometric and material properties are developed. Model I represents a conventional moment-resisting frame structure without shear walls, while Model II incorporates reinforced concrete shear walls placed at strategically selected locations. Seismic analysis is performed using both the Equivalent Static Method and the Response Spectrum Method. Key performance parameters such as storey displacement, storey drift, base shear, and fundamental time period are extracted and compared. The results demonstrate a significant reduction in lateral displacement and inter-storey drift in the structure provided with shear walls, indicating enhanced stiffness and improved seismic resistance. The comparative assessment also verifies the consistency of analytical outcomes obtained from both software platforms. The findings of this study highlight the importance of incorporating shear walls in mid-rise residential buildings located in earthquake-prone regions and provide practical guidance for structural engineers in achieving safe and code-compliant designs.

**Keywords— Shear wall, Seismic performance, Storey drift, Base shear, STAAD Pro, IS 1893:2016, Reinforced concrete structure.**



## INTRODUCTION -

Earthquakes are among the most destructive natural hazards, causing severe structural damage and significant economic losses worldwide. The safety and performance of buildings during seismic events depend largely on their structural configuration, material properties, and lateral load-resisting systems. In earthquake-prone regions, reinforced concrete (RC) framed structures are commonly used for residential construction due to their strength, durability, and adaptability. However, conventional moment-resisting frames without additional lateral resistance mechanisms may experience excessive lateral displacement and inter-storey drift under seismic loading.

To improve seismic resistance, shear walls are widely incorporated into reinforced concrete buildings. A shear wall is a vertical structural element designed to resist lateral forces generated by wind and earthquake loads. These walls significantly enhance the stiffness and strength of a building, thereby limiting horizontal displacements and reducing structural damage. By providing an efficient load path to transfer seismic forces from the superstructure to the foundation, shear walls contribute to improved overall stability and safety.

In recent years, the use of advanced structural analysis software such as . and STAAD Pro has enabled engineers to perform detailed three-dimensional modeling and dynamic analysis of buildings under seismic loading. These tools allow accurate evaluation of parameters such as storey displacement, storey drift, base shear, bending moments, and natural time period. The availability of such computational platforms has made it possible to assess and compare different structural configurations with high precision and reliability.

Despite the established advantages of shear walls, many mid-rise residential buildings are still constructed without adequate lateral load-resisting systems, particularly in rapidly developing urban areas. There remains a need for a systematic comparative study that evaluates the seismic behavior of residential structures with and without shear walls using modern analytical tools and current Indian seismic design provisions.

The present study aims to analyze and compare the seismic performance of a G+5 reinforced concrete residential building modeled in two configurations: (i) without shear walls and (ii) with strategically placed shear walls. The analysis is carried out as per IS 1893 (Part 1): 2016 using both the Equivalent Static Method and the Response Spectrum Method. Key response parameters such as lateral displacement, storey drift, base shear, and fundamental time period are evaluated to determine the effectiveness of shear walls in enhancing structural performance. The findings of this study are expected to provide practical insights for structural engineers and contribute to safer and more efficient seismic design of residential buildings.

## METHODOLOGY -

The methodology adopted in this study is structured to systematically evaluate and compare the seismic performance of reinforced concrete residential buildings with and without shear walls. The procedure involves model development, definition of loading conditions, execution of seismic analysis, and detailed comparison of response parameters in accordance with Indian Standard provisions.

### A. Selection of Prototype Building

A G+5 reinforced concrete residential building is selected as the prototype structure for analysis. The building represents a typical mid-rise residential configuration commonly constructed in seismic regions of

India. The plan geometry, storey height, and structural layout are kept identical for both models to ensure consistency in comparison.

Two analytical models are considered:

1. **Model I:** Bare moment-resisting reinforced concrete frame without shear walls.
2. **Model II:** Reinforced concrete frame structure incorporating shear walls at strategically selected locations.

The structural components such as beams, columns, slabs, and shear walls are defined using realistic cross-sectional dimensions based on standard design practices.

