

Comparative Analysis of A G+15 RCC Residential Building with and Without Shear Wall Using E Tabs

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Abstract

The rapid growth of high-rise buildings due to urbanization, population increase, and limited land availability has significantly influenced modern construction practices. Tall buildings are subjected to various lateral loads such as wind and earthquakes, which create major challenges in maintaining structural stability and safety. Shear walls are widely used in reinforced concrete (RCC) structures as an effective structural element to resist lateral forces and improve the overall strength and durability of buildings.

This study focuses on the comparative performance analysis of a G+15 RCC residential building with and without shear walls. The main objective is to evaluate the influence of shear walls on the structural behaviour of multi-storey buildings under lateral loads. The building models were developed and analysed using ETABS software, which is based on the finite element method, to simulate real structural behaviour accurately.

The analysis was carried out as per IS 1893 (Part 1): 2016 guidelines to determine the response of the structure under seismic and wind loads. Important parameters such as storey displacement, storey drift, and base shear were considered to assess the structural performance. Different shear wall locations, such as at the lift core and building periphery, were also studied to identify the most effective placement for improving building stability and stiffness.

The results of the comparative study indicate that the inclusion of shear walls significantly reduces lateral displacement and storey drift, thereby enhancing the stiffness and seismic resistance of the structure. Proper placement of shear walls improves safety,

serviceability, and structural efficiency of high-rise buildings. This study provides valuable guidance for engineers and designers in selecting suitable structural systems for G+15 RCC residential buildings while ensuring safety, economy, and performance.

Keywords: Shear wall, Storey displacement, Storey drift, Base shear, Structural schemes.

1. Introduction

The use of multi-storey buildings in India has increased significantly in recent years due to rapid urbanization, population growth, and limited availability of land. Not only metropolitan cities but also moderately populated cities are adopting multi-storey structures to meet residential and commercial demands. Constructing buildings vertically helps in reducing urban sprawl and promotes efficient land utilization, leading to more compact and sustainable urban development. However, as the height of buildings increases, structural challenges also increase, especially in resisting lateral forces.

Multi-storey buildings are highly influenced by lateral loads such as earthquake and wind forces. These loads act horizontally on the structure and can cause significant displacement, drift, and instability if not properly designed. Without adequate structural planning and analysis, buildings may experience excessive deformation, cracking, or even collapse, which may result in loss of life and property. Therefore, it is essential to design buildings capable of safely resisting these lateral loads by following Indian Standard codes such as IS 1893 (Part 1): 2016 for seismic loads and IS 875 (Part 3) for wind loads.

In reinforced concrete (RCC) structures, shear walls play a major role in improving the lateral load resistance of buildings. A shear wall is a vertical reinforced concrete member that extends

from the foundation level to the top of the building height. It acts like a vertically oriented wide beam that transfers lateral loads safely to the foundation. Shear walls increase the stiffness and rigidity of the building, thereby reducing lateral displacement and improving overall structural stability. Buildings designed with shear walls have shown better performance during past earthquake events.

Shear walls are widely adopted in high-rise buildings due to their effectiveness, ease of construction, and economical nature. The detailing of reinforcement in shear walls is comparatively simple, and their placement at construction sites is convenient. The performance of shear walls depends on several factors such as wall thickness, length, material properties, and their location within the structural frame. Proper positioning of shear walls, such as at lift cores or building peripheries, significantly improves the efficiency of the structural system and enhances resistance against lateral forces.

This project focuses on the comparative performance analysis of a G+15 RCC residential building with and without shear walls using ETABS software. ETABS is a widely used structural analysis and design software based on the finite element method, which allows accurate simulation of building behaviour under different loading conditions. The study evaluates the structural response under seismic and wind loads by considering parameters such as storey displacement, storey drift, and base shear. The results of this study aim to provide valuable insights into the effectiveness of shear walls in enhancing structural safety, stability, and performance of multi-storey buildings.

1.1 SHEAR WALL:

A shear wall is a vertically oriented planar structural element primarily designed to resist lateral loads acting in its own plane. Shear walls are important vertical structural members that act as a horizontal force resisting system in buildings. They are constructed to counter the effects of lateral forces such as wind loads and earthquake loads acting on structures. In residential buildings, shear walls are often provided as straight external walls that offer lateral support and stability to the structure.

