

Influence of Aspect Ratio, Geometric Configuration and Continuity on Shear Wall Performance in High-rise Buildings

Kurhade Nikita T.^{1,*}, R.S. Londhe²

Abstract

This study investigates the dynamic behavior of shear walls in high-rise buildings, focusing on the impact of varying parameters like aspect ratio, geometry, and continuous-discontinuous structures. This is done by accurately identifying and quantifying various loads and conducting comprehensive structural analysis. The high-rise complex features reinforced concrete shear walls designed to resist lateral forces, ensuring safety and stability. This topic is chosen because the dynamic behavior of shear walls in high-rise buildings is critical for ensuring structural integrity and stability against lateral forces like wind and earthquakes. By investigating aspects such as aspect ratio, geometry, and continuous-discontinuous wall structures, this study aims to optimize the design and placement of shear walls. Low aspect ratio walls having best performance due to high stiffness. Continuous wall has high stability and load distribution than discontinuous wall. C-shaped, I-shaped, and T-shaped walls are good for design and structural stability but the displacement in minimum in these shapes.

Keywords: Shear wall, stability, parameter, aspect ratio, geometry, lateral displacement, base shear, response spectrum method, high-rise structures, comparative study

INTRODUCTION

Shear walls have evolved from ancient thick-walled structures relying on gravity for stability to modern, sophisticated designs essential for high-rise buildings. The development of reinforced concrete in the early 20th century enabled the construction of taller and more slender shear walls without compromising stability.

In tall buildings, the design process includes conceptual design, approximate analysis, preliminary design, and optimization to support both gravity and lateral loads. These loads include dead loads, live loads, and snow loads, as well as lateral forces from wind and earthquakes.

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Shear walls are critical in high-rise buildings for resisting lateral loads, offering significant in-plane stiffness and strength. Their performance in high-rise structures differs from low-rise buildings, as they help reduce lateral displacement and enhance overall stability.

Typically made of reinforced concrete, shear walls in high-rise buildings vary in thickness from 150 mm to 400 mm and are usually provided along the building's length and width. They play a crucial role in resisting forces generated by earthquakes and wind, preventing excessive swaying and potential structural failure.

Shear walls are fundamental in modern construction, ensuring structural stability and resistance to lateral forces. Their importance is particularly pronounced in urban high-rise structures. As engineering practices and materials continue to advance, the design and implementation of shear walls will evolve, contributing to safer and more resilient buildings.

SHEAR WALL

A shear wall is a structural part of a building designed to resist forces that push sideways, parallel to the wall that resist lateral forces, such as those induced by wind, earthquakes, and other dynamic loads. In tall, thin walls where bending is more noticeable, shear walls help resist these sideways forces as shown in Figure 1. Simply put, shear walls are vertical structures that help a building withstand horizontal forces like wind and earthquakes. These walls provide significant in-plane stiffness and strength, helping to prevent swaying and potential structural failure in buildings, especially high-rise structures. Typically constructed from reinforced concrete, shear walls transfer lateral loads to the foundation, ensuring the stability and integrity of the overall structure.

Shear forces, uplift forces, lateral forces, and gravity loads all significantly impact the structural performance of shear walls in high-rise buildings. Shear forces, generated by earthquakes and external forces like wind and waves, create horizontal shear throughout the height of the wall, causing it to shear horizontally between the top and bottom stories. Uplift forces, arising from horizontal forces applied to the top of the wall, such as wind and seismic loads, attempt to lift one end of the wall while pushing the other end down, potentially causing the wall to tip over. Lateral forces, originating from wind pressure, seismic movement, and sometimes waves, push the wall sideways, requiring it to resist bending and prevent swaying. Gravity loads, comprising the self-weight of the structure and any additional vertical loads it carries, provide stability against uplift forces and contribute to the overall compressive force on the wall. Together, these forces necessitate careful design and placement of shear walls to ensure the stability and integrity of high-rise buildings (Figure 1).

SCOPE OF STUDY

The scope of the research is to:

- Investigate the impact of variation in parameters of shear wall configurations, including changes in aspect ratio, geometry and continuous-discontinuous wall structure of shear wall.
- Assess the base shear, story drift, stiffness, and displacement for structural responses of shear walls with different parameters.

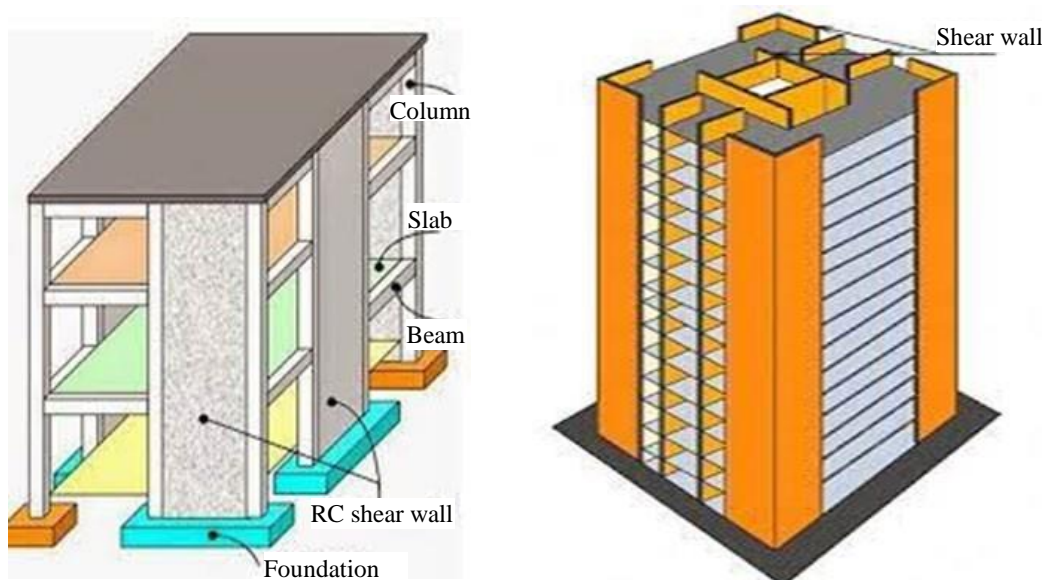


Figure 1. Shear Wall.

- This study aims to enhance the understanding of how varying shear wall parameters can influence the overall performance and safety of high-rise buildings, providing valuable insights for future construction projects.