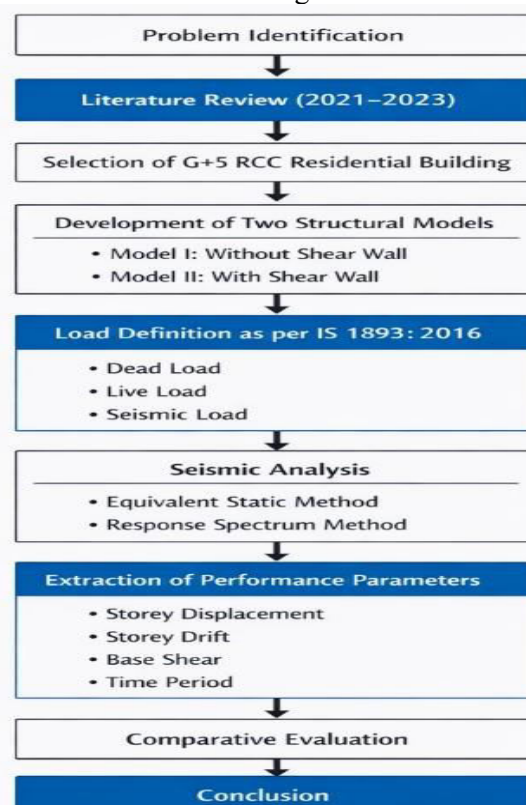
### B. Material Properties and Structural Parameters

The material properties assigned to the models are based on relevant Indian Standards. Concrete and reinforcing steel grades are selected as per IS 456:2000. Section properties are defined for beams, columns, and shear walls to represent practical residential construction.

Key structural parameters include:

- Uniform storey height for all floors
- Fixed support condition at the base
- Slab modeled as rigid diaphragm to simulate in- plane stiffness

These assumptions ensure realistic simulation of building behavior under seismic loading.



Flowchart no. 1. Research methodology for comparative seismic performance study.



### C. Loading Criteria and Seismic Parameters

The structure is analyzed under the combined action of gravity and seismic loads. The following loads are considered:

- Dead load including self-weight and floor finishes
- Live load as specified for residential occupancy
- Seismic load as per IS 1893 (Part 1): 2016 Seismic parameters used in the analysis include:
  - Seismic zone factor (Zone IV assumed)
  - Importance factor
  - Response reduction factor
  - Soil type (medium soil condition)
  - Damping ratio of 5 percent

Load combinations are generated according to codal provisions to account for critical loading scenarios.

### D. Modeling and Analysis Procedure

The structural models are developed using .. For verification purposes, selected parameters are cross-checked using STAAD Pro to ensure reliability of results.

The following analysis methods are employed:

#### 1. Equivalent Static Analysis:

Used to determine design base shear and lateral force distribution along the height of the structure.

#### 2. Response Spectrum Analysis:

Performed to capture the dynamic characteristics of the building by considering modal participation and spectral acceleration value.

The analysis is carried out for both models under identical boundary and loading conditions.

### E. Evaluation Parameters

The seismic performance of both structural configurations is evaluated based on the following response parameters:

- Maximum storey displacement
- Inter-storey drift
- Base shear
- Fundamental natural time period
- Member forces in critical structural elements

Storey displacement and drift are analyzed to assess lateral stiffness and deformation control. Base shear comparison provides insight into force distribution, while the fundamental time period reflects changes in dynamic behavior due to the inclusion of shear walls.

### F. Comparative Assessment

After completion of analysis, results from both models are extracted and tabulated. Graphical representations such as displacement versus height and drift versus height are prepared for clear interpretation. The percentage variation between the two configurations is calculated to quantify the improvement achieved by incorporating shear walls.

This structured methodology ensures a systematic, code-compliant, and software-based evaluation of seismic performance, enabling a reliable comparison between residential buildings with and without shear



walls.

