

# Performance Based Seismic Evaluation of G+12 RCC Structures in Seismic Zone IV with and without Corner Shear Walls Considering Soil Types I, II, and III

Komal Kailas Salve<sup>1\*</sup>, Dinesh M. Pandit<sup>2</sup>

## Abstract

*Seismic behavior of multi-storey buildings is significantly influenced by structural stiffness and supporting soil conditions. This study investigates the seismic response of a G+12 reinforced concrete building by comparing two structural configurations, namely buildings with shear walls and buildings without shear walls, under three soil conditions: Type I, Type II, and Type III soils. The analysis is carried out using the response spectrum method in accordance with IS 1893 (Part 1): 2016, and evaluates important response parameters such as storey displacement, storey drift, base shear, and overturning moment. The results indicate that the inclusion of shear walls considerably improves the seismic performance of the structure. In the Y-direction, lateral displacement is reduced by approximately 15–20%, while storey drift decreases by nearly 25–30%, with all drift values remaining within permissible limits. The influence of soil type is also significant, as displacement and drift increase progressively from hard soil to soft soil due to seismic wave amplification. Soft soil conditions produce the highest structural response, whereas hard soil conditions result in comparatively lower values. The study further reveals that the inclusion of shear walls increases the base shear by about 35–42% and the overturning moment by approximately 9–10%. This increase is attributed to the enhanced stiffness and reduced natural time period of the structure, which leads to greater seismic force attraction. Despite the increase in seismic forces, the overall structural performance improves because of better control over lateral deformation and inter-storey drift. The study concludes that shear walls play a crucial role in enhancing the seismic resistance of multi-storey reinforced concrete buildings, particularly in regions with weak soil conditions, and the most efficient structural performance is achieved when shear walls are combined with hard soil conditions.*

**Keywords:** Shear wall, seismic analysis, storey drift, displacement, soil type, e-tab

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## INTRODUCTION

### General Background

The continuous expansion of urban infrastructure has created a growing demand for multistorey buildings for residential and commercial purposes. In earthquake-prone regions, such structures are subjected to dynamic ground motions that generate lateral forces, which may lead to deformation or structural damage if they are not adequately designed. The response of a building during seismic events is governed by several factors, including the structural configuration, material properties, building height, and characteristics of the supporting soil [1–5]. Reinforced concrete (RCC) moment-resisting frame systems are widely used in construction because of their durability and design

flexibility. However, as the height of a building increases, these systems alone may not be sufficient to effectively control lateral displacement and inter-storey drift. To improve the lateral load resistance, shear walls are introduced as vertical structural elements that enhance stiffness and provide greater stability under seismic forces [6, 7].

In addition to the structural configuration, the type of soil supporting the foundation plays a significant role in the seismic response. Soil conditions, such as hard, medium, and soft strata, influence the propagation and amplification of seismic waves. Structures resting on softer soils generally experience higher displacement and deformation due to amplification effects, whereas buildings on hard soil tend to exhibit lower response levels [8, 9]. Recent research has highlighted the importance of shear wall configuration and positioning in improving the seismic performance of multi-storey buildings [1, 2].

### **Importance of the Study**

Evaluating the combined influence of structural systems and soil conditions is essential to ensure the safety and reliability of building performance in seismic zones. The seismic response of a structure is governed by its stiffness, mass distribution, and dynamic characteristics of the supporting soil, which influence the propagation and amplification of ground motion [5, 9]. Neglecting these aspects during design may lead to excessive deformation, structural distress, or even collapse under earthquake loads. Therefore, proper consideration of seismic forces in conjunction with soil–structure interaction is necessary to achieve a safe and efficient structural design [6].

The present study focuses on assessing the seismic response of a G+12 reinforced concrete building by comparing two structural configurations, with and without shear walls, under different soil conditions. The analysis was performed using the response spectrum method in accordance with IS 1893 (Part 1): 2016 [9]. Key performance parameters, such as storey displacement, storey drift, base shear, and overturning moment, are evaluated to understand the structural behavior under seismic loading [5].

The results of this study are expected to identify the most efficient structural configuration and emphasize the importance of shear walls in improving the seismic resistance. This is particularly significant for buildings constructed on weaker soils, where the seismic effects are more pronounced. The findings will contribute to the development of safer, more economical, and performance-based design practices for structures in earthquake-prone regions [1, 2, 8, 10, 11].

## **LITERATURE REVIEW**

### **Review of Previous Studies**

Several researchers have examined the seismic response of multi-story reinforced concrete buildings by considering variations in the structural systems and foundation conditions. Earlier investigations on moment-resisting frame structures suggest that these systems perform adequately for low-rise buildings; however, as the number of stories increases, their ability to control lateral deformation reduces owing to insufficient stiffness [6, 7].

To address this limitation, several studies have focused on the use of shear walls as primary lateral load-resisting elements. The findings indicate that the incorporation of shear walls increases the rigidity of the structure and effectively limits the lateral displacement and inter-storey drift. Comparative analyses between structures with and without shear walls consistently demonstrate improved seismic performance when shear walls are included, particularly under strong ground motion [11, 12].

The effects of soil characteristics on structural responses have also received considerable attention. It has been observed that the soil type significantly influences the magnitude of the seismic forces experienced by a building. Softer soils tend to amplify ground vibrations, resulting in increased

displacement and drift, whereas harder soils provide more stable support with reduced amplification effects. Researchers have highlighted the importance of incorporating soil behavior into seismic analyses to achieve more realistic and reliable design outcomes [13, 8].

Furthermore, response spectrum analysis has been widely adopted as a practical approach to seismic evaluation. According to Chopra, response spectrum analysis provides an efficient and reliable estimation of the peak structural response under earthquake loading [5]. This method enables engineers to efficiently estimate the structural response under earthquake loading without the need for complex time-history simulations, making it suitable for comparative and parametric studies [10].