LITERATURES REVIEW

Shear walls have been extensively studied as critical components in high-rise buildings for resisting lateral forces such as wind and seismic loads. Research has shown that shear walls significantly enhance structural stability and reduce lateral displacements and drift. Various studies have investigated the optimal placement, aspect ratio, and geometry of shear walls to maximize their effectiveness.

Lubell et al. [1] investigated the performance of unstiffened thin steel plate shear walls in medium- and high-rise buildings, highlighting their critical role in resisting lateral loads. The study utilized experimental testing on two single-story and one four-story steel shear wall specimens, each representing a quarter-scale model of a typical office building core with column-to-column and floor-to-floor dimensions of 900 mm. The experimental findings were compared to simplified tension field analytical models based on the Canadian code for limit-states design of steel structures. These models accurately predicted post-yield strength but were less satisfactory for elastic stiffness calculations. The study concluded with an evaluation of current design guidelines, offering insights to enhance the performance and efficiency of steel plate shear walls in practical applications.

Wen et al. [2] investigated the influence of site conditions and epicentral distance on structural damages resulting from earthquakes, focusing on a 21-story shear wall building in Hong Kong. The study examined various design earthquake intensities and site conditions, creating fragility curves based on the ductility factor, which compares story yield shear to inter-story seismic shear. The findings revealed that softer site conditions significantly increased the probability of damage, particularly for far-field earthquakes. For intensity VIII earthquakes, the probability of complete collapse rose from 1% to 24% for near-field and from 1% to 41% for far-field earthquakes when the building was relocated from a rock site to an 80-meter soft clay site. For intensity IX earthquakes, this probability increased from 6% to 69% for near-field and from 14% to 79% for far-field earthquakes under similar conditions. The study emphasized the critical importance of considering site effects in the design and analysis of high-rise structures.

Kim et al. [3] analyzed the effectiveness of shear walls in high-rise buildings designed to withstand horizontal forces, particularly in contemporary high-rise apartments in Asia that use a box system of reinforced concrete walls and slabs. These shear walls often have openings for functional purposes, requiring a refined finite element model for accurate analysis. Subdividing the entire building into a finer mesh is computationally intensive. To address this, the study introduced an efficient analysis method using super elements, substructures, and fictitious beams, accommodating various numbers, sizes, and locations of openings. Static and dynamic analyses of example structures demonstrated that the proposed method achieves highly accurate results while significantly reducing computational time and memory requirements.

Lee and Ko [4] conducted a study using three 1:12 scale 17-story reinforced concrete wall building models to investigate their seismic responses under simulated earthquake excitations, focusing on structures with irregularities at the bottom two stories. The models included a symmetrical moment-resisting frame (Model 1), a shear wall infill in the central frame (Model 2), and a shear wall infill in one of the exterior frames (Model 3) at the bottom two stories. The study concluded that the estimated fundamental periods for structures other than moment frames and bearing wall structures, as specified in UBC 97 (1997 Uniform Building Code) and AIK 2000 (2000 Architectural Institute of Korea), were reasonable. It was found that the total energy absorption by damage was similar regardless of the presence or location of the infilled shear wall, with the largest energy absorption occurring due to overturning, followed by shear deformation. Additionally, the rigid upper system induced a rocking

behavior in the lower frame, and the self-weight of the structure contributed up to approximately 23% of the resistance against the total overturning moment.

Su and Wong [5] conducted experiments on three reinforced concrete (RC) wall specimens to study the effects of axial load ratio (ALR) and confinement on their seismic performance. These specimens, designed as slender vertical cantilevers with a high aspect ratio of 4, used high-strength concrete and had a high longitudinal reinforcement ratio. The study analyzed how ALR and confinement influenced failure mode, ductility capacity, strength degradation, and axial load capacity. It highlighted the importance of ALR in evaluating the seismic performance of RC shear walls and discussed its impact on life safety and collapse performance criteria for rectangular shear walls.

Alinia and Shirazi [6] conducted a numerical study to develop a design approach for increasing the stiffness of thin steel plate shear walls using one-sided transverse and longitudinal flat stiffeners. These stiffeners, arranged in various configurations, divide the plate into subpanels, enhancing tension fields across the infill walls. Nonlinear static analyses provided empirical relationships to determine the optimal stiffener dimensions. The study also evaluated the effect of these optimized stiffeners on the post-buckling behavior and ultimate load-bearing capacity of the shear walls.

Carpinteri et al. [7] introduced a three-dimensional analytical approach to assess lateral load distribution in high-rise buildings, accommodating various bracing systems, including those with open thin-walled cross-sections. Using Timoshenko-Vlasov's theory of sectorial areas, this method simplifies the initial stages of structural design by assuming infinitely rigid floors within their planes. Numerical examples validated its effectiveness and flexibility, showing accurate results and comparable performance to finite element analysis with three-dimensional shell elements. This approach offers a reliable tool for preliminary high-rise building design, providing insights into lateral load distribution and stress/strain patterns.

Zou et al. [8] analyzed a large-scale reinforced concrete shear wall typical in high-rise structures, subjected to sustained loads over a year to monitor shrinkage and creep strains. The research found that strain rates were influenced by component geometry, challenging existing prediction models based on prismatic or cylindrical specimens. Specifically, these models tended to underestimate shrinkage rates in shear walls with similar volume-to-surface ratios. The study also highlighted how seasonal changes in ambient humidity significantly impact shrinkage and creep, suggesting that using mean annual relative humidity may not accurately predict axial shortening in high-rise buildings.

Hiremath and Hussain [9] concluded that shear walls significantly enhance the earthquake resistance of multi-story reinforced concrete buildings. Their integration into tall structures has proven highly effective in preventing total structural failure during seismic events. The study focused on a 25-story building in seismic zone IV, where reinforced concrete shear walls were strategically incorporated to improve seismic response. This approach not only enhances structural rigidity but also proves cost-efficient due to ease of construction. The research investigated the optimal placement and thickness variations of shear walls, assessing their impact on displacements and story drift through pushover analysis using ETABS version 9.7.1.

Rama Rao et al. [10] conducted a study focusing on the nonlinear behavior of shear wall specimens with medium aspect ratios in multi-story reinforced concrete buildings. Shear walls are essential for resisting lateral loads and reducing sway in such structures. The research involved testing three identical shear wall specimens under monotonic and cyclic loading to evaluate their flexural behavior and ductility. A parametric study examined the influence of axial load on these characteristics. Analytical pushover curves were generated using a layer-based approach and validated against experimental results. The study highlighted stiffness and strength degradation, as well as pinching effects observed during cyclic tests. It compared plastic rotation limits and ductility capacities under both loading

conditions, aiming to establish guidelines for performance-based seismic design of shear walls with medium aspect ratios.

