# Seismic Analysis of Steel Building with RC Shear Wall – Research Paper

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*Abstract* — In high-rise steel buildings, RC shear walls play a vital role in improving seismic resistance by significantly reducing lateral displacement, story drift, and structural instability during earthquake loading. This research presents the seismic analysis of a G+10 steel building with and without RC shear wall using STAAD.Pro software. The study is to evaluate the effect of RC shear walls on displacement, base shear, and story drift of the steel structure subjected to seismic and wind loads. The type of building is regular. The study indicates that the provision of RC shear wall significantly reduces the lateral top displacement of the steel building from 36.503 mm to 11.958 mm, resulting in approximately 67.17% and improves structural stiffness.

***Keywords:*** Steel Building, RC Shear Wall, Seismic Analysis, Story Drift, Base Shear

## I. Introduction

Earthquakes are among the most destructive natural phenomena, causing severe damage to buildings and infrastructure, particularly in seismic-prone regions. The increasing trend toward the construction of high-rise and long-span structures has intensified the need for efficient seismic-resistant structural systems. Steel buildings are widely preferred in modern construction due to their high strength-to-weight ratio, ductility, flexibility, and ease of fabrication. However, steel frame structures are vulnerable to excessive lateral displacement and instability during strong earthquake ground motions if suitable lateral load-resisting systems are not incorporated [1] and [4].

Extensive research has been carried out on the seismic behaviour of steel structures under earthquake loading. Naman and Goodno investigated the seismic evaluation of low-rise steel buildings and emphasized the importance of proper structural configuration in improving earthquake resistance [1]. Gad et al. performed modal analysis on steel-framed residential structures and reported that dynamic characteristics such as natural frequency and mode shape significantly influence seismic performance [2]. Awkar and Lui studied multistorey semi-rigid steel frames and concluded that frame flexibility plays an important role in structural response under seismic excitation [3]. Hall examined the behavior of steel frame buildings subjected to near-source ground motions and observed that such motions can produce severe deformation demands and structural damage [4].

Further studies have focused on improving the seismic performance of steel structures through various lateral load-resisting systems. Fragiacomo et al. analysed steel frames subjected to repeated earthquake ground motions and highlighted the necessity of adequate energy dissipation mechanisms for structural safety [5]. Sangle et al. evaluated high-rise steel frame buildings with and without bracing systems and found that bracing considerably reduces storey displacement and enhances overall stiffness [6]. Khan and Naqvi carried out reliability analysis of steel building frames under earthquake forces and emphasized the importance of safe and reliable seismic design [7]. Akbar et al. investigated steel frames equipped with low-yield-point steel dampers and demonstrated improved seismic behavior through enhanced energy absorption capacity [8].

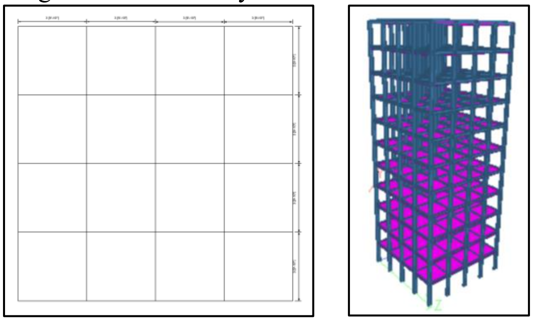
Among the various seismic-resistant systems, shear walls are considered one of the most effective structural components for resisting lateral loads caused by earthquakes and wind forces. Shear walls significantly increase the stiffness, strength, and stability of buildings, thereby reducing storey drift and lateral displacement. Steel plate shear walls and RC shear walls are widely used in multi-storey structures due to their excellent energy dissipation characteristics and lateral load resistance. Guo et al. studied the behaviour of steel plate shear walls connected to frame beams and concluded that shear walls contribute significantly to structural stiffness and seismic performance [9]. Gupta et al. analysed tall buildings with RC and steel plate shear walls and reported that the incorporation of shear walls effectively reduces lateral deflection and improves structural stability during seismic loading [10]. Chandurkar and Pajgade conducted seismic analysis of RC buildings with and without shear walls and concluded that buildings with shear walls exhibit better seismic performance compared to conventional framed structures [11].

In India, the seismic analysis and design of structures are governed by IS 1893 (Part 1): 2016 [12], which provides criteria for earthquake-resistant design. Load calculations are carried out according to IS 875 [13], while the design provisions for steel structures are specified in IS 800: 2007 [17]. Standard references such as Punmia et al. [14], Duggal [15], and Murty [18] provide comprehensive knowledge regarding structural analysis and earthquake-resistant design principles. STAAD.Pro software [16] is widely used for modelling and seismic analysis of structures because of its accuracy and efficiency in evaluating structural behaviour under different loading conditions.