Recent studies have focused on enhancing the seismic performance of RC buildings through the optimal configuration and positioning of shear walls. Reliability-based optimization approaches have been employed to determine efficient shear wall locations, demonstrating that proper placement significantly improves the structural performance and overall efficiency [1, 3]. It has also been observed that the position of shear walls plays a crucial role, where centrally located walls improve serviceability, whereas corner shear walls enhance strength and resistance to lateral forces [3]. Furthermore, experimental and analytical studies have confirmed that the inclusion of shear walls effectively reduces lateral displacement and inter-storey drift, thereby improving the seismic performance of RC frame structures [2].

### **Key Findings from Literature**

1. The incorporation of shear walls significantly reduces the lateral displacement and inter-storey drift, thereby enhancing the overall structural stability under seismic loading [11, 12].
2. Structures without shear walls exhibit greater flexibility and are more vulnerable during seismic events because of insufficient lateral stiffness [14, 15].
3. Soil conditions significantly influence the structural response, with soft soils resulting in higher displacement and deformation owing to the amplification of seismic waves [9, 8].
4. Response spectrum analysis is a reliable and widely accepted method for seismic evaluation, enabling the efficient estimation of structural responses under earthquake loading [5, 10].
5. Structural stiffness plays a critical role in controlling deformation, and increased stiffness leads to reduced displacement and inter-storey drift during seismic events [5, 6].

### **Research Gaps**

Although significant work has been carried out in this field, certain limitations remain:

- Few studies have addressed the combined effects of shear walls and varying soil conditions within a single analytical framework.
- Direction-specific analysis, particularly focusing on the Y-direction displacement and drift, has not been extensively explored.
- Existing research often considers the structural configuration and soil effects independently rather than examining their combined influence.
- Limited comparative studies include additional response parameters, such as base shear and overturning moment, along with displacement and drift.

### **PROBLEM STATEMENT**

With the continuous increase in the construction of multi-story buildings, ensuring their safety under seismic conditions has become a critical concern. Conventional reinforced concrete moment-resisting frame systems may not provide sufficient stiffness to effectively control lateral displacement and storey drift, particularly in tall structures. Excessive deformation can lead to structural damage, reduced serviceability, and potential failure during strong earthquakes [6, 7].

In addition to the structural configuration, the nature of the supporting soil plays a significant role in determining the seismic response. Buildings constructed on softer soils are more susceptible to

amplified ground motion, resulting in higher displacement and drift than those constructed on hard soil [8, 9]. However, many designs do not adequately evaluate the combined effects of soil type and structural system. Furthermore, most existing studies focus either on the influence of shear walls or on soil conditions independently, with limited emphasis on their combined impact on the overall structural performance [11, 12]. In addition, a detailed analysis of the directional response, particularly in the Y-direction, along with key parameters such as the base shear and overturning moment, is lacking.

Therefore, there is a need to systematically evaluate the seismic behavior of multi-story buildings with and without shear walls under different soil conditions to identify a safe and efficient structural configuration.

## OBJECTIVES OF THE STUDY

The main objectives of this study are as follows:

1. A three-dimensional model of a G+12 reinforced concrete building was developed using ETABS software [4].
2. To perform seismic analysis using the response spectrum method in accordance with IS 1893 (Part 1): 2016 [9].
3. To compare the structural behavior of buildings with shear walls (SW) and without shear walls (WSW).
4. To study the influence of different soil types (Type I, Type II, and Type III) on seismic response [8].
5. To evaluate key response parameters, including story displacement, story drift, base shear, and overturning moment [5].
6. To analyze displacement and storey drift specifically in the Y-direction.
7. To identify the most suitable and safe structural configuration under varying seismic and soil conditions [11, 12].

## METHODOLOGY

### General

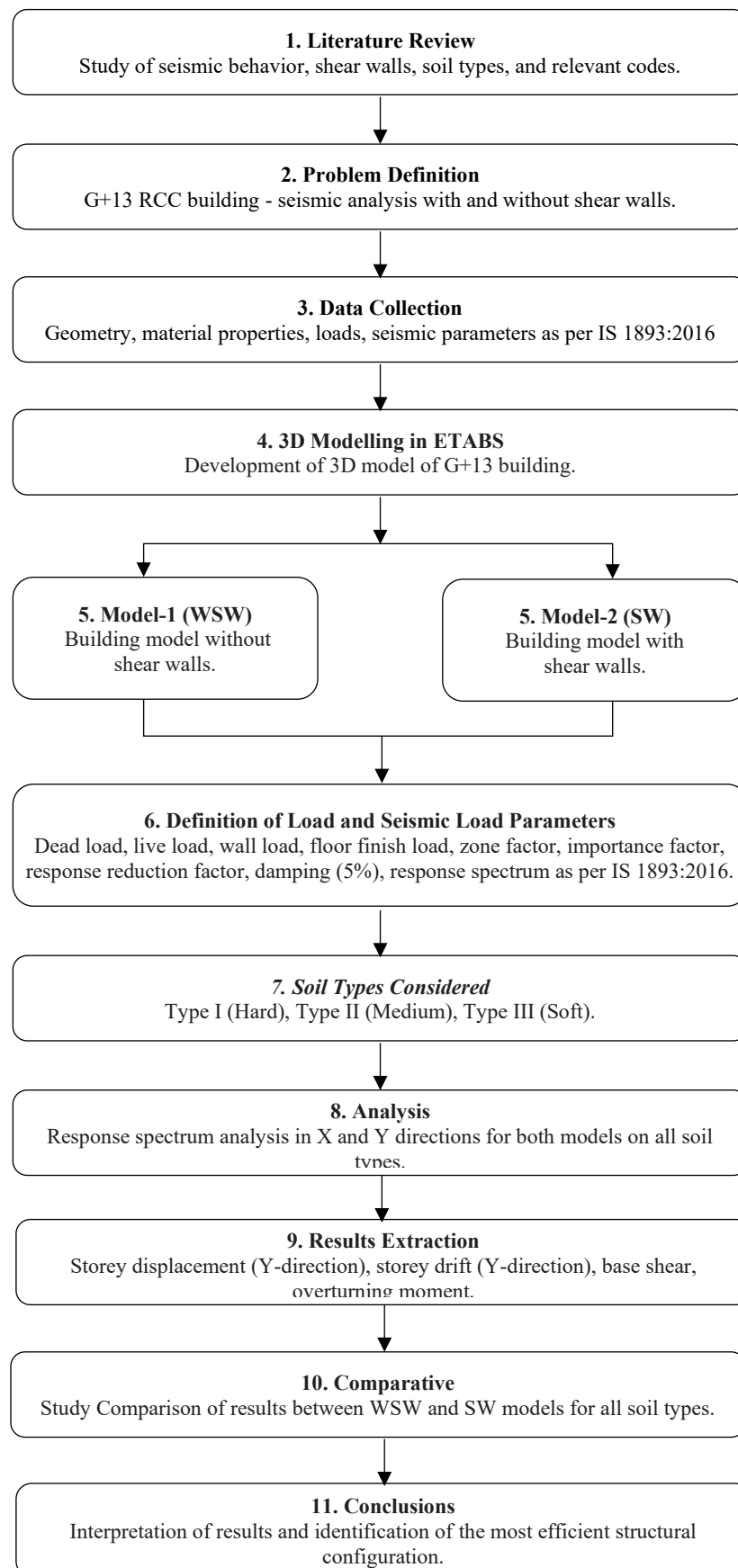
The present study focuses on evaluating the seismic behavior of a G+12 reinforced concrete building under different soil conditions with and without shear walls. The analysis was carried out using a numerical modeling approach in ETABS [4], following the provisions of IS 1893 (Part 1): 2016 [9].