These walls transfer lateral forces from exterior walls, floors, and roofs safely to the foundation, thereby reducing displacements, base shear, bending moments, and stresses in the building.



Fig: Shear wall building

Shear walls play a significant role in improving the performance of high-rise buildings by providing greater strength and stiffness in the direction of their orientation. They help in reducing lateral sway of the building and improve overall structural stability. The behaviour of shear walls mainly depends on factors such as the material used, wall thickness, wall length, and the location of the wall within the building frame. Proper design and placement of shear walls are essential to achieve effective resistance against lateral forces and to enhance the safety of the structure.

Shear walls are capable of resisting not only lateral loads due to wind and earthquakes but also vertical gravity loads to some extent. Their construction is relatively simple, and reinforcement detailing is generally straightforward, making them economical and practical for modern construction. Different shapes of shear walls such as L-shape, T-shape, U-shape, box shape, channel shape, and barbell shape can be adopted depending on the architectural layout and structural requirements of the building.

Compared to ordinary moment resisting frame systems, shear wall structural systems provide higher stability and stiffness, making them highly suitable for multi-storey and high-rise buildings. Properly designed shear walls significantly reduce structural damage during earthquakes and improve the overall safety and durability of buildings. Therefore, shear walls are widely used as an efficient lateral load resisting system in modern reinforced concrete structures.

1.1.1 FUNCTIONS OF SHEAR WALL:

- It carries lateral loads arising due to earthquake and wind forces acting on the structure.
- It provides additional rigidity and stiffness to the building.
- It reduces lateral displacement and storey drift in multi-storey buildings.
- It transfers lateral loads safely from the structure to the foundation.
- It improves the overall stability

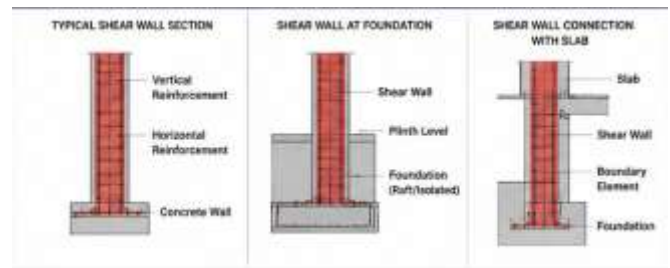
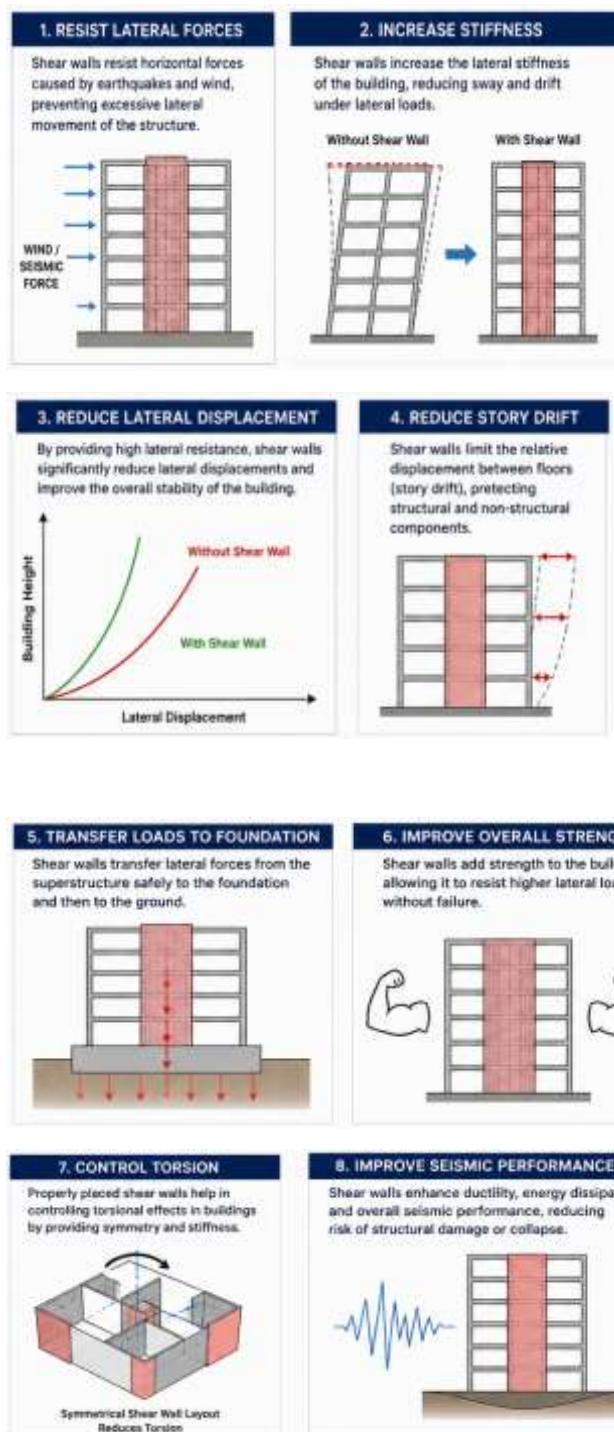