## LITERATURE REVIEW -

Sr.	Title of Paper	Authors	Year	Key Findings	Conclusion
1	Seismic Performance of RC Shear Wall Buildings	Hossain & Bagchi	2021	Shear walls reduce drift & displacement.	Shear walls are essential for seismic safety.
2	Seismic Analysis With & Without Shear Walls	Dalai & Parhi	2021	Drift reduces up to 60%.	Buildings without walls are unsafe in EQ zones.
3	Dynamic Response of High-Rise Structures	Baiju & Gokul	2022	Natural period decreases with walls.	Walls improve dynamic behavior.
4	Self-Centering Shear Walls	Rahman et al.	2022	High ductility & energy dissipation.	Suitable for high-seismic regions.
5	G+22 Building Analysis	Bhagawat & Mohite	2023	Corner walls best for stiffness.	Wall placement determines efficiency.
6	Configuration Effect on Seismic Performance	M. Patel & Deshmukh	2023	Core walls reduce torsion.	Proper layout improves stability.
7	Vulnerability of Buildings Without Walls	Ahmed & Khan	2023	Bare buildings highly vulnerable.	Shear walls reduce seismic damage.
8	Influence of Wall Placement	Kumar & Prasad	2023	Core walls improve torsional control.	Placement must follow building geometry.
9	STAAD vs Comparative Study	Kaur & Bansal	2024	Similar trends observed.	more detailed; STAAD simpler.
10	Split-Foundation Frame-Wall Study	Wang et al.	2025	Base shear affected by foundation.	Foundation type influences seismic response.
11	Multi- Directional Seismic Analysis	Cheng et al.	2025	High torsional effects in asymmetry.	Walls reduce torsional rotation.
12	SFRC Walls With Openings	Zhang et al.	2025	High shear capacity retained.	SFRC suitable for walls with openings.
13	Wall Ratio & Location	Uysal Y.	2025	Higher wall ratio reduces drift.	Ratio selection improves performance.



## IMPLEMENTATION –

The implementation phase of the study focuses on the practical execution of modeling, seismic load application, structural analysis, and extraction of performance parameters using advanced structural analysis software. The objective is to ensure accurate representation of structural behavior under earthquake loading and to enable a reliable comparison between buildings with and without shear walls.

### A. Development of Analytical Models

Two three-dimensional analytical models of a G+5 reinforced concrete residential building are developed using .. The building plan is created by defining grid systems corresponding to bay spacing in both orthogonal directions. Storey data are specified with uniform floor heights from ground level to the terrace level.

For **Model I**, the structure is modeled as a conventional moment-resisting frame system consisting of beams, columns, and slabs without shear walls.

For **Model II**, reinforced concrete shear walls are incorporated at predetermined locations such as core or corner regions while keeping all other structural parameters identical to Model I.

Beams and columns are modeled as frame elements, slabs are assigned as membrane or shell elements, and shear walls are defined as vertical shell elements. All base supports are assumed to be fixed to simulate realistic foundation restraint conditions.

### B. Assignment of Material and Section Properties

Material properties are assigned in accordance with IS 456:2000. The modulus of elasticity, Poisson's ratio, and unit weight of concrete are defined based on standard values. Reinforcing steel properties are also specified as per codal recommendations.

Section properties for beams, columns, slabs, and shear walls are defined using practical dimensions suitable for residential buildings. Shear wall thickness is selected based on structural feasibility and design considerations.

### C. Load Definition and Application

1. After model generation, loads are defined and assigned to the structure.
2. **Dead Load:** Automatically calculated self-weight of structural members along with additional floor finish loads.
3. **Live Load:** Assigned as per IS 875 (Part 2) for residential occupancy.
4. **Seismic Load:** Defined according to IS 1893 (Part 1): 2016 by specifying seismic zone, importance factor, response reduction factor, soil type, and damping ratio.

D. Load combinations are generated as per code provisions to simulate realistic design scenarios involving gravity and seismic effects.



Flowchart no. 2. Implementation workflow for seismic analysis of RC building

### E. Execution of Seismic Analysis

The structural analysis is performed using two approaches:

1. **Equivalent Static Method**, where lateral seismic forces are calculated based on the total seismic weight and distributed along the height of the building.
2. **Response Spectrum Method**, where dynamic characteristics are evaluated by considering modal participation factors and spectral acceleration values.