Initially, a three-dimensional model of the building was developed with a typical story height of 3.1 m. The structural components, including beams, columns, slabs, and shear walls, were defined with appropriate material properties and section dimensions in accordance with standard design practices [16]. Two separate models were prepared: one without shear walls (WSW) and another with shear walls (SW), to enable comparative analysis.

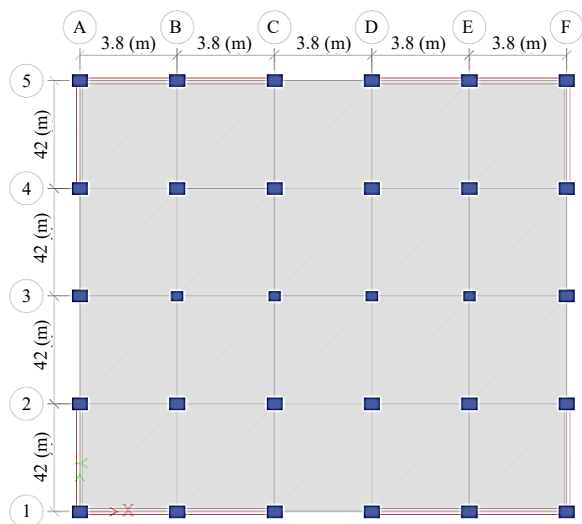
Seismic loads were applied using the response spectrum method specified in IS 1893 (Part 1): 2016 [9]. The building was analyzed for three different soil conditions: Type I (hard soil), Type II (medium soil), and Type III (soft soil). The seismic parameters, such as the zone factor, importance factor, response reduction factor, and damping ratio (5%), were defined according to the code requirements [9]. Load combinations were generated to capture the critical effects of seismic forces in both principal directions [6].

An analysis was performed to obtain the key response parameters, including the maximum storey displacement, storey drift, base shear, and overturning moment. The results were extracted for each soil type and structural configuration.

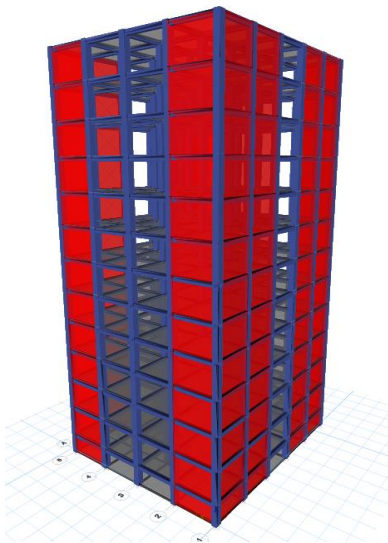
A comparative evaluation was then conducted to assess the influence of shear walls and soil conditions on the overall seismic performance of the building (Table 1 and Figures 1–5) [11, 8].



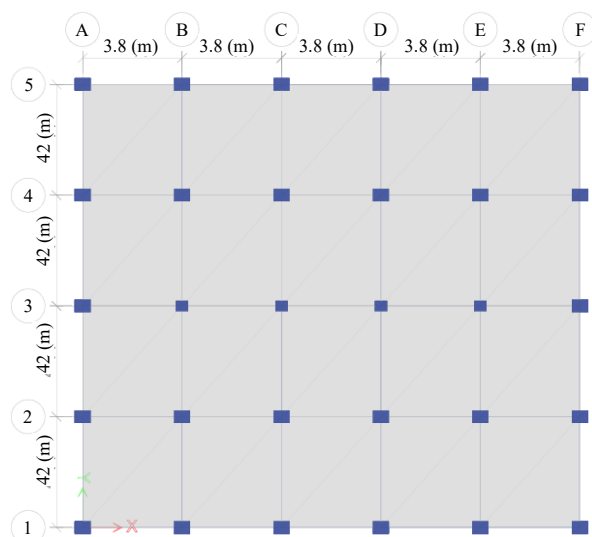
**Figure 1.** Methodology.