Sengupta [11] conducted a study focusing on the optimal design of shear walls in multi-story buildings using varying thicknesses and reinforcement percentages. Their research, utilizing ETABS software, involved creating building models with systematically placed shear walls and analyzing different thicknesses across buildings ranging from 5 to 15 stories. Key findings highlighted that the required reinforcement percentage increases with higher seismicity levels and the number of stories, for a constant shear wall thickness. The study also identified an initial increase in reinforcement percentage with increasing shear wall thickness within a certain range across all seismic zones considered. However, beyond a specific thickness range, the required reinforcement percentage decreased. These observations underscore the importance of balancing shear wall thickness and reinforcement to achieve optimal earthquake-resistant design in multi-story buildings.

Farzampour et al. [12] conducted a detailed numerical study comparing the performance of corrugated steel plate shear walls to simple steel plate shear walls, focusing on their behavior under lateral forces including those with openings. The research explored various parameters such as plate thickness, corrugation angle, and opening characteristics to assess initial stiffness, ultimate strength, energy absorption, and force-displacement relationships. Findings indicated that corrugated steel plate shear walls offer enhanced initial stiffness, increased energy absorption, and improved ductility compared to simple steel plate walls, albeit with a slight reduction in ultimate strength. These walls also demonstrated delayed onset of ultimate strength and degradation, making them advantageous for seismic resistance. The study proposed a method for predicting the ultimate strength of corrugated steel plate shear walls with optimized rectangular openings.

Hilo et al. [13] reviewed extensive research on double-skinned composite walls (DSCWs) over recent decades, focusing on their behavior with and without infill materials. The study categorized DSCWs into three types based on sheeting (profiled steel, flat steel, profiled-flat combinations) and analyzed their responses to various loads (axial, cyclic, lateral, impact, thermal). The interaction between sheets and infill materials was thoroughly examined, with special attention to the influence of openings on structural behavior. The paper compiled findings into comprehensive tables, summarizing parameters studied and providing insights crucial for understanding and designing composite walls efficiently and cost-effectively.

Khanmohammadi and Heydari [14] highlighted a shift towards seismic design strategies focused on damage avoidance rather than damage limitation. Their study investigated various shear wall buildings using precise modeling, comparing multiple rocking system designs with traditional methods across buildings of different heights (8, 12, 16, and 20 stories) subjected to varying ground motion levels. They found that incorporating energy dissipation and post-tensioning in multiple rocking systems effectively mitigates higher mode effects on shear and moment actions. Drift ratios were comparable to base rocking systems, with minimal increase compared to traditional designs. Horizontal acceleration values remained stable along the building height, and residual displacements were negligible. The study concluded that multiple rocking systems offer substantial benefits in reducing seismic damage and improving overall seismic performance, highlighting their potential in modern seismic design practices.

Wu et al. [15] investigated the seismic behavior of steel and concrete composite shear walls with embedded steel trusses, crucial in high-rise buildings. Testing involved scaled specimens subjected to cyclic lateral and constant axial loads until failure. Variations in embedded truss chords and web braces influenced hysteretic behavior, lateral load capacity, energy dissipation, and ductility. Finite element models validated test results, leading to parametric analysis across 27 models. Findings showed higher axial load ratios improved stiffness but reduced energy dissipation. Optimal performance required a specific volumetric ratio of embedded truss web braces, enhancing lateral load capacity while maintaining critical seismic performance and ductility.

Wang et al. [16] investigated the emergence of steel plate reinforced concrete (SPRC) composite shear walls in Mainland China for enhancing seismic performance in super-tall buildings. They discussed the use of OpenSees software to model SPRC shear wall hysteretic behavior, validated against experimental data. A parametric study examined steel plate ratio, axial compressive load ratio, concrete strength, and web reinforcement ratio, providing insights crucial for practical SPRC shear wall applications in seismic design.

Looi et al. [17] conducted an experimental study focusing on RC shear walls with short shear spans, typical in tall buildings with transfer structures. They investigated the influence of ALR on seismic performance using test specimens designed with low shear span-to-length ratios and detailed reinforcement typical of tall building sub-structures. Results showed that ALR significantly affects crack patterns, failure modes, and deformability, leading to proposed empirical models for shear strength capacity and ultimate drift ratio prediction. Their findings contribute to understanding RC shear wall behavior under high axial loads in tall buildings with short shear spans, aiding in performance-based design and assessment.

Aly and Galal [18] concluded a novel approach using generative adversarial networks (GANs) for shear wall design in high-rise buildings, driven by the increasing role of artificial intelligence in enhancing building design efficiency. Their method involved training a GAN model on structural design datasets, optimizing it through adversarial training and hyper-parameter analytics. Case studies validated its efficacy, showing accelerated design processes while maintaining high quality, highlighting potential widespread applicability in the field of structural engineering loads in tall buildings with short shear spans, aiding in performance-based design and assessment.

Based on an extensive literature review focused on structural analysis methods, several innovative approaches have emerged to enhance the seismic performance and efficiency of shear wall systems in high-rise buildings. Studies have highlighted the strategic placement of shear walls with varying thickness and height to mitigate displacements and lateral drift during earthquakes. Specifically, placing shear walls on both outer and inner sides of buildings has been shown to optimize performance by maintaining structural behavior within the elastic range. These findings underscore the importance of thoughtful shear wall design in enhancing building safety and resilience.

SYSTEM DEVELOPMENT

The current study is dedicated to investigating the dynamic behavior of shear walls in high-rise buildings, focusing on key parameters such as aspect ratio, shear wall geometry, and the distinction between continuous and discontinuous wall structures. Shear walls are pivotal components in ensuring the structural integrity and stability of tall buildings, effectively resisting lateral forces such as wind and seismic loads. The initial phase involves comprehensive structural analysis to precisely quantify various loads like dead, live, wind, and seismic forces that the building will experience. This analysis guides the initial design of shear walls, adhering to regulatory standards while determining optimal locations, lengths, and thicknesses based on both structural and architectural requirements.