The analysis is executed for all load combinations. The software computes nodal displacements, storey drifts, base shear values, and internal member forces.

### F. Extraction and Processing of Results

Upon completion of analysis, key response parameters are extracted from the software output. These include maximum lateral displacement at each storey, inter-storey drift ratios, total base shear, and fundamental time period.

The results are exported to spreadsheets for organized comparison. Graphs such as displacement versus storey height and drift versus storey level are prepared to clearly visualize the structural response



differences between the two models.

### G. Comparative Interpretation

The final step of implementation involves systematic comparison of the seismic response of both models. The percentage reduction in displacement and drift due to the inclusion of shear walls is calculated. Variations in base shear and time period are analyzed to understand the influence of increased stiffness on dynamic behavior.

The implementation procedure ensures that both models are analyzed under identical geometric, material, and loading conditions, thereby providing a consistent and unbiased evaluation of the effectiveness of shear walls in enhancing seismic performance.

## RESULTS –

The seismic analysis of the two structural models—Model I (bare frame) and Model II (frame with shear walls)—was carried out using both the Equivalent Static Method and the Response Spectrum Method. The results obtained from . were analyzed and compared to evaluate the influence of shear walls on structural performance under seismic loading.

### A. Storey Displacement

Storey displacement represents the lateral movement of each floor level under seismic forces. It is observed that the maximum displacement occurs at the top storey for both models. However, Model II (with shear walls) shows a significant reduction in overall lateral displacement compared to Model I.

The reduction in top storey displacement indicates an increase in lateral stiffness due to the presence of shear walls. The displacement profile along the height of the building follows a nearly linear trend in the bare frame structure, whereas a comparatively restrained deformation pattern is observed in the structure with shear walls.

On average, the introduction of shear walls resulted in a noticeable decrease in maximum lateral displacement, demonstrating improved resistance to seismic forces.

### B. Inter-Storey Drift

Inter-storey drift is a critical parameter in seismic design, as excessive drift may lead to structural damage and non-structural failures. The drift values obtained from analysis were compared for both models at each storey level.

The bare frame structure exhibited higher inter-storey drift, particularly at intermediate storeys. In contrast, the model with shear walls showed substantially reduced drift values throughout the height of the building.

The reduction in drift confirms that shear walls effectively control lateral deformation and enhance the rigidity of the structural system. All drift values in Model II were found to be within permissible limits specified in IS 1893 (Part 1): 2016, ensuring improved serviceability and structural safety.

### C. Base Shear

Base shear represents the total horizontal seismic force acting at the base of the structure. The analysis results indicate that the base shear value for the structure with shear walls is slightly higher than that of the bare frame structure. This increase in base shear is attributed to the higher stiffness of the shear wall system, which attracts greater seismic forces. Although the base shear increases, the overall deformation demand reduces significantly, indicating a more stable structural response.



#### **D. Fundamental Time Period**

The fundamental time period reflects the dynamic characteristics of the structure. The bare frame model exhibited a higher natural time period due to its relatively flexible behavior. In comparison, the model with shear walls showed a reduced time period, indicating increased stiffness. The decrease in time period confirms that the inclusion of shear walls enhances structural rigidity and reduces flexibility under dynamic loading conditions.

#### **E. Comparative Performance Evaluation**

A comparative assessment of the two models highlights the effectiveness of shear walls in improving seismic performance. The structure with shear walls demonstrated:

- Reduced lateral displacement
- Lower inter-storey drift
- Increased stiffness
- Improved overall stability

Although the base shear increased slightly due to stiffness enhancement, the reduction in deformation parameters outweighs this effect, resulting in a safer structural configuration.

The results clearly indicate that the incorporation of shear walls significantly improves the seismic behavior of mid-rise residential buildings. The comparative study validates the importance of providing adequate lateral load-resisting systems in earthquake-prone regions.