Fig.: SHEAR WALL DETAILS

1.1.2 IMPORTANCE OF SHEAR WALL:

- It provides large stiffness and strength to buildings.
- It reduces lateral deformation of the structure.
- It decreases torsional effects on the structure.
- It resists seismic loads and vertical forces acting on the building.
- It improves the overall stability and safety of high-rise structures.
- It controls excessive sway caused by wind and earthquake forces.
- It enhances the load carrying capacity of the structure.

1.1.3 POSITION OF SHEAR WALL:

1. Shear Walls at Corners

Shear walls are placed at the four corners of the building.

- Provides maximum resistance to lateral loads
- Improves overall building stability
- Reduces drift significantly

Advantages

- Strong resistance to overturning
- Better moment resistance

Disadvantages

- May create torsion if not symmetric
- Architectural limitations

2. Shear Wall at Building Core (Central Core)

Shear walls are placed at the center of the building, usually around lift shafts and staircases.

- Most common and effective placement
- Provides uniform stiffness
- Reduces torsional effects
- Ideal for high-rise buildings (G+10 and above)

Advantages

- Better seismic performance
- Efficient load transfer
- Saves exterior space

Disadvantages

- Congestion in core area
- Design complexity for services

3. Shear Walls at Corners

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Disadvantages

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- Architectural limitations

4. Shear Walls Along Periphery

Walls are placed along the outer edges (periphery) of the building.

- Works like a box system
- Increases lateral stiffness
- Used in commercial buildings

Advantages

- High resistance to wind & earthquake
- Better control of displacement

Disadvantages

- Limits façade openings

- Affects aesthetics

5. Shear Walls in Parallel Direction

Walls are placed in one direction (X or Y direction).

- Resists loads in one direction only
- Often used in rectangular buildings

Advantages

- Simple design
- Cost-effective

Disadvantages

- Weak in perpendicular direction
- May lead to uneven stiffness

6. Shear Walls in Both Directions (Orthogonal System)

Walls are placed in both X and Y directions.

- Provides balanced resistance
- Most suitable for earthquake-prone areas

Advantages

- Reduces torsion
- Uniform stiffness distribution

Disadvantages

- Higher construction cost

7. Shear Walls with Openings

Shear walls include doors, windows, or service openings.

- Common in residential buildings
- Reduces stiffness compared to solid walls

Advantages

- Functional design
- Better usability

Disadvantages

- Stress concentration near openings
- Requires careful design

8. Coupled Shear Walls

Two shear walls connected by coupling beams.

- Acts as a single unit

- Improves energy dissipation

Advantages

- Better seismic resistance
- Increased ductility

Disadvantages

- Complex detailing
- Requires skilled construction

9. Shear Walls at Irregular Positions

Walls are placed unsymmetrically or irregularly.

- Causes torsional effects
- Not recommended without analysis

Advantages

- Flexible architectural planning

Disadvantages

- Poor seismic performance
- Uneven load distribution

- ☐ Shear walls should be placed symmetrically in the building plan to reduce torsional effects
- ☐ Shear walls should be provided along both principal directions of the building to resist lateral loads effectively.
- ☐ Shear walls are commonly placed at the periphery of the building to improve lateral stiffness and reduce displacement.
- ☐ Shear walls can be provided at the lift core area to form a rigid central core and improve structural stability.

In this project, L-shaped shear walls are provided at the periphery of the building to enhance stiffness along the edges.

- ☐ Proper positioning of shear walls helps in reducing lateral displacement, storey drift, and torsional effects in multi-storey buildings.