The high-rise building complex under study is designed to cater to urban populations with modern amenities and efficient space utilization. Spanning multiple floors, ranging from G+30 to G+50, each building within the complex combines functionality with aesthetic appeal, incorporating spacious floor plans and contemporary facade materials. Reinforced concrete shear walls are strategically integrated into the structural system to ensure stability and safety against lateral forces. The study progresses by systematically varying the dimensions of shear walls to explore diverse configurations, evaluating their impact on structural performance metrics such as lateral deflection, drift, shear forces, and moments. The overarching objective is to optimize shear wall design by identifying the most effective lengths and thicknesses that balance safety, performance, and cost-effectiveness, guided by a rigorous methodology integrating modeling, analysis, and design phases aligned with building codes and standards [19–21].

1. Modeling

2. Analysis phase
3. Design phase

STRUCTURE DESCRIPTIONS

The current study focuses on designing a building structure with varying parameters of shear walls: aspect ratio, geometry of shear wall, and continuous-discontinuous wall structures. The building dimensions are 40 m × 40 m with multiple stories, each 3.0 m in height, featuring a square plan and other dimension as mentioned in Table 1 for straightforward analysis. Located in seismic zone III and founded on medium soil, the design incorporates shear walls typically shaped as T, C, I, and L configurations, positioned in both X and Y directions of the building. Additionally, rectangular shear walls for continuous and discontinuous configurations are strategically placed on the outer sides of the building structure.

RESPONSE SPECTRUM METHOD

Response spectrum analysis is a method used in engineering to evaluate the seismic performance of structures. It involves analyzing the maximum response of a structure subjected to a range of frequencies of ground motion. This analysis is based on the concept that the dynamic response of a structure during an earthquake can be understood by studying its response to a spectrum of possible earthquake ground motions, each characterized by a specific frequency.

LOADING CONDITION

The analysis and design processes are done by the loading condition as mentioned in Table 2 on the basis of IS Codes. The loading conditions calculated for a structural analysis purpose are as follows:

Dead Load

A constant load in a structure, such as a bridge, building, or machine, is attributed to the weight of the structural components, the supported structure, and permanent attachments or accessories. Known as dead loads, these forces remain relatively constant over time.

Live Load

Live loads refer to the transient or moving loads that structures encounter due to human occupancy, furniture, vehicles, and other temporary factors. These loads vary in magnitude and location over time, and are influenced by the intended use and occupancy of the structure.

Table 1. Structure descriptions.

S.N.	Specification	Value
1.	Size of buildings	40–40 m
2.	Building height	87 m, 117 m, 147 m
3.	Floor to floor height	3 m
4.	Bottom story height	1.5 m
5.	Number of stories	30, 40, 50
6.	Thickness of shear wall	230 mm
7.	Thickness of slab	200 mm
8.	Beam size	450 × 450 mm
9.	Outer column size	800 × 800 mm
10.	Inner column size	1000 × 1000 m
11.	Material property	M30
12.	Grade of steel	HYSD 415, HYSD 500
13.	Density of concrete	25 kN/m
14.	Density of light weight brick	10 kN/m
15.	Support condition	Fixed Support

Wind Loads

Wind load refers to the pressure exerted by wind on a structure, distributed over its entire surface area. Larger structures are more impacted by wind because the load intensity increases with building height.

Earthquake Loads

Earthquake or seismic load refers to the forces or shaking that a structure endures during an earthquake. It is a crucial factor in the design and analysis of buildings, bridges, and other structures in seismically active areas.

Table 2. Loading conditions.

1. Dead Load: IS 875: 2000 PART 1.	
i. Self-weight	1 kN/m
ii. Floor finished	1 kN/m
iii. Wall load	4 kN/m
2. Live Load: IS 875: 2000 PART 2.	
i. Live load	4 kN/m
3. Wind Load: IS 875: 2000 PART 3.	
i. Terrain category	III
ii. Windward coefficient (C_p)	0.8
iii. Leeward coefficient (C_p)	0.25
iv. Internal coefficient (C_{pi})	1
v. Wind speed	44 m/s
vi. Risk coefficient (k_1)	1
vii. Terrain height	87 m, 117 m, 147 m
viii. Topography factor (k_3)	1
ix. Directionality factor	0.85
x. Area overaging factor	0.8
xi. Load combination factor	1.5.
xii. Importance factor	1
4. Earthquake Load: IS 1893: 2016 Part 1	
i. Seismic zone	III
ii. Zone factor	0.24
iii. Response reduction factor	5
iv. Importance factor	1.2
v. Soil type	Medium
vi. Damping ratio	5%

PLAN OF MODEL

In the current study, the building structure is designed to consider variations in shear wall parameters such as aspect ratio, geometry, and continuous versus discontinuous wall structures. The building plan measures $40\text{ m} \times 40\text{ m}$ with multiple stories, each having a height of 3.0 m.

DESCRIPTION OF MODELS

The complete list of all 12 models is shown in Figures 2 to 13 below:

Model 1: Structure of 40 m span with discontinuous short shear wall at outer edges of building.

Model 2: Structure of 40 m span with discontinuous long shear wall at outer edges of building.

Model 3: Structure of 40 m span with continuous long shear wall at outer edges of building.

- Model 4:* Structure of 40 m span with continuous short shear wall at outer edges of building.
- Model 5:* Structure of 40 m span with C-shaped shear wall in Y-direction.
- Model 6:* Structure of 40 m span with C-shaped shear wall in X-direction.
- Model 7:* Structure of 40 m span with L-shaped shear wall in Y-direction.
- Model 8:* Structure of 40 m span with L-shaped shear wall in X-direction.
- Model 9:* Structure of 40 m span with I-shaped shear wall in Y-direction.
- Model 10:* Structure of 40 m span with I-shaped shear wall in X-direction.
- Model 11:* Structure of 40 m span with T-shaped shear wall in Y-direction.
- Model 12:* Structure of 40 m span with T-shaped shear wall in X-direction.

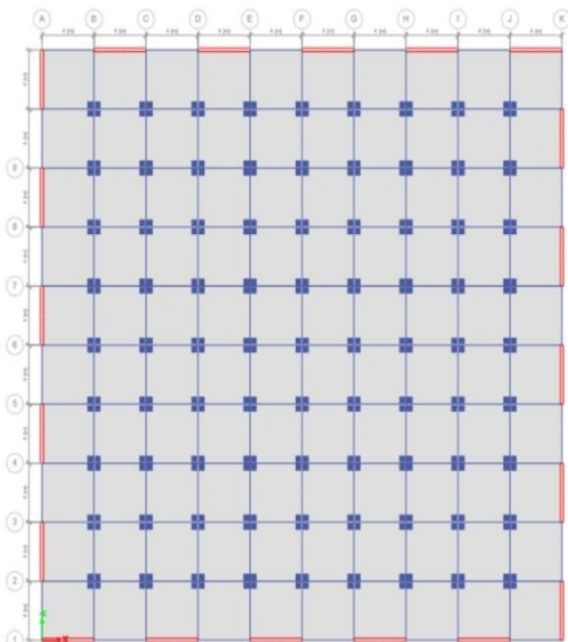


Figure 2. Model 1.

