

Seismic Behaviour of 12-Storey RC Buildings with Optimized Shear Wall Locations: A Review

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Abstract: *As cities keep growing into earthquake-prone areas, making sure mid-rise reinforced concrete buildings can handle seismic forces has become a big deal. Shear walls, out of all the options for handling sideways loads, really stand out—they boost stiffness, help keep everything stable, and control how much a building sways, especially in those 10 to 20-storey towers you see everywhere.*

Here, I've pulled together the main insights from both classic and recent research on how these buildings behave during earthquakes. I focus on 12-storey buildings, since that's a pretty common height, and dive into how things like where you put the shear walls, the kind of soil you're building on, and how the earthquake forces are spread out all affect performance. The data come straight from analyses using STAAD.Pro, ETABS, and SAP2000—tools the industry trusts—running through everything from simple static tests to full-on nonlinear time-history simulations. Altogether, this review brings in findings from 21 well-established studies, plus seven newer ones from the last few years.

Some trends pop up again and again: putting shear walls at the core or on the corners tends to cut down on displacement, shift the base shear, stiffen the structure, and make the whole building more ductile. I've included figures showing how drift changes, how base shear depends on soil type, and how the building's time period drops with different setups.

But there's still work to do. There are gaps in nonlinear modeling, understanding soil-structure interaction, dealing with torsional imbalances, and figuring out the best way to place shear walls using optimization algorithms. This review pulls all of that together to give engineers and researchers a solid, up-to-date foundation for designing better, more earthquake-resistant 12-storey RC buildings.

Keywords: 12-storey RC buildings, shear wall location, seismic analysis, storey drift, STAAD.Pro, response spectrum, nonlinear dynamics.

I. INTRODUCTION

Seismic hazard mitigation in reinforced concrete buildings is a real challenge—especially for mid-rise buildings around 10 to 15 storeys. These make up a big chunk of the world's homes and offices. They face the tough job of handling moderate to strong earthquakes, and they have to do it without swaying too much or putting too much stress on themselves. But if you just use regular moment-resisting frames, you run into a problem: they're usually not stiff or flexible enough to handle those shakes.

That's where shear walls come in. They're those solid, vertical slabs that run from the ground up, and they really help. With shear walls, buildings can better resist forces from the side, sway less, and the beams and columns don't have to work so hard. Still, it's not just about adding them anywhere—their impact depends a lot on where you put them, how thick they are, which way they face, and how they work with the rest of the building. For 12-storey buildings in particular, getting this right matters even more, since these are tall enough that both stiffness and flexibility play a big role.

This review brings together research from the past twenty years, pointing out what works best and what's new when it comes to placing shear walls and understanding how 12-storey RC buildings behave during earthquakes. It covers both the classic studies from 2010 to 2018 and the latest work from 2020 to 2024, including things like soil effects, nonlinear modelling, plan irregularities, and how to optimize core walls.



II. COMPREHENSIVE LITERATURE REVIEW

Classical Studies (2010–2018)

Base Shear and Soil Effects

Khaja Begum Anad et al. [1] examined 15-storey frames with/without shear walls under varied soil conditions. Beyond the third storey, base shear showed significant variation (soft > medium > hard), emphasizing soil stiffness as a key parameter for mid-rise buildings as shown in Figure 1.