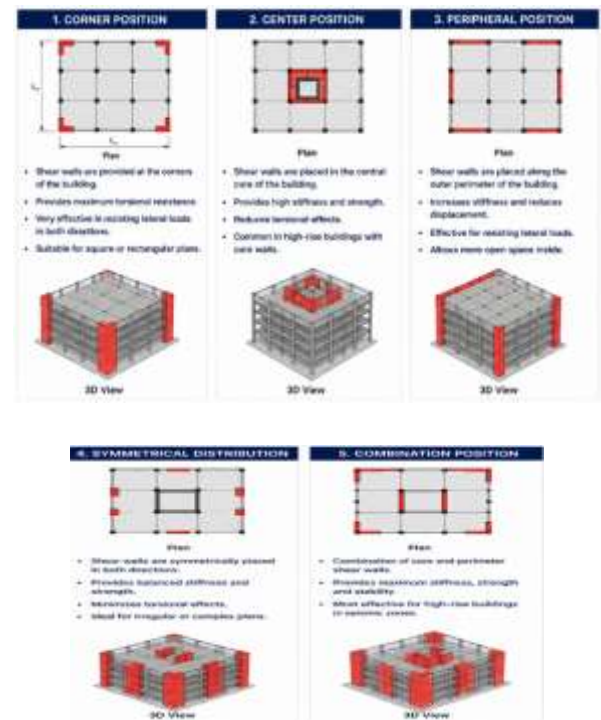


Fig: DIFFERENT LOCATIONS OF SHEAR WALLS

EFFECT ON BUILDING BEHAVIOUR

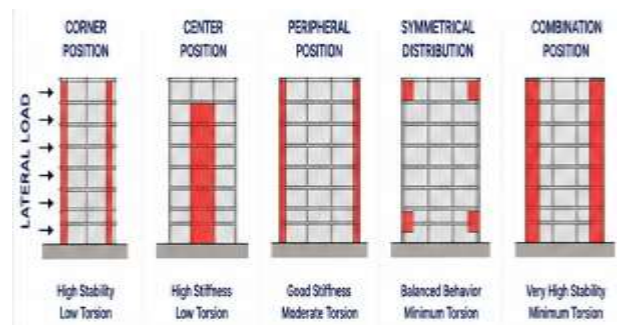


Fig: Effect of building behaviour

Objectives: To analyse the G+15 RCC residential building using ETABS analysis software.

- To check the adequacy of shear walls for a G+15 storeyed RCC building under lateral loads.
- To study the behaviour of the structure with different shear wall locations such as L-shaped

shear walls at the periphery and box-shaped shear walls at the lift core.

- To compare storey lateral displacement, storey drift, and base shear of G+15 RCC building with and without shear walls.
- To suggest the suitable structural scheme to resist various lateral loads such as wind and earthquake loads.

2. Need for the Study

The need for this study arises due to the rapid growth of multi-storey buildings driven by urbanization, population increase, and limited availability of land. As building height increases, the effect of lateral loads such as earthquakes and wind becomes more significant, which can lead to excessive displacement, storey drift, and structural instability if not properly controlled. Conventional RCC frame structures alone may not provide sufficient resistance against these forces, making it essential to adopt effective lateral load resisting systems. Ensuring safety, serviceability, and compliance with IS codes like IS 1893 and IS 875 is therefore a major requirement in modern structural design.

In this context, shear walls are widely used to improve stiffness and reduce lateral deformation in high-rise buildings. However, their effectiveness depends on proper placement, shape, and configuration within the structure. Hence, this study is necessary to evaluate and compare the behaviour of a G+15 RCC building with and without shear walls. By analysing parameters such as storey displacement, storey drift, and base shear using ETABS, the study helps in understanding how shear walls enhance structural performance and provides guidance for selecting an efficient and safe structural system.

The scope of the study includes:

- Modeling a G+15 RCC residential building with and without shear walls using ETABS software.
- Considering different shear wall configurations such as periphery (L-shaped), lift core (box type), and combined arrangements.
- Performing linear static and response spectrum analysis as per IS 1893 (Part 1): 2016 for seismic

loads and IS 875 for wind loads.