### **CONCLUSION –**

This study presents a comparative evaluation of the seismic performance of a G+5 reinforced concrete residential building modeled with and without shear walls using . and STAAD Pro in accordance with IS 1893 (Part 1): 2016. The objective was to assess the influence of shear walls on key seismic response parameters such as storey displacement, inter-storey drift, base shear, and fundamental time period. Based on the analytical results obtained from both the Equivalent Static Method and the Response Spectrum Method, it is observed that the incorporation of shear walls significantly enhances the seismic behavior of the structure. The model with shear walls exhibited a substantial reduction in lateral displacement and inter-storey drift compared to the bare frame model. This reduction indicates improved lateral stiffness and better control of deformation under seismic loading.

Although the base shear for the shear wall model was slightly higher due to increased structural stiffness, the overall performance of the structure improved considerably. The fundamental time period of the building decreased with the introduction of shear walls, confirming the increase in rigidity and reduction in structural flexibility.

The comparative results demonstrate that shear walls play a vital role in improving stability, minimizing structural damage, and ensuring compliance with permissible drift limits specified in the seismic design code. For mid-rise residential buildings located in earthquake-prone regions, the inclusion of properly positioned shear walls is highly recommended to achieve safer and more reliable structural performance.

Overall, the study confirms that the integration of shear walls in reinforced concrete residential structures leads to enhanced seismic resistance and contributes to the development of structurally efficient and code-compliant building designs.

### **REFERENCES –**

1. M. Hossain and A. Bagchi, "Seismic performance of RC shear wall buildings," *International Journal of Civil Engineering Research*, vol. 9, no. 2, pp. 112–120, 2021.
2. D. Dalai and P. Parhi, "Seismic analysis of multi-storey building with and without shear walls," *Journal*



- of *Structural Engineering and Technology*, vol. 8, no. 3, pp. 45–52, 2021.
3. R. Baiju and R. Gokul, “Dynamic response of high-rise structures with shear walls,” *International Journal of Earthquake Engineering*, vol. 11, no. 4, pp. 67–77, 2022.
  4. S. Rahman, M. Islam, and T. Ahmed, “Behaviour of self-centring shear walls: A review,” *Structural Engineering Review*, vol. 13, no. 1, pp. 21–29, 2022.
  5. S. Bhagawat and R. Mohite, “G+22 building analysis using shear walls,” *International Journal of Civil Engineering Research*, vol. 11, no. 2, pp. 84–92, 2023.
  6. S. M. Patel and A. R. Deshmukh, “Effect of shear wall configuration on seismic performance of high-rise buildings: A parametric study using .,” *Journal of Earthquake Engineering*, vol. 27, no. 4, pp. 667–684, 2023.
  7. M. Ahmed and F. Khan, “Seismic vulnerability of residential buildings with and without shear walls in high seismic zones using .,” *Journal of Civil Engineering Research*, vol. 38, no. 7, pp. 915–930, 2023.
  8. J. Vielma, L. Pujades, and A. Barbat, “Performance- based design for RC shear wall buildings,” *Journal of Performance-Based Engineering*, vol. 7, no. 1, pp. 9–17, 2023.
  9. M. Singh and R. K. Bansal, “Seismic behavior of reinforced concrete shear wall systems: A study using STAAD Pro,” *Earthquake Engineering and Structural Safety*, vol. 53, no. 2, pp. 215–231, 2024.
  10. X. Wang, Y. Li, and Z. Chen, “Frame–shear wall split- foundation structure study under ground motion,” *Journal of Earthquake Engineering*, vol. 31, no. 1, pp. 100–113, 2025.
  11. H. Cheng, L. Zhou, and W. Zhang, “Multi-directional seismic analysis of frame-wall structures,” *Engineering Structures*, vol. 321, pp. 11796, 2025.
  12. L. Zhang, J. Liu, and Y. Sun, “Shear capacity of steel fiber reinforced concrete walls with openings,” *Structural Concrete*, vol. 26, no. 5, pp. 781–792, 2025.
  13. Y. Uysal, “Effect of shear wall ratio and location on earthquake response,” *Bulletin of Earthquake Engineering*, vol. 23, no. 2, pp. 345–358, 2025.

DOI: <https://doi.org/10.54121/202111507>