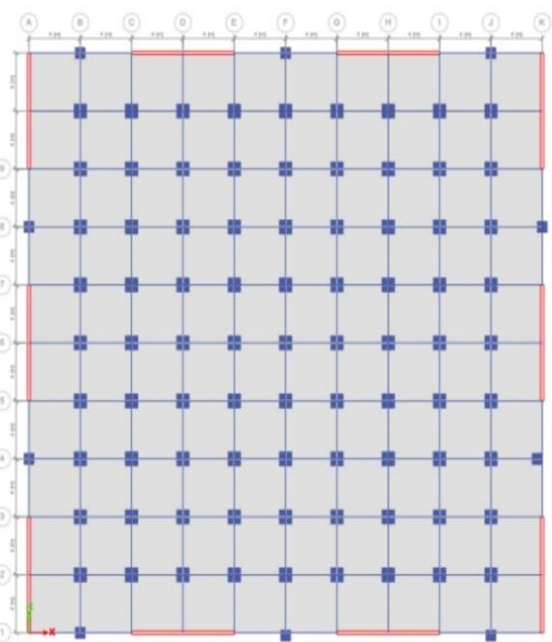


Figure 3. Model 2.

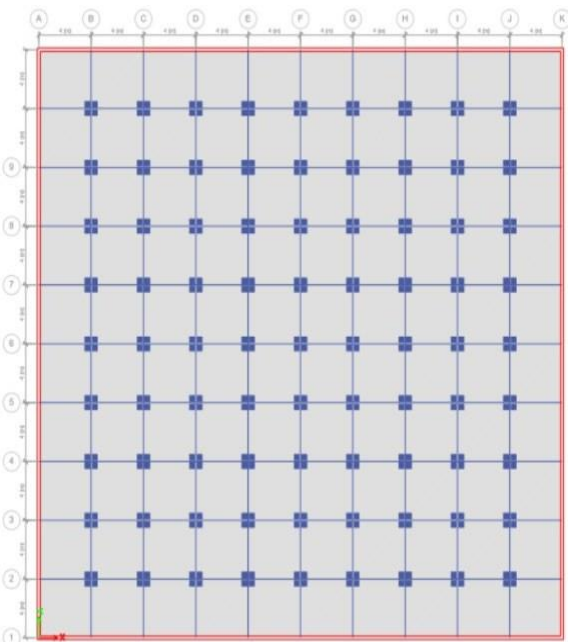


Figure 4. Model 3.

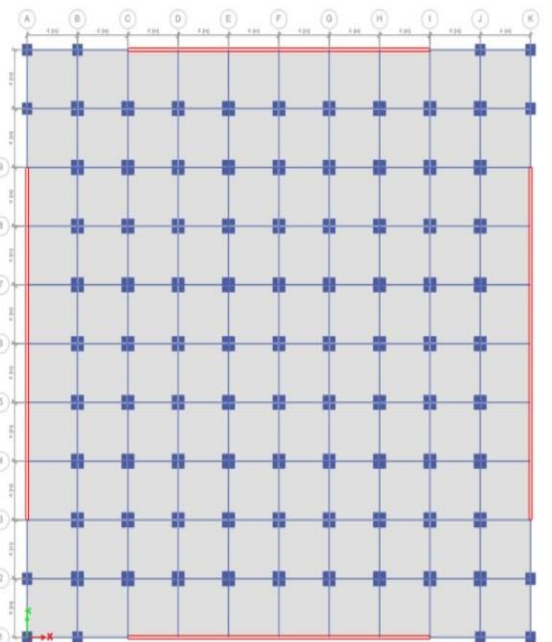


Figure 5. Model 4.

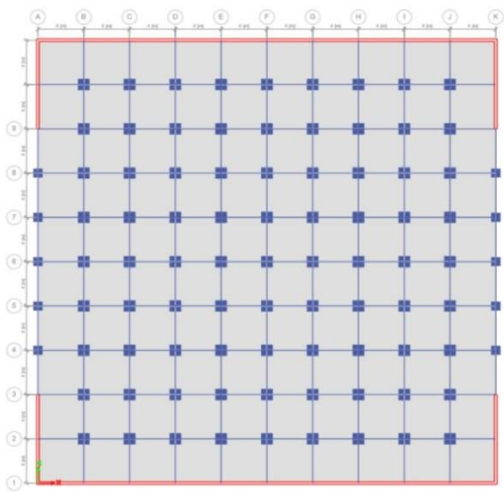


Figure 6. Model 5.

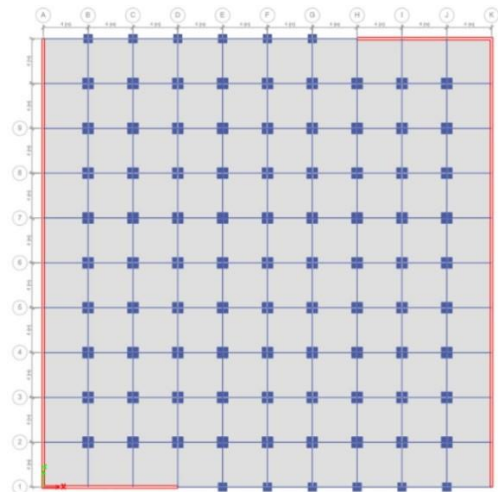


Figure 7. Model 6.

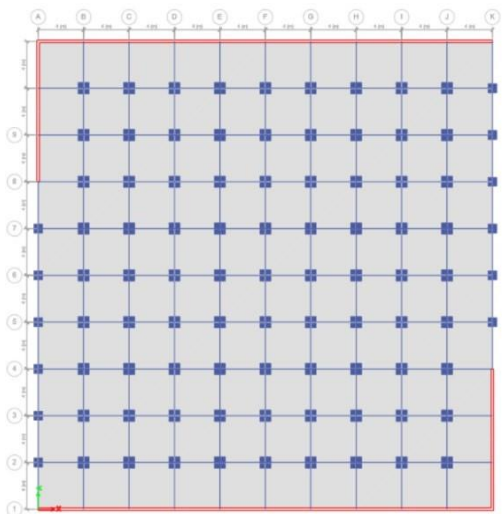


Figure 8. Model 7.