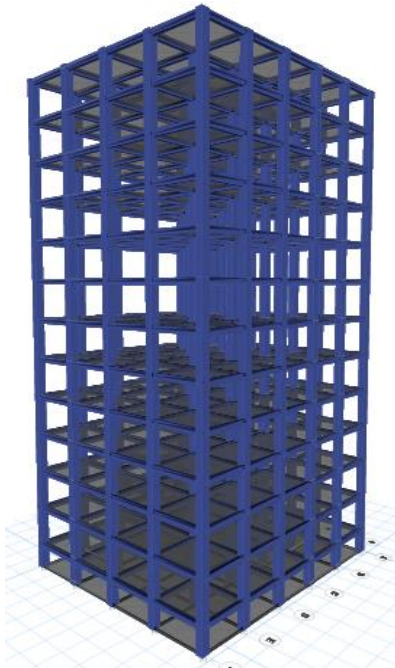
**Figure 2.** 2D view G+12 building SW.



**Figure 3.** 3D view G+12 building SW.



**Figure 4.** 2D view G+12 building WSW.



**Figure 5.** 3D view G+12 building WSW.

**Table 1.** Summary of building properties, loads, seismic parameters, and soil conditions [9, 16]

| S.N. | Category           | Parameter                       | Details                           |
|------|--------------------|---------------------------------|-----------------------------------|
| 1    | Building details   | Building type                   | RCC Residential Building          |
| 2    |                    | Software used                   | E-TABS                            |
| 3    |                    | Number of Storeys               | Ground Floor + 12                 |
| 4    |                    | Storey height                   | 3.1 m                             |
| 5    |                    | Total height                    | 43.4 m                            |
| 6    |                    | Plan dimensions                 | 16.8 m × 19 m                     |
| 7    |                    | Beam size                       | 305 mm × 380 mm                   |
| 8    |                    | Column size                     | 380 mm × 460 mm & 600 mm × 460 mm |
| 9    |                    | Slab thickness                  | 150 mm                            |
| 10   |                    | Wall & Shear wall               | 230 mm                            |
| 11   |                    | Concrete grade                  | M25 & M35 [16]                    |
| 12   |                    | Steel grade                     | Fe500                             |
| 13   |                    | Seismic zone                    | Zone IV [9]                       |
| 14   |                    | Soil type                       | Type I, II, III [16]              |
| 15   | Loads considered   | Dead load                       | Self-weight (Auto in ETABS)       |
| 16   |                    | Floor finish                    | 1.0 kN/m <sup>2</sup> [16]        |
| 17   |                    | Wall load                       | 14.3 kN/m [16]                    |
| 18   |                    | Reduced live load 25% (seismic) | 0.5 kN/m <sup>2</sup> [16]        |
| 19   |                    | Live load                       | 2.0 KN/m <sup>2</sup> [16]        |
| 20   | Seismic parameters | Code                            | IS 1893 (Part 1): 2016 [9]        |
| 21   |                    | Seismic zone                    | IV Raigad MH [9]                  |
| 22   |                    | Zone factor (Z)                 | 0.24                              |
| 23   |                    | Importance factor (I)           | 1.0                               |
| 24   |                    | Response reduction factor (R)   | 5 (SMRF)                          |
| 25   |                    | Damping ratio                   | 5%                                |

## RESULTS AND DISCUSSION

### Storey Displacement

The seismic performance of the G+12 storey building was analyzed under different soil conditions, namely Type I (hard soil), Type II (medium soil), and Type III (soft soil), with and without the inclusion of shear walls, in accordance with IS 1893 (Part 1): 2016 [9]. The parameter considered for comparison is the maximum storey displacement, as shown in Table 2.

The results indicate that the maximum displacement occurs at the top storey and gradually decreases towards the base, which is consistent with the behavior of a cantilever structure subjected to lateral loads. In the case without shear walls (WSW), the top-storey displacement for Soil Type I was 37.262 mm, which increased to 45.715 mm for Soil Type II and further to 52.862 mm for Soil Type III. This trend clearly demonstrates that the displacement increases with decreasing soil stiffness owing to higher seismic amplification in softer soils.

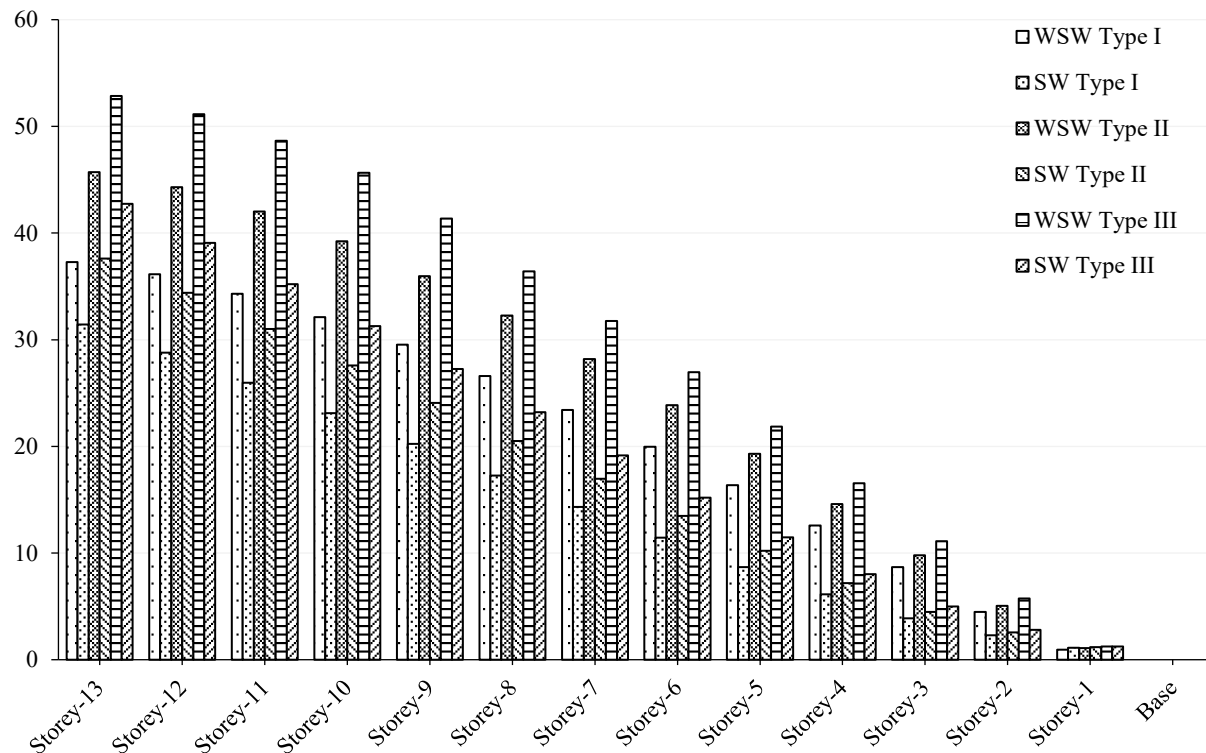
The inclusion of shear walls (SW) significantly improved the structural response by reducing the displacement values. For Soil Type I, the displacement decreased from 37.262 mm to 31.411 mm, representing a reduction of approximately 15%. Similarly, for Soil Type II, the displacement reduced from 45.715 to 37.593 mm, and for Soil Type III, it reduced from 52.862 to 42.729 mm, showing reductions of approximately 18% and 19%, respectively. These results confirm that shear walls enhance the lateral stiffness of the structure and effectively control its deformation.