The present study focuses on the seismic analysis of steel buildings with RC shear walls. The main objective is to evaluate the effectiveness of RC shear walls in improving the seismic performance of steel frame structures by comparing parameters such as storey displacement, storey drift, base shear, and structural stability under earthquake loading. The analysis is performed using STAAD.Pro software in accordance with relevant Indian Standard codes. This study aims to contribute toward the development of safe, efficient, and economical earthquake-resistant steel building systems for modern construction practices.

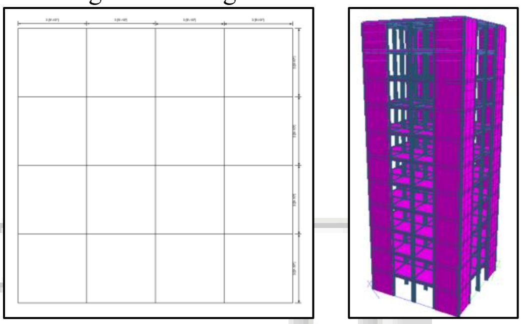
The present study investigates the behavior of a G+10 steel structure with and without RC shear wall under seismic loading conditions in Nagpur region. To model and analyze a G+10 steel building in Stand. Pro. Many previous studies have focused on steel buildings with bracing systems.

No research has been carried out on the behavior of steel buildings combined with RC shear walls. To compare the seismic behavior of building with and without the RC shear wall. To determine top displacement, base shear, and story drift. To evaluate the effectiveness of the RC shear wall in improving structural stability.



PLAN ELEVATION

Fig. 1: Building Without Shear Wall



PLAN ELEVATION

Fig. 2: Building with Shear Wall

## II. BUILDING DETAILS

| Parameter | Details |
|---|---|
| Building Type | G+10 Steel Building |
| Plan Dimension | 12 m × 12 m |
| Total Height | 33 m |
| Storey Height | 3 m |
| Beam Section | ISMB 350 |
| Column Section | ISMB 450 |
| Slab Thickness | 125 mm |
| Shear Wall Thickness | 200 mm |
| Support Condition | Fixed Support |
| Software Used | STAAD.Pro |
| Region | Nagpur |

Table 1: Building Parameter and Details

## III. METHODOLOGY

The building was modeled in STAAD.Pro considering dead load, live load, wind load, and seismic load as per IS 1893:2016 (part-1). Two models were analyzed: one without shear wall and another with RCC shear wall. The results were compared based on displacement, base shear, and story drift.

### A. *Material Properties*

#### 1) *Steel Properties*

- Steel sections are assigned for beams and columns.
- Young's modulus and density are defined according to IS 800:2007 code provisions.

#### 2) *Concrete Properties*

- RCC shear wall properties are assigned using concrete material specifications.
- According to IS 456:2000

### B. *Structural Steel*

| Property | Values |
|---|---|
| Modulus of Elasticity | $2 \times 10^5$ N/mm² |
| Poisson Ratio | 0.3 |
| Density | 7850 kg/m³ |

Table 2: Properties and Values of Structural Steel

### C. *Concrete*

| Property | Values |
|---|---|
| Grade of Concrete | M30 |
| Density | 25 kN/m³ |
| Poisson Ratio | 0.2 |

Table 3: Properties and Values of Concrete

### D. *Loading Details*

The following loads are considered in the analysis:

#### 1) *Dead Load*

- Self-weight of structure - -1 KN/m
- Slab load - 4 KN/m
- Wall load – 15.15 KN/m
- Floor finish load - -2 KN/m

#### 2) *Live Load*

- Imposed load on floors as per IS 875

#### 3) *Seismic Load*

Earthquake loads are applied according to IS 1893:2016 provisions.

Parameters considered:

- Zone factor – 0.1
- Importance factor – 1.0
- Response reduction factor
- Soil type – Medium
- Damping ratio – 5 %

Seismic loads are applied in:

- X-direction (EQX)
- Z-direction (EQZ)

#### 4) *Seismic Analysis*

Seismic analysis of the structure is performed using STAAD.Pro software. The analysis helps in determining the behaviour of the structure under earthquake forces.

## IV. RESULTS AND DISCUSSION

| Parameter | Without Shear Wall | With RCC Shear Wall |
|---|---|---|
| Top Displacement | 36.503 mm | 11.985 mm |
| Base Shear | 193.220 kN | 165.817 kN |
| Maximum Story Drift | 4.746 mm | 1.345 mm |
| Structural Stiffness | Lower | Higher |

The analysis results indicate that the addition of RC shear wall significantly improves the seismic performance of the steel building. The displacement and story drift values are considerably reduced due to increased lateral stiffness.