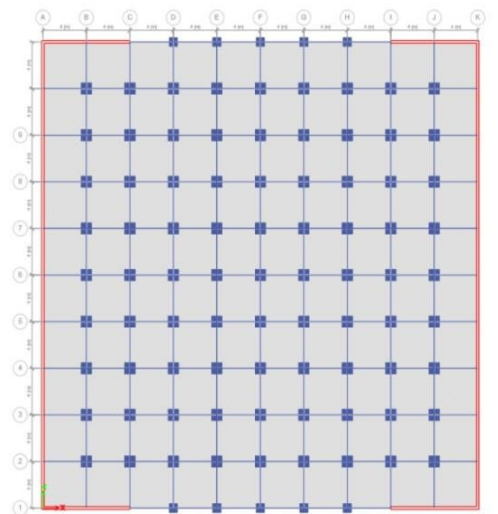


Figure 9. Model 8.

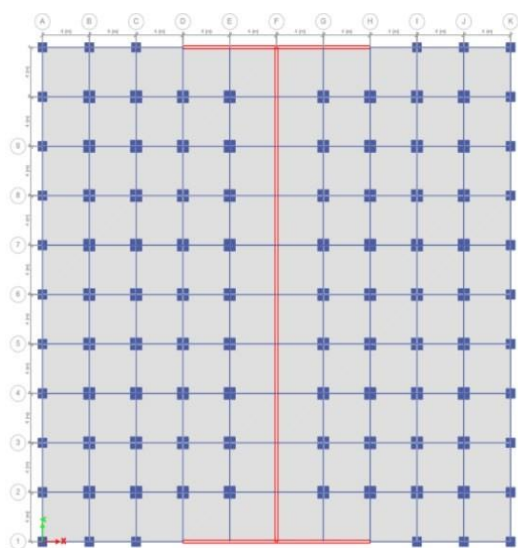


Figure 10. Model 9.

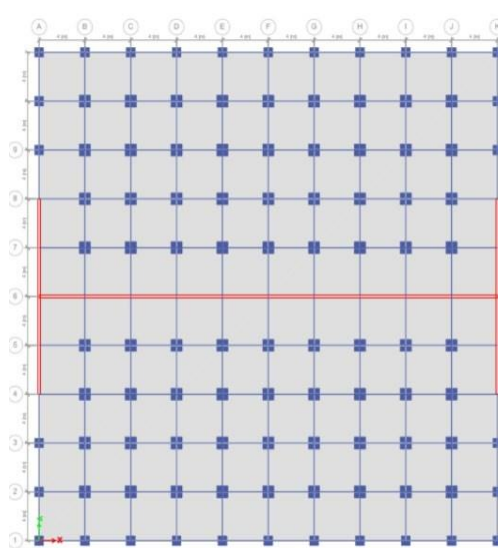


Figure 11. Model 10.

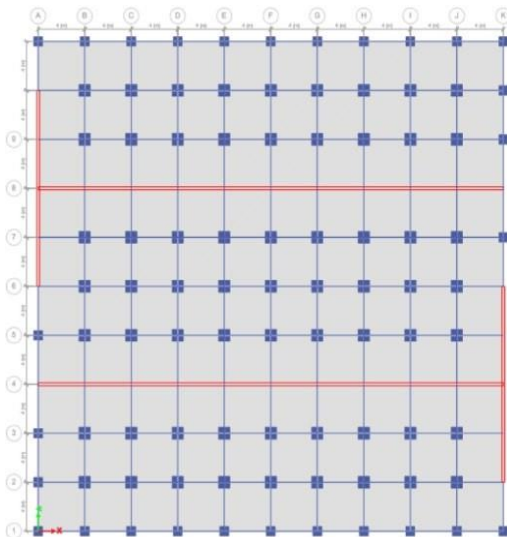


Figure 12. Model 11.

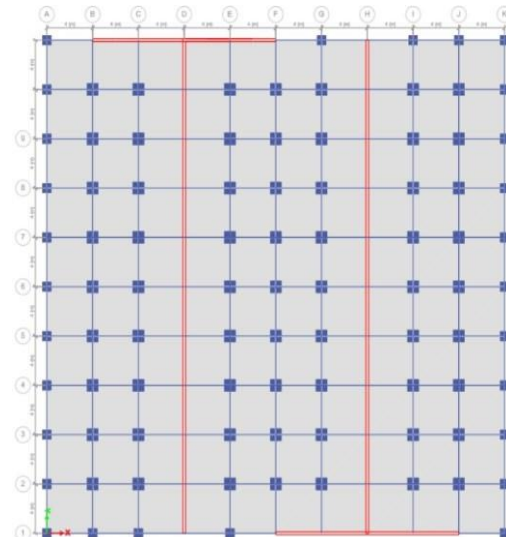


Figure 13. Model 12.

RESULTS AND DISCUSSION

Using ETABS software for shear wall analysis and design has proven highly beneficial, significantly enhancing structural performance and stability. The software enabled detailed modeling and evaluation of shear wall systems under varying loads, including wind and seismic forces. It demonstrated that shear walls exhibit strong lateral stiffness and resistance, effectively minimizing lateral displacements and inter-story drifts. Stress distribution within the shear walls remained well within safe limits, ensuring structural integrity and safety. Optimal placement and design of shear walls were highlighted as crucial factors in improving overall seismic resistance. In conclusion, ETABS facilitates a comprehensive understanding of shear wall behavior, enabling engineers to optimize designs for both performance and cost-efficiency.

Maximum Lateral Displacement

Lateral displacement, a critical concept in structural engineering, refers to the horizontal movement of a structure or its components due to applied lateral forces. These forces originate from sources such as strong winds, seismic activity, and other horizontal loads. Wind, for instance, can exert significant pressure on buildings, causing them to sway.

Lateral Displacement Comparison for All Shapes of Shear Walls

The loads on wall generate lateral forces through ground shaking, leading to horizontal movement, while other external impacts, explosions, or uneven foundation settlements can also contribute to these forces. The comparison of max. lateral displacements for all shape of shear wall are detailed in Table 3, while Figure 14 is the graphical representation of values given in Table 3.