- Evaluating important structural parameters such as storey displacement, storey drift, and base shear.
- Comparing the structural behaviour of buildings with and without shear walls under lateral loading conditions.
- Studying the effect of shear wall location on the overall stability, stiffness, and performance of the building.
- Assessing the improvement in seismic resistance and reduction in lateral deformation due to shear walls.
- Presenting results using graphs and charts for clear comparison and interpretation.
- Providing conclusions for selecting suitable shear wall configurations for safe and economical design of multi-storey buildings.

3. Literature Review

3.1 International Journal of Creative Research Thoughts (IJCRT)

Volume 10, Issue: 11 November 2022

A REVIEW ON HIGH RISE STRUCTURE HAVING SHEAR WALLS SUBJECTED TO LATERAL LOADS

AUTHORS: Kumar Gandharv, Dolendra Patel

This study reviews the behavior of high-rise buildings with shear walls under lateral loads such as earthquakes and wind. It highlights that structural performance depends on factors like soil conditions, building height, and shear wall configuration. Various previous studies using ETABS and SAP2000 were analyzed by comparing models with and without shear walls, considering parameters such as storey displacement, drift, base shear, and stiffness. The results show that shear walls significantly improve strength and stiffness, reducing lateral displacement and enhancing stability. The study concludes that proper placement and design of shear walls play a crucial role in resisting seismic forces and improving the overall performance of high-rise structures.

3.2 International Journal of Creative Research Thoughts (IJCRT)

Volume 13, Issue: 11 November 2025

SEISMIC ANALYSIS OF MULTI-STOREY BUILDING WITH SHEAR WALL AND FLOATING COLUMNS

AUTHORS: V. Pram Kumar, Dr. K. Manjulavani

This study presents the seismic analysis of a G+12 multistorey RCC building with different configurations of shear walls and floating columns using ETABS as per IS 1893:2016. Five models were developed, including a basic structure without shear walls, models with floating columns, and models with shear walls placed at corners and alternative positions. Key parameters such as storey drift, base shear, storey shear, time period, and structural stability were evaluated. Results indicate that the building without shear walls shows maximum displacement and instability, while the inclusion of shear walls significantly improves stiffness, reduces drift, and enhances seismic performance. Among all configurations, the alternative shear wall arrangement provides the best results with minimum displacement and maximum stability. The study concludes that proper placement of shear walls plays a crucial role in improving the seismic resistance and overall performance of multistorey buildings.

4. Study Area

S. No	Type of structure	Residential
1	Number of stories	G+15
2	Number of basements	1
3	Floor to floor height	3 m
4	Height of building	50.75m
5	Location of building	Kaikaluru mandal, Krishna district

The study area consists of a residential building with a configuration of G+15 floors along with one basement. The floor-to-floor height is maintained at 3 meters, resulting in a total building height of approximately 50.75 meters. The structure is located in Kaikaluru Mandal of Krishna district. This configuration represents a typical mid-rise to high-rise residential building, making it suitable for analyzing structural behavior, especially under seismic and load conditions.

4. Methodology

The methodology adopted in this project focuses on the comparative performance analysis of a G+15 RCC residential building with and without shear walls using ETABS software. The study is carried out to understand the effect of shear walls on the structural behaviour of multi-storey buildings under seismic and wind loads. The complete methodology is divided into different stages including modelling, analysis, comparison of structural parameters, and interpretation of results.

4.1 Modelling of Different Structures in ETABS

In this study, a G+15 RCC residential building is selected for structural analysis. Two different structural models are developed using ETABS software. The first model consists of a conventional RCC framed structure without shear walls, while the second model includes shear walls to improve lateral load resistance and structural stability. L-shaped shear walls are provided at the building periphery, and box-shaped shear walls are provided around the lift core area.



The modelling process begins with opening ETABS software and creating a new project. The required project settings such as units, material properties, design codes, and load parameters are defined according to Indian Standard codes. IS 456:2000 is

used for RCC design, IS 875 is used for load calculations, and IS 1893 (Part 1): 2016 is used for seismic analysis.

The building geometry is then created by defining grid spacing, number of storeys, storey height, beam sections, column sections, slab thickness, and support conditions. Structural components such as beams, columns, slabs, and shear walls are modelled accurately to simulate the actual behaviour of the building. Material properties for concrete and steel are also assigned. Concrete grades such as M30 and M40 and reinforcement grades such as Fe500 are used in the modelling process.