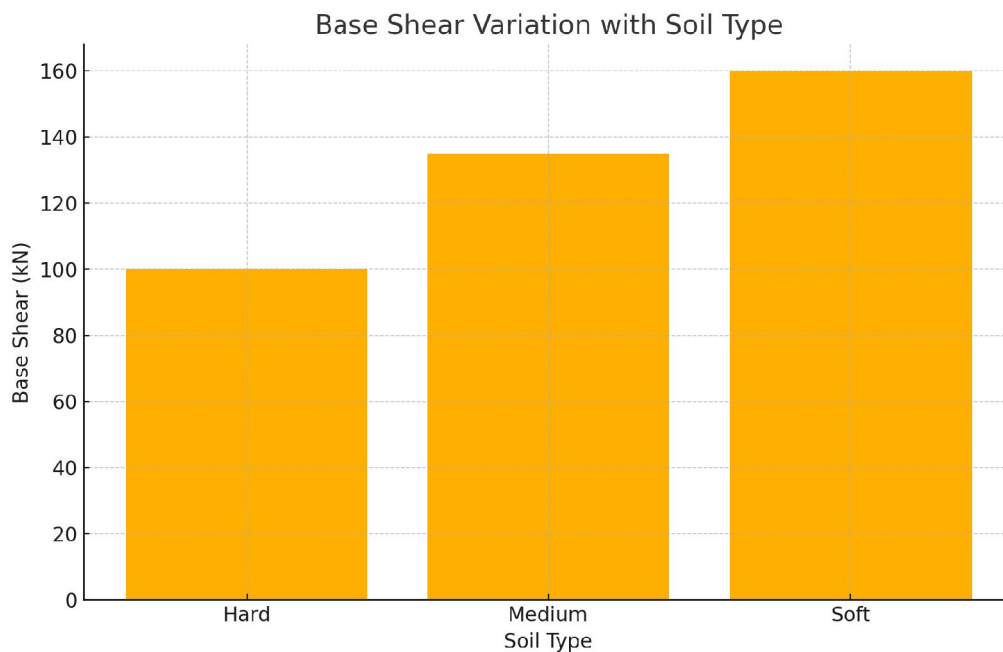


Figure 1 Base Shear Variation with Soil Type

Placement Sensitivity

Gaharwal and Sharma [2] evaluated a G+4 structure and concluded central shear walls reduced displacement and moments most effectively. Bare frames experienced the largest storey shear at ground level.

Core vs Corner Wall Designs

Karnale and Shinde [3] reported that core walls reduced deflection but increased seismic forces due to time-period reduction, while corner walls resulted in lower base shear.

Height-Based Behaviour

Thapa and Sarkar [4] found the displacement reduction benefit increased with height ($G+5 < G+10 < G+15$), validating the importance of shear walls in 12-storey buildings.

Pushover Analysis Trends

Kurma and Rathod [5] demonstrated drastic displacement reductions upon introducing shear walls for 10- and 15-storey buildings—findings that correlate strongly with expected behaviour in 12-storey frames.

Load Distribution Observations

Patel and Amin [6] showed that shear walls carried over 50% of lateral load up to lower mid-storeys, similar to distribution patterns expected in 12-storey structures.



Wind–Earthquake Combined Effects

Harsha and Rao [7] emphasized that shear walls significantly reduce torsion and bending in mid-rise buildings subjected to multi-hazard scenarios.

Software-Based Comparisons

Begum [8] confirmed shear wall efficiency under STAAD.Pro modelling, with reductions in drift and storey shear under both seismic and wind loading.

Time-History and Spectrum-Based Analyses

Tikde et al. [9] and Krishnan & Jose [10] showed that shear walls improve stiffness and energy absorption capabilities.

Optimal Ductility at Core

Akhil Krishnan [11] reported that buildings with centrally located shear walls displayed superior ductile behaviour.

Influence of Openings

Maksudul Haque et al. [12] found force and moment amplification in lower storeys of buildings with significant openings, stressing careful shear wall alignment.

Studies on Irregularity and Sloping Ground

A combination of studies [13–21] highlighted:

- Reduced lateral deflection on sloping ground when core walls are used.
- Larger displacements in irregular buildings without shear walls.
- Flat slab systems greatly benefit from wall stiffening.

Recent Research (2020–2024)**Nonlinear Time-History Analysis**

Pandey and Kumar [22] found that nonlinear simulations reveal superior performance for shear-wall-equipped buildings, reducing collapse risk.

Shear Wall Geometry Optimization

Sharma et al. [23] reported improved lateral resistance for coupled and flanged walls.

Dual Systems in Tall Buildings

Al-Ghamdi and Al-Saadi [24] confirmed shear walls reduce mode-shape irregularity, beneficial to 12-storey frames.

Soil–Structure Interaction (SSI)

Jain and Mehta [25] verified that SSI significantly increases drift, underscoring the need to model soil properties accurately.

Performance-Based Design (PBD)

Qasrawi et al. [26] validated the role of shear walls in meeting IO, LS, and CP standards.

Core Wall Stiffness Effects

Ghosh and Debnath [27] highlighted the efficiency of core-wall systems in drift reduction.

Stiffness and Drift Optimization

Lee and Park [28] showed that balanced shear wall distribution along main axes yields improved drift control.



III. COMPARATIVE DISCUSSION

Lateral Stiffness and Drift Control

Across all studies, shear walls reduce drift by 40–80%, especially in mid-rise buildings such as 12-storey frames as shown in Figure 2.