It is also observed that the Y-direction displacements are comparatively lower than those in the X-direction, indicating a higher inherent stiffness of the structure along the Y-axis. However, the influence of the soil type and the effectiveness of the shear walls remained consistent in both directions. The variation in displacement along the height followed a uniform pattern, with a maximum at the top and zero at the base.

From the analysis, it can be concluded that the most favorable condition in the Y-direction is achieved when shear walls are provided in hard soil (Type I), where the displacement is minimum at 31.411 mm. Conversely, the most critical condition occurred in the absence of shear walls in soft soil (Type III), where the displacement reached a maximum value of 52.862 mm. Overall, this study highlights the importance of incorporating shear walls in multi-storey buildings, especially in regions with poor soil conditions, to ensure improved seismic performance and structural safety (Figure 6).

**Table 2.** Maximum storey displacement in Y-direction (mm).

| Storey    | WSW Type I | SW Type I | WSW Type II | SW Type II | WSW Type III | SW Type III |
|-----------|------------|-----------|-------------|------------|--------------|-------------|
| Storey-13 | 37.262     | 31.411    | 45.715      | 37.593     | 52.862       | 42.729      |
| Storey-12 | 36.148     | 28.788    | 44.300      | 34.406     | 51.143       | 39.072      |
| Storey-11 | 34.307     | 25.975    | 42.018      | 31.014     | 48.656       | 35.205      |
| Storey-10 | 32.112     | 23.124    | 39.241      | 27.579     | 45.661       | 31.279      |
| Storey-9  | 29.527     | 20.223    | 35.961      | 24.072     | 41.363       | 27.267      |
| Storey-8  | 26.607     | 17.262    | 32.254      | 20.501     | 36.393       | 23.190      |
| Storey-7  | 23.404     | 14.316    | 28.192      | 16.953     | 31.744       | 19.143      |
| Storey-6  | 19.971     | 11.434    | 23.850      | 13.492     | 26.968       | 15.201      |
| Storey-5  | 16.353     | 8.686     | 19.292      | 10.201     | 21.861       | 11.459      |
| Storey-4  | 12.582     | 6.143     | 14.578      | 7.167      | 16.537       | 8.018       |
| Storey-3  | 8.687      | 3.884     | 9.780       | 4.488      | 11.102       | 4.990       |
| Storey-2  | 4.489      | 2.284     | 5.062       | 2.560      | 5.751        | 2.796       |
| Storey-1  | 0.927      | 1.120     | 1.084       | 1.180      | 1.231        | 1.238       |
| Base      | 0          | 0         | 0           | 0          | 0            | 0           |



**Figure 6.** Maximum storey displacement in Y-direction (mm).

### Storey Drift

The storey drift of the G+12 building in the Y-direction was evaluated for different soil conditions with and without shear walls, in accordance with IS 1893 (Part 1): 2016 [9]. The permissible limit for storey drift according to IS 1893 is 0.004 (h/250). The obtained results for all cases were within this allowable limit, indicating the satisfactory performance of the structure under seismic loading (Table 3).

In the absence of a shear wall (WSW), the maximum storey drift in the Y-direction was 0.00136, 0.001548, and 0.001753 for Soil Types I, II, and III, respectively. These values were approximately in the mid-height region of the building. It is evident that the story drift increases as the soil stiffness decreases, with soft soil (Type III) exhibiting the highest drift owing to increased seismic amplification.

With the inclusion of shear walls (SW), a noticeable reduction in the storey drift was observed across all soil types. The maximum drift values reduce to 0.000994 (Type I), 0.00119 (Type II), and 0.001354 (Types I, II, and III). This corresponds to a reduction of approximately 25% to 30%, confirming the effectiveness of the shear walls in enhancing the lateral stiffness and controlling the inter-storey deformation.

The variation of storey drift along the height shows a typical pattern, where the drift increases from the base, reaches a maximum at mid-height, and then slightly reduces towards the top. This behavior is consistent with the dynamic response of multi-storey buildings subjected to lateral seismic forces.