Two separate analytical models are prepared:

- Model without shear walls
- Model with shear walls

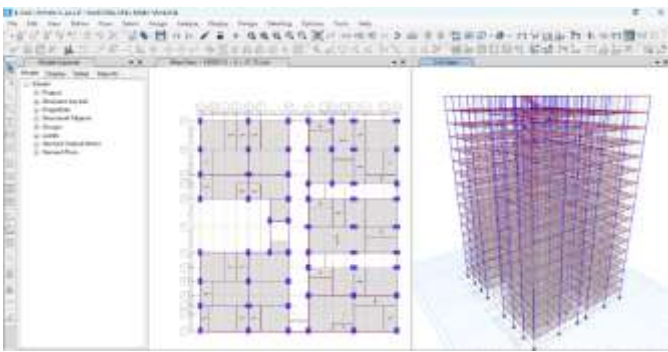


Fig: Model without shear walls

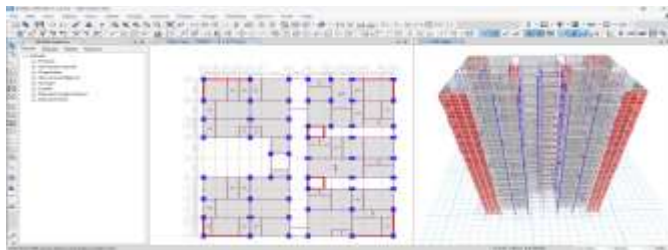


Fig: Model with shear walls

Both models are kept identical in all aspects except the provision of shear walls. This helps in understanding the exact influence of shear walls on the seismic performance of the structure.

The modelling process in ETABS also includes defining load patterns such as dead load, live load, earthquake load, and wind load. The dead loads consist of self-weight and wall loads, while live loads are assigned according to building usage. Seismic loads are applied based on IS 1893 provisions, considering seismic zone, importance factor, response reduction factor, and soil condition. Wind loads are assigned according to IS 875 (Part 3).

Load combinations are then defined to simulate realistic loading conditions. These combinations help in identifying the critical loading conditions acting on the building. Proper load combinations ensure safe and reliable structural design under different loading scenarios.

4.2 Analysis of Different Structures in ETABS

After completing the modelling process, structural analysis is carried out using ETABS software. The analysis is performed to evaluate the structural response of the building under seismic and wind loads. ETABS provides accurate results based on finite element analysis methods and helps in understanding the behaviour of multi-storey structures under lateral loading conditions.



Before running the analysis, the model is checked carefully to ensure that all structural elements, supports, load cases, and material properties are correctly assigned. ETABS provides model checking features to identify errors and warnings before analysis. Proper model checking improves the accuracy and reliability of the analysis results.

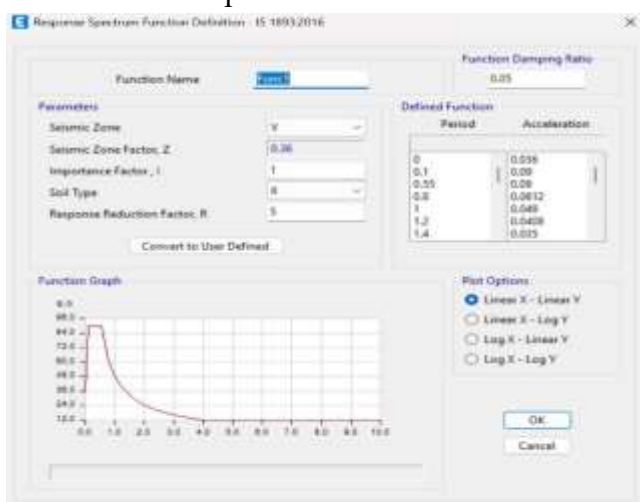
The following analysis methods are used in this project:

Response Spectrum Analysis

Response Spectrum Analysis is performed to study the dynamic behaviour of the structure under earthquake loading. This method is based on the response spectrum provided in IS 1893 (Part 1): 2016. It considers the effect of multiple vibration modes and evaluates the seismic response of the structure more accurately than simple static analysis. The response spectrum method helps in determining important structural parameters such as:

- Storey displacement
- Storey drift
- Base shear

- Natural time period
- Mode shapes



This method is especially suitable for high-rise buildings because earthquake forces are dynamic in nature and vary with time. Response Spectrum Analysis captures the inertia effects and modal participation of the structure during seismic activity.