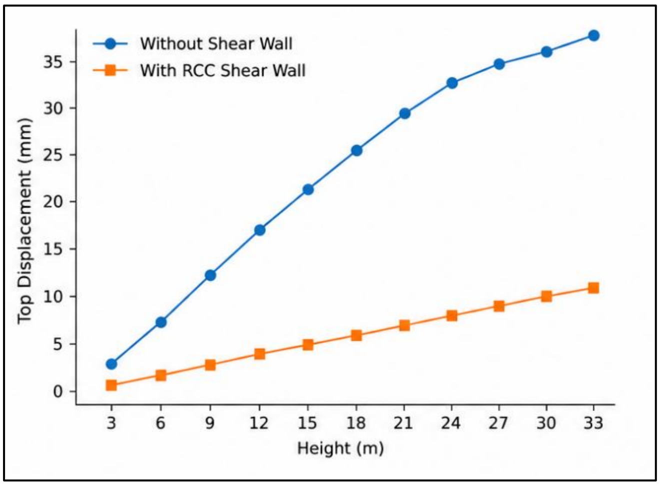



Fig. 3: Displacement Comparison

In Figure 3. The graph compares the top displacement of a G+10 steel building with and without RCC shear wall under earthquake loading. It can be seen that the displacement increases as the height of the building increases. The building without shear wall shows higher displacement at all storeys, while the building with RCC shear wall shows considerably lower displacement values. At the top storey, the displacement is reduced from about 36.503 mm to 11.985 mm after providing the RC shear wall. This reduction in displacement shows that the shear wall improves the stiffness and stability of the structure and helps the building resist seismic forces more effectively.

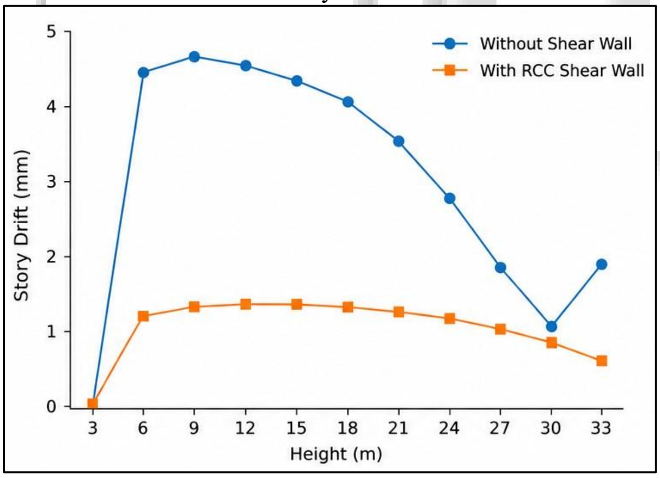



Fig. 4: Story Drift Comparison

In Figure 4. The graph shows the comparison of story drift in a G+10 steel building with and without RCC shear wall under seismic loading. It is observed that the building without shear wall experiences higher story drift at almost all levels, with the maximum drift occurring at the middle stores. In contrast, the building with RC shear wall shows much lower and more uniform drift values throughout the height of the structure. This reduction in story drift indicates that the RC shear wall improves the lateral stiffness of the building and helps in controlling excessive movement during earthquake loading, resulting in better structural stability and safety.

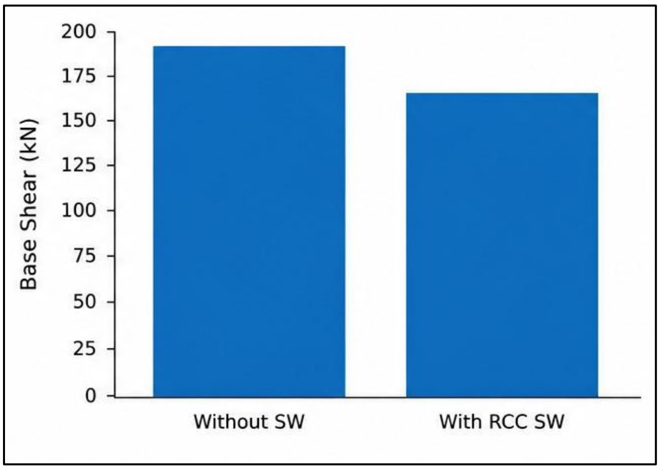



Fig. 5: Base Shear Comparison

In Figure 5. The graph compares the base shear of the steel building with and without RC shear wall under seismic loading. It is observed that the building without shear wall has higher base shear compared to the building with RC shear wall. The provision of RC shear wall helps in improving the overall stiffness and seismic resistance of the structure, which results in better distribution of earthquake forces. This shows that the RC shear wall enhances the structural performance and stability of the building during seismic conditions.

## V. CONCLUSION

1) The RC shear wall effectively reduced the top displacement from 36.503 mm to 11.985 mm.
2) Story drift was significantly reduced, indicating improved structural performance.
3) The building with RC shear wall showed higher stiffness and better seismic resistance.
4) The study confirms that RC shear walls are effective in controlling lateral displacement in steel buildings.

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