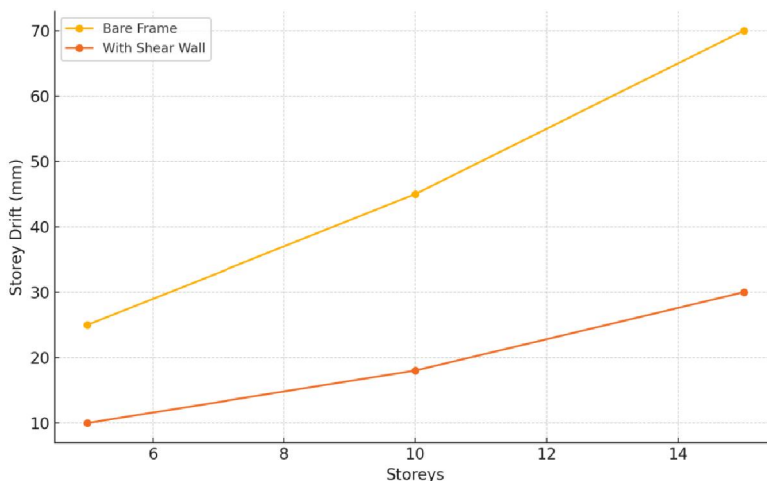


Figure 2 Drift vs building height

Best Wall Position

Core walls → Best ductility & drift control

Corner walls → Lowest base shear

Combined layouts → Best stiffness balance as shown in Figure 3.

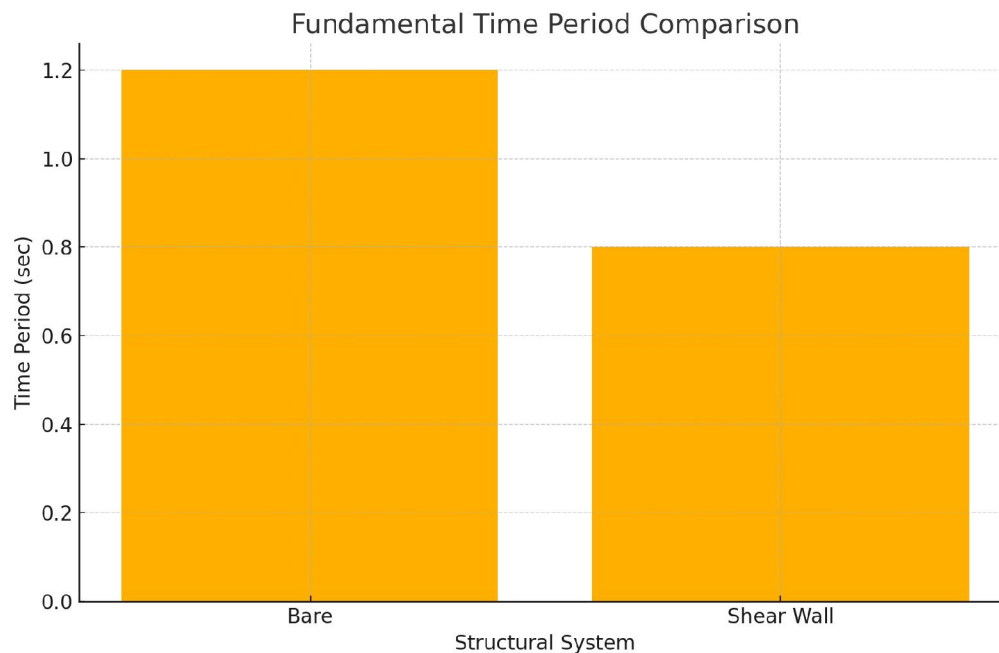


Figure 3 Fundamental Time Period Comparison



Soil Influence

Soft soil amplifies drift and base shear; harder soil reduces forces.

Irregularity Sensitivity

Plan irregularity or sloping ground increases forces and displacement unless shear walls are strategically placed.

Nonlinear Behaviour

Most recent studies agree: nonlinear analysis reveals higher accuracy in predicting seismic demand.

IV. RESEARCH GAPS

- Lack of advanced nonlinear analysis for 12-storey optimized structures.
- Minimal work incorporating SSI, especially for mid-rise buildings.
- Limited consideration of torsional irregularities.
- Few studies use AI-based optimization for wall placement.
- Insufficient research on hybrid systems (core + bracing + outriggers).

V. CONCLUSION

This review confirms that optimized shear wall location is central to the seismic safety of 12-storey RC buildings. Shear walls significantly enhance stiffness and reduce drift, internal forces, and torsion. Optimal wall placement at the core or corners provides the best seismic response. Research trends from 2020–2024 reinforce the need for nonlinear, SSI-integrated, and performance-based design methods. This synthesis serves as a solid foundation for advancing seismic design guidelines for mid-rise RC buildings.

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