Base Shear

Base shear is the total horizontal force at a structure's base due to seismic activity, crucial for seismic-resistant design. It ensures structural safety, influences design, and complies with building codes. Values mentioned in Table 4 are obtained by analyzing ETABS model. Base shear depends on seismic zone, building characteristics, and soil conditions. Design considerations include effective load distribution, ductility, and robust foundations. Mitigation strategies involve seismic isolation, damping systems, and reinforcement.

Base Shear Comparison for All Shapes of Shear Walls

The comparison of maximum base shear for all shapes of shear walls is given in Table 4. By analyzing all models in ETABS, we know that the maximum base shear is obtained at the bottom of high-rise structure, and this is represented in graphical form in Figure 15.

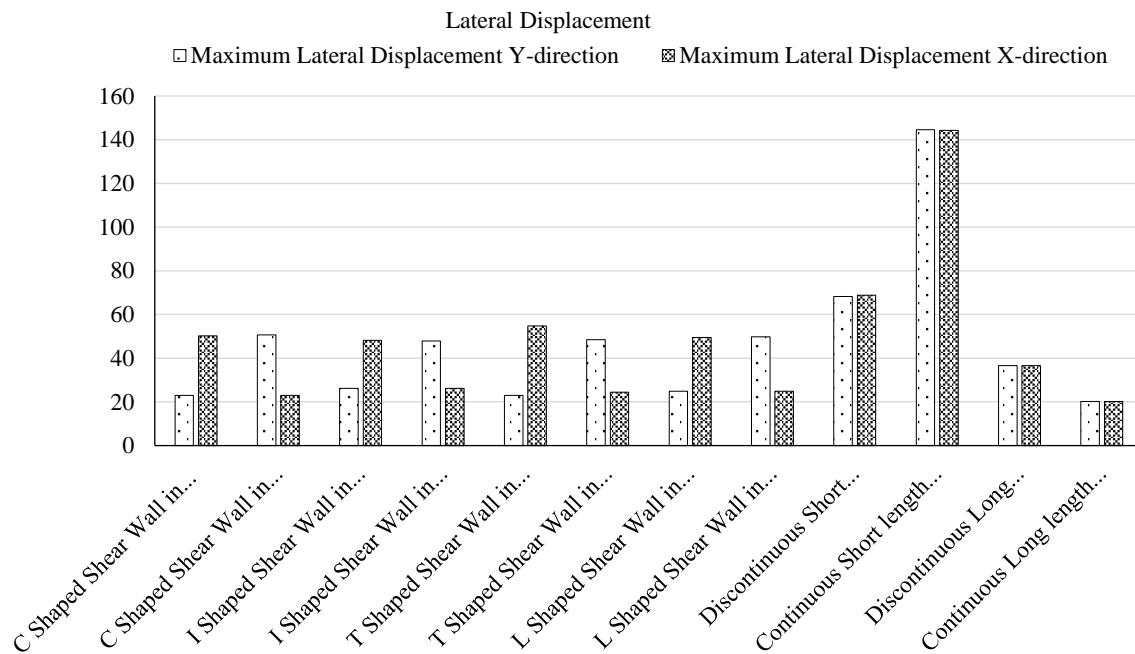


Figure 14. The comparison of maximum lateral displacements for all shapes of shear walls.

Table 3. The comparison of maximum lateral displacements for all shapes of shear walls.

S.N.	Model Name	Maximum Lateral Displacement	
		X-direction	Y-direction
1	C-shaped shear wall in X-direction	23.656	51.062
2	Cshaped shear wall in Y-direction	51.461	23.829
3	I-shaped shear wall in X-direction	27.289	48.302
4	I-shaped shear wall in Y-direction	48.302	27.289
5	T-shaped shear wall in X-direction	23.879	55.138
6	T-shaped shear wall in Y-direction	49.355	24.079
7	L-shaped shear wall in X-direction	24.92	50.248
8	L-shaped shear wall in Y-direction	50.248	24.92
9	Discontinuous short length shear wall	69.578	69.578
10	Discontinuous long length shear wall	145.787	145.787
11	Continuous short length shear wall	37.119	37.211
12	Continuous long length shear wall	21.12	21.12

Table 4. The comparison of maximum base shear for all shapes of shear walls.

S.N.	Model Name	Maximum Base Shear	
		X-direction	Y-direction
1.	C-shaped shear wall in X-direction	22263.6275	8736.9371
2.	C-shaped shear wall in Y-direction	8736.9417	22305.9959
3.	I-shaped shear wall in X-direction	17119	9503.7328
4.	I-shaped shear wall in Y-direction	9503.7324	18163.0006
5.	T-shaped shear wall in X-direction	21948.0054	10472.6678
6.	T-shaped shear wall in Y-direction	9295.5877	22449.0025
7.	L-shaped shear wall in X-direction	20973.9965	8941.019
8.	L-shaped shear wall in Y-direction	8941.0189	20973.997
9.	Discontinuous short length shear wall	7996.2349	7996.2349
10.	Discontinuous long length shear wall	8113.2316	7187.6561
11.	Continuous short length shear wall	12333.0039	13666.1968
12.	Continuous long length shear wall	25627.9977	25649.1141