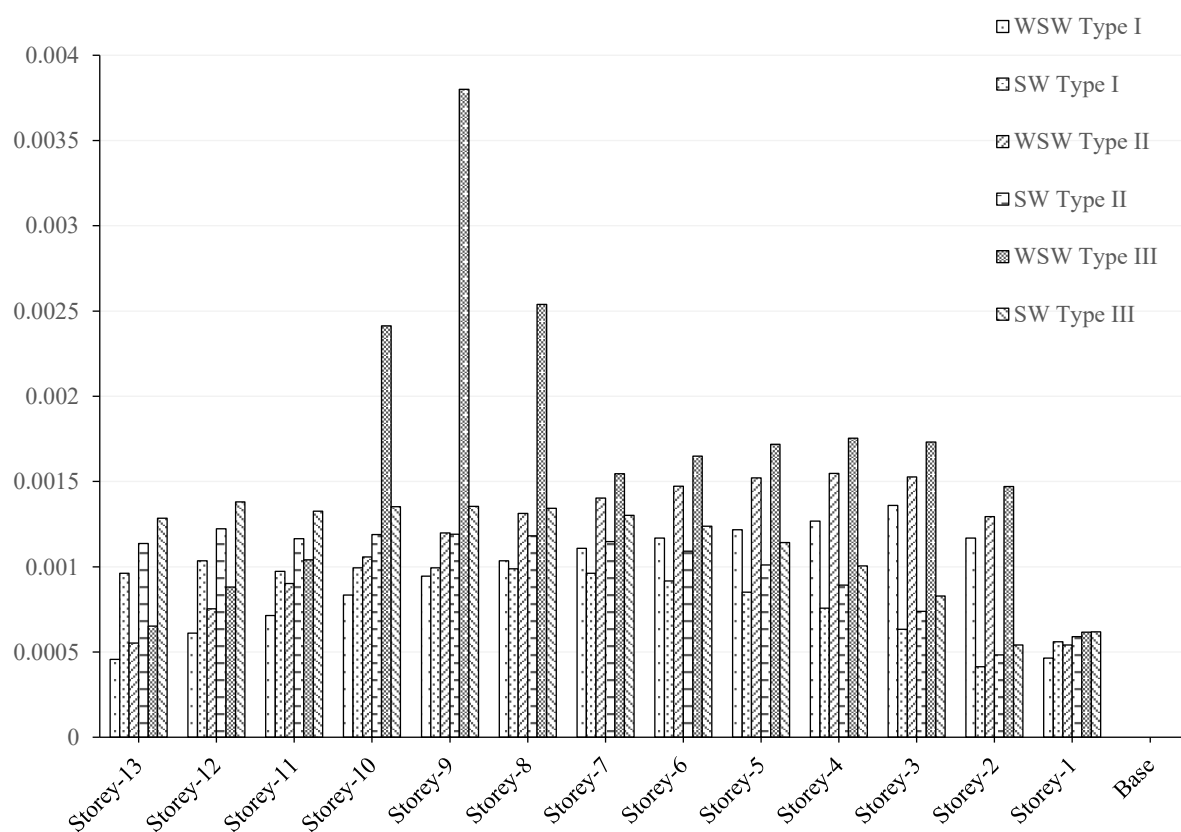
Furthermore, the drift values in the Y-direction were significantly lower than those in the X-direction, indicating greater stiffness along the Y-axis. However, the influence of soil type and the beneficial effect of shear walls remained consistent in both directions.

From the analysis, it can be concluded that the safest condition is achieved with a shear wall in hard soil (Type I), where the drift is minimum (0.000994). The most critical condition occurred in the

absence of shear walls in soft soil (Type III), where the drift reached a maximum value of 0.001753. Nevertheless, all values were well within the permissible limit of 0.004, confirming that the structure is safe against the storey drift criteria, as shown in Figure 7.

**Table 3.** Maximum storey drift in Y-direction.

| Storey    | WSW Type I | SW Type I | WSW Type II | SW Type II | WSW Type III | SW Type III |
|-----------|------------|-----------|-------------|------------|--------------|-------------|
| Storey-13 | 0.000456   | 0.000961  | 0.000553    | 0.001137   | 0.000651     | 0.001284    |
| Storey-12 | 0.000611   | 0.001035  | 0.000753    | 0.001222   | 0.000881     | 0.001380    |
| Storey-11 | 0.000714   | 0.000973  | 0.000901    | 0.001165   | 0.001040     | 0.001325    |
| Storey-10 | 0.000834   | 0.000994  | 0.001058    | 0.001189   | 0.002412     | 0.001352    |
| Storey-9  | 0.000944   | 0.000994  | 0.001198    | 0.001190   | 0.003801     | 0.001354    |
| Storey-8  | 0.001035   | 0.000988  | 0.001312    | 0.001182   | 0.002539     | 0.001343    |
| Storey-7  | 0.001109   | 0.000961  | 0.001402    | 0.001147   | 0.001545     | 0.001302    |
| Storey-6  | 0.001168   | 0.000917  | 0.001472    | 0.001092   | 0.001648     | 0.001237    |
| Storey-5  | 0.001217   | 0.000851  | 0.001522    | 0.001010   | 0.001719     | 0.001141    |
| Storey-4  | 0.001268   | 0.000757  | 0.001548    | 0.000892   | 0.001753     | 0.001005    |
| Storey-3  | 0.001360   | 0.000633  | 0.001526    | 0.000739   | 0.001731     | 0.000828    |
| Storey-2  | 0.001169   | 0.000413  | 0.001294    | 0.000483   | 0.001470     | 0.000542    |
| Storey-1  | 0.000464   | 0.000560  | 0.000542    | 0.000590   | 0.000616     | 0.000619    |
| Base      | 0          | 0         | 0           | 0          | 0            | 0           |



**Figure 7.** Maximum storey drift in Y-direction.

## Overturning Moment

The overturning moment at the base of the structure was evaluated in the X-direction for different soil conditions with and without the inclusion of shear walls, as per IS 1893 (Part 1): 2016 [9]. The results indicate a clear variation in the overturning moment owing to changes in the structural stiffness and soil conditions, as shown in Table 4.

In the absence of shear walls (WSW), the overturning moment values were 14,505,776 kN·m for soil types I, 14,496,390 kN·m for Soil Type II, and 14,641,815 kN·m for Soil Type III. The variation among the soil types was relatively small, indicating that soil stiffness has a moderate influence on the overturning moment when the structure is relatively flexible.