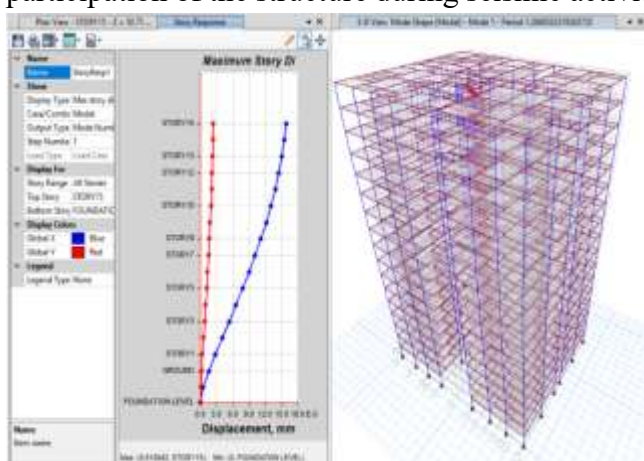


Fig: Response spectrum Analysis -Graph

4.3 Comparison of Structures with and without Shear Walls

The main objective of this project is to compare the structural behaviour of RCC buildings with and without shear walls. Therefore, the analysis results obtained from both models are compared in detail.

The following structural cases are considered:

- RCC building without shear wall system
- RCC building with shear wall system

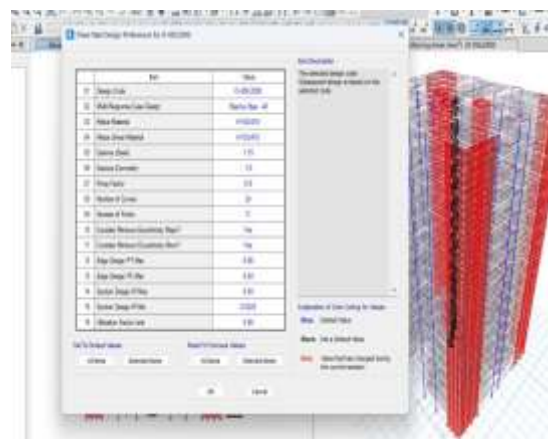


Fig: Design preferences of shear wall

Further comparison is also carried out for different shear wall configurations such as:

- L-shaped shear walls at building periphery
- Box-shaped shear walls at lift core
- Combination of lift core and peripheral shear walls

The comparison helps in understanding the effectiveness of shear walls in improving the seismic performance of the building. The structural response is studied under lateral loads such as earthquake and wind forces.

The comparison is mainly based on the following parameters:

- Maximum storey displacement
- Maximum storey drift
- Base shear
- Structural stiffness
- Stability of the building

The obtained results are represented using charts, graphs, and tabular forms for better understanding and interpretation.

4.4 Determination of Storey Displacement, Storey Drift and Base Shear

The important structural parameters considered in this study are storey displacement, storey drift, and base shear. These parameters are obtained from ETABS analysis results and used to evaluate the seismic performance of the structure.

Storey Displacement

Storey displacement refers to the lateral movement of a particular floor due to the action of wind or earthquake loads. Excessive displacement may lead to structural instability and serviceability problems. The maximum displacement values for each storey

are obtained from ETABS and compared for both models.

The building with shear walls is expected to show lower displacement values because shear walls provide additional stiffness and lateral resistance to the structure. Reduced displacement indicates improved stability and better seismic performance.

Storey Drift

Storey drift is defined as the relative displacement between two consecutive storeys. It is an important parameter in earthquake-resistant design because excessive drift can cause damage to both structural and non-structural components.

As per IS 1893 (Part 1): 2016, the permissible storey drift limit is:

$$\text{Maximum Storey Drift} = 0.004 \times h$$

where h is the storey height.

The storey drift values obtained from ETABS are compared with the permissible limits to ensure the safety and stability of the structure. The provision of shear walls helps in reducing inter-storey deformation and controlling excessive drift.

Base Shear

Base shear is the total horizontal seismic force acting at the base of the structure. It represents the overall lateral force resisted by the building foundation during an earthquake.

The base shear values obtained from ETABS are compared for buildings with and without shear walls. The model with shear walls generally shows higher base shear because the additional stiffness attracts greater seismic force. However, the increased stiffness improves overall structural stability and lateral load resistance.