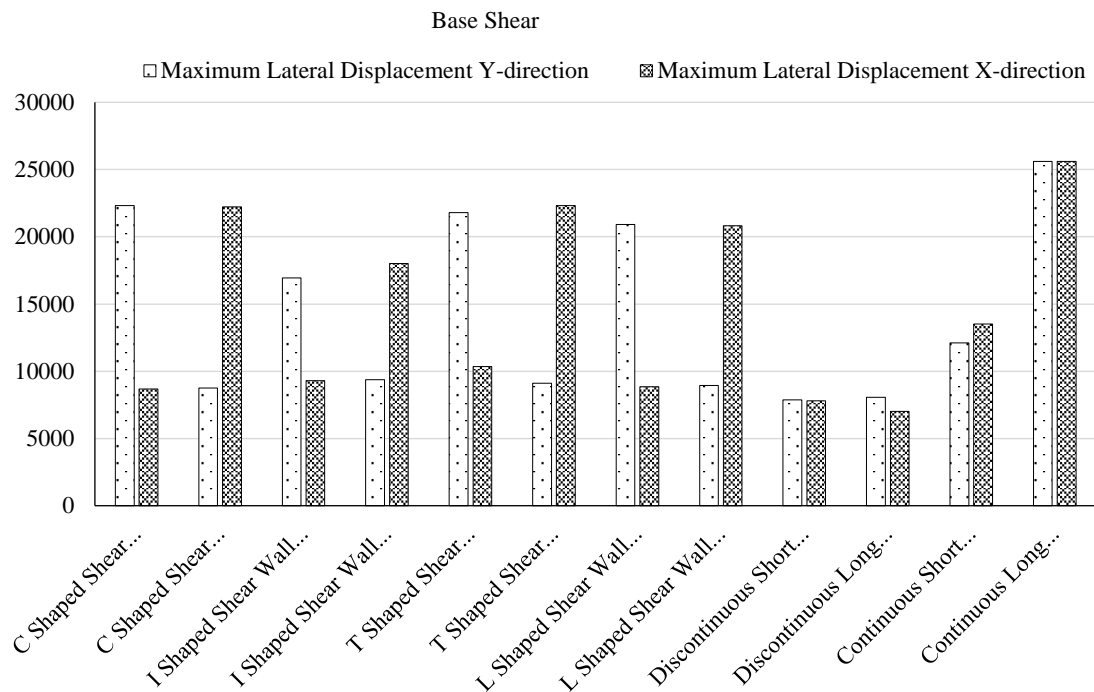


Figure 15. The comparison of maximum base shear for all shapes of shear walls.

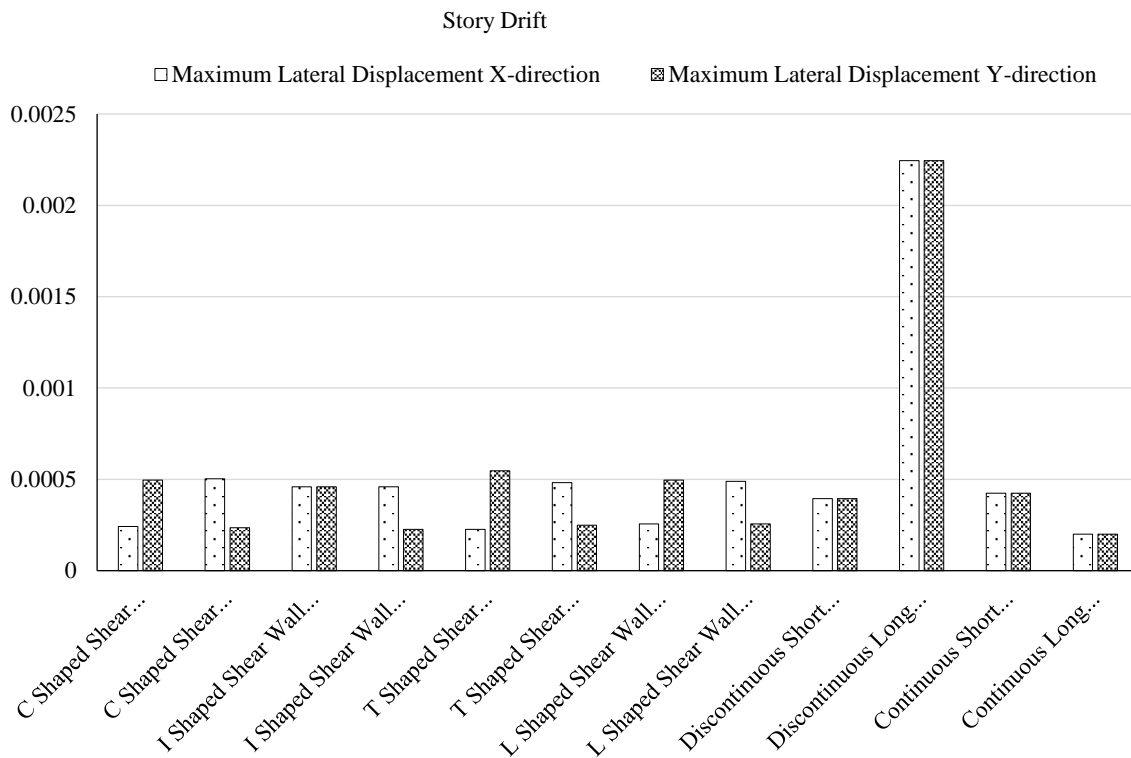


Figure 16. The comparison of maximum story drift for all shapes of shear walls.

Story Drift

After identifying maximum drift value and story at which it occurs it is compare with the drift value with allowable limits (typically, the inter-story drift ratio should not exceed 0.002 to 0.005 times the story height) as shown in Table 5. On the basis of this data, Figure 16 ensures the drift value for specific model.

Table 5. The comparison of maximum story drift for all shapes of shear walls.

S.N.	Model Name	Maximum Lateral Displacement	
		<i>X-direction</i>	<i>Y-direction</i>
1	C-shaped shear wall in X-direction	0.000257	0.000511
2	C-shaped shear wall in Y-direction	0.000515	0.000259
3	I-shaped shear wall in X-direction	0.000475	0.000475
4	I-shaped shear wall in Y-direction	0.000475	0.000248
5	T-shaped shear wall in X-direction	0.000247	0.000558
6	T-shaped shear wall in Y-direction	0.000502	0.00025
7	L-shaped shear wall in X-direction	0.000284	0.000507
8	L-shaped shear wall in Y-direction	0.000507	0.000284
9	Discontinuous short length shear wall	0.000394	0.000394
10	Discontinuous long length shear wall	0.002271	0.002271
11	Continuous short length shear wall	0.000431	0.000432
12	Continuous long length shear wall	0.000199	0.000199

CONCLUSIONS

Aspect Ratio

- Low aspect ratio: Higher stiffness, more effective in resisting lateral loads, less prone to buckling, efficient force transfer to foundation.
- High aspect ratio: Lower stiffness, higher flexibility, more susceptible to lateral deformations and buckling, may require additional reinforcement or bracing.

Geometry of the Wall

- Rectangular shear walls: Provide uniform stiffness and strength, easier to design and construct, commonly used.
- Non-rectangular shear walls: Enhanced resistance in multiple directions, beneficial for complex layouts, potential design and construction challenges due to stress concentration and torsional effects.

Continuous and Discontinuous Shear Walls

- Continuous shear walls: Run continuously from foundation to top, provide consistent lateral resistance, evenly distribute loads, enhance overall stability, reduce soft-story mechanisms.
- Discontinuous shear walls: Have interruptions or are not continuous across all stories, create weak points and stress concentrations, potential vulnerabilities during seismic events, require proper detailing and additional reinforcements for load transfer continuity.

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