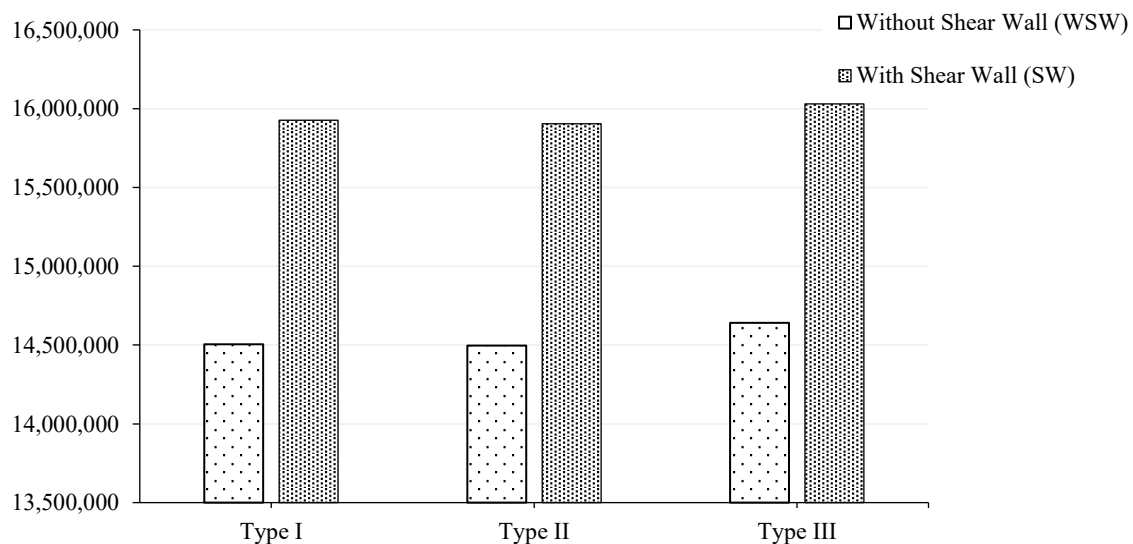
With the provision of shear walls (SW), the overturning moment increased significantly for all soil types. The values increased to 15,926,539, 15,904,686, and 16,030,615 kN·m for soil types I, II, and III, respectively. This represents an increase of approximately 9% to 10% compared to a structure without shear walls.

The increase in the overturning moment can be attributed to the increase in structural stiffness owing to the addition of shear walls. A stiffer structure attracts higher seismic forces, resulting in increased base shear and, consequently, higher overturning moments. Among all the soil conditions, soft soil (i.e., Soil Type III) showed the highest overturning moment, indicating that softer soils amplify seismic forces more significantly.

From the analysis, it can be concluded that although the inclusion of shear walls increases the overturning moment, it is beneficial for the overall structural performance, as it significantly reduces displacement and drift. The safest structural configuration was achieved with shear walls in hard soil (Type I), whereas the most critical condition was observed in soft soil (Type III) with shear walls, where the overturning moment was maximum, as shown in Figure 8.

**Table 4.** Overturning moment at base in X-direction (kN·m).

| Soil type | Without shear wall (WSW) | With shear wall (SW) |
|-----------|--------------------------|----------------------|
| Type I    | 14,505,776               | 15,926,539           |
| Type II   | 14,496,390               | 15,904,686           |
| Type III  | 14,641,815               | 16,030,615           |



**Figure 8.** Overturning moment at base in X-direction (kN·m).

### Base Shear

The base shear of the structure in the X-direction was evaluated for different soil conditions with and without shear walls, in accordance with IS 1893 (Part 1): 2016 [9]. The results indicate a significant variation in the base shear owing to both the soil type and structural configuration (Table 5).

In the absence of shear walls (WSW), the base shear values were 15,677.68 kN for Soil Type I, 16,113.34 kN for soil types I, II, and 17,597.44 kN for Soil Type III. It is evident that the base shear increases as the soil becomes softer, which is due to the higher seismic amplification in soft soil conditions.

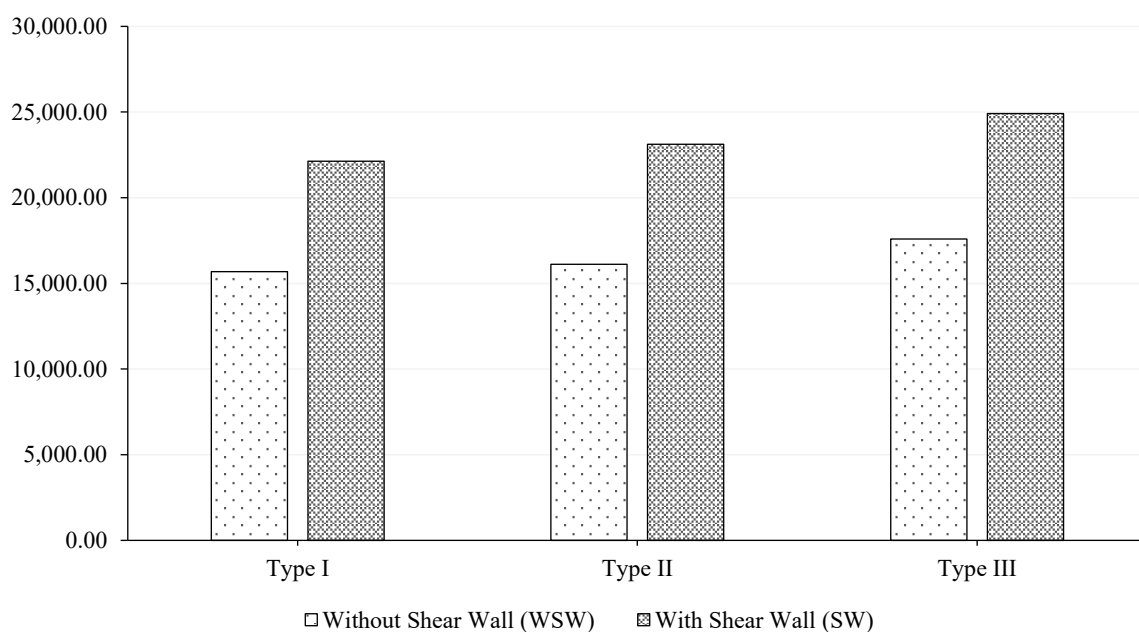
With the inclusion of shear walls (SW), the base shear increased considerably for all soil types. The values increased to 22,129.89, 23,126.46, and 24,906.04 kN for soil types I, II, and III, respectively. This represents an increase of approximately 35% to 42% compared with the structure without shear walls.