5. Graphs



Fig. 5.1: Storey displacement chart (Without shear wall)



Fig. 5.2: Storey displacement chart (With shear wall)



Fig. 5.3: Storey drift chart (Without shear wall)



**Fig. 5.4: Storey drift chart
(With shear wall)**

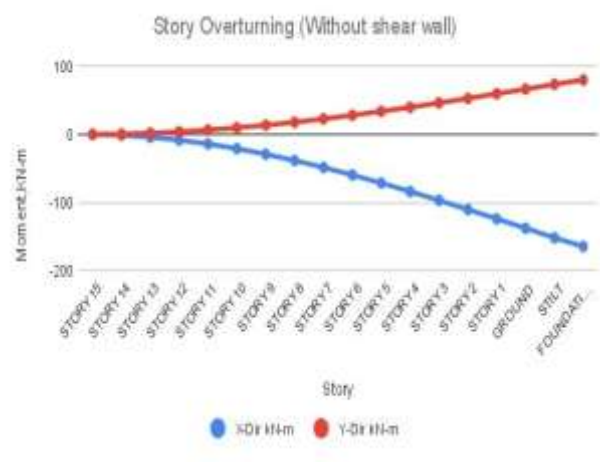


**Fig. 5.5: Storey overturning chart
(Without shear wall)**



**Fig. 5.6: Storey overturning chart
(With shear wall)**

6. Results and Discussions:

• Fig. 5.1 (Maximum Story Displacement): Displacement is highest at the top storey and gradually decreases towards the foundation. The Y-

direction shows higher displacement compared to the X-direction, indicating greater flexibility along that axis.

• Fig. 5.2 (Story Displacement with Shear Wall): The introduction of shear walls significantly reduces displacement in both X and Y directions. The reduction is more prominent in upper storeys, showing improved lateral stiffness of the structure.

• Fig. 5.3 (Story Drift without Shear Wall): Story drift increases from lower storeys to mid-height and then decreases towards the top. The Y-direction drift is higher than the X-direction, indicating higher lateral deformation without shear walls.

• Fig. 5.4 (Story Drift with Shear Wall): With shear walls, drift values are considerably reduced across all storeys. The drift becomes more uniform and controlled, ensuring the structure satisfies permissible drift limits.

• Fig. 5.5 (Story Overturning without Shear Wall): Overturning moments increase significantly from top to base. The structure experiences higher moments in lower storeys, indicating greater vulnerability without shear wall support.

• Fig. 5.6 (Story Overturning with Shear Wall): The presence of shear walls reduces overturning moments drastically. The variation of moments becomes more stable, showing improved resistance against lateral loads.

Base shear:

• The model with shear wall shows higher base shear and base moments than the model without shear wall.

• The model without shear wall shows lower base reaction values, which means it has less resistance to lateral loads.

• Shear walls help in transferring seismic forces more effectively to the foundation.

• Overall, the structure with shear wall provides better stability and seismic performance compared to the structure without shear wall.

• Structures without shear walls show higher deformation and instability under lateral loads.

7. Conclusions

From the analysis of the G+15 building with and without shear walls, the following conclusions are drawn:

- Storey displacement is significantly reduced with the provision of shear walls, especially in the upper storeys, indicating improved structural stiffness and control over lateral movement.
- Storey drift values are considerably lower in the model with shear walls, ensuring that the structure satisfies permissible drift limits and performs better under seismic loading.
- The structure without shear walls shows higher deformation and irregular drift distribution, making it more vulnerable to seismic effects.
- Base shear and overturning moments are effectively resisted in the shear wall model due to increased rigidity and better load transfer mechanism.
- Shear walls act as primary lateral load-resisting elements, thereby reducing the load and stress on beams and columns and enhancing overall structural efficiency.
- Proper placement of shear walls in both X and Y directions helps in minimizing torsional effects and ensures uniform distribution of seismic forces.
- Critical response parameters such as displacement, drift, and overturning are well controlled in the shear wall model, indicating improved seismic performance.
- Overall, the study concludes that the G+15 building with shear walls is safer, more stable, and better suited for seismic-resistant design compared to the structure without shear walls. The use of shear walls is essential for enhancing strength, stiffness, and overall performance in earthquake-prone regions.

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- Shear walls improve stiffness, strength, and overall seismic resistance of the building.
- The results clearly indicate that shear walls are essential for high-rise buildings in seismic regions.