The increase in the base shear is attributed to the increased stiffness of the structure owing to the presence of shear walls. A stiffer structure has a reduced natural time period, which leads to a higher spectral acceleration ( $S_a/g$ ) and, consequently, higher seismic forces. Among all the soil conditions, Soil Type III exhibited the maximum base shear, indicating that soft soil conditions are more critical for seismic design.

Although the base shear increases with the inclusion of shear walls, it should be noted that the overall structural performance improves because of the significant reduction in displacement and story drift. Therefore, the increase in the base shear is a desirable outcome, as it reflects improved stiffness and better seismic resistance, as shown in Figure 9.

**Table 5.** Base shear in X-direction (kN).

| Soil type | Without shear wall (WSW) | With shear wall (SW) |
|-----------|--------------------------|----------------------|
| Type I    | 15,677.68                | 22,129.89            |
| Type II   | 16,113.34                | 23,126.46            |
| Type III  | 17,597.44                | 24,906.04            |



**Figure 9.** Base shear in X-direction (kN).

## CONCLUSION

1. The inclusion of shear walls reduced the lateral displacement in the Y-direction by approximately 15–20%, indicating improved stiffness and better control over structural deformation.
2. The soil type significantly influenced the response. As the soil changes from Type I to Type III, the displacement increases by approximately 42%, indicating higher seismic amplification in soft soil conditions.
3. The storey drift values in all cases were within the permissible limit of 0.004 (as per IS 1893 (Part 1): 2016), confirming structural safety. The presence of shear walls further reduced the drift by approximately 25–30%.
4. The maximum displacement occurred at the top story, whereas the maximum drift occurred at the mid-height, which is the typical behavior of multi-story buildings under seismic loading.
5. The base shear increases significantly with the inclusion of shear walls by approximately 35–42% (e.g., 17,597–24,906 kN in soft soil) owing to the increased stiffness and reduced natural time period.
6. The overturning moment also increases by approximately 9–10% with the provision of shear walls owing to the higher lateral force attraction.
7. The safest condition is achieved with a shear wall in hard soil (Type I), where the displacement (~31.41 mm), drift (~0.000994), base shear, and overturning moment are within the controlled limits.
8. The most critical condition occurred in soft soil (Type III) without a shear wall, where maximum displacement (~52.86 mm), drift (~0.001753), and seismic effects were observed.

## REFERENCES

1. A. M. Abualreesh, “Reliability-based optimization of shear walls in RC shear wall-frame buildings subjected to earthquake loading,” *Case Studies in Construction Materials*, vol. 16, Jun. 2022, Art. no. e00978. DOI: <https://doi.org/10.1016/j.cscm.2022.e00978>.
2. T. A. Ozku, “Effect of shear wall on seismic performance of RC frame buildings,” *Engineering Failure Analysis*, vol. 100, pp. 60–75, Jun. 2019. DOI: <https://doi.org/10.1016/j.engfailanal.2019.02.032>.
3. P. K. Khand, “Reliability-based approach to shear wall positioning in seismic design,” *International Journal of Structural Engineering*, vol. 13, no. 1, pp. 25–38, 2025.
4. Computers and Structures Inc. (CSI), ETABS – Integrated Building Analysis and Design Software, Berkeley, CA, USA.
5. A. K. Chopra, *Dynamics of Structures: Theory and Applications to Earthquake Engineering*, 4th ed., Pearson Education, 2017.
6. S. K. Duggal, *Earthquake Resistant Design of Structures*, 2nd ed., Oxford University Press, 2013.
7. P. Agarwal and M. Shrikhande, *Earthquake Resistant Design of Structures*, PHI Learning, New Delhi, India, 2006.
8. M. F. Haque et al., “Seismic performance evaluation of multi-storey RC structures,” *Results in Engineering*, vol. 22, pp. 101234, 2025.
9. Bureau of Indian Standards, IS 1893 (Part 1): 2016 – Criteria for Earthquake Resistant Design of Structures, New Delhi, India, 2016.
10. R. Suwondo, “Comparative seismic analysis of RC buildings using response spectrum and static methods,” *Engineering, Technology & Applied Science Research*, vol. 15, no. 2, pp. 12456–12463, 2025.
11. A. Seçkin, “Influence of shear wall layout on seismic performance of RC buildings,” *Journal of Innovative Engineering and Natural Science*, vol. 9, no. 1, pp. 45–52, 2025.
12. S. Nandarge and K. R. Kale, “Comparative seismic analysis of G+40 RCC building using ETABS,” *International Journal for Research in Applied Science and Engineering Technology (IJRASET)*, vol. 14, no. 3, pp. 890–897, 2026.
13. A. A. Sourov et al., “ETABS-based structural analysis of a high-rise building on soft soil,” *Open Access Library Journal*, vol. 12, no. 3, pp. 1–10, 2025.
14. D. S. Wagh et al., “Earthquake analysis of structure using ETABS,” *International Journal of Innovative Research in Technology*, vol. 12, no. 11, pp. 1123–1129, 2026.

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15. A. P. Sahane and K. R. Kale, “Seismic performance of regular and irregular high-rise buildings,” *International Journal for Research in Applied Science and Engineering Technology (IJRASET)*, vol. 14, no. 2, pp. 567–573, 2026.
  16. Bureau of Indian Standards, IS 456: 2000 – Plain and Reinforced Concrete – Code of Practice, New Delhi, India